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Iodine Contrast Media and Computer Tomography Enhancement: Less is More (or at Least Equal)?

Authors: **L. Marciano**, B. V. Coelho, F. M. Kiipper, D. L. Cardoso, J. A. B. Araujo-Filho, P. Caparroz Lucio, A. Evangelista, C. K. Chi, A. M. A. Pereira, C. H. Nomura, G. G. Cerri

Hospital Sírio-Libanês
São Paulo - Brazil

SOCIEDADE BENEFICENTE DE SENHORAS
SÍRIO-LIBANÊS

BACKGROUND

Recent strategies to reduce radiation exposure in CT examinations involve lower tube voltage (kVp) (automated dose modulation) combined with iterative reconstruction (IR)

kVp

Penetrating x-ray beam

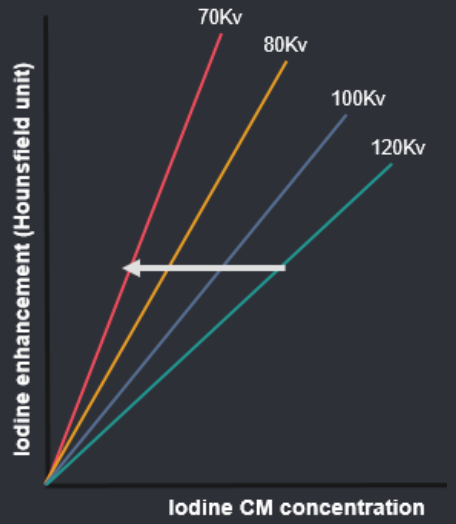
Radiation exposure

increased **image noise (N)** is a consequence of imaging at **low Kvp** due to the absorption of X-rays in soft tissues

IR

alternative image reconstruction algorithm to filtered back projection to reduce noise without impairing signal

Iodine attenuation increases at lower kVp values as the mean photon energy approaches the k-edge value of iodine (33keV)



Enhancement in contrast CT

Delivery Iodine rate in target structures

Graphic demonstrating iodine enhancement increase when using different kVp values at same CM iodine concentration.

BACKGROUND

Increased iodine enhancement with lower kVp can be used as a complementary approach to reduce contrast media (CM) dose to maintain noise image level and image diagnostic quality

The combination of IR and low kVp scan allows a **decrease in the dose of intravenous contrast medium** with preservation of image quality

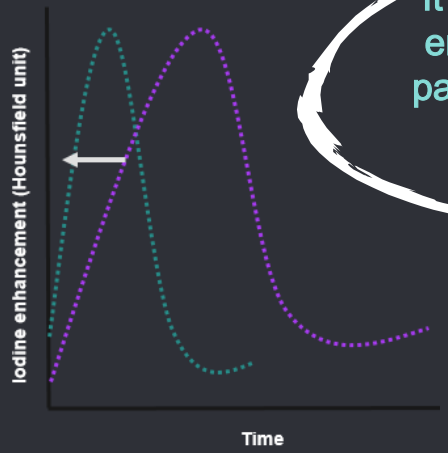
Improve **safety and tolerability of CM** injections during CT examinations

patients with risk factors for **kidney injury**

CM volume reduction protocol

Implies in a shorter injection duration and earlier enhancement peak

Is complex and associated with iodine concentration, and patients body mass index (BMI) and heart rate



It is possible to achieve good enhancement of vessels and parenchyma , with low volume injection using high iodine concentration CM

Graphic comparing shorter CM injection duration (blue) compared to a longer CM injection (purple) due to volume reduction. The CM volume reduction implies in an earlier enhancement when compared to a higher CM volume injection

Achieving ideal iodine enhancement in abdominal CT associating lower kVp protocols and reduced CM volume

METHODS

1. A **worldwide shortage** of iodine CM)in the latter half of 2022 and the beginning of 2023 necessitated its judicious use in healthcare facilities and clinical practice.

2. In an effort to enhance institutional injection protocols for the safe use of iodine CM, **a high -concentration, multi -dose iodine CM** was introduced in our CT service.

3. Optimizing kVp values according to **automatic exposition control** (modulation), following manufacturers recommendations

4. Incorporating protocol parameters such as **CarekV** and **IR** to enhance image quality while employing lower kVp settings and reducing the volume of iodine contrast media in abdominal CT examinations.

5. Applying a **new formula** to calculate CM volume for abdominal CT scans

   Patient weight x 1.3 mL - % kVp reduction according manufacters recom mendation

6. Qualitative and quantitative **data analyses** , along with retrospective comparative analyses, were conducted.

Reference kV	New kV	% CM safe
120 kV	120 kV	-
120 kV	110 kV	- 10,2%
120 kV	100 kV	- 19,9%
120 kV	90 kV	- 30,4%
120 kV	80 kV	- 40%
120 kV	70 kV	- 49,2%

CT scanner manufacture recommendation

AEC:automatic exsposure control

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RESULTS

(Quantitative analyses)

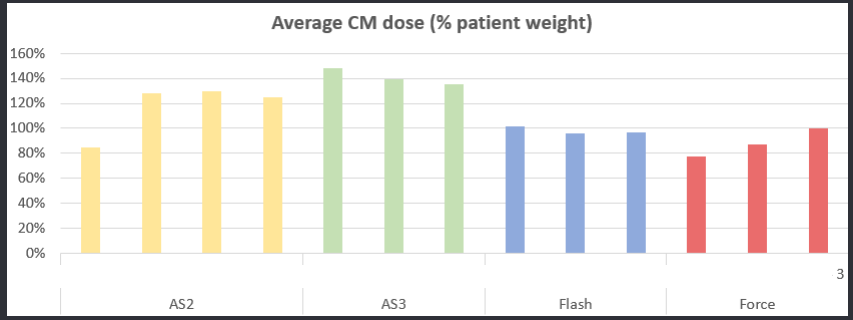
AS2 and AS3 (control group)

- 120kV as reference for abdominal CT
- Iodine CM volume injected:
1.3ml/kg x patient weight
(institutional protocol for abdominal CT contrast scans)

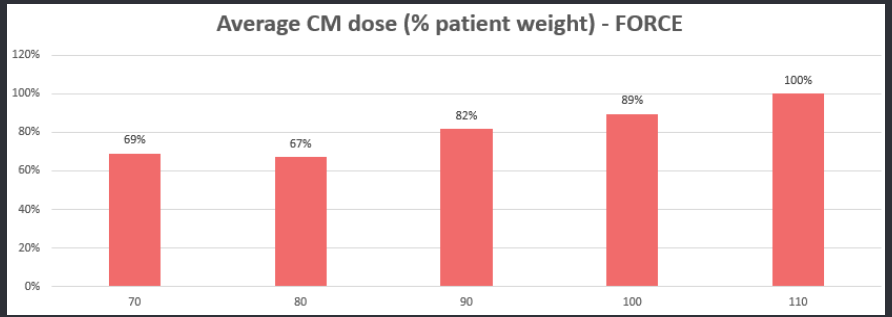
SOMATOM Flash and Force CT systems (Siemens):
(CM volume reduction application group)

- 120kV as reference for abdominal CT + new kV modulation applied
- Iodine CM volume injected:
Patient weight x 1.3 mL - % kVp reduction according manufacturers recommendation
Patient weight x 1.3 mL - % kVp reduction according manufacturers recommendation – 14% reduction when used 400 I/mg CM

FORCE: 39% volume CMreduction



Graphic demonstrates average CM volume injected according to patients' weight (%). Compared to AS2 and AS3 (control group), Flash and Force CT scanners presented siginificant CM dose reduction according to patients' weight (30% and 39% respectively).



Graphic demonstrates average CM volume injected (%) according to patients' weight and kV modulation in Force CT scanner. Large kVp options (70 to 150kVp) implicate more flexibility to reduce CM volume according to kVp modulation manufacture recommendations

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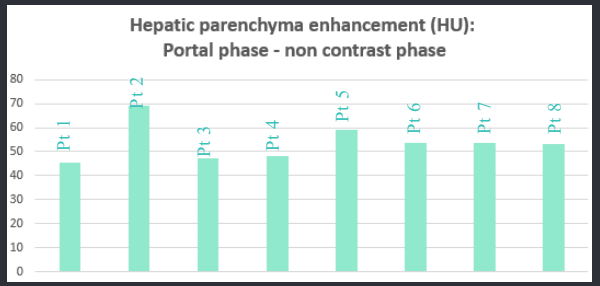
RESULTS

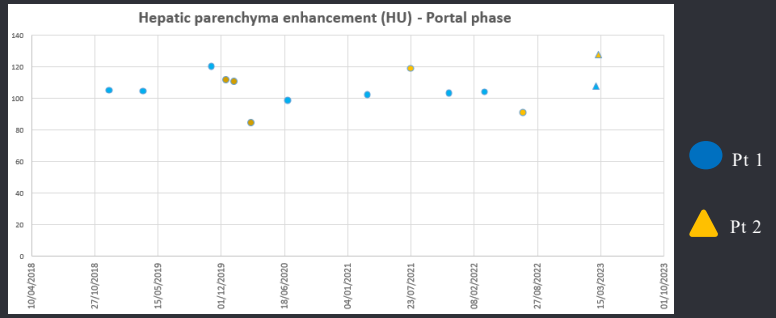
(Qualitative analyses)

1. Evaluating hepatic parenchyma enhancement (HU): portal phase – non-contrast phase in the same patient

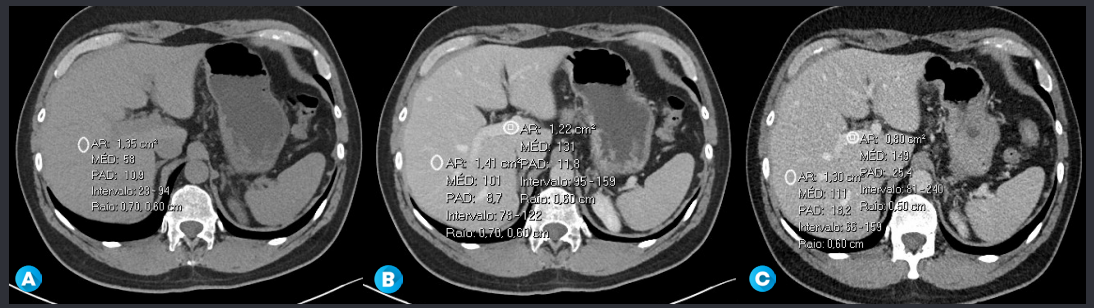


Literature recommends an hepatic parenchyma enhancement difference between portal phase and non contrast phase >/= 50HU, reached using high concentration iodine CM in lower doses

2. Comparing hepatic parenchyma enhancement (HU) in the portal phase from two patients which performed abdominal contrast CT exams before (blue and yellow circles) and during the high iodine concentration CM volume optimization (blue and yellow triangles)

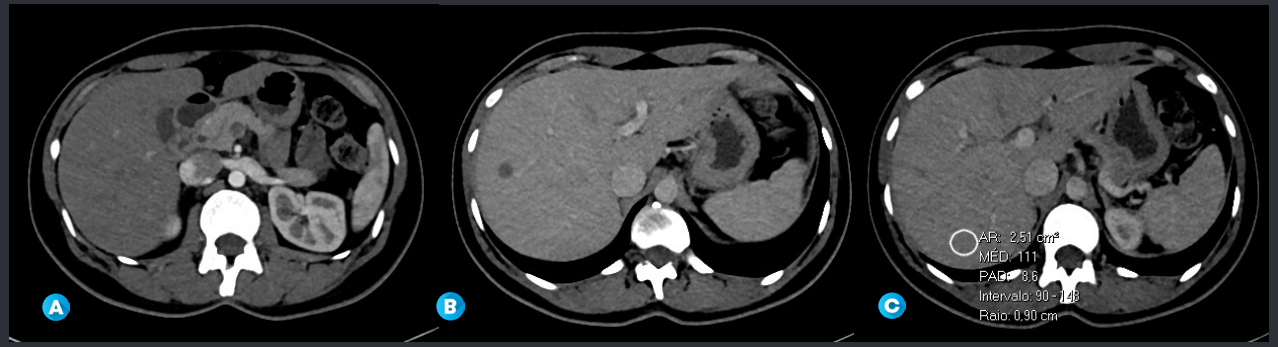


Reached hepatic parenchyma enhancement level in the same patient when compared previous hepatic enhancement versus hepatic enhancement obtained using high concentration iodine CM in lower doses



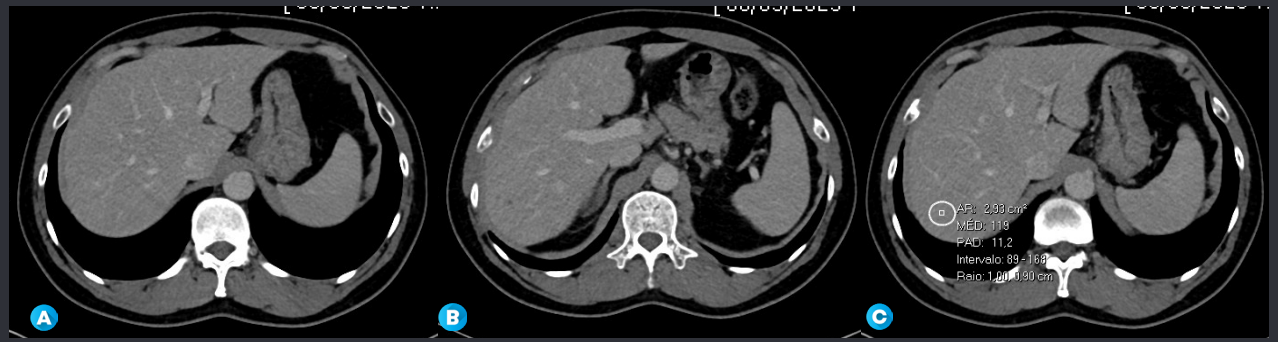
Example of hepatic parenchyma enhancement evaluation in the same patient using different ROIs. Non-contrast image (A), portal phase using the institutional protocol performed in 2021 (B), and portal phase with the optimized dose using high iodine CM performed in 2023 (C).

CT scans were not repeated or subjected to additional CM injections



Example of abdominal CT for abdominal pain investigation. The patient weighted 53 kg and realized intravenous CM injection of 30mL high iodine CM (400 I/mg); 70kV AEC modulation. Arterial phase (A) and portal phase (B and C).

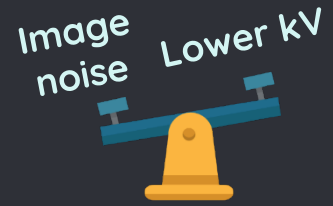
Achieved CM volume reduction more than 30% patient's weight



Example of abdominal CT to investigate kidney infection. The patient weighted 78 kg and realized intravenous CM injection of 45mL high iodine CM (400 I/mg); 70kV AEC modulation. Portal phase (A,B and C).

TAKE HOME MESSAGES

Utilizing a combination of **IR and low kVp scans** results in reduced intravenous CM dosage while maintaining **image quality** .



High-concentration iodine CM can be a powerfull tool in low-radiation dose CT examinations protocol

Reducing CM volume is desirable to avoid contrast-induced **nephropathy**, especially for oncology patients (multiple risk factors for kidney injury)

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Thank You!

Contact : Larissa.marciano72@gmail.com

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