Enhancing Conventional Biopsies: Ultrasound-Guided Percutaneous Bone Marrow Biopsy and Aspiration

Caroline Cushman, Andrew Ibrahim, Evan Hernandez, Brendan MacKay MD, Thomas Callahan MD, Mohammed Attaya MD

Introduction

- Historically, bone marrow biopsies have been performed by oncologists and pathologists using palpable landmarks at bedside or by interventionalists using fluoroscopy or CT-guidance.
- Image-guided bone marrow biopsies using fluoroscopy or CT guidance expose patients to ionizing radiation and require patients to be in specific imaging suites, which cannot be performed at the bedside.
- Ultrasound guidance, typically used for bone and focal lesions, is rarely used for bone marrow biopsies due to limitations in visualizing needle trajectory. Despite these limitations, ultrasound-guided bone marrow biopsies have shown efficacy.
- The method utilizes the contour of the bone cortex to infer the appropriate site for needle passage into the posterior iliac bone.
- This technique is described as a hybrid of landmark-guided and image-guided methods for bone marrow biopsies.

Figure 1: Starting scout image at lumbosacral junction positively identifying the sacrum at lumbosacral junction at red arrow, and the superior posterior edge of the ilium on the patient's right in green and on the patient's left in blue. From this starting point, the curved probe is slid down and to the side, while following the iliac to find the widest and most posterior exposed bony edge of the iliac bone.

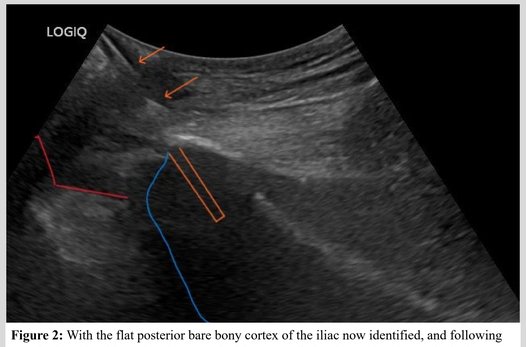

Figure 2: With the flat posterior bare bony cortex of the iliac now identified, and following anesthetic to the skin and periosteum, the biopsy needle is advanced to the cortical edge, purchase ensured by tapping or pushing the needle stylet into the cortex and then advancing the needle to its inferred position outlined by orange lines and arrows into the inferred bony space of the iliac bone outlined by blue line. This is done with care to avoid the sacrum outlined by red and the sacroiliac joint between the red and blue lines.

Figure 3. After locating the appropriate position for the ultrasound probe (a), a subcutaneous and periosteal local anesthetic was administered (b). This was followed by making a dermatomy and advancing the guide needle, securing it with a hammer tap (c). The coaxial stylet containing the core sample of the cortex was removed, and the guide needle was advanced into the marrow for subsequent aspiration (d). The inner flat-ended stylet was used to push the core sample onto the table for collection (e). Bone marrow aspirate was then collected into a heparinized syringe (f). The pathology team confirmed the presence of spicules within the sample. If spicules were not found, additional aspirate samples would be obtained until approved (g). The pathologist prepared samples from the remaining total of 20mL aspirate in the procedure suite, ensuring sufficient volume and quality of both aspirate and core (h). A post-biopsy ultrasound was conducted to check for hematoma or other postoperative complications (i).

Advantages of US- Guided Bone Biopsy	Disadvantages of US- Guided Bone Biopsy
Portable and accessible with bedside application	Loss of high resolution and 3D imaging
Avoidance of ionizing radiation	Absence of intramedullary visualization with preserved bone cortex
Less expensive compared to CT -guided ones	Not safely applicable in all skeletal sites
Real time needle evaluation	Operators experience dependent
Fast acquisition time	
Extra and intra lesional vascular mapping	
Targeted accuracy in specific areas of lesions (avoiding necrotic tissue and effusions)	

Bone marrow biopsy diagnosis	No. of cases	Percentage
Myelodysplastic syndromes	63	24.32%
Multiple myeloma	46	17.76%
Non-Hodgkin lymphoma	26	10.04%
Chronic myelogenous leukemia	23	8.88%
Acute myeloid leukemia	18	6.95%
Chronic lymphocytic leukemia	10	3.86%
Normal marow	10	3.86%
Adult acute lymphoblastic leukemia	8	3.09%
Acute promyelocytic leukemia	6	2.32%
Hodgkin lymphoma	5	1.93%
Immune thrombocytopenic purpura	5	1.93%
Infection	4	1.54%
Aplastic anemia	3	1.16%
Lymphoproliferative disorder	3	1.16%
Monoclonal gammopathy of undetermined significance	3	1.16%
Essential thrombocythaemia	2	0.77%
Metastasis	2	0.77%
Myelofibrosis	2	0.77%
Myeloproliferative disorder	2	0.77%
Plasmacytoma	2	0.77%
Polycythemia vera	2	0.77%
Acute megakaryoblastic leukemia	1	0.39%
ANCA-positive vasculitis	1	0.39%
Bone marrow transplant	1	0.39%
Hairy cell leukemia	1	0.39%
Stevens-Johnson syndrome	1	0.39%
Small lymphocytic lymphoma	1	0.39%
Miscellaneous	7	2.70%
	258	100%

Conclusion

- Ultrasound-guided percutaneous bone marrow biopsy and aspiration is a promising alternative to traditional methods.
- It offers advantages over palpated landmark, fluoroscopic, and CT-guided approaches.
- The technique provides real-time guidance, avoids ionizing radiation, allows comprehensive evaluation of adjacent soft tissues and neurovascular structures, and offers bedside convenience with image-guided precision.

References