

SONO case series: point-of-care ultrasound for fracture diagnosis

CASE PRESENTATION

A 34-year-old man with no significant medical history presented to the ED with right lower extremity (RLE) pain after a motorcycle crash. The patient reported that he was travelling at approximately 8 km per hour when he hit a piece of trash on the roadway, skidded to one side, and fell to the ground with his motorcycle landing on top of his RLE. He attempted to ambulate on scene but was unable to bear weight due to severe pain in his RLE. He was helmeted during the crash and denied any other problems.

On physical examination, he was well-appearing overall, with vital signs notable only for mild hypertension to 156/94 mm Hg, a pulse of 80 beats/min, a respiratory rate of 15 breaths/min, and an oxygen saturation of 99% on room air. Examination of his distal right leg was notable for swelling without obvious deformity nor other evidence of trauma. Passive and active range of motion of his right knee and ankle were limited by pain. His right foot was neurovascularly intact, with normal sensation and motor function and palpable distal pulses. The rest of the physical examination was unremarkable.

After a negative extended Focused Assessment with Sonography in Trauma, a point-of-care ultrasound (POCUS) of the right lower leg was performed as part of the initial evaluation, revealing a discontinuity of the cortical surface of the tibia consistent with an acute fracture. This diagnosis was subsequently confirmed on X-ray, which also demonstrated an ipsilateral proximal fibula fracture (figure 1).

WHAT ARE THE INDICATIONS AND CONTRAINDICATIONS FOR PERFORMING MUSCULOSKELETAL (MSK) POCUS FOR FRACTURES?

In 2016, the American College of Emergency Physicians specifically included MSK ultrasound, such as for abscess, cellulitis, fractures, tendon injuries and joint effusions, in their recommended curriculum for emergency ultrasound learning objectives.¹ This case presentation will focus specifically on MSK POCUS for fractures.

MSK POCUS for fractures is indicated whenever a fracture is clinically suspected. POCUS is potentially advantageous over other imaging modalities in the following scenarios:

1. Rapidity of diagnosis: As a bedside modality performed by the treating physician, ultrasound can be more rapidly obtained than X-ray and much more rapidly than cross-sectional imaging such as CT or MRI.^{2,3}
2. Avoidance of ionising radiation: Unlike traditional radiographic modalities such as X-ray or CT, ultrasound does not expose the patient to ionising radiation.



Figure 1 Photograph of the patient's right lower extremity at time of arrival in the ED, lateral x-ray of the right ankle, and longitudinal ultrasound of the right tibia showing a cortical disruption.

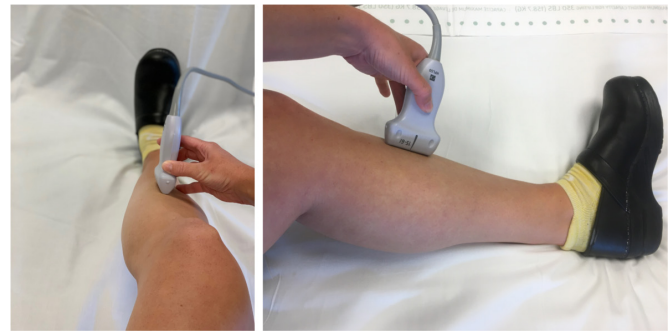


Figure 2 Transducer orientation for tibial ultrasound, longitudinal view.

3. Low-resource settings: With the increasing availability of ultrasound machines, POCUS can provide a uniquely accessible diagnostic tool for acute traumatic bony injuries in settings where access to advanced imaging is limited, such as global health practices, military field medicine, and event or disaster medicine.
4. Paediatrics: In addition to the avoidance of ionising radiation, POCUS offers a better paediatric patient experience. The machines are smaller and less noisy than other imaging techniques, and bedside imaging allows caregivers to remain with the patient during image acquisition, all of which helps to decrease patient anxiety. There is increasing data that ultrasound is a better tolerated imaging modality in children as compared with either X-ray or CT.⁴⁻⁷

While there are no absolute contraindications to MSK POCUS for fractures, consideration should be given to the following specific situations:

1. Patient comfort: MSK POCUS for fractures can be uncomfortable for the patient as it requires making contact with the affected area. Adequate analgesia should be administered prior to performing MSK POCUS.
2. Open wounds or open fractures: The clinician must take caution not to seed infectious material into a patient's wound and to protect the ultrasound transducer from becoming contaminated. The use of sterile ultrasound gel and disposable transducer covers can minimise risk of infection.

WHICH TRANSDUCER IS BEST SUITED FOR PERFORMING MSK POCUS FOR FRACTURES?

The high-frequency linear transducer provides higher resolution images of more superficial structures. POCUS for fractures is intended to evaluate the bony cortex, the outermost layer of the bone structure. As most bones are within 1–5 cm of the skin,



Figure 3 Transducer orientation for tibial ultrasound, transverse view.

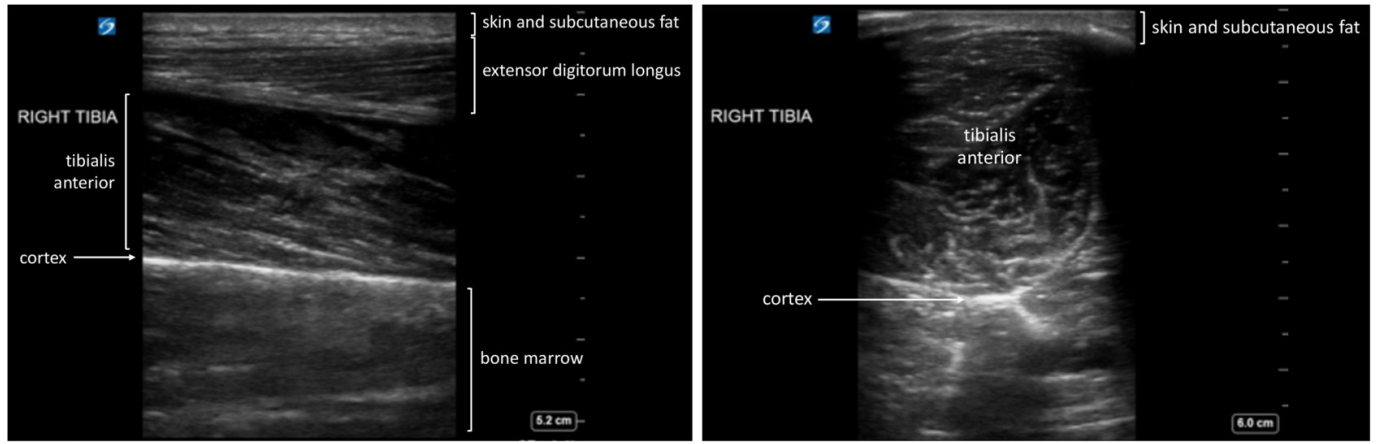


Figure 4 Normal tibial ultrasound, longitudinal (left) and transverse (right) views.

the high-frequency transducer is ideal for imaging most skeletal injuries. For most upper extremity, hand, and lower leg injuries, the high-frequency transducer has adequate depth to visualise all structures superficial to and including the bony cortex.⁸

For patients with larger amounts of tissue between skin and bone or for deeper structures such as the hip or femur, the high-frequency transducer may not offer sufficient depth; in this scenario, the examiner should use the curvilinear transducer, which reaches greater depth at the expense of lower resolution.

WHICH VIEWS SHOULD BE ACQUIRED FOR MSK POCUS FOR FRACTURES?

Ideally all POCUS, including MSK POCUS for fractures, assesses the structure of interest in two views: longitudinal and transverse. In the longitudinal view, the transducer axis is aligned with the long axis of the bone; in the transverse view, the transducer is perpendicular to the long axis of the bone (see figures 2 and 3).

To assess for fractures, the clinician should first obtain a longitudinal view of the bone either proximal or distal to the area of maximal pain. Ultrasound images of normal bone show an uninterrupted line of bright white, echogenic cortex (see figure 4). The clinician can then scan proximally or distally across the area of maximal pain, assessing for a disruption in the cortical line, as seen in figure 5.

Though it is more difficult to see cortical disruptions in the transverse view, this view can also demonstrate associated soft-tissue abnormalities, such as haematomas, which are visualised as anechoic or hypoechoic fluid collections and are often associated with fractures.



Figure 5 Longitudinal view of tibial fracture, showing cortical disruption and associated haematoma.

HOW DO YOU INTERPRET MSK POCUS FOR FRACTURES?

A normal superficial bony cortex is seen as a bright white, echogenic line. As ultrasound waves do not travel through bone, all structures deep to the cortex (including bony trabeculae and bone marrow) appear as anechoic or hypoechoic shadows below the echogenic cortical line (see figure 4).

Fractures are seen as disruptions and/or displacements of the echogenic cortical line. Ultrasound of the surrounding soft tissue can also identify associated haematomas, seen as anechoic or hypoechoic fluid collections near the site of cortical disruption (see figure 5).⁹

There is an increasing body of literature demonstrating that the sensitivity and specificity of ultrasound for long bone fractures justifies its inclusion in clinical practice. A meta-analysis performed in 2013 of ED physician-performed POCUS for extremity fractures showed sensitivities ranging from 85% to 100% and specificities from 73% to 100%.¹⁰

HOW DO YOU INTEGRATE MSK POCUS FOR FRACTURES INTO CLINICAL PRACTICE?

While ultrasound will likely never completely replace X-ray and CT imaging for many orthopaedic injuries, it is increasingly being used for identification of MSK injuries in the ED and has many advantages over traditional imaging modalities. POCUS offers a more portable and faster diagnosis of fractures,² can be less anxiety provoking⁴⁻⁶ and is safer than ionising radiation. MSK POCUS for fractures is also easy to accurately perform, even by physicians without extensive sonography training.¹¹ Furthermore, there is evidence that MSK POCUS for fractures can be relied on to guide management. For example, a study comparing management decisions for elbow fractures and dislocations based on ED physician-performed POCUS found high sensitivity and specificity for appropriate management decisions when compared with treatment decisions based on CT imaging.¹²

In our case, the diagnosis of a tibial fracture was suspected on the patient’s presentation and confirmed by bedside ultrasound within 10 min of the patient’s arrival in the ED, prior to any other imaging. This allowed for prompt diagnosis-guided management, including providing appropriate analgesia prior to manipulation for additional imaging and rapidly obtaining orthopaedics consultation.

WHAT ARE SOME OF THE PITFALLS OF MSK POCUS FOR FRACTURES?

The sensitivity and specificity of ultrasound for fracture identification are generally lower than that of conventional X-ray imaging and CT^{4 9 13}; thus, POCUS is seldom used as a sole imaging modality. Additional imaging should always be obtained if clinical suspicion for bony injury persists after an unrevealing POCUS study.

POCUS should be used with caution in cases where there is suspicion of open fracture to avoid introduction of bacteria into the wound and subsequent iatrogenic infection.

CASE CONCLUSION

The patient was admitted to the orthopaedic surgery service and underwent tibial open reduction/internal fixation with intramedullary nail placement on hospital day 1. The fibular fracture was managed non-operatively with a short leg splint. He was discharged home on hospital day 2 in good condition.

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