Ultrasound-Diagnosed Tibia Stress Fracture: A Case Report

Clinical Medicine Insights: Arthritis and Musculoskeletal Disorders
Volume 10: 1–3
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DOI: 10.1177/1179544117702866

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ABSTRACT: Stress fractures are a frequent cause of lower extremity pain in athletes, and especially in runners. Plain imaging has a low sensitivity. Magnetic resonance imaging (MRI) or bone scan scintigraphy is the criterion standard, but expensive. We present the case of a young female distance runner with left shin pain. Plain radiography was unremarkable. Ultrasound showed focal hyperechoic elevation of the periosteum with irregularity over the distal tibia and increased flow on Doppler. These findings were consistent with a distal tibia stress fracture and confirmed by MRI. Examination of our case will highlight the utility of considering an ultrasound for diagnosis of tibial stress fracture.

KEYWORDS: Stress fracture, tibia, ultrasound

RECEIVED: November 13, 2016. **ACCEPTED:** February 28, 2017.

PEER REVIEW: Six peer reviewers contributed to the peer review report. Reviewers' reports totaled 649 words, excluding any confidential comments to the academic editor.

TYPE: Case Report

FUNDING: The author(s) received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

Stress injuries are the most common cause of lower extremity pain in athletes.[1] Bone stress injuries account for approximately 8.2% of all injuries in elite track and field athletes.[2] Bone stress injuries may mature into stress fractures.[3] Stress fractures are a result of accelerated physiologic change from excessive loading applied to a normal bone.[4,5] This is the sequelae of high intensity, duration of training, nutrition, and biomechanical, muscular, and hormonal imbalance.[2,3] Typically, the metatarsal bones in the lower extremity are involved. However, the tibia is the most commonly implicated in runners.[6] Differential diagnosis includes fracture of the tibia, muscle sprain or contusion, periostitis, bursitis, medial tibial stress syndrome, and compartment syndrome.[2]

The diagnosis of tibia stress fractures requires high level of clinical suspicion, and confirmation is needed with imaging. Plain radiographs have often times yielded negative results until 3 weeks to 3 months when bone callus is formed.[6,7] The criterion standard for diagnosis of stress fractures is magnetic resonance imaging (MRI) or bone scan scintigraphy.[8,9] The high cost of these 2 imaging modalities has paved way for research into other less diagnostic tests such as ultrasonography.[10] Ultrasonography has been shown to be beneficial in the diagnosis of lower extremity stress fractures, primarily in metatarsal bones and ankle malleoli.[5,11,12] The diagnosis of tibia stress fractures with ultrasound has only been reported in a few cases.[13,14] The purpose of this case report is to contribute to the limited evidence in literature regarding the diagnosis of tibia stress fractures with ultrasonography.

Case Presentation

The patient was an otherwise healthy 19-year-old white female division 1 collegiate mid-distance runner who came to the office complaining of left shin pain. She had been an athlete throughout high school and recollected having pain in the same area for several months. However, 3 weeks prior to coming to the office, she had increased her intensity in training and noted increased pain. She described the pain as a sharp pain and initially rated it as a 3/10 in intensity (measured by visual analog scale of 1-10, where 10 is worst pain). The pain, however, had progressed to a 9/10 in intensity prior to being seen in clinic. The pain was constant and radiated to the calf region. It was worsened by walking and running. The pain was alleviated temporarily by ibuprofen and ice. She denied any swelling, numbness, or tingling in the foot. She had no medical or surgical history and was not currently taking any medications. Family history was negative for musculoskeletal disease.

Patient's examination revealed tenderness on the left midshaft of the tibia along the anterior border. Neurological examination was within normal limits. After a trial of conservative management with rest, ice, and nonsteroidal anti-inflammatory drugs, plain radiography of the left lower extremity was performed and was unremarkable (Figure 1). Ultrasound of the left tibia showed focal hyperechoic elevation of periosteum with irregularity over the left distal tibia measuring about 3 cm with a positive Doppler over the area (Figures 2 and 3). An MRI was ordered that confirmed periosteal reaction consistent with stress fracture over the distal tibia with no fracture line (Figure 4).

Patient was advised to stop running and use ibuprofen as needed. She was also given a Velcro walking boot to wear that

provided leg support. On 3 weeks of follow-up, the patient was doing well without any significant symptoms (Figure 5).

Discussion

Stress fractures are especially prominent in individuals who suddenly increase physical activity. It is important to diagnose stress fractures early to prevent bone remodeling, nonunion injuries, and loss of function.[2,6] The sensitivity of standard radiography which can miss fractures in the early stages of stress fractures due to the absence of callus formation can be as low as 10%.[15] Bone scan with technetium Tc 99m diphosphonate allows for early diagnosis but is coupled with high costs, lengthy procedure times, and exposure to ionizing radiation.[4] Magnetic resonance imaging provides a noninvasive method of detecting stress fractures with good sensitivity, but its high cost and poor accessibility in some rural areas prevent routine use.[8] Both are highly sensitive and provide optimal depiction of bone marrow edema, periosteal inflammation, and cortical fractures.[16]

Figure 1. Normal x-ray findings of the left lower extremity in the posterior anterior view.

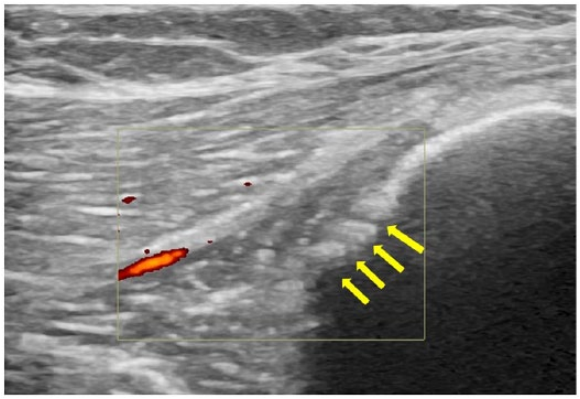

Figure 2. Ultrasound image with transverse view of tibia showing increased periosteal inflammation. Increased periosteal Doppler flow is also seen (hyperemia/hypervascularity).

Although these modalities have become the standard for diagnosis, ultrasonography is becoming more accepted as a first-line imaging modality for soft tissues, muscles, and tendon pathologies.[17,18] Cortical irregularities and hypertrophic changes may be visualized before they are seen on plain radiographs or MRI.[18] In stress fractures, ultrasound offers dynamic images in a noninvasive, fast, and inexpensive manner.[19] Its sensitivity and specificity compared with MRI remain inferior despite its 81.8% sensitivity and 66.6% specificity of ultrasound in the diagnosis of metatarsal stress fractures.[2] Hallmark findings are present in the diagnosis of stress fractures using ultrasound and were likewise found in this case report. These findings include the following:

1. Hyperechogenicity of the surrounding soft tissue which indicates soft tissue edema and inflammatory reaction[12,20];
2. Thickening of the periosteum[10];
3. Cortical disruption[18,21];
4. Increased periosteal color Doppler flow.[22]

Widespread use of the ultrasound in stress fractures varies by circumstance and is still an area of ongoing research. Its major drawback is that it is heavily operator dependent, requiring skill to recognize normal anatomy and pathology. Given its small field of view, nearby anatomical structures are often unavailable. However, the current imaging modalities are cost intensive, poorly accessible, and invasive and are linked with increased patient discomfort. Continued improvements in ultrasound resolution quality have increased its clinical utility.

Figure 3. Longitudinal view of the anterior tibia showing discontinuity of hyperechoic line representing disruption of bony cortex (green arrow) and periosteal edema (yellow arrows). On the left-hand side is a diagram showing the orientation of the probe.

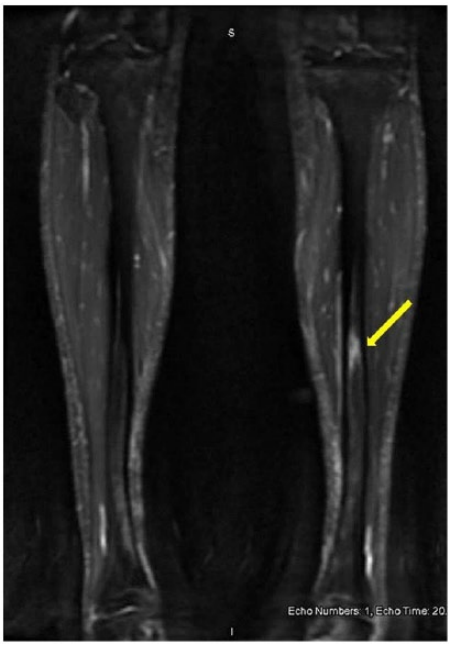

Figure 4. T2 coronal (left) image shows a lucent appearance at site of pain, and axial (right) image reveals marrow edema (green arrow) and periosteal edema (yellow arrows) of the tibia.

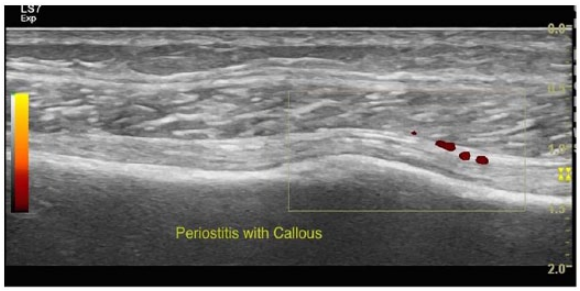

Figure 5. Follow-up longitudinal view at 3 weeks shows callous formation at site of injury which signifies healing.

In the hands of a skilled technician, ultrasound can provide real-time unparalleled images to detect stress fractures in a safe and portable manner. This case emphasizes that in cases where there is suspicion of stress fracture, diagnostic ultrasound can provide a good alternative.

Author Contributions

Case conception and design: AAm, RM, AS. Acquisition of data: AAm, RM, AS. Analysis and interpretation of data: AAm, AAb, RM, AS. Drafting of manuscript: AAm, AAb, RM, AS. Critical revision: AAm, AAb, RM, AS.

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