Ultrasound-Diagnosed Tibia Stress Fracture: A Case Report

Adae Amoako1, Ayesha Abid2, Anthony Shadiack3 and Robert Monaco4

1Departments of Acute Care and Physical Medicine and Rehabilitation, Mid-Atlantic Permanente Medical Group, Upper Marlboro, MD, USA. 2Department of Family and Community Medicine, Penn State Milton S. Hershey Medical Center, Hershey, PA, USA. 3Department of Family Medicine, Ocala Health Family Medicine, Ocala, FL, USA. 4Department of Sports Medicine, The State University of New Jersey, New Brunswick, NJ, USA.

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

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.\textsuperscript{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%.\textsuperscript{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.\textsuperscript{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.\textsuperscript{9} Both are highly sensitive and provide optimal depiction of bone marrow edema, periosteal inflammation, and cortical fractures.\textsuperscript{16}

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.\textsuperscript{17,18} Cortical irregularities and hypertrophic changes may be visualized before they are seen on plain radiographs or MRI.\textsuperscript{18} In stress fractures, ultrasound offers dynamic images in a noninvasive, fast, and inexpensive manner.\textsuperscript{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.\textsuperscript{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\textsuperscript{12,20};
2. Thickening of the periosteum\textsuperscript{10};
3. Cortical disruption\textsuperscript{18,21};
4. Increased periosteal color Doppler flow.\textsuperscript{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.
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.

**REFERENCES**

1. Dobrindt O, Hoffmeyer B, Ruf J, et al. Blinded-read of bone scintigraphy: the impact on diagnosis and healing time for stress injuries with emphasis on the foot. *Clin Nucl Med*. 2011;36:186–191.

2. Papalada A, Malliaropoulos N, Tzitas K, et al. Ultrasound as a primary evaluation tool of bone stress injuries in elite track and field athletes. *Am J Sports Med*. 2012;40:915–919.

3. Reeder MT, Dick BH, Atkin JK, Pribis AB, Martinez JM. Stress fractures: current concepts of diagnosis and treatment. *Sports Med*. 1996;22:198–212.

4. Gredien GE, Thrall JH, Espinosa JL, et al. Early detection of stress fractures using 99mTc-polyphosphonate. *Radiol*. 1976;121:683–687.

5. Bianchi S, Luong DH. Stress fractures of the ankle malleoli diagnosed by ultrasound: a report of 6 cases. *Skeletal Radiol*. 2014;43:813–818.

6. Romani WA, Perrin DH, Dussault RG, Ball DW, Kahler DM. Identification of tibial stress fractures using therapeutic continuous ultrasound. *J Orthop Sports Phys Ther*. 2000;30:442–452.

7. Krestan C, Hojreh A. Imaging of insufficiency fractures. *Eur J Radiol*. 2009;71:398–405.

8. Ishibashi Y, Okamura Y, Otsuka H, Nishizawa K, Sasaki T, Toh S. Comparison of scintigraphy and magnetic resonance imaging for stress injuries of bone. *Clin J Sport Med*. 2002;12:79–84.

9. Stafford SA, Rosenthal DI, Gebhardt MC, Brady TJ, Scott JA. MRI in stress fracture. *Am J Roentgenol*. 1986;147:553–556.

10. Sofka CM. Imaging of stress fractures. *Clin Sport Med*. 2006;25:53–62.

11. Bodner G, Stöckl B, Fiebinger A, et al. Sonographic findings in stress fractures of the lower limb: preliminary findings. *Eur Radiol*. 2005;15:356–359.

12. Banal F, Gandjbakhch F, Foltz V, et al. Sensitivity and specificity of ultrasonography in early diagnosis of metatarsal bone stress fractures: a pilot study of 37 patients. *J Rheumatol*. 2009;36:1715–1719.

13. Khy V, Wyssa B, Bianchi S. Bilateral stress fracture of the tibia diagnosed by ultrasound: a case report. *J Rheumatol*. 2012;15:130–134.

14. Jones SL, Phillips M. Early identification of foot and lower limb stress fractures using diagnostic ultrasonography: a review of three cases. *Foot Ankle Online J*. 2010;3:3.

15. Greaney RB, Gerber FH, Laughlin RL, et al. Distribution and natural history of stress fractures in U.S. Marine recruits. *Radiology*. 1983;146:339–346.

16. Fredericson M, Bergman AG, Hoffman JL, Dillingham MS. Tibial stress reaction in runners. Correlation of clinical symptoms and scintigraphy with a new magnetic resonance imaging grading system. *Am J Sports Med*. 1995;23:472–481.

17. Blankstein A. Ultrasound in the diagnosis of clinical orthopedics: the orthopedic stethoscope. *World J Orthop*. 2011;2:13–24.

18. Backhaus M, Burmester G, Gerber T, et al. Guidelines for musculoskeletal ultrasound in rheumatology. *Annu Rheum Dis*. 2011;70:641–649.

19. Patel DS, Roth M, Kapil N. Stress fracture: diagnosis, treatment, and prevention. *Am Fam Physician*. 2011;83:39–46.

20. Arzio D, Lambert V, Delmi M, Bianchi S. Insufficiency fracture of the calcaneum: sonographic findings. *J Clin Ultrasound*. 2009;37:424–427.

21. Pohl M, Mullineaux D, Milner C, Hamill J, Davis IS. Biomechanical predictors of retrospective tibial stress fractures in runners. *J Biomech*. 2008;41:1160–1165.

22. Warden S, Burr D, Brukner P. Stress fractures: pathophysiology, epidemiology, and risk factors. *Curr Osteoporos Rep*. 2006;4:103–109.