Brief Report
Evaluation of Suspected Stress Fractures
Jonathan D. Roebuck, MD
David R. Finger, MD
Thomas L. Irvin, MD

abstract
Stress fractures can occur if normal bone is exposed to repeated abnormal stress (fatigue fractures) or if normal stress is placed on bones with compromised elastic resistance (insufficiency fractures). This article describes two patients without a history of excessive stressful activity or apparent metabolic bone disease who developed bilateral distal tibial stress fractures. Different etiologies, clinical presentation, differential diagnosis, and diagnostic imaging modalities of stress fractures are discussed.

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clinical presentation
Two patients presented with bilateral distal tibial stress fractures despite having no history of excessive stressful activity nor any apparent metabolic bone disease. Plain radiographs were unremarkable in both patients, but bone scintigraphy revealed intense symmetric radiotracer uptake involving bilateral distal tibias in both patients. Magnetic resonance imaging (MRI) identified transverse stress fractures clearly in one patient, but longitudinal stress fractures in the second patient were less clearly outlined. These cases were unusual in that the fractures were bilateral, they involved the distal tibia, no preceding history of new or unusual stressful activity was elicited, and no metabolic bone disease was present.

Given the bilaterality and distal location of our patients’ complaints, stress fracture initially had not been at the forefront of our differential diagnosis. Neither patient presented with the classic history of a new strenuous or repeated activity that caused discomfort in the affected area. Moreover, anterior distal tibial pain would implicate a stress fracture if the patient participated in activities involving leaping such as ballet, basketball, or aerobics, which both patients denied. In addition, tibial stress fractures typically are unilateral and involve the proximal tibia.

risk factors
Risk factors for insufficiency fractures include osteoporosis, rheumatoid arthritis, osteomalacia, diabetes mellitus, fibrous dysplasia of bone, Paget’s disease of bone, osteogenesis imperfecta, hyperparathyroidism, scurvy, previous local irradiation, and gross proximal fracture of the affected bone.

While the first patient had none of these conditions, the second patient had rheumatoid arthritis, which is considered an independent risk factor even in the absence of corticosteroid use due largely to disuse of painful inflamed extremities. Her bone mineral density was normal, however, and for serum calcium, phosphorous, alkaline phosphatase, 1,25 vitamin D, thyroid stimulating, and parathyroid hormone levels were normal for both patients.

From the Department of Medicine and Rheumatology, Madigan Army Medical Ctr, Tacoma, Wash.
The opinions and assertions herein are those of the authors and should not be construed as official policy of the Department of the Army or Department of Defense.
Reprint requests: David R. Finger, MD, Rheumatology Service, Tripler Army Medical Ctr, Honolulu, HI 96859.

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Differential Diagnosis

The differential diagnosis in our patients included local strain injury, shin splints, tendinitis, periostitis, osteomyelitis, stress fractures, osteoid osteoma, osteomalacia, metastatic disease, and primary tumor of bone. In patients presenting with typical historical and physical findings, it may be possible to diagnose a stress fracture clinically. The history often reveals participation in a new repetitive or strenuous activity that causes discomfort in a focal area.

Physical examination findings include localized pain, swelling, and warmth as well as palpation of a thickened periosteum. Although these historical clues and physical findings are helpful, they are rare. As the diagnosis was not readily apparent based on history and physical examination in either of our patients, ancillary radiographic imaging modalities were used.

Imaging Modalities

Plain Radiographs

Plain radiographs should be the first imaging modality used. If classic findings of a linear cortical radiolucency or localized periosteal reaction are present, the diagnosis is clear and low in cost. However, the sensitivity of initial plain radiographs can be as low as 15% and is dependent on the timing of the study in relation to the injury.

In a patient who is able to rest and avoid further stressful activity, conservative treatment and repeat plain radiographs within a few weeks are recommended to confirm the diagnosis. In such cases, follow-up radiographs are still only diagnostic in 50%.

In competitive athletes who lack preceding risk factors or have complaints of symptoms in unusual locations, proceeding with further imaging studies to make a prompt diagnosis is recommended.

Bone Scintigraphy

The next imaging modality to be used is bone scintigraphy. The sensitivity of radionuclide bone scanning approaches 100% for stress fractures. Moreover, subtle changes in bone metabolism and injury are demonstrated much earlier than on plain radiographs. The classic findings on bone scintigraphy indicative of a stress fracture include focally intense and fusiform cortical uptake. However, these findings are not diagnostic, as other conditions such as tumor, infection, bone infarct, and shin splints can produce similar findings. Stress fractures can be diagnosed in 90% of cases using a combination of plain radiographs and bone scintigraphy.

Although nonspecific, a negative radionuclide study effectively rules out a stress fracture or other active bony process. The pattern of radiotracer uptake on bone scintigraphy may further guide imaging studies. Focal uptake is more suggestive of a transverse fracture (Figure 1A), while a pattern of diffusely increased uptake is more characteristic of a longitudinal fracture (Figure 1B).

Computed Tomography and Magnetic Resonance Imaging

The literature suggests longitudinal stress fractures are best visualized with computed tomography, whereas MRI is best used for transverse stress fractures. Magnetic resonance imaging has a comparable sensitivity to bone scintigraphy with an improved specificity. However, cost and availability make this an improper screening tool.

Transverse fractures image well (Figure 2) with a characteristic decreased signal on T1-weighted images and increased signal on T2-weighted images with surrounding low signal bands in the bone marrow, representing edema or hemorrhage. Longitudinally directed stress fractures often are not well visualized on MRI. In such cases, computed tomography (CT) appears to be the study of choice.

Computed tomography is believed to have a limited role in the diagnosis of stress fractures. Less sensitive than scintigraphy and plain radiographs, CT
is mainly used when other modalities fail to show characteristic lesions in nontransaxial planes. Most tibial stress fractures are transverse or oblique and are best imaged by MRI, although up to 10% are longitudinal.14

The advantage of CT is in demonstrating the fracture line in a longitudinally directed injury, which often is not imaged well with MRI. Computed tomography demonstrates these fractures better than the more common transverse fracture due to decreased volume averaging in longitudinal fractures. The characteristic finding is a lucent, linear cortical breach with periosteal and endosteal sclerosis.14 When bone scintigraphy demonstrates a more diffuse, longitudinal pattern of uptake, CT should be used.

CONCLUSION

In patients with underlying risk factors, stress fractures occur in characteristic locations following specific types of physical activity. However, historical clues and physical examination findings are absent when patients initially present to the physician. It often is necessary to proceed with radiographs to make a prompt and accurate diagnosis. In all cases, plain radiographs should be the initial imaging modality due to low cost and accessibility. If these initial studies are negative and the clinical suspicion for a stress fracture is high, plain radiographs should be repeated within 2 weeks. Further imaging studies should be obtained if: there are no risk factors, the patient requires a prompt diagnosis for occupational reasons, or if symptoms are bilateral or in unusual locations.

Radionuclide bone scintigraphy should be the next imaging study performed because a negative study rules out a stress fracture or other bony abnormality. Increased radiotracer uptake in a typical pattern and location essentially confirms the diagnosis. However, if the radiotracer uptake is bilateral or in an atypical location, further imaging is required. In this setting, the pattern of radiotracer uptake can be useful in determining which imaging study to order. Computed tomography is recommended if there is diffuse uptake, which is more suggestive of a longitudinal fracture, while MRI should be performed when the uptake is focal, which is representative of a more common transverse stress fracture.

REFERENCES
