WILDERNESS & ENVIRONMENTAL MEDICINE 2021; 32(1): 59–62

CASE REPORT

Grade 4 Distal Femur Stress Fracture in a Long-Distance Hiker on the Appalachian Trail

Michelle Kavin, PA; Adam Chrusch, MD

Rothman Orthopedic Institute at Thomas Jefferson University, Philadelphia, PA

Although stress injuries are a common occurrence in sports medicine clinics, a distal femur stress fracture is less so. Early detection can result in a favorable prognosis and may prevent the need for surgical intervention. A misdiagnosis resulting in delay of care can result in significant complications. This case report documents a rare distal femur stress fracture in a long-distance hiker. A 35-y-old male presented to an orthopedic clinic in Pennsylvania with left knee pain after completing 1423 km (884 mi) of the Appalachian trail over a 4-mo period. He was attempting a thru-hike, a specialized type of backpacking focused on completing a trail from end-to-end. Thru-hiking of this trail involves backpacking between Georgia and Maine, covering about 3540 km (2200 mi) with approximately 141,580 m (464,500 ft) of gain/loss in elevation. His pain began 2 mo into his hike when he noted medial sided left knee discomfort. Over the following 2 mo he sought treatment at 2 different locations along the trail with etiology undetermined. Upon evaluation in Pennsylvania, history and physical exam were suggestive of a stress fracture. Radiologic studies confirmed a closed nondisplaced nonangulated grade 4 transverse fracture of the shaft of the distal left femur. The patient was instructed to terminate his hike immediately and he was placed on nonweight bearing status. This case illustrates the importance of considering a distal femur stress fracture for the differential diagnosis of persistent knee pain in a long-distance hiker.

Keywords: thru-hiker, backpacking, distal femur fracture, stress fracture, overuse injury

Introduction

Stress fractures are a common overuse injury. Activity specific biomechanics may dictate fracture frequency and anatomic location. However, when rare stress patterns are involved, it can make diagnosis more challenging. This case report documents a rare distal femur stress fracture in a long-distance hiker. It reviews stress fractures and explores the biomechanics of long-distance hiking in relation to stress injury in the distal femur. While 1 case does not prove causality, it serves as an example of why stress injury should be on the differential diagnosis of persistent knee pain in long-distance hikers.

Corresponding author: Michelle Kavin, 925 Chestnut Street 5th Floor, Philadelphia, PA 19107; e-mail: michelle.kavin@rothmanortho.com.

Submitted for publication March 2020.

Accepted for publication August 2020.

CASE REPORT

A 35-y-old male presented to an orthopedic urgent care in Pennsylvania complaining of a 2 mo history left knee pain. He had begun a thru-hike on the Appalachian trail 4 mo before the evaluation. Thru-hiking of this trail involves backpacking between Georgia and Maine, covering about 3540 km (2200 mi) with approximately 141,580 m (464,500 ft) of gain/loss in elevation. He had completed 1423 km (884 mi) of the trail over the 4 mo period he had been hiking, starting in Georgia and heading north.

His pain began approximately 2 mo into his hike when he noted medial sided left knee discomfort. He denied an inciting injury at the time the pain began. He sought treatment at a walk-in physical therapist in Virginia who taught him stretches and suggested orthotics. He then sought treatment at a second walk-in physical therapy clinic in Virginia with no further intervention. He stated that no x-rays were ordered at either site. Then, 3 d prior to his evaluation in Pennsylvania, the pain became sharp and intensified when bearing weight or changing position.

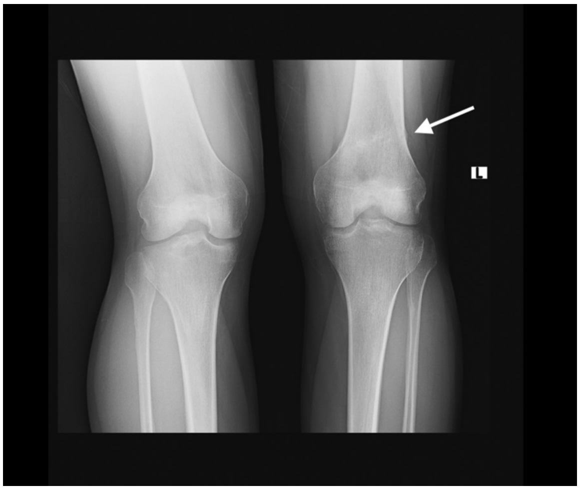

Figure 1. AP x-ray view of left knee demonstrating a distal femur fracture.

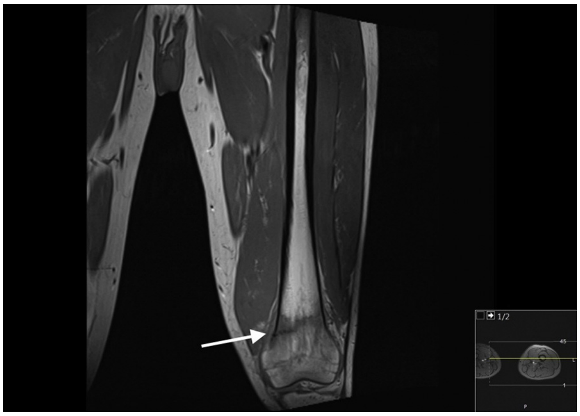

Figure 2. Single cut of MRI demonstrating grade 4 stress fracture of the distal femur.

Upon evaluation in Pennsylvania, he denied any fever, chills, rashes, or previous fractures or surgeries in this extremity. He reported no trauma during his hike. He had no known stress fractures previous to this incident. He denied steroid or nicotine use. He had no history of tick bite, Lyme disease, or gout.

Physical exam revealed a well-developed, well-nourished male in no acute distress. Examination of the left leg demonstrated mild swelling throughout the thigh and knee. There were no abrasions, lacerations, or ecchymotic lesions. There was no joint effusion. The range of motion of the knee was 0 to 115 degrees. He had tenderness to palpation over the distal femur. The ligamentous exam revealed firm endpoints. The extremity was neurovascularly intact. He was ambulatory with an antalgic gait. X-ray revealed a closed nondisplaced nonangulated transverse fracture of the distal left femur (Figure 1). He was placed in a knee immobilizer and given crutches with nonweight bearing status.

He was referred to a sports medicine physician where magnetic resonance imaging (MRI) of the left knee was obtained for grading. T_1-T_2 image findings were consistent with a closed nondisplaced nonangulated grade 4 transverse fracture of the shaft of the distal left femur (Figure 2). He was instructed to immediately terminate his hike. A surgical consult was obtained with an orthopedic trauma and fracture care specialist. It was determined that surgery was not indicated. He returned to the sports medicine physician for further follow-up.

After 4 wk of nonweight bearing status, he started a stretching protocol. After 6 wk, the distal femur pain resolved and he had 5/5 strength with active knee flexion and extension. He was instructed to wean off crutches and begin physical therapy. At that time, he returned to his home state. He continued care with a second orthopedic team and completed 2 mo of physical therapy. He later reported that it took approximately 1 y for resolution of all symptoms and return to baseline activity.

Discussion

Stress injuries develop when there is repeated force applied to a bone that is lower than that required for a fracture.[1] The stress results in bone remodeling. Osteoclasts gather at the surface of the bone absorbing injured bone tissue. Osteoblasts form new bone to strengthen the damaged area. If physical stress continues before the osteoblasts strengthen the bone, inflammation, micro-fractures, and eventually a cortical break can result. Although stress injury is often used interchangeably with stress fracture, the former can be limited to bone inflammation, whereas the latter includes the cortical disruption of a fracture.[2]

Stress injuries are common, accounting for up to 20% of cases seen in sports medicine clinics.[1] Patients may describe localized pain of insidious onset that worsens with activity and is relieved by rest. Multiple risk factors have been described including poor physical fitness, smoking, low body mass, and low muscle mass.[3-6] Alterations in training programs such as an increase in frequency, duration, or intensity have been linked to stress fractures in runners, but not widely studied in hikers.[7]

The most common locations for stress fractures include the metatarsals, tibia, fibula, and tarsal navicular.[8] The femur accounts for approximately 5 to 7% of all stress fractures.[9,10] Although not always consistent, most studies suggest the femoral neck is the most common part of the femur involved.[11-13] It has been proposed that the femoral neck is at increased risk due to weight bearing forces from the trunk causing compressive forces on this section of the bone.[14] Femoral shaft fractures may account for 3 to

20% of stress fractures of the femur with 1 study identifying the proximal third of the bone as the more common shaft fracture site.[15-17]

Activity specific biomechanics may predispose individuals to stress fractures. For example, stress fractures have been identified in 15% of runners and military trainees alerting clinicians to consider stress fractures when patients note persistent pain with these activities.[18] The biomechanics of the activity may further delineate anatomic fracture locations. For example, sprinting athletes are more likely to develop stress fractures in the feet, whereas long-distance runners are more likely to develop stress fractures in the pelvis and long bones.[19] Of 31,758 lower extremity stress fractures found in military members, 40% involved the tibia/fibula, 16% involved the metatarsals, and 9% involved the femoral neck.[11] Therefore, clinicians may have heightened awareness to look for a stress fracture in patients with insidious pain in a certain location associated with a specific activity.

Little research is available on frequency of stress fractures in long-distance hiking. However, 1 study found 5 self-reported stress fractures in a cohort of 334 backpackers who hiked the Appalachian trail for at least 7 d (duration of hike 140±60 [mean+SD] d).[20] Although this suggests there may be a correlation between this activity and stress fractures, study design prohibited causal inference. The study did not report anatomical fracture location and its limited sample size may not represent the true rate of injury.

Research has been done evaluating lower limb kinematic and kinetic changes following prolonged load carriage (such as backpacking). One study found quadriceps muscle fatigue resulted in the knee joint being unable to effectively absorb impact forces.[21] Another study found significant changes in lower extremity muscle activity in response to increases in both load mass and walking distance in female recreational hikers.[22] Therefore, long-distance hiking, such as thru-hiking, may have specific stressors and biomechanics that lead to unique findings in stress injury patterns.

The combination of harsh conditions, aggressive hiking schedules, limited medical resources along the trail, and the sheer length of the hike, make these participants susceptible to multiple injuries including stress fractures. Variations in training prior to long-distance hikes may also play a role in overuse injuries. The insidious onset of these fractures may mislead hikers into believing they should continue backpacking without understanding the progressive nature of stress fractures and the potential severity of the condition. Unless activity is modified, bone stress can progress to a complete fracture and may ultimately require surgical intervention.

The progression from stress reaction to stress fracture can make use of diagnostic imaging challenging. When stress fracture is suspected, plain radiography is the study of choice. It has an initial sensitivity of 10% but increases to 30 to 70% 3 wk after the fracture occurs.[9,23] In contrast, MRI has near 100% sensitivity, but comes with significantly more cost.[24] According to the American College of Radiology, if initial x-rays are negative but a stress fracture is still suspected, plain radiography should be repeated at 10 to 14 d. An MRI without contrast would be an equivalent follow-up option.[25] Computed tomography is not regularly recommended because of its lower sensitivity and higher radiation exposure.

The differential diagnosis for a distal femur stress fracture can include patellofemoral pain syndrome, degenerative joint disease, meniscal injury, and ligamentous strain. Most variants of these conditions can be treated conservatively; however, providers should consider an x-ray for point tenderness over a bone or persistent pain.

Treatment of stress injuries include protection, rest with nonweight bearing status, ice, elevation, and pain control. In instances where the stress injury has progressed to full fracture, surgery may be indicated. For minor stress fractures, the bone usually requires a minimum of 6 wk before a patient should return to full activity. For full fractures, including those requiring surgery, it may take 3 to 6 mo for complete resolution. Some patients may need physical therapy to regain muscle strength that was lost while in nonweight bearing status.

Prognosis is good for stress injuries that are caught early. Delayed diagnosis and treatment can lead to poor outcomes including nonunion. Long-term symptoms may include muscle weakness, gait abnormalities, and chronic pain. Prevention includes gradual increase in activity to allow the body to respond to increase load stresses and adequate rest periods in training. Nutritional counseling may also play a role.

This case describes a distal femur stress fracture in a long-distance hiker. While 1 case does not prove causality, it suggests there may be a need for a well-designed epidemiologic study identifying occurrence of knee pain in long-distance hikers and distal femur stress as a possible etiology. Clinicians should consider stress fracture on the differential diagnosis of a thru-hiker with persistent knee pain.

Author Contributions: Case study concept and design: MK, AC; acquisition of the data: MK, AC; analysis of the data: MK, AC; drafting of the manuscript: MK, AC; critical revision of the manuscript: MK, AC; approval of the final manuscript: MK, AC.

Financial/Material Support: None.

Disclosures: None.

References

1. Matcuk Jr GR, Mahanty SR, Skalski MR, Patel DB, White EA, Gottsegen CJ. Stress fractures: pathophysiology, clinical presentation, imaging features, and treatment options. *Emerg Radiol*. 2016;23(4):365−75.
2. Behrens SB, Deren ME, Matson A, Fadale PD, Monchik KO. Stress fractures of the pelvis and legs in athletes: a review. *Sports Health*. 2013;5(2):165−74.
3. Valimaki VV, Alfthan H, Lehmuskallio E, Löyttyniemi E, Sahi T, Suominen H, et al. Risk factors for clinical stress fractures in male military recruits: a prospective cohort study. *Bone*. 2005;37(2):267−73.
4. Lappe JM, Stegman MR, Recker RR. The impact of lifestyle factors on stress fractures in female Army recruits. *Osteoporos Int*. 2001;12(1):35−42.
5. Korpelainen R, Orava S, Karpakka J, Siira P, Hulkko A. Risk factors for recurrent stress fractures in athletes. *Am J Sports Med*. 2001;29(3):304−10.
6. Mattila VM, Niva M, Kiuru M, Pihlajamaki H. Risk factors for bone stress injuries: a follow-up study of 102,515 person-years. *Med Sci Sports Exerc*. 2007;39(7):1061−6.
7. Goldberg B, Pecora C. Stress fractures. *Phys Sportsmed*. 1994;22(3):68−78.
8. Brukner P, Bradshaw C, Khan KM, White S, Crossley K. Stress fractures: a review of 180 cases. *Clin J Sport Med*. 1996;6(2):85−9.
9. Matheson GO, Clement DB, McKenzie DC, Taunton JE, Lloyd-Smith DR, MacIntyre JG. Stress fractures in athletes. A study of 320 cases. *Am J Sports Med*. 1987;15(1):46−58.
10. Monteleone Jr GP. Stress fractures in the athlete. *Orthop Clin North Am*. 1995;26(3):423−32.
11. Waterman BR, Gun B, Bader JO, Orr JD, Belmont Jr PJ. Epidemiology of lower extremity stress fractures in the United States military. *Mil Med*. 2016;181(10):1308−13.
12. Niva MH, Kiuru MJ, Haataja R, Pihlajamäki HK. Fatigue injuries of the femur. *J Bone Joint Surg Br*. 2005;87(10): 1385−90.
13. DeFranco MJ, Recht M, Schils J, Parker RD. Stress fractures of the femur in athletes. *Clin Sports Med*. 2006;25(1):89−103.
14. Jones BH, Harris JM, Vinh TN, Rubin C. Exercise-induced stress fractures and stress reactions of bone: epidemiology, etiology, and classification. *Exerc Sport Sci Rev*. 1989;17: 379−422.
15. Orava S. Stress fractures. *Br J Sports Med*. 1980;14(1):40−4.
16. Johnson AW, Weiss Jr CB, Wheeler DL. Stress fractures of the femoral shaft in athletes—more common than expected. A new clinical test. *Am J Sports Med*. 1994;22(2): 248−56.
17. Hershman EB, Lombardo J, Bergfeld JA. Femoral shaft stress fractures in athletes. *Clin Sports Med*. 1990;9(1):111−9.
18. Armstrong 3rd DW, Rue JP, Wilckens JH, Frassica FJ. Stress fracture injury in young military men and women. *Bone*. 2004;35(3):806−16.
19. Harrast MA, Colonno D. Stress fractures in runners. *Clin Sports Med*. 2010;29(3):399−416.
20. Boulware DR, Forgey WW, Martin 2nd WJ. Medical risks of wilderness hiking. *Am J Med*. 2003;114(4): 288−93.
21. Quesada PM, Mengelkoch LJ, Hale RC, Simon SR. Biomechanical and metabolic effects of varying backpack loading on simulated marching. *Ergonomics*. 2000;43(3): 293−309.
22. Simpson KM, Munro BJ, Steele JR. Backpack load affects lower limb muscle activity patterns of female hikers during prolonged load carriage. *J Electromyogr Kinesiol*. 2011;21(5):782−8.
23. 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(2):79−84.
24. Marshall RA, Mandell JC, Weaver MJ, Ferrone M, Sodickson A, Khurana B. Imaging features and management of stress, atypical, and pathologic fractures. *Radiographics*. 2018;38(7):2173−92.
25. Bencardino JT, Stone TJ, Roberts CC, Appel M, Baccei SJ, Cassidy RC, et al. ACR Appropriateness Criteria® Stress (fatigue/insufficiency) fracture, including sacrum, excluding other vertebrae. *J Am Coll Radiol*. 2017;14(5S): S293−306.