

Diagnosing an Acute Quadratus Plantae Tear in a 37-Year-Old Athlete: A Case Report

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Abstract

Foot injuries occur frequently in distance runners and can notably impact training performance. Common diagnoses include plantar fasciitis, tendinopathies of the forefoot or midfoot, and stress fractures of the metatarsals. Occasionally, more obscure structures may be involved. We describe a 37-year-old male distance runner who presented with symptoms of heel pain and ecchymosis, suggesting an acute plantar fascia injury. However, findings of magnetic resonance imaging revealed a tear to the quadratus plantae (QP). The patient gradually returned to normal levels of physical activity, with complete resolution of symptoms by 4 months after the initial injury. Healthcare providers should be aware of the possible presence of a QP tear in patients who present with symptoms suggestive of acute plantar fascia rupture.

Introduction

Lower-extremity injuries are frequent in both elite and recreational runners.¹ The foot is the third most common location for injury,² with plantar fasciitis being the most common foot problem. Traditional imaging for running-related foot injuries has primarily involved standard radiographs, magnetic resonance imaging (MRI), computerized axial tomography scans, and less commonly nuclear-medicine scanning. Musculoskeletal ultrasound has become an increasingly more common choice in the past decade.³ Challenges exist for advocates of using musculoskeletal ultrasound, including determining the imaging accuracy and reliability compared to traditional imaging and demonstrating improved outcomes and more efficient return to play. Furthermore, diagnostic challenges occur when less-common structures such as the quadratus plantae (QP) muscle are involved.

We describe a 37-year-old distance runner who presented with symptoms and bedside musculoskeletal ultrasound imaging suggestive of an acute plantar fascia tear in his right heel, yet MRI findings revealed the presence of a QP tear. We found no published case report of specific tearing or strain injuries to the QP, although the structure is affected in hind-foot compartment syndrome after calcaneal fractures.⁴⁻⁶ The patient was informed that the data concerning his case would be submitted for publication, and he provided verbal consent.

Case Report

A 37-year-old male runner presented to the sports medicine clinic with 3 days of right-heel pain, which began acutely near the beginning of his morning run. He ignored the pain and finished his 10-mile run (16.1 km). After the run, he self-treated with stretching, ice, and 800 mg of ibuprofen, but his pain continued throughout the day. The next morning, the patient noticed considerable bruising along the plantar aspect of his foot and medial ankle (Figures 1A and 1B). He also experienced paresthesias and burning pain in the lateral foot and two toes, with prolonged ambulation that diminished with rest. He was an otherwise healthy individual, with no chronic conditions, regular medications, pre-existing foot injuries, or corticosteroid injections.

Results of his physical examination showed an antalgic gait, with noted exaggerated supination and avoidance of push-off on great toe by placing all of his weight on the outside of his foot during ambulation. Static inspection revealed bilateral pes planus. There was extensive ecchymosis on the medial plantar surface of the foot, originating about 5 cm distally from the medial aspect of the calcaneus, and prominent ecchymosis posterior to the medial malleolus. Neurovascular structures were intact. The ankle had complete range of motion, and results of the

Tinel test over the tarsal tunnel were negative. There was pinpoint tenderness over the medial plantar aspect of the calcaneus near the attachment of the plantar fascia.



Figure 1. The patient's right foot at 36 hours after the initial injury. (A) The plantar aspect of the foot. (B) The medial aspect of the ankle.

Bedside ultrasound examination showed a small anechoic fluid collection around the posterior tibialis tendon at the ankle (Figure 2A) and a large anechoic fluid collection inferior to the plantar fascia, near the insertion on the calcaneus, consistent with signs of hematoma (Figure 2B). A possible partial tear of the medial band of the plantar fascia was present at the calcaneal insertion. An MRI at 2 weeks after the injury showed edema and high signal within the proximal QP muscle near the calcaneal insertion (Figures 3A and 3B), consistent with a partial QP tear. The plantar fascia was non-ruptured.

Many of the patient's initial symptoms were observed as a result of Baxter neuropathy from extensive edema and hematoma. At initial presentation, the patient was placed in a walking boot for 2 weeks and underwent daily soft-tissue therapy treatments and modalities. The patient was allowed to gradually increase his level of activity and resume stretching. At the 30-day point, he was pain free, could walk, and began short runs. Serial ultrasound imaging, obtained weekly, showed some resolution of hematoma formation within the QP (Figures 4A through 4C).

Resolution of the anechoic fluid signal around the posterior tibialis at 2 weeks after the injury was noted in repeat ultrasonography examinations (Figure 2B). Around the QP, the fluid collection decreased in size at that time (Figure 4B). Ultrasound was obtained before resuming workouts and at 1 week after return to running (Figure 4C). The ultrasounds had similar findings, with a small fluid collection remaining; however, the size of the collection did not increase and pain did not return with the initiation of training. At 4 months after the injury, we noted

resolution of the original hematoma around the QP and the anechoic fluid collection around the posterior tibialis tendon, with no recurrent symptoms despite a regular running-training routine.

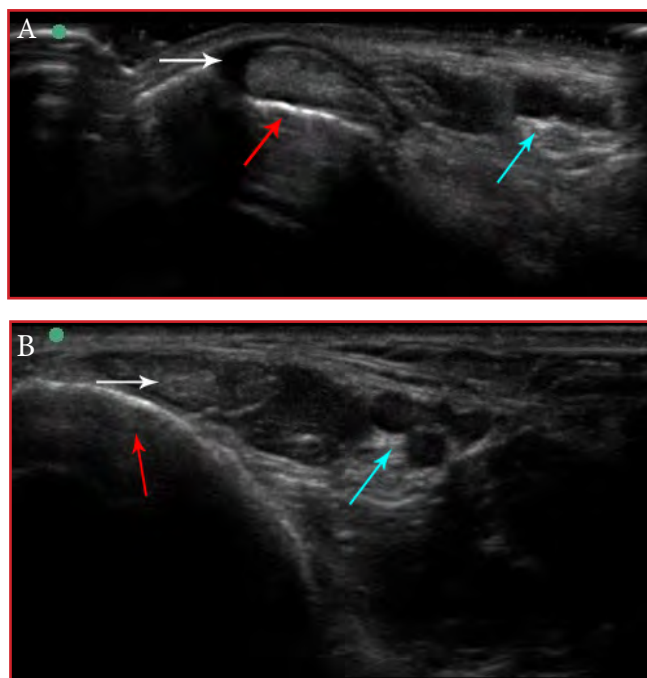


Figure 2. Ultrasound of the posterior tibialis, showing short-axis view and the medial malleolus (red arrow) and tibial neurovascular bundle (blue arrow). (A) Findings of initial scanning noted anechoic fluid (white arrow) around the tendon. (B) At 1-week after initial scanning, findings indicate resolving fluid (white arrow) around the tendon.

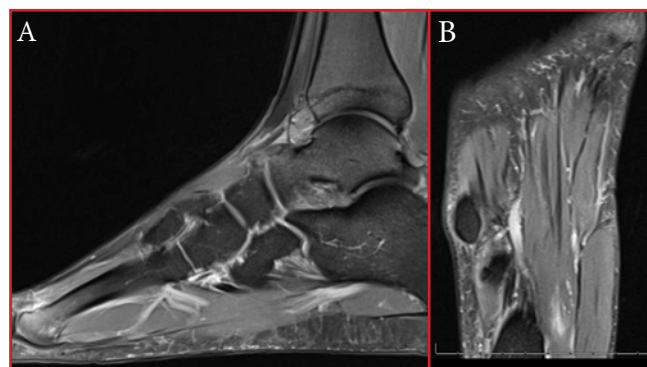


Figure 3. Magnetic resonance imaging of the quadratus plantae, showing signs of edema (arrows). (A) Sagittal view. (B) Axial view.

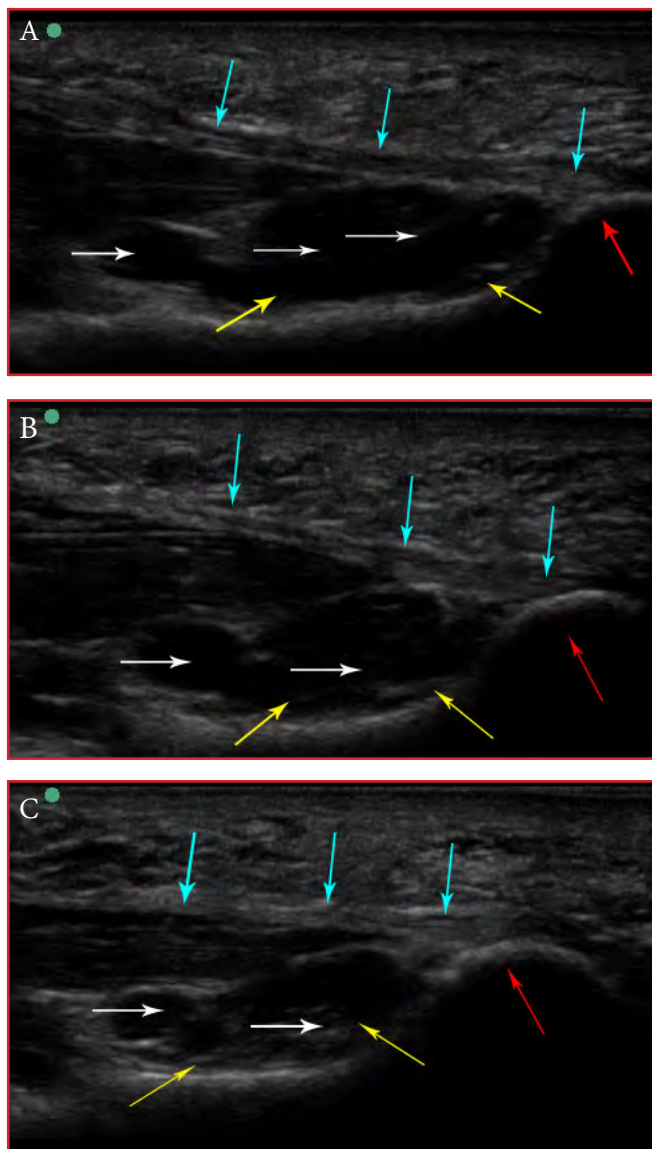


Figure 4. Ultrasound of the quadratus plantae (yellow arrows), showing long-axis view and the medial calcaneous (red arrow) and plantar fascia (blue arrows). (A) Anechoic fluid collection (white arrows) extending from the calcaneus, indicating evolving hematoma. (B) Same view at 1 week later, showing that the anechoic fluid collection stopped tracking distally (white arrows) and the hematoma has become more defined. (C) Same view at 4 weeks later, showing that the hematoma has notably reduced in size and the anechoic fluid has become more heterogeneous (white arrows).

Discussion

We believe this to be the first case report of a QP injury involving an acute injury with a tendon tear and strain. Among podiatrists and chiropractors, QP injury is known as a masquerader of plantar fascia injury. It is typically treated conservatively in a similar manner to that of a plantar fascia injury (ie, treated with rest, ice, nonsteroidal anti-inflammatory drug, and a period of immobilization

accompanied by soft-tissue modalities, stretching, and intrinsic foot-muscle strengthening exercises).

The QP is an intrinsic muscle of the foot, which is innervated by the first branch of the lateral plantar nerve (Baxter's nerve) and aids in plantar flexion of the four lateral toes. Additionally, Baxter's nerve innervates the flexor digitorum brevis and abductor digiti quinti, and sends sensory fibers to the periosteum of the medial calcaneal tuberosity, lateral plantar skin, and long plantar ligament. Baxter's nerve lies deep to the abductor hallucis and flexor digitorum brevis, and superficial to the QP (Figure 5). Bleeding into the QP can lead to compression of the lateral plantar nerve between the flexor digitorum brevis and QP, leading to symptoms of Baxter's neuropathy, with pain at the medial heel and burning pain in the lateral foot.^{7,8} Compartment syndrome of the midfoot, which can mimic Baxter's neuropathy, can lead to the devastating complications of paresis and ischemic contracture of the short flexors of the toes, resulting in hammer- or claw-toe deformity.⁴

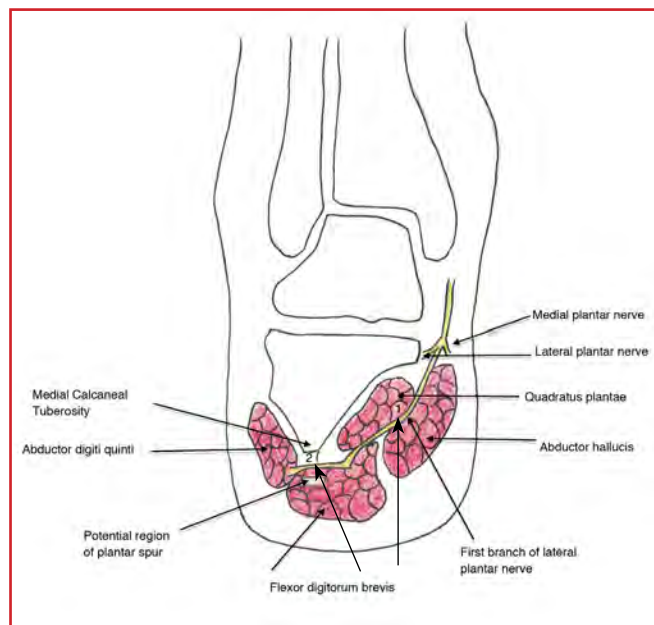


Figure 5. Illustration of a left heel showing the potential sites of compression of the Baxter nerve: the deep margin of the abductor hallucis muscle (1) and the point at which the nerve passes anterior to the medial calcaneal tuberosity (2). Adapted from: Lareau CR, Sawyer GA, Wang JH, DiGiovanni CW. Plantar and medial heel pain: diagnosis and management. *J Am Acad Orthop Surg* 2014;22(6):372-80.

Fortunately for our patient, the symptoms were only present with prolonged ambulation and were completely resolved with rest. Had his symptoms been more persistent, this would have warranted a referral for evaluation by a surgeon specializing in the foot and ankle. It has also been shown that the QP has fascia connections to other midfoot structures and to the posterior compartment of

the leg through the retinaculum posterior to the medial malleolus.^{7,8} Thus, bleeding into the QP can lead to hematoma formation in both of those locations. This may account for the external bruising pattern seen in our case.

Initial bedside ultrasound indicated an acute injury, mistaken for a plantar fascia tear. Subsequently, an MRI accurately diagnosed the QP injury. After MRI, the ultrasonographer refined his technique and felt that the QP could be imaged. Scanning protocols from the American Institute of Ultrasound Medicine do not address QP injuries.⁹ Ultrasound findings were used to monitor hematoma resolution while our patient returned to activity. Radwan et al¹⁰ suggested that ultrasound could monitor improvement and disease process after rehabilitation interventions. However, at this time, routine musculoskeletal ultrasound monitoring for management is not supported.¹¹

There is no clear indication that either the treatment or the time to return to running with this patient's injury—a partial QP tear—would have been any different if the injury had been a plantar fascia tear. As described in the current case report, it should be noted that the learning curve is longer for diagnosing atypical and uncommon injuries such as QP tears with ultrasound than the more common structures such as an acute plantar fasciitis injury.

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Conflict of Interest

The authors report no conflicts of interest.

References

1. Kindred J, Trubey C, Simons SM. Foot injuries in runners. *Curr Sports Med Rep* 2011;10(5):249-54. doi: 10.1249/JSR.0b013e31822d3ea4.
2. van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *Br J Sports Med* 2007;41(8):469-80; discussion 480.
3. Jacobson JA. Musculoskeletal ultrasound and MRI: which do I choose? *Semin Musculoskelet Radiol* 2005;9(2):135-49.
4. Andermahr J, Helling HJ, Tsironis K, Rehm KE, Koebke J. Compartment syndrome of the foot. *Clin Anat* 2001;14(3):184-9.

5. Manoli A 2nd, Weber TG. Fasciotomy of the foot: an anatomical study with special reference to release of the calcaneal compartment. *Foot Ankle* 1990;10(5):267-75.
6. Andermahr J, Helling HJ, Rehm KE, Koebke Z. The vascularization of the os calcaneum and the clinical consequences. *Clin Orthop Relat Res* 1999;(363):212-8.
7. Sooriakumaran P, Sivananthan S. Why does man have a quadratus plantae? A review of its comparative anatomy. *Croat Med J* 2005;46(1):30-5.
8. Lareau CR, Sawyer GA, Wang JH, DiGiovanni CW. Plantar and medial heel pain: diagnosis and management. *J Am Acad Orthop Surg* 2014;22(6):372-80. doi: 10.5435/JAAOS-22-06-372.
9. American College of Radiology (ACR).; Society for Pediatric Radiology (SPR).; Society of Radiologists in Ultrasound (SRU). AIUM practice guideline for the performance of a musculoskeletal ultrasound examination. *J Ultrasound Med* 2012;31(9):1473-88.
10. Radwan A, Wyland M, Applequist L, Bolowsky E, Klingensmith H, Virag I. Ultrasonography, an effective tool in diagnosing plantar fasciitis: a systematic review of diagnostic trials. *Int J Sports Phys Ther* 2016;11(5):663-671.
11. Klauser AS, Tagliafico A, Allen GM, et al. Clinical indications for musculoskeletal ultrasound: a Delphi-based consensus paper of the European Society of Musculoskeletal Radiology. *Eur Radiol* 2012;22(5):1140-8. doi: 10.1007/s00330-011-2356-3.