CLINICAL CASE - TEST YOURSELF | Musculoskeletal Imaging

Medial heel pain in a long-distance runner

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PART A

Question

A 45-year-old male, elite long-distance runner, presented with left ankle pain on the medial and plantar midfoot over the last 12 months. Pain was typically exacerbated after running or standing with no response to NSAIDs or pain killers. No history of trauma was reported. The patient was not on medication at presentation and had an otherwise unremarkable medical history. Clinical examination did not show any gait malfunction or any medial pain on percussion and palpation. Sagittal fat suppressed T2-w **(Fig. 1)**, coronal STIR **(Fig. 2)**, axial T2-w **(Fig. 3)** and coronal T1-w **(Fig. 4)** MR images, are shown.

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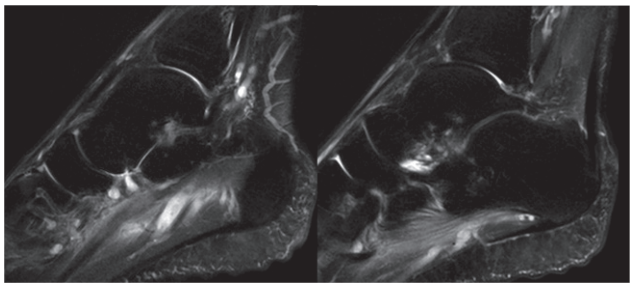

Fig. 1. *Sagittal fat suppressed T2-w MR images.*

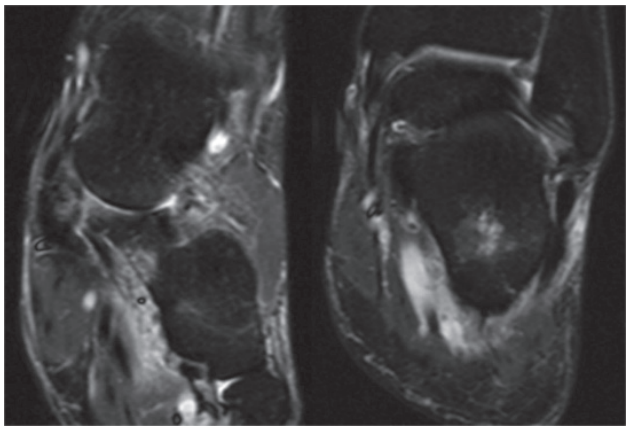

Fig. 2. *Coronal STIR T2-w MR images.*

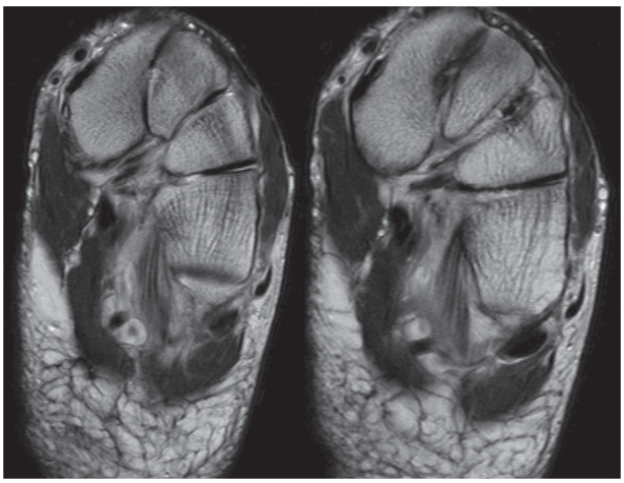

Fig. 3. *Consecutive axial T2-w MR images.*

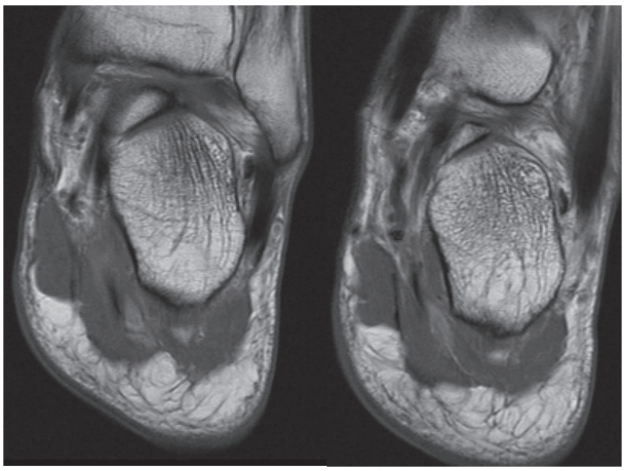

Fig. 4. *Consecutive coronal T1-w MR images.*

PART B

Diagnosis
Answer: Baxter's syndrome secondary to a varicose lateral plantar vein and muscle hypertrophy

Discussion

Long distance running is a popular sport, mainly in the middle-aged adult group of athletes. This might be explained by the current scientific evidence that running prevents a wide spectrum of diseases and contributes to good health. Running however, induces a significant risk for injuries, which are related to many factors such as the quality of the surface, footwear, technique, underlying anatomical variants such as flatfoot deformity and overuse. The most common injuries in the foot in runners include the stress reaction or fracture (sesamoids, metatarsals, and navicular), plantar fasciitis, various tendinopathies of the mid- and forefoot, Achilles's tendinopathy, ankle sprains, osteochondral lesions of the talus, and various nerve disorders such as interdigital neuralgia, tarsal tunnel syndrome, superficial peroneal neuropathy, Baxter's nerve entrapment and Jogger's foot [1,2]. The latter is the result of medial plantar nerve irritation which is clinically demonstrated with pain and numbness along the medial arch of the foot. In the general population, medial heel and plantar pain is the result of plantar fasciitis, heel pad atrophy, and tarsal tunnel syndrome [3].

Very often, the clinical signs and symptoms in patients with medial heel and plantar pain, are not specific and the clinical tests, including the Tinel's sign, do not provide an accurate diagnosis. Indeed, nerve entrapment, although rare, may clinically simulate plantar fasciitis which is much more common and top on the list of differentials [4]. The clinical differential diagnosis includes plantar fasciitis, fatigue fracture of the calcaneus, posterior tibial tendon dysfunction, tarsal tunnel syndrome and Baxter's neuropathy. Since it's a difficult task to depict clinical indicators of Baxter's nerve entrapment clinically, this disorder is often missed, and the diagnosis delayed. Although nerve conduction tests and electromyography may be helpful, there are many patients in which these show false negative results. Thus, imaging is an important diagnostic tool towards a specific diagnosis. Due to its superb spatial and contrast resolution, MR imaging is the method of first choice in this clinical setting.

MR imaging in our patient showed oedema within the quadratus plantae muscle (QP) and a dilated lateral plantar vein (LPv) with incidental small filling defects (**Fig. 1-4**). Since this muscle is innervated from the lateral plantar nerve, a diagnosis of nerve entrapment with acute denervation of the muscle, was raised. More specifically, Baxter's neuropathy (BN) which results from entrapment of the first branch of the lateral plantar nerve, was suggested. Considering that a dilated vein coexisted and that the QP was oedematous (**Fig. 1-3**) and swollen on MR imaging (**Fig. 4**), a double pathophysiological mechanism, muscle hypertrophy and varicose vein, was suggested. This has not been reported in the literature, to the best of our knowledge.

The inferior calcaneal nerve (ICN) or Baxter's nerve, has origin from the lateral plantar nerve, runs superficially to the QP and deep to the abductor hallucis (AH) and flexor digitorum brevis (FDB) muscles and provides motor function to QP, FDB and abductor digiti minimi (ADM) muscles [5]. BN is a neuropathy caused by compression of the ICN. This may occur between the QP and the AH, or by calcaneal enthesophytes and thickened plantar fascia (**Fig. 5**) [6]. Although the former is believed to occur in runners, no similar reports exist in the literature. Another cause is stretching of the ICN in a hypermobile and pronated foot [7]. Up to now, only case reports have been describing the syndrome, mostly related to plantar fasciitis, often with bilateral presentation [4,8]. One large series showed that there is significant association between ADM atrophy with age, calcaneal spurring, and plantar fasciitis [9]. Although BN has been reported to be responsible for 15-20% of the heel pain, it is often overlooked [9]. Typically, the pain due to BN is constant. In our patient, the pain was exacerbated during running, apparently due to AH and QP hypertrophy but also in the standing position, obviously because of increased dilatation of the LPv.

The main sequences for diagnosing the Baxter's neuropathy are the fluid sensitive ones for showing the active muscle denervation and the possible cause, i.e., plantar fasciitis, and the T1-w to show the chron-

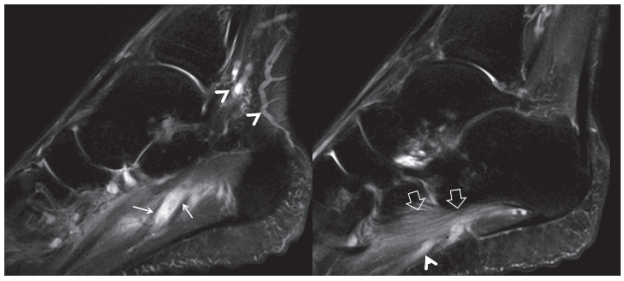

Fig. 1. *Sagittal fat suppressed T2-w MR images showing the varicose lateral plantar vein with tiny filling defects (arrows) and the oedematous quadratus plantae muscle (open arrows). Additional varicose veins are shown (arrowheads).*

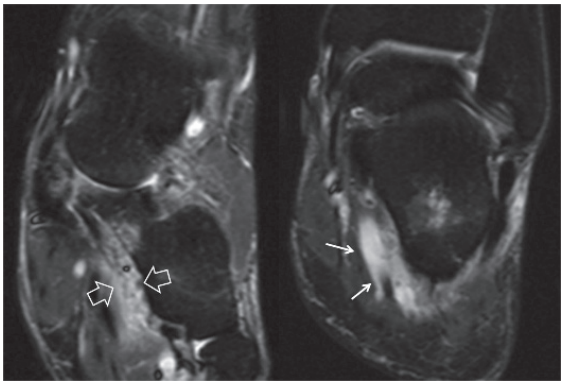

Fig. 2. *Coronal STIR MR images, at the level of midfoot (left) and hindfoot (right) showing the varicose lateral plantar vein (arrows) and the oedematous quadratus plantae muscle (open arrows).*

Fig. 3. *Axial consecutive T2-w MR images showing the varicose lateral plantar vein (arrows) with a small centrally located thrombus and the oedematous quadratus plantae muscle (open arrows).*

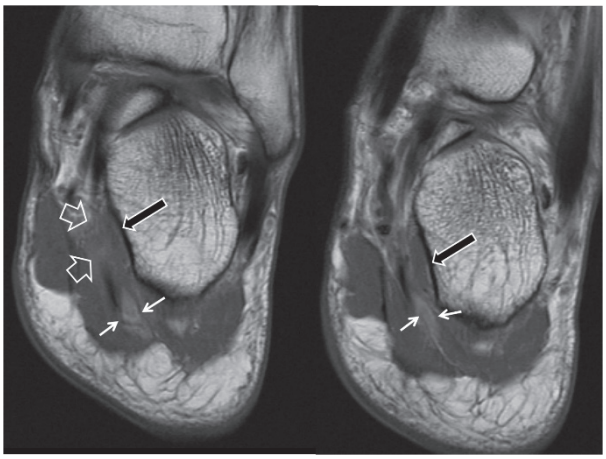

Fig. 4. *Consecutive T1-w MR images showing the swollen quadratus plantae muscle (thick and open arrows) and the high signal intensity of the lateral plantar vein (thin arrows) in keeping with clinically occult thrombosis.*

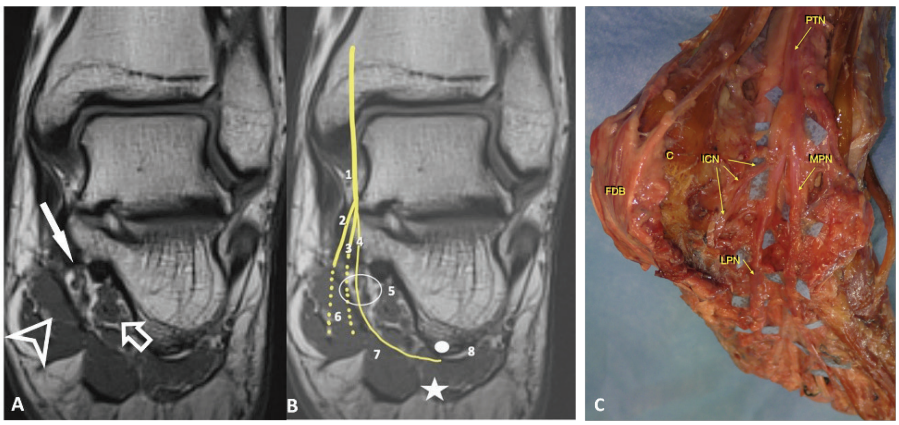

Fig. 5. A. *Coronal T1-w MR image in an asymptomatic athlete showing the normal anatomy. The lateral plantar vein (arrow) is shown in the space between the abductor hallucis muscle (arrowhead) and the quadratus plantae muscle (open arrow).* ***B.*** *The same anatomical image with lower contrast and higher brightness to highlight the drawing on the normal structures. 1. Posterior tibial nerve, 2. Medial plantar nerve branch, 3. Lateral plantar nerve branch, 4. Inferior calcaneal nerve branch (Baxter's nerve), 5. Quadratus plantae muscle, 6. Abductor hallucis muscle, 7. Flexor digitorum brevis muscle, 8. Abductor digiti minimi muscle. The open circle shows a site of entrapment in-between the muscles. Another and more common site of entrapment is the space between calcaneal plantar enthesophytes (circle) and plantar fascia (star).* ***C.*** *A fresh frozen anatomic specimen of the foot after removal of the layers containing the skin and plantar fascia. The flexor digitorum brevis muscle (FDB) is reflected onto the calcaneus (C). Dissection of the posterior tibial nerve trifurcation. PTN posterior tibial nerve, ICN inferior calcaneal nerve or Baxter's nerve, LPN lateral plantar nerve, MPN medial plantar nerve.*

ic muscle denervation and other possible causes, i.e., bony spurs. The most common MR imaging finding in BN is the increased fat within ADM, which represents a delayed diagnosis since atrophy with fatty infiltration of the muscle is the result of chronic, and not reversible, denervation [4,8,9]. Very often, calcaneal enthesophytes and plantar fasciitis are associated findings. Ultrasound has been used in BN showing thickening (>4.5 mm) and altered echogenicity of the plantar fascia and fatty atrophy of the ADM. However, its clinical utility in case of entrapment more superiorly between the QP and the AH, has not been tested.

ICN entrapment between the AH and QP muscles may occur because of muscle hypertrophy, which occurs in runners. Other rare causes include an accessory muscle and a tumour such as the fibrolipomatous hamartoma of the nerve [10]. In our patient, the muscle hypertrophy was suggested because of the elimination of the normal fat plane in the interface (compare Figures 4 and 5). In addition, a dilated LPv was detected in this anatomical interface with incidental intraluminal thrombus. The presence of oedema withing the QP muscle without any fatty infiltration on T1-w MR images, suggested acute/subacute muscle denervation.

The treatment of BN includes primarily a conservative approach with physiotherapy, orthotics, or NSAIDs. Plantar fasciitis may be amenable to treatment with US-guided dry needling and steroid injection deep to the fascia. Persistent pain may require surgical decompression. In case of ICN entrapment between the QP and AH muscles though, conservative treatment usually fails. In our case, catheter-assisted endovenous radiofrequency therapy was utilised for the varicose vein and change and reduction of the training program for the muscle hypertrophy. The patient was symptom free in 3 months following treatment and in the 1-year follow-up there were no symptoms at rest or during running or standing.

In conclusion, this clinical case presentation highlights the pathophysiology regarding ICN entrapment in an anatomical area which is seen in athletes. The coexistence of a dilated vein, contributed to the complex pathophysiology of the BN. MR imaging had an important contribution to early diagnosis and treatment planning and prompt intervention. R

Conflict of interest

The authors declared no conflicts of interest.

KEY WORDS

Heel/innervation; Running/injuries; Foot/diagnostic imaging; Magnetic Resonance Imaging; Nerve Compression Syndromes/diagnostic imaging; Muscle, Skeletal/ diagnostic imaging

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