# Imaging the patient with heel pain


## ABSTRACT

Heel pain is a common presentation in primary care and affects a wide range of the population but predominantly elderly, obese and athletic patients. History and clinical assessment are paramount in the management of this condition but the presentation can confound clinicians, necessitating the use of imaging to confirm or clarify the diagnosis when there is clinical uncertainty. This article illustrates the various conditions producing heel pain to help clinicians determine the appropriate imaging modality to image the common causes of heel pain. A linked article detailing the management of heel pain is included in this issue (https://doi.org/10.12968/hmed.2019.80.4.196).


Heel pain, also referred to as calcaneodynia, is a common condition and affects around one in five adults, with a higher prevalence reported in older patients (Hill et al, 2008). Various correlating factors include obesity, manual occupations and physical inactivity (Chatterton et al, 2015). Heel pain can be a source of significant disability but establishing a cause can be challenging. Taking a clear history may go a long way to finding a diagnosis but the role of imaging in confirming and establishing diagnoses has increased in recent years. Image-guided intervention also allows precise delivery of treatment.

An anatomical understanding of the heel is important – there are six anatomical sites for the cause of heel pain:

1. The plantar fascia
2. The calcaneus
3. The tendons of flexor halluces longus, flexor digitorum longus and the Achilles tendon
4. The retroachilles and retrocalcaneal bursae
5. The fat pad of the heel
6. The tarsal tunnel.

Dysfunction of any of these structures can give rise to heel pain. This article reviews the imaging findings of the causes of heel pain and discusses how different modalities can help clinicians come to a more accurate diagnosis.


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## Inferior heel pain

### Plantar fasciitis

Plantar fasciitis is the most common cause of inferior heel pain (Radwan et al, 2016). Plantar fasciitis is caused by repetitive strain to the plantar fascia leading to microtears, with inflammation of the fascia and the perifascial soft tissues leading to thickening in the form of fibrotic changes.

Ultrasonography is the most useful imaging modality in confirming the diagnosis of plantar fasciitis. The normal plantar fascia has an echogenic fibrillar structure on ultrasound imaging. In plantar fasciitis, there is loss of the fibrillar structure and fascial thickening >5 mm with or without calcifications, perifascial fluid, occasional increased blood flow in the plantar fascia on Doppler imaging and a loss of elasticity of the plantar fascia with sonoelastography are all features that can confirm a diagnosis of plantar fasciosis (*Figure 1*). Sonoelastography is the latest ultrasonographic technique that can establish the rigidity of a tissue and can be used to identify early plantar fasciitis (Wu et al, 2015). Ultrasound is also effective in the treatment of plantar fasciitis, both in assisting with corticosteroid injections if appropriate and in reviewing response to treatment. Chen et al (2013) demonstrated that fascial hyperaemia correlated with self-perceived pain, and both hyperaemia and fascial thickness were correlated with foot dysfunction.

Radiography is often performed in the investigation of heel pain but is mainly used to exclude osseous bony causes of heel pain such as calcaneal stress fractures. Radiography may reveal bony projections into the plantar fascia from the calcaneus called spurs. Calcaneal spurs are more prevalent in patients with plantar fasciosis, but have very poor specificity as they are found in up to 46% of people (Osborne et al, 2006).

Magnetic resonance imaging (*Figure 2*) can exquisitely show the plantar fascial thickening predominantly near the calcaneal insertion, fascial and perifascial oedema and bone marrow oedema at the site of the calcaneal insertion

Figure 1. Ultrasound scan, panoramic image, demonstrating the thickening and low echogenicity at the plantar fascia origin (arrows), consistent with plantar fasciitis. The rest of the plantar fascia has an echogenic fibrillar appearance.

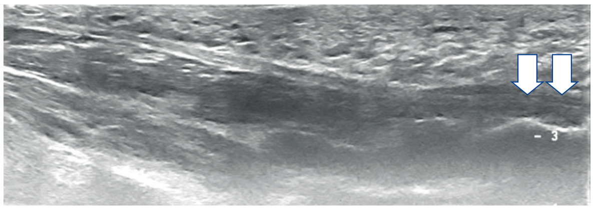


Figure 2. Sagittal T2-weighted fat suppressed image of the ankle, demonstrating the thickened plantar fascia with interstitial tear, surrounding soft tissue oedema and adjoining calcaneal oedema (arrows). The magnetic resonance imaging findings are consistent with plantar fasciitis.

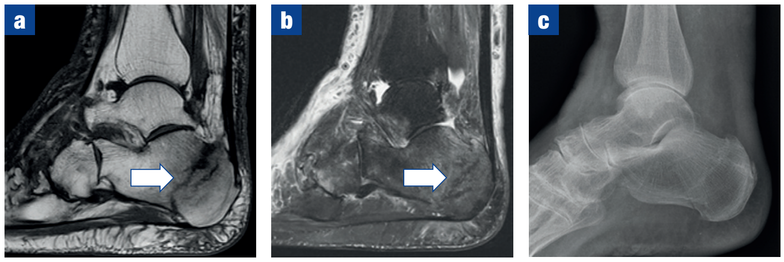
of the plantar fascia (Lawrence et al, 2013). Magnetic resonance imaging is time consuming and costly and should be reserved as a final line investigation, especially given the sensitivity and specificity of ultrasound with sonoelastography (Radwan et al, 2016). Magnetic resonance imaging is helpful when there is diagnostic uncertainty or lesions have been identified within the plantar fascia on assessment that require further characterization.

### Calcaneal stress fracture

After metatarsal stress fractures, this is the commonest site of stress fractures of the feet (Lawrence et al, 2013). These fractures can occur when normal bone undergoes abnormal stress or when abnormal bone undergoes normal stress. In either case, fractures commonly occur over the postero-superior surface or posterior aspect of the calcaneum. These are poorly visualized on plain radiography in the early acute phase, appearing normal in more than 70% of cases, as reported by Daftary et al (2005). The fracture manifests as a poorly defined sclerotic line projected medial to the calcaneal tuberosity on plain film radiography (*Figure 3c*). Since this is a stress fracture, radiography may not reveal any findings until 2–3 weeks after the fracture. If a high index of suspicion is present, further imaging with magnetic resonance imaging is useful. Magnetic resonance imaging will show a band of low signal from the medulla to the cortex with marrow oedema and haemorrhage in the region surrounding the fracture (*Figures 3a* and *b*).

Computed tomography can be used if magnetic resonance imaging is not available. This can demonstrate the discontinuity of the cortex, and trabecular and periosteal proliferation, confirming the fracture, but has lower sensitivity than magnetic resonance imaging.

Figure 3. **a.** Magnetic resonance scan sagittal T1 weighted and **(b)** T2 fat suppressed sequences, demonstrating stress fracture (arrow) of the posterior calcaneum in a 65-year-old female, active walker complaining of persistent heel pain. **c.** Plain radiograph of the ankle, taken after the magnetic resonance scan, demonstrating the faint sclerotic linear fracture line corresponding to the stress fracture seen on the magnetic resonance scan.




## Posterior heel pain

### Achilles tendonitis

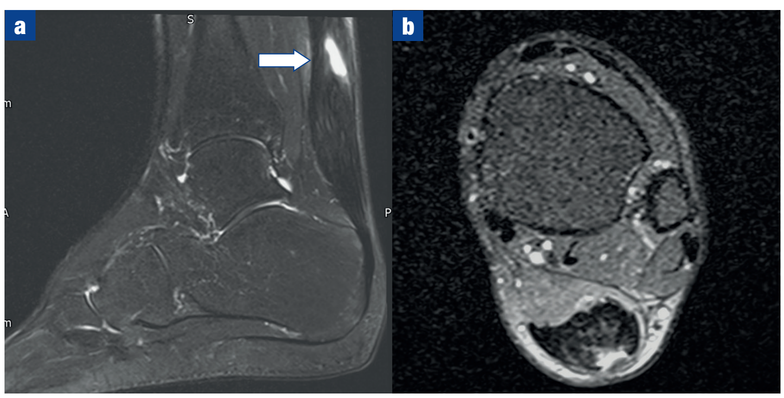
The Achilles tendon is the largest tendon in the body, connecting to the muscles of gastrocnemius and soleus, which acts to plantar flex at the ankle. Repetitive use and microtears lead to tendonitis, one of the commonest causes of posterior heel pain. This tends to involve the tendon, 2–6 cm proximal to the calcaneal insertion, which is a relatively hypovascular area and referred to as the 'critical zone'. This condition is generally referred to as non-insertional Achilles tendinopathy (Lawrence et al, 2013).

Insertional Achilles tendinopathy involves the Achilles insertion at the calcaneum and is generally seen in runners, or people with Haglund deformity or inflammatory arthropathy.

Plain radiography may reveal calcification within the tendon or an increased width of the Achilles tendon on a lateral film. This would be shown as a thickening in the soft tissue shadow of Achilles tendon, and may be associated with an enthesis of the calcaneus and Achilles tendon.

As a soft tissue structure, the Achilles tendon is best evaluated with ultrasound or magnetic resonance imaging (*Figures 4a* and *b*). A diagnostic feature is increased thickness

Figure 4. **a.** Sagittal T2 weighted fat suppressed magnetic resonance image of the ankle, demonstrating the fusiform thickening of Achilles tendon, away from the insertion site at the calcaneum, in keeping with non-insertional Achilles tendinopathy. A partial tear is noted as a bright signal (see arrow). **b.** Axial T2 weighted fat suppressed magnetic resonance image of the ankle in the same patient, demonstrating the partial tear on a background of thickened Achilles tendinopathy.



> Osteoarthritic disease of the subtalar joint may present with similar symptoms to those of calcaneal stress fracture.

of the Achilles tendon >1 cm on ultrasound and increased vascularity is associated with a more painful tendon. More subtle signs on magnetic resonance imaging are a loss of the natural concave shape of the anterior Achilles tendon border, which becomes more convex as the Achilles tendon becomes thickened (Chang and Wu, 2017). Interstitial partial tears may be seen as the condition progresses and may eventually lead to full thickness rupture if not adequately treated.

Ultrasound is also a useful tool for therapeutic procedures, such as dry needling and high volume injections in Achilles tendinopathy. Steroid injections should be avoided because of the high risk of tendon rupture.

### Achilles peritendinitis and paratendinitis

Achilles peritendinitis is the inflammation of the peritenon that surrounds the Achilles tendon and is similar to tenosynovitis seen in tendon sheath inflammation. Magnetic resonance imaging and ultrasound are useful in demonstrating inflammation in the peritenon surrounding the Achilles tendon.

Achilles paratendinitis is the inflammation of the anteriorly located Kager's fat pad. Both these conditions are associated with Achilles tendinopathy but may occur in isolation.

### Retrocalcaneal bursitis

Retrocalcaneal bursitis is caused by repetitive trauma to the retrocalcaneal bursa but may be related to seronegative spondyloarthropathies (Lawrence et al, 2013). Plain radiography may be helpful since retrocalcaneal bursitis rarely occurs without either adjacent tendinitis or a Haglund deformity. A Haglund deformity, as per Pavlov et al (1982), is a bony enlargement of the posterosuperior aspect of the calcaneus at the Achilles tendon insertion (*Figures 5a* and *b*). Magnetic resonance imaging is only used in cases of diagnostic uncertainty or where clinicians are unclear if the Haglund deformity is related to the patient's pain. Magnetic resonance imaging would demonstrate an inflamed and thickened retrocalcaneal bursa with associated free fluid, usually associated with adjoining bone oedema and Achilles tendinopathy.

### Subtalar osteoarthritis

Osteoarthritic disease of the subtalar joint may present with similar symptoms to those of calcaneal stress fracture. The key features of subtalar osteoarthritis are the same as any other form of osteoarthritis on plain radiographs: joint space narrowing, subchondral sclerosis, periarticular osteophytes and subchondral cysts. Weight-bearing ankle anterior-posterior, lateral and mortise views with foot oblique and anteroposterior views provide the best views of the subtalar joint to assess this.

Computed tomography helps assess the degree of osteoarthritis within the joint more accurately and is useful in preoperative planning (*Figures 6a* and *b*). Magnetic resonance imaging is also helpful in the assessment of subtalar osteoarthritis, but can assess the surrounding soft tissue structures, especially when there is diagnostic uncertainty.

## Neurological causes of heel pain

### Tarsal tunnel syndrome

Tarsal tunnel syndrome refers to entrapment of the tibial nerve or branches within the tarsal tunnel (Lawrence et al, 2013). The tarsal tunnel is a confined space on the medial aspect of the ankle, containing the tibial nerve, posterior tibial artery and vein and the tendons of flexor hallucis, digitorum longus and tibialis posterior. The tarsal tunnel can be filled with a ganglion cyst, varicosities, bony deformities or tumours. Magnetic resonance imaging provides the best resolution imaging to identify various structures which may be causing obstruction within the tarsal tunnel. The aim of magnetic resonance imaging is to identify a surgical cause of tarsal tunnel syndrome as demonstrated in *Figures 7a–c*. There is little role for

Figure 5. **a.** Sagittal T1 and **(b)** T2 weighted magnetic resonance scan of the ankle. Haglund's deformity (protuberant postero-superior aspect of calcaneum, compare with *Figure 4a*) is seen in the posterior calcaneum, with adjoining retrocalcaneal bursitis (white arrow). The Achilles tendon attachment at the calcaneum is thickened with a partial tear, in keeping with associated insertional Achilles tendinopathy.

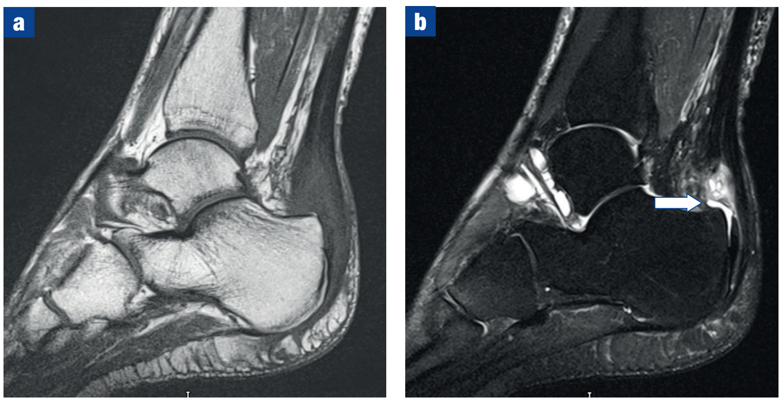



Figure 6. **a.** Three dimensional volume-reconstructed computed tomography image and **(b)** sagittal reconstruction of the ankle, exquisitely demonstrating subtalar osteoarthritis, with narrowing of the joint space and osteophytes formation (see arrows).

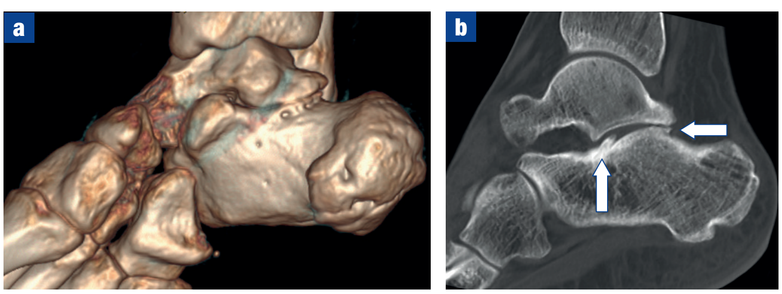
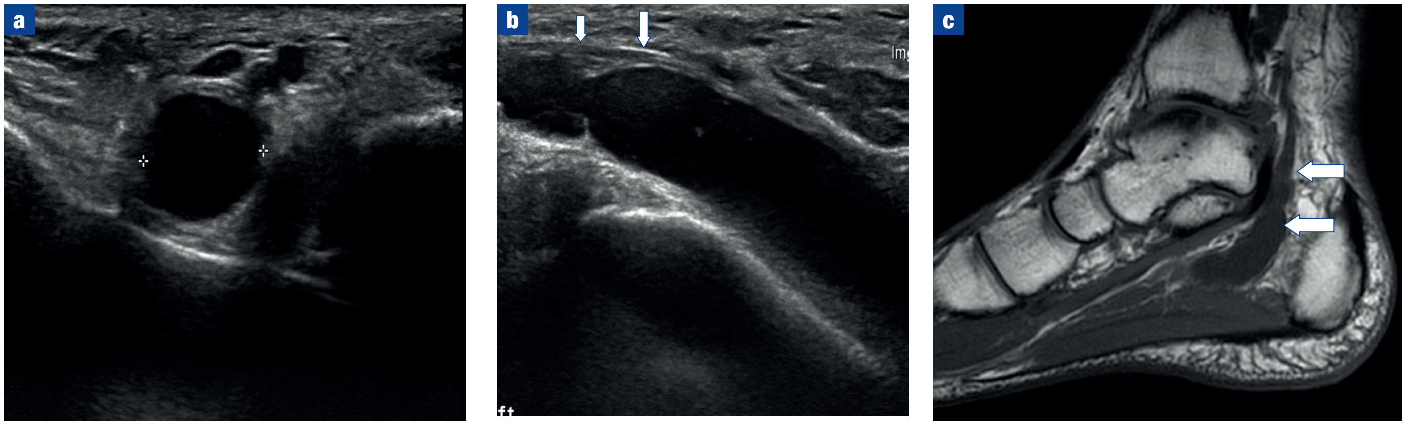


Figure 7. **a.** Transverse ultrasound scan image of the tarsal tunnel, demonstrating the ganglionic cyst, marked by the asterisk (*). The neurovascular bundles are seen superficial to the ganglionic. **b.** Ultrasound scan in the long axis, demonstrating the elongated ganglionic cyst in the tarsal tunnel. The impinged posterior tibial nerve is just discernible (see arrows). **c.** Magnetic resonance scan of same patient, sagittal T1 weighted sequence, demonstrating the serpiginous and elongated ganglionic cyst in the tarsal tunnel (arrows).




plain radiographs if tarsal tunnel syndrome is suspected. Ultrasound assessment can indicate a ganglion cyst or varicosities but may not be able to give a definitive diagnosis and may ultimately require magnetic resonance imaging for confirmation.

### Sinus tarsi syndrome

Sinus tarsi syndrome is a condition that occurs in young patients following trauma to the soft tissues around the sinus tarsi (a tunnel-like subtalar joint space between the talus and calcaneum). The sinus tarsi contain the talocalcaneal interosseous and cervical ligaments, fatty tissue and neurovascular bundle. In sinus tarsi syndrome, caused either by post trauma or inflammatory arthropathies, the sinus tarsi fat is replaced with fluid and scar tissue. This may progress to produce erosion of the adjoining bones. Magnetic resonance imaging is the modality of choice for assessing this condition. In sinus tarsi syndrome, the fatty tissue is lost or infiltrated with inflammatory tissue and fluid caused by the local reaction to damage to the sinus tarsi ligaments (Wong and Tan, 2016).

## Conclusions

Heel pain is a challenging subject with a wide range of differential diagnoses. Clinical history and examination is important in refining the differential diagnosis and confirming a diagnosis. This article provides a pictorial review of the key features on imaging alongside the reasoning for requesting specific imaging relating to each condition. **BJHM**

*Conflict of interest: none.*

## KEY POINTS

- The commonest cause of inferior heel pain is plantar fasciitis and of pain in the posterior heel is Achilles tendinopathy.
- Ultrasound and magnetic resonance imaging are the main imaging modalities used to assess heel pain.
- X-ray is useful as a first-line imaging investigation for any osseous abnormality.
- Imaging helps with the diagnosis and also, by determining the extent of the abnormal change, with planning the management.
- Ultrasound also helps to guide therapeutic procedures in patients with heel pain.

Chang CD, Wu JS. MR imaging findings in heel pain. Magn Reson Imaging Clin N Am. 2017 Feb;25(1):79–93. https://doi.org/10.1016/j.mric.2016.08.011

Chatterton BD, Muller S, Roddy E. Epidemiology of posterior heel pain in the general population: cross-sectional findings from the clinical assessment study of the foot. Arthritis Care Res (Hoboken). 2015 Jul;67(7):996–1003. https://doi.org/10.1002/acr.22546.

Chen H, Ho HM, Ying M, Fu SN. Association between plantar fascia vascularity and morphology and foot dysfunction in individuals with chronic plantar fasciitis. J Orthop Sports Phys Ther. 2013 Oct;43(10):727–734. https://doi.org/10.2519/jospt.2013.4774

Daftary A, Haims AH, Baumgaertner MR. Fractures of the calcaneus: a review with emphasis on CT. Radiographics. 2005 Sep;25(5):1215–1226. https://doi.org/10.1148/rg.255045713

Hill CL, Gill TK, Menz HB, Taylor AW. Prevalence and correlates of foot pain in a population-based study: the North West Adelaide health study. J Foot Ankle Res. 2008 Dec;1(1):2. https://doi.org/10.1186/1757-1146-1-2

Lawrence DA, Rolen MF, Morshed KA, Moukaddam H. MRI of heel pain. AJR Am J Roentgenol. 2013 Apr;200(4):845–855. https://doi.org/10.2214/AJR.12.8824

Osborne HR, Breidahl WH, Allison GT. Critical differences in lateral X-rays with and without a diagnosis of plantar fasciitis. J Sci Med Sport 2006 Jun;9(3):231–237. https://doi.org/10.1016/j.jsams.2006.03.028

Pavlov H, Heneghan MA, Hersh A, Goldman AB, Vigorita V. The Haglund syndrome: initial and differential diagnosis. Radiology. 1982 Jul;144(1):83–88. https://doi.org/10.1148/radiology.144.1.7089270

Radwan A, Wyland M, Appleguist 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 Oct;11(5):663–671.

Wong GNL, Tan TJ. MR imaging as a problem solving tool in posterior ankle pain: A review. Eur J Radiol. 2016 Dec;85(12):2238–2256. https://doi.org/10.1016/j.ejrad.2016.10.016

Wu CH, Chen WS, Wang TG. Plantar fascia softening in plantar fasciitis with normal B-mode sonography. Skeletal Radiol. 2015 Nov;44(11):1603–1607. https://doi.org/10.1007/s00256-015-2215-4