Ultrasound of the hindfoot

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**Nicki Delves**
Specialist MSK sonographer

**Andrew Carne**
Consultant MSK radiologist

**Matthew Solan**
Consultant orthopaedic foot and ankle surgeon

**Emma Wood**
Consultant MSK radiologist

Department of radiology, Royal Surrey County Hospital
email: nicki.delves@nhs.net, andrew.carne@nhs.net

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**Introduction**

Pain is the most common reason for orthopaedic foot and ankle referral. The prevalence is quoted as 20-25% in population based studies. Hindfoot pain can be complex. In our previous article, we considered the role of ultrasound scans in the diagnosis of disorders the forefoot. In this article we review those common, as well as some rare but important, problems that present with hindfoot pain.

Ultrasound imaging, in the right hands, is highly appropriate for diagnostic evaluation of the ankle and hindfoot. Tendon pathology in particular is often “underestimated” on MRI. Joint effusions from mechanical or inflammatory arthritis are well seen on ultrasound, and diagnostic injections can readily be performed. This article will focus on soft tissue conditions.

Regardless of who undertakes the ultrasound examination (sonographer or radiologist) an in-depth knowledge of anatomy and pathology is mandatory. Establishing a mutual understanding with referring clinicians is adviseable. We hold regular meetings to discuss cases for this purpose.

**Plantar heel pain**

Plantar fasciopathy is the most common cause of plantar heel pain, accounting for 1% of all orthopaedic referrals. It is a debilitating and poorly understood condition. It is traditionally described as fasciitis, a painful inflammation of the plantar fascia, but should more correctly be referred to as fasciopathy (painful dysfunction) or fasciosis as it is, in fact, a degenerative process. The causes are multifactorial: Structural causes such as pes planus, tight Achilles and occupational situations increase mechanical overload that may be the fundamental cause. Typically plantar fasciopathy affects the middle age population. It is considered as a self-limiting condition with resolution within 12 months in 80% of cases. Diagnosis is clinical, with typical symptoms including insidious onset of heel pain, noticed particularly on first steps in the mornings and after periods of rest. The majority of patients are managed within the community by their general practitioners with rest, analgesia, orthotics and stretching exercises. In our institution the recallnt cases will only attend for ultrasound imaging following assessment at our orthopaedic foot and ankle clinic and following intensive courses of physiotherapy exercises.

The typical ultrasound appearances in cases of plantar fasciopathy are of focal thickening of the proximal attachment to the os calcis. However, a study from our institution included 125 patients with recalcitrant ‘plantar fasciitis’, and only 66% showed typical focal insertional disease. The remainder had plantar fascia pathology more distally (atypical plantar fasciopathy) or a mixed picture. Additional and other less common pathology may mimic the symptoms of plantar fasciitis and this must be kept in mind when undertaking the ultrasound examination.

The plantar fascia is a thickened flat fibrous aponeurosis under the sole of the foot. Originating from a broad attachment to the calcaneal tuberode it runs distally as three main cords. The central cord is the largest and strongest, originating from the medial calcaneal tubercle, dividing into five diverging bands that insert into the deep, short transverse ligaments of the metatarsal heads. The lateral cord originates from the lateral calcaneal tubercle, runs superficial to the abductor digiti minimi and inserts onto the base of the fifth metatarsal, inferior and posterior to the peroneus brevis tendon insertion. The thin, less significant, medial cord runs superficial to the abductor hallucis muscle, merging with the fascia distally. At the metatarsal phalangeal joints (MTPJs) the digital bands form the fibrous flexor sheath. It is increasingly recognised that the plantar fascia is a continuation of the Achilles tendon (figure 1).

The term gastro-calcaneo plantar system is quite a mouthful, but emphasises that the achilles tendon and the plantar fascia are a continuum with posterior surface of the calcaneus acting as a fulcrum.

The purpose of the plantar fascia is to act as static support to the longitudinal arch of the foot. In children, there is an obvious and intimate connection between the distal Achilles tendon fibres with the proximal plantar fascia, which recedes with age (figure 2). By middle age, there remain only superficial periosteal fibres, however a direct relationship remains as an increase in the tension strain within the Achilles has a direct effect of increasing the tension strain of the plantar fascia.

**Imaging technique**

Ultrasound of the plantar fascia is technically straightforward. The patient lies either prone with an elevation pad under the anterior ankle or sits on the couch with the legs extended over the couch to allow access to the plantar aspect of the foot. We prefer to use a high frequency (12-18MHz) linear probe.

The ultrasound image of the main central cord of the fascia demonstrates a uniformly hyper-echoic fibrillar structure, with a plantar/dorsal thickness of less than 3-4mm, depending upon the size of the patient. Thickness is usually measured just distal of the calcaneal footprint. The obliquity of the deep insertion fibres at the calcaneal origin can appear hypo-echoic due to anisotropy. The lateral cord is a thin band that abruptly widens at the insertion onto the fifth metatarsal.

The most common location of fasciosis is the proximal third of the central cord. Characterised by hypoechoic thickening of the fascia, with loss of fibrillar uniformity, there is blurring of the deep and superficial borders of the aponeurosis and enthesopathy of the calcaneal insertion. The plantar fascia should be visualised from the calcaneal insertion all the way to the distal metatarsals, since this may reveal less commonly seen focal pathology within the middle or distal fascia (figure 3).

The lateral cord of the plantar fascia is less often involved than the central cord but distal enthesopathy of the insertion can manifest as lateral or plantar pain. This may be secondary to plantar fasciopathy of the central cord causing a change of gait to avoid walking on the painful medial
tubercle (protective supination of the foot). The lateral cord has a broad insertion on to the inferior aspect of the fifth metatarsal, not to be confused with the distal peroneus brevis tendon, which has a lateral insertion.

Plantar fascial tears can occur in both the proximal third and mid fascial regions. Ultrasonically there will be the loss of fibrillar continuity and focal nodular thickening, particularly of the superficial fibres. Partial intrasubstance tears can be difficult to distinguish from focal fasciitis. The clue may be in the history, with an acute onset of pain following trauma, or a recent local steroid injection. Unique to ultrasound scanning, real-time imaging allows for dynamic assessment of the integrity of a full thickness tear with dorsiplantar flexion of the halluc and ankle.

Other causes of plantar heel pain
Calcaneal stress fractures
Plain radiography should be the first line investigation for a suspected fracture, but the presence of cortical irregularity with hypoechoic thickening of the periosteum and focal vascularity on ultrasound should raise this suspicion and direct the patient for a radiograph.

Plantar fibromatosis (Ledderhose disease)
This is a benign fibroblastic proliferation with characteristic relative echopoor nodules on the superficial surface of the plantar fascia, usually within the mid or distal region. These can be singular, multiple and often bilateral. Careful attention is required to distinguish this condition, which indents the superficial surface of the aponeurosis, from focal fasciopathy, which lies more centrally.

Tarsal tunnel syndrome (TTS)
The innervation of the plantar fascia is from the lateral and medial plantar nerves and proximally from the medial calcaneal nerve, all branches of the tibial nerve (figure 4). Consequently, entrapment neuropathy of the distal tibial nerve within the tarsal tunnel or of the plantar nerves can cause hindfoot pain. Ultrasound imaging of the tarsal tunnel should be routine in the assessment of hind foot pain. TTS can be caused by foot deformity, particularly pes planus. Alternatively it may be from a space occupying lesion such as a ganglion, neuroma or flexor tendinopathy with tenosynovitis (figure 5).

Baxter’s nerve
The nerve to the abductor digiti quinti (first branch of the lateral plantar nerve) can be entrapped as it passes overtight fascia. If the plantar fascia is sonographically normal then this should be considered. An MRI scan may show muscle atrophy and signal change consistent with denervation.

Tendon pathology
Achilles tendon
Problems here are divided into those of the main body of the Achilles and those at the insertion.

Non-insertional tendinopathy is usually obvious clinically, with patients suffering painful stiffness, particularly with first steps in the morning or after a prolonged period of sitting. There is swelling and tenderness of the tendon a few centimetres above the calcaneus. Most commonly the tender swelling moves up and down with ankle motion, since the lump is an area of tendinosis. An ultrasound scan affords the opportunity to establish the severity of tendinosis and in selected cases where conservative therapy (stretches) have failed, treat the condition. We favour injection prolotherapy although other groups have good results with high volume injections to achieve a non-surgical strip of the anterior paratenon. Steroid injections are not advisable around the Achilles for fear of ‘causing’ a rupture.

Ultrasonographically the appearances of focal tendinosis are sometimes referred to as partial ruptures. Micro-tears is a better phrase. Patients who tear their Achilles have “never had a day of trouble” before, and those with a “grumbling Achilles” never tear their (thickened) tendon. This rule applies to all except the elderly.

Recent advances include the recognition that sometimes it is the plantaris tendon, on the medial side of the Achilles, which is diseased rather than the Achilles itself.

Insertional tendinopathy is complex to manage. The problems of tendinosis of the distal Achilles, enthesopathy with calcaneal spur formation and bursitis between bone and tendon (retrocalcaneal bursitis) or between tendon and skin (retroachilles bursitis) are rarely present in isolation. Often all co-exist. Ultrasound is an excellent modality for helping to establish the severity of each problem. Retrocalcaneal bursitis will often be improved, at least temporarily, by a targeted injection. We recommend extreme caution injecting a retroachilles bursa because steroid atrophy here is very poorly tolerated.

Rupture of the Achilles tendon is increasingly managed non-operatively but informed surgeons will request an ultrasound scan to ensure that there is no fat or haematoma preventing good opposition of the tendon ends when the foot is plantar-flexed. Such problems are a relative indication for surgical management. Hospitals are struggling to provide rapid access to ultrasound scans for this relatively common injury.

Tibialis posterior
Fallen arches, or acquired adult flat foot, is usually due to tendinopathy of the posterior tibial tendon. This tendon supports the longitudinal arch of the foot, inverts the ankle and through these actions allows optimum Achilles function. As the severity and duration of the flat footedness progresses there is gradual attenuation of the spring (calcaneo-navicular) ligament and eventually lateral hindfoot impingement with pain from the peroneal tendons as they are squashed between the os calcis and the distal fibula.

A different source of pain may be the tendon’s attachment to the navicular tuberosity, with tendinosis or inflammation at the synchondrosis between an accessory navicular and the main body of that bone.

Flexor hallucis
The flexor hallucis longus tendon (FHL) at the ankle lies immediately posterior to the talus. Within the tarsal tunnel it is postero-lateral to the tibial nerve. Tendonovitis may cause plantar pain due to the close proximity to the tibial nerve but it should be noted that a small amount of fluid in the FHL sheath should be considered physiological. Posterior ankle impingement may be due to FHL tendinopathy or to a prominent posterior talar process/separate os trigonum. Dynamic assessment of the FHL should be part of the routine examination in posterior or plantar ankle pain. A carefully placed injection of local anaesthetic at the site of potential impingement is a useful confirmatory diagnostic test.

Peroneal tendons
The peroneus longus tendon runs from the lateral ankle to the medial side of the foot. It plantar flexes and everts the foot. Insertion is onto the plantar aspect of the base of the first metatarsal/medial cuneiform. It can contain a sesamoid bone, the os peroneum, at the level of the cuboid. Traumatic rupture of the distal peroneus longus, which is uncommon, can occur from an inversion-dorsiflexion injury. Proximal displacement of the os peroneum should raise suspicion of a distal tendon tear but the distal portion of the tendon is difficult to scan due to anisotropy.

The peroneus brevis inserts laterally onto the base of the fifth metatarsal. In lateral plantar pain, systematic imaging...
will differentiate insertional tendinopathy of the peroneus brevis from the more plantar insertion of the lateral cord of the plantar fascia.

The peroneal tendons are a common source of discomfort in the ‘ankle sprain that fails to heal’ and ultrasound provides a much better assessment than the static images from an MRI. Mechanical symptoms can arise from the longus tendon clicking between two parts of a split in the brevis tendon, or rarely from the two intact tendons subluxing relative to one another. The retinaculum may be injured allowing the tendons to escape from behind the fibula (this can be subtle) or there may be swelling and tenderness where the two tendons diverge at the peroneal tubercle on the lateral wall of the os calcis.

In conclusion

Hind foot pain can be complex. A sound knowledge of the orthopaedic differential diagnosis as well as a keen eye for inflammatory arthropathy are essential.

Plantar ‘fasciitis’ is certainly the most common cause of plantar heel pain, but a thorough and systematic approach to scanning should be standard practice.

Posterior heel pain usually relates to the Achilles tendon or the insertion complex. Posterior impingement and FHL pathology can be usefully categorised with ultrasound scanning. The whole spectrum of peroneal tendon pathology is well visualised with ultrasound, the dynamic assessment being especially beneficial over information from MRI.

References


Figure 1
Anatomy of the foot.

Figure 2
Gastroc-calcaneo plantar complex.

Figure 3
Focal fasciopathy.
**Figure 4**
Plantar nerves.

**Figure 5**
Ganglion.