Heel pain

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Case Study

A 41 year old man presented with pain in the right heel when running. The left heel was asymptomatic. The patient was a keen amateur sportsman but had slowly become unable to participate in sports due to gradual increase in pain over the previous six months. Physical examination revealed localised tenderness over the anterior plantar surface of the right calcaneus and soft-tissue thickening and focal tenderness over the distal third of the Achilles tendon. The left heel was unremarkable. The patient also complained of vague low back pain with increased back stiffness. Clinical examination of the lumbar spine and sacro-iliac joints was normal.

Figure 1 Lateral radiograph of the right calcaneus demonstrating small inferior calcaneal spur.

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Figure 2 Tc 99m MDP isotope bone scan for both heels. There is increased uptake in both anterior calcaneal regions right > left, and also increased uptake in the first MTP joint on the right.

Serological studies showed the patient to be rheumatoid factor negative but HLA B27 antigen positive. Lateral radiograph of os calcis (fig 1), AP radiograph of pelvis and sacro-iliac joints as well as isotope bone scan of the heels (fig 2) and sacro-iliac joints were obtained. Imaging of sacro-iliac joints failed to reveal any abnormality and it was decided to perform ultrasound (fig 3 and 4) and magnetic resonance imaging (fig 5) of both heels.

Imaging techniques in heel pain

RADIOGRAPHY

Conventional radiographs are cheap, broadly accessible, easy to interpret and are a useful investigation when bone pathology is suspected. However, they provide little information on soft-tissue pathologies responsible for the vast majority of heel pain complaints.

NUCLEAR MEDICINE

Isotope bone scans utilising 99 Technetium MDP are more sensitive to bone pathology than conventional radiographs when considering such conditions as early infection, primary and secondary bone tumours, early Paget's disease and stress fractures. They may also demonstrate increased activity with certain inflammatory conditions such as plantar fascia origin disease or calcific tendinitis. The changes are non-specific, however, and usually unsuccessful in demonstrating pure soft-tissue lesions.

COMPUTED TOMOGRAPHY

Computed tomography (CT) provides exquisite osseous detail of the hindfoot, but, due to its limited soft-tissue resolution capabilities, it has only a minor role in the investigation of heel pain. CT is useful in the localisation of abnormalities present on Isotope bone scans but not visible on plain radiographs, or in the assessment of possible tarsal tunnel syndrome (although even in these circumstances magnetic resonance imaging should be used if available).

ULTRASOUND

High resolution, real-time ultrasound (US) provides extremely good spatial resolution when examining superficial structures such as the Achilles tendon, posterior calcaneal and plantar fascia origin regions. US is inexpensive and quick to perform, relatively easily

Figure 3 Longitudinal US scans of both plantar fascia origins. (a) The left plantar fascia (arrows) is of normal echogenicity but slightly thickened at 4.1 mm; (b) the right plantar fascia origin is considerably thickened (arrowheads) at 6.5 mm with decreased heterogeneous echo pattern.

obtainable, well tolerated by patients and does not use ionising radiation. Also current work suggests that colour flow doppler imaging may have a role in the assessment of inflammatory disease activity. It has the disadvantages that the modality is operator dependant requiring meticulous technique and has a field of view limited by acoustic-shadowing from bone and the reduced penetration depth of high-frequency, high-resolution transducers. Localised or diffuse fluid accumulations in the tissue planes are easily detected. US guided needle placement can be done for fluid sampling and steroid injections.

MAGNETIC RESONANCE IMAGING

The broad field of view allowing good visualisation of both soft-tissue and bone pathology over a wide area makes this an ideal modality for the investigation of heel pain. Magnetic resonance imaging (MRI) has superior soft tissue contrast compared with other modalities although US probably provides better spatial resolution for superficial structures particularly within connective tissue. MRI has the disadvantages of being expensive and usually of limited access. It is also unsuitable for patients with claustrophobia (although less of a problem when the heel is being examined as most of the body is outside the bore of the scanner), obesity, certain metal implants and in those patients who are unable to stay motionless for prolonged periods.

Imaging findings

The plain films revealed bilateral small inferior calcaneal and retrocalcaneal spurs. Tc99m isotope bone scan showed a discrete area of increased uptake at the anterior plantar border of the right calcaneus with less activity at the same site on the left. Ultrasound examination of the inferior calcaneal regions showed the right plantar fascia origin to be considerably thickened at 6.5 mm while the left was also mildly thickened at 4.1 mm. Both plantar fascia origins demonstrated a mixed and generally reduced echogenicity; these changes being again more marked on the right. The left Achilles tendon demonstrated an echogenic fibrillar pattern and was oval in transverse cross-section. The right mid-Achilles tendon was of homogenous low echogenicity and more rounded in cross-section. The retrocalcaneal and distal-Achilles regions were normal. MRI confirmed contour changes in plantar fascia and Achilles tendon, demonstrating increased signal within areas of tissue thickening.

Discussion and differential diagnosis

MID-ACHILLES TENDINITIS

In mid-Achilles tendinitis, US and MRI reveal a fusiform or diffuse thickening of the tendon on longitudinal section. The normal oblique ellipse tendon seen on cross-section becomes more rounded as the condition progresses. A normal tendon (and fascia) being dense connective tissue is echogenic on US and produces a virtual echo void on MRI. In tendinitis (and fasciitis) the echogenicity decreases and becomes more heterogeneous on US while there may be focal areas of signal increase on T2-weighted MRI sequences. In patients with exercise related Achilles tendinitis, microruptures appear to accumulate in the mid tendon probably related to the fact that there is a vascular watershed in this region. Continued repetitive injury is likely to result in partial or complete tendon rupture. Such a scenario is supported by the clinical evidence that patients with Achilles ruptures often have a previous symptomatic history that suggests tendinitis and there is often histological evidence of mucoid degeneration within the

Figure 4 Longitudinal US scans of right Achilles tendon insertion. There is hypoechoic fluid within slightly echogenic walled retrocalcaneal bursa (arrows).

Figure 5 T2 gradient echo sagittal image of right calcaneus. The plantar fascia origin is thickened and demonstrates increased signal (arrows) and there is increased signal due to fluid in the region of the retro-calcaneal bursa (arrowhead).

ends of ruptured tendons at the time of surgical repair. Most of the known systemic conditions predisposing to tendon rupture, for example, steroid therapy, systemic lupus erythematosus, rheumatoid arthritis, renal transplantation plus or minus cyclosporin therapy and hypercholesterolaemia have an effect on small vessel circulation.

DISTAL-ACHILLES TENDINITIS

Although distal-Achilles disease may be due to repetitive trauma abundant vascular supply promotes tendon healing, and tendinitis would appear to usually reflect inflammatory changes secondary to adjacent retrocalcaneal or precalcaneal bursal disease. Prolonged inflammation may result in weakening of the tensile strength of the distal-Achilles collagen bundles with subsequent tendon rupture.

RETROCALCANEAL BURSITIS

The retrocalcaneal bursa lies between the postero-dorsal tubercle of calcaneus and the Achilles tendon insertion at the inferior apex of Kager's fat triangle. This angle becomes obliterated by hindfoot dorsiflexion and therefore the bursa potentially acts as a protective cushion for the distal Achilles tendon. Excessive repetitive injury however results in inflammation of the bursa, that is, retrocalcaneal bursitis. Similar changes may occur with inflammatory processes such as rheumatoid arthritis, ankylosing spondylitis, psoriatic arthropathy and Reiter's syndrome. Inflamed, fluid filled retrocalcaneal bursae are well demonstrated as high signal areas on MRI T2-weighted sequences, particularly if some form of fat suppression technique is utilised (fat normally is high signal on T2-weighted images but the signal is reduced from fat by such techniques highlighting the increased signal in the fluid-filled retrocalcaneal bursa). The bursa appears as an anechoic sac on US often with reduced echogenicity of adjacent tissues representing oedema within fat and distal-Achilles tendon secondary to retrocalcaneal bursa inflammation. Occasionally mixed echogenicity due to pannus within the bursa is seen in RA, or small echogenic foci plus or minus acoustic shadowing may be present in calcific or crystalline bursitis. Persistent bursal inflammation results in resorption or erosion of adjacent os calcis.

PRECALCANEAL BURSITIS

The small adventitial bursa superficial to the Achilles tendon at its calcaneal insertion may also become inflamed by repetitive friction injury particularly when an underlying posterior calcaneal exostosis is present (pump-bump). The MRI and US characteristics are similar to those seen in retrocalcaneal bursitis. The bursa is apparently less commonly involved with inflammatory arthropathies.

PLANTAR FASCIITIS

The plantar fascia (fig 6) functionally acts as the aponeurotic attachment for the first layer of intrinsic plantar muscles, that is, abductor hallucis, flexor digitorum brevis and abductor digiti minimi. The plantar fascia has a well defined broad based attachment to the inferior aspect of the calcaneus, the thickest section originating from the medial calcaneal tubercle. Plantar fasciitis may be a true inflammatory process or reflect injury to the plantar

Figure 6 (A) Plantar fascia; (B) Calcaneo-navicular ligament; (C) Interosseous talo-calcaneal ligament; (D) Tendo-achilles.

aponeurosis. Injury would appear to take two different forms. Firstly repetitive isometric intrinsic muscle contraction against a maximally stretched plantar fascia as occurs during the push off phase of gait may result in traction injury at the calcaneal attachment. Such a traction phenomena would explain why bony spurs when present occur at the deep anterior margin and not at the fascia insertion per se, that is, they appear to be buttressing osteophytes. Mechanical factors predisposing to plantar fasciitis include calcaneo-valgus, pes planus and pronation deformity. The latter deformity is interesting as it occurs in 80% of patients with plantar fasciitis, and is associated with short or 'tight' Achilles tendons. Secondly, overloading of the medial longitudinal arch of the foot produces excessive strain on the plantar fascia bowstring resulting in repetitive focal tears in the mid/posterior section of aponeurosis. This theory is supported by the fact that acute mid-plantar fascia tears are known to occur occasionally and obesity predisposes to plantar fasciitis. Active inflammation tends to produce decreased signal on T1- and increased signal on T2-weighted image sequences while increased signal on both T1- and T2-weighted images suggests mucoid degeneration. It should be noted, however, that local anaesthetic and steroid infiltration may also result in an area of increased signal for some weeks following injection into the region of plantar fascia origin particularly when a lipid based agent has been used. Ultrasound not only demonstrates the qualitative changes of heterogenous decreased echogenicity consistent with oedema/inflammation but also allows easy quantification of plantar fascia thickening. Occasionally, focal areas of fluid collection are demonstrable in the angle between plantar fascia origin and calcaneus or superficial to the plantar fascia calcaneal origin but it is unclear whether these reflect subcalcaneal bursae or oedema within soft-tissues adjacent to inflamed plantar fascia.

CALCANEAL STRESS FRACTURES

The os calcis is a common site for stress fractures (normal bones, abnormal stress) of the lower extremities representing approxi-

mately 30 to 45% of cases. It has been known for some time from conventional radiography that these stress injuries run along or just anterior to a line joining the posterior-dorsal and medial-plantar calcaneal tubercles. More recently CT (fig 7) and MRI have shown that these stress fracture lines not only pass between regions of Achilles tendon and plantar fascia attachments to os calcis in the sagittal plane but also in the axial plane, that is, they predominate postero-medially. Such fractures may reflect repetitive shear strain across the posterior aspect of os calcis trabeculae being sheared by the traction effects of Achilles tendon and plantar fascia. The same mechanisms operate to generate insufficiency fractures (abnormal bones, normal stress) in osteoporosis and associated with rheumatoid osteitis and steroid therapy.

CALCANEAL APOPHYSITIS

Although there has been much debate on the radiographic significance of the condition first described by the US orthopaedic surgeon J W Sever, there is little doubt that the condition exists clinically and it is detectable by technetium 99 SG DP isotope scans. It is likely that the condition again reflects the shearing action of Achilles tendon and plantar fascia calcaneal traction forces. It is also likely that both MRI and US should be able to provide objective evidence of the condition as they do for apophysitis of the tibial tubercle. As yet, however, such studies have not been forthcoming.

NEOPLASMS

Primary bone neoplasms are a rare cause of heel pain. Benign neoplasms are more frequent than malignant with a ratio of approximately 8:1. Osteoid osteomas are probably the most common primary bone lesion to cause heel

Figure 7 Axial CT showing a retained glass foreign body embedded in the tendo-Achilles.

pain, this being the site for 2–3% of all osteoid osteomas. In view of the calcaneal apophysis, chondral tumours too have a predilection for the calcaneum. Simple bone cysts are more common but are usually asymptomatic unless there is associated pathological fracture. Less than 4% of all skeletal metastases occur distal to the knee joint with the majority of these being part of widespread skeletal dissemination. Therefore, even though it is a site of relative predilection for metastasis within the foot, an isolated calcaneal metastatic deposit is rare. Isotope bone scans are more sensitive than plain radiographs in the detection of metastatic disease (and many primary bone tumours, for example, osteoid osteoma) while allowing visualisation of the whole skeleton to search for further bony deposits. It is therefore the correct initial imaging modality if such lesions are clinically suspected, and followed by CT in defining the underlying structural abnormality. Benign soft-tissue neoplasms in the heel region also outnumber malignant lesions by approximately 8:1. The most common soft-tissue tumours are plantar fibromas and plantar neuromas both of which may be demonstrated on MRI or US although if neuromas secondary to tarsal tunnel syndrome are suspected then MRI is more appropriate.

OSTEOMYELITIS

In 10% of children with osteomyelitis the primary site of involvement is one of the bones of the foot with more than half of these being in the os calcis. Infective foci produce areas of increased uptake on isotope bone scans and decreased signal on T1- and increased signal on T2-weighted MRIs.

MISCELLANEOUS

Paget's disease may be the source of heel pain in the elderly population and is demonstrable on all forms of bone imaging. Foreign bodies within the tendon, heel, or pad may also cause heel pain, these being particularly well demonstrated and localised for removal using US or CT to demonstrate metal, glass and vegetative materials (fig 7).

Diagnosis

In our patient the imaging findings suggested bilateral plantar origin fasciitis much more marked on the right. The changes may be due to early sero-negative inflammatory arthropathy or repetitive traction injury. The posterior heel changes are consistent with a retrocalcaneal bursitis which in conjunction with the changes of increased isotope in the region of the first metatarso-phalangeal joint makes inflammatory arthropathy more likely.

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