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## Impingement syndromes of the ankle

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**Abstract** Ankle impingement syndromes are categorised according to their anatomical site around the tibiotalar joint. Anterolateral, anterior and posterior ankle impingement has been extensively described in the orthopaedic and radiology literature with more recent studies describing posteromedial and anteromedial impingement. This article aims to demonstrate the potential

spectrum of imaging findings for each ankle impingement syndrome as well as the relative contributions of ultrasound and MR imaging for diagnosis and image-guided treatment.

**Keywords** Ankle · Injuries · Ankle impingement · Ankle · MRI · Ankle · Ultrasound · Athletic injuries

### Introduction

Supination (inversion) injury of the ankle is one of the most common injuries in the general population and athletes. Although the majority respond to rehabilitation, 15–20% of sports injuries can result in persisting symptoms [1]. Because of the large volume of acute ankle injuries chronic pain is a frequent clinical problem with the differential diagnosis including osteochondral injury, mechanical instability and impingement syndromes [1]. Originally described in the 1950s, impingement syndromes are now recognised as a significant cause of chronic ankle pain [2–5]. Impingement used to be considered a clinical diagnosis of exclusion, but the literature now shows it can coexist with other causes of chronic ankle dysfunction [5, 6].

Ankle impingement is defined as painful mechanical limitation of full ankle movement secondary to osseous and/or soft tissue abnormality. These conditions occur more commonly in active people and athletes probably because recurrent subclinical injury is an important factor in development [7]. Onset of symptoms is variable and can either be insidious or secondary to a precipitating injury in a different anatomical area of the ankle [4, 7, 8].

Ankle impingement syndromes are categorised according to their anatomical site around the tibiotalar joint. Anterolateral, anterior and posterior ankle impingement

has been extensively described in the orthopaedic and radiology literature with more recent studies describing posteromedial and anteromedial impingement [2–5, 9].

This article aims to demonstrate the potential spectrum of imaging findings for each ankle impingement syndrome emphasising the contributions of ultrasound and MR imaging for diagnosis and image guided treatment.

### Anterolateral impingement

#### Aetiology and clinical features

The boundaries of the anterolateral recess of the ankle consist of the tibia and fibula posteromedially and laterally with the capsule of the tibiotalar joint forming the anterior and lateral margins (Fig. 1). The capsule is reinforced by the anterior tibiofibular, anterior talofibular and calcaneo-fibular ligaments [2].

Anterolateral impingement is thought to develop subsequent to a relatively minor injury usually consisting of forced ankle plantar flexion and supination [2, 6, 10]. This injury mechanism generates tensile forces which tear the anterolateral capsular tissues without clinically significant mechanical instability. However, subsequent functional instability and associated repeated microtrauma can lead



**Fig. 1** Normal anatomy. (a) Normal axial PD-weighted MR arthrogram image shows anterior talofibular (black arrowheads) and posterior talofibular (\*) ligaments. The anterolateral recess is seen with its smooth capsular margin (arrows) extending between the talus and fibula. (b) Sagittal T1-weighted fat-suppressed MR

arthrogram image shows normal triangular configuration of the posterior inter-malleolar ligament (arrow) adjacent to the tibia. Note anterior synovitis (\*). (c) Axial PD weighted MR arthrogram image at the level of the talar dome shows the inter-malleolar ligament (arrowheads) extending from the fibula

to further soft tissue haemorrhage, synovial scarring and hypertrophy. Although some studies have described additional hypertrophy of the inferior portion of the anterior tibiofibular ligament and occasionally osseous spurs, these are rarely a predominant feature at imaging or surgery (Fig. 2) [2, 6, 11, 12].

Initially anterolateral impingement was described as a clinical diagnosis of exclusion only made in the absence of mechanical instability and tendon abnormality [11]. However it now is recognised that all the ankle impingement syndromes can exist on their own or in combination with injuries such as chondromalacia and tendinopathy. It is important to recognise this clinically and radiologically so that coexistent pathologies are not missed resulting in potential treatment failure [1].

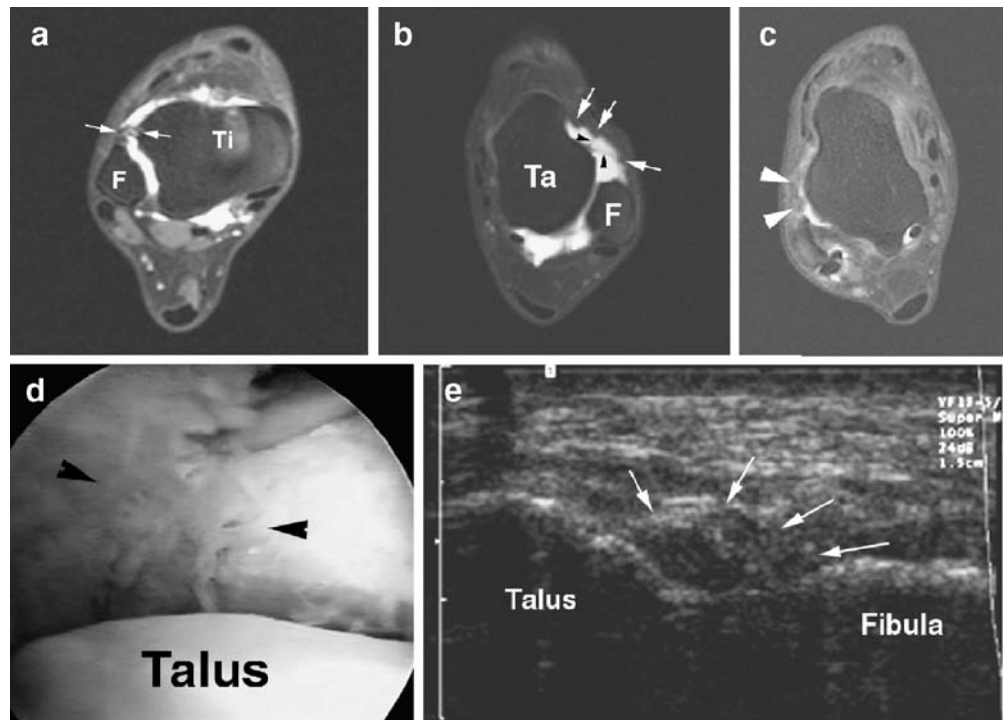
Patients typically complain of anterolateral ankle pain which is exacerbated on supination or pronation of the foot. Surgical series have found anterolateral tenderness, swelling, pain on single leg squat and pain on ankle dorsiflexion and eversion seem to correlate most strongly with subsequent abnormality at surgery [11].

#### Imaging features

This condition remains a predominantly clinical diagnosis and the role of cross-sectional imaging in detecting capsular abnormalities is more controversial [2, 3, 6, 10]. Ultrasound has not been fully evaluated in this condition with one series reporting capsular nodularity in patients with clinical impingement, but no significant data regarding asymptomatic or symptomatic controls are available (Fig. 2e) [13].

Studies investigating the use of conventional MR imaging have produced conflicting results in the pre-operative patient [10, 14–17]. Sensitivity and specificity for the detection of abnormality vary widely with an increase of accuracy occurring when a significant joint effusion is present [10]. However most prior surgical and radiology series have retrospectively selected positive surgical cases with no evaluation in controls [10, 14, 16, 17]. MR and CT arthrography studies have found a strong association between capsular irregularity of the anterolateral recess and subsequent surgical abnormality [6, 18]. Arthrography may be most effective in anterolateral impingement as this condition predominantly consists of internal capsular irregularity rather than soft tissue oedema and has no significant osseous component which can be evaluated on conventional MR imaging and radiographs respectively. This capsular irregularity can be easily missed on conventional MR imaging and indirect MR arthrography unless a native effusion is present. One prospective study of patients with clinical anterolateral impingement and controls with chronic ankle pain found a smooth contour on MR arthrography correlated with normal capsular findings at arthroscopy. An irregular or nodular deep contour of the anterolateral capsule on MR arthrography correlated with scarring and synovitis of the ankle recess at arthroscopy (Fig. 2). The most common abnormality was best seen on axial sequences and involved the capsule just above the level of the anterior talofibular ligament, but could extend superiorly to the tibiofibular ligament. The ligaments themselves are usually not abnormal and unlike posterior impingement syndromes soft tissue oedema is not commonly seen. A more specific sign was adherence of the capsular

**Fig. 2** Patients with clinical anterolateral impingement. **(a)** Axial T1-weighted fat-suppressed MR arthrogram image shows thickening of the anterior tibiofibular ligament (arrows) (Ti = tibia, F = fibula). **(b)** Axial T1-weighted fat-suppressed MR arthrogram image shows nodularity (white arrows) and stranding (black arrowheads) in the anterolateral recess (Ta = talus, F = fibula). **(c)** Axial T1-weighted fat-suppressed MR arthrogram image shows an irregular and thickened anterolateral recess (arrowheads) with a nodular contour that does not distend away from the fibula and talus. **(d)** Corresponding arthroscopic image (to **c**) shows the talar dome with anterolateral synovitis and nodularity (arrowheads). **(e)** Transverse axial ultrasound shows a predominantly hypoechoic nodule (arrows) in the anterolateral recess between the talus and fibula



tissues to the anterolateral talus despite good arthrographic distension elsewhere in the joint (Fig. 2). This feature correlated with marked, adherent, scarring at surgery and was only found in a subset of patients with clinical impingement. However this study also highlighted a number of patients without clinical anterolateral impingement that had surgically confirmed capsular thickening on MR arthrography. All previous clinical series have described concomitant intra-articular abnormalities including chondral damage, ligament abnormality and osseous spurs. These additional findings are usually relatively minor, but not surprising given the original mechanism of injury and subsequent functional problems.

#### Management and role of imaging

The majority of patients with anterolateral impingement respond to rehabilitative physiotherapy; however if this is unsuccessful, debridement of synovitis and scarring results in considerable improvement in symptoms and ankle function [2, 11, 12].

If MR imaging is to play a role it should be reserved for patients where there is some clinical uncertainty regarding the diagnosis or if surgery is planned. A normal MR arthrogram seems to exclude anterolateral synovial scarring; however in patients with definite clinical impingement conventional MR imaging may be all that is necessary to detect coexisting pathology prior to surgery [6, 19, 20].

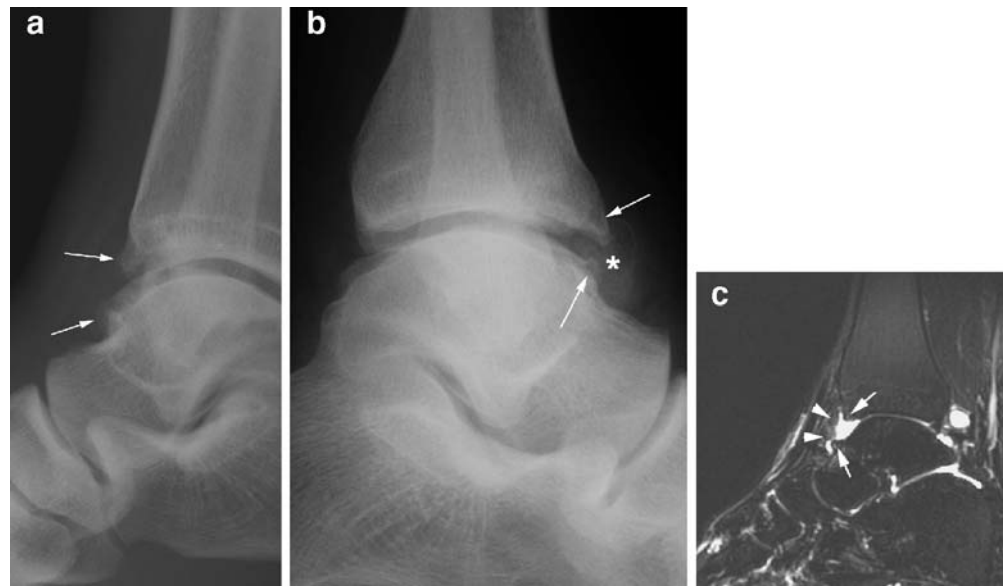
#### Anterior impingement

##### Aetiology and clinical features

Anterior ankle impingement has been extensively described as a cause of chronic ankle dysfunction and is sometimes termed “footballer’s ankle”. The underlying mechanism of injury implicated is repeated supination injury which causes damage at the anteromedial margins of the articular cartilage [21, 22]. Other aetiological factors include repeated forced dorsiflexion (common in ballet and football) and direct microtrauma (particularly seen in football players during ball striking) [23, 24]. Unlike other impingement syndromes osseous abnormality (anterior tibiotalar spurs) forms a significant component of the impinging mass (Fig. 3) [1, 22, 25–27]. Chronic damage to the chondral margins leads to repair with fibrous tissue, hyaline and fibro-cartilage undergoing subsequent enchondral ossification producing bone spurs. Studies of asymptomatic professional athletes have found a significant portion (45–59%) to have anterior tibiotalar spurs on X-ray [28]. It is thought that although these osseous abnormalities are an important part of this condition the development of additional capsular abnormality is critical for producing the clinical syndrome (Fig. 3b & c) [23, 24, 27].

The clinical features of this condition are anterior ankle pain with a subjective feeling of blocking on dorsiflexion. Examination reveals restrictive and painful dorsiflexion with occasionally palpable soft tissue swelling over the anterior joint [27].

**Fig. 3** Footballers with clinical anterior impingement. (a) Lateral ankle radiograph shows anterior tibial and the talar spurs (arrows) at the anterior articular cartilage margin. (b) Lateral ankle radiograph shows anterior tibial and the talar spurs (arrows) with degeneration at the anterior articular cartilage margin and soft tissue thickening (\*). (c) Sagittal T2-weighted fat suppressed MR image shows anterior tibial and talar spurs (arrows) but within the anterior recess of the joint there is an effusion with capsular thickening and stranding (arrowheads)



### Imaging features

After clinical assessment conventional radiographs are usually performed to confirm the extent and presence of osseous spurs on the lateral view [1, 21, 29]. The tibiotalar spurs occur in typical positions at the anterior and medial articular cartilage margins and some authors advocate a special anteromedial view to highlight their extent [30]. Radiographs also allow assessment of the remainder of the tibiotalar joint for secondary signs of degeneration including joint space reduction (Fig. 3b). Often this will be the only imaging required, because if the patient does proceed to arthroscopy, the remainder of the joint can be visualised at that time. There have been no significant radiology series evaluating cross-sectional imaging or ultrasound in this condition. MR imaging can demonstrate osseous spurs and synovial thickening extending over the anterior aspect of the joint (Fig. 3c). Like anterolateral impingement and unlike posterior impingement (see later) these abnormalities rarely show striking soft tissue or osseous oedema.

### Management and the role of imaging

In athletes with anterior ankle impingement resistant to rehabilitative physiotherapy, arthroscopic resection of the osseous spurs and soft tissue abnormality with joint washout has been shown to yield excellent functional and symptomatic results [27]. As already stated radiographs are usually the only imaging required. Occasionally conventional MR imaging can be a useful tool for aiding management decisions allowing evaluation of the entire joint for other pathologies when symptoms are not severe enough to proceed directly to surgery. CT scanning can

have a role in surgical planning if the extent of the tibiotalar spurs is not clearly evident on radiographs.

The surgical literature shows that despite the presenting clinical severity overall outcome is more dependant on the degree of degenerative change (chondral and sub-chondral damage) present in the remainder of the tibiotalar joint at the onset of treatment [27]. A large surgical series of anterior ankle impingement described 57 patients with either a normal joint space or minimal degeneration on conventional radiograph who had excellent function at 6.5 years post operatively (100% and 77% respectively) [27].

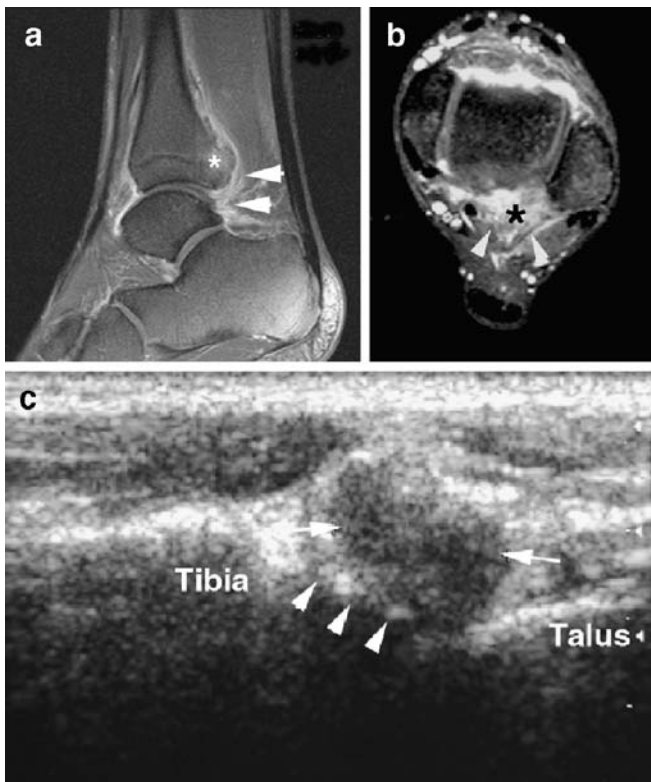
## Posterior impingement

### Aetiology and clinical features

Posterior impingement develops secondary to repeated or forced ankle plantarflexion with subsequent compression of the soft tissues between the posterior process of the calcaneus and the tibia (Figs. 4 and 5) [4, 31–33]. The lateral talar process or an os trigonum can also increase the degree of soft tissue compression with or without stress reaction in the bone itself. The lateral process of the talus initially forms as a secondary ossification centre between the ages of 7 to 13 years and usually fuses with the main body of the talus within 1 year of appearance [31]. If there is a failure of fusion, the ossicle is known as an os trigonum and articulates with the talus via a synchondrosis (incidence 7 to 14%) [31]. If the lateral talar process is unusually large or prominent it is sometimes termed a Steida process.

The soft tissues compressed include the tibiotalar capsule, posterior talofibular, intermalleolar and tibiofibular ligaments (Fig. 1). The flexor hallucis longus (FHL)





**Fig. 4** Footballer with clinical posterior impingement. **(a)** Sagittal T1 fat-suppressed post intravenous gadolinium MR image shows marked posterolateral soft tissue oedema and thickening (arrowheads) and oedema of the posterior tibia (\*). **(b)** Axial T2-weighted fat-suppressed MR image shows posterior capsular oedema (\*) and bulging (arrowheads) posterior to the talus. **(c)** Corresponding longitudinal ultrasound image shows cortical irregularity (arrowheads) of the posterior tibia and associated nodular soft tissue thickening (arrows). Palliative injection to this area was made under ultrasound guidance

tendon runs in the groove between the lateral and medial processes of the talus and can also be secondarily involved although a primary tenosynovitis can clinically mimic posterior impingement [4].

Posterior impingement is typically a chronic problem of insidious onset affecting athletes who regularly undergo forced plantarflexion especially ballet dancers, jumping athletes, squash and football players. Football players are particularly affected because plantarflexion occurs not only on push off during sprinting and changing direction but also occurs during kicking [4, 34]. As has been described in other impingement conditions the syndrome usually manifests clinically when a significant soft tissue component forms [4].

Symptoms can also develop subacutely after an acute injury either posteriorly or elsewhere in the ankle and is not uncommon in football and ballet athletes who develop symptoms 4–6 weeks after a precipitating injury (Fig. 4) [4, 7]. This presentation would suggest that there is constant stress on the posterior tibiotalar capsular structures causing



**Fig. 5** Footballer with clinical posterior impingement. Sagittal T1 fat-suppressed post intravenous gadolinium MR image shows enhancing posterolateral capsular synovitis and thickening (arrows). There was relatively little soft tissue oedema seen on T2-weighted images

subclinical posterior capsular damage and repair. Presumably the acute injury leads to haemarthrosis and further synovial thickening which added to the background damage is enough to precipitate the syndrome. In football players as the initial anterolateral symptoms, bruising and swelling settle, posterolateral ankle pain develops as the player starts to try and sprint, push off, change direction or strike through the ball [7].

Patients complain of posterior ankle pain exacerbated by dorsiflexion or plantarflexion, which results in stretching or compression of the abnormal tissues respectively [4, 34]. On examination there is posterior tibiotalar joint tenderness not involving the achilles tendon exacerbated by plantar flexion and dorsiflexion.

#### Imaging features

Conventional radiographs can demonstrate an os trigonum or a Steida process; however these findings are commonly seen in asymptomatic individuals and minor stress fractures can be easily missed [4]. CT scanning can demonstrate more detailed bony anatomy including stress fractures; however soft tissue resolution is poor [4, 31]. Isotope bone scans have been previously advocated [4, 31];

however if positive, precise resolution of the bony abnormality is difficult and this technique is relatively insensitive for soft tissue problems.

Conventional MR imaging is the optimal imaging modality as it can define bone marrow oedema, fracture lines or disruption of the synchondrosis indicating active bony impingement (Figs. 4, 5, 6 and 7) [31, 32, 35]. This technique is also accurate in assessing the integrity of the posterior capsular ligaments, capsular abnormality and oedema [7, 20, 32, 36]. The ligaments are usually intact, but surrounding posterior (particularly posterolateral) capsular oedema is commonly best seen on axial and sagittal T2-weighted sequences extending into Kager's fat pad. These features mean that direct and indirect MR arthrography are not necessary, but intravenous gadolinium can highlight small focal areas of enhancing synovitis around the posterior ligaments if oedema is not a predominating feature (Fig. 5). MR imaging also allows accurate assessment of the remainder of the tibiotalar joint and surrounding tendons, which can aid treatment and surgical planning.

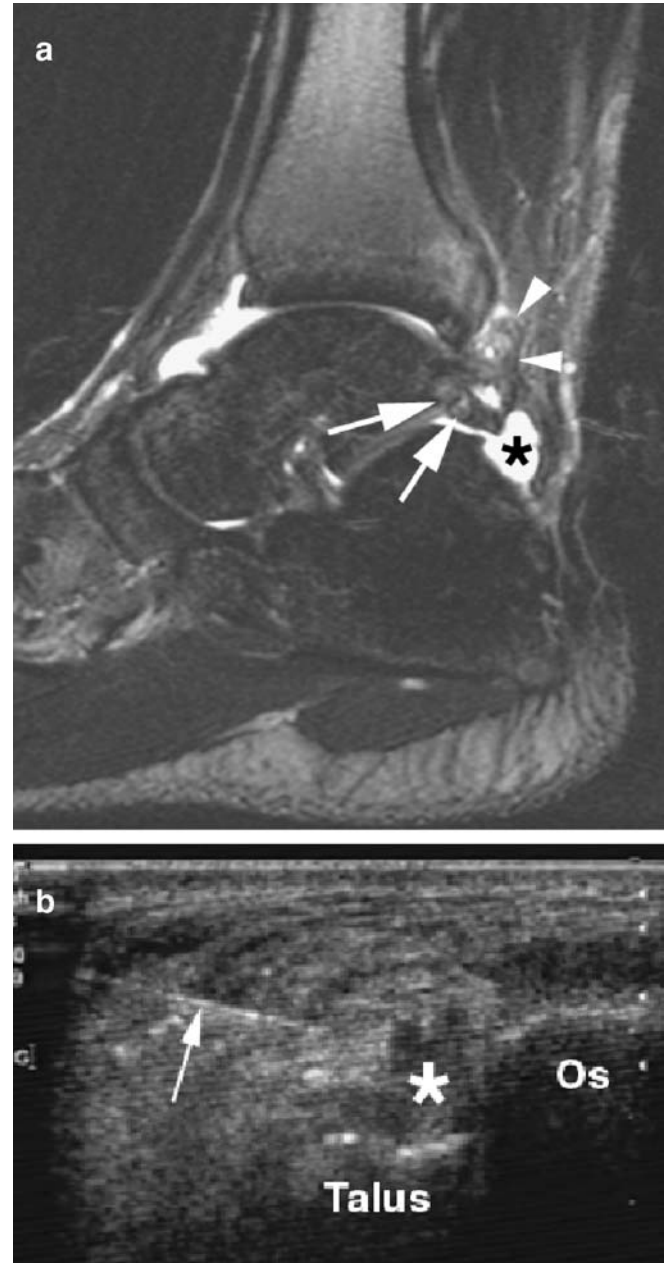
Ultrasound is a very useful technique in this condition, as the symptomatic area is usually quite focal and amenable to visualisation despite diffuse oedema on MR imaging (Fig. 4) [7]. If the abnormality is confirmed as focal with no other significant internal derangement on MR imaging, athletes can get good symptomatic relief after targeted ultrasound-guided injection of local anaesthetic and steroid into the nodular area (see below).



**Fig. 6** Patient with clinical posterior impingement. Sagittal T2-weighted fat-suppressed MR image shows bone marrow oedema within the os trigonum (\*) and fluid (large arrow) in the synchondrosis. Marked nodular thickening (small arrows) in the posterior capsular recess

## Management and role of imaging

The majority of cases of posterior impingement of the ankle respond to conservative treatment (physiotherapy) [4]. Conventional MR imaging can define the degree of oedematous change and exclude concomitant abnormal-



**Fig. 7** Footballer with clinical posterior impingement. (a) Sagittal T2-weighted fat-suppressed MR image shows a joint effusion (\*) and nodular posterolateral synovitis (arrowheads). There is oedema at the margins of the os trigonum synchondrosis (arrows). (b) Axial sonography image of the os trigonum (Os) and adjacent talus (Talus) shows nodular synovitis (\*) with needle (arrow) placed during infiltration and injection

ities. It is our institutional practice to perform MR imaging prior to capsular injection so osteochondral injuries are not potentially masked and allowed to progress. Image-guided steroid and local anaesthetic injection into focal capsular thickening or the Os trigonum synchondrosis provides long-lasting symptomatic relief in the majority of patients, which can mean surgery is not required (Fig. 7) [7, 37]. Even if this effect is temporary the treatment can allow professional athletes to delay surgery.

A number of surgical studies have shown that arthroscopic resection of soft tissue thickening and any associated bony abnormality with joint wash out produces good symptomatic and functional results in resistant cases [4, 34].

### Posteromedial impingement

#### Aetiology and clinical features

The exact aetiology and characteristic imaging features of posteromedial impingement have not been as completely defined as other impingement syndromes [5, 38, 39]. The condition develops after compression of the posteromedial tibiotalar capsule and posterior fibres of the tibiotalar ligament (PTTL) between the talus and medial malleolus during a supination injury [5]. It is thought that subsequent fibrosis and thickening of the contused PTTL and posteromedial capsule lead to painful impingement between the medial wall of the talus and posterior margin of the medial malleolus [5]. Posteromedial tenderness on inversion with the ankle in plantar flexion is an important clinical finding which differentiates pain originating from primary tibialis posterior abnormality [5]. In a similar manner to posterior impingement symptoms can be insidious or develop subacutely after another injury [5, 8, 38].

#### Imaging

Isotope bone scan, ultrasound and MR imaging features have previously been presented for three groups of patients with clinical posteromedial impingement [5, 8, 38]. Paterson et al. described increased posteromedial activity on isotope bone scanning in six patients (including five athletes) who presented a mean of 52 weeks after the original injury. However further abnormalities not detected on bone scan were treated at arthroscopy [5]. The other two series have concentrated on MR imaging and ultrasound features. Axial PD- and T2-weighted sequences show loss of striation of the posterior tibiotalar ligament (PTTL), capsular thickening with oedema abutting and occasionally encasing the posteromedial tendons (especially tibialis posterior) (Figs. 8 and 9). Ultrasound can identify hypo-echoic posteromedial capsular thickening deep to and sometimes displacing tibialis posterior, obscuring detail of the underlying PTTL (Fig. 9). The main difference between



**Fig. 8** Footballer with clinical posteromedial impingement. Axial PD-weighted MR image shows loss of striation of the tibiotalar ligament (arrows) with soft tissue thickening displacing tibialis posterior (\*)

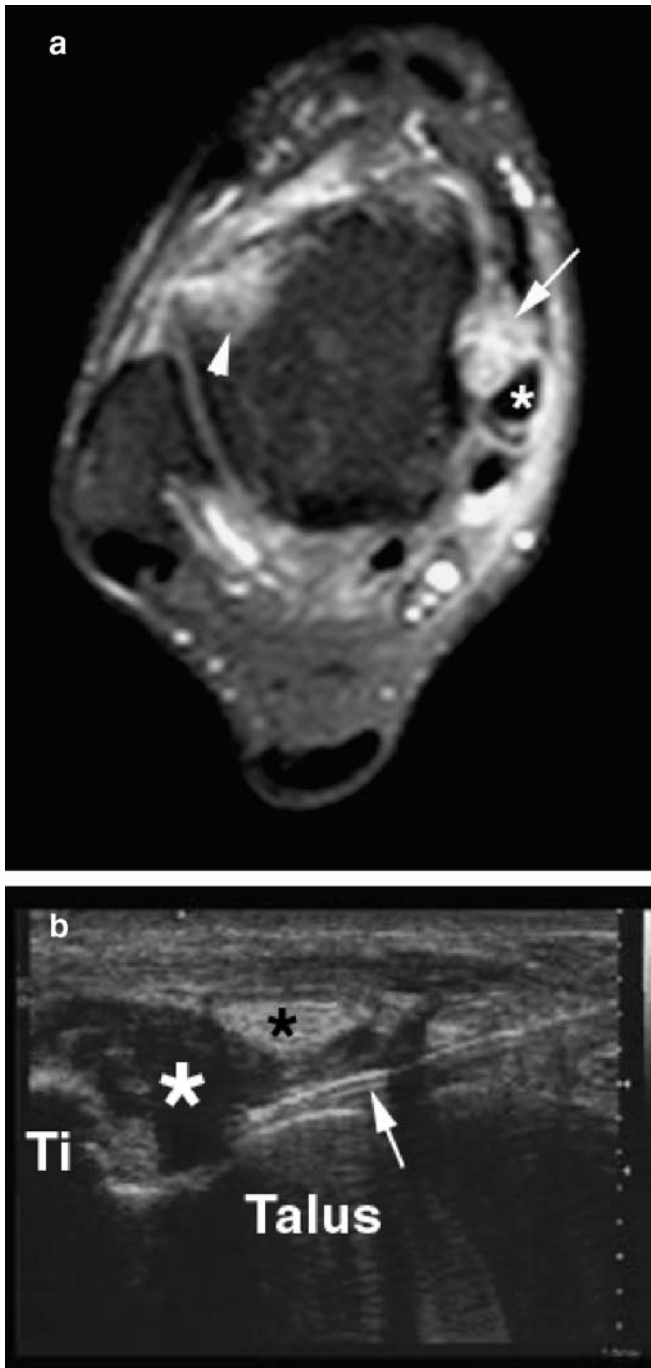
these two studies was the relatively low incidence of tendon encasement in the most recent series which evaluated athletes presenting subacutely (within 4–6 weeks) while in the earlier series patients had symptoms in excess of 1 year [8, 38]. This time difference may have resulted in differing proportions of encasing scar tissue present in the groups studied [8].

Arthrographic techniques and CT have not been evaluated in this condition, but conventional MR imaging is probably the optimal imaging technique. The use of intravenous gadolinium may be helpful in highlighting low grade synovitis in more subtle cases.

#### Management and role of imaging

After failed rehabilitation MR imaging can be performed to confirm posteromedial abnormality and exclude concomitant abnormality. Ultrasound can then identify the capsular abnormality and guide effective injection treatment (Fig. 9) [8]. Injection of steroid and long-acting anaesthetic along





**Fig. 9** Footballer with clinical posteromedial impingement presenting 3 weeks after a supination injury. **(a)** Axial T2-weighted fast spin echo fat-suppressed MR image shows posteromedial capsular oedema (arrow) displacing tibialis posterior (\*). Note asymptomatic anterolateral talar oedema (arrowhead). **(b)** Axial ultrasound image of the posteromedial talus and tibia (Ti) during injection (arrow) shows hypoechoic capsular thickening (white\*) displacing tibialis posterior (black\*)

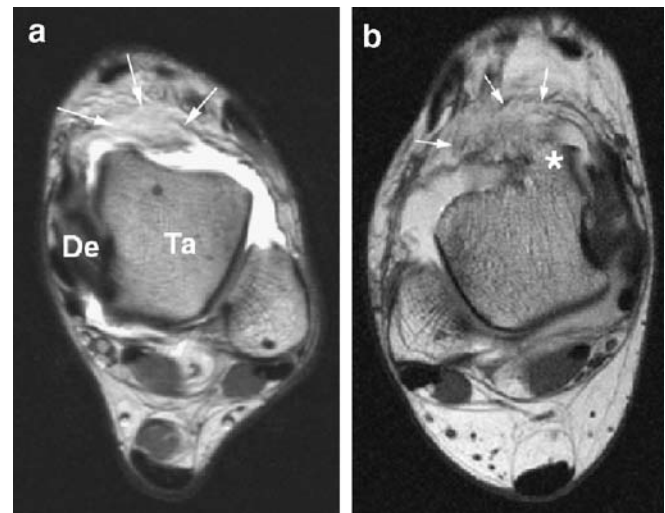
with dry needling of the capsular abnormality allows the majority of patients to rapidly return to activity without surgical intervention. Surgical resection of capsular thickening is successful in resistant cases and no formal ligamentous repair is usually necessary [5, 38].

### Anteromedial impingement

#### Aetiology and clinical features

The underlying mechanism of injury for this particular impingement syndrome is not completely understood, but the majority of cases described have initially suffered a supination injury [9, 40]. It seems likely that this condition is a rare complication of supination injury and not secondary to an eversion injury. There is probably a superimposed rotational component that leads to subsequent anteromedial capsular tearing, and in a similar process to anterolateral impingement, repeated micro trauma leads to synovitis and capsular thickening (Fig. 10a). However, unlike anterolateral impingement, a proportion of the cases described have also had significant osseous spurs (Fig. 10b) [9, 40].

Clinically the majority of the patients described have chronic anteromedial pain exacerbated by dorsiflexion. On clinical examination, there is usually focal anteromedial tenderness, with possible superimposed soft tissue swelling and limitation of full dorsiflexion and supination [9, 40].



**Fig. 10** **(a)** Male patient with clinical anteromedial impingement following a rotational injury. Axial T1-weighted fat-suppressed MR arthrogram image shows nodular capsular thickening (arrows) filling the anteromedial recess anterior to the deltoid ligament (De) and talus (Ta). **(b)** Female patient with clinical anteromedial impingement with no known precipitating injury. Axial PD-weighted MR arthrogram image shows anteromedial synovitis (arrows) and medial talar spur (\*)



## Imaging features

There are no large studies describing typical imaging appearances and previous surgical studies did not formerly evaluate imaging. The few reports of imaging features describe focal anteromedial capsular thickening and synovitis with or without additional anteromedial tibiotalar spurs on MR arthrography (Fig. 10) [9]. Arthrographic techniques are probably more accurate than conventional imaging as both CT and MR arthrography will detect the capsular abnormality as well as any osseous spurs.

## Management and role of imaging

All surgical studies have described good symptomatic and functional results after arthroscopic resection of the synovitis and any associated bony abnormality [9, 40]. It is difficult to definitively describe a positive role of imaging given the limited series presented. Conventional MR imaging may have a role in detecting concomitant chondromalacia and other injuries allowing for the fact it may miss subtle capsular changes in clinical definite cases.

## Conclusions

In recent years impingement syndromes of the ankle have been increasingly recognised as a cause of chronic ankle

pain especially in younger and athletic age groups. The precipitating mechanism of injury involved implies an associated risk of additional concomitant ankle abnormalities (e.g., cartilage defects, ligament disruption). Imaging evaluation should be performed remembering impingement can coexist with other abnormalities and is no longer a diagnosis of exclusion.

The imaging features associated with these conditions should be cautiously interpreted, especially in athletes where some capsular and osseous changes can be asymptomatic. MR imaging is valuable in assessing the possible soft tissue and osseous abnormalities implicated in a particular clinical setting of ankle impingement. However the other advantage of performing MR imaging rather than CT or ultrasound is its ability to provide a global assessment of the joint and soft tissues prior to treatment. Especially for posterior and posteromedial impingement this allows ultrasound-guided injection to provide effective treatment avoiding surgery. Direct arthrographic techniques are probably more accurate for defining the capsular abnormality associated with anterolateral and anteromedial impingement, but are rarely performed in clinical practice. In this situation conventional MR imaging can miss subtle capsular changes, but is used to assess the rest of the joint when clinical features of anterolateral impingement are definite.

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