Acute Ankle Injuries

CHAPTER 33

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Epidemiological data suggested that there were over 300 000 annual emergency department presentations with ankle sprains in the United Kingdom[1] and that 42 000 of these were 'severe'. The highest rates were in girls aged 10–14 years. Extrapolated to the populations of Australia and the United States, these UK data would equate to an ankle-injury related burden of 100 000 emergency department presentations annually in Australia, and 1.5 million annually in the United States.

Although the term 'sprained ankle' is sometimes thought to be synonymous with 'lateral ligament injury' and, thus, imply a rather benign injury, this is not always the case. If the ankle injury is indeed a lateral ligament sprain, inadequate rehabilitation can lead to prolonged symptoms, decreased sporting performance and high risk of recurrence. Thus, the first half of this chapter focuses on anatomy, clinical assessment and management of lateral ligament injuries after ankle sprain and two less common sequelae of ankle sprain—medial ligament injury and Pott's fracture.

The seemingly benign presentation of 'sprained ankle' can also mask damage to other structures in addition to the ankle ligaments, such as subtle fractures around the ankle joint, osteochondral fractures of the dome of the talus and dislocation or rupture of the peroneal tendons, in most cases the peroneus brevis tendon. Such injuries are frequently not diagnosed and thus cause ankle pain that persists much longer than would be expected with a straightforward ankle sprain. This is often referred to as 'the problem ankle' and this presentation is discussed in the second half of this chapter.

Functional anatomy

The ankle contains three joints (Fig. 33.1):

1. talocrural (ankle) joint
2. inferior tibiofibular joint
3. subtalar joint.

The talocrural or ankle joint (Fig. 33.1a) is a hinge joint formed between the inferior surface of the tibia and the superior surface of the talus. The medial and lateral malleoli provide additional articulations and stability to the ankle joint. The movements at the

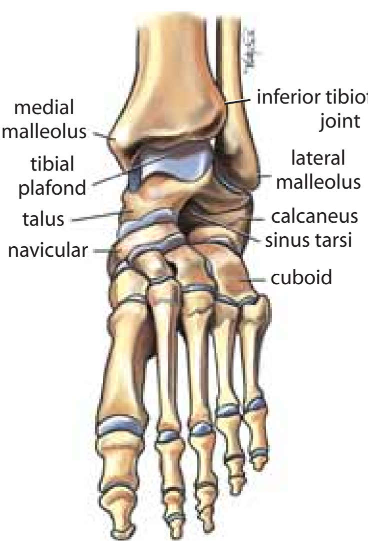
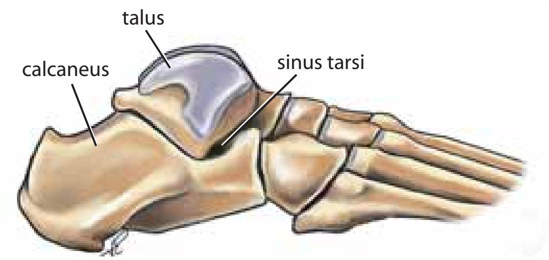
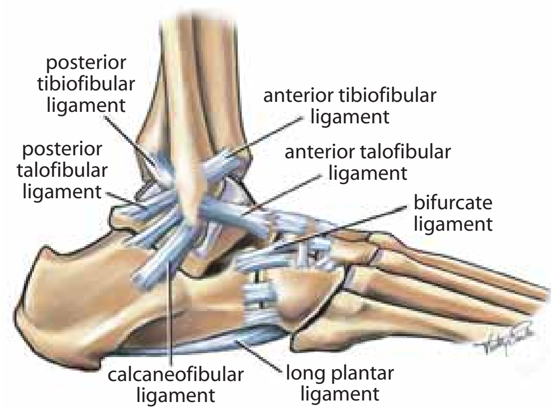


Figure 33.1 Anatomy of the ankle

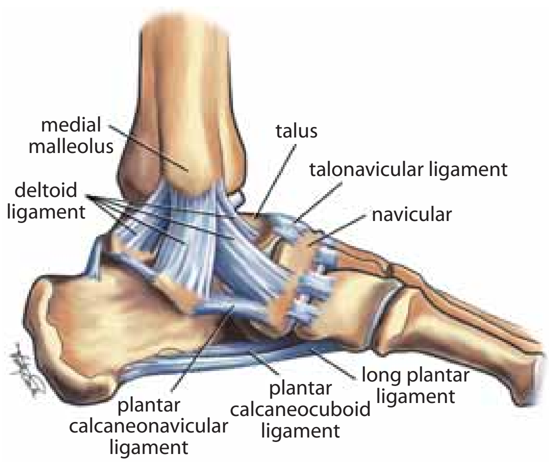
(a) Talocrural (ankle) joint



(b) Subtalar joint



(c) Ligaments of the ankle joint—lateral view



(d) Ligaments of the ankle joint—medial view

ankle joint are plantarflexion and dorsiflexion; the joint is least stable in plantarflexion. This leads to an increased number of injuries with the foot in the position of plantarflexion.

The inferior tibiofibular joint is the articulation of the distal parts of the fibula and tibia. The inferior tibiofibular joint is supported by the inferior tibiofibular ligament or syndesmosis. A small amount of movement is present at this joint and the rotational movement, even though minimal, is extremely important, for instance, for barefoot walking and running.

The subtalar joint (Fig. 33.1b), between the talus and calcaneus, is divided into an anterior and posterior articulation separated by the sinus tarsi. The main roles of the subtalar joint are to provide shock absorption, to permit the foot to adjust to uneven ground and to allow the foot to remain flat on the ground when the leg is at an angle to the surface. Inversion and eversion occur at the subtalar joint.

The ligaments of the ankle joint are shown in Figures 33.1c, d. The lateral ligament consists of three parts: the anterior talofibular ligament (ATFL), which passes as a flat and rather thin band from the tip of the fibula anteriorly to the lateral talar neck, the calcaneofibular ligament (CFL), which is a cord-like structure directed inferiorly and posteriorly, and the short posterior talofibular ligament (PTFL), which runs posteriorly from the fibula to the talus. The medial or deltoid ligament of the ankle is a strong, fan-shaped ligament extending from the medial malleolus anteriorly to the navicular and talus, inferiorly to the calcaneus and posteriorly to the talus. This ligament is strong and composed of two layers, one deep and the other more superficial. Accordingly, the deltoid ligament is infrequently injured.

Clinical perspective

Inversion injuries are far more common than eversion injuries due to the relative instability of the lateral joint and weakness of the lateral ligaments compared with the medial ligament. Eversion injuries are seen only occasionally. As the strong medial ligament requires a greater force to be injured, these sprains almost always take longer to rehabilitate. The differential diagnoses that must be considered after an ankle injury are listed in Table 33.1. The aim of the initial clinical assessment is to rule out an ankle fracture, if possible, and to diagnose the site of abnormality as accurately as possible.

History

The mechanism of injury is an important clue to diagnosis after ankle sprain. An inversion injury suggests lateral ligament damage, an eversion injury suggests medial ligament damage. If the injury has involved compressive forces on the ankle mortise, consider the possibility of osteochondral injury.

The onset of pain is very important. A history of being able to weight-bear immediately after an injury

Table 33.1 Acute ankle injuries

Common	Less common	Not to be missed
Ligament sprain Lateral ligaments (Fig. 33.1c) ATFL CFL PTFL	Osteochondral lesion of the talus Ligament sprain/rupture Medial ligament injury AITFL injury Fractures Lateral/medial/posterior malleolus (Pott's) Tibial plafond Base of the fifth metatarsal Anterior process of the calcaneus Lateral process of the talus Posterior process of the talus Os trigonum Dislocated ankle (fracture/dislocation) Tendon rupture/dislocation Tibialis posterior tendon Peroneal tendons (longitudinal rupture)	Complex regional pain syndrome type I (post-injury) Greenstick fractures (children) Sprained syndesmosis Tarsal coalition (may come to light as a result of an ankle sprain)

ATFL = anterior tibiofibular ligament. AITFL = anteroinferior tibiofibular ligament. CFL = calcaneofibular ligament. PTFL = posterior tibiofibular ligament.

with a subsequent increase in pain and swelling as the patient continues to play sport or walk about suggests a sprain (ligament injury) rather than a fracture. The location of pain and concomitant swelling and bruising generally gives an indication as to the ligaments injured. The most common site is over the anterolateral aspect of the ankle involving the ATFL. Occasionally in severe injuries, both medial and lateral ligaments are damaged. The degree of swelling and bruising is usually, but not always, an indication of severity.

The degree of disability, both immediately following the injury and subsequently, is an important indicator of the severity of the injury. The initial management, the use of the RICE regimen and the duration of restricted weight-bearing after the injury are important.

The practitioner should ask about a previous history of ankle injury and assess whether post-injury rehabilitation was adequate. Did the athlete use protective tape or braces after previous injury?

Examination

One aim of ankle examination is to assess the degree of instability present and thus the grade of the ligamentous injury. Another is to detect functional deficits, such as loss of range of motion, reduced strength and reduced proprioception. The practitioner should be alert for associated injuries and examine for them. For example, avulsion fracture of the base of the fifth metatarsal is commonly overlooked but is easily detected by palpation.

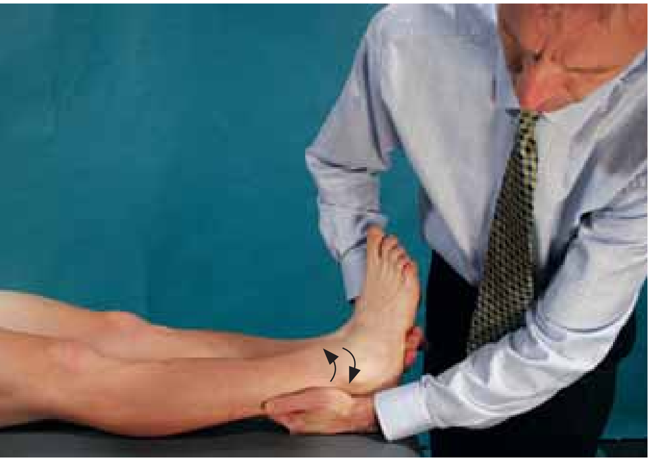
Examination involves:

1. Observation
   (a) standing
   (b) supine
2. Active movements
   (a) plantarflexion/dorsiflexion (Fig. 33.2a)
   (b) inversion/eversion
3. Passive movements
   (a) plantarflexion/dorsiflexion
   (b) inversion/eversion (Fig. 33.2b)
4. Resisted movements
   (a) eversion (Fig. 33.2c)
5. Functional tests
   (a) lunge test (Fig. 33.2d)
   (b) hopping
6. Palpation
   (a) distal fibula
   (b) lateral malleolus
   (c) lateral ligaments (Fig. 33.2e)
   (d) talus
   (e) peroneal tendon(s)
   (f) base of fifth metatarsal
   (g) anterior joint line
   (h) dome of talus
   (i) medial ligament
   (j) sustentaculum tali
   (k) sinus tarsi
   (l) anteroinferior tibiofibular ligament (AITFL)

7. Special tests (comparison with other side necessary)
   (a) anterior drawer (Fig. 33.2f)
   (b) lateral talar tilt (increased inversion) (Fig. 33.2g)
   (c) proprioception (Fig. 33.2h)

Figure 33.2 Examination of the patient with an acute ankle injury

(a) Active movement—plantarflexion/dorsiflexion. Assessment of dorsiflexion is important as restriction results in a functional deficit. Range of motion can be compared with the uninjured side. Tight calf muscles may restrict dorsiflexion. This can be eliminated by placing the knee in slight flexion



(b) Passive movement—inversion/eversion. Inversion is frequently painful and restricted in lateral ligament injury, while eversion is painful following injuries to the medial ligament. Increased pain on combined plantarflexion and inversion suggests ATFL injury

(c) Resisted movement—eversion. In acute, painful ankle injuries, resisted movements may not be possible. In cases of persistent pain following ankle injury, weakness of the ankle evertors (peroneal muscles) should be assessed

(d) Functional test—lunge test. Assess ankle dorsiflexion compared with the uninjured side. Note any pain. Other functional tests may be performed to reproduce the patient's pain if appropriate (e.g. single-leg standing, hopping)

(e) Palpation—lateral ligament

(f) Ligament testing—anterior drawer test. The ankle is placed in slight plantarflexion and grasped as shown. Pressure is exerted upwards and the degree of excursion (anterior drawer) is noted and compared with the uninjured side. This test assesses the integrity of the ATFL and CFL. Pain on this test should also be noted; if painful it may indeed mask injury to the ligament. Then the test should be repeated within five days. The most optimal time to test the integrity of the lateral ligaments is on the fifth post-injury day

(g) Ligament testing—talar tilt. This tests integrity of the anterior talofibular and calcaneofibular ligaments laterally and the deltoid ligament medially. The ankle is grasped as shown and the medial and lateral movement of the talus and calcaneus are assessed in relation to the tibia and fibula. Pain on this test must also be noted

(h) Special test—proprioception. Single-leg standing with eyes closed may demonstrate impaired proprioception compared with the uninjured side

Investigations

Many practitioners are unsure whether or not to X-ray a moderately severely sprained ankle where the patient has difficulty weight-bearing. For experienced sports medicine practitioners, palpation should reveal whether or not tenderness is greatest on bone (lateral or medial malleolus) or on ligament tissue itself. For practitioners not as confident in physical examination, the Ottawa ankle rules provide very useful guidance (Fig. 33.3).[2] We recommend that X-rays of the ankle joint include the base of the fifth metatarsal to exclude avulsion fracture. If damage to the lower tibiofibular syndesmosis (AITFL) is suspected, special ankle mortise or syndesmosis views are required.

An osteochondral lesion of the talus may not be apparent on initial X-ray. If significant pain and disability persist despite appropriate treatment four to six weeks after an apparent 'routine' ankle sprain, a radioisotopic bone scan, CT or MRI is indicated to exclude an osteochondral lesion (see p. 624). If MRI is not available and the bone scan gives a positive result, a CT scan should be ordered to image the site of abnormality. Although MRI is very popular because it also images soft tissues, CT often provides superior images of bony damage.

Lateral ligament injuries

Lateral ligament injuries occur in activities requiring rapid changes in direction, especially if these take place on uneven surfaces (e.g. grass fields). They are also seen when a player, having jumped, lands on another competitor's feet. They are one of the most common injuries seen in basketball, volleyball, netball and most football codes.

The usual mechanism of lateral ligament injury is inversion and plantarflexion, and this injury usually damages the ATFL before the CFL. This occurs because the ATFL is taut in plantarflexion and the CFL is relatively loose (Fig. 33.4). Also, the ATFL can only tolerate half the strain of the CFL before tearing. Complete tear of the ATFL, CFL and PTFL results in a dislocation of the ankle joint and is frequently associated with a fracture. Such an injury is rather infrequent, however. Isolated ligament ruptures of the CFL and especially the PTFL are rare.

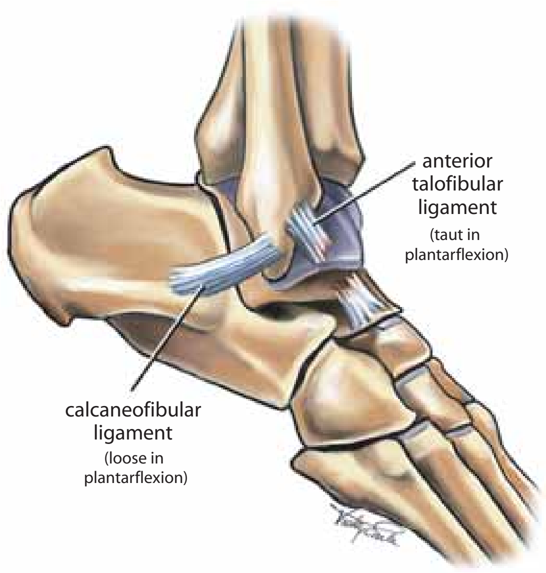


Figure 33.4 A plantarflexion injury can lead to injury of the anterior talofibular ligament before the calcaneofibular ligament

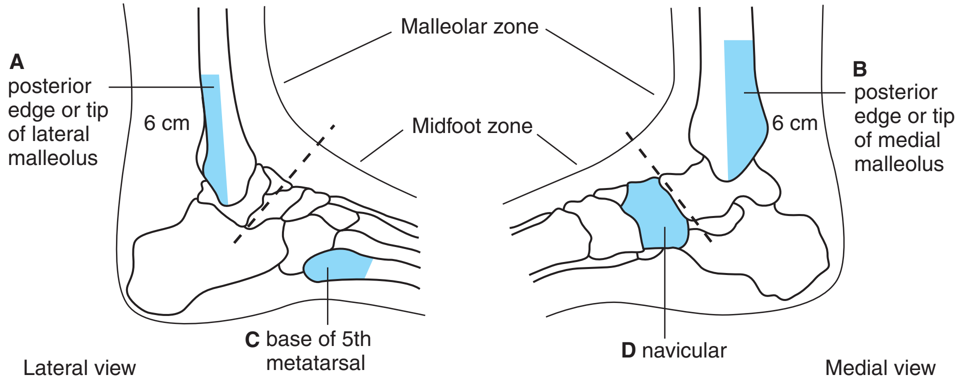


Figure 33.3 Ankle X-ray: recommendation 1. Ankle X-rays are only required if there is any pain in the malleolar zone and any one of these findings: bone tenderness at **A**; or bone tenderness at **B**; or inability to bear weight both immediately and at the clinical assessment (four steps). Foot X-ray: recommendation 2. Foot X-rays are only required if there is any pain in the midfoot zone, and any one of these findings: bone tenderness at **C**; or bone tenderness at **D**; or inability to bear weight both immediately and at the clinical assessment (four steps)

Ankle sprain may be accompanied by an audible snap, crack or tear, which, although often of great concern to the athlete and onlookers, has no particular diagnostic significance (unlike the case in knee ligament injuries where it has profound implications, Chapter 27). Depending on the severity of the injury, the athlete may continue to play or may rest immediately. Swelling usually appears rapidly, although occasionally it may be delayed some hours.

To assess lateral ligament injuries, examine all three components of the ligament and determine the degree of ankle instability. In a grade I tear there is no abnormal ligament laxity. It is important to compare both sides (assuming the other side has not been injured) as there is a large inter-individual variation in normal ankle laxity. Grade II injuries reveal some degree of laxity but have a firm end point. Grade III injuries show gross laxity without a discernible end point. All three grades are associated with pain and tenderness, although grade III tears may be least painful after the initial episode has settled. Grading of these injuries guides prognosis and helps determine the rate of rehabilitation.

Treatment and rehabilitation of lateral ligament injuries

The management of lateral ligament injuries of all three grades follows the same principles. After minimizing initial hemorrhage and reducing pain, the aims are to restore range of motion, muscle strength and proprioception, and then prescribe a progressive, sport-specific exercise program.

Initial management

Lateral ligament injuries require RICE treatment (Chapter 10). This essential treatment limits the hemorrhage and subsequent edema that would otherwise cause an irritating synovial reaction and restrict joint range of motion. The injured athlete must avoid factors that will promote blood flow and swelling, such as hot showers, heat rubs, alcohol or excessive weight-bearing. Gradually increased weight-bearing will, however, help reduce the swelling and increase the ankle motion, and enhances the rehabilitation.

Reduction of pain and swelling

Analgesics may be required. After 48 hours, gentle soft tissue therapy and mobilization may reduce pain. By reducing pain and swelling, muscle inhibition around the joint is minimized, permitting the patient to begin range of motion exercises.

The indications for the use of NSAIDs in ankle injuries are unclear. The majority of practitioners tend to prescribe these drugs after lateral ligament sprains although their efficacy has not been proven (Chapter 10). The rationale for commencing NSAIDs two to three days after injury is to reduce the risk of joint synovitis with early return to weight-bearing.

Restoration of full range of motion

If necessary, the patient may be non-weight-bearing on crutches for the first 24 hours but then should commence partial weight-bearing in normal heel–toe gait. This can be achieved while still using crutches or, in less severe cases, by protecting the damaged joint with strapping or bracing. Thus, partial and, ultimately, full weight-bearing can take place without aggravating the injury. Lunge stretches and accessory and physiological mobilization of the ankle (Fig. 33.5a), subtalar (Fig. 33.5b) and midtarsal joints should begin early in rehabilitation. As soon as pain allows, the practitioner should prescribe active range of motion exercises (e.g. stationary cycling).

Muscle conditioning

Active strengthening exercises, including plantarflexion, dorsiflexion, inversion and eversion (Fig. 33.6), should begin as soon as pain allows. They should be progressed by increasing resistance (a common method is to use rubber tubing). Strengthening eversion with the ankle fully plantarflexed is particularly important in the prevention of future lateral ligament injuries. Weight-bearing exercises (e.g. shuttle [Fig. 33.6b], wobble board exercises) are encouraged as soon as pain permits, preferably the first or second day after injury.

Proprioception

Proprioception is invariably impaired after ankle ligament injuries. The assessment of proprioception is shown in Figure 33.2h. The practitioner should begin proprioceptive retraining (Chapter 12) early in rehabilitation and these exercises should gradually progress in difficulty. An example of a common progression is balancing on one leg, then using the rocker board (Fig. 33.7a) or minitrampoline, and ultimately performing functional activities while balancing (Fig. 33.7b).

Functional exercises

Functional exercises (e.g. jumping, hopping, twisting, figure-of-eight running) can be prescribed when the athlete is pain-free, has full range of motion and adequate muscle strength and proprioception. Specific

Figure 33.5 Mobilization of the ankle joint

(a) Ankle dorsiflexion. The calcaneus and foot are grasped to passively dorsiflex the ankle

(b) Eversion mobilization techniques to restore subtalar joint movement after ankle sprain

technical training not only accelerates a player's return to sport but can also substantially reduce the risk of reinjury.[3–5] It should be borne in mind that approximately 75% of those who sustain an ankle ligament injury have had a previous injury, in many cases not fully rehabilitated.

Return to sport

Return to sport is permitted when functional exercises can be performed without pain during or after activity. While performing rehabilitation activities and upon return to sport, added ankle protection should be provided with either taping or bracing.

Figure 33.6 Strengthening exercises—eversion

(a) Using a rubber tube as resistance

(b) Shuttle exercises

The relative advantages of taping and bracing have been discussed in Chapter 6. As both seem equally effective, the choice of taping or bracing depends on patient preference, cost, availability and expertise in applying tape.

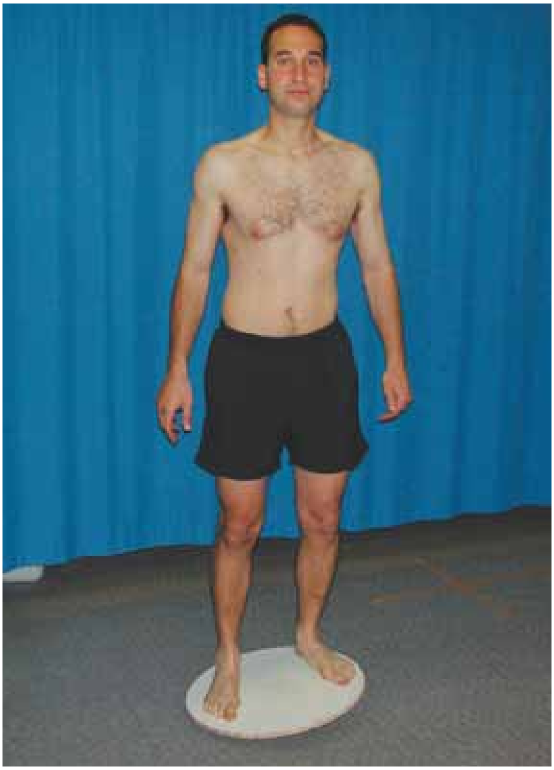


Figure 33.7 Proprioceptive retraining following acute ankle injury

(a) Rocker board

(b) Functional activity while balancing

Any athlete who has had a significant lateral ligament injury should use protective taping or bracing while playing sport for a minimum of six to 12 months post-injury.[4, 5] There are a number of methods to protect against inversion injuries. The three main methods of tape application are stirrups (Fig. 33.8a), heel lock (Fig. 33.8b) and the figure of six (Fig. 33.8c). Usually at least two of these methods are used simultaneously.

Braces have the advantage of ease of fitting and adjustment, lack of skin irritation and reduced cost compared with taping for a lengthy period. There are a number of different ankle braces available. The lace-up brace (Fig. 33.9) is popular and effective.

Treatment of grade III injuries

A 2002 Cochrane systematic review concluded that there was insufficient information from randomized trials to recommend surgery over conservative treatment of grade III ankle sprains.[6] They found that functional recovery (as measured by return to work) was quicker in those treated with rehabilitation, subsequent rate of ankle sprains was no different between groups, and there was more ankle stiffness in those treated surgically.[6] Finnish researchers compared surgical treatment (primary repair plus early controlled mobilization) with early controlled mobilization alone in a prospective study of 60 patients with grade III lateral ankle ligament injuries.[7] Of the patients treated with rehabilitation alone, 87% had excellent or good outcomes compared with 60% of patients treated surgically. Thus, early mobilization alone provided a better outcome than surgery plus mobilization in patients with complete tears of the lateral ankle ligaments. Dutch investigators have reported better long-term outcomes after surgery for lateral ligament rupture compared with rehabilitation but this conclusion was controversial.[8] Differences in 'rehabilitation' protocols can explain such contradictory study results.

In clinical practice, it is widely agreed that all grade III ankle injuries warrant a trial of initial conservative management over at least a six-week period, irrespective of the caliber of the athlete. If, despite appropriate

Figure 33.8 Application of ankle tape

(a) Stirrups. After preparation of the skin, anchors are applied circumferentially. The ankle should be in the neutral position. Stirrups are applied from medial to lateral, and repeated several times until functional stability is achieved

(b) Heel lock. One method used to limit inversion is taping commenced at the front of the ankle and then angled inferiorly across the medial longitudinal arch, then diagonally and posteriorly across the lateral aspect of the heel, and then continued medially over the back of the Achilles tendon to loop back anteriorly. Tape direction is thereafter reversed to restrict eversion

(c) Figure of six. This is applied over stirrups. Tape runs longitudinally along the lateral ankle, under the heel and is pulled up to loop back around the medial ankle as shown

rehabilitation and protection, the patient complains of recurrent episodes of instability or persistent pain, then surgical reconstruction of the lateral ligament is indicated. The preferred surgical method is anatomical reconstruction using the damaged ligaments; this method has been shown to produce good functional results in several studies. The ligaments are shortened

Figure 33.9 Ankle braces—a long lace-up brace is effective and comfortable

and reinserted to bone, and only if the ligament tissue is extremely damaged or even absent, may other methods such as tenodesis, in most cases using the peroneus brevis tendon, be considered. Following surgery, it is extremely important to undertake a comprehensive rehabilitation program to restore full joint range of motion, strength and proprioception. The principles of rehabilitation outlined on page 618 are appropriate. The anatomical reconstruction will produce good clinical results in more than 90% of patients. There is, however, increased risk of inferior results in cases of very longstanding ligament insufficiency and generalized joint laxity.

Less common causes

Medial (deltoid) ligament injuries

Because the deltoid ligament is stronger than the lateral ligament, and probably because eversion is a less common mechanism of ankle sprain, medial ankle ligament injuries are less common than lateral ligament injuries. Occasionally, medial and lateral ligament injuries occur in the same ankle sprain. Medial ligament injuries may occur together with fractures (e.g. medial malleolus, talar dome, articular surfaces). Medial ligament sprains should be treated in the same manner as lateral ligament sprains, although return to activity takes about twice as long (or more) as would be predicted were the injury on the lateral side.

Pott's fracture

A fracture affecting one or more of the malleoli (lateral, medial, posterior) is known as a Pott's fracture. It can be difficult to distinguish a fracture from a moderate-to-severe ligament sprain as both conditions may result from similar mechanisms of injury and cause severe pain and inability to weight-bear. Careful and gentle palpation can generally localize the greatest site of tenderness to either the malleoli (fracture) or just distal to the ligament attachment (sprain). X-ray is often required; the Ottawa rules (Fig. 33.3) are useful in these cases.

The management of Pott's fractures requires restoration of the normal anatomy between the superior surface of the talus and the ankle mortise (inferior margins of the tibia and fibula). If this relationship has been disrupted, internal fixation is almost always required.

Isolated undisplaced spiral fractures of the lateral malleolus (without medial ligament instability) and posterior malleolar fractures involving less than 25% of the articular surface are usually stable. These fractures can be treated symptomatically with early mobilization using crutches only in the early stages for pain relief.

Lateral malleolar fractures associated with medial instability, hairline medial malleolar fractures or larger undisplaced posterior malleolar fractures are potentially unstable but may be treated conservatively with six weeks of immobilization using a below-knee cast with extension to include the metatarsal heads. In cases of undisplaced or minimally displaced fractures, the immobilization time may be shortened considerably, using an ankle brace and early range of motion training. A walking heel may be applied after swelling has subsided (three to five days).

Displaced medial malleolar, large posterior malleolar, bimalleolar or trimalleolar fractures, or any displaced fracture that involves the ankle mortise, require orthopedic referral for open reduction and internal fixation. A comprehensive rehabilitation program should be undertaken following surgical fixation or removal of the cast. The aims of the rehabilitation program are to restore full range of motion, strengthen the surrounding muscles and improve proprioception. Guidelines for ankle rehabilitation are provided on page 618.

Maisonneuve fracture

This injury is found more commonly in patients presenting to emergency departments than in the sports setting, but occasionally high-impact sports injuries can cause this variant of the syndesmosis sprain. The injury involves complete rupture of the medial ligament, the AITFL (see below) and interosseous membrane, as well as a proximal fibular fracture. Surprisingly, non-weight-bearing X-rays may not demonstrate the fracture, and the unstable ankle can reduce spontaneously. Urgent referral to an orthopedic surgeon is necessary.[9]

Persistent pain after ankle sprain—'the problem ankle'

Most cases of ankle ligament sprain resolve satisfactorily with treatment—pain and swelling settle and function improves. However, as ankle sprain is such a common condition, there remains a substantial number of patients who do not progress well and complain of pain, recurrent instability, swelling and impaired function three to six weeks after injury. This is a very common presentation in a sports medicine practice and the key to successful management is accurate diagnosis. The ankle may continue to cause problems because of an undiagnosed fracture or other bony abnormality (Table 33.2). Alternatively, there may be ligament, tendon, synovial or neurological dysfunction (Table 33.3). In the remainder of this chapter, we discuss a clinical approach to managing patients with this presentation before detailing management of specific conditions.

Clinical approach to the problem ankle

The clinician should take a detailed history that clarifies whether the problem has arisen following an ankle sprain (the true 'problem ankle') or whether the patient has longstanding ankle pain that arose without a history of injury (see Chapter 34). The patient who has had inadequate rehabilitation will usually complain of persistent pain and limitation of function with increasing activity. Determine whether the rehabilitation was adequate by asking the patient to show you the exercises he or she performed in rehabilitation. Did therapy include range of motion exercises (particularly dorsiflexion), strengthening exercises (with the foot fully plantarflexed to engage the peroneal muscles) and proprioceptive retraining?

Examination of the inadequately rehabilitated ankle reveals decreased range of motion in the ankle joint (especially dorsiflexion), weak peroneal muscles and impaired proprioception. These findings can be reversed with active and passive mobilization of the ankle joint (Fig. 33.5), peroneal muscle strengthening (Fig. 33.6) and training of proprioception (Fig. 33.7). Other abnormalities can also cause this constellation of examination findings—remember that the ankle may be inadequately rehabilitated because of the pain of an osteochondral lesion of the talus.

If rehabilitation has been appropriate and symptoms persist, it is necessary to consider the presence of other abnormalities. Was it a high-energy injury that may have caused a fracture? Symptoms of intra-articular abnormalities include clicking, locking and joint swelling. The practitioner should palpate all the sites of potential fracture very carefully to exclude that condition.

Soft tissue injuries that can cause persistent ankle pain after sprain include chronic ligament instability, complex regional pain syndrome type 1 (formerly known as reflex sympathetic dystrophy, RSD) and, rarely, tendon dislocation or subluxation, or even

Table 33.2 Fractures and impingements that may cause the 'problem ankle'—persistent ankle pain after ankle injury

Fractures	Bony impingements[(a)]
Anterior process calcaneus	Anterior impingement
Lateral process talus	Posterior impingement
Posterior process talus (also os trigonum fracture)	Anterolateral impingement
Osteochondral lesion	
Tibial plafond chondral lesion	
Fracture of base of fifth metatarsal	

(*a*) Although impingements are included here in the bony causes, pain commonly arises from soft tissue impingement between bony prominences.

Table 33.3 Ligamentous, tendon and neurological causes of the 'problem ankle'—persistent ankle pain after ankle injury

Atypical sprains	Tendon injuries	Other soft tissue and neural abnormalities
Chronic ligamentous instability	Chronic peroneal tendon weakness	Inadequate rehabilitation
Medial ligament sprain	Peroneal tendon subluxation/ rupture	Chronic synovitis
Syndesmosis sprain (AITFL sprain)	Tibialis posterior tendon subluxation/rupture	Sinus tarsi syndrome
Subtalar joint sprain		Complex regional pain syndrome type 1

tendon rupture. Inflammation of the sinus tarsi (sinus tarsi syndrome) can be a cause of persistent ankle pain in its own right, but this syndrome can also occur secondary to associated fractures. Thus, even if the patient has features of the sinus tarsi syndrome, the clinician should still seek other injuries too.

Appropriate investigation is a key part of management of patients with the problem ankle. Both radioisotopic bone scan or MRI are able to distinguish soft tissue damage from bony injury; MRI is preferred in most cases. In soft tissue injuries, isotope activity in the bone phase is normal. If bony damage is present, isotope activity in the bone phase is increased. MRI can detect bony and soft tissue abnormalities but the clinician must remember that a subluxing tendon can appear normal on MRI. The conditions that are associated with the various findings on MRI and bone scan are listed in Figure 33.10.

Osteochondral lesions of the talar dome

It is not uncommon for osteochondral fractures of the talar dome to occur in association with ankle sprains, particularly when there is a compressive component to the inversion injury, such as when landing from a jump. The talar dome is compressed by the tibial plafond, causing damage to the osteochondral surface. The lesions occur most commonly in the superomedial corner of the talar dome, less commonly on the superolateral part.

Large fractures may be recognized at the time of injury. The fracture site will be tender and may be evident on X-ray (Fig. 33.11a). Usually, the lesion is not detected initially and the patient presents some time later with unremitting ankle aching, despite appropriate treatment for an ankle sprain. The patient often gives a history of progressing well following a sprain but then developing symptoms of increasing pain and swelling, stiffness and perhaps catching or locking as activity is increased. Reduced range of motion is often a prominent symptom.

Examination with the patient's foot plantarflexed at 45° to rotate the talus out of the ankle mortise may reveal tenderness of the dome of the talus. If this diagnosis is suspected, the practitioner should image the ankle with MRI (Fig. 33.11d) or isotopic bone scan (Fig. 33.11b). A positive bone scan should be supplemented with a CT scan (Fig. 33.11c) to determine the exact degree of injury. MRI alone provides anatomical and pathological data, and is as the investigation of choice. The grading of osteochondral fractures of the talar dome is shown in Table 33.4.

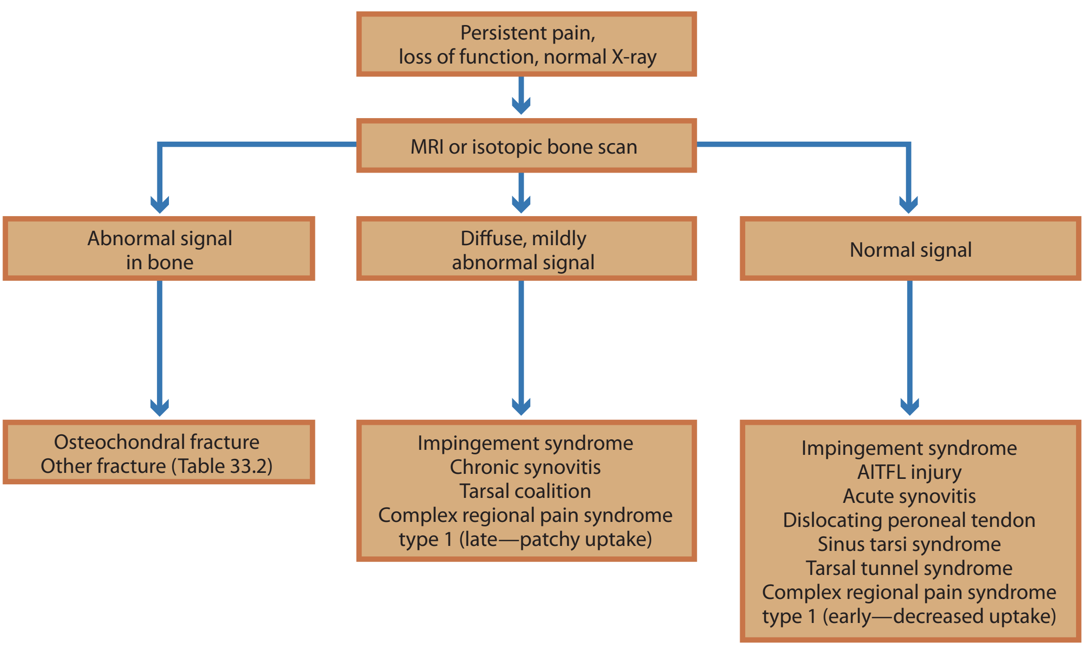
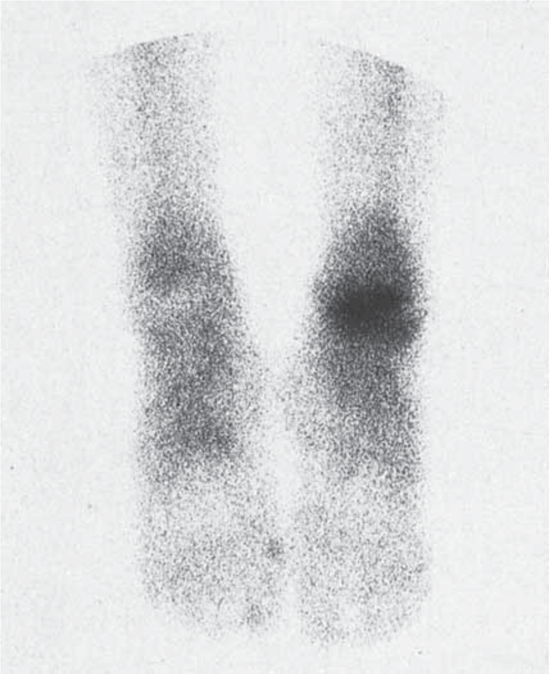


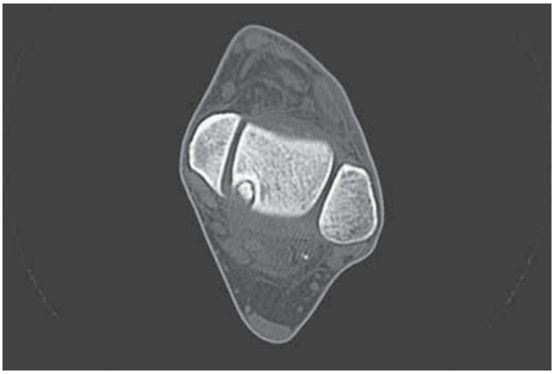
Figure 33.10 Investigation pathway in the patient with persistent ankle pain following an acute injury. When MRI is readily available it serves as an ideal first-line investigation for persistent ankle pain

Figure 33.11 Osteochondral lesion of the talar dome

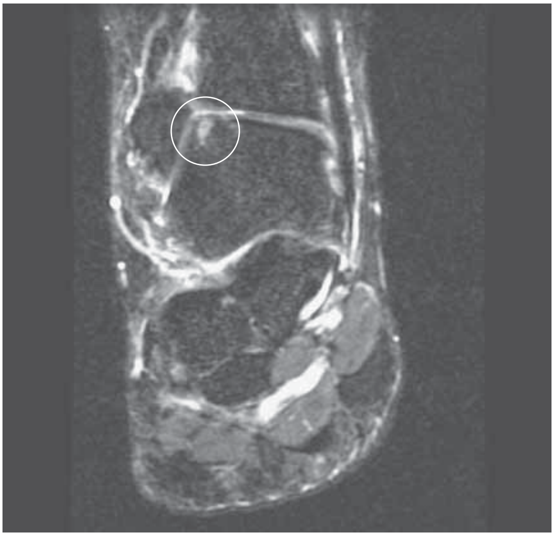
(a) X-ray



(b) Radioisotopic bone scan



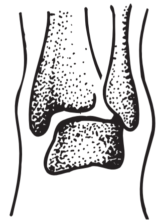
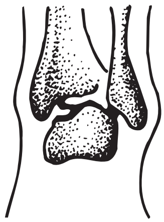
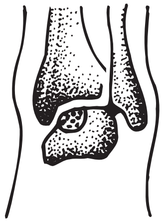
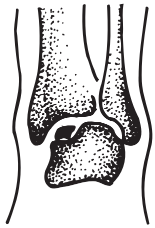
(c) CT scan (grade IV)



(d) MRI (grade I)

Chronic grade I and II lesions should be treated conservatively. The patient should avoid activities that cause pain and be encouraged to pedal an exercise bicycle with low resistance. Formerly, cast immobilization was advocated for these injuries, but joint motion without significant loading is now encouraged to promote articular cartilage healing. If there is pain, or symptoms of clicking, locking or giving persist beyond two to three months of this conservative management, ankle arthroscopy is indicated. A grade IIa, III or IV lesion also requires arthroscopic removal of the separated fragment or cyst and curetting and drilling of the fracture bed down to bleeding bone. After treatment of osteochondral lesions, a comprehensive rehabilitation program is required. Tibial plafond chondral lesions (see below) are managed identically.

Table 33.4 Grading of osteochondral fracture of the talar dome

Grade	Description	Investigation	Appearance
I	Subchondral fracture	MRI	
II	Chondral fracture	CT/MRI	
IIa	Subchondral cyst	CT/MRI	
III	Chondral fracture with separated but not displaced fragments	CT/MRI	
IV	Chondral fracture with separated and displaced fragment(s)	X-ray/CT/MRI	

Avulsion fracture of the base of the fifth metatarsal

Inversion injury may result in an avulsion fracture of the base of the fifth metatarsal either in isolation or, more commonly, in association with a lateral ligament sprain. This fracture results from avulsion of the peroneus brevis tendon from its attachment to the base of the fifth metatarsal.

X-rays should be examined closely. Avulsion fracture is characterized by its involvement of the joint surface of the base of the fifth metatarsal (Fig. 33.12). A potentially confusing fracture is the fracture of the proximal diaphysis of the fifth metatarsal that does not involve any joint surfaces. This fracture is known as the Jones' fracture and may often require internal fixation (Chapter 35). Although the mechanism can appear to be one of 'acute' injury, in most cases the Jones' fracture is a result of repetitive overuse (i.e. a stress fracture) of the proximal diaphysis of the fifth metatarsal. Fracture of the base of the fifth metatarsal may be treated conservatively with immobilization for pain relief followed after one to two weeks by protected mobilization and rehabilitation.

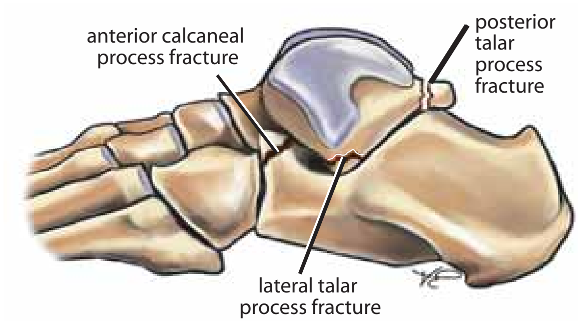


Figure 33.13 Fractures around the talus and calcaneus

Other fractures

A number of other fractures may occasionally be seen as a result of acute ankle injuries (Fig. 33.13), alone or in association with ligamentous injury. They may appear quite subtle on plain X-ray.

Fractured lateral talar process

The lateral talar process is a prominence of the lateral talar body with an articular surface dorsolaterally for the fibula and inferomedially for the anterior portion of the posterior calcaneal facet (Fig. 33.13). Patients with a fracture of this process may present with ankle pain, swelling and inability to weight-bear for long periods. Examination reveals swelling and bruising over the lateral aspect of the ankle and tenderness over the lateral process, immediately anterior and inferior to the tip of the lateral malleolus. The fracture is best seen on the mortise view X-ray of the ankle. Undisplaced fractures may be treated in a short leg cast. Fractures displaced more than 2 mm (0.1 in.) require either primary excision or reduction and internal fixation. Comminuted fractures may require primary excision.

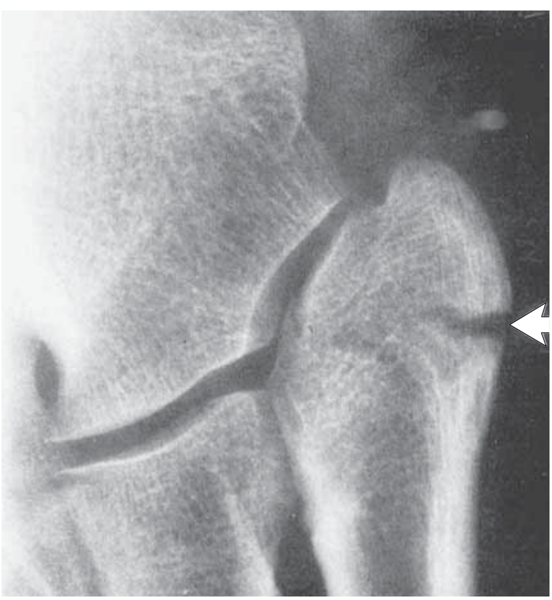


Figure 33.12 Avulsion fracture of the base of the fifth metatarsal

Fractured anterior calcaneal process

Fractures of the anterior calcaneal process may cause persistent pain after an ankle sprain. Palpation of the anterior calcaneal process, just anterior to the opening of the sinus tarsi (Fig. 33.13), is painless in patients with a tear of the ATFL but will cause considerable pain in those with a fracture of the anterior process. If plain X-rays (including oblique foot views) fail to show a fracture that is suspected clinically, isotopic bone scan or MRI/CT is indicated. If the fracture is small, symptomatic treatment may suffice. If large, it requires four weeks of non-weight-bearing cast immobilization or surgical excision of the fragment.

Tibial plafond chondral lesions

Tibial plafond (the inferior tibial articular surface, Fig. 33.1a) injuries may occur with vertical compression forces, such as a fall from a height. However, they can also complicate otherwise straightforward ankle sprains. The patient complains of difficulty weight-bearing, and examination reveals swelling and restricted dorsiflexion. As with talar dome lesions, X-ray is generally normal, so MRI/CT or isotopic bone scan are necessary to demonstrate the lesion. If imaging and clinical features are consistent with bony damage, arthroscopic debridement is indicated but ankle pain can persist for months to a year, even after treatment.

Fractured posterior process of the talus

Acute fractures of the posterior process of the talus (Fig. 33.13) occasionally occur and may require six weeks of cast immobilization or excision (see also Chapter 34). Acute os trigonum fractures may require surgical excision. This is often the result of an acute plantarflexion injury in kicking and has been seen in fencing.

Impingement syndromes

The impingement syndromes of the ankle are usually the result of overuse but are occasionally present as persistent pain following an acute ankle injury. For example, ballet dancers often suffer posterior impingement following lateral ankle sprain. Posterior impingement syndrome was discussed in Chapter 32. Anterior and anterolateral impingement syndromes are discussed in Chapter 34.

Tendon dislocation or rupture

Dislocation or rupture of the peroneal tendon can cause lateral ankle symptoms of the 'problem ankle' and tibialis posterior injury can cause similar symptoms medially.

Dislocation of peroneal tendons

The peroneal tendons are situated behind the lateral malleolus and fixed by the peroneal retinaculum. They are occasionally dislocated as a result of forceful passive dorsiflexion. This may occur when a skier catches a tip and falls forward over the ski. The peroneal retinaculum is then ripped off the posterior edge of the lateral malleolus and one or both of the tendons slip out of their groove. This dislocated tendon(s) may remain in its dislocated position or spontaneously relocate and subsequently become prone to recurrent subluxation. Examination reveals tender peroneal tendons that can be dislocated by the examiner, especially with ankle plantarflexion.

Treatment of dislocation of peroneal tendons is surgical replacement of the tendons in the peroneal groove and repair of the retinaculum, using bone anchors or drill holes. If the peroneal groove is shallow, in a few cases retinacular repair should be accompanied by deepening of the groove or rotation of the malleolus to better secure the tendons. Soft tissue repair, however, produces a good result in most cases.

Dislocation of the tibialis posterior tendon

Dislocation of the tibialis posterior tendon is extremely rare in sport. However, it occurs with ankle dorsiflexion and inversion so that strong contraction of the tibialis posterior muscle pulls the tendon out of its retinaculum using the malleolus as a fulcrum. The patient may complain of moderate, not exquisite, medial ankle pain and inability to weight-bear. Examination reveals swelling and bruising of the medial ankle above and about the medial malleolus with tenderness along the path of the tibialis posterior tendon. The tendon can be subluxed anteriorly and subsequently relocated posteriorly with the foot in the fully plantarflexed position. The diagnosis is clinical but ultrasonography or MRI (Fig. 33.14) may reveal fluid around the tendon.

Immediate surgical treatment is indicated to minimize the time that the tendon is dislocated while permitting primary repair of the flexor retinaculum and reattachment of the tibialis posterior sheath.[10] Post-operatively the ankle is immobilized in a below-knee plaster cast with a total of six weeks non-weight-bearing on the affected ankle. After the cast is removed, an ankle brace can be used to immobilize the ankle but active ankle motion is permitted three times daily while taking care to avoid resisted inversion. Weight-bearing can recommence at six weeks under physiotherapy/physical therapy supervision followed

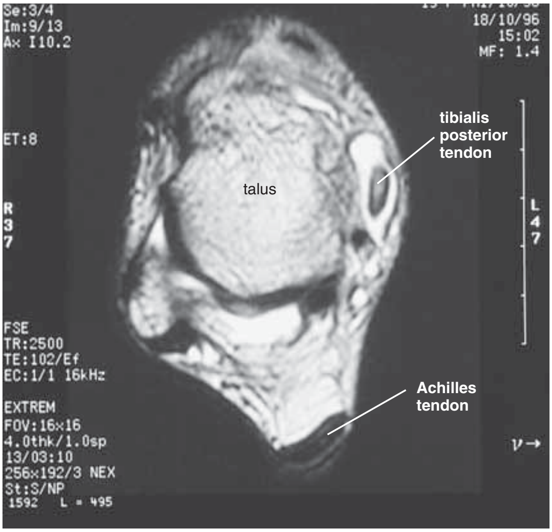


Figure 33.14 MRI appearance (T2-weighted) shortly after tibialis posterior tendon dislocation shows the tibialis posterior tendon (dark) in cross-section surrounded by abnormal fluid (high signal intensity). The tendon is in its normal position during this examination. If imaging had been delayed sufficiently, fluid would have been absent and the MRI appearance may have been normal

by strengthening and functional rehabilitation. In an elite ballet dancer, return to full performance occurred at five months post-surgery[11] and at eight years follow-up the dancer was still performing in a major professional company without recurrence.

Rupture of the tibialis posterior tendon

An athlete with a ruptured tibialis posterior tendon presents with pain in the region of the tubercle of the navicular extending to the posterosuperior border of the medial malleolus and along the posteromedial tibial border. Examination reveals thickening or absence (less frequent) of the tibialis posterior tendon and inability to raise the heel. A flattened medial arch is a classic sign but this may not be evident immediately. MRI is the investigation of choice in this condition, although ultrasound may also be helpful. Surgical repair is indicated as the tibialis posterior tendon is essential to maintain the normal medial arch of the foot.

Other causes of the problem ankle

Anteroinferior tibiofibular ligament injury

The AITFL is one component of the ankle syndesmosis. It may be damaged in more severe ankle injuries (Fig. 33.15) and it is occasionally associated with fractures (e.g. Maisonneuve fracture, see p. 622). This injury causes considerably more impairment than does a lateral ankle sprain. Palpation reveals maximal tenderness over the AITFL (Fig. 33.1c). Combined rotation of the foot and dorsiflexion of the ankle joint may reproduce the pain. Weight-bearing views are needed to improve the sensitivity of plain X-ray to detect this injury. Complete interruption to the syndesmosis may occur with very severe injuries. Widening of the ankle mortise is the diagnostic feature on X-ray. Orthopedic surgical referral is essential.

Post-traumatic synovitis

Some degree of synovitis will occur with any ankle injury due to the presence of blood within the joint. This usually resolves in a few days but may persist if there is excessive early weight-bearing, typically in athletes eager to return to training soon after their ankle sprain, or due to insufficient rehabilitation. These athletes will often develop persistent ankle pain aggravated by activity and associated with swelling. Synovitis of the ankle joint is also seen in athletes who have chronic mild instability because of excessive accessory movement of the ankle joint during activity.

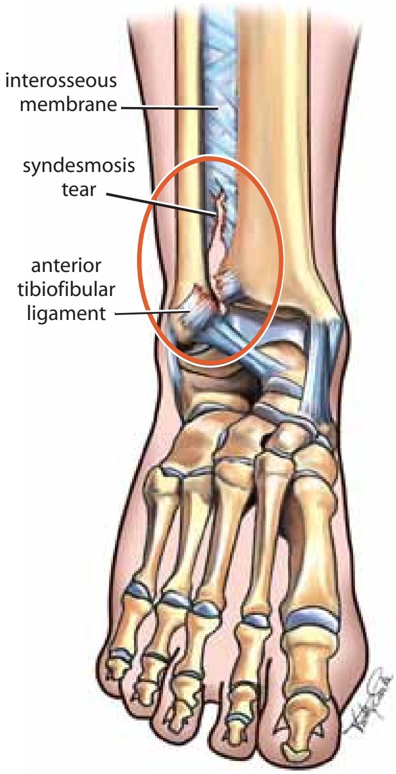


Figure 33.15 Anatomy of a syndesmosis sprain. This injury may be associated with medial malleolar fracture (not illustrated)

Treatment of synovitis includes NSAIDs, rest from aggravating activity and local electrotherapy. A corticosteroid injection into the ankle joint (Fig. 33.16) may be required. Injection should be followed by 48 hours of limited weight-bearing and gradual resumption of activity. Sometimes arthroscopy may be indicated.

When synovitis is associated with a degree of chronic instability, treatment involves taping or bracing. Such a patient can gain significant relief by wearing a brace for activities of daily living as well as sport. These patients may also benefit from ankle reconstructive surgery.

Sinus tarsi syndrome

The sinus tarsi syndrome may occur as an overuse injury secondary to excessive subtalar pronation (Chapter 34) or as a sequel to an ankle sprain. Pain occurs at the lateral opening of the sinus tarsi (Fig. 33.1b). The pain is often more severe in the morning and improves as the patient warms up.

Figure 33.16 Corticosteroid injection into the ankle joint in the treatment of post-traumatic synovitis. The needle is inserted medial to the tibialis anterior tendon and directed posterolaterally

Forced passive inversion and eversion may both be painful. The most appropriate aid to diagnosis is to monitor the effect of injection of a local anesthetic agent into the sinus tarsi (Fig. 33.17).

Treatment consists of relative rest, NSAIDs, electrotherapeutic modalities, subtalar joint mobilization and taping to correct excessive pronation if present. If conservative management is unsuccessful, injection of corticosteroid and local anesthetic agents may help resolve the inflammation.

Figure 33.17 Injection into the sinus tarsi. The lateral opening of the sinus is maintained when the foot is inverted. The needle is directed towards the tip of the medial malleolus

Complex regional pain syndrome type 1

Complex regional pain syndrome (CRPS) type 1, formerly known as RSD (Chapters 3, 4), may occasionally complicate ankle injury. Initially, it appears that the patient with a 'sprained ankle' is improving but then symptoms begin to relapse. The patient complains of increased pain, swelling recurs and the skin may become hot or, more frequently, very cold. There may also be localized sweating, discoloration and hypersensitivity.

As early treatment substantially improves the prognosis in CRPS type 1, early diagnosis is imperative. Initial X-rays are normal. Later, patchy demineralization occurs and this can be seen as regions of decreased opacity on X-ray and areas of increased uptake on bone scan—the investigation of choice.[12] Tests of sympathetic function (Chapter 9) may confirm the diagnosis.[13]

It is most important that the peculiar nature of the condition be explained to the patient as it may be a particularly painful condition, even at rest. It remains very difficult to treat and there have been few controlled treatment trials for established CRPS type 1.[14] Physiotherapy may play a role[15] and ultrasound and hydrotherapy may facilitate range of movement exercises. Gabapentin, an anticonvulsant with a proven analgesic effect in various neuropathic pain syndromes, has shown mild efficacy as treatment for pain in patients with CRPS type 1.[16] Because CRPS type 1 is associated with regional osteoclastic overactivity (excessive bone turnover, as shown by increased uptake on radionuclide bone scan), a bisphosphonate medication (alendronate) was trialed in 39 patients.[17] In contrast to placebo-treated patients, all of the alendronate-treated patients had substantially reduced pain and improved joint mobility as early as the fourth week of treatment.

If the pain does not settle, chemical or surgical blockade is indicated. However, a Cochrane systematic review failed to support this therapy for relieving pain.[18] CRPS type 1 remains a very difficult condition to treat.

Recommended Reading

Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. *BMJ* 2003; 326(7386): 417.

A nice summary of the status of the Ottawa ankle rules 10 years after the original paper by Stiell et al. (see below).

Chan KM, Karlsson J. *ISAKOS-FIMS World Consensus Conference on Ankle Instability*. Stockholm: International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine, 2005.

Kannus P, Renstrom P. Treatment for acute tears of the lateral ligament of the ankle. *J Bone Joint Surg Am* 1991; 73A: 305–12.

Remains a classic paper showing that these 'fathers of sports medicine' provided answers to many important questions nearly 20 years ago.

Osborne MD, Rizzo TD Jr. Prevention and treatment of ankle sprain in athletes. *Sports Med* 2003; 33(15): 1145–50.

Quisel A, Gill JM, Witherell P. Complex regional pain syndrome underdiagnosed. *J Fam Pract* 2005; 54(6): 524–32. Available online: <http://www.jfponline.com/Pages.asp?AID=1947>.

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Retained even in this third edition as a classic paper.

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