Management of sports injuries of the foot and ankle

AN UPDATE

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Injuries of the lateral ligaments

Sprains of the ankle are one of the most common lower limb sporting injuries with an incidence in the United States of 2.15 per 1000 persons each year.1 Between the ages of 15 and 24 years the incidence is slightly higher in males (incidence rate ratio, 1.04) but becomes higher in females over the age of 30 years (incidence rate ratio, 1.53).1 A recent systemic review and meta-analysis showed that overall, females have a higher incidence than males (13.6 vs 6.94 per 1000 exposures).2 An MRI study showed that 75% of patients with inversion injuries of the ankle have an isolated anterior talofibular ligament (ATFL) injury, 41% have injured both the ATFL and calcaneofibular (CFL) ligament and only 5% had damaged the posterior talofibular ligament (PTFL).3 The diagnosis can usually be made four or five days after the injury with tenderness over the ATFL strongly suggestive of injury and lack of tenderness there effectively excluding it.4,5 Once the acute symptoms have subsided, a positive anterior drawer test has a reported sensitivity of 73% and specificity of 97% for ATFL injury.4-6 A cadaveric study comparing the anterior drawer test and the anterolateral drawer test of the ankle after sectioning the lateral ankle complex showed a sensitivity 100% and specificity of 66.67% for both tests.6 Oae et al7 demonstrated that the accuracy of detecting ATFL injury in stress radiography, ultrasound examination and MR imaging was 67%, 91% and 97%, respectively. They also showed that in 93% of cases MR imaging demonstrated in the same location of the ATFL injury as arthroscopy.7 Some authors advocate stress radiographs but these have little advantage over a good clinical examination.8 MRI is also not often necessary in the acute setting other than to differentiate between a simple sprain and a high ankle sprain (injury to the syndesmotic ligaments) or where early surgery is being contemplated (Fig. 1).9

The majority of acute lateral ankle injuries can be treated without surgery.10 In a multicentre randomised trial, Lamb et al11 showed that following severe acute sprains of the ankle, initial immobilisation using an Aircast brace (DJO Global, Vista, California) or below-knee cast resulted in faster recovery than simple compression with tubular bandaging. There is also good evidence that functional rehabilitation, after a short period of immobilisation, is better than the traditional treatment of six weeks in a cast.12,13

A meta-analysis has suggested that there is a lower incidence of chronic instability with early surgery compared with conservative treatment and this may be considered in the elite athlete.9,12 However, most patients will recover with conservative treatment, and therefore surgery is usually reserved for those who have failed six months of non-operative treatment (Fig. 2).14-19

In patients presenting with chronic instability, MRI (Fig. 1) is the imaging modality of choice.9 It has the major advantage of being able to detect common associated injuries, such as osteochondral lesions (OCLs) of the talus, which may require treatment at the same time as the ligament surgery. It also has the advantage of quantitative assessment of the ATFL.20

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Surgical treatment can be divided into non-anatomical and anatomical reconstruction. Non-anatomical reconstructions, such as the Evans\textsuperscript{21} and Chrisman-Snook\textsuperscript{22} procedures, have been associated with high incidences of stiffness of the ankle and subtalar joints and osteoarthritis, and other complications related to abnormal kinematics, and have largely gone out of favour.\textsuperscript{23-26} The preferred standard anatomical procedure is the Broström-Gould or modified Broström repair (Fig. 3).\textsuperscript{27,28} In a series of 42 athletes with a minimum two years follow-up post-repair, White, McCol-
lum and Calder\textsuperscript{29} reported a median return to sports of 77 days. The reported success rates, including return to sport, range between 94\% and 100\%.\textsuperscript{29-30}

The modified Broström (or Broström-Gould) procedure can also be undertaken using suture anchors to reattach the lateral ligaments to the lateral malleolus with re-enforcement using the inferior extensor retinaculum. A prospective randomised trial compared the use of single and double suture anchors in the modified Broström procedure and showed that both techniques produced similar clinical and functional outcomes, but with the double anchor giving superior results for talar tilt test post-operatively.\textsuperscript{31} The study also showed, with a minimum of a two year follow-up post-operatively, that each group of 25 patients achieved satisfactory results using the Sefton grading system\textsuperscript{32} as well as significant improvement in the Karlsson scale.\textsuperscript{33}

Intra-articular pathology, including bony and/or soft-tissue impingement lesions and OCLs are often associated with chronic instability of the ankle and therefore arthroscopy is often undertaken at the same time as the ligament surgery to address these.\textsuperscript{29,34-36} A previous study involving 38 patients with combined injuries showed that, at a mean of 8.7 years, the mean American Orthopaedic Foot and Ankle Society (AOFAS) score\textsuperscript{37} improved from 51 (32 to 71) to 90 (67 to 100) points; and 22 patients (58\%) practiced sports at the pre-injury level, while six (16\%), although competing at a lower level, were still active in less demanding sports such as cycling and tennis.\textsuperscript{38} In the same study, a total of ten patients (26\%) had abandoned active sports although they were still physically active. This was due to new episodes of instability of the ankle in six patients who did not feel safe participating in sports while the remaining four felt that they were too old to continue in such activities. The authors concluded that a combined standard Broström repair and arthroscopy of the ankle are safe and allow most patients to return to the pre-injury daily and sport activities.\textsuperscript{38} Another study attempted to quantify the negative prognostic contribution of various associated lesions in patients undergoing a modified Broström procedure and found that syndesmotic widening was associated with the worst results.\textsuperscript{39}

In a recent study of 42 exclusively professional athletes, White et al\textsuperscript{29} found that all were able to return to full sports after a modified Broström procedure but those with associated injuries, such as OCLs or deltoid ligament injuries took significantly longer (a mean of 116 days compared with 72 days, \( p = 0.01 \)).

Various arthroscopically assisted modified Broström-type of procedures have been described with some promising results.\textsuperscript{40,41} A systematic review identified studies with a total of 178 patients (179 ankles) who underwent arthroscopic anchor repair of the ATFL with a mean follow-up of 38.9 months (6 to 117.6).\textsuperscript{42} All patients were reported to have subjective improvement of the stability, with complications in 31 patients, including portal site irritation in four, delayed wound healing in four, wound infection in two, neurological complications in five, deep vein thrombosis in two and additional acute ankle sprain in four.\textsuperscript{42}

On the rare occasions when recurrent instability occurs following a modified Broström procedure, an anatomical reconstruction using a tendon graft may be considered. Autologous or allogenic semitendinosus or gracilis grafts are usually used (Fig. 4). Reconstruction using the tendon of plantaris has also been reported.\textsuperscript{43} Ibrahim et al\textsuperscript{44} reported their experience using a gracilis tendon graft on 16 patients with a minimum follow-up of 33.5 months; the mean post-operative AOFAS score was 96, the mean Karlsson score\textsuperscript{33} was 94.7 and the mean Olerud and Molander score\textsuperscript{45} was 87.5. They also noted that although the range...
of movement of the ankle was not affected by lateral reconstruction, there was a significant reduction in the talar tilt from a mean of 12° to 4° (p < 0.0001) and the anterior drawer reduced from a mean of 11 mm to 4 mm (p < 0.001). Miyamoto et al\(^5\) reported excellent clinical and radiographic results of lateral ligament reconstruction using a gracilis autograft with no difference in clinical outcomes between those immobilised after surgery and those who were allowed to bear weight fully without immobilisation immediately after surgery. The early mobilisation group, however, returned to full athletic activity at a mean of five weeks earlier than the immobilisation group.\(^4\) Early mobilisation after ankle ligament surgery appears to be appropriate, followed by a criteria-based milestones protocol to return patients back to activity safely.\(^4\)

**Injuries to the syndesmosis**

The syndesmosis complex comprises the anterior inferior tibiofibular ligament (AITFL), the posterior inferior tibiofibular ligament (PITFL), the inter-osseous ligament (IOL) and the transverse tibiofibular ligament (TTL). The incidence of injuries involving the syndesmosis ranges from 1% to 18% of all ankle sprains.\(^4\)\(^-\)\(^5\) The most common mechanism of injury is forceful internal rotation of the leg with external rotation of the talus on a planted foot. The ankle can be dorsi-flexed or plantar flexed.\(^5\) Pain on palpation over the AITFL and “high ankle pain” increasing with passive dorsiflexion of the ankle may suggest an injury to the syndesmosis.\(^5\)\(^)\) The dorsiflexion/external rotation test has a sensitivity of 92% and although the squeeze test is only 33% sensitive, it is more specific for an injury to the syndesmosis, and if positive it correlates with a longer time to return to sports.\(^3\)\(^,\)\(^4\)\(^)\) The West point grading system divides syndesmotic injuries into three grades based on clinical examination.\(^5\)\(^)\) Grade I is a mild sprain to the AITFL with no clinical instability, Grade II includes tears of the AITFL and incomplete tear of the IOL with slight instability, while Grade III has complete disruption of all ligaments and definite instability.\(^5\)\(^6\) Grade II has recently been subdivided into grades IIa and IIb.\(^5\)\(^7\) The differentiation between the two subclasses is made after assessment of the ankle five to ten days post-injury and looking specifically for any of the following: deltoid ligament injury on an MR scan, positive external rotation with a positive squeeze test, the presence of tenderness along the anterior interosseous membrane > 6 cm proximal to the ankle, and suspicion of widening of the syndesmosis on plain radiographs. The absence of any of these findings makes it a grade IIa (stable) injury while the presence of any of these findings will make the injury a grade IIb (dynamically unstable) syndesmotic injury.\(^5\)\(^7\)

Weight-bearing anteroposterior, mortise and lateral radiographs of the ankle can help in the diagnosis. Findings such as increased medial clear space between the talus and medial malleolus, reduced tibiofibular overlap and increased space between the incisural tibial surface and the fibula of > 6 mm, is highly suggestive of injury although, the accuracy of such measurements is questionable in more subtle cases.\(^5\)\(^8\)\(^-\)\(^6\)\(^0\) MRI is the benchmark imaging modality with 100% sensitivity and 93% specificity for AITFL and 100% sensitivity and specificity for PITFL injuries (Fig. 5).\(^5\)\(^1\) Arthroscopy plays a major role in the diagnosis of instability where the clinical and radiological diagnosis is inconclusive and associated injuries such as impingement or OCLs can be treated at the same time.\(^6\)\(^2\)\(^,\)\(^6\)\(^3\)

Non-operative treatment for grade I and grade IIa stable syndesmotic injuries has shown good results.\(^6\)\(^4\)\(^,\)\(^6\)\(^5\) Initial rest, ice and immobilisation in a boot or cast with non-weight-bearing for between five and seven days to help with swelling and the initial inflammation is recommended.\(^6\)\(^4\)\(^,\)\(^6\)\(^5\) This is followed by one to two weeks of partial weight-bearing and physiotherapy concentrating on proprioception and range of movement exercises. Full weight-bearing is then commenced with strengthening. The ability to perform a single leg hop for 30 seconds is a good sign of healing; this is usually observed between six and eight weeks after injury (Fig. 6).\(^5\)\(^4\)

In patients with grade IIb injuries, arthroscopy is recommended to assess the stability of the syndesmosis dynamically and aid the decision about whether stabilisation is required.\(^5\)\(^7\) Fixation is warranted in the presence of dynamic instability, especially when diastasis > 2 mm is confirmed arthroscopically.\(^5\)\(^7\) Return to sports is around six weeks in grade IIa and nine weeks in grade IIb injuries.\(^5\)\(^7\)

Grade III injuries should be reduced and stabilised. Repair may be with screw fixation, the suture button ‘tight rope’ technique (Arthrex, Naples, Florida) or direct repair of the AITFL.\(^5\)\(^6\) When a using a screw, there appears to be no difference between engaging three or four cortices in the fixation. A randomised controlled trial by Wikeroey et al\(^5\)\(^7\) compared the outcome at a mean of 8.4 years following tricortical fixation in 25 patients and quadrincortical fixation...
in 23 patients and found no difference between the two groups with regards to the degree of osteoarthritis in the ankle or the Olerud-Molander Ankle score. There was also no difference between the two groups in the range of dorsiflexion of the ankle. Tornetta et al also reported no difference in the range of movement of the ankle if the screws are tightened with the ankle in dorsiflexion or plantar flexion. There is also controversy regarding whether screws should be removed and the timing if this is undertaken. In a randomised controlled trial comparing the outcome one year after removal or retention of syndesmotic screws following fixation of a fibular fracture, Boyle et al found no difference between the two groups with regards to the Olerud-Molander ankle score, the American Academy of Orthopaedic Surgery foot and ankle (AOFAS) score, VAS score for pain and the range of movement of the ankle. A total of 19 patients (76%) of the retention group had a broken or loose screw but with no clinical difference in outcome when compared to those with intact screws.

A recent radiological study showed that reduction and fixation of a syndesmotic injury using a ‘tight rope’ technique provided more accurate reduction than fixation with a screw. In a recent systematic review and meta-analysis evaluating different methods of fixation of syndesmotic injuries, although only short- and mid-term data were included, those treated with a suture button technique had significantly better movement of the ankle (p = 0.02),
functional scores (p = 0.003) and fewer complications (p = 0.0008) than those treated with a screw.70

The post-operative rehabilitation in grade III injuries includes immobilisation in a non-weight-bearing cast or boot for ten to 14 days. Range of movement and proprioceptive exercises are commenced two weeks post-operatively, with partial weight-bearing until three weeks, and protection in a boot until between five and six weeks, with an expected return to full sporting activities at eight weeks.84

Chronic injury of the syndesmosis
Missed syndesmosis injuries may result in chronic instability and the early onset of osteoarthritis if associated with lateral talar shift.72 The diagnosis is made with a combination of clinical examination and imaging. The presence of a fracture of the fibula with associated malunion and shortening makes the restoration of stability difficult without addressing the fibular shortening.63 Most studies have advocated MRI to identify associated intra-articular pathology. Many agree that arthroscopy should be performed to debride the soft tissues anterior and distal to ATFL and to clear the medial gutter if there is an associated injury of the deltoid ligament.73 Once reduction is achieved, the method of fixation is similar to that for acute injuries, commonly involving either the tight rope technique or fixation with a screw. It is recognised that the late stabilisation of a syndesmosis injury gives less favourable outcomes than early stabilisation.74 Tendon grafts may also be used for the reconstruction of the syndesmosis in patients with chronic instability. Grass et al75 reported that all of his 16 patients who underwent reconstruction using a peroneous longus tendon graft for late syndesmotic widening had relief of symptoms of instability at a mean of 16.4 months post-operatively. As a last resort, when other techniques have failed and when symptoms of instability have continued for more than six months, fusion of the syndesmosis can give good relief of symptoms.76 Return to sports after these late reconstructive procedures is unpredictable, however, and having a low threshold for treating the acute injury can prevent problems in the future.74-76

Injuries to the deltoid ligament
The deltoid ligament limits pronation, abduction and external rotation of the talus. It consists of two distinct structures, the superficial and deep components. The superficial deltoid ligament consists of the tibiospring ligament, the tibionavicular ligament, the tibiocalcaneal ligament and the superficial posterior tibiotalar ligament. The deep deltoid ligament consists of the deep posterior tibiotalar ligament and the anterior tibiotalar ligament. Parts of the superficial deltoid ligament cross both the ankle and the subtalar joints whereas the deep deltoid only stabilises the ankle joint. When the deep deltoid ligament and the ATFL ligament are divided, both external and internal rotation movements of the talus are increased. When the syndesmosis is also divided, the talus becomes unstable and dislocates on external rotation.77

Isolated injury to the superficial deltoid is a stable injury with a good prognosis. Injury to both components is usually associated with other ankle injuries.57,78 Pain and swelling on the medial side can indicate injury but clinical testing of stability in the acute setting may be difficult. Once the acute phase has subsided, delayed examination may be useful and includes the gravity stress test, anterior drawer test with the foot in external rotation and the lateral tilt test.79 Stress radiographs may be used to assess medial laxity.80,81

In chronic deltoid injury, patients may present with instability. They may report giving way of the ankle usually when going downstairs or downhill.82 In chronic instability, there may be a high valgus deformity of the hindfoot when compared with the un-injured side which corrects on tip toe or on activation of the tibialis posterior muscle.82 An associated injury of the spring ligament should also be considered.83 It is important to assess the lateral structures to rule out associated injuries. MRI is again the imaging modality of choice with sensitivity for superficial deltoid tears of 83.3% (45/54) and specificity of 93.9% (31/33) and for deep deltoid ligament tears sensitivity of 96.3% (26/27) and specificity of 97.9% (46/47) as shown in a recent radiological study (Fig. 7).84

Isolated, superficial or partial tears are treated in a non-weight-bearing boot for between five and seven days and active rehabilitation is started at the same time.83 Significant deltoid lesions can be classified into three types.85 In type I, the lesion is at the proximal attachment of the ligament and may be treated by freshening its origin and reattaching it using suture anchors. A type II lesion is a mid-substance tear which can be addressed surgically by dividing the ligament into two flaps. The distal flap is fixed into the medial malleolus using bone suture anchors, which reconstructs...
Injuries involving the peroneal tendons

Above the ankle, the peroneal tendons share the same synovial sheath and pass behind the lateral malleolus in a fibro-osseous tunnel. This tunnel is formed by the fibular groove and is deepened by the presence of a fibrocartilaginous rim at the posterior aspect of the distal fibula with the tendons being stabilised by the superior peroneal retinaculum. Distal to the tip of the lateral malleolus, the tendons have separate synovial sheaths and are stabilised by the inferior peroneal retinaculum. The peroneus longus tendon passes under the peroneal tubercle and through a fibro-osseous tunnel under the cuboid and inserts into the base of the first metatarsal. The tendon of peroneus brevis inserts into the base of the fifth metatarsal. An accessory peroneus quartus, which may originate from fibres of the peroneal brevis muscle, is present in 6.6% to 21.7% of individuals.\(^{86,87}\)

Instability of the peroneal tendons can result from a shallow fibular groove or as a result of a sudden forceful contraction of the peroneal muscles with the foot either in dorsiflexion and eversion or inversion.\(^{88,89}\) The superior peroneal retinaculum may be ruptured or avulsed with or without a flake of bone from the posterolateral aspect of the fibula, leading to subluxation or dislocation of the tendon. Cadaveric studies have shown that disruption of the lateral ligament places significant strains on the superior peroneal retinaculum and therefore peroneal subluxation and chronic instability of the ankle are often seen together.\(^{90}\) Peroneal tendon instability is a common cause of peroneus brevis tendon tears.\(^{91}\) Acute tears of the peroneus longus tendon are less common and are usually chronic degenerative tears especially in athletes returning to sports after a period of inactivity.\(^{92}\) Degeneration of this tendon may be seen either behind the peroneal tubercle and the lateral malleolus or under the cuboid as it changes direction.\(^{91,93}\)

Patients will usually give a history of sprain or instability and posterolateral pain in the ankle and swelling during exercise and can often demonstrate peroneal subluxation on demand. Clinically, there may be focal tenderness in the retromalleolar region of the fibula with swelling and crepitus. Passive inversion of the hindfoot and plantar flexion or resisted eversion of the hindfoot and dorsiflexion of the foot can reproduce pain in patients with peroneal tears and subluxation of the tendons may also be observed.

Plain radiographs including weight-bearing anteroposterior, mortise and lateral views are often the first investigation to be ordered in any ankle injury. A fleck sign on the mortise view is pathognomonic of acute peroneal tendon dislocation.\(^{94}\) Dynamic ultrasonography is the imaging modality of choice to identify tears, tenosynovitis and to demonstrate subluxations with a sensitivity and specificity of 100% and 85%, respectively.\(^{95}\) MRIs have a specificity of 80%, 100% and 60% for brevis, longus and combined longus and brevis tears, respectively, and have the advantage of a wide field of view to detect concomitant injuries.\(^{96}\) Sobel and Geppert\(^{97}\) classified peroneal brevis tears into four grades: in grade I, the tendon shows splaying, grade II shows a partial thickness split, grade III shows 1 cm to 2 cm diameter full thickness tears and in grade IV there is a full thickness tear > 2 cm. Non-operative treatment should be considered in patients with tenosynovitis or if the symptoms are minor. This includes physiotherapy with stabilisation and proprioceptive exercises, nonsteroidal anti-inflammatory medication and the use of a boot or short leg walking cast.\(^{93}\) Blind corticosteroid injections into the tendon sheath are not recommended due to complications such as fat necrosis,\(^{98}\) however, there may be a role for ultrasound guided injections in patients who have isolated tenosynovitis.

When surgery is required, direct repair may be performed for longitudinal tears combined with debridement of the tenosynovitis and degenerative tendon. A repair should always be attempted in the athlete.\(^{93}\) If direct repair is not possible due to significant degenerative changes in the remaining tendon, tenodesis to the adjacent healthy tendon might be required. This is usually performed 3 cm to 4 cm proximal to or 5 cm distal to the tip of the lateral malleolus in order to avoid fibular impingement.\(^{99}\) Excision of an os peroneum may be performed if symptoms fail to settle with immobilisation. Some authors have reported outcomes following repair of peroneal tendon tears. Demetracopoulos et al\(^{100}\) looked at the long-term results of peroneal tendon tears debridement and repair. In 18 patients, at a mean follow-up of 6.5 years, the mean VAS pain scores improved from 39 pre-operatively to 10 post-operatively. The mean Lower Extremity Functional Scale (LEFS) improved from 45 pre-operatively to 71 post-operatively with 17 patients out of the 18 returning to full sporting activity.\(^{101}\) Worryingly, in another study, only 12 out of 26 patients at a mean of 31 months follow-up were able to return to athletics successfully.\(^{96}\) Using an endoscopic repair technique on seven male patients, and at a mean of 21.8 months, there were no recurrences. One patient needed removal of a suture knot three months post-operatively.\(^{102}\)

Acute rupture of the superior peroneal retinaculum with subluxation of the peroneal tendons has a poor outcome with conservative treatment.\(^{88,102}\) Chronic peroneal tendon instability can be treated by deepening the fibular groove...
and repair of the retinaculum. This can also be performed endoscopically as described by Guillo and Calder.

In all injuries involving the ankle, alignment of the hind-foot should be assessed carefully. The subtle cavus foot (or ‘underpronator’) is often associated with both peroneal tendon problems and chronic instability of the ankle in the athlete and can affect the outcome of treatment. Whenever possible, alignment should be addressed by corrective orthoses both in the conservative and operatively treated patient.

In conclusion, the ankle is the most common joint to be injured in sports and the severity of these injuries can range from a simple sprain, which is likely to recover within a few days, to more serious conditions which require accurate diagnosis and early treatment to ensure a full and expedient return to sports. The orthopaedic surgeon needs to be aware of the more subtle presentations of significant injuries and use appropriate imaging to make the diagnosis and treat the athlete appropriately.

Supplementary material
Photographs showing the peroneal brevis tendon tear pre-repair and post-repair can be found alongside this paper at http://www.bjj.boneandjoint.org.uk/

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