REVIEW ARTICLE

Injuries to the tibiofibular syndesmosis

The management of injury to the distal tibiofibular syndesmosis remains controversial in the treatment of ankle fractures. Operative fixation usually involves the insertion of a metallic diastasis screw. There are a variety of options for the position and characterisation of the screw, the type of cortical fixation, and whether the screw should be removed prior to weight-bearing. This paper reviews the relevant anatomy, the clinical and radiological diagnosis and the mechanism of trauma and alternative methods of treatment for injuries to the syndesmosis.

In the United Kingdom, of the fractures sustained by patients between the ages of 20 and 65 years those involving the ankle are the most common, with an incidence of almost 90 000 per year.\(^1\) In up to 13% of all ankle fractures,\(^2-3\) and in 20% of patients requiring internal fixation,\(^4,5\) there will be an associated injury to the syndesmosis. Also, up to 0.5% of all ankle sprains without a fracture will have disruption of the syndesmosis.\(^6-8\) Such injuries provide a considerable workload for the orthopaedic surgeon, but despite this there is no consensus as to the optimal method of treatment. Most operations involve the insertion of a screw across the diastasis. There are varying opinions regarding the characteristics and position of the screw, the type of cortical fixation, and whether the screw should be removed prior to weight-bearing. It remains unclear whether these technical aspects of surgery affect the clinical outcome.

Anatomy

The articulation between the tibia and fibula can be divided into three regions: the proximal (superior) tibiofibular joint, the interosseous membrane and the distal (inferior) tibiofibular joint, also known as the tibiofibular syndesmosis. The proximal tibiofibular joint maintains the proximal integrity between the tibia and fibula.\(^9\) The interosseous membrane functions to prevent any posteriorlateral bowing of the fibula which might occur with weight-bearing,\(^9\) and plays a critical role in the load-sharing ability of the fibula.\(^10\) The distal tibiofibular syndesmosis is formed by the rough, convex surface of the medial aspect of the lower end of the fibula and the rough concave surface on the lateral aspect of the tibia. Its integrity is fundamental in allowing adequate functioning of the ankle.

The distal tibiofibular syndesmosis comprises the anterior and posterior tibiofibular ligaments and the interosseous tibiofibular ligament. The anterior tibiofibular ligament is a flat, triangular band of fibres, 2 cm wide and 0.5 cm thick, extending obliquely downwards and laterally between the adjacent margins of the tibia and fibula on the front of the syndesmosis.\(^11\) In addition to holding the fibula tight to the tibia, this ligament prevents excessive movement of the fibula and external rotation of the talus.\(^12\) The posterior tibiofibular ligament is smaller than its anterior counterpart and runs more horizontally than the anterior ligament to the posterior aspect of the fibula. It has both a superficial and a deep component. The superficial part works in conjunction with the anterior tibiofibular ligament to hold the fibula tight in the fibular groove of the tibia.\(^9\) The deep part, also known as the transverse tibiofibular ligament, passes transversely across the back of the joint from the lateral malleolus to the posterior border of the articular surface of the tibia, almost as far as its malleolar process. This ligament projects below the margin of the bone and forms part of the articulating surface for the talus.\(^11\) It functions to prevent posterior translation of the talus, creates a posterior labrum which deepens the articular surface of the distal tibia, and fills in the posteromedial aspect of the lateral malleolus, deepening the mortise and increasing joint stability.\(^9\)

The interosseous tibiofibular ligament consists of numerous short, strong, fibrous bands...
Biomechanics
When the ankle goes from full plantar flexion to full dorsiflexion, the mortise widens by 1.5 mm. Up to 5’ or 6’ of rotation of the talus on the tibia also occurs while walking. During plantar flexion the talus rotates internally and also supinates slightly. This in turn causes posterolateral wedging of the trochlea of the talus. As plantar flexion increases, wedging between the posterolateral trochlea and the lateral malleolus also increases. Therefore, during dorsiflexion the talus must pronate, which may account for many injuries to the tibiofibular ligament occurring as a result of dorsiflexion and external rotation.

Mechanism of injury
Over 90% of the total resistance to lateral displacement of the fibula is provided by the three syndesmotic ligaments, and injury to one or more of them results in weakening, abnormal movement of the joint and instability. Although many mechanisms for syndesmotic injury have been reported, the most common is external rotation of the foot, and, to a lesser extent, forced dorsiflexion of the ankle joint.

Diagnosis
The four clinical tests which are most commonly used in diagnosing injuries of the syndesmosis are described in Table I. Pain on palpation of the anterior tibiofibular ligament and reduced passive dorsiflexion may also indicate injury to the syndesmosis. However, none of these tests has a high predictive value for acute disruption of the syndesmosis. External rotation has the lowest false positive results, and the fibula translation test has the most.

Radiological assessment. The tibiofibular clear space is defined as the distance between the lateral border of the posterior tubercle and the medial border of the fibula. The tibiofibular overlap is the distance between the medial border of the fibula and the lateral border of the anterior distal tibial tubercle. A radiological study using cadavers demonstrated that normally there is a tibiofibular ‘clear space’ on the anteroposterior (AP) and mortise views of < 6 mm, tibiofibular overlap on the AP view of > 6 mm or 42% of the fibula width, and tibiofibular overlap on the mortise of > 1 mm. The study concluded that an absence of tibiofibular overlap may be an indication of syndesmotic injury, and that a medial clear space greater than a superior clear space was indicative of injury to the deltoid ligament. However, the positioning of the ankle greatly influenced these measurements, and some authors believe there are no optimal radiological parameters to assess the integrity of the syndesmosis. Using direct arthroscopic visualisation in patients undergoing open reduction and internal fixation of displaced fractures of the lateral malleolus, Schuberth et al showed that radiological widening
of the medial clear space is not a reliable indicator of rupture of the deltoid ligament.

Although stress radiographs with the foot in external rotation and the ankle in both dorsiflexion and plantar flexion may demonstrate the diastasis, they are rarely used in clinical practice. CT scanning is more sensitive than radiography for detecting minor degrees of syndesmotic injury, but has been superseded by MRI, which is highly accurate in detecting disruption. As MRI becomes increasingly available it will become the investigation of choice for evaluating the syndesmosis.

**Fluoroscopic examination.** Many surgeons assess the need for a diastasis screw intra-operatively by pulling laterally on the fibula with a bone hook. Widening of the syndesmosis by more than 2 mm on the mortise radiograph suggests the need for a screw. Despite being a popular diagnostic tool, the ‘hook test’ is poorly described in the literature and can be difficult to interpret. Candal-Couto et al assessed the reliability of this test in a cadaver model by sequentially dividing the ligaments of the syndesmosis and finally the deltoid ligament. They showed that the AP mortise view correlated poorly with the observed clinical diastasis. However, performing the hook test in the sagittal plane (the sagittal-shift test) appeared to be a more sensitive assessment of inferior tibiofibular instability. Similarly, fluoroscopic examination following the application of an external rotation stress has been shown to demonstrate syndesmotic instability.

**Arthroscopy.** Damage to the tibiofibular syndesmosis can be diagnosed accurately in 100% of cases by arthroscopy of the ankle, compared with only 48% by AP radiography, 64% by mortise views and 96% with MRI. Some authors suggest that arthroscopy is required for the accurate diagnosis of injuries to the syndesmosis.

**Conservative treatment.** Most injuries to the syndesmosis without an associated fracture can be treated conservatively, although recovery time is prolonged. In injuries with a concomitant Weber B or low Weber C fracture, if the deltoid ligament and the posterior part of the syndesmosis remain intact, conservative and early functional treatment can be advocated. A diastasis screw is recommended only for fractures of the fibula > 3.5 cm above the ankle joint if the deltoid ligament is ruptured, and 15 cm above if there is a concomitant fracture of the medial malleolus. It has been suggested that between 15% and 60% of syndesmotic fixations are performed unnecessarily.

**Operative treatment.** The initial 1 mm of lateral displacement of the talus is associated with a 42% reduction in the tibiotalar contact area. Accurate reduction of the syndesmosis is associated with the best functional outcomes. Injuries with persisting tibiofibular diastasis require operative fixation. Most authors advocate the use of metal screws for stabilisation of the syndesmosis but opinions vary with regard to the characteristics of the procedure.

**Type of metal.** A cadaver study simulating protected weight-bearing after syndesmotic fixation comparing stainless-steel screws with titanium showed no difference between the two implants. Tricortical or quadricortical fixation. Biomechanical studies have found no difference between tricortical and quadricortical fixation. A randomised prospective trial comparing fixation with a single quadricortical screw with two tricortical screws showed improvement in early function in the latter group, but after one year there was no significant difference between the groups in their functional score, pain or dorsiflexion.

Single or double screws. Although no consensus exists on the use of one or two screws, mechanical studies have found fixation with two screws to be superior to that using one screw. The AO school advocate the use of two screws only in cases with multiple fractures of the fibula. The diameter of the screws. There is no biomechanical advantage of a 4.5 mm screw over a 3.5 mm screw in tricortical fixation of the syndesmosis. However, for quadricortical fixation a 4.5 mm screw provides significantly improved resistance to the shear stresses applied to the distal syndesmosis during weight-bearing. The position of the screw. There are conflicting reports on the ideal level for placement of the diastasis screw. One study has shown less widening of the syndesmosis on external rotational stress when the screw is inserted 2 cm rather than 3.5 cm above the ankle joint, but another has shown the optimal level to be 5 cm above the tibial plafond. Although trans-s syndesmotic insertion of the screw within 2 cm of the tibial plafond is not advocated owing to the possibility of producing inferior tibiofibular synostosis, found no significant difference in the incidence of inferior tibiofibular synostosis between placement of the screw at this site or in a supra-s syndesmotic position 2 cm to 5 cm above the plafond. The AO school recommend that diastasis screws should be placed parallel and 2 cm to 3 cm above the ankle joint 20° to 30° anteromedially.

Given the larger anterior transverse dimension of the talus compared with its posterior transverse dimension, the traditional recommendation has been that syndesmosis fixation should be undertaken with the ankle in maximal dorsiflexion to avoid over-tightening and subsequent restriction of dorsiflexion. This view is based on the anatomical observation that during dorsiflexion the talus glides posteriorly, with its broader section engaging the ankle mortise. However, recent studies have challenged this view and shown that even when fixation of the syndesmosis has been performed in plantar flexion, restriction of subsequent dorsiflexion does not occur. Removal of the screw(s). Opinions differ as to whether the screw should be removed prior to weight-bearing or left in place indefinitely. Fixation with a screw provides rigid fixation of the distal tibiofibular joint where physiological micromovement has been shown to occur. Therefore, leaving it in place may contribute to abnormal ankle movement, which, in turn, may result in loosening or fatigue.
fracture of the screw. Otherwise, other complications attributed to a retained screw include excessive widening of the syndesmosis, inferior tibiofibular synostosis and osteolysis around the implant. However, de Souza, Gustilo and Meyer have shown that walking prior to removal of the screw does not adversely affect the clinical outcome. In their study, patients who had the screw left in place were reviewed up to three and a half years after its insertion. Although the majority of the screws had become radiologically loose, none had backed out or broken. Similar findings were confirmed in another study, which found loosening in 91% of the patients with a retained tricortical screw, indicating that micromovement of these screws makes them more likely to loosen rather than to break. Furthermore, the range of ankle movement does not seem to be affected by retaining the screw. Another argument for not removing the screw is that a second operation, with an incision into an incompletely-healed wound, may contribute to the higher rates of infection noted with the use of metallic implants.

Functional outcome. The single most important predictor of good functional outcome is accurate reduction of the syndesmosis. The worst results are observed in ankles dislocated at the time of injury, those associated with a fracture of the medial malleolus, and a > 1.5 cm increase in the width of the syndesmosis. Buchholz, Henry and Henley found an average loss of 3° to 4° of dorsiflexion and 10° to 12° of plantar flexion at follow-up after three years, irrespective of the type of fixation used or the quality of reduction. They attributed the loss of movement to peri-articular scarring of the ligaments and capsule, associated injuries, and/or prolonged immobilisation. A return to normal gait can take up to four months after removal of the diastasis screw.

Alternatives to fixation with metal screws. Other methods have been increasingly used in attempts to avoid the complications associated with screw fixation. Suture of the anterior tibiofibular ligament does not provide sufficiently strong fixation and is therefore not recommended. The introduction of two 1.5 mm Kirschner wires obliquely across the distal tibiofibular syndesmosis has been shown to give stabilisation comparable with that of a single transverse 2.3 mm screw. This less rigid form of fixation may have the advantage of allowing more physiological function of the ankle without the need for early removal of the fixation. Randomised studies comparing metal and bioabsorbable screws have demonstrated that both techniques are equally effective in fixation of a diastasis, with patients more likely to return to their previous level of activity when treated with a bioabsorbable rather than a metal screw. However, concerns about the use of bioabsorbable materials include osteolysis, foreign-body reaction, late inflammatory reaction, and osteoarthritis due to polymer debris entering the joint.

Suture buttons may be used with placement of a heavy suture, which is looped and tightened through cortical but-
INJURIES TO THE TIBIOFIBULAR SYNDESMOSIS


