Chapter 10
Syndesmosis Injuries

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10.1 Epidemiology

Injuries of the distal tibiofibular syndesmosis comprise approximately 1–18% of all ankle sprains and are involved in 10% of all ankle fractures.[1] A low reported incidence may be due to poor sensitivity in identifying subtle widening of the syndesmosis on radiograph, as these injuries are often unnoticed in the absence of frank diastasis. Though they represent a low percentage of ankle injuries, syndesmotic injury is the single most predictive factor for long-term disability and chronic ankle pain regardless of grade.[2] In athletes, syndesmosis injuries significantly increase the time to return to activity compared to lateral ankle sprains and can be a source of significant disability.[3]

10.2 Anatomy and Function

The distal tibiofibular syndesmotic complex consists of four ligaments which tighten as the ankle dorsiflexes, locking the talus into a "closed and packed" position for the propulsive phase of gait. The anterior inferior tibiofibular ligament originates from the anterior tubercle of the tibia and descends obliquely to the anterior border of the lateral malleolus. This ligament is often multi-fasicular and occasionally will have a branch of the perforating peroneal artery penetrating the ligament. In cadaveric studies, isolated sectioning of this ligament allows 2.3 mm of diastasis and 2.7° of external rotation.[4]

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The posterior tibiofibular ligament is composed of the superficial and deep components. The superficial portion descends posterolaterally from the posterior tubercle of the tibia and attaches to the digital fossa of the lateral malleolus. The deep component, also known as the transverse tibiofibular ligament, is located more inferior to its superficial counterpart, is more fibrocartilage in composition, and serves as the primary restraint against syndesmotic widening.[5]

The interosseous tibiofibular ligament is formed by dense short elastic fibers originating from the medial aspect of the fibular shaft inserting along the lateral tibia. This ligament continues superiorly forming the aponeurotic fibers of the interosseous ligament which ascends the remaining interval between the tibia and fibula. The vertical and concave groove along the distal lateral tibia formed between the anterior and posterior tibial tubercles, known as the fibular notch or the tibial incisura, allows a structural fit of the medial distal fibula.

10.3 Biomechanics

The fibula at the level of the tibiofibular joint is dynamic throughout the gait cycle in both translational and rotational movements. The tibiofibular syndesmosis tightens as the ankle dorsiflexes to accommodate the wider anterior portion of the talar dome. Concomitant tension of the deltoid and lateral collateral ligaments with ankle dorsiflexion creates a tightly restrained position of the talus within the ankle mortise for stable forward translation of body weight. Additionally, as the ankle dorsiflexes, there is intermalleolar widening approximately 1.25 mm and 2.5° of external rotation to accommodate anterior widening of the talar dome.[6,7]

10.4 Mechanism of Injury

Most syndesmotic injuries are commonly reported in athletic sports such as skiing, ice hockey, football, and basketball.[3,8,9] Sporting activities have been considered a risk factor for these injuries compared to the non-sporting population. Injury to the syndesmosis commonly occurs with a forced external rotation of the foot on the ankle and may be completely ligamentous, but is commonly associated with fractures of the malleoli.

10.5 Clinical Diagnosis

Patients with syndesmotic injuries will often report more difficulty bearing weight compared to patients with isolated lateral ankle sprains. In contrast to lateral ankle sprains, pain is located along the syndesmosis and is often accompanied by supramalleolar swelling with or without ecchymosis. Several clinical maneuvers have been described

Fig. 10.1 Temporarily restoration of ankle function with standing, walking, or heel rises after circumferential taping of syndesmosis is considered diagnostic of syndesmosis injury

to identify injury at the ankle syndesmosis including the fibular squeeze, fibular translation, Cotton, and external rotation test.[10] Fibular squeeze test is performed by squeezing the fibula against the tibia at the proximal leg attempting to widen and elicit pain at the distal syndesmosis. A variation of this maneuver is the "cross-legged test" which is performed by having the patient rest the injured leg on the thigh of the contralateral limb to reproduce pain along the syndesmosis.[11] Another diagnostic test is the "stabilization test" which involves circumferential taping to stabilize the ankle syndesmosis (see Fig. 10.1). The test is considered positive for syndesmosis injury if the patient is able to perform standing, walking, and heel rises after taping.[12] The external rotation test or the Kleiger's test involves externally rotating the foot on the leg attempting to elicit pain by widening the syndesmosis (see Fig. 10.2). In cadaveric studies, the external rotation test achieved the most widening of the syndesmosis and therefore is considered the most clinically provocative test for syndesmosis injury.[10] The interosseous tenderness length, which measures the distance of palpated pain from the syndesmosis, has been shown to correlate well with time to return to activity.[13]

10.6 Radiographs

Medial clear space, tibiofibular clear space, and tibiofibular overlap are com mon radiographic parameters used to measure anatomic joint alignment and syndesmosis integrity. Though commonly used, these radiographic parameters have

Fig. 10.2 External rotation of the foot on the leg can elicit acute pain to an injured ankle syndesmosis

sensitivity for identifying occult syndesmosis injuries. In a study correlating radiographic and magnetic resonance imaging (MRI) for syndesmotic injuries, only medial clear space widening greater than 4 mm correlated with syndesmotic and deltoid ligament rupture (Fig. 10.3).[14]

10.7 Computed Tomography and Magnetic Resonance Imaging

Occult syndesmosis injuries are often subtle and difficult to identify with conventional radiographic studies in the absence of frank diastasis. Axial views of the syndesmosis from computed tomography (CT) can improve detection of syndesmotic widening by quantitatively comparing tibial fibular distance to the contralateral limb. A difference of 2 mm or greater is considered abnormal.[15] Magnetic resonance imaging (MRI) can identify specific syndesmotic ligament

Fig. 10.3 Radiographic findings of an increased medial clear space and tibiofibular clear space widening are both indicators of both deltoid and syndesmotic disruption, respectively

tears with high sensitivity and specificity and can be used in conjunction with biomechanical criteria to predict degree of syndesmosis injury and level of instability.[16]

10.8 Stress Imaging

Stress imaging of ankle injuries can improve identification of syndesmosis injuries previously undetected by plain radiograph.[17] Ligamentous insufficiency can be detected with stress testing demonstrating increased medial clear space or tibiofibular clear space widening under radiograph or fluoroscopic imaging. The lateral stress test reproduces the greatest increase in tibiofibular clear space in experimentally induced syndesmotic ligaments injuries.[36] Results of stress testing may vary due to inconsistency of projection beam angle and stabilizing the proximal limb from motion during stress maneuver.

10.9 Nonsurgical Treatment

There is no consensus regarding the duration and method of treatment for nondisplaced syndesmotic injuries; however, most agree that these injuries recover well with a short course of immobilization followed by progressive stages of non-weight-bearing mobilization, resistance training, and functional rehabilitation.[13,18] A period of non-weight-bearing with the foot kept in slight plantarflexion, protected in a below-knee cast or brace should be rendered. Early institution of physical and manipulative therapy has been proposed in the rehabilitation of syndesmotic injuries; however, its role remains controversial and undocumented.

10.10 Surgical Treatment

Surgical intervention for tibiofibular syndesmotic injuries is indicated if greater than 2 mm of syndesmotic widening or greater than 4 mm of medial clear space widening of the ankle mortise is identified on radiograph or stress imaging. The authors also recommend stabilization when two or more syndesmotic ligaments are compromised with concomitant deltoid ligament injury, regardless of fibular position.

10.10.1 Surgical Technique

10.10.1.1 Positioning

Patient is placed in the supine position on the radiolucent operating room table. A bump may be placed beneath the hip of the surgical limb to internally rotate the ankle allowing surgical access to the lateral ankle and proper positioning of fluoroscopic C-arm imaging. Folded blankets are used to elevate the surgical limb to avoid obstruction of contralateral limb during lateral imaging.

10.10.1.2 Reduction of the Syndesmosis

The tips of the medial and lateral malleoli of the ankle are identified. The syndesmosis is reduced by placing a reduction clamp across the medial and lateral malleoli matching the biomechanical axis of the ankle. This axis is approximately 25° from posterolateral to anteromedial direction (Fig. 10.4). Once clamp is tightened, reduction is verified with mortise and anterior-posterior views under fluoroscopy (Fig. 10.5).

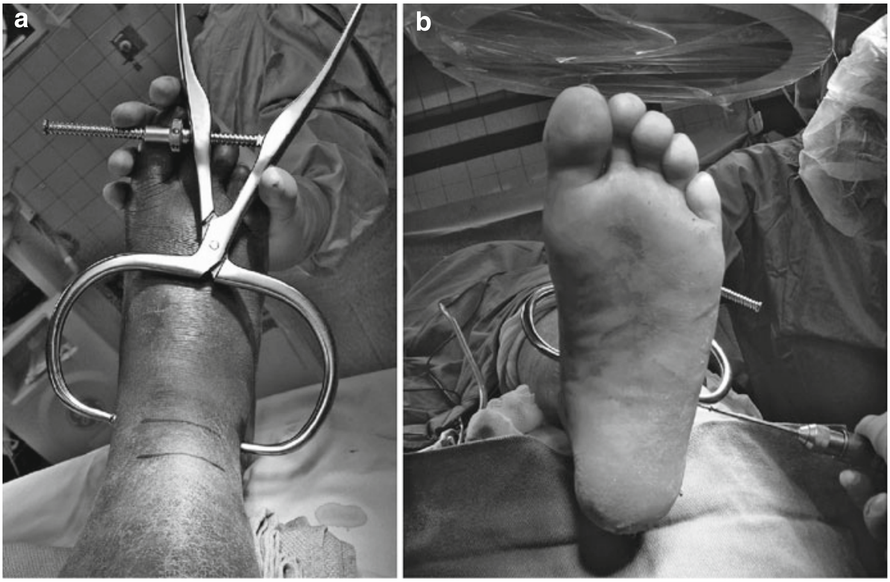

Fig. 10.4 (**a**) Periarticular reduction clamp traverses the bi-malleolar axis of the ankle. (**b**) The tips of the reduction clamp are positioned approximately 20–25° posterolateral to anteromedial matching the bi-malleolar axis

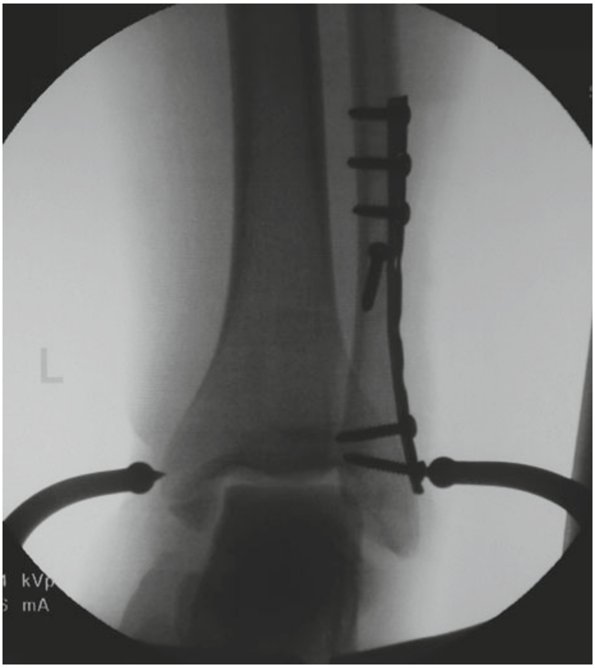

Fig. 10.5 Once the periarticular clamp is tightened, fluoroscopic imaging is used to verify syndesmotic reduction

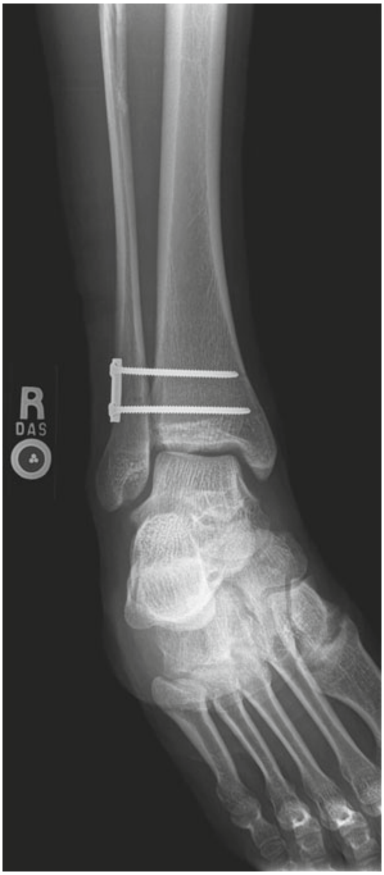

Fig. 10.6 Two 3.5 fully threaded cortical screws are placed through a one-third tubular plate to increase torsional stability and purchase of the screws

10.10.1.3 Screw Fixation

Under fluoroscopic imaging, a 2.5-mm drill hole is made from the fibula to the tibia approximately 1.5–2.0 cm superior as well as parallel to the tibiotalar joint line and angulated 25° from posterolateral to anteromedial trajectory. The cortices are tapped to avoid distraction of the fibula from the tibia when engaging the 3.5-mm screw through the third cortex and to achieve non-lag technique. The hole is measured and a 3.5-mm fully threaded cortical screw is placed tricortically maintaining the reduction of the tibiofibular syndesmosis. Two 3.5-mm fully threaded cortical screws with tricortical purchase or one 4.5-mm fully threaded cortical screw tetracortical have equivocal purchase strength.[19]

Screw fixation through a one-third tubular plate can increase stability of fixation by distributing the stress of screw head purchase to the fibula.[20] For an isolated syndesmotic disruption without distal fibula fracture or syndesmotic disruptions with a Maisonneuve fracture, a 2-hole one-third tubular plate may be incorporated with transsyndesmotic fixation (Fig. 10.6).

10.10.1.4 Suture Button

A proposed advantage of tensioned suture button fixation of the syndesmosis was that it did not require removal. Though mechanical studies comparing the stability of suture versus screw fixation reveal that screw fixation better resists syndesmotic widening and external rotation compared to suture, there are no significance differences with clinical outcomes of either technique.[21–23]

Using the same drill hole orientation as described for transsyndesmotic screw fixation and with the reduction clamp in place, all four cortices are drilled. The straight needle attached to the suture-button fixation is passed from lateral to medial through the drill hole and out of the intact medial skin while avoiding injury of the saphenous nerve and vein. The oblong button is advanced through the drill hole of the medial tibial cortex. The two medial lead sutures are pulled in opposite directions to seat the oblong button flush to the medial tibial cortex. Both lead sutures are cut and removed. The suture attached to the trailing lateral button is tensioned by pulling on either free end of the suture tightening the syndesmosis. Once the lateral button is flush to the fibula, the suture ends are secured with 4–5 ties and cut 1 cm long to allow the knot to lay flush, reducing suture prominence. Position of the buttons is confirmed with fluoroscopy. A second tightrope may be placed 1 cm proximal using the same method but divergent angle to improve rotational stability (Fig. 10.7).

10.10.2 Postoperative Course

Though there is little consensus regarding postoperative weight-bearing status surgeons generally instruct patients to be non-weight-bearing for 6 weeks, then transition into a weight-bearing walking boot for 2 weeks, followed by a soft lace-up ankle brace thereafter. Despite studies reporting similar clinical outcomes whether syndesmosis screws were retained, removed, or eventually failed, the convention of practice is to remove the screws at 6–12 weeks.[24–27]

10.11 Rehabilitation

Early return to function is often the goal of either conservative or surgical treatment; however, timing of return may vary with the degree of injury and type of activity. Most rehabilitation programs involve three progressive phases of therapy. In the acute phase, protection of the limb by immobilization is needed to reduce the inflammatory response and pain of the acute injury or the immediate postoperative period. Goals of the second phase are to restore strength, mobility, and normal gait.

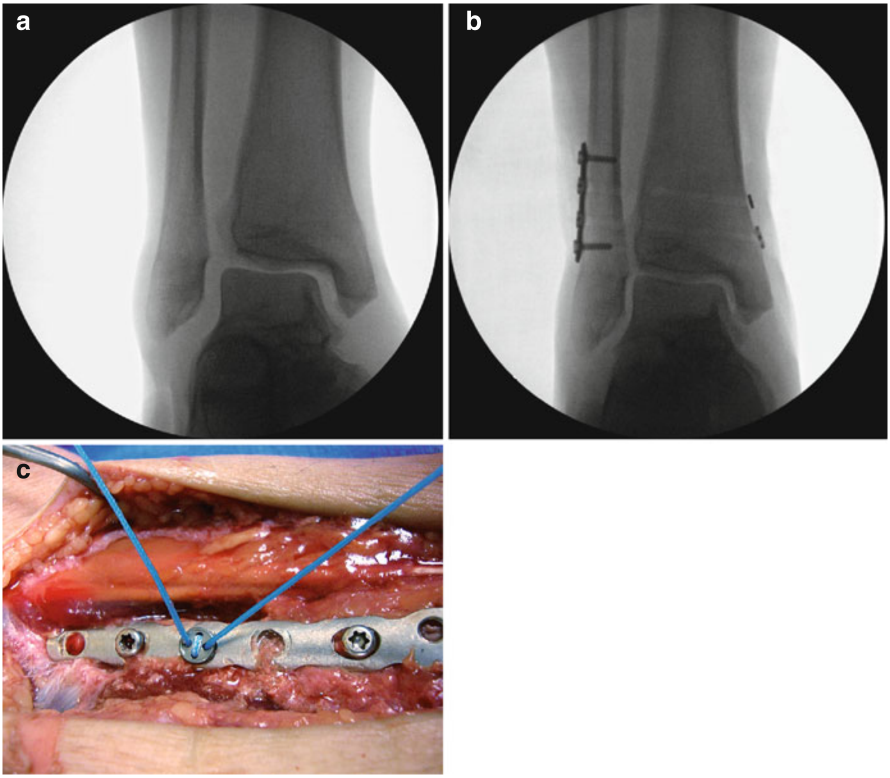

Fig. 10.7 (**a**) Widening of the syndesmosis with decreased tibiofibular overlap is identified. (**b**) Suture button is shown maintaining syndesmotic reduction. (**c**) Suture-button fixation provides adequate stability and more physiologic rehabilitation of the syndesmosis

Patients who are able to perform repetitive hopping without pain proceed to the final phase of rehabilitation which involves increasing strength, proprioception, neuromuscular control, and sport-specific training.[2,13]

10.12 Outcomes

Anatomic reduction of the syndesmosis is the most important factor prognostic of outcomes regardless of method of stabilization. Nonanatomic reduction of the syndesmosis correlates with fair-to-poor functional outcomes.[28,29] Mechanical studies simulating physiologic cyclic loading of both syndesmosis disruptions repaired with one tricortical 3.5-mm screw or Tightrope™ suture button (Arthrex Inc., Naples FL USA) demonstrate no significant changes in syndesmotic gapping between the two groups.[30] Though transsyndesmotic screw fixation exhibits improved stiffness and higher load to failure, clinical observational studies demonstrate no significant differences in outcomes between screw fixation and suture-button methods.[21,22,30]

10.13 Chronic Syndesmosis Injuries

Delayed diagnosis of syndesmosis injuries may lead to chronic ankle pain, instability, and eventually posttraumatic arthritis.[29,31–34] Symptoms of chronic syndesmosis injuries may include continued low-to-moderate grade pain, sensation of instability, and inability to return to pre-injury activities. Clinical findings are often less specific; therefore, diagnostic studies including bilateral weight-bearing radiographs and stress radiographs are often useful in identifying diastasis. CT is the diagnostic study of choice to quantitatively detect widening of the syndesmosis. MRI can identify chronic ligament tears of the syndesmosis, incongruencies of the tibiofibular joint, and syndesmotic widening.[35]

Open or arthroscopic debridement of the syndesmotic ligaments, without addressing the functional insufficiency of the syndesmotic ligaments, may lead to continued instability. Conventional treatment of chronic syndesmosis injuries entails debridement of the disorganized scarred ligamentous tissues, anatomic reduction of the fibula into the tibial incisura, and stable transsyndesmotic fixation in hopes to achieve stable fibrosis of the syndesmosis. Ligamentoplasty or ligament reconstruction of the tibiofibular syndesmosis can be performed in chronically unstable syndesmosis injuries in young, high demand patients without manifestations of degenerative arthritis or if little viable ligaments remain for adequate healing of the ankle syndesmosis. Ligamentoplasty with split peroneus longus tendon autograft weaved through distal tibial and fibular canals reproducing anatomic locations of the anterior, posterior tibiofibular, and interosseous ligaments has been reported to be effective in reduction of ankle pain and eliminating instability associated with chronic syndesmotic ankle injuries[31] (Fig. 10.8).

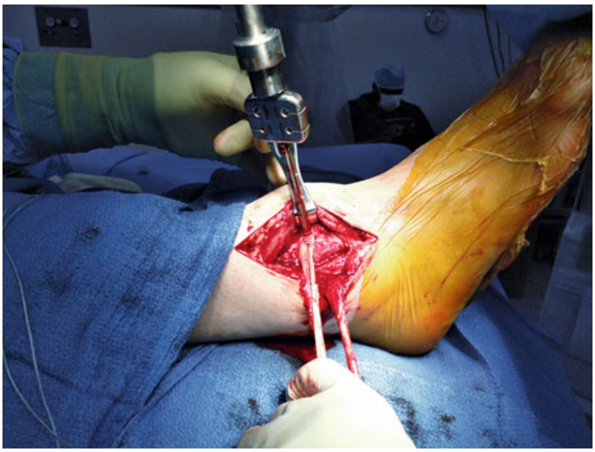

Fig. 10.8 Peroneus longus tendon allograft is routed circumferentially about the distal tibiofibular syndesmosis through anterior-posterior drill holes in both tibia and fibula. The allograft is tightened and secured with an interference screw within the tibia and depending on the fibula's width, either an interference screw or an anchor laterally

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