CHAPTER **27**

ANKLE SYNDESMOSIS INJURIES

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Ankle injuries involving the disruption of the distal tibiofibular syndesmosis, sometimes referred to as high ankle sprains, can be isolated or associated with ankle fractures. If no ankle fracture is present, these injuries can often be misdiagnosed and mismanaged. The purpose of this article is to review the anatomy and biomechanics of the distal tibiofibular joint, mechanism of injury, diagnosis criteria, and current treatment recommendations.

ANATOMY AND BIOMECHANICS

The tibiofibular syndesmosis can be divided into 3 regions: the proximal tibiofibular joint, the interosseous membrane, and the distal tibiofibular joint. The proximal tibiofibular joint is maintained by the anterior superior and posterior superior tibiofibular ligaments. The interosseous membrane nearly spans the entire length between the tibia and fibula (1-7). The tibia and fibula are held together by the interosseous membrane, and during weightbearing this minimizes any posterolateral bowing of the fibula (4).

The distal or inferior tibiofibular joint is stabilized by the following: the anterior-inferior tibiofibular ligament (AITFL), interosseous ligament (IOL), interosseous membrane, posterior-inferior tibiofibular ligament (PITFL), and inferior transverse ligament (ITL). The AITFL originates at the anterolateral (Wagstaffe's) tubercle and upper portion of the lateral malleolus that articulates with the talus. The fibers of the AITFL are directed superiorly and medially to insert on the anterolateral (Chaput's) tubercle of the distal tibia. The AITFL holds the fibula tight to the tibia, and prevents excessive fibular motion and external rotation of the talus (1, 8).

The IOL is the thickened distal portion of the interosseous membrane. It originates from the medial aspect of the distal fibular shaft, and attaches to the lateral surface of the distal tibia. The IOL allows slight separation between the tibia and fibula during dorsiflexion of the ankle joint (1, 5, 9-13). The PITFL consists of two components: a superficial and deep portion. The superficial portion originates from the posterior border of the lateral malleolus and is directed superiorly and medially to attach to the posterolateral tibial (Volkmann's) tubercle. The deep portion is the ITL. This portion also originates at the posterior border of the lateral malleolus and is directed superiorly, medially, and posteriorly to attach on the inferior posterior border of the tibia's articulating surface. The ITL prevents posterior translation of the talus (1).

The function of the distal tibiofibular syndesmosis is to prevent diastasis of the fibula from its groove in the tibia (14-16). The articulating surfaces of the malleoli and talus stay in close contact throughout ankle dorsiflexion and plantar flexion. The normal ankle's active dorsiflexion is approximately 15^o-20^o and active plantar flexion is between 45^o-55^o (17). Sarrafian (11) reported that the superior talar surface is 4.2 mm wider anteriorly than posteriorly on average, and that the talus rotates internally and supinates slightly during ankle joint plantar flexion. The talus will pronate and externally rotate during ankle dorsiflexion (1). Approximately 1-2 mm of widening at the mortise will occur at the distal tibiofibular syndesmosis during ankle dorsiflexion and plantar flexion (1, 2, 9, 10, 15, 18-20). The fibula has been shown to laterally rotate with dorsiflexion and medially rotate with plantar flexion approximately 3^o-5^o (1, 15, 19, 21-23). There is no contact of the fibula with the weightbearing surface of the talus, but approximately 16% of the weight is transmitted to the fibula because of the strong syndesmosis ligaments (24).

MECHANISM OF INJURY

External rotation and hyperdorsiflexion are the most common causes of ankle syndesmosis injuries that have been reported in the literature (2, 10, 16, 21, 25-30). Excessive external rotation of the talus will cause the fibula to rotate from the tibia and cause an increased strain of the syndesmosis ligaments leading to rupture. Dorsiflexion of the ankle causes an increase in tension to the interosseous ligament. During hyperdorsiflexion, the wider anterior portion of the talus drives the malleoli apart and can injure the syndesmosis. However, syndesmosis injuries from hyperdorsiflexion are less likely to occur if the knee is extended because of the gastrocnemius muscle tension (1). Other causes such as eversion (4, 10, 30), inversion (10, 18, 29), plantar flexion (9, 25, 30), pronation (22), and internal rotation (9), have been conveyed.

Boytim et al (26) described two external-rotation mechanisms that occur in football causing syndesmotic injuries. The first is caused by a direct blow to the lateral leg of a player in the prone position with the foot externally rotated. The second type described was external rotation of the foot being caused by a blow to the lateral aspect of the player's knee with the body rotating in the opposite direction. Syndesmosis injuries have also been described to occur in slalom skiers by Fritschy (30). If a ski catches in the snow, excessive external rotation of the leg and rotation of the body in the opposite direction can cause an ankle syndesmosis injury. Hyperdorsiflexion can also occur in running and jumping sports (1).

CLINICAL AND DIAGNOSTIC ASSESSMENT

Upon presentation, two clinical tests that may be beneficial in diagnosing syndesmosis injuries are the squeeze test and external rotation test. When performing the squeeze test, compression of the tibia and fibula above the midpoint of the calf will cause the two bones to separate distally and cause pain at the region of the syndesmosis. Pain can also be produced at the syndesmosis by externally rotating the foot while the leg is stabilized with the knee flexed at 90^{o} (31).

Three radiographic views of the ankle (anterioposterior [AP], mortise, and lateral), and two tibiofibular views (AP, and lateral) should be performed. The tibiofibular clear space, tibiofibular overlap, and medial clear space should be evaluated. An increased tibiofibular clear space, decreased tibiofibular overlap, and increased medial clear space are all associated with syndesmosis injuries (Figure 1). The tibiofibular clear space is the distance between the lateral border of the posterior tibia (incisura fibularis) and the medial border of the fibula. This is measured 1 cm proximal to the plafond, and should be less than 6 mm in both the AP and mortise ankle views (Figure 2). The tibiofibular overlap is the overlap of the anterior tibial tubercle and fibula 1 cm proximal to the plafond. The AP view should have an overlap of greater than 6 mm, and the mortise view should have an overlap of greater than 1 mm. A decreased tibiofibular overlap has been shown to be the most reliable indicator of syndesmosis injuries (32, 33). The medial clear space is the distance between the medial border of the talar dome and lateral aspect of the medial malleolus. The medial clear space should be evaluated in the mortise view when the ankle is in a neutral position. The medial clear space should be equal to or less than the length between the superior aspect of the talar body and the tibial plafond (superior clear space). An increase in the medial clear space signifies that the deltoid ligaments are ruptured, and if present, a high fibular fracture needs to be ruled out.

Diastasis of the ankle mortise without fibular fracture has been categorized as latent or frank diastasis by Edwards and DeLee (28). Latent diastasis has no widening of the ankle syndesmosis in initial radiographs and requires stress (external rotation) radiographs to be performed. Lateral displacement of the fibula will be present in the stress mortise view, and posterior displacement of the fibula relative to the tibia will be noted on the stress lateral view in syndesmotic injuries. Frank diastasis is visualized on initial radiographs.

Computed tomography studies are able to detect minor (2-3 mm) syndesmotic widening (34), and magnetic resonance imaging (MRI) is highly sensitive and specific in the diagnosis of ankle syndesmosis injuries (35, 36). Oae et al (36) reported that MRI studies have a specificity of 93% and sensitivity of 100% for the diagnosis of an AITFL rupture.

Figure 1. Anterior posterior ankle view showing an increased medial clear space, decreased tibiofibular overlap, and increased tibiofibular clear space.

Figure 2. Normal ankle radiograph.

CONSERVATIVE CARE

Conservative treatment can be performed in the absence of syndesmotic diastasis or instability. The patient should begin with rest, ice, compression, and elevation of the affected extremity at the initial time of injury. It is recommended that initial treatment consist of a non-weightbearing cast for 2-3 weeks. The patient can then be transitioned to weightbearing as tolerated in a walking boot before progressing to a shoe. Hopkinson et al (25) treated 13 of 15 ankle syndesmotic injuries conservatively due to no diastasis being present. They noted that the recovery period was significantly longer compared with severe non-syndesmotic ankle sprains (55 days compared to 28 days).

Some authors have also recommended conservative care for syndesmotic injuries with latent diastasis if the fibula is in good anatomic alignment and can be maintained. In these cases it is recommended that the patient be treated with a non-weightbearing cast for 4-6 weeks (37).

SURGICAL CARE

Surgical treatment is warranted when diastasis is present. The goal of surgical treatment is to reestablish the normal anatomic tibiofibular relationship. This is successfully performed by restoring the length and rotational relationship of the fibula to the tibia. There are many controversies with surgical correction including: what position the ankle joint should be in at the time of repair, what fixation to use, how many cortices to engage, the need and timing of implant removal, and postoperative weightbearing status.

It has been recommended that the ankle should be maintained in a dorsiflexed position during hardware insertion. The wider anterior portion of the talus will decrease the chance of over tightening the syndesmosis, and theoretically ankle dorsiflexion will not be limited. However, Tornetta et al (38) in a cadaveric study showed that fixing the ankle syndesmosis when the ankle was in plantarflexion did not limit dorsiflexion. In this study, one downfall is that they used an unloaded method to assess the range of motion. Furthermore, it has been suggested that dorsiflexion recreates the deforming force of external rotation and actually may contribute to malreduction of the unstable syndesmosis (31).

Guidelines recommend that fixation be placed between 2-3 cm superior to the tibial plafond, parallel to the ankle joint, and have an angulation of 20^{o}-30^{o} from the frontal plane (9). In one clinical study, there was no difference in outcome with patients who had a syndesmotic screw placed 2 cm proximal to the joint versus 3-5 cm (40).

Fixation options include absorbable screws, non-absorbable screws, and suture buttons. There appears to be no difference in the use of stainless steel versus titanium screws (41). Mikkonen et al (42) treated 18 patients with a bioabsorbable self-reinforced poly-L-lactide screw, and 12 patients with a metallic screw. They examined the patients after a minimum of 12 months, and noted that there were no tissue reactions or wound infections in any of their patients. Thordarson et al (43) tested polylactide screws, which retain 80% of their tensile strength at 4 weeks, versus stainless steel screw fixation. At a mean follow-up of 11 months, there were no subjective complaints in ankle range of motion between the two groups, and there was no medial clear space widening or loss of syndesmosis reduction in any patient. Screw sizes typically used are either 3.5 mm or 4.5 mm. Studies have shown that there is greater resistance to shear stress with the use of 4.5 mm screws (44). However, this advantage has not been shown to provide a biomechanical advantage (45). Recently, suture button devices have been advocated because they maintain physiologic micromotion and should not have to be removed. In 2011, Ghazaly et al (46) performed an in vivo study using a suture button repair on 24 patients with acute injuries. Their patients had an average AOFAS score of 94 postoperatively at an average of 20 months follow-up. They also noted that approximately 25% of patients required removal of the device due to local irritation or lack of motion.

Controversy exists as to whether screw fixation should purchase 3 or 4 cortices. Supporters of tricortical purchase suggest that this technique does not require removal of fixation before weightbearing is initiated. Micromotion occurs, and normal motion of the syndesmosis may be reestablished without the need of screw removal (47, 48). Proponents of the quadricortical technique state that it is more rigid, and prevents syndesmotic widening more often than the tricortical technique (49, 50) Smith et al (51) performed a prospective randomized study using 3.5 mm fully threaded cortical screws through either 3 or 4 cortices. They inserted screws without compression, and found that either 3 or 4 cortices of fixation are sufficient to stabilize the syndesmosis during healing. They also noted that a loss of reduction may occur if patients started weightbearing earlier than 6 weeks postoperatively.

Another debate is whether or not the syndesmotic screw must be removed prior to weightbearing. In 2011, a literature review was performed by Schepers (52). Most studies reviewed showed no difference in outcome between retained or removed screws. The author noted that the current literature suggests that hardware causing irritation or reduced range of motion after 4-6 months be removed. It has been advocated to remove the screws at 12 weeks postoperatively if the surgeon chooses to remove them (31, 53).

POSTOPERATIVE COURSE

There are a variety of recommendations for postoperative treatment. Non-weightbearing has been advocated for 6 weeks, followed by 2 weeks in a short-leg walking cast. An ankle brace can then be used for 4 weeks (31). In athletes, a functional 3-phase rehabilitation program has been suggested by Porter and Jelinek (54). This consists of allowing early range of motion postoperatively with the use of a walking boot, and transitioning the patient to an ankle brace with athletic shoe at 4-6 weeks after surgery. They suggest that the athlete should wear the brace during athletic activities for the first 3 months postoperatively.

CONCLUSION

Ankle syndesmosis injuries can easily be misdiagnosed and mismanaged when no fracture is present, and currently there is still much debate on the appropriate treatment for these injuries. Clinical examination and radiographic criteria needs to be observed thoroughly. Stress radiographic views are warranted when a latent diastasis is suspected. When surgery is required, it is imperative that the surgeon be attentive to restoring the normal anatomical orientation of the ankle syndesmosis.

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