Ankle Syndesmosis Injuries

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The incidence of ankle syndesmosis injuries—also known as high ankle sprains—is increasing, in part because of an increased awareness of the diagnosis. The most likely mechanism of injury involves some component of external rotation and eversion; this is different from common lateral ankle sprains that have an inversion internal rotation mechanism of injury. The management of acute and chronic syndesmosis injuries are discussed in this article.

Incidence

The real prevalence of ankle syndesmosis injuries probably is underestimated because many are missed or are not treated acutely. Hopkinson and colleagues [1] suggested that ankle syndesmosis injuries account for 1% of all ankle injuries in the United States military. Fallat and colleagues [2] followed all ankle injuries that presented at a local emergency department and a primary care clinic prospectively for 33 months. The diagnosis of a high syndesmosis injury was made on physical examination without any further investigation. Of 639 patients who had 547 soft tissue injuries and 92 ankle fractures, the prevalence of syndesmosis injuries was 0.5%. In contrast, Boytin and colleagues [3] reported a prevalence of 18% for syndesmosis injuries in a prospective study of 98 ankle injuries. The diagnosis was reached by physical examination. The emphasis of the study was placed on the length of time that it took to recover from a syndesmosis injury compared with a lateral ankle sprain. The high prevalence of ankle syndesmosis injuries in this subpopulation of professional football players...
can be explained easily by the rules and contact that is sustained during the practice of football. That percentage should not be extrapolated to the more standard population. As a rare injury, the diagnosis may be missed and appropriate treatment may be delayed.

Anatomy

The ankle syndesmosis is the joint between the distal tibia and the distal fibula. Motion at this joint includes some translation and rotation during tibiotalar dorsiflexion and plantarflexion to accommodate the asymmetric talus while maintaining congruency [4]. Three main structures provide stability at the syndesmosis: the interosseous tibiofibular ligament, the anterior inferior tibiofibular ligament, and the posterior inferior tibiofibular ligament.

The interosseous tibiofibular ligament represents the distal continuation of the interosseous membrane. At approximately 4 cm to 5 cm above the ankle joint it forms a triangle with a lateral base and a medial apex. Inferiorly, this forms the anterior inferior tibiofibular ligament that is defined from the interosseous ligament by a space. The posterior inferior tibiofibular ligament has a similar relationship. The bulk of the interosseous tibiofibular ligament ends 1 cm to 1.5 cm above the joint line at the upper margin of the three-faceted distal tibiofibular joint.

The anterior inferior tibiofibular ligament forms three fascicles. The middle is the strongest and most prominent. These bundles arise in the vicinity of the anterior distal tibial (Chopart’s) tubercle, and insert into the most anterior tubercle of the distal fibula. The superior bundle is proximal to the tubercles, whereas the inferior bundle is distal to the tubercles. The middle bundle travels obliquely from Chaput’s tubercle to the distal fibula at a 30° angle to the joint line.

The posterior inferior tibiofibular ligament has less distinct bundles that originate from the posterior tubercle of the tibia and attach into the posterior tubercle of the distal fibula. The direction of the posterior inferior tibiofibular ligament is more horizontal than is the anterior inferior tibiofibular ligament.

The morphology of the distal tibiofibular joint is variable. The distal tibiofibular joint has three facets; the middle is the most consistent. The anterior facet has fibrotic tissue that blends with the anterior inferior fibular ligaments. The variable-sized posterior facet has a plica. This facet is visualized intraarticularly extending proximally into the syndesmosis up to 12 mm to 15 mm from the ankle joint line. The middle facet has a cartilaginous surface that articulates with the lateral tibial facet.

Biomechanics

With ankle dorsiflexion, the distal fibula moves proximally, posteriorly and rotates externally. Beumer and colleagues [5] demonstrated by radiostereo-
metry that an external rotation force rotates the fibula externally and translates it posteromedially.

In a cadaver study, Ogilvie-Harris and colleagues [6] showed that the anterior inferior tibiofibular ligament contributes 35% of the strength of the syndesmosis, the posterior inferior tibiofibular ligament contributes 40%, and the interosseous ligament contributes 21%.

A partial transection of the anterior inferior tibiofibular ligament can provide enough diastases to be clinically significant but not demonstrated by plain radiographic imaging [7]. A translation of 2.3 mm of the talus after complete transaction of the anterior tibiofibular ligament alone will increase to 7.3 mm of translation after complete transaction of all syndesmosis ligaments. Instability may be present, despite having some remaining structures intact.

A missed unstable ankle syndesmosis injury can result in end-stage ankle degeneration; however, the mechanism for degenerative change is not clear. Pereira and colleagues [8] studied the ankle joint kinetics after a complete syndesmosis and deltoid ligament injury. In contrast to other studies, under a full weight-bearing axial load, the talus has a tendency to relocate itself to the most congruent position and restore its symmetry within the mortise, even with a displaced syndesmosis. The likely mechanism for lateral talar shift after syndesmosis injury includes posterior translation of the fibula.

Pathophysiology

An external rotation torque that is applied to the foot may tear the soft tissue structures that are responsible for stability of the ankle syndesmosis; the intraosseous ligament is torn to the knee, a spiral fracture of the fibula may occur low or high (a Maissoneuve fracture), or the intraosseous ligament becomes torn above the fracture site. A high fracture or intraosseous ligament tear may be missed if the proximal leg is not examined.

Clinical presentation and diagnosis

Instability may be the main presenting complaint in an acute ankle syndesmosis injury. In patients who have a chronic injury, pain and functional deficits secondary to a widened syndesmosis are the predominant symptoms.

Acute injuries

The mode of injury indicates the potential for a syndesmosis injury. The patient may have some anterolateral ankle pain proximal to the lateral collateral ligaments. The patient may be able to walk on a straight line, but may have
symptoms during external rotation, cutting or shifting directions because of the syndesmosis instability and pain. Swelling or contusion may be minimal.

**Physical examination**

Special tests have been described to assess a syndesmosis injury. These include the Hopkins (squeeze) test, external rotation under stress test, palpation test, and compression of the syndesmosis with maximum dorsiflexion [9,10]. In a study on the reliability of these tests, the external rotation under stress test was most reliable and the squeeze test, or Hopkins test, was the least valuable. The external rotation test is performed with the knee and ankle at 90° and a force with external rotation is applied to the midfoot area. If pain is present, the test is positive. An alternative test that was not studied but that can be performed on less symptomatic patients requires the patient to stand on the affected leg and rotate the pelvis towards the opposite side; this maneuver applies an external rotation torque to the affected ankle which will reproduce pain in the presence of ankle syndesmosis instability.

**Diagnostic imaging studies**

Standing anteroposterior (AP), lateral, and mortise views should be obtained of both ankles in weight-bearing patients. Patients who have proximal leg tenderness also should have an AP and lateral view of the whole leg. CT scans and MRI scans may be of value in more subtle cases. Examination under anesthesia may be the final test before surgery. On a mortise view a lateral translational force is applied to the ankle; opening of the syndesmosis confirms the diagnosis. A concomitant deltoid ligament injury result in a greater degree of translation [11].

Beumer and colleagues [12] studied motion of the distal fibula before and after a syndesmosis injury in cadavers. The fibula tended to rotate externally after disruption of the syndesmosis. This is hard to visualize on plain radiographs. Posterior translation of the distal fibula on a lateral projection of the ankle joint was seen as a secondary pathology.

Beumer and colleagues [13] concluded in a separate cadaver study that the fibular overlap and the clear space are the most valuable radiographic signs of syndesmosis injury. The clear space is defined as the area created between the lateral cortex of the tibia and the medial one from the fibula at 1 cm above the joint line. A clear space of greater than 6 mm indicates a syndesmosis injury. A widened medial joint space is suggestive of an associated deltoid ligament injury.

In an MRI study, injuries that were associated with a syndesmosis disruption included anterior tibiofibular ligament disruption in 74% of cases, osteochondral lesions of the talus in 28% of cases, and bone bruises in 24% of cases [14]. This
study may have overestimated the associated injury rate, but the treating physician should examine for these associated injuries.

**Chronic injuries**

In the presence of a chronic painful ankle syndesmosis, pain may be due to the presence of scar tissue or the lack of congruency of the syndesmosis and tibiotalar joints. The scar tissue may be present at the level of the syndesmosis or along the medial gutter of the ankle. Scar tissue must be removed to allow reduction of the syndesmosis. A preoperative MRI indicates the size and location of scar tissue.

The congruency of the ankle syndesmosis and the relative position of the fibula with respect to the tibia is assessed best by CT scan. A CT scan can detect 1 mm of syndesmosis displacement, whereas plain radiographs miss 3 mm of displacement 50% of the time [15].

Thordarson and colleagues [16] studied the contact pressures within the ankle joint with any displacement of the fibula in nine fresh frozen cadavers. The fibula was displaced in all three planes, by translation in one single plane as well as a combination of planes, and fixed during the testing sequence with an external fixator. They concluded that shortening was associated with the highest increase in contact pressures, followed by lateral translation of the fibula, or widening of the ankle syndesmosis. A lateral translation of the fibula of 2 mm—the smallest increment that was tested on their experimental sequence—increased the contact pressure by almost 40% from baseline in some of the quadrants on the surface of the talus. Out of all of the quadrants of the talus, the posterolateral one was affected most by the change in position of the fibula (Fig. 1).

**Treatment of acute injuries**

Takao and colleagues [17] published the results of arthroscopic evaluation of tibiofibular syndesmosis disruption. They collected 38 patients who had Weber B ankle fractures. Using AP and mortise radiography they diagnosed ankle syndesmosis disruption on 42% and 55% of the cases, respectively. With the use of ankle arthroscopy, the diagnosis increased to 87%.

Tornetta and colleagues [18] showed in a cadaver study that overtightening of the intact fibula at the syndesmosis was hard to achieve. It is possible that a fractured fibula may prevent dorsiflexion if the fracture is not anatomic. Therefore, full dorsiflexion of the ankle during screw placement is not required. Instead, attention should be directed at making sure that the fibula is out to length, rotated correctly, and reduced into the syndesmosis with no anterior posterior or lateral translation.

The most reliable way to assess reduction of the syndesmosis is through comparison with the opposite ankle after obtaining an AP, mortise, and lateral...
fluoroscopy or radiographic image. The clear space and the overlap of the fibula with the tibia at 1 cm proximal to the joint line are the parameters to analyze on the AP and mortise views. The lateral view helps to assess proper reduction of the fibula with the tibial sulcus. It should have no increased anterior or posterior translation when compared with the noninjured side.

**Screw placement, type, and technique**

McBryde and colleagues [19] studied the best location for the syndesmosis screw in 17 paired cadaver limbs. A 3.5-mm self-tapping stainless steel cortical screw was used. The specimens were tested to failure through an external rotation torque at 90° per minute. They concluded that a screw which is located 2 cm proximal to the joint line provided better fixation than did one that was 3.5 cm proximal to the joint line (Fig. 2).

Thompson and Gesink [20] studied the biomechanical difference between a 3.5-mm and a 4.5-mm stainless steel screw in cadavers. Three cortices were purchased. The screw pulled out in five out of six specimens that had the 3.5-mm screw, whereas the fibula fractured in five out of the six specimens that had the 4.5-mm screw. The investigators concluded that there was no biomechanical advantage to using a 4.5-mm tricortical screw for syndesmosis fixation. No washers or plates were used in either group.

Hoiness and Stromsoe [21] followed a randomized group of 64 patients prospectively to evaluate the use of a single tetracortical screw versus two tricortical screws for instability of the syndesmosis. All but three injuries were related to ankle fractures. Although there was no clinical difference between the two groups at 1 year of follow-up, the investigators recommended the use of tricortical screws because it represented a safe option and improved early function. The number of syndesmosis surgically fixed where there was inherent stability and no need for such fixation, is not clear in clinical studies.

Beumer and colleagues [22] studied the biomechanical behavior of titanium versus stainless steel screws, and the purchasing of three versus four cortices of the ankle syndesmosis on 16 fresh frozen cadavers. Two hundred and twenty-five thousand cycles of axial load were applied through the ankle joint. Despite no fracture of bones or screws, they recorded widening of the syndesmosis of 1.05 mm.

Cox and colleagues [23] studied the biomechanical behavior of 5.0 mm stainless steel screws versus 5.00 mm poly-L-lactic-polyglycolic acid (PLLA-PGA) bioabsorbable screws. Eight paired cadaver limbs were used. A cycling

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Fig. 1. (A) Radiographs obtained at the time of injury with a medial malleolus and fibula fracture and disruption of the syndesmosis. (B) Radiographs taken 2 months after open reduction and internal fixation. There is lateral displacement of the talus with widening of the medial joint space and lack of reduction of the ankle syndesmosis. (C) Radiographs taken 18 months after index injury shows advanced degenerative changes of the ankle secondary to joint incongruency.
load protocol was applied followed by a test to failure. There was no difference in the mechanical behavior of the screws; therefore, mechanically, a bioabsorbable screw is a reasonable alternative.

Hovis and colleagues [24] reported the results of 23 patients after reduction and fixation of the syndesmosis with a 4.5-mm bioabsorbable screw. Postoperatively, the patients were treated with 6 weeks of nonweight bearing that was followed by a program of physical therapy. The investigators reported no malunion, nonunion, or loss of reduction of the syndesmosis or any complications that were related to the biomechanical or biochemical properties of the bioabsorbable screws. Of the 70% of patients who were available for follow-up for a minimum of 24 months, 83% had excellent results and 17% had good results using the Olerud and Molander outcome tool for ankle fractures.

Thornes and colleagues [25] studied a new method of fixation for syndesmosis which included a suture–button construction. Sixteen patients were followed prospectively for 12 months and were compared with a control group that

Fig. 2. (A) Pronation external rotation injury to the ankle with a syndesmosis disruption. (B) After open reduction and internal fixation of the medial malleolus and fixation of the syndesmosis.
underwent screw fixation. The investigators reported that a faster return to work was associated with the suture–button fixation and no complications occurred with that system. All patients showed a well-maintained reduction on the CT scan findings at 3 months. The randomization process was based on the surgeon’s preference and technique.

The TightRope (Arthrex Inc., Naples, Florida) was designed to maintain reduction of the syndesmosis while allowing motion of the fibula with respect to the tibia in a rotational and proximal–distal plane. To place the TightRope, a 3.5-mm hole is drilled across the syndesmosis from lateral to medial at approximately 1 cm to 2 cm above the ankle joint line. The TightRope is passed across the tibia in the same direction. After the medial button on it reaches the medial cortex of the tibia, the button is flipped and is placed flat against the cortex. The button must lay flat against the cortex without any soft tissue interposition to avoid subsequent loosening of the construction. Tension in the suture loads across the medial and lateral button maintains reduction of the syndesmosis. Tension is obtained by suturing tightly over the lateral button (Fig. 3).

Some investigators advocate ankle arthroscopy when reducing an ankle fracture. This assists in the identification of associated injuries and helps to assess the reduction and necessity of addressing the syndesmosis joint surgically (Figs. 4–7).

Treatment of chronic injuries

In the presence of hypertrophic scar tissue, ankle arthroscopy is recommended to assess the joint and to remove scar tissue from the medial gutter and syndesmosis. From the ankle joint it can be reached up to 1 to 1.5 cm proximally into the syndesmosis recess.

Ogilvie-Harris and Reed [26] reported on 17 patients who had chronic syndesmosis injuries that were evaluated and treated arthroscopically. Preoperatively, all of the patients had a positive external rotation stress test. At the time of arthroscopy, the investigators reported clear visualization of the posterior and anterior inferior tibiofibular ligaments and the interosseous ligament. They assessed the instability of the syndesmosis by probing the tibiofibular joint and looking for any gapping in excess of 2 mm. In the presence of instability, debridement of the syndesmosis area with a 3.5-mm soft tissue resector was performed. No fixation was used. The patients participated in a physical therapy program for at least 3 months. All patients required resection of the remaining interosseous ligament; the ligament protruded into the joint 1 mm to 4 mm. Pain was improved in 50% of the patients and stiffness was improved in 25% of the patients. Half of the patients were examined postoperatively; the external rotation stress test did not produce any further pain. Fixation of the syndesmosis may have improved these results.

Harper [27] reported on the reconstruction of failed syndesmosis fixation from 2003. The investigator described a 1-year follow-up, using the American Orthopaedic Foot and Ankle Society outcome score, on six patients who had
Fig. 3. (A) Anteroposterior (AP) view of a widened syndesmosis. (B) TightRope system for syndesmosis fixation. (C, D) AP and lateral weight-bearing radiographs 6 months after a TightRope fixation of a syndesmosis disruption.
recurrent widening of the syndesmosis. Two patients required debridement of the tibiofibular interspace and two patients required debridement of the medial gutter and the tibiofibular interspace. Syndesmosis fixation constructs included 4.5-mm to 7.3-mm cannulated screws that engaged three or four cortices. A well-reduced and maintained reduction occurred in all but one case. On CT scan assessment, function was related to the quality of reduction. The one patient with a poor outcome had failure of the reconstruction. The investigator em-

![Fig. 3 (continued).](image)

**Acute injury without a fracture**

- **Examine under anesthesia**
  - **Stable**
    - No surgical treatment.
    - Functional return to activities
  - **Minimal instability**
  - **Obvious instability**
    - Tight rope. Partial weight bearing until pain free.
    - Two tight ropes or screws. Non-weight bearing x 6 weeks.

Fig. 4. Algorithm for ankle syndesmosis injuries in the absence of a fracture.
phasized the possibility of accurate diagnosis and reduction of such a chronic injury, and the possibility of restoring the ankle mechanics through a stable and sturdy construction.

Grass and colleagues [28] reported on 16 patients who underwent reconstruction of the syndesmosis ligaments using an autogenous peroneus longus tendon graft. The reconstruction reproduced the three main soft tissue restrainers of the ankle syndesmosis. The peroneus brevis tendon could not be used because of its short length. The patients were allowed partial weight bearing for the first 8 weeks. No rigid fixation was used to maintain reduction of the syndesmosis. The average Karlsson score was 88. Ninety-four percent of the patients were

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**Fig. 5. Algorithm for ankle syndesmosis injuries in the presence of a Weber B ankle fracture.**

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**Weber C ankle fracture**

- **Distal fracture**
  - Plate fibula
  - Tight rope through plate or distal to the plate. Non weight bearing x 6 weeks.
- **Proximal fracture**
  - Screws or tight rope. No need for fibula ORIF if length preserved. Non weight bearing x 6 weeks.

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**Fig. 6. Algorithm for ankle syndesmosis injuries in the presence of a Weber C ankle fracture.**
pain-free after an average of 16 months. The radiographic parameters of the ankle syndesmosis improved as there was a more congruent ankle syndesmosis.

**Special situations for ankle syndesmosis**

**Synostosis**

The presence of a synostosis in the syndesmosis may cause future disability that is secondary to pain or stiffness of the ankle joint. In a retrospective study, Taylor and colleagues [29] reported the findings on 50 syndesmosis injuries in 44 football players. Fifty percent of those who had radiographs developed heterotopic ossification within the interosseous membrane that prolonged the recovery time.

The reason for a synostosis of the ankle syndesmosis after an injury is not clear. The pathophysiology of heterotopic ossification continues to be unknown. Similarly, it is difficult to propose any treatment to avoid heterotopic ossification or synostosis.

Kottmeier and colleagues [30] reported a case report of a fibula stress fracture in a patient who had synostosis of the ankle syndesmosis. Bostman [31] reported a slightly higher prevalence of synostosis within the ankle syndesmosis after the use of bioabsorbable implants. The biologic environment that is created by alpha-hydroxy polyester may promote heterotopic bone and syndesmosis.

The prevalence of an ankle syndesmosis synostosis after an ankle fracture has been reported between to range between 1.7% and 18.2% [32–35].

**Ankle syndesmosis fusion**

**Surgical technique**

An ankle syndesmosis fusion may be performed through an anterolateral approach. Soft tissues are stripped from the medial distal fibula and the most lateral tibia. The most distal margin of the fusion site should be 1 cm proximal to the joint line. The lateral cortex of the tibia and the medial cortex of the fibula are stripped and pushed posteriorly for a total extension of 2 cm to 3 cm (or 3–4 cm from the joint line). Special attention has to be paid to avoid any disruption of the articular surface of the ankle which could create a stress raiser.
along the most distal portion of the tibia with subsequent collapse of the articular surface. A large amount of bone graft is packed into the site, and two syndesmosis screws are placed across the joint. It is ideal to place a small bone block between the tibia and fibula to prevent narrowing of the ankle mortise when the screws are inserted. A one-third semitubular plate helps to compress the syndesmosis by applying a buttress effect and avoids any widening of the most distal fibula. Postoperatively, the patient is maintained nonweight bearing until radiographic fusion is visualized—approximately the eighth to tenth postoperative week.

**Outcome**

The outcome of an ankle syndesmosis fusion is not reported in the English literature. Although it is an excellent option as a salvage procedure, it must be emphasized that patient satisfaction is related directly to the preoperative pain and disability. It is the authors’ perception that final ankle function after the distal tibiofibular joint motion is obliterated is acceptable for activities of daily living.

![Algorithm for ankle syndesmosis injuries for recurrence of syndesmosis instability after screw removal.](image)

**Recurrence after screw removal**

- **If less than 6 months**
  - Open debridement and fixation with 2 screws
  - Evaluate integrity of ankle joint with CT scan.
  - Minimum incongruency
  - Significant incongruency
  - Syndesmosis fusion with bone block

- **If longer than 6 months**

- **Second recurrence**

**Screw removal:**
- Never before 6 months
- Four cortices to allow removal of medial broken fragment

Fig. 8. Algorithm for ankle syndesmosis injuries for recurrence of syndesmosis instability after screw removal.
but it definitely is not sufficient to maintain an active athletic life. Therefore, only the most disabled patient is satisfied with such an intervention (Figs. 3–8).

References


