Syndesmotic Ankle Sprains in Athletes

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Ankle sprains are among the most common athletic injuries and represent a significant source of persistent pain and disability. Despite the high incidence of ankle sprains in athletes, syndesmosis injuries have historically been underdiagnosed, and assessment in terms of severity and optimal treatment has not been determined. More recently, a heightened awareness in sports medicine has resulted in more frequent diagnoses of syndesmosis injuries. However, there is a low level of evidence and a paucity of literature on this topic compared with lateral ankle sprains. As a result, no clear guidelines are available to help the clinician assess the severity of injury, choose an imaging modality to visualize the injury, make a decision in terms of operative versus nonoperative treatment, or decide when the athlete may return to play. Increased knowledge and understanding of these injuries by clinicians and researchers are essential to improve the prevention, diagnosis, and treatment of this significant condition. This review will discuss the anatomy, mechanism of injury, diagnosis, and treatment of syndesmosis sprains of the ankle while identifying controversies in management and topics for future research.

Keywords: syndesmosis; anterior inferior tibiofibular ligament; sports injury; rehabilitation

Despite the fact that ankle sprains are the most common injury sustained by athletes, these injuries continue to be a challenge for the sports medicine professional. The management of tibiofibular syndesmosis sprains (high ankle sprains) is especially problematic. A study from the United States Military Academy found that syndesmosis involvement was the most predictive factor of chronic ankle dysfunction 6 months after an ankle injury.[22] Although our ability to diagnose this injury has improved, determining the extent and severity of injury, predicting when an athlete is ready to return to sports participation, and identifying those who would be best treated by operative stabilization remain enigmatic. This review will discuss the anatomy, mechanisms of injury, and the diagnosis and treatment of distal tibiofibular syndesmosis sprains. We will also identify controversies in management and discuss topics for future research. The focus of this article is the management of syndesmosis sprains without associated fractures or frank diastasis of the ankle mortise, as this is the most common syndesmosis injury experienced when treating the athletic population.

ANATOMY AND BIOMECHANICS

The stability of the syndesmosis is provided by the architecture of the distal tibia and fibula and by the syndesmotic ligaments. The fibula sits in a groove created by the anterior and posterior tibial processes, which provides bony stability to the syndesmosis.[14] The ligaments of the distal tibiofibular syndesmosis include the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, the inferior transverse ligament, and the interosseous ligament.[14,49] The deep portion of the deltoid ligament also contributes to the stability of the syndesmosis and must be evaluated after these injuries, either acutely or in the chronic situation.[36,49] The anterior inferior tibiofibular ligament attaches to the anterolateral distal tibia and runs distal and lateral in an oblique direction to attach to the anteromedial distal fibula. The tibial attachment is wider than the fibular attachment, giving the ligament a trapezoidal shape. The anterior inferior tibiofibular ligament has a width of approximately 18 mm and a thickness of 2 to 4 mm. The posterior inferior tibiofibular ligament attaches to the posterolateral distal tibia and runs horizontally to the posteromedial distal fibula. This ligament has a width of approximately 18 mm and a thickness of approximately 6 mm.[2] Both of these ligaments, as well as the relationship between the tibia and fibula, can be visualized arthroscopically (Figure 1).

The distal tibiofibular syndesmosis is a very stable joint; however, movement of the fibula occurs to accommodate the talus during gait. Radiostereometric evaluation of normal ankles by Beumer et al[4] showed that with an external rotation moment of 7.5 N·m applied to the foot, the fibula externally rotated between 2° and 5°, translated medially between 0 and 2.5 mm, and translated posteriorly between 1 and 3.1 mm. This movement occurs chiefly during the stance phase of gait. In a second study evaluating the mechanical and material properties of the syndesmotic ligaments, Beumer et al[8] demonstrated that there is no

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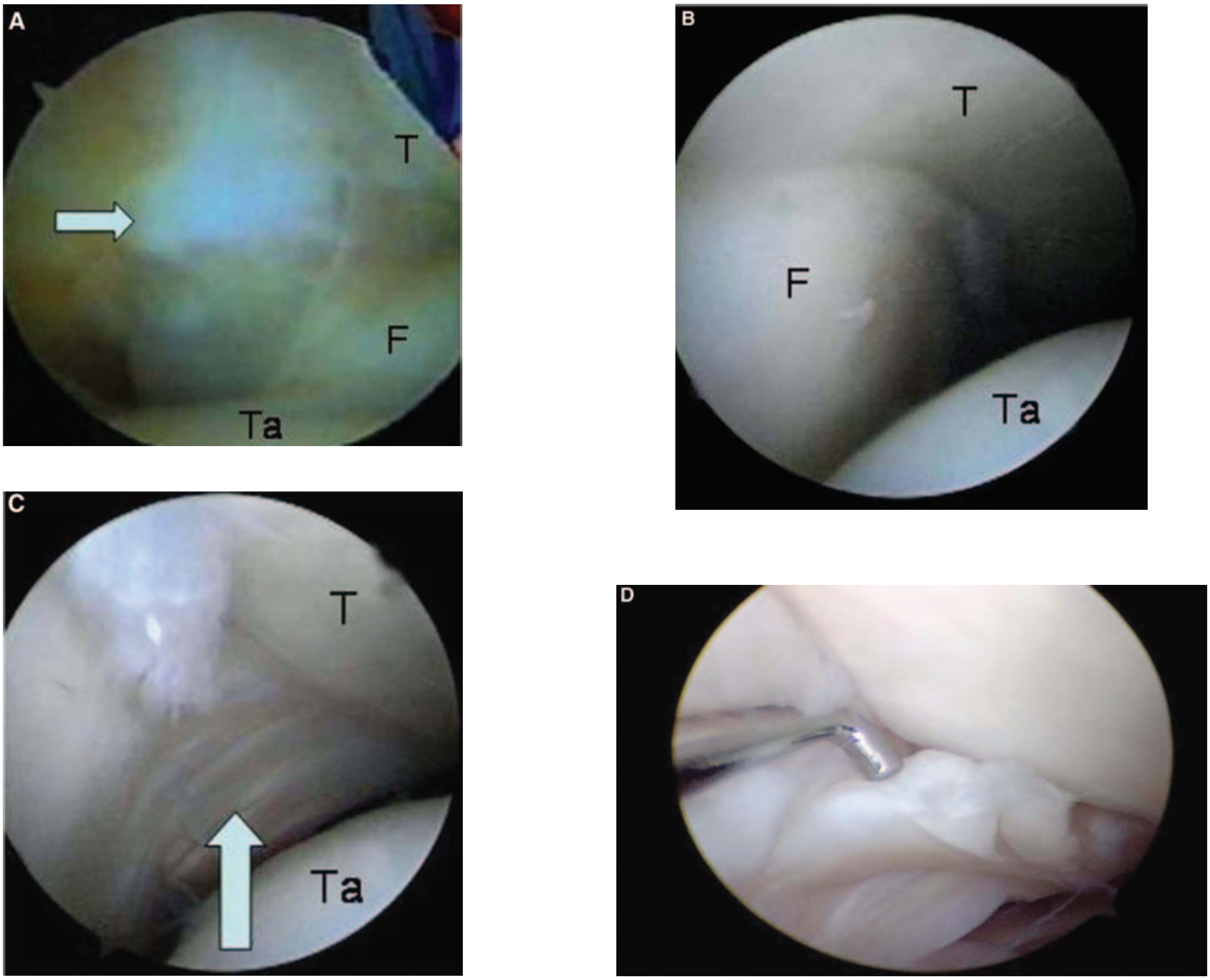

Figure 1. A, an arthroscopic picture of a normal anterior inferior tibiofibular ligament (arrow). B, arthroscopic view of the normal tibiofibular relationship. C, normal anterior inferior tibiofibular ligament (arrow). D, a probe is touching the end of a torn anterior inferior tibiofibular ligament. T, tibia; F, fibula; Ta, talus.

significant difference in strength or stiffness between the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, and the deep portion of the deltoid ligament. Xenos et al[49] used cadaveric specimens to evaluate the effect of sequential syndesmotic ligament sectioning on the ankle's resistance to an external rotation force. The distal tibiofibular diastasis was 2.3 mm after sectioning of the anterior inferior tibiofibular ligament, 5.5 mm with the additional sectioning of the distal 8 cm of the interosseous ligament, and 7.3 mm after sectioning the posterior inferior tibiofibular ligament as well. In the same study, sectioning of all 3 ligaments allowed a mean of 4.7° of pathologic external rotation at the ankle joint.

MECHANISM OF INJURY

The mechanism of injury for syndesmosis sprains has classically been ascribed to the ankle being subjected to an external rotation moment with the foot in a dorsiflexed, pronated position.[49] Athletes with a planovalgus (flat) foot alignment are more likely to have their foot in this externally rotated position when planted, although this has not been demonstrated scientifically. This mechanism of injury is supported by many biomechanical studies that demonstrate increased external rotation of the talus and fibula relative to the tibia as syndesmotic structures are sequentially sectioned.[14] By far, the most common mechanism of injury reported involves an external rotation fracture mechanism. In this mechanism, the foot is planted fixed on the ground with internal rotation of the leg and body with respect to the foot, resulting in relative external rotation of the talus within the mortise and creating an external rotation force on the fibula with respect to the tibia. As a result, the fibula separates from the tibia, causing disruption of the distal inferior anterior syndesmotic ligament. In addition, the talus externally rotates with respect to the tibia, possibly injuring the medial deltoid. The severity of the force and how long it is applied will determine how proximal the syndesmotic and interosseous injury extends. Sometimes the proximal extent of the injury on the fibula results in fracture. This mechanism has been shown to reliably produce syndesmotic and deltoid injury in vivo and in the laboratory, but a paucity of studies are available that test the maximal inversion, plantarflexion injury that also occurs commonly in sport. One possible explanation for why some of these more subtle injuries are diagnosed late is that on initial evaluation, it was not clear that the injury mechanism or the syndesmosis sprain were associated with a lateral ankle sprain.[32] A survey of National Football League athletic trainers conducted by Doughtie[17] suggests that current opinion continues to favor this mechanism of injury; 70% of respondents thought that most syndesmotic sprains involved an external rotation component. However, in a retrospective review of 15 cases by Hopkinson et al,[26] 3 patients reported a hyperdorsiflexion mechanism, 3 reported an inversion mechanism, one reported a plantarflexion mechanism, and only 1 reported an abduction/external rotation mechanism. The results of these studies suggest that an injury that causes significant rotation of the talus within the mortise, such as a severe inversion sprain, may injure the syndesmotic ligaments. In one biomechanical study with hyper plantar flexion, deltoid injury occurred, suggesting that injury to the deltoid would aggravate any amount of injury to the syndesmosis.[16] In addition, a radiologic study inferred that syndesmotic injury can occur with inversion sprains.[32] Further investigations are warranted to increase understanding of the mechanism of injury so that preventive strategies can be developed.

INCIDENCE

Syndesmosis injuries are more common than lateral ankle sprains in collision sports and those that involve rigid immobilization of the ankle in a boot, such as skiing and hockey. Fritschy[21] noted a shift from lateral ankle sprains to syndesmosis injuries in skiers in the late 1970s as ski boots became more rigid. He reported 10 injuries in World Cup skiers that all occurred during the slalom event, when the skier straddled a gate, caught the inner ski on a stake, and experienced a violent external rotation force on the ankle and foot. Flik et al[19] prospectively collected injury data for 12 National Collegiate Athletic Association Division I hockey teams over 1 season. There were 114 injuries reported in 23 096 athlete exposures. Five of the 14 ankle injuries reported were syndesmosis sprains. Wright et al[48] retrospectively reviewed medical records for 2 National Hockey League teams over 7 to 10 years. They reported that 74% of the ankle sprains (14 of 19) were syndesmosis injuries. Other collision sports in which syndesmosis sprains are common include football, rugby, wrestling, and lacrosse. In the series reported by Hopkinson et al,[26] 75% (6 of 8) of injuries occurred during football. In the series of Nussbaum et al,[34] 72% (43 of 60) of the injuries occurred during football or lacrosse, while 75% (12 of 16) of the syndesmosis injuries reported by Gerber et al[22] occurred during football, lacrosse, or rugby. In the general athlete population, the incidence of syndesmosis sprains is much lower; reported values are between 10% and 20% of all ankle sprains.[13,22]

HISTORY AND PHYSICAL EXAMINATION

A careful history and physical examination are essential for the diagnosis of syndesmosis injuries. Patients may report a variety of injury mechanisms as described above. They may complain of pain anteriorly between the distal tibia and fibula, as well as posteromedially at the level of the ankle joint. Patients will also complain of pain when bearing weight or pushing off the ground. Physical examination should begin with an evaluation of swelling and palpation for areas of tenderness. Anterior tenderness between the tibia and fibula should be evaluated, and the distance that this tenderness extends proximal to the ankle joint should be measured. This distance, termed "tenderness length," has been reported to correlate well with degree of injury and time to return to sports participation.[34]

Special tests for the evaluation of syndesmosis injuries include the squeeze test, the external rotation stress test, the fibula translation test, the Cotton test, and the crossed-leg test.[7,29] The squeeze test is performed by compressing the proximal tibia and fibula. Pain at the level of the ankle joint indicates a positive test result. The external rotation stress test is performed by placing the ankle in a dorsiflexion position and applying an external rotation force (Figure 2). Pain with this maneuver indicates a positive test result.[1] In the fibula translation (drawer) test, the examiner attempts to translate the fibula from anterior to posterior. In the normal ankle, there is a firm end point and little movement. Increased translation relative to the contralateral side and pain indicate a positive test result. The Cotton test is performed by translating the talus within the mortise from medial to lateral. Increased translation or pain may suggest syndesmosis involvement, as well as a deltoid (medial) ligament injury. Kiter and Bozkurt[29] recently reported a new test for syndesmosis injury that mimics the squeeze test and is called the crossed-leg test. This test result is performed by having the sitting patient rest the midtibia of the affected leg on the knee of the unaffected leg. The patient then applies a gentle downward force on the medial side of the knee, and the test result is positive if the patient experiences pain in the region of the syndesmosis. They report using this test to diagnose 9 patients with syndesmosis injuries. Amendola has described the "stabilization test," which can be useful to confirm diagnosis during the subacute or chronic phase of injury once acute swelling and pain have subsided (unpublished data, 2001). This test is performed by tightly applying several layers of 1.5-in athletic tape just above the ankle joint to stabilize the distal syndesmosis (Figure 3). The patient is then asked to stand, walk, and perform a toe raise and jump. The test result is positive if these maneuvers are less painful after taping. In general, the diagnosis of a syndesmosis sprain is fairly straightforward; however, there is no specific test or imaging study that clearly defines the severity or extent of injury. Consequently, it remains difficult to prescribe highly specific treatment strategies for the spectrum of syndesmosis injuries seen in athletes. Only 1 test, the external rotation test, has been correlated with the presence of a syndesmosis sprain and is associated with a longer return to preinjury activities.[1]

Beumer et al[7] performed a biomechanical evaluation of 4 special tests to determine the degree of distal tibiofibular displacement induced by each test in intact cadaveric ankles and after sectioning of the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular

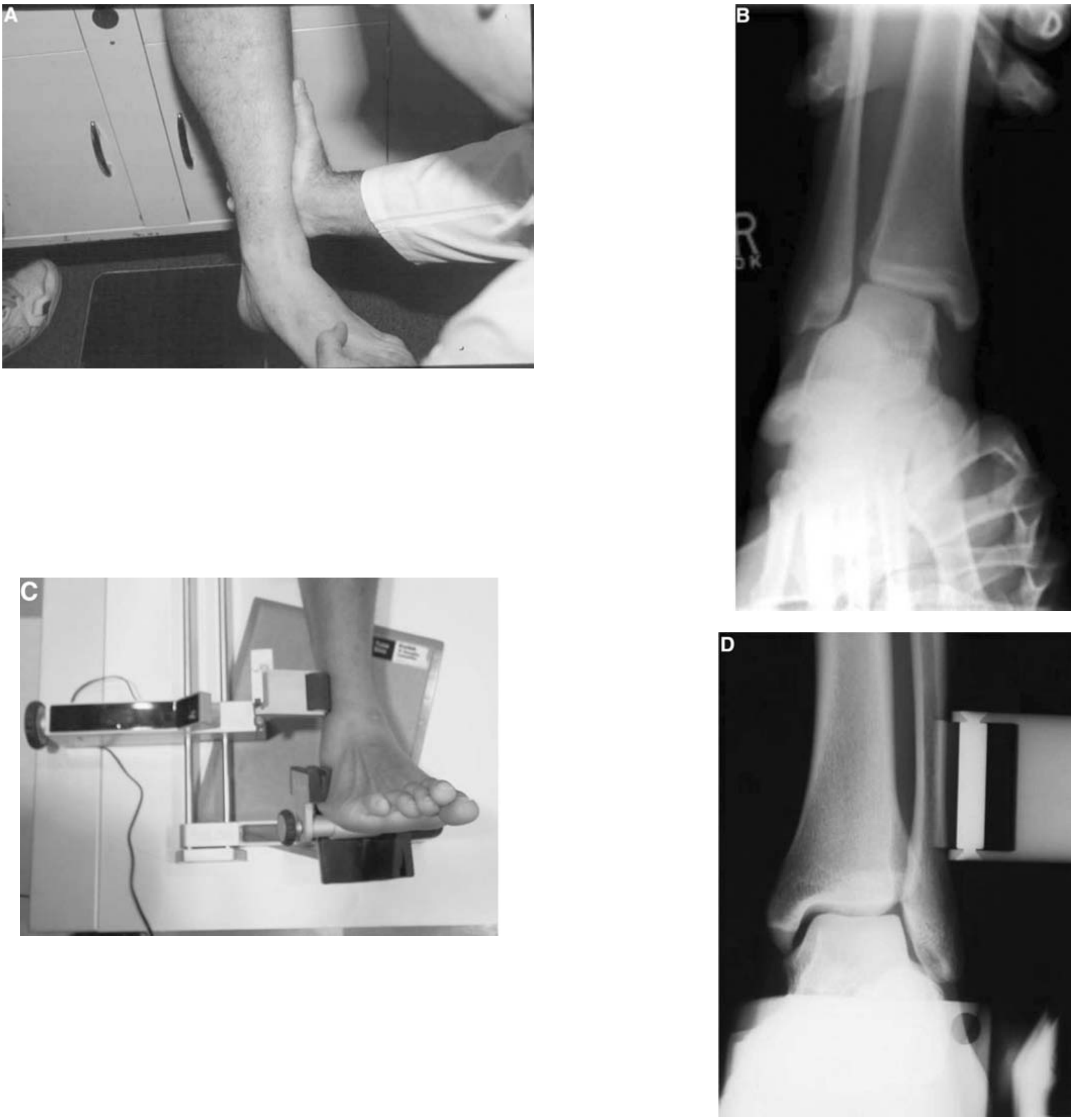

Figure 2. A, the manual external rotation test. B, radiographic view of a right ankle demonstrating diastasis. C, external rotation test using a standardized Telos machine. D, radiographic view of the left ankle during the external rotation test.

ligament, and the deltoid ligament. The average increase in displacement after sectioning of all ligaments was only about 1 mm. Another biomechanical evaluation of the squeeze test demonstrated that the distance between the tibial and fibular attachment sites of the anterior tibiofibular ligament only increased by approximately 0.2 mm after sectioning of syndesmotic ligaments.[41] These findings suggest that current clinical tests for syndesmosis injuries are not able to accurately predict the degree of mechanical instability associated with a syndesmosis injury.

IMAGING

Imaging of syndesmosis injuries of the ankle should begin with plain radiographs to rule out fracture and to look for

Figure 3. The stabilization test is performed by applying tape, allowing the patient to run/jump, and determining if the tape stability improves symptoms.

Figure 4. Diastasis of the ankle demonstrated with radiography.

the presence of diastasis of the syndesmosis (Figure 4). Common views include weightbearing anteroposterior, mortise, and lateral. Diastasis is identified by an increased tibiofibular clear space on an anteroposterior radiograph to a value of 6 mm or greater.[25] Avulsion fractures from the anterior or posterior tibia can occur in up to 50% of syndesmosis injuries and aid in identifying disrupted structures[20]; however, the use of radiographs to assess integrity of the syndesmosis is difficult because of the inability to consistently position the patient, even under ideal conditions.[6]

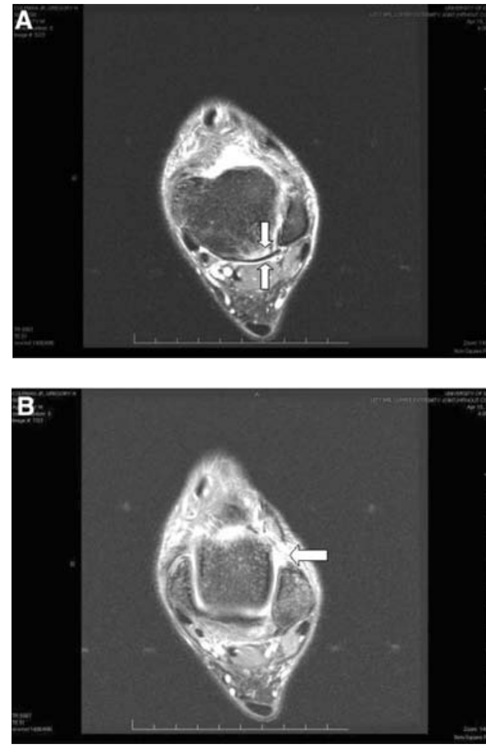

Figure 5. A, magnetic resonance image demonstrating a syndesmosis injury with tibial bone edema at the posterior attachment of the posterior inferior tibiofibular ligament with an intact ligament. B, the same magnetic resonance image showing a torn anterior inferior tibiofibular ligament.

Some authors have advocated using stress radiographs to identify injuries to the syndesmosis. Beumer et al[5] used radiostereometric techniques to evaluate changes in translation and rotation when a 7.5-N·m external rotation moment was applied after sequential sectioning of the syndesmotic ligaments in cadaveric ankles. When the anterior tibiofibular, posterior tibiofibular, and deltoid ligaments were sectioned, the mean medial-lateral translation was only 1.0 mm (range, 0.1-2.1 mm), and the mean anterior-posterior translation was only 1.9 mm (range, 6.2 mm posterior to 3.5 mm anterior). These data suggest that external rotation stress views cannot be used to reliably predict syndesmosis injury; however, if widening of the mortise is seen on radiographs, it indicates a more severe injury and potentially complete disruption of the syndesmosis, which requires operative stabilization.

Magnetic resonance imaging (MRI) can be used to diagnose syndesmosis injury. A cadaveric study demonstrated that high-resolution MRI can effectively image the structures of the syndesmosis,[33] and a clinical study demonstrated high interobserver agreement ($\kappa = 0.9$) in the evaluation of these structures (Figure 5).[45] A subsequent study correlating MRI evaluation of the syndesmosis with arthroscopy in 52 patients showed a sensitivity of 100% and a specificity of 93% for diagnosis of anterior inferior tibiofibular ligament tear and sensitivity and specificity of 100% for diagnosis of posterior inferior tibiofibular ligament tear.[38]

Researchers have yet to demonstrate the relationship between MRI findings and clinical outcomes or the need for operative intervention.

CLASSIFICATION

Gerber et al[22] described the West Point Ankle Grading System that classifies syndesmotic injuries into 3 categories (grade I, II, or III) based on evidence of syndesmosis instability. Grade I indicates no instability, grade II indicates some evidence of instability, and grade III suggests definite instability. The criteria these authors used to differentiate the grades of instability include ability to bear weight, extent of edema, localization of tenderness, response to manual stress testing, and evidence of widening on radiographs. Edwards and DeLee[18] proposed a classification scheme for syndesmosis injury without ankle fracture and divided patients into those with latent diastasis and those with frank diastasis. This classification system has limited applicability to most tibiofibular syndesmosis sprains in athletes because disruptions with acute or latent diastasis, which require reduction and stabilization, are relatively uncommon in this population.

NATURAL HISTORY AND ASSOCIATED INJURIES

Based on the studies available in the literature, one must conclude that there is a spectrum of syndesmosis injury severity that leads to variability in the time lost from injury. The high prevalence of associated injuries leads to further variability because the resulting pain and chronic dysfunction often prevent a timely return to sport.

Guise[24] identified 20 ankle injuries that resulted in time lost from practice or competition on a professional football team over a 5-year period. Sixteen of these injuries (80%) were syndesmosis injuries diagnosed by the presence of tenderness over the distal tibiofibular syndesmosis and a positive dorsiflexion-external rotation test result. The average time lost was 2.5 weeks (range, 0.5-7), 11.7 practices (range, 5-30), and 1.4 games (range, 0-6). In comparison, the 4 patients with severe lateral ankle sprains missed an average of 1.25 weeks (range, 0.5-3), 3.5 practices (range, 2-5), and 0.3 games (range, 0-1).

Taylor et al[40] reported 44 consecutive syndesmotic sprains in collegiate football players with an average 47 months of follow-up. Players required an average of 31 days to return to full activity, but all players still reported persistent stiffness and pain while pushing off. At final follow-up, 18 patients reported no symptoms, 20 patients reported mild symptoms, and 6 patients reported moderate symptoms. Three patients sustained another syndesmosis sprain, 15 patients sustained subsequent lateral ankle sprains, and 1 patient sustained a bimalleolar ankle fracture. Of 22 patients who had follow-up radiographs, 11 had interosseous calcification.

In their review of 1344 ankle sprains that occurred in West Point cadets over a 41-month period, Hopkinson et al[26] identified 10 syndesmosis sprains. These injuries required an average of 55 days for return to full activity, compared with 28 days for grade III lateral ankle sprains. Nine of the patients had interosseous calcification on follow-up radiographs.

Boytim et al[10] reported on 98 ankle injuries on a professional football team over a 6-year period; 18 of these were syndesmosis sprains. Players with syndesmosis injuries missed or were limited for a mean of 6.3 practices, compared with 1.1 practices for players with lateral ankle sprains. Radiographs were taken a minimum of 1 month after injury in 8 players; interosseous calcification was present in 6 ankles.

Fritschy[21] reported 10 syndesmosis injuries in World Cup skiers over an 11-year period. Three patients underwent surgical repair of the anterior inferior tibiofibular ligament and fixation of the syndesmosis with a screw or Kirschner wire, followed by 3 to 6 weeks immobilization in a nonweightbearing cast. The other 7 patients were treated with walking casts for 2 to 6 weeks. All patients resumed training after 4 to 8 weeks and were able to resume their preinjury level of activity. One patient who was treated with a cast complained of persistent ankle pain; the remaining patients were asymptomatic after a follow-up of between 18 months and 12 years.

Brown et al[12] evaluated 94 ankle magnetic resonance images in patients with a history of severe ankle sprains and identified syndesmosis injuries in 59 ankles (63%). Associated injuries included anterior talofibular ligament injury in 49 of 59 ankles (83%), bone bruises in 18 of 23 patients (78%) with acute injury and 4 of 36 patients (11%) with chronic injury, talar dome osteochondral lesions in 11 of 23 patients (48%) with acute injury and 14 of 36 patients (39%) with chronic injury, and osteoarthritis in 1 of 23 patients (4%) with acute injury and 7 of 36 patients (19%) with chronic injury.

The results of these studies indicate that syndesmosis sprains are unpredictable in the time it will take an athlete to return to sports participation and the rate of reinjury and ankle dysfunction; these injuries also have a high rate of associated injuries. Further research is necessary to more completely define the extent and severity of these complex injuries. Additional studies are needed to define when surgery should be considered and when associated findings such as osteochondral injuries should be addressed.

TREATMENT

Rehabilitation

There are no published randomized controlled trials in indexed journals that have investigated the efficacy or effectiveness of rehabilitation programs for tibiofibular syndesmosis injuries. Consequently, the optimal rehabilitation program for patients with these injuries is currently unknown. Common questions related to rehabilitation that the sports medicine team must address include the following: Is there a need for complete immobilization? If so, for how long? How much stress can be safely placed on the joint during the subacute phase of rehabilitation? Should patients' symptoms alone guide functional progression, or should the medical team stipulate certain limitations based on science related to healing and their repeat clinical assessments? Finally, when can the athlete return to sport safely and effectively?

We found only 3 articles in which rehabilitation programs for syndesmosis sprains have been described in sufficient detail to allow discussion.[11,22,34] The programs presented in these papers are relatively similar. Each has included a 3-phase or 4-phase program. The first phase is an acute phase, in which the primary goals are protection of the injured joint and minimization of the inflammatory response, including pain control. The second phase is a subacute phase, in which the goals are to restore mobility, strength, and function in basic tasks such as ambulating with a normal gait pattern. The remaining phase(s) include advanced training, directed at preparing the athlete for return to sports participation by increasing strength, neuromuscular control, and function in sport-specific tasks such as cutting, pivoting, and jumping. Two of the groups[11,34] provide temporal guidelines for progression from phase I to phase II, whereas Gerber et al[22] describe a functional, criterion-based approach to progression. Gerber et al[22] and Nussbaum et al[34] both state that to be progressed to phase III, patients must demonstrate the ability to ambulate and hop repetitively without pain or dysfunction. Each of the groups describe the use of functional testing as criteria for return to sports participation; testing includes 1 or more of the following tasks: forward hopping, vertical hopping, lateral hopping, sprinting, cutting, figure-8 drills, or backward pedaling.

Authors' Preferred Approach. The 3-phase approach described above is consistent with our preferred approach. The most critical factors to success are careful and continual assessment of the patient; tailoring the program to the individual patient's unique circumstances, needs, and goals; and frequent, unambiguous communication with the patient and other members of the sports medicine team. In the first phase (acute, protection phase), our key considerations are immobilization, weightbearing status, and control of the inflammatory process. The question of whether complete immobilization is required is not a trivial issue. Safety and joint protection are the critical concerns. For this reason, complete immobilization by splinting, casting, or a boot-type immobilizer is reasonable if the patient has significant pain, poor muscle activation, or the early assessment suggests that the extent of the injury is severe. If pain is not especially severe, there is evidence of good muscle activation, and the early assessment suggests that the joint is fairly stable; then use of an ankle brace, stirrup, or taping is a reasonable alternative.

Patients who sustain syndesmosis sprains rarely are able to ambulate without the use of an assistive device. The use of crutches or other assistive devices is advised until the patient's gait is essentially normal, including ascending/descending stairs and ambulating on the various types of surfaces he or she will experience during activities of daily living. The level of weightbearing (nonweightbearing, partial, as tolerated, or full) depends on the patient's symptoms, early assessment of injury severity, and the patient's functional presentation. Weightbearing should progress in a safe but timely fashion to mitigate potential neuromuscular and biomechanical deficiencies that can result from prolonged disuse and dysfunction.

Pain and edema are minimized through the protection provided by immobilization and limited weightbearing, as well as elevation, compression, appropriate use of therapeutic modalities, and the judicial use of anti-inflammatory medications. Combined compression, elevation, and cryotherapy are particularly beneficial in minimizing postinjury edema. In addition to cryotherapy, other helpful therapeutic modalities include electric stimulation, compression pumps, antiedema massage, and joint mobilization. In addition, athletes often find alternative therapies such as acupuncture and acupressure helpful. When the medical team feels that it is safe for range of motion exercises to begin (those with minor injuries may be ready immediately, whereas others may take 1 to 2 weeks), mobility exercises are begun within the comfortable range of motion. Light use of a cycle ergometer is often a good choice for mobilizing the ankle in this stage. Patients are progressed to the subacute phase of treatment when pain and edema are controlled and the patient can walk with a minimally antalgic gait on the various surfaces they will experience in their daily activities.

The subacute phase is directed at obtaining normal mobility; increasing strength; improving neuromuscular control; and promoting function in basic tasks such as pivoting of the foot when walking, quickly moving over and around small obstacles, light jogging, and hopping. Mobility is facilitated with the use of assistive devices such as towels or cords, or activities such as squatting, gastrocnemius-soleus stretching, and riding a cycle ergometer. Joint mobilization is especially helpful and effective in this stage. Strengthening begins with basic resistance exercises using bands, cords, or ankle weights and progresses to closed-chain functional tasks such as heel raises/dips and calf presses with weight machines. Strengthening begins with lower-intensity, higher-repetition sets and progresses to the use of high-intensity, low-repetition sets directed at inducing muscle overload and, thereby, hypertrophy. Strength, endurance, and muscle control are facilitated through balancing on unstable surfaces such as air-filled cushions, domes, or trampolines. Aquatic therapy is also beneficial in this stage. Patients are progressed to the advanced training phase when they are able to jog and hop repetitively without difficulty.

The advanced training phase is directed at ensuring that the patient is ready to return to sports participation at discharge. In this phase, more aggressive strengthening, additional neuromuscular training, and sport-specific functional/agility training exercises are employed. In addition to more intense training in the activities described above, functional activities such as jumping rope, bounding, carioca, and shuffling forward, backward, and laterally are begun. Plyometric training is employed late in the phase and directed at improving power. As the patient progresses, activities become quicker and more intense. Sport-specific drills such as dribbling a soccer ball, running reception patterns in football, or shooting a basketball are

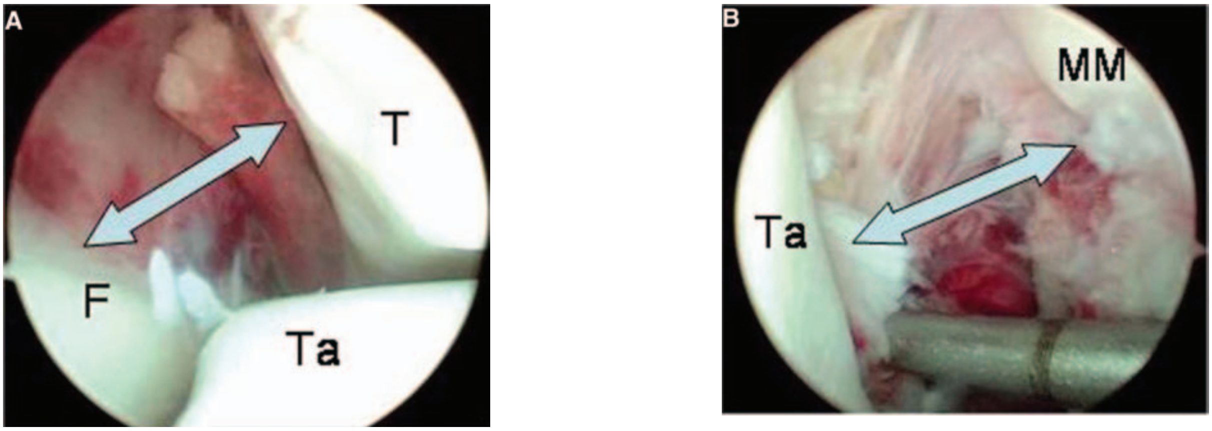

Figure 6. A, arthroscopic views of a widened syndesmosis (arrow). B, deltoid ligament injury with widening between the talus and medial malleolus (arrow). T, tibia; F, fibula; Ta, talus; MM, medial malleolus.

performed in a progressive fashion. Determining when an athlete is able to safely and effectively return to sports participation is challenging. This decision is based on a confluence of information indicating that the patient is ready, including patient report and outcomes ratings, results of functional testing including activities like those described earlier (lateral hopping, quick acceleration/deceleration, cutting at high rates of speed, jumping, and other sport-specific skills), and the patient's physical examination.

Surgical Treatment of Acute Injuries

Current indications for surgical treatment of acute syndesmosis injuries include frank diastasis of the syndesmosis or diastasis on stress radiographs. Arthroscopic evidence of syndesmotic instability is another indication for operative treatment (Figure 6). Surgical treatment should include reduction and transsyndesmotic fixation with 1 or 2 metallic screws (Figure 7). The patient should be placed in a nonweightbearing cast for 6 weeks postoperatively and then begin progressive weightbearing and range of motion exercises. These can begin with the screws in place. We prefer removal of screws at 8 to 10 weeks, but this should not slow down the rehabilitation process. Rehabilitation can progress to functional activities when the patient demonstrates the ability to perform activities of daily living, ambulate on uneven/soft surfaces, and ascend/descend stairs without difficulty. Patients may return to sports participation when they demonstrate the ability to perform aggressive sport-specific tasks like running, jumping, kicking, and cutting/pivoting at competition/practice speed without noteworthy symptoms during or after participation. The expected time frame to return is around 12 to 14 weeks.

Surgical Treatment of Chronic Injuries

Mosier-LaClair et al reported on late stabilization under formal arthrotomy of the ankle joint and open debridement of the syndesmosis (unpublished data, 2000). Open reduction with syndesmosis fixation and repair of the anterior distal tibiofibular ligament were performed an average of 35 months after injury in 8 patients. All patients reported excellent results and return to full activities.

Tasto reported treatment of 10 patients with missed initial diagnosis or failure of traditional appropriate treatment (unpublished data, 2001). Arthroscopic evaluation of the syndesmosis was performed to establish diagnosis and treat associated injury in the ankle. Instability was noted not only in the coronal plane but also in the sagittal plane and with rotation. On diagnosis of instability, the distal syndesmosis was stabilized with percutaneous screw fixation after arthroscopic curettage and debridement. Eight of 10 patients had good results with return to full activities.

Beumer et al[3] reported on 9 patients who underwent late reconstruction of the syndesmosis an average of 27 months after injury (range, 4-102 months). All patients had arthroscopically confirmed instability of the syndesmosis. Through an anterolateral incision, a 0.7 cm × 0.7-cm bone block at the tibial attachment of the anterior inferior tibiofibular ligament was mobilized medially and proximally and fixed into a bony trough with a screw. In addition, a syndesmotic screw was placed across 4 cortices. Patients were placed in a nonweightbearing cast for 6 weeks before screw removal, followed by full weightbearing. At a mean follow-up of 45 months (range, 38-62 months), all patients felt improved, and none complained of instability.

Wolf and Amendola[47] reported on the treatment of 14 patients with syndesmosis injury treated from 1991 to 1999. All patients were athletically active individuals without fracture or tibiofibular diastasis. The diagnosis was made using clinical examination and radiographs as well as additional imaging modalities in select cases. Arthroscopy was performed at an average of 9.5 months after injury (range, 2-20 months). Arthroscopic debridement of soft tissue anterior and distal to the anterior inferior tibiofibular ligament was performed to allow adequate visualization of the syndesmosis, and percutaneous transsyndesmotic fixation was performed with arthroscopic demonstration of syndesmosis instability. Three patients required additional lateral ligament reconstruction using a Brostrom technique. Postoperative management included 2 weeks in a bulky dressing followed by

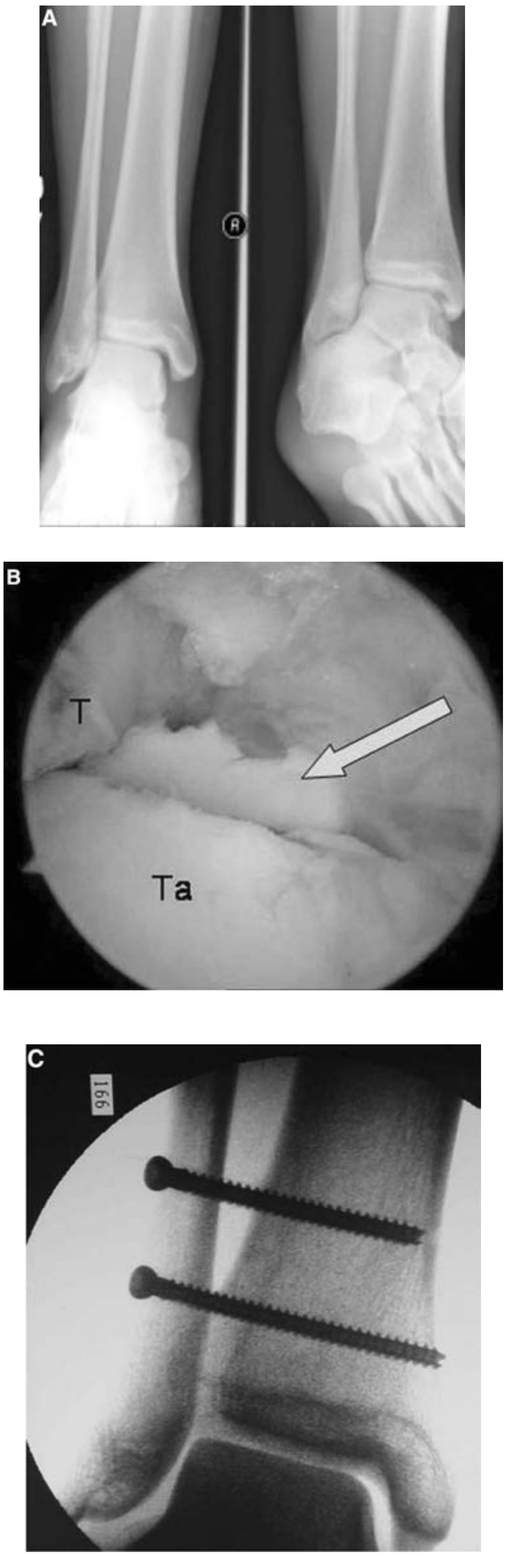

Figure 7. A, anteroposterior and mortise views demonstrate a complete disruption of the syndesmosis. B, arthroscopic examination revealed widening of the syndesmosis as pictured in Figure 6 and a chondral flap (arrow). C, radiographic view demonstrates reduction and stabilization with 2 screws. T, tibia; Ta, talus.

active and passive range of motion exercises. Nonweightbearing continued for a total of 8 weeks, and the syndesmosis screw was removed at 8 to 10 weeks under local anesthesia in the outpatient clinic. After screw removal, aggressive range of motion, strengthening, and functional rehabilitation exercises were begun with a goal of return to sporting activities. At a minimum of 6 months after surgery, all 14 patients were evaluated by history, physical examination, and radiographs. Results were rated using the scale developed by Edwards and DeLee.[18] Two of 14 patients (14%) had an excellent result, 10 of 14 (71%) had a good result, and 2 of 14 (14%) had a fair result.

Controversies in Surgical Treatment

From our point of view, the main area of controversy lies in the decision to perform early surgery versus nonoperative rehabilitation in those injuries without obvious syndesmotic or mortise widening (normal radiograph parameters). The purpose of this surgery is to prevent the late pain and chronic syndesmotic injury as reported in the chronic injury section. Because the severity of the injury is difficult to assess, deciding on surgical intervention remains difficult. Different methods of treatment have been described. On the basis of the literature, reconstruction of the syndesmotic ligaments does not appear to be necessary to gain stability, but stabilizing the tibial fibular relationship with fixation in a reduced position will facilitate stable healing. Ligamentoplasty has been described[23] to restore ligamentous anatomy.

Surgeons have traditionally advocated fixation of the syndesmosis with the foot in maximal dorsiflexion to avoid overtightening of the mortise and limited ankle motion postoperatively.[35] Tornetta et al[43] evaluated the effect of foot position on ankle range of motion during syndesmosis fixation in cadaveric specimens. Fluoroscopy was used to measure range of motion in 19 specimens before and after compression fixation of the syndesmosis with varying degrees of ankle flexion, and there was no significant difference in postfixation motion between the specimens, suggesting that foot position during syndesmosis fixation will not influence postoperative range of motion. Another topic of controversy concerns the optimal mode of syndesmosis fixation. Traditionally, various authors have advocated fixation across 3 or 4 cortices with 1 or 2 metallic screws followed by screw removal before resumption of weightbearing. Our preference would be to use 2 screws and 4 cortices; in the case of screw breakage, the medial end can be removed from the medial side. Recent studies have evaluated the use of bioabsorbable fixation or flexible fixation to obviate the need for hardware removal. Bioabsorbable screws provide stability comparable with that of metallic screws in cadaveric specimens,[15] as well as equivalent clinical results without the need for subsequent screw removal.[28,37,42] Complications of bioabsorbable screw fixation may include formation of a sterile abscess or cyst, particularly with a rapidly degrading polymer such as polyglycolic acid; more slowly degrading polymers such as polylevolactic acid are less likely to have this effect.[9,27,28,36]

Foot alignment is also a consideration. In the planovalgus foot, there is an inherent external rotation moment on the ankle and the distal fibula. Therefore it is likely prudent in this type of foot alignment to be more cautious, leaving the fixation in place longer and returning to sport when the syndesmosis is completely stabilized.

Complications

Several authors have reported calcification of the syndesmosis as a complication after both conservative and operative treatment of isolated syndesmosis injury, although this condition is not always symptomatic.[30,31] During a 24-month period, McMaster and Scranton[30] identified 7 patients with persistent pain after a soft tissue injury to the ankle who had radiographic evidence of distal tibiofibular synostosis. This finding was identified from 3 to 11 months after injury. All patients underwent operative excision of the synostosis. The first 2 patients had recurrence of the synostosis, but after the procedure was modified by applying bone wax to the bone edges, the subsequent 5 patients had no recurrence of pain or synostosis at a maximum of 28 months of follow-up. Miller et al[31] reported calcification of the syndesmosis in 25% (1 of 4) of their syndesmosis injury cases treated with single-screw transsyndesmotic fixation (Figure 8); the patient had a score of "good" on the scale of Edwards and DeLee.[18] The other 3 patients rated excellent (4 of 4) on the scale, and the complication was attributed to screw placement too close to the ankle joint. Veltri et al[44] reported symptomatic interosseous ossification in 2 professional football players after syndesmosis sprain. Both players initially underwent nonsurgical treatment and returned to play at 5 and 6 weeks after injury. After regaining their preinjury levels of activity, they developed subsequent pain in the region of the syndesmosis at 8 months and 1 year postinjury. Radiographs revealed ossification of the syndesmosis, and both players underwent operative excision of the ossification. After immobilization in a splint for 3 days, a progressive rehabilitation program was started, and both players eventually returned to full activity, including professional football. Whiteside et al[46] identified calcification of the syndesmosis in 6 professional athletes after ankle injuries. Although 3 of the athletes experienced significant symptoms, 2 were asymptomatic with all activities, and 1 experienced only occasional pain after vigorous exercise.

Figure 8. Lateral (A) and anteroposterior (B) radiographs demonstrating calcification at 6 weeks after sprain. The lateral view shows calcification in the area of the posterior inferior tibiofibular ligament.

FUTURE DIRECTIONS

Further investigation is required to increase our understanding of syndesmosis injuries and improve the diagnosis, treatment, and prevention of this significant injury. Although there have been many case series that have provided information regarding the incidence and natural history of syndesmosis sprains, the results of these studies have been variable. This is understandable because many different populations have been studied. Additional epidemiologic studies are needed that carefully describe the sample profile and evaluate the risk factors for this injury, including sport, position, experience, performance level, sex, strength, endurance/fatigue, sensorimotor control, and psychosocial influences. Studies that examine the specificity, sensitivity, and clinical relevance of our physical examination methods are also required to define the precision of our methods and find better tests. The role that imaging plays in diagnosing the extent and severity of injury, as well as predicting the patient's prognosis, should be another topic of research. Randomized controlled trials are needed that evaluate the efficacy and effectiveness of rehabilitation and surgical approaches to treating syndesmosis injuries. Finally, longitudinal cohort studies that evaluate the long-term effects of these injuries are needed to assess the prevalence of osteoarthritis and chronic dysfunction.

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