Injuries to the Distal Lower Extremity Syndesmosis

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Abstract

Disruption of the distal syndesmosis of the lower extremity is most commonly associated with ankle fractures but can also occur without gross bone injury. Definitive management of these injuries remains controversial. The current indications for syndesmosis fixation are based on tibiotalar joint mechanics as determined in cadaveric and biomechanical studies, as well as radiologic evaluation and an understanding of the pertinent anatomy and the etiology of these injuries. Such data support the use of syndesmotic screws in selected fractures that include a disruption of the syndesmosis. However, definitive fixation recommendations for syndesmosis disruption with or without ankle fracture remain under investigation. Distal lower extremity syndesmosis sprains without fracture or subluxation consistently require longer recovery time than typical lateral sprains and can be associated with greater long-term disability.

J Am Acad Orthop Surg 1997;5:172-181

Injuries to the distal lower extremity syndesmosis (DLES) range from minor sprains to injuries that can produce significant disability. The spectrum includes injuries to the syndesmotic ligaments and interosseous membrane and ankle fractures with syndesmosis disruption. Gross disruption of the DLES is not difficult to diagnose, but the evaluation and treatment of less severe injuries can be more challenging, requiring an appreciation of subtle clinical and radiologic findings.[1-3]

A syndesmosis (from the Greek *syndesmos*, meaning "ligament," and *-osis*, meaning "condition") is a fibrous articulation in which the opposing surfaces are united by ligaments. Four ligaments and the interosseous membrane combine to form the tibiofibular syndesmosis (Fig. 1). The ligaments are the anterior tibiofibular, the posterior tibiofibular, the transverse tibiofibular (often regarded as a portion of the posterior tibiofibular ligament), and the interosseous ligament (the thickened and strongest distal portion of the interosseous membrane).

Mechanism of Injury

External rotation forces are generally thought to be the primary mechanism of injury to the structures of the DLES. Disruption of these ligaments can occur without a fracture, but more commonly involves Weber type C, Lauge-Hansen pronation–external rotation, and supination–external rotation injury patterns. The relative contributions of the various ligaments in resisting external-rotation, axial, and lateral-displacement forces are relatively consistent, but the specific contributions vary, depending on the experimental protocols employed.

In a study performed on fresh-frozen cadaveric specimens that included only the distal tibia, the distal fibula, and their connecting ligaments, Ogilvie-Harris et al[4] found that the force required to produce lateral diastasis of 2 mm with an intact DLES averaged 87 N. The contribution to resistance to lateral displacement was approximately 35% for the anterior tibiofibular ligament, 40% for the posterior tibiofibular ligament, 22% for the interosseous ligament, and less than 10% for the interosseous membrane. These specimens did not include the proximal tibiofibular joint or the proximal third of the tibiofibular interosseous membrane. The investigators concluded that injury to two of the three major stabilizers (anterior and posterior tibiofibular ligaments and interosseous ligament) would lead to a greater than 50% reduction in

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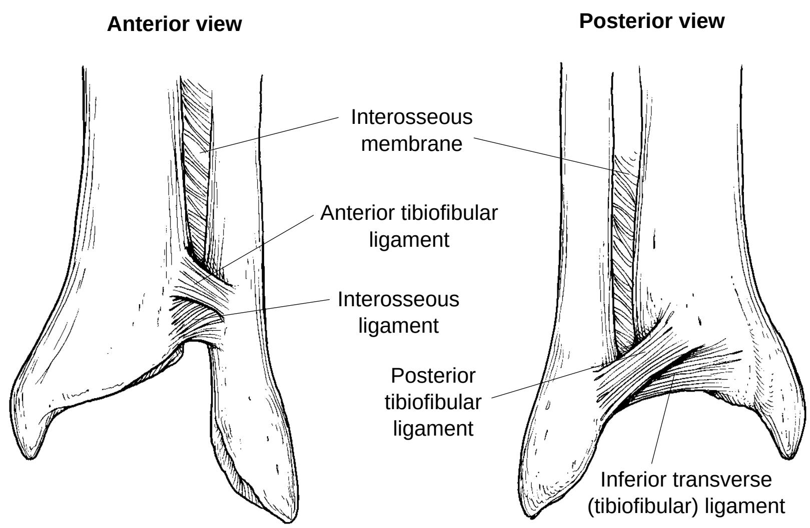

Fig. 1 The components of the DLES.

the resistance of the syndesmosis to lateral stress and might lead to instability.

In another cadaveric study by Xenos et al,[5] external-rotation forces were applied while incrementally sectioning the syndesmotic ligaments to produce progressive instability. Mortise and lateral radiographs were taken at each step under both unloaded and loaded conditions. Sectioning the anterior tibiofibular ligament increased the diastasis by an average of 2.3 mm. With each subsequent 2-cm sectioning of the interosseous ligament, the diastasis increased by approximately 0.5 mm. Complete sectioning of the remaining interosseous ligament and the posterior tibiofibular ligament resulted in a further increase of 2.8 mm. The cumulative effect of a complete disruption of all ligaments was a diastasis that averaged 7.3 mm under an external rotation torque of 5.0 N·m. The increases noted in the degree of external rotational instability followed a similar pattern. Of clinical importance was the observation that external-rotation stress lateral views were more useful in identifying posterior displacement of the fibula with respect to the tibia and accurately correlating it with true diastasis than were the more conventional mortise stress views.

A cadaveric study by Boden et al[6] revealed that the critical level of syndesmosis disruption under external rotational loads is 3.0 to 4.5 cm proximal to the plafond if there is associated medial ankle instability. An intact deltoid ligament or stable medial malleolar and fibular fixation provided adequate resistance to external rotation forces. The authors suggested that if there is no medial injury or if the medial malleolus is rigidly fixed, additional syndesmotic fixation is not required when syndesmosis injuries are less than 3.0 to 4.5 cm proximal to the mortise. Their view has been supported by other studies that emphasized the importance of the medial structures in maintaining DLES stability.

In a study by Burns et al,[7] a cadaveric model was axially loaded after sequential sectioning of the anatomic components of a pronation–external rotation injury. At each stage, tibiotalar contact area, peak pressure, diastasis, and deltoid ligament strain were measured. With the medial structures intact, there were only negligible changes in joint contact area and peak pressures and only a very slight (average, 0.24 mm) syndesmotic widening. Deltoid ligament strain was noted to increase serially with progressive sectioning of the syndesmosis. When the deltoid ligament was transected, there was a diastasis measuring on average 0.73 mm, a reduction in the tibiotalar contact area of 39%, and a 42% increase in the peak pressure.

In another cadaveric study by Solari et al,[8] a medial malleolar osteotomy was performed, followed by sequential sectioning of the distal anterior tibiofibular ligament, the posterior tibiofibular ligament, and the distal interosseous membrane and then by a fibular osteotomy 4 cm proximal to the mortise. External rotation torques were applied at each stage of progressive injury. The mean external rotation in an intact ankle was 7.7 degrees. This increased to 13.8 degrees with a medial malleolar osteotomy, to 18.9 degrees with the anteroinferior tibiofibular ligament sectioned, and to 23.8 degrees when the posterior tibiofibular ligament and interosseous membrane were severed. Complete disruption of the DLES combined with the fibular osteotomy resulted in a mean rotation of nearly 32 degrees.[8]

The clinical rationale for these cadaveric models is supported by the operative findings detailed by Pankovich[9] in a review of the Maisonneuve fracture of the fibula. The five sequential stages in the development of a complete injury were presented as (1) rupture of the anterior tibiofibular ligament or avulsion fracture of one of its bone insertions and rupture of the interosseous ligament; (2) fracture of the posterior tibial tubercle or rupture of the posterior tibiofibular ligament; (3) rupture of the anteromedial joint capsule or avulsion of one of its bone insertions; (4) fibular fracture; and (5) deltoid ligament disruption or medial malleolar fracture. The importance of medial disruption in producing a "complete" lesion was emphasized.

Diagnosis

History and Physical Examination

An accurate history emphasizing the mechanism of injury can be helpful in obtaining the proper diagnosis. Participants in football, soccer, and other turf sports are particularly susceptible to these injuries. One common mechanism of injury is an external rotation force applied to the foot when a player is down on the field in the prone position and is stepped on or impacted on the posterior aspect of the lower extremity, resulting in a severe external rotation force to the foot. Similar injuries can occur when the planted foot remains fixed and relative internal rotation of the proximal tibia caused by either cutting or direct contact exerts an external rotation force on the foot and ankle.[2]

Competitive slalom skiers can be susceptible to DLES injury when a ski tip straddles a gate at high speed, causing a sudden external rotation force. Ligamentous and meniscal injuries to the knee are more common with this mechanism; however, when the knee is spared, the force appears to be transmitted to the ankle, and a syndesmotic disruption occurs.[10]

While gross syndesmotic disruption associated with fracture is readily apparent, a high degree of clinical suspicion and the use of specific examination techniques are often required to diagnose syndesmotic injury without fracture. Hopkinson et al[1] reviewed more than 1,300 ankle injuries in military cadets and found that the "squeeze test" was a reliable examination technique for detecting syndesmosis sprains. This test involves compression of the fibula to the tibia at approximately midcalf. If pain is produced in the area of the DLES, the test is positive unless there is an obvious fracture of the tibia or fibula, compartment syndrome, or associated soft-tissue injuries. Also clinically important is pain on direct palpation over the distal tibiofibular ligament or reproduction of pain with manipulation of the fibula in the sagittal or coronal plane.

The external-rotation stress test is also useful in the diagnosis of syndesmosis sprains. An external rotation force is applied to the ankle in the neutral position, while the proximal tibia is stabilized with the knee flexed at 90 degrees. Pain over the DLES denotes a positive test. Tenderness over the anterior tibiofibular ligament, but not the more distal anterior talofibular ligament, is often useful, but can be difficult to distinguish. Severe swelling, which is often a component of lateral ankle sprains, is usually much less prominent in the syndesmosis sprain, although delayed appearance of ecchymosis proximal to the ankle joint is often noted.[2] This finding is distinct from the more distally based delayed ecchymosis that accompanies lateral ankle sprains. Pain with push-off and pain and difficulty with ankle dorsiflexion can also be clues to subtle syndesmotic injuries.

Radiologic Examination

A variety of radiographic techniques have been described to assess the integrity of the syndesmosis and to judge the adequacy and stability of the reduction of a fracture or ligamentous injury to the DLES. The standard mortise view is used to evaluate the talocrural angle, the medial clear space, and the presence or absence of talar tilt. Specific criteria based on anatomic and clinical studies are useful in evaluating the integrity of the syndesmosis. These include the tibiofibular clear space and the tibiofibular overlap (Fig. 2). A variety of stress maneuvers are also useful.

Harper and Keller[11] evaluated the criteria for normal and widened syndesmoses in a cadaveric study. Specimens without evidence of syndesmosis disruption were radiographed initially with anteroposterior (AP) and mortise views. Spacers between the tibia and the fibula were then added incrementally after division of the syndesmosis, and the two radiographic measurements were repeated. The clear space is the distance between the medial border of the fibula and the lateral border of the posterior tibia, as measured 1 cm above the distal tibial articular surface. Specimens with no syndesmotic injury consistently had a tibiofibular clear space on the AP and mortise views that measured less than 6 mm. Tibiofibular overlap (i.e., the maximum amount of overlap of the distal fibula and the anterior tibial tubercle) was greater than 6 mm or represented 42% or more of the total fibular width on the AP view (Fig. 2). On the mortise view, an overlap of 1 mm or more was

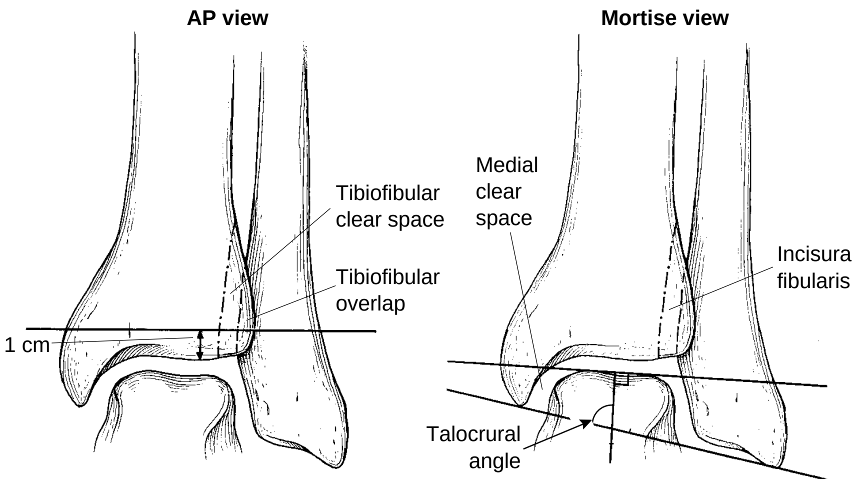

Fig. 2 Radiographic criteria for evaluating the DLES.

indicative of an intact syndesmosis. In the cadavers studied, a clear space greater than 6 mm on both the AP and mortise views was the most reliable predictor of early syndesmotic widening; tibiofibular overlap was less predictive of subtle syndesmosis widening. In specimens with as much as 3 mm of induced abnormal widening, the tibiofibular overlap values often remained within the "normal" intact range.

In another cadaveric study by Harper,[12] the anatomic landmarks of the tibia and fibula that are the radiographic borders of the tibiofibular clear space were delineated more crisply with the use of radiopaque markers. On the basis of computed tomographic (CT) scans and plain radiographs, the interval that constitutes the clear space was shown to represent the posterior aspect of the tibiofibular syndesmosis. The tibial landmark for the clear space is the vertical cortical sclerotic border at the depth of the incisura fibularis, which is posterior to the midline (Fig. 2). Internal rotation of the fibula relative to the tibia increases the tibiofibular clear space; external rotation of the fibula narrows it. This interval is also noted to increase with direct lateral displacement of the distal fibula. Harper suggested that comparison of CT scans of both the injured ankle and the noninjured ankle in similar orientations was a more precise technique for detecting subtle rotational abnormalities of the fibula when the plain radiographs of a patient with a suspected DLES injury are normal or equivocal.

Ostrum et al[13] analyzed the anatomy of the intact syndesmosis as visualized on the AP radiographs of 40 male and 40 female volunteers and found considerable variability in the tibiofibular-overlap and clear-space absolute values. The authors therefore suggested a ratio as a more accurate assessment technique, which eliminated any differences due to gender. The average tibiofibular overlap was 54% of the total fibular width, and the tibiofibular clear space averaged 30% of the total fibular width. Within a 90% confidence interval, the reported values for an intact syndesmosis were as follows: (1) tibiofibular clear space less than 5.2 mm in women and 6.5 mm in men, (2) a tibiofibular overlap of greater than 2.1 mm in women and 5.7 mm in men, (3) a ratio of tibiofibular overlap to total fibular width greater than 24%, and (4) a ratio of tibiofibular clear space to total fibular width less than 44%. A linear regression model was used to produce a formula to predict the normal tibiofibular overlap, as follows: $TFO = 0.862 \times LT - 2.62$, where TFO represents the tibiofibular overlap and LT represents the distance (in millimeters) from the lateral tibia to the incisura fibularis, as measured on an AP radiograph 1 cm proximal to the tibial plafond. While a bit cumbersome, this formula may be helpful in determining the accuracy of reduction and in diagnosing syndesmotic injuries. However, relying solely on the calculation of the tibiofibular overlap may cause one to miss some cases of subtle syndesmotic widening.

Sclafani[14] also used radiographic measures to evaluate the syndesmosis. He retrospectively reviewed the radiographs of patients with clinically established DLES injuries and compared them with the radiographs of noninjured subjects. In patients without ankle injury, the tibiofibular clear space was never greater than 5 mm on the mortise view. Abnormal diastasis was defined as being present if the tibiofibular clear space was greater than 5 mm on either the AP or the mortise view. The importance of a congruent joint on a true lateral radiograph also was emphasized. The crescentic cortical line of the distal tibial articular surface should parallel precisely the arc of the talar dome, and the medial malleolus should project slightly anterior to the lateral malleolus. In cases of syndesmotic injury, congruence between the tibial and talar crescentic articular margins often is lost. In Sclafani's study, anterior widening on lateral radiographs was frequently noted in cases of posterolateral talar displacement. Widening of the posterior aspect of the tibiotalar joint was rarely noted.

Another approach is stress views, in which external rotation and lateral displacement forces are applied. Care must be taken to stabilize the upper portion of the limb when applying the deforming external rotation force. The resultant displacements are then compared with the anatomic relationship in the contralateral noninjured ankle. Stress films may also be useful intraoperatively to evaluate the adequacy and stability of the reduction. Posterior displacement of the fibula with external rotation stress correlates with increased diastasis. This can be more easily interpreted when lateral views are employed rather than mortise stress views.[5] The positioning and alignment for the lateral view are easier to achieve than the subtle rotational adjustments necessary for a "perfect" mortise view.[8]

Although routine use of bone scans is unnecessary, radionuclide imaging can be an important diagnostic tool in selected situations. It is useful when a patient with a suspected syndesmotic injury cannot tolerate stress radiography and when stress radiographs cannot be obtained accurately. In one study,[15] bone scintigraphy was performed on 27 athletes with suspected acute DLES injuries. All studies were performed within 2 weeks of injury. None of the initial radiographs showed fracture or frank diastasis. Scans showing focal activity at the DLES or along the interosseous membrane were interpreted as positive. All 20 patients who had positive stress radiographs had a positive scan, as did 2 of the 7 patients with negative stress radiographs. A negative scan essentially ruled out traumatic injury, but the scans were not predictive of instability—only injury. The time period after injury in which bone scans are no longer sensitive has yet to be determined.

In summary, when a DLES injury is suspected, AP, mortise, and lateral radiographs should be obtained. If these are not diagnostic on the basis of the overlap and clear-space criteria, stress radiographs should be obtained. If the patient cannot tolerate stress radiography, a bone scan or CT study can be obtained if symptoms persist or the diagnosis remains uncertain.

Treatment

After documenting the mechanism of injury, performing a careful physical examination, and reviewing appropriate radiographic studies, the clinician is prepared to provide definitive treatment. An injury to the DLES is diagnosed when there is a clearly established mechanism of injury; when the clinical signs include a positive squeeze test, positive external-rotation stress test, and localized tenderness; and when radiographs demonstrate a tibiofibular clear space greater than 5 to 6 mm. When there is an associated fracture, the radiographs obviously provide the definitive evidence. Even with a clear diagnosis, however, the treatment of these injuries can be problematic.

Treatment of DLES Without Fracture

Five studies have evaluated treatment of DLES injuries without fracture. All involved relatively small numbers of patients. In one study, Edwards and DeLee[16] reported on six cases of frank diastasis without fracture that were treated operatively. All patients presented acutely with clearly established diastasis visualized on routine radiographs. Plastic deformation of the fibula was often present, and fibular osteotomy was required to obtain and maintain anatomic reduction of the DLES. Tibiofibular screw fixation was used in all cases, as well as repair of the anterior-inferior tibiofibular ligament and superficial and deep deltoid ligaments. The authors emphasized that the syndesmosis screw should be placed parallel to the joint to avoid any relative shortening or lengthening of the fibula. The patients were immobilized in plaster for 8 to 12 weeks, after which the syndesmosis screw was removed. All reductions remained anatomic throughout the follow-up period, but two of the six patients had residual stiffness and pain with activity.

In another study, Hopkinson et al[1] reviewed 15 DLES injuries in military cadets. Only one patient had frank diastasis on the initial radiographs. Stress mortise films showed abnormal widening in only one of seven patients examined. The patient with frank diastasis and the patient with abnormal stress films were treated operatively. As in most studies of syndesmotic sprains, the authors noted the prolonged time for recovery compared with routine lateral ankle sprains (55 versus 28 days before return to activities or sports). Calcification of the interosseous membrane was observed in 9 of 10 ankles available for review, but no predilection to recurrent injury or chronic ankle problems was noted during the 20-month follow-up period. No specific guidelines regarding casting, length of immobilization, weight-bearing protocols, or hardware removal were provided.

Taylor et al[3] retrospectively reviewed the data on 44 collegiate football players with suspected DLES injury at an average follow-up interval of 47 months. In no instance was a fracture or frank diastasis depicted on radiographs taken at the time of injury. All patients were treated with a non-operative regimen of ice, whirlpool therapy, taping, and activity restriction. Some received a short course of oral prednisone. A return to full activity was permitted only after ankle tenderness had resolved and there was no "functionally limiting" pain. Heterotopic ossification was noted on the follow-up plain films of 11 patients (25%), but there was no correlation between the presence or absence of ossification and the level of function. However, a trend toward longer time to recovery was noted in those with heterotopic ossification. Pain on push-off was the most common symptom preventing return to football activity. More than a third of the patients complained of persistent mild to moderate stiffness of the ankle; fewer than one fourth had mild to moderate pain, which was often activity related; and those with recurrent injury tended to do worse. Good to excellent ankle function was reported by 86% of the patients, and none had poor results.

In a study of professional football players, Boytim et al[2] noted that DLES sprains also led to a prolonged delay of return to activity. No player who suffered a syndesmotic sprain during the course of a game was able to continue to play, and most were unable to participate fully for up to 6 weeks. Players with lateral ankle sprains missed an average of only 1.1 practices (range, 0 to 12); those with DLES sprains had an average of 6.3 missed or limited practices (range, 2 to 21). No apparent relationship between DLES injury and shoe type, player position, or type of playing surface was noted.

Fritschy[10] reported on syndesmotic disruption in World Cup skiers, which was treated operatively in 3 of 10 patients. A Kirschner pin or tibiofibular screw was used with cast immobilization for 3 to 6 weeks. Nonoperative treatment involved use of a walking cast for 2 to 6 weeks, followed by supportive ankle taping. No skier was able to continue with training and/or competition for at least 4 to 8 weeks. One patient treated nonoperatively had chronic activity-related pain in the anterior syndesmosis and interosseous membrane. Fritschy asserted that this patient would have been better treated with an open repair and fixation.

The small cohort sizes in these clinical studies make it difficult to arrive at definitive conclusions. However, if a patient presents with frank diastasis or if instability is clearly demonstrated on stress views, one must seriously consider operative intervention. Sprains of the DLES without instability should be treated in a closed manner.

Syndesmosis Screw Application in Fractures

Obtaining and maintaining an anatomic reduction in displaced ankle fractures associated with syndesmotic disruption reduces long-term disability. In a retrospective review of 34 patients followed up for an average of 4 years after injury, Leeds and Ehrlich[17] found that the accuracy of reduction of the lateral malleolus correlated closely with syndesmosis reduction. An inadequate initial reduction of the syndesmosis and mortise led to late arthrosis and instability, which correlated with poor subjective and objective results. More recent evidence also emphasizes the importance of medial-side stability in maintaining the reduction of the DLES in unstable ankle fractures.[18] Nevertheless, the clinical application of syndesmosis screw fixation and postoperative protocols varies widely.

Numerous other methods of fixing the syndesmosis, including "flexible" fixation and the use of various hooks, screws, and other devices, have been described. The currently preferred fixation method involves the use of one or two 3.5- or 4.5-mm fully threaded cortical screws angled anteriorly 20 to 30 degrees from the fibula to the tibia. Each screw is fully tapped—not lagged—and engages either three or four cortices.[18] The issue of syndesmosis screw removal remains controversial.

In a study by de Souza et al,[19] syndesmosis screw fixation was used to restore fibular length and stabilize the syndesmosis in 150 patients with displaced external rotation–abduction ankle fractures. The results were reviewed retrospectively at an average follow-up interval of 3.5 years. Patients were allowed full weight bearing at 4 weeks. The syndesmosis screws were removed from 50% of the patients an average of 1 year after the time of fixation. Essentially all of the syndesmosis screws were loose at the time of removal, but none had broken or backed out. In patients with two screws, the distal screw consistently showed radiographic resorption consistent with loosening, while the proximal one was not associated with any obvious lucency on plain films.

In another study, Finsen et al[20] found no obvious deleterious clinical effect on weight bearing when a syndesmosis screw was left in place. Fifty-six patients were randomized to one of three protocols after operative fixation of an ankle fracture: (1) immediate active range of motion on a non-weight-bearing basis without cast immobilization, (2) non-weight-bearing activity in a short-leg cast, and (3) weight bearing as tolerated in a short-leg cast. All groups progressed to full weight bearing at 6 weeks. At follow-up (average interval, 2 years), there were no consistent differences in the clinical results between the three groups. The time out of employment and the distribution of excellent and good results were not influenced by the postoperative regimen. The syndesmosis screws were removed at an average of 9 weeks, and the remainder of the hardware was removed at approximately 36 weeks.

Despite these clinical observations, there is evidence that placement of the syndesmosis screw does alter normal ankle motion and joint mechanics. In a cadaveric study by Olerud,[21] a fully threaded tricortical screw was placed with the ankle in varying degrees of dorsiflexion and plantar flexion. Dorsal extension measured after screw placement decreased by an average of 0.1 degree for every degree of increase in plantar flexion at the time of fixation. The author recommended maximal dorsiflexion of the talus at the time of syndesmosis screw placement to minimize the risk of limitation in ankle range of motion after fixation. Specimens that demonstrated decreased total ankle range of motion before screw application had a more notable change in lack of dorsiflexion after fixation.

In a cadaveric study by Needleman et al,[22] a single 4.5-mm cortical screw was placed across four cortices at 3 cm proximal to the ankle in otherwise normal ankle specimens. All screws were placed with the talus in maximum dorsiflexion. There was no traumatic sectioning or injury, and no fractures were imparted. A decrease in tibiotalar external rotation and anterior and posterior drawer tests was noted; however, no marked change in ankle flexion occurred. This led to the conclusion that the syndesmosis screw should be removed before resumption of full activity because it may limit normal ankle motion and could lead to local discomfort or a fatigue fracture of the screw.

In clinical practice, however, the limitation in range of motion of the ankle may be only temporary. In a retrospective review of 30 patients followed up for a maximum of 3 years, Kaye[23] noted lytic changes around the screws. These changes were thought to be due to the resumption of a proportion of the normal motion between the tibia and the fibula despite adequate syndesmosis screw fixation. There was a trend toward increased lucency in those patients who began weight bearing earlier and underwent screw removal relatively later. No screw breakage was reported and no evidence of late widening of the syndesmosis was identified at an average follow-up interval of 6.3 months.

Tibiotalar contact area and pressure distribution in cadaver specimens has also been studied in relation to widening of the mortise and DLES fixation. Pereira et al[24] found that placement of two fully threaded 4.5-mm cortical screws through four cortices decreased the joint contact area. However, in specimens in which the mortise was left widened at 2 or 4 mm, there was no marked change in contact area, centroid position, or joint contact pressure. The talus tended to move to a position of maximal congruence in the mortise. The evidence suggested that syndesmosis fixation adversely affects the normal kinematics and congruity of the ankle joint and may therefore lead to increased contact stresses during weight bearing and activities.

In an attempt to clinically assess the findings of prior biomechanical studies, Yamaguchi et al[25] used the previously mentioned recommendations of Boden et al[6] as a guide for operative care of patients with fractures associated with syndesmotic disruption. Of the 21 consecutive Weber type C ankle fractures, only 3 required transsyndesmotic fixation. The authors' protocol emphasized rigid bimalleolar fracture fixation and a secure anatomic lateral fixation. Only patients with fibular fractures located more than 4.5 cm proximal to the joint and associated with a deltoid ligament rupture were treated by placement of a syndesmosis screw. Only non-weight-bearing activity in a short-leg cast was allowed for 4 weeks, followed by full weight bearing in a cast for an additional 2 to 4 weeks and then splint support for an additional 4 weeks after cast removal. At the follow-up examination an average of 1 to 3 years after treatment, there was no obvious widening on either static films or external-rotation stress views. Guidelines for screw removal were not clearly delineated.

In another study using the guidelines of Boden et al, Chissell and Jones[26] reviewed 43 Weber type C fractures. At the follow-up examination an average of 4.5 years after injury, widening of the normal clear space by more than 1.5 mm was the threshold between satisfactory and unsatisfactory clinical results. The worst functional results were noted in patients who had a medial malleolar fracture as well as a dislocation, presumably due to increased soft-tissue and articular surface damage. The authors recommended that syndesmosis screw application be used to treat those fibular fractures that were located more than 3.5 cm above the mortise and were associated with deltoid ligament disruption. In patients with a medial malleolar fracture, if rigid anatomic fixation could be obtained, a diastasis screw was required only if the fibular fracture was more than 15 cm above the syndesmosis.

Parfenchuck et al[27] also attempted to use previous cadaveric data to provide clinical guidelines for fixation of pronation–external rotation fractures. In their review of the data on 18 patients followed up for an average of 2.5 years, they found that patients with a deltoid ligament rupture who did not undergo syndesmosis fixation fared less well than those with medial malleolar fractures regardless of the level of fibular fracture. Patients with a medial malleolar fracture in whom good medial and lateral fixation could be obtained were considered not to require syndesmosis stabilization. Non-weight-bearing status was maintained for 6 weeks, after which the syndesmosis screw was removed. The authors considered the level of the fibular fracture less crucial in deciding whether to use a syndesmosis screw than the presence or absence of a deltoid ligament injury.

Making definitive recommendations on the basis of the available data is difficult; however, the importance of medial-side stability and fixation is becoming clear. If the fixation provides rotational stability of the mortise and there is no widening, use of the syndesmosis screw may not be as crucial as earlier surmised.

Author's Approach

Despite the conflicting reports in the literature, a rational approach to the treatment of DLES injuries is possible. In cases without fracture and no gross radiographic evidence of abnormal widening, syndesmotic sprains can be treated nonoperatively. Temporary stabilization with either a short-leg cast or a commercial splint or brace will likely decrease the acute symptoms. An aggressive rehabilitation program stressing range of motion, strengthening, and proprioception is advisable. The clinician must appropriately counsel the patient with a syndesmotic sprain regarding the longer length of time to recovery and the potential for pain and late sequelae, as well as heterotopic ossification. As long as both the clinician and the patient are fully cognizant of the often dramatically longer time to recovery compared with lateral ankle sprains, an excellent outcome should be possible.

The treatment of DLES disruption without fracture can be addressed surgically or nonoperatively. The crucial factor is obtaining and maintaining an anatomic reduction of the mortise and DLES. This can occasionally be accomplished with casting techniques; however, more often surgical intervention is necessary. Surgery also offers the advantage of allowing direct exposure of the site of injury. One often finds debris and interposed ligamentous and/or capsular tissues, which need to be extracted before obtaining reduction and fixation. Frequent clinical follow-up coupled with rigorous review of radiographs is recommended regardless of whether open or closed treatment is selected. Late widening of the syndesmosis can be a difficult problem to treat; if any change in position of the reduction of the DLES is noted, surgical treatment to regain anatomic reduction should be pursued.

In treatment of fractures associated with widening of the syndesmosis, the preoperative and intraoperative assessments are crucial. The biomechanical and some recent clinical reports support more stringent application of the syndesmosis screw. Obtaining and maintaining anatomic rigid fixation on both the medial and lateral sides is critical. Intraoperative testing of the syndesmosis after fixation can be a useful adjunct if the stability of the reduction is in question. If there is persistent lateral subluxation of the fibula or marked widening or opening of the mortise with external rotation on lateral stress views taken intraoperatively, syndesmosis fixation is recommended. Without the ability to obtain medial-side stability (e.g., as in cases of deltoid ligament rupture or a severely comminuted medial malleolus), the syndesmosis screw may be required more often than when there is a rigidly fixed medial malleolar fracture.

There is no doubt that placement of the syndesmosis screw alters normal ankle biomechanics and fibular motion. However, syndesmosis fixation has not yet been proved to cause any obvious detrimental clinical sequelae. Screw removal or loosening is likely necessary to allow a full return of normal ankle motion and mechanics. The length of time required for adequate syndesmosis healing appears to be 6 to 12 weeks; however, definitive data regarding the optimal time for screw removal are lacking.

I prefer to err on the side of overuse of syndesmosis fixation. The subtle changes in ankle biomechanics and limitation of motion in the short term are not as crucial as obtaining and maintaining anatomic reduction of the syndesmosis and mortise. Touch weight bearing is allowed immediately postoperatively; however, full weight bearing and full activities are limited until the syndesmosis screw has been removed.

Use of a fully threaded 4.5-mm screw, inserted through four cortices, is recommended for a number of reasons. The four-cortex placement allows for less complicated removal should there be any implant failure or screw fracture. Also, because of its slightly larger head, the 4.5-mm screw is much easier to identify and palpate than the standard small-fragment 3.5-mm cortical screw; as a result, the procedure for syndesmosis screw removal is very simple and can be performed with only local anesthetic and, if necessary, fluoroscopic guidance. While the larger screw size could potentially lead to lateral wound problems, fortunately this has not been the case in clinical practice. Intraoperative stress testing of the mortise, with both direct inspection and fluoroscopic and / or radiographic imaging, and the surgeon's impression in the operating room of syndesmosis stability should be used as guidelines in the application of syndesmosis fixation.[28,29]

Summary

Disruption of the DLES is most commonly associated with ankle fractures. Syndesmotic injury without fracture is also well recognized. Attention to detail in radiographic interpretation, a review of the pertinent anatomy and the etiology of these injuries, and an understanding of the basic science investigations that have been done should allow the practitioner to synthesize a reasonable approach to treatment. Cadaveric and biomechanical studies clearly demonstrate an alteration in ankle motion and contact forces and provide support for the use of screws in selected fractures that include a disruption of the syndesmosis. Nevertheless, definitive clinical application of syndesmosis fixation continues to be debated. Distal lower extremity syndesmosis sprains without fracture or subluxation consistently require longer recovery time than typical lateral sprains and can be associated with greater long-term disability. It is hoped that this review will allow the clinician to formulate a reasonable approach to these often complex injuries. Thorough prospective studies with clearly defined treatment guidelines and adequate follow-up are required to further address many of the current clinical controversies.

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