CHAPTER 4

SYNDESMOTIC INSTABILITY OF THE ANKLE FOLLOWING FRACTURE: THE NEED FOR PROPER STRESS EXAMINATION AND RIGID INTERNAL FIXATION

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INTRODUCTION

The anatomy of the syndesmosis is complex and must be understood in order to appreciate why its function is vital to ankle stability. It is made up of the anterior inferior tibiofibular ligament (AITFL), the posterior inferior tibiofibular ligament (PITFL), the transverse ligament, and an interosseous ligament that links the distal fibula to the distal tibia (1).

The AITFL, which is about 20% intra-articular, runs from the anterior tubercle of the distal tibia to the anterior tubercle of the distal fibula (1, 2). External rotation injuries of the ankle have long been implicated in causing ankle instability. In comparison to other mechanisms of ankle fractures, external rotation of the ankle results in the largest and most consistent displacements of the fibula at the level of the syndesmosis. The reason for this displacement lies largely in the fact that the weakest ligament if the syndesmosis, the anterior inferior tibiofibular ligament, is usually ruptured in external rotation ankle fractures (1). The rupture of the AITFL allows the rotational system of injury described by Lauge-Hansen to subsequently cause fracture or ligament tears to the fibula and/or tibia and damage to the remaining syndesmotic ligaments as the force of the body's weight is dispersed around the ankle.

The PITFL runs from the posterior tibial malleolus to the posterior tubercle of the fibula. Due to the inherent strength of the ligament, often a posterior malleolus or Volkman's fracture of the tibia will occur rather than a PITFL tear (1-3). As reported by Miller et al anatomic reduction and fixation of a posterior malleolus avulsion fracture results in syndesmotic stabilization at least equal to that of screw fixation due to the subsequent stabilization of the PITFL (4). The importance of restoring the PITFL is supported Ogilvie-Harris et al's finding the PITFL alone makes up 42% of the strength of the syndesmosis (3, 4).

The transverse ligament runs from the lateral malleolus of the fibula to the posterior border of the articular surface of the tibia (1, 2). Its relevance in ankle fractures is difficult to assess as the ligament is thought to be the deep part of the PITFL (5).

The interosseous ligament consists of short fibrous bands and fatty tissue that run between the inferior tibia and fibula. Although the interosseous ligament is the shortest of the 4, it provides the greatest support between the tibia and fibula. It is the main cohesion between the tibia and fibula and plays a crucial role as a stabilizer in gait (2, 6).

While it is evident that syndesmotic stabilization should be performed when indicated, other variables are still debatable. The amount of cortices captured with a syndesmotic screw does not seem to make a difference in the stability of the ankle. Moore et al found that there was no statistical significance in loss of reduction, screw breakage, or need for hardware removal when comparing 3.5 mm fully-threaded cortical screws capturing 3 versus 4 cortices of bone (7). Often, healing of the syndesmosis is a race between ligamentous healing and hardware failure. It is not necessary, however to remove a syndesmotic screw due to hardware failure unless it backs out or becomes painful (7). In our experience, spanning of 3 or 4 cortice screws was used depending on the patient type. If the patient was morbidly obese or had osteoporotic bone the trans-syndesmotic screw captured 4 cortices. Screw size, namely 3.5 mm versus 4.0 mm fully-threaded cortical screws, does not seem to have much bearing on maintaining syndesmotic reduction. Thompson et al found that there was no biomechanical advantage of using 4.5 mm rather than 3.5 mm screws in cadaveric simulated fixation of the syndesmosis (8). Although many of these decisions become surgeon preference, the routine of stressing all ankle fractures should be mandatory. In office stress examination should be performed on isolated fibular fractures and then if positive, performed under anesthesia in a surgical setting. While some may argue that a conscious patient may be able to resist or guard against a stress examination, this has not been the case in our experience.

Another topic of debate is whether the syndesmosis can be overtightened. In the majority of the approximately 200 patients who underwent syndesmotic fixation at our facility, a lagged 3.5 mm trans-syndesmotic cortical screw was inserted using standard AO technique. While some may argue that a syndesmotic screw should be purely positional due to the possibility of limiting ankle motion (i.e., dorsiflexion), we feel that the benefits of achieving and maintaining anatomic reduction across the syndesmosis outweigh the negatives. Patient compliance cannot be predicted and lagging of syndesmosis improves the odds that the syndesmosis will remain anatomically reduced and decreases the chance of screw back-out. Furthermore, Tornetta et al showed that tightening of the syndesmosis does not adversely affect ankle motion (9). Using 4.5 mm lag screws to fixate the syndesmosis in plantarflexion, the authors disproved the notion that a syndesmotic screw limits ankle dorsiflexion. They determined that as long as anatomic alignment is achieved, the position of the ankle while inserting the screw does not affect ankle dorsiflexion. In fact, placing the ankle in maximal dorsiflexion while inserting a syndesmotic screw may result in malreduction of the syndesmosis (9).

Using magnetic resonance imaging (MRI) as the modality of analysis, Nielson et al determined that the level of the interosseous membrane tear could in fact be higher than the level of the fibular fracture (10). These MRI findings correlate with the findings of Stark and Tornetta that clearly demonstrate a high incidence of syndesmotic instability in Weber B fractures (10, 11). Although recent literature is now supporting the notion that the level of the fibular fracture is not indicative of syndesmotic instability, the purpose of our study was to explore whether the incidence of syndesmotic instability was underreported.

MATERIALS AND METHODS

A total of 325 patients from 2007-2010 received open reduction internal fixation of an ankle fracture with plate and screw fixation. Surgical intervention for isolated fibular fractures was determined if a presurgical stress examination was positive or if plain film radiographs showed an increased medial clear space (>4 mm). One author, assisted by resident(s) at a level II trauma center in Philadelphia, PA performed the surgeries. All of the ankle fractures included in our data could be classified using both the Danis-Weber classification as well as the Lauge-Hansen classification. Ankle fractures that could not be classified (i.e., direct trauma, pilon fractures, etc.) were not included in our retrospective analysis. Syndesmotic instability was determined using an intra-operative external rotation stress test (i.e, the Cotton test). Instability was considered to be positive by analyzing both the lateral tibiotalar joint mortise and the medial clear space before and after stress examination. The ability of the talus to sublux when placed under external stress rotation in conjunction with an increased medial clear space relative to superior clear space was indicative of a positive stress examination. Stress examination was performed only after all associated ankle fractures had been fixated. Fixation of ankle fractures was performed first by inserting a 3.5 mm fully-threaded cortical lag screw perpendicular to the fibular fracture followed by plating of the fibula with 3.5 mm locking and nonlocking screws. Medial malleolus fractures were fixed using either one or two screws, or a plate. Posterior malleolus fractures when amenable to fixation were fixed using screws or a plate. All subjects were placed in a fiberglass posterior splint and made nonweight bearing immediately following surgery.

RESULTS

During a period spanning from February 2006 to May 2010, a total of 322 ankle fractures that were classifiable by both the Danis-Weber and Lauge-Hansen classification systems underwent open reduction and internal fixation of all associated fractures. Ankle fractures not requiring surgery or those that were not classifiable (i.e., high-energy trauma) were not included in our analysis. Four of the fractures were classified as supination adduction (SAD), 19 as pronation abduction (PAB), 80 as pronation external rotation (PER), and 219 as supination external rotation (SER).

Overall 199 of the 322 fractures (62%) demonstrated syndesmotic instability after initial fixation of the fibular, medial malleolar, and posterior malleolar fractures (if present) as indicated by a positive fluoroscopic external rotation stress examination. Syndesmotic instability was demonstrated in 0 of the 4 SAD fractures (0%), 9 of the 19 PAB fractures (47%), 65 out of 80 of the PER fractures (81%), and 125 out of 219 of the SER fractures (57%). All results were confirmed intra-operatively under live fluoroscopy and the same physician performed each stress examination.

Instability was seen in 85/102 (83%) of isolated fibular fractures with predetermined deltoid incompetence after fixation of the fibular fracture. Deltoid incompetence 28/69 (41%) of bimalleolar fractures opened on stress examination after fixation each fracture. Trimalleolar fractures yielded 84 out of 149 (56%) of patients with syndesmotic instability after fixation of associated fractures.

Variation in syndesmotic tears was seen when comparing sexes. A total of 98 out of 188 (53%) of women displayed syndesmotic instability, while 101 out 142 (71%) of men were positive. Within this group, 67 out of 131

(46%) women had instability compared with 58 out of 88 men (56%) with SER type fractures.

DISCUSSION

Much of the early literature on syndesmotic instability attempted to create guidelines on when the syndesmosis should be stabilized by analyzing cadaveric ankles. Boden et al analyzed pronation external rotation ankle fractures based on cadaveric simulation. They concluded that the need for syndesmotic stabilization could be determined based upon the height of the fibular fracture and the competence of the deltoid ligament. They stated that rigid medial and lateral fixation of these fractures was adequate if the level of the fibular fracture was not proximal to the “critical transition zone” identified by them to be 3-4.5 cm proximal to the ankle joint (12). As stated by Stark et al, Boden’s study failed to take into account that the interosseous membrane, interosseous ligament, and capsular tissues may stretch prior to the actual fracture of the bone. While Boden’s findings can be useful in surgical planning, the results obtained in his study were obtained from cadaveric simulation and do not correlate with current literature or our findings (11).

Current literature has placed an emphasis on the fact that Weber B fractures, namely those with a mechanism of supination external rotation, may have syndesmotic instability. Stark et al examined 238 adults with unstable SER Weber B fractures that had radiographically identified deltoid ligament incompetence. They found that 39% of these fractures demonstrated syndesmotic instability after plate and screw fixation of the fibular fracture. Syndesmotic instability was identified with the use of intra-operative external rotation stress examination under fluoroscopy. These patients who displayed instability on stress examination received stabilization with a 3 cortice trans-syndesmotic positional screw spanning across the distal fibula into the distal tibia. The authors concluded that intra-operative stress examination must be performed in unstable SER Weber B fractures in order to avoid having syndesmotic instability go undiagnosed (11). Our data support Stark and Tornetta as 83% of our bimalleolar equivalent ankle fractures displayed syndesmotic instability. This number cannot be directly compared to Stark’s finding of 39% however, as the criteria to bring the patient to the operating room for Stark et al was based on deltoid incompetency seen on standard radiographs while our criteria was based on an in office fluoroscopic external rotation stress examination. What can be deduced from both of our results is that syndesmotic instability in Weber B fractures has widely been underreported and more importantly unaddressed (11).

The intra-operative stress examination itself must be performed correctly in order to achieve an accurate representation of syndesmotic instability. The “hook test” of merely translating the distal fibula with lateral force in a coronal plane under fluoroscopy is not an adequate measure of syndesmotic stability. By placing only a transverse stress on the fibula, the test fails to take into account that the mechanism of injury in ankle fractures and damage to the syndesmosis is often rotational. The hook test should be considered antiquated and current recommendations rely on a fluoroscopic external rotation stress of the ankle (i.e., the Cotton test). Heim et al relied on the hook test to assess syndesmotic stability in Weber B fractures after fixation of fibula and/or medial malleolus fractures and found only 19% to be unstable (13). It is conceivable to think that Heim’s prevalence of instability would have been higher if an external rotation stress examination was used in place of the hook test.

Fixation of syndesmotic instability has directly been linked to an improved functional outcome in patients following an ankle fracture (14). The goal of the trans-syndesmotic screw is to allow for the syndesmotic ligaments and ankle mortise to heal in anatomic alignment when the patient is nonweight bearing. The classic article by Ramsey and Hamilton demonstrated that a 1mm lateral shift in the talus decreased tibiotalar articulation by 42% (15). Because instability of the syndesmosis is capable of causing lateral talar shift, proper identification of instability is crucial. In a retrospective study by Weening et al that examined PER (70%) and SER (30%) ankle fractures that received 3 cortice syndesmotic screw stabilization, it was determined that there was a direct link to functional outcome. These patients had a significant increase in Short Musculoskeletal Functional Assessment Index, a scoring system used to assess functional outcome (14).

CONCLUSION

Our collection of ankle data show that syndesmotic instability is prevalent in all types of rotational ankle fractures. An extremely high amount of syndesmotic instability related to ankle fractures was seen in our large sample of patients. The discrepancy in the prevalence of syndesmotic tears in previously published literature may be related to underutilization or improper fluoroscopic stress examinations. We recommend that all ankle fractures, regardless of the type or level of the fibular fracture, be assessed with a fluoroscopic external rotation stress examination. Furthermore, ankles that display a positive stress test for syndesmotic instability should be rigidly fixated with either 3.5 mm or 4.0 mm fully-threaded screws that capture either 3 or 4 cortices.

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