CHAPTER **45**

CONTROVERSIES IN THE TREATMENT OF TIBIO-FIBULAR DIASTASIS

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INTRODUCTION

It is well accepted that incomplete or inaccurate reduction of the tibiofibular joint after ankle fracture can cause premature arthrosis and/or dysfunction. Common convention dictates that anatomic reduction of the fibular fracture will lead to accurate position of the fibula relative to the tibia. If one assumes this to be true and trans-syndesmotic fixation is delivered, any malposition, however subtle will be maintained in the postoperative period Apposition of fibula can be incomplete for several reasons. First the fibula can be displaced posteriorly, anteriorly or laterally. Even though the fibular fracture (if present) has been reduced and fixated, there may be residual malalignment because of plastic deformation, or soft tissue interposition of the tibiofibular ligaments. Furthermore trans-syndesmotic fixation must be stable for a period of time longer than that required for complete ligamentous healing. Insufficient fixation may allow for postoperative migration and loss of optimal tibio-fibular relationship.

The issues surrounding trans-syndesmotic fixation are quite variable and controversial. Perioperative decisions include 1) the requirement for any surgical fixation of the tibiofibular articulation; 2) the type of screw (cortical or cancellous); 3) the caliber of the screw; 4) the material of the fixative (absorbable, nonabsorbable, or flexible); 5) the position of insertion; 6) the number of fixation devices; 7) the length of screw (tri- or quadricortical); 8) the question of removal (if and/or when); 9) the position of the ankle during insertion (dorsiflexed, neutral, or arbitrary); and 10) technique of reduction.

The following information represents the author's technique based on experience with over 3000 fractures of the ankle in 25 years. The techniques herein will be presented as small vignettes to aid the reader in the subsequent management of these injuries.

THE TECHNIQUE OF REDUCTION

The accurate apposition of the fibula to the tibia within the incurisa is predicated on the application of a reduction force that is coaxial to the tibio-fibular axis. This force can be delivered indirectly by a manual internal rotation of the foot against the tibia (Figure 1), but is more difficult to maintain during the hardware insertion process. More importantly, it does not assure the proper positional housing for the fibula. It is most accurate to use a reduction clamp that is oriented in a coaxial fashion (Figure 1). Either a large pincer type forceps or a periarticular reduction clamp can be utilized. The clamp should be placed at the level of the syndesmotic articulation and tightened to reduce the fibula within the notch. The correct orientation should be checked by visualizing the orientation of the jaws from the end of the operating table (Figure 1).

When there is no plate on the lateral aspect of the fibula such as in a high fibular fracture with diastasis, the clamp is placed in a percutaneous fashion. If there is a plate on the fibula, one of the jaws of the clamp should be placed into the recess of one of the screws that is at the level of the syndesmosis (Figure 1).

The issue of the position of the ankle during insertion of the screws is controversial at best. There are arguments on both extremes, those being full dorsiflexion versus an arbitrary position of the talus. Further it has been stated that it is "impossible" to over tighten the syndesmosis fixation during repair.[1] This has not been a universal observation in the author's experience. This is probably the most potent maneuver that will partially extrude the talus even if the drill is oriented in a coaxial manner at the level of the syndesmosis (Figure 2). Although this phenomenon is not universal it is critical to asses the congruency of the mortise prior to the conclusion of the operation.

There are other factors that contribute to altered mechanics during syndesmotic fixation. First, the direction of the drill channel and screw can cause subtle but potentially significant malalignments of the fibula. The proper orientation of the drill and subsequent screw is in a coaxial direction with the syndesmosis (Figure 3). One of the more frequent errors during the trans-syndesmotic drilling is an inaccurate direction. Most commonly the drill is directed too anterior in an attempt to recreate the trans-syndesmotic axis (Figure 3C). This orientation can anteriorly displace the fibula with concomitant displacement of the talus. However radiographic evidence of displacement

Figure 1A. Intraoperative photograph of right ankle with internal rotation force being delivered to reduce tibiofibular joint.

Figure 1B. Radiograph of same ankle prior to maneuver.

Figure 1C. Radiograph taken during the process showing widening of both the medial clear space and tibiofibular overlap.

Figure 2A. Intraoperative radiograph of left ankle showing loss of integrity of the syndesmosis. There is a fracture of the fibula at the neck.

Figure 2B. Reduction clamp applied with excessive pressure. Note the distal extrusion of the talus.

Figure 2C. Reduction clamp applied with proper pressure across the joint.

Figure 2D. Intraoperative view showing correct orientation of the clamp. Note the internal rotation of the foot and that the clamp is parallel to the floor.

Figure 2E. Side view showing orientation of the clamp.

Figure 2F. Intraoperative fluoroscopic view showing placement of the first screw and drill sleeve for the second screw.

of the talus is often subtle or lacking, but is reflected in a loss of dorsiflexion on the operating table. A less common error is a posterior orientation of the screw. This malposition is often forgiven if the screw is placed low enough to capture the metaphyseal flare of the posterior malleolus (Figure 3).

TYPE AND NUMBER OF SCREWS

The parameters surrounding the type and number of fixation devices are poorly defined because of variable literature and personal preferences of all surgeons that do operative reductions of ankle fractures. Although most surgeons recommend the use of fully threaded screws, the number and caliber of the screws is highly individualistic. The decision to place more than one trans-syndesmotic screw should be predicated upon stability of the tibio-fibular joint as well as the anticipated postoperative activity. As the stability of the ankle mortise is multi-dimensional, one should be concerned about recurrent diastasis after weight bearing is initiated. However it is important to dampen any rotatory forces that may be imparted in the postoperative course, including from early weight bearing. In particular when ankle motion is allowed, there is a rotational thrust to the fibula as the talus dorsiflexes. If the syndesmotic ligaments have completely healed at a physiologic length by the time weight bearing is commenced, then the number of screws is irrelevant. In some cases it may be desirable for early weight bearing, prior to adequate tensile strength of the ligamentous complex. In these instances more than one screw will fortify the construct and dampen rotatory instability. If one determines then that more than one screw is necessary, it should be placed higher than the first screw in the syndesmotic notch to capitalize on the robust cortical bone of the tibia (Figure 4).

Since most plates used for internal fixation of the fibular are designed to accommodate 3.5 mm or 4.5 mm screws, the surgeon is confined to either of these for syndesmotic stabilization. The issues herein are related to several factors as well as to one another. These issues include the location of the screw(s), the surgeon's policy of removal, the quality of the bone, and the number of cortices that are purchased by the threads. Using larger caliber screws (4.5 mm) usually will provide for better purchase with all other things equal (Figure 4C). This will lead to better resistance of pull-out or loosening in the postoperative period. Yet this may lead to a higher frequency of screw failure because of fatigue failure. Experience shows that virtually all trans-syndesmotic screws will either loosen or fail with time, particularly if the screw is placed close to the syndesmotic articulation. This issue is further complicated by the length

Figure 3A. Lateral fluoroscopic view showing correct orientation of the drill for coaxial placement of the screw.

Figure 3B. Note the screw is coaxial with the syndesmosis.

Figure 3C. Lateral radiograph showing excessive anterior deviation of the trans-syndesmotic fixation.

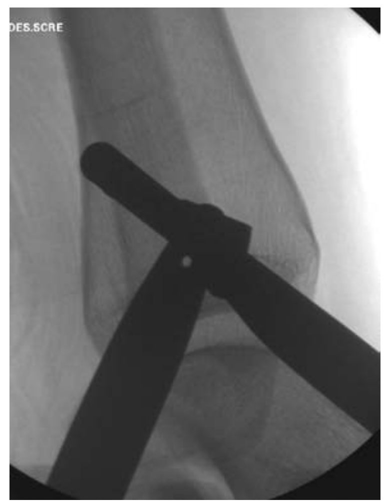

Figure 3D. Posterior orientation of the drill bit.

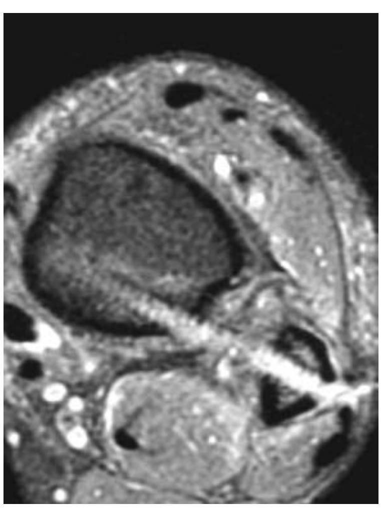

Figure 3E. Computed tomography (CT) scan of patient with excessive posterior deviation of the drill bit. Although the screw has purchased the posterior malleolus, the fibula is incorrectly rotated.

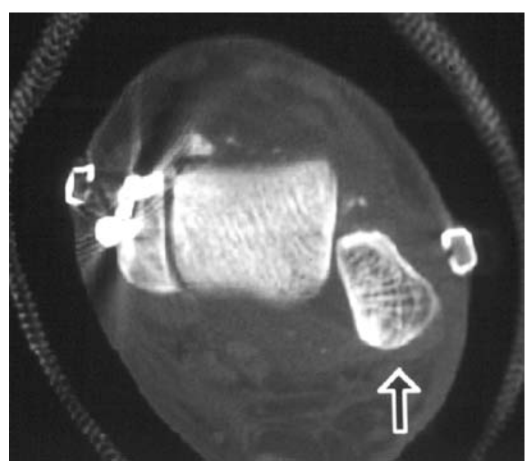

Figure 3F. CT scan of another patient with a malreduced syndesmosis.

Figure 4A. Low energy rotational fracture with widening of the medial clear space.

Figure 4B. Lateral view showing equivocal involvement of the syndesmotic complex.

Figure 4C. Final construct showing optimal orientation and number of screws that will allow for early weight bearing.

of the screws that are standard in most internal fixation sets. As such, it is not always possible to insert a 3.5 mm screw at the level of the syndesmosis that will purchase all 4 cortices because the screw may not be long enough. However this may diminish the incidence of failure of the 3.5 screws because there are only 3 points of purchase. The 2 cortices of the fibula are usually robust, but the lateral cortex of the tibia at the level of the syndesmosis is often frail. The smaller diameter screw that only purchases 3 cortices is more likely to loosen than break. If this happens, it may lead to insufficiency of the syndesmosis. Lastly, if the surgeon routinely removes the trans-syndesmotic fixation, the larger head of the 4.5 mm screw facilitates retrieval, and can often be done in the office setting without fluoroscopy.

Given these factors, it seems that the most effective form of trans-syndesmotic fixation is the use of 4.5 mm screw(s) that purchase all 4 cortices. Maintenance of the intraoperative position is usually realized until clinically relevant and the patient becomes weight bearing.

WHEN TO USE TRANS-SYNDESMOTIC FIXATION

Conventional wisdom indicates that fixation of the syndesmosis should be employed when the fibula fracture is superior to the syndesmosis. In most cases the adoption of this philosophy will lead to a stable syndesmosis. When the injury pattern follows the pathway described by Lague-Hansen, damage to the syndesmosis will be predictable. Experience shows that this is not a universal observation. There are instances when the fibular fracture is well above the syndesmosis, and none of the ligaments are insufficient. The corollary is a more common observation in that there are many fibular fractures at the level of the syndesmosis but there is some insufficiency of the syndesmosis. These observations lend some debate. In order to reconcile the inconsistent application of the Lague-Hansen classification scheme, it is first necessary to clarify the exact nature of syndesmotic insufficiency.

The syndesmotic complex is primarily composed of 3 ligaments: the anterior inferior tibio-fibular ligament, the posterior inferior tibio-fibular ligament, and the interosseous tibio-fibular ligament. The primary soft tissue restraint for lateral displacement of the fibula is the interosseous tibio-

Figure 5A. Intraoperative photograph showing technique to assess integrity of interosseous tibio-fibular ligament. Bone clamp in place without lateralward force.

Figure 5B. Lateral displacement of the fibula with lateralward force. Note the gap between the fibula and tibia at the level of the syndesmosis.

Figure 6A. Final radiograph appearance of trimalleolar fracture.

Figure 6B. Immediate post reduction external rotation stress maneuver. The medial clear space and tibiofibular space have increased.

Figure 6C. Placement of trans-syndesmotic screw to dampen rotatory instability.

fibular ligament. It follows that trans-syndesmotic surgical stabilization is designed to substitute for this ligament until sufficient healing and tensile strength is realized. However, the loss of integrity of the interosseous ligament comes at the expense of anterior and/or the posterior tibio-fibular ligaments. These structures dampen rotatory forces when the ankle joint is loaded. As such, rotatory instability can manifest in spite of an intact interosseous ligament, with the latter serving as the axis of rotation.

The injury radiographs in many cases will demonstrate unequivocal separation of the tibia and fibula. It is not necessary to further investigate the integrity of the syndesmosis. In those situations when the fibular fracture is at the level of the syndesmosis, or the fibula appears to be well positioned in the syndesmotic notch, it is necessary to investigate further. In order to clearly identify the damage to this ligamentous complex it is critical to do an intraoperative assessment of the integrity of these

Figure 7A. Lateral radiograph showing halo effect around the loose trans-syndesmotic fixation.

Figure 7B. AP radiograph showing same effect.

structures. Moreover it is important to determine this in both the transverse and frontal planes. In order to test the stability in the transverse plane, the surgically stabilized fibula is grasped with a bone forceps and a lateralward force is applied by attempting to dissociate the fibula from the incurisa. If one can visualize excessive lateral movement, then one should infer that there is damage to the interosseous tibio fibular ligament (Figure 5). The test for rotatory instability of the frontal plane requires a bit of finesse in that it is difficult to determine the threshold between stable and unstable. The maneuver requires fluoroscopy and is performed by applying an external rotation force to the foot against a stable tibia. In some instances there will be widening of the tibiofibular space. Almost invariably the medial clear space will widen a bit, but it is difficult to ascribe any sense of integrity to the deltoid.[2] The widening of the tibio-fibular space strongly suggests that the interosseous tibiofibular ligament has failed, but widening of the clear space only may be attributed to insufficiency of the anterior inferior tibio-fibular ligament (Figure 6).

When the tibio-fibular space widens with external rotational stress, fixation of the tibia to the fibula may be indicated. Although controversial, it may not be absolutely necessary if the fibula is situated in its anatomic housing. It is conceivable that there will be no subsequent malalignment if the postoperative disruptive forces are eliminated by a non-weight bearing course and the apposition is monitored carefully throughout the healing phase of the ligaments. On the contrary, if one desires to initiate early weight bearing, it is probably prudent to stabilize the syndesmosis. It is also within the possibilities to allow for weight bearing in a short leg cast in that the destructive rotational forces that are imparted to the fibula as the talus dorsiflexes are neutralized. The cast prevents rotation of the foot on the leg and this may still allow for maintenance of the tibio-fibular relationship. It becomes evident that the issue of weight bearing after rotational ankle fractures remains cloudy. Conventional practice patterns have established the indications for surgical stabilization, but few studies show any evidence of unequivocal mandates.

REMOVAL OF TRANS-SYNDESMOTIC FIXATION

There are several questions that need resolution regarding the removal of trans-syndesmotic fixation. It must be determined if the fixation should be removed at all and if so, when should it be removed. Many surgeons would suggest that screws placed across the tibiofibular joint might restrict the motion of the articulation that is a component of normal ankle biomechanics during gait. However it should be noted that this restriction of motion is almost always temporary if it exists at all. Once the patient becomes weight bearing with sagittal excursion of the talus in the mortise, the tibiofibular joint will be subjected to cyclical loads. The forces that are imparted to the tibiofibular joint are both rotatory and bending ones. Assuming that the fixation is at or proximate the articulation, these forces will serve to either loosen the screw(s) or cause them to fail in a fatigue manner. Once the screw becomes loose, the tether between the tibia and fibula is released. This phenomenon is evidenced by a radiographic halo effect around the screw (Figure 7). It follows then that screw removal may be unnecessary based on the lack of biomechanical action at the joint. Yet some patients request screw removal because the head of the screw is often prominent if a 4.5 mm screw is utilized.

Aside from loosening, the cyclical load may cause fatigue failure at or near the confluence of the tibia and fibula. Again the biomechanic effect of the restraint is eliminated, thus countering the argument that ankle joint motion is restricted. Some patients react negatively to the situation of retained metal, particularly if the screw has broken, and often request removal. Retrieval of the proximal or head side of the screw is routine, but harvest of the remaining portion of the screw can be problematic. In order to obviate this problem, the screw can originally be placed 2-4 mm longer than was measured during the insertion process. Should the patient request screw retrieval, it is a relatively simple exercise with standard screw removal sets. The screw is "reversed" from the medial side of the distal tibia at the point of protrusion.

Except in the cases of screw failure, removal in the vast majority of cases is done in the office setting with a stab incision under local anesthesia. The use of a small fluoroscopy unit is sometimes helpful to localize the position of the screw head, but is usually not necessary if larger caliber screws (4.5 mm) are utilized because the head is palpable. Those patients with a thick soft tissue envelope over the distal fibula may require a longer incision and might be better served in a formal outpatient operatory.

NEW FIXATION MATERIALS

There are a number of newer materials available for trans-syndesmotic fixation. These include absorbable screws and flexible restraints placed across the syndesmosis.

Although some have touted significant advantages of these devices the only universal benefit is that these devices generally do not need to be removed. Although this may be seemingly more convenient, analysis of the risks and benefits have yet to establish any advantage, particularly with regard to clinical utility or superiority. It is quite obvious that absorbable screws and other flexible restraints are less rigid than metallic screws. The fundamental issue is defining when, if ever do either of these alternatives offer a distinct mechanical advantage to warrant either episodic or routine use. Absorbable screws do not withstand shear and cyclical load well and as such, probably are not well suited for those patients that are weight bearing soon after surgery. Contrarily, if the load imparted to the fibula can be dampened by a short leg walking cast sufficiently to protect the shearing forces imparted to absorbable fixation, then the mechanical issues are not relevant. From a clinical perspective, it is not practical to maintain some sort of cast immobilization for a 12 week period during the ligament healing phase. This issue and others must be clarified in order to refine the utility.

Modified sutures and button constructs have been touted as a superior form of trans-syndesmotic fixation. Interestingly, there are few unbiased studies that compare the important parameters between this concept and conventional fixation. It has not been established whether the allowed motion between the tibia and fibula is detrimental or not in the first 12 weeks after injury. Furthermore rotational instability cannot be remedied, but is remains unclear whether this is important or not during ligamentous healing. It is clear that if morbid loads to the fibula are eliminated in the postoperative period the pull-out strength of any of these materials is completely extraneous.

In turn the cost-benefit analysis has also not yet been done. The natural question is "Does the use of trans-syndesmotic fixatives that do not require removal save the health care system money?" Although one can provide testimonials on small series of cases, the collective cost benefit needs further resolution.

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