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Foot and Ankle Tips & Tricks: Syndesmotic Screw Fixation—Principles and Technique

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Introduction

Ankle injuries are the most common injury to the lower extremity. Ankle fractures occur at an incidence of roughly 127 per 100,00 adult individuals, and that continues to increase.[1-3] It has been reported that 15% to 23% of operatively managed ankle fractures have associated syndesmotic injuries that require fixation.[4,5] Syndesmotic injuries are a significant source of morbidity and require precise anatomic reduction for successful outcomes.[6,7] It has been shown that the slightest malreduction can foreshadow a poor clinical outcome.[6,7] As little as one millimeter of displacement reduces contact area by up to 42%.[8]

Ankle syndesmotic injuries that require surgical fixation can be treated with a variety of devices. Despite the number of instruments, syndesmotic screws were the historic *gold standard* for fixation of the syndesmosis. However, clinical practice is still highly variable regarding technical aspects of screw fixation. Some of these controversies include the optimal number of cortices needed to stabilize the injury, the size of screw(s), the number of screws, the position of the foot during screw insertion as well as postoperative protocols.

This paper will 1) describe the principles of syndesmotic screw fixation and 2) discuss the technical considerations when inserting syndesmotic screws.

Principles

Anatomy and Biomechanics

The syndesmosis is comprised of five main structures: the anterior-inferior tibiofibular ligament (AITFL), posterior-inferior tibiofibular ligament (PITFL), interosseous membrane, interosseous ligament (IOL) and inferior transverse ligament (ITL).

The syndesmosis functions to maintain integrity between the tibia and fibula by resisting axial, rotational, and translational forces during ankle dorsiflexion and plantar flexion. More specifically, the fibula externally rotates and translates laterally during dorsiflexion in order to accommodate the asymmetric talus.[9,10] Previous studies demonstrate that the syndesmosis widens 1 mm during normal gait, establishing the dynamicity of the tibiofibular syndesmosis.[9,11]

Although the syndesmosis provides stability to the distal tibiofibular joint, the deltoid ligament provides the primary stability. With an intact deltoid ligament, an injured to completely transected syndesmosis demonstrates minimal widening on radiographs as shown in a cadaveric model.[12] The syndesmosis aims to restrain lateral fibular motion with the AITFL and transverse ligaments being the most important. Disruption of the deltoid and syndesmotic ligaments leads to abnormal ankle biomechanics manifesting as lateral translation of the fibula, external rotation of the talus, and increased tibiotalar contact pressures.[7,10]

One novel cadaveric study sequentially sectioned each ligament of the syndesmosis and noted that each ligament imparted varying degrees of stability; the AITFL provided 35%, the AITFL provided 35%, the interosseous ligament 22%, the superficial PITFL 9%, and the deep PITFL 33%.[12] Rupture of two or more of these ligaments may lead to instability.[12]

Stable versus Unstable

The identification of an unstable syndesmotic injury is clinically difficult and requires the use of physical exam findings, radiographic parameters, advanced imaging, and/or intra-operative evaluation to determine whether or not an unstable syndesmotic injury is present that requires fixation.

The most common physical exam findings patients present with are ankle pain, swelling, instability, and pain with walking on uneven surfaces.[13] Patients who have tenderness to palpation over the syndesmosis and/or have reduced ankle dorsiflexion are more likely to have a syndesmotic injury.[10,13,14] Numerous provocative maneuvers can be performed to help clinically diagnose syndesmotic injuries including the Hopkins squeeze test, external rotation test, crossed-leg test, forced dorsiflexion text, and the Cotton test. Despite the number of tests, the clinical diagnosis of syndesmotic injury can be missed up to 20% of the time.[15,16]

When evaluating radiographs for syndesmotic injury, it is important to evaluate certain radiographic parameters including the tibiofibular overlap, tibiofibular clear space and medial clear space (Figure 1). Cadaveric studies attempted to define the upper limits of normal for the aforementioned parameters. Measurements that should raise suspicion for syndesmotic injuries are tibiofibular clear space greater than 6 mm on the AP and mortise views, a tibiofibular overlap of less than 1 mm on the mortise view and less than 6 mm on the AP view, and a medial clear space greater than 5 mm.[17,18] However, a medial clear space of greater than 4 mm was associated with deltoid and tibiofibular ligament disruption.[17,18]

In addition to static imaging, stress views can help determine the magnitude of instability and thus the need for surgical fixation. Weightbearing and external rotation stress films help identify unstable ankle injuries by displacing the fibula laterally, leading to widening of the tibiofibular clear space (and decreasing the tibiofibular overlap).[19]and an intact ankle mortise underwent an external rotation stress test to confirm injury to the deltoid ligament (stress positive Adjuvant advanced imaging in the form of CT scan or MRI have been shown to be sensitive and specific for detecting syndesmotic injuries and therefore can be used in patients with equivocal radiographic findings or to aid in surgical planning.[20,21]however, can be difficult to diagnose. The purpose of this study was to evaluate both distal tibiofibular articulations using weightbearing computed tomography (CT

In the operating room, two fluoroscopic tests are commonly utilized after rigid ankle fixation to help identify the presence of an unstable syndesmosis: the modified Cotton test and the external rotation stress test. The modified Cotton test, also known as the hook test or lateral fibular stress test, is performed by translating the fibula laterally often with a surgical clamp and visualizing widening of the tibiofibular clear space on fluoroscopy; greater than 2 mm of widening in the syndesmosis is suggestive of an unstable syndesmotic injury. The external rotation stress test, performed similarly during physical exam and obtaining external rotation stress films, is positive if there is talar tilting leading to medial clear space greater than or equal to 5 mm. One prospective study showed that the difference in widening with the stress external rotation stress was significantly greater than the modified Cotton test. This suggests that stress external rotation radiographs are a more reliable indicator of mortise instability than traditional lateral fibular stress.[22] Of note, the fibula is more unstable in the sagittal plane than the coronal plane, and intra-operative direct visualization of stability in the sagittal plane should be determined. This can be completed by placing a reduction clamp on the fibula with a posterior and anterior directed force applied; a 2-mm translation is consistent with instability.[10]

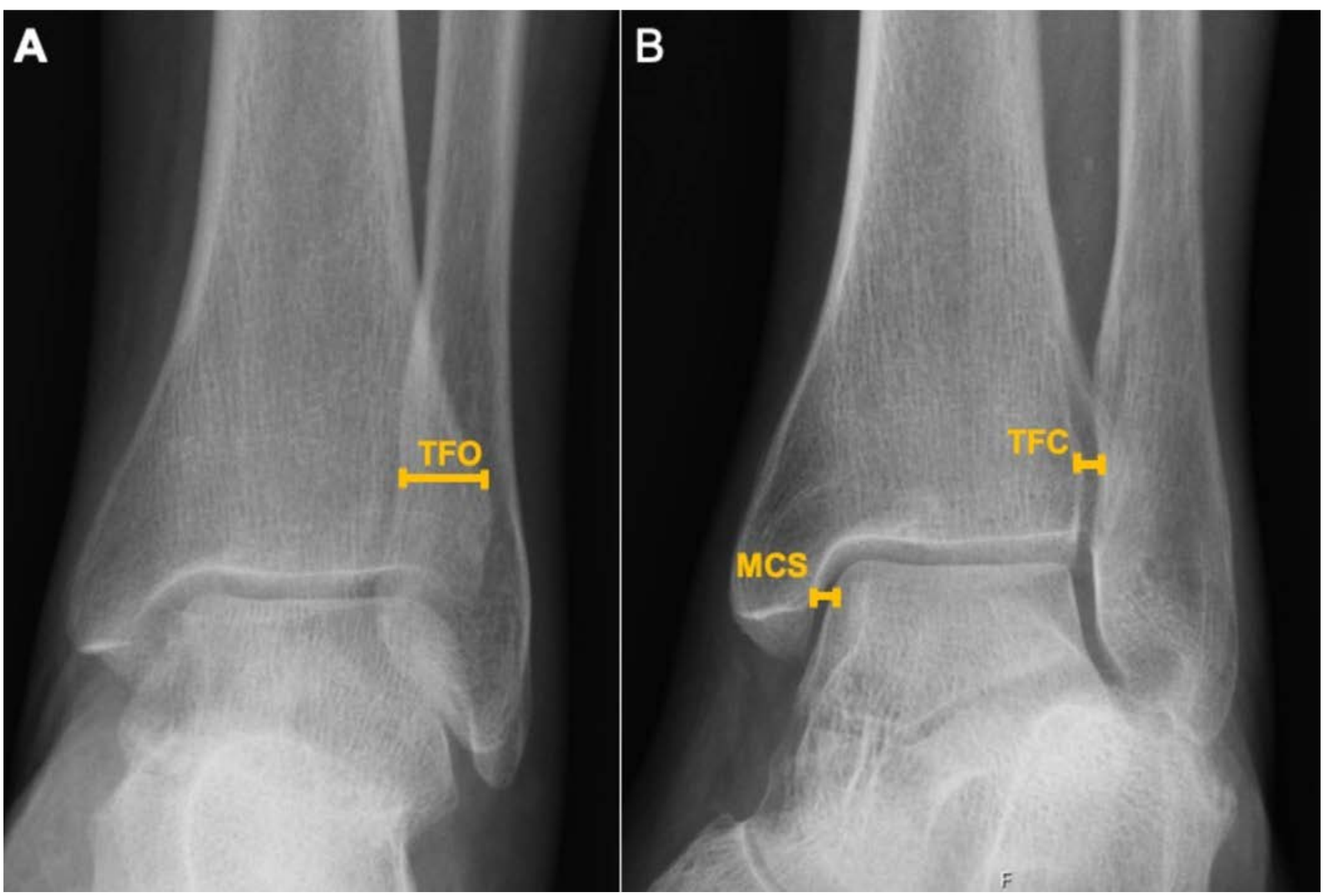

Figure 1. Radiographic parameters of the ankle associated with the syndesmosis. **(A)** Tibiofibular overlap (TFO); **(B)** Tibiofibular clear space (TFC) and medial clear space (MCS).

Importance of Reduction

Syndesmotic injuries are difficult to diagnose, and even when identified and treated, a slightly malreduced syndesmosis can lead to joint destruction and poor functional outcomes.[5,23] Successful outcomes require anatomic reduction of the syndesmosis as a malreduction of just 1.5 mm can portend poor clinical results.[5]

Technical Considerations

Proper Level for Syndesmotic Screw

Syndesmotic screw placement has been described relative to the plafond or syndesmosis. Though technical variability exists, there is no radiographic or clinical difference between trans-syndesmotic and suprasyndesmotic screw placement.[24] However, biomechanical studies frequently use the level of 2.5 cm above the plafond to restore ankle stability.[25,26] A more recent biomechanical study suggests syndesmosis fixation between 30-40 mm above the joint is most advantageous with regards to stress.[27] Caution should be made not to place the screw too proximal as one retrospective cohort study demonstrated that patients with syndesmotic screw placement 41 mm above the joint line had poorer patient outcomes scores.[28]

Hardware

There are numerous considerations and controversies in regard to the hardware and technique for placement of syndesmotic screws. Despite these controversies, numerous studies have demonstrated no clinical difference between one and two screws for fixation, although one study did show less pain and higher functional score at 3 months when comparing a single 4.5 mm screw to two 3.5 mm screws.[29,30] No differences in functional outcome have been demonstrated when comparing the size (3.5 mm vs 4.5 mm) of screws.[30–32] Additionally, numerous studies demonstrated no long-term functional differences between three and four cortices for syndesmotic screw fixation.[30,33–35]

Foot Position during Screw Insertion

Foot position is critical when placing a syndesmotic screw due to the asymmetry of the talus; the talus is wider anteriorly and narrower posteriorly. As the foot goes from dorsiflexes to plantarflexes, the tibial plafond and fibula articulate with anterior and then posterior aspect of the talus. As such, there is fear that over compression of the tibiofibular relationship will occur if fixation is accomplished in plantar flexion because the narrower posterior talus articulates with the tibia and fibula in that position. This would ultimately lead to limited dorsiflexion. However, several studies have demonstrated that maximal dorsiflexion during fixation is not required to avoid loss of dorsiflexion.[36–38] Poor patient outcomes after syndesmotic malreduction may be due to other factors and not loss of dorsiflexion motion.

Authors' Preferred Technique

The authors' prefer to stabilize the syndesmosis most commonly with two, tri-cortical 4.5-millimeter screws placed 2 cm and 3 cm, respectively, above and parallel to the level of the plafond exiting the far medial tibial cortex. It is important to note that these screws are not orthogonal to the sagittal plane of the extremity; they are angulated 20-30 degrees in the axial plane from posterior to anterior to match the orientation of the syndesmosis. Post-operatively, patients are advanced to full weight-bearing at 10 weeks. Routine removal of hardware is not done unless patients are symptomatic.

Suture Button versus Syndesmotic Screw

Suture button fixation is an alternative option for syndesmotic fixation with at least equivalent and possibly better clinical and radiographic outcomes when compared to conventional screw fixation. In one systematic review comparing suture-button versus syndesmotic screws, patients who achieved fixation by suture-button led to a better objective range of motion and earlier return to work.[39] Moreover, the suture-button fixation group had lower rates of implant removal, implant failure, and malreduction.[39] Another systematic review and meta-analysis demonstrated that the suture-button technique showed a significantly lower reoperation rate and tendency towards less malreduction and better American Orthopaedic Foot and Ankle Society scale scores.[40] However, high-quality randomized controlled trials are still needed to determine long-term effects and cost-effectiveness of the suture-button device.

Conclusion

Injuries to the ankle syndesmosis are common and require thorough clinical evaluation via physical examination, radiographs and advanced imaging, as well as intra-operative fluoroscopy for diagnosis. Many controversies exist surrounding syndesmotic screw placement, although no functional or clinical differences have been demonstrated despite numerous studies. The most important factor for obtaining successful patient outcomes is anatomic reduction of the syndesmosis. Reduction can be best achieved through direct visualization and confirmation with intra-operative fluoroscopy and post-operative advanced imaging. Suture button devices have more recently been used as alternatives to syndesmotic screws and have shown promising early results. However, additional high-quality studies are needed to further support these findings.

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