

TECHNIQUE OF SYNDESMOTIC REPAIR: Investigating the Innovative Tightrope™ in Treatment of Syndesmotic Injuries

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INTRODUCTION

Fractures of the adult ankle with disruption of the tibiofibular syndesmosis call for sufficient stabilization of the ankle mortise to ensure proper healing of the syndesmotic ligaments. Several internal fixation techniques for stabilization of the syndesmosis have been employed in the past, including 3.5 mm, 4.5 mm, and 5.0 mm metallic and bioabsorbable screws, 1.5 mm and 1.6 mm Kirschner wire fixation, and staple fixation.

As technology advances and we increase our knowledge of the factors involved in the repair of syndesmotic injuries, an innovative syndesmotic repair device has recently been introduced. The TightRope™ (#AR-8920DS, AR-8921DS, Arthrex, Naples, FL) is well suited for syndesmotic injuries of the ankle, because it opposes diastasis while allowing for favorable micromotion. The TightRope™ offers a novel solution to many of the dilemmas encountered with traditional methods of syndesmotic repair. The device is constructed as to not require removal, it is resilient allowing ample ligament healing, and it is less invasive than traditional syndesmotic screw insertion. The TightRope™ displays promise in the field of foot and ankle surgery. With this in mind, we critically look at this emerging tool and introduce the technique of insertion.

RECENT DEVELOPMENTS

In 1995, Mulligan and Hopkinson noted that two syndesmotic screws purchasing 3 cortices provided more stability than a single screw.¹ Moreover, if the screws engage only 3 cortices, the normal external rotation of the fibula, during dorsiflexion, was preserved and the likelihood of screw failure would consequently decrease. Thompson and associates found no biomechanical advantage of 4.5 mm metallic screws over 3.5 mm metallic screws in 2000.²

In 2001, Thordarson reported no statistical difference in range of motion or subjective complaints when he compared 4.5 mm polylactic acid bioabsorbable syndesmotic screw fixation with 4.5 mm stainless steel screw fixation in patients with pronation-external rotation Stage IV injuries.³ The clear benefit of the bioabsorbable screw was that it obviated the need for screw removal. Hovis, in 2002, treated 33 consecutive patients with a fibular fracture and syndesmotic disruption with traditional plate and screw fixation and a 4.5 bioabsorbable screw purchasing four cortices across the syndesmosis.⁴ He concluded that bioabsorbable, transyndesmotic screw fixation was a successful method of treating syndesmotic injuries encountered in ankle fractures.

In 2004, a biomechanical, cadaveric study by Cox and associates revealed that 5.0 mm bioabsorbable screws were biomechanically equivalent to 5.0 mm stainless steel screw for repair of syndesmosis disruption.⁵ A randomized, prospective, blinded study by Kaukonen in 2005 showed that polylevulactic acid screws worked as well, or slightly better than, metallic screws for syndesmosis fixation in patients with ankle fractures with associated syndesmotic disruption.⁶ In the same year, Hoiness and Stromsoe stated that syndesmosis fixation with 2 tricortical screws was safe overall and improved earlier return to activity when compared to metallic screw fixation. At 1 year followup, there was no noteworthy difference between the bioabsorbable screw and metallic screw groups in functional score, pain, and ankle joint dorsiflexion.

ARTHREX TIGHTROPE™ SYNDESMOSIS FIXATION DEVICE

The TightRope™ is indicated for the treatment of syndesmotic disruption without associated ankle fractures as well as Weber B and Weber C fractures with syndesmotic disruption. For fractures located in the distal half of the

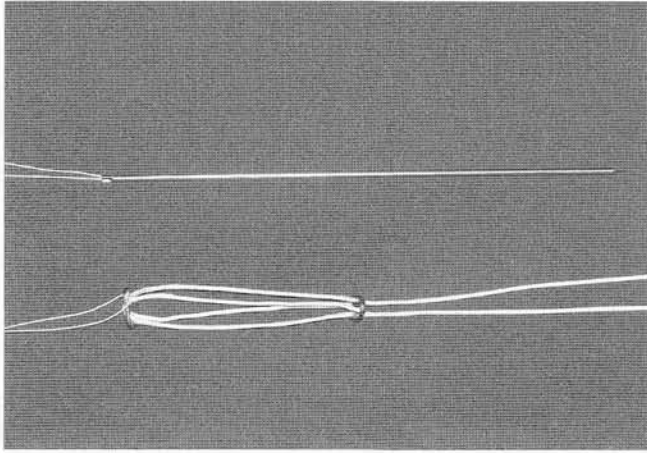


Figure 1. Shown is the TightRope™ with the 1.6 mm Guidewire with 2-0 FiberWire pull-through suture (white), the 3.5 mm and 6.5 mm buttons with #5 FiberWire Suture (blue) looped twice through the holes and buttons.

fibula, it is recommended to restore the length and rotation of the fibula and employ one TightRope™ device 1.5 cm above the mortise ankle. For high Weber C fractures located in the proximal half of the fibula, 2 TightRope™ devices should be utilized in an axially divergent pattern. In patients who are overweight and in those with comminution, it is suggested 2 TightRope™ devices be used. The device is comprised of #5 Fiber-Wire and uses tension across metal anchors against the medial cortex of the tibia and the lateral cortex of the fibula to stabilize the mortise ankle, thus holding the talus within the malleolar fork. The design of the device allows for simple insertional technique.

TightRope™ Syndesmosis Repair Kit (Figure 1) consists of 3.5 mm Drill Bit, 3.5 mm medial button (Titanium or Stainless Steel), 6.5 mm lateral button (Titanium or Stainless Steel), #5 FiberWire Suture (blue), 2-0 FiberWire pullthrough suture (white), 1.6 mm Guidewire.

TECHNIQUE (FIGURE 2)

The fibula is maintained within the tibial sulcus utilizing the Large Periarticular Reduction Forceps (#389.228, Synthes, Paoli, PA.) (Figure 3) or the Collinear Reduction Clamp Set (#690.498, Sythes). Utilizing intraoperative flourescopy the 3.5 mm Drill Bit is used to drill across the fibula and tibia (lateral to medial) positioned 1-2 centimeters above and parallel to the ankle joint. The drill hole can be created through a fibular plate or directly through the fibula (Figure 4A-B). Utmost care must be taken to identify and avoid harm to the saphenous nerve and artery located medially. If two TightRopes are being utilized divergent positioning is suggested (Figure 5).

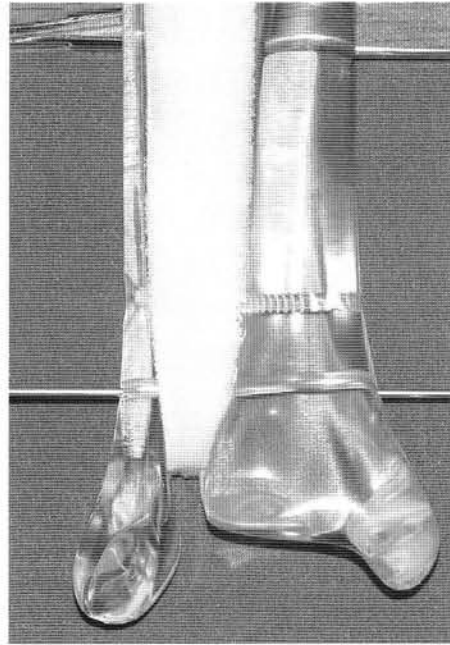


Figure 2A-E. The Guidewire and "pull-through" suture are passed along the drill hole from lateral to medial. The medial button is pulled through the drill hole via "pull-through suture." The medial button exits the drill hole and an upward tension is placed on the "pull-through" suture. It then engages the medial tibial cortex. Pulling on the syndesmosis suture tightens the lateral button on the fibula and secures the distal ankle syndesmosis. Note reduction of the diastasis.

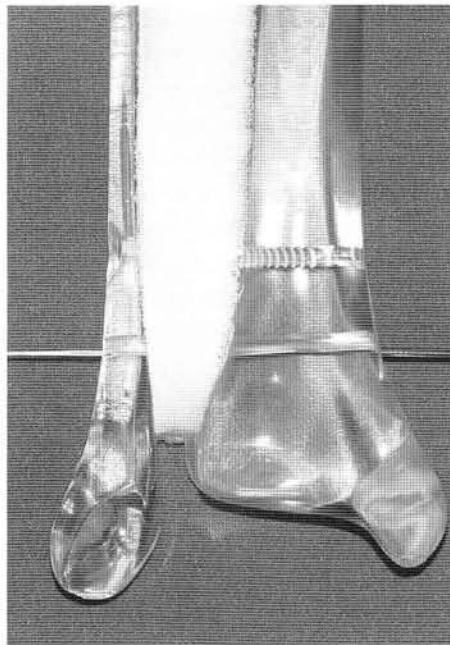


Figure 2B.

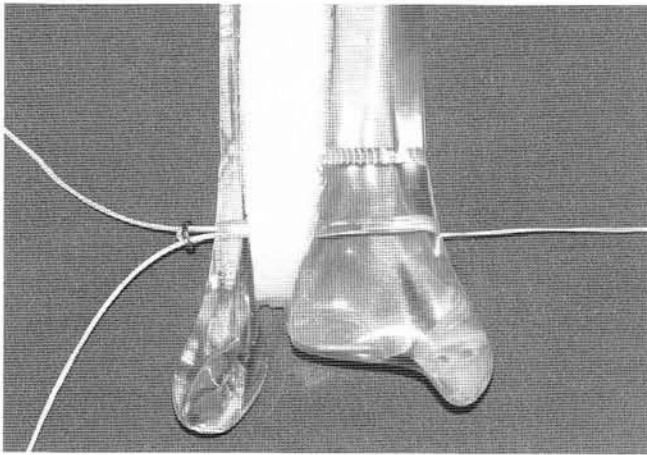


Figure 2C.

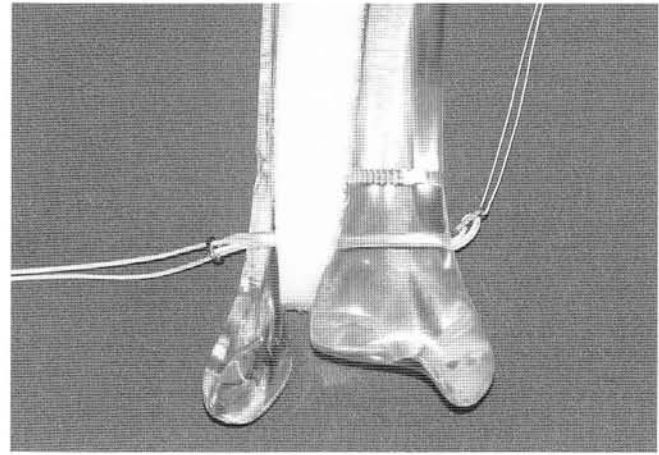


Figure 2D.

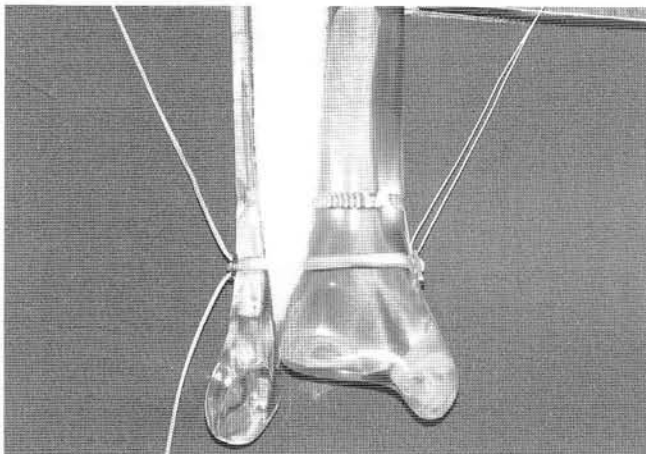


Figure 2E.

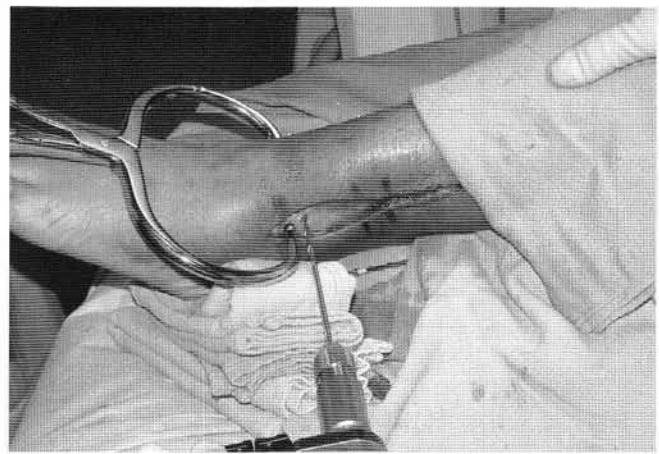


Figure 3. Employment of the Large Periarticular Reduction Forceps in maintaining the fibula's position within the tibial sulcus while drilling the guide hole with the 3.5 mm Drill Bit.

The 1.6 mm Guidewire along with the #5 FiberWire suture, 2-0 FiberWire pull through suture, and 3.5 mm medial button are passed through the drill hole until the medial button and "pull through" suture are retrieved on the medial side. The Guidewire and pull through suture will exit the skin through a small medial puncture. A medial incision is not required; however, it improves visualization of the Guidewire and medial button when proper position is questionable. This medial incision can be circumvented when the surgeon gains confidence in the technique of insertion.

Once the medial button has passed through the medial tibial cortex proximal tension can be placed on the medial "pull-through" suture, thereby "tipping" the medial button into proper position against the tibial

cortex. The color coding of the suture helps facilitate which suture to utilize for pull-through. In addition, palpation of medial skin can facilitate securing of the medial anchor. Insertion of the device is complete when the position of the medial button is confirmed under fluoroscopy, it must sit flush with the cortex. Once proper placement of the medial button has been achieved, the Guidewire and the pull-through suture can be cut and passed from the operative site. The lateral button is tightened down by applying a traction force on the free ends of the #5 Fiberwire and tied by hand utilizing a square reef knot with an extra half-hitch. The ends of the #5 Fiberwire are cut leaving 1 cm tails to permit the knot and free ends to lay flat. If two TightRope™ devices are used, the authors suggest gathering the tails of the #5 FiberWire



Figure 4A. Postoperative radiograph of Weber C fracture after osteosynthesis and TightRope™ fixation 6 months postoperatively. Note the placement of the device outside of the plate.



Figure 4B. Postoperative radiograph of Weber C fracture after osteosynthesis and TightRope™ fixation 2 months postoperatively. Note the placement of the device within the plate.

with 3-0 Vicryl suture (Figure 8). It should be noted that the knot and lateral button are less prominent than a 4.5 mm screw head.

Stability of the syndesmosis should be tested under fluoroscopy with a forced lateral dislocation of the fibula with a bone hook and by external rotation of the foot on the leg. Intra-operative radiographs are helpful and recommended to ensure proper insertion of the device and stability of the syndesmosis. While there is a low learning curve associated with the TightRope™ precise technique is still a requirement.

DEVICE REMOVAL

There are scenarios necessitating device removal. They include, but are not limited to, infection, failure, and pain. In these cases, flourosopic guidance is utilized to identify the buttons and incisions are created over the medial and lateral buttons. The device is then removed by elevating the buttons off the cortical surfaces with an elevator or curette. The authors have had limited experience with removal; however, the only apparent complicating factors are the fibrous ingrowth into the suture and around the buttons, but this is likely to cause minimal difficulty.



Figure 5. Repair of Weber C fracture with two TightRope™ devices. Two devices are suggested in patients with syndesmotic injuries associated with fractures of the proximal half of the fibula, fibula fractures that demonstrate comminution, and in overweight patients.

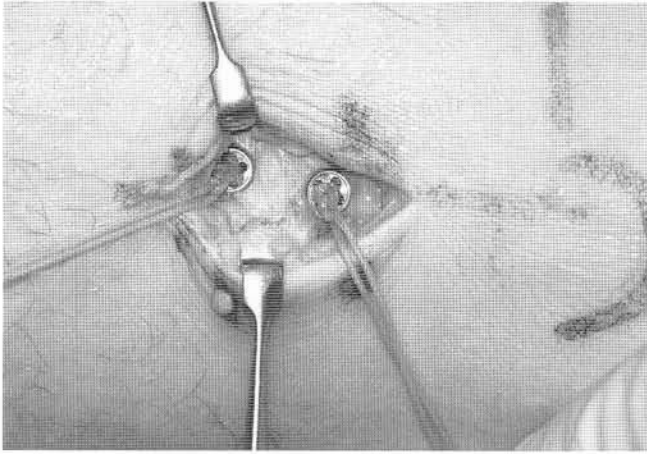


Figure 6A. An intraoperative photograph of the fibula with two TightRope™ devices in place.

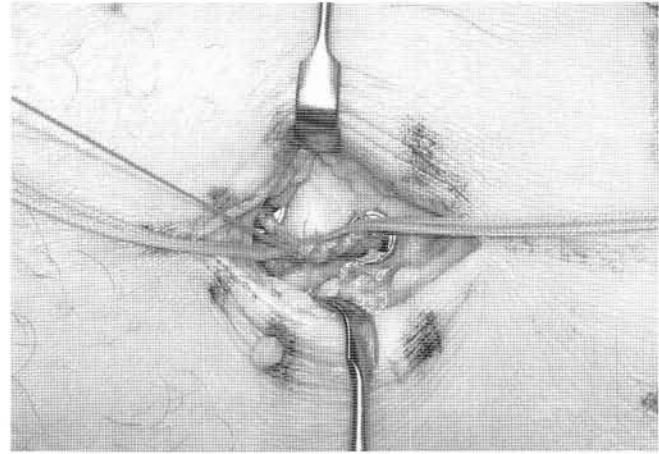


Figure 6B. The technique of gathering the tails of the #5 FiberWire® with 3-0 Vicryl suture.



Figure 7A. A Fluoroscopic image of a Weber C fracture.

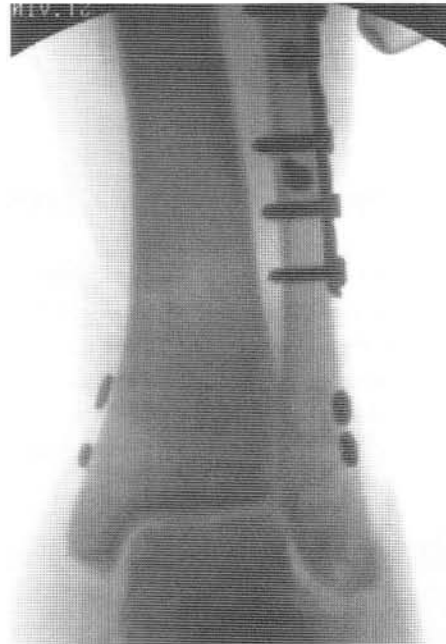


Figure 7B. Postoperative fluoroscopic image following ORIF and insertion of two TightRope™ devices.



Figure 8. Postoperative radiograph of complete repair of a syndesmotic injury associated with a high Weber C fracture.

POSTOPERATIVE MANAGEMENT

The postoperative course for syndesmotic repair with the TightRope™ includes application of a short-leg cast for 6 weeks, with the first 2 weeks nonweightbearing and the final 4 weeks practicing partial or 50% weightbearing. Following short-leg cast removal at the 6 week mark, full weight bearing can begin in a removable fracture boot or ankle support brace.

ASSESSING THE POTENTIAL BENEFITS OF THE TIGHTROPE™

Thornes 2-phase cadaveric study compared suture-endobutton flexible fixation and 4.5 mm syndesmotic screw fixation purchasing four cortices.⁸ In the first phase of the study, the cadaveric lower extremity specimens, with intact syndesmotic structures, were placed in a jig and an external torque force was applied and measurements of the diastasis were recorded. In the second phase, the performance of suture-endobutton was compared to that of the 4.5 mm screw. There was no difference between rate of failure between the 2 devices in a prospective clinical study by Seitz and associates.⁹ The mean American Orthopaedic Foot and Ankle Society ankle scores were significantly better in patients who had suture-button fixation than in a comparative group of 16 patients who



Figure 9. Shown is a fluoroscopic image displaying a unique use of the TightRope™ along the medial cuneiform and second metatarsal in a Lisfranc joint dislocation.

had syndesmotic screw fixation at 3 months and at 12 months postoperatively. Patients receiving the suture-button fixation returned to work approximately 2 months faster than those with screw fixation. No patients who had suture-buttons required a second surgery for device removal.

Seitz and associates performed biomechanical tests on paired cadaver ankles that demonstrated a suture tensile strength of 60 lbs as well as consistent suture-button strength of 49 pounds.¹⁰ Whereas tricortical screw fixation was found to have a 82 pounds higher average pull-out strength; however, screw fixation demonstrated a wide variability depending on bone quality.

In a randomized biomechanical and cadaveric study conducted by Miller, two strands of Number 5 suture were passed through holes through the fibula and tibia and tied.¹¹ Correspondingly, a 3.5 mm tricortical screw was placed on the opposite cadaveric lower extremity. The ankles were tested to failure. This process was repeated at 2 cm and 5 cm above the tibial plafond. Maximum load and displacement at failure of the suture construct at 2 cm and at 5 cm were compared with the tricortical screw at identical positions on a cadaveric specimen, and no significant difference in strength or displacement was found at either height above the tibial plafond or with either device.

The TightRope™ presents several advantages, over both metal and bioabsorbable screws, in the event of postoperative complications. The TightRope™ does not require removal, while screw removal is recommended from 8 weeks postoperatively to 4 months postoperatively. Weightbearing can begin earlier as loading does not

contribute to failure of the TightRope.[™] The debate still exists as whether weightbearing should be permitted prior to transyndesmotic screw removal for fear of screw failure and backing out. The TightRope[™] flexibility allows normal physiologic motion, resists diastasis, and avoids the possibility of screw failure, and demonstrates potential to be employed in tarsometatarsal joint dislocations (Figure 9).

Most syndesmotic repair techniques require partial device removal before weight bearing can be initiated. Once early fracture healing has been obtained, weight bearing can begin (average 6 weeks). If infection of hardware is encountered, the TightRope[™] is easily removed as opposed to the awkward and arduous process for bioabsorbable screw removal. It is unlikely that the TightRope[™] will loosen, whereas both metal and bioabsorbable screws can loosen and become prominent. While patients undergoing transyndesmotic screw placement should be warned of the probability of screw failure, patients may still view this complication as a surgical error. The TightRope[™] circumvents this drawback. Despite an uneventful postoperative course, late diastasis is possible following screw removal. Conversely, since the TightRope[™] does not require removal, the probability of late diastasis is doubtful. The TightRope[™] can be used in patients with osteopenic bone, while the function of both bioabsorbable and metallic screws is dependent on bone. The cost of the TightRope[™] is considerably greater than traditional methods of fixation, however the surgeon and hospital staff must recognize that the TightRope[™] does not require the fee of surgery for removal the screw. Specifically, an entire instrument set does not need to be prepared and opened for the removal of the TightRope.[™]

CONCLUSION

Further clinical studies are still needed and no doubt will be forthcoming in the near future. The technique of insertion of the TightRope[™] is relatively simple, but the surgeon must be familiar with the instrumentation and technique to ensure proper application and avoidance of surgical mishap. From our clinical perspective, we have observed enhanced efficiency within the operating room and positive results. While further clinical studies and bench testing are needed to justify the cost of this device, the TightRope[™] shows great promise based on our experiences, and it is our goal to increase the awareness of this device to enhance healing in patients with syndesmotic injuries.

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