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Given the common nature of ankle sprains and the fact that 85 percent involve lateral ankle ligament injury, these authors assess the research on techniques for lateral ankle stabilization and the use of interference screw fixation. They also offer pertinent step-by-step pearls on a technique that utilizes a split peroneus brevis tendon with interference screw fixation to help address chronic ankle instability.


[12]

An ankle sprain is one of the most common injuries that physicians evaluate in the emergency room. This injury commonly involves the lateral collateral ligaments. These acute ankle injuries can in turn become chronically unstable ankles due to recurring injuries. Residual symptoms after lateral ankle sprains can affect the injured patients for a significant period of time following the initial injury.

Eighty-five percent of ankle sprains involve injury to the lateral ankle ligaments.[1] The most common predisposition to suffering a lateral ankle sprain is the history of at least one previous ankle sprain, thus resulting in chronic ankle instability.[1-5] Individuals with chronic ankle instability often suffer from joint instability, which may require surgical intervention.

After attempts at non-operative care fail, providing stability and relief of symptoms is a challenging scenario for the foot and ankle surgeon. In scenarios in which surgical stabilization is necessary for a chronic unstable ankle, the surgeon must select the best procedure and optimal form of fixation to address the instability.

Numerous stabilization techniques are in use to restore or repair the anterior talofibular and calcaneofibular ligaments. In the past, surgeons have implemented both anatomic and non-anatomic, as well as single repair techniques (anterior talofibular ligament) and double repair techniques (anterior talofibular and calcaneofibular ligaments).[6] One can address this via primary or secondary repair of the anterior talofibular and/or calcaneofibular ligaments.

[13]

When addressing the lateral ankle ligaments, one must consider the goals of the procedure, restoring anatomic configuration and encouraging a synergistic stabilization between the dynamic tendons and static ligaments.[3] There are many procedures for reconstruction of the lateral ankle ligament complex. In addition to the variety of procedures, there is debate as to which means of fixation is the most appropriate.

What The Research Says About Reconstructive Ankle Procedures

The anterior talofibular ligament is the most frequent ligament damaged in ankle injuries followed by the calcaneofibular ligament. Injury to the posterior talofibular ligaments typically occurs only in severe ankle sprains.[1-5]

The two potential causes of chronic ankle instability are mechanical instability and functional instability.[2] Functional instability is defined as proprioceptive defects within injured ligaments leading to subjective giving away. Mechanical instability is motion beyond physiologic limits due to pathologic laxity of the injured ligaments. Pathologic instability can result in joint instability, most often in the talocrural and subtalar joints.[2] One can assess joint stability clinically and radiographically by the talar tilt and anterior drawer test. With gross instability of talocrural and/or subtalar joints, it is necessary to re-approximate or recreate the lateral ankle ligamentous structures.

Reconstructive procedures require sacrifice of a tendon to simulate the function of the damaged ligaments. Indications for this reconstructive procedure include evidence of both anterior talofibular ligament and calcaneofibular damage, heavier patients, or failed previous direct repair.[4] In general, procedures fall into two categories: tendon transfer procedures or anatomic repairs.

The Broström procedure is for primary and secondary repair of ruptured lateral ligaments. Surgeons have modified this procedure to reinforce the construct, including incorporation of the capsular structures into the repair for added strength.[7] Bell and colleagues studied 39 patients for a 67-month period.[8] All patients underwent the Broström-Gould procedure. There was one poor outcome, two reports of wound dehiscence, six patients with edema for greater than six months and one patient had continued pain, stiffness and recurrent sprains. Study researchers found the modified Broström procedure provided good to excellent results in 91 percent of patients at a 26-year follow-up.[8]

[14]

Despite the favorable outcomes of the Broström procedure, it is not always possible to perform it due to over-attenuation of lateral soft tissues or poor quality of soft tissues due to previous surgery.[7,8]

When primary repair of torn ligaments is not possible, many surgeons will turn to tendon transfers or free tendon grafts. Elmslie described one of the first procedures, a technique in which surgeons weave fascia lata grafts through drill holes in the calcaneus, distal fibula and talus to reconstruct the calcaneofibular and the anterior talofibular ligaments.[9]

Chrisman and Snook modified this technique by using a split peroneus brevis graft rather than the fascia lata.[10] One would insert the split peroneus brevis graft retrograde through the distal fibula and then back antegrade through a tunnel in the calcaneus. Then the surgeon would sew the graft back upon the insertion of the peroneus brevis at the base of the fifth metatarsal.

[15]

Westlin and co-workers described a technique utilizing the extensor digitorum brevis muscle to recreate the anterior talofibular ligament.[11] Their study included 13 ankles in 10 patients with a mean follow-up of 10 years. While all patients reported an excellent or good outcome, the study authors noted a decreased supination range of motion postoperatively in comparison to the non-surgical side.

Expert Insights On Interference Screw Fixation

The orthopedic literature recognizes interference screw fixation as one of the standard techniques of graft fixation.[12] Surgeons frequently use it in anterior cruciate ligament (ACL) reconstruction. Studies on ACL graft healing concluded that the graft tissue heals within the bone tunnel and new bone forms adjacent to the graft and bioabsorbable screw.[13,14] No inflammatory reaction occurred. Osteointegration occurs between six and 15 weeks after surgery.

In recent years, interference screws have been in use in foot and ankle surgery for various graft fixations as well. Schuberth and colleagues reported on a technique utilizing an interference screw with a split peroneus longus tendon.[6] This reconstruction is designed to augment repair of the anterior talofibular and calcaneofibular ligaments without restricting subtalar motion. The surgery restores mechanical stability in the ankle with resulting postoperative improvement in function. Patients maintain eversion strength and subtalar joint motion after surgery.

[16]

Feldman compared the strength of interference screw fixation to suture-button fixation and staple fixation.[15] The failure load was 62.8 N for interference screws, 13.9 N for staple fixation and 23.9 N for suture-button fixation. Weiler and colleagues researched the pull-out strength of six different biodegradable interference screws in comparison to a titanium screw.[16] The titanium screw had an 8 mm thread diameter and was 25 mm in length. Researchers found that the absorbable interference screws achieved initial pull-out forces comparable with those of a conventional titanium interference screw.

In a more recent study, surgeons performed a biomechanical evaluation for ankle stabilization, comparing interference screws to bone anchors.[17] They tested two devices: the Mitek GII anchor with Ethibond (DePuy) and the 5.5 mm Bio-Tenodesis Screw with FiberWire (Arthrex). The study authors performed a separate group of tests that involved a secured anchor and use of the FiberWire suture to determine the effect of the suture on the construct. Completely gripped screws produced a mean load of approximately double that of the bone anchors.

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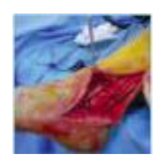

Researchers also found that the suture material has little effect on the screws.[17] Load to failure for the single pull anchor and Ethibond group was significantly lower than the failure load required to rupture the anterior talofibular and calcaneofibular ligaments. The failure load of the single pull screw group was significantly greater than that of the anterior talofibular ligament and not significantly different from the failure load of the calcaneofibular ligament.

The fully gripped interference screw group showed significant biomechanical advantages over the partially gripped screw and anchor when reconstructing the anterior talofibular and calcaneofibular ligaments.[17] The authors also concluded that patients in the bone anchor group may not be suitable for reconstruction of either the anterior talofibular or calcaneofibular ligaments.

Barber measured the load to failure for each anchor test (anchor pullout, eyelet wire or suture cut out, or wire or suture breakage).[18] In order of strongest to weakest suture in terms of failure load were Fiberwire no. 5, Ethibond no. 5 (Ethicon), Fiberwire no. 2, Panacryl no. 2, Ethibond no. 2 and Fiberwire no. 2-0. The most likely mode of repair failure is the suture cutting through the tissue rather than suture anchor failure.

[18]

According to the study, the Ultrasorb was the weakest in load to failure and the TwinFix Ti 5.0 (Smith and Nephew) was the strongest.[18] In order from weakest to strongest in terms of failure load were UltraSorb, BioCorkscrew 6.5 (Arthrex), BioCorkscrew 5.0, AlloAnchor RC (Regeneration Technologies), Duet (Bionix Implants), TwinFix Ti 3.5 (Smith & Nephew), Super Revo (Linvatec), TwinFix AB (Smith and Nephew), Opus Magnum (Opus Medical) and TwinFix Ti 5.0.

Keys To Performing The Split Peroneus Brevis Tendon Technique

Prior to surgery, patients have received a diagnosis of a functional or mechanical instability involving the ankle joint and subtalar joint. The ligaments involved typically include the anterior talofibular and the calcaneofibular ligaments. With a mechanical instability, the patient would have had a positive ankle stress test (anterior drawer and talar tilt) and/or advanced imaging that demonstrates ruptures of the lateral collateral ligaments.

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After ensuring supine positioning of the patient, apply a mid-thigh tourniquet. One may obtain intraoperative stress views consisting of the talar tilt test and anterior drawer test to verify the amount of ankle instability.

Make an incision over the peroneal tendons, beginning approximately 6 to 8 cm proximal to the distal tip of the fibula and extending distally toward the base of the fifth metatarsal. Deepen the incision through the same plane. Perform sharp and blunt dissection, but be sure to avoid all neurovascular structures.

Dissect the tissues down to the peroneal tendon sheath. Incise the sheath and identify the peroneus longus and brevis tendons. Split the peroneal brevis tendon with fiber wire. Cut the anterior one-third to one-half of the brevis tendon (split portion) proximally. This will be available for the ligament replacement graft. Proceed to make a periosteal incision over the anterior aspect of the distal fibula at the level of the ankle joint, creating a periosteal flap. This will be another form of fixation at the end of the procedure prior to securing the tendon to the bone during closing.

Using a 4.5 mm drill, create an osseous tunnel in the mid-portion of the distal fibula, aiming from proximal anterior to posterior inferior of the fibula. It is imperative that this drill is centrally located in order to prevent stress on the cortices of the fibula.

Proceed to apply a whipstitch to the free end of the brevis tendon. Pass the tendon in an anterior to posterior direction through the fibula. Make a small incision through the soft tissues superior to the calcaneus. Introduce a guide wire through the central dorsal aspect of the calcaneus and create a channel from a dorsal to plantar direction in the mid-portion of the calcaneus. Confirm the central placement of the guide wire through the calcaneus under fluoroscopy with a lateral and a calcaneal axial view.

[20]

Then use a cannulated drill to drill over the guide wire to the expected length of the interference screw. Place the tendon graft end along with the whipstitch over the remaining peroneal brevis and peroneal longus tendon. Then insert the whipstitch into the guide wire and pull the guide wire from the plantar aspect of the foot, leaving the fiber wire to exit the plantar soft tissues of the calcaneus.

At this time, place the ankle into a neutral position at 90 degrees to the leg and insert the peroneal brevis tendon graft into the osseous calcaneal tunnel. Proceed to insert a smaller guide wire from the superior calcaneus into the osseous tunnel and exiting the plantar skin along with the fiber wire.

At this time, the surgical assistant is holding the ankle at a neutral position 90 degrees to the leg and is pulling the fiber wire firmly to the desired physiologic tension. Once you confirm the position and are happy with the tension, insert a cannulated interference screw from a superior to inferior direction in the mid-body of the calcaneus. While inserting the absorbable screw into the calcaneus, one should appreciate a positive "squeak sign," which indicates good bone and tendon purchase.

Perform a stress test. This should demonstrate stability with the talar tilt and anterior drawer tests. After confirming stability, the guide wires exit through the plantar aspect of the foot and one cuts the fiber wire while applying tension on the fiber wire. Then suture the periosteal flap closed at the anterior aspect of the fibula, which includes the transferred tendon acting as another point of fixation. Close the deep and superficial layers per your preference and cast the patient in a neutral position for four weeks. At four weeks, the patient can bear full weight in a surgical cast boot and initiate a physical therapy program.

In Conclusion

Lateral ankle stabilization utilizing an interference screw with a split peroneal brevis tendon transfer is an excellent procedure for anterior talofibular and calcaneofibular ligament repair. The tendon transfer coupled with the tensile strength of the interference screw fixation provides superior stability to the ankle and subtalar joints.

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