Tips, Quips, and Pearls

The delta-snook ankle ligament reconstruction for combined deltoid insufficiency and lateral ankle instability

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ABSTRACT

Background: Ankle sprains are one of the most common injuries amongst the general population and affect all spectrums of activity levels. While the anterior talofibular and calcaneofibular ligaments are most prevalently injured during sprains there are instances when chronic lateral ankle instability leads to rotational ankle instability and attenuate the deltoid ligament. The few literature that exists concerning lateral and medial ankle ligament reconstruction focus on an arthroscopic approach.

Aim: The goal of this current work is to describe a novel open surgical reconstruction of the lateral collateral ligaments and anterior deltoid through a coupled repair.

Surgical Technique: A singular semitendinosus allograft is utilized to reconstruct the anterior deltoid, anterior talofibular and calcaneofibular ligaments. Canals are reamed for anchoring of the allograft through the medial malleolus, anterior talar body, distal fibula, and midline calcaneus. The anterior talar body, distal fibula and midline calcaneus are reamed fully to allow for pull through technique of the allograft. The medial malleolus and talar neck are anchored first, followed by the anterior fibula, and lastly the lateral calcaneus. All anchoring is performed with the ankle in a neutral position.

Conclusion: This work successfully describes a novel open surgical reconstruction of the lateral collateral ligaments and anterior deltoid through a coupled repair. This technique affords the surgeon greater control over the final product and allows for a repair in a neutral position. The semitendinosus allograft also allows for a more anatomic repair with less incidence of stiffening at the ankle joint. The authors’ have noted good results and return to full activity for the patients that have undergone this procedure.

Introduction

Ankle sprains are one of the most common injuries amongst the general population and affect all spectrums of activity levels. The lateral ankle ligaments are predisposed to these inversion plantarflexion types of injuries with the anterior talofibular ligament (ATFL) being the most commonly injured ligament, followed by the calcaneofibular ligament (CFL). In the acute setting, ankle sprains can be managed conservatively; however, up to 20% of these patients remain symptomatic and eventually develop chronic ankle instability which leads to repetitive ankle sprains.1-3

Patients with chronic ankle instability may develop both medial and lateral ankle symptoms. The literature describes up to 40% of patients with chronic ankle instability to suffer from partial deltoid injuries.4-6 Ligamentous laxity of the lateral ankle leads to increased anterior translation, internal rotation and superior translation of the talus, which leads to a rotational ankle instability in a subset of patients.5-10 Rotational ankle instability increases the susceptibility of degenerative changes inside of this joint as well as injury to the anterior fibers of the deltoid ligament. Rotational ankle instability is difficult to diagnose as the deltoid ligaments may not be symptomatic until after a lateral ankle stabilization procedure has been performed. It is therefore advised to have a low threshold for clinical suspicion of chronic deltoid ligament injury in patients with a history of chronic ankle instability.

Concurrent medial and lateral ankle ligament repair has been sparsely mentioned in the literature. To date, the only mention of concomitant medial and lateral ankle ligament repair exists in the arthroscopic setting.11,12 These arthroscopic techniques have been met with excellent results. While these few works describe the ligamentous repair with synthetic suture type, allograft tendon has been described in the

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literature for ligamentous repair as well. Utilization of semitendinosus graft for deltoid ligament repair has been described in the literature to produce satisfactory results. Reconstruction of the lateral ankle ligaments with allograft tendon repair has been identified as a safe and effective method to managing lateral ankle instability, and perform similar to autograft options.

The purpose of this study is to introduce a new technique to treat lateral and medial ligament instability in patients with rotational ankle instability. This open technique aims to surgically repair rotational ankle instability in a coupled approach to address the instability while decreasing the likelihood of stiffening at the ankle joint.

Case Report

A 34 year old male was originally seen in the clinical setting with a longstanding history of right ankle pain. The patient relayed suffering from multiple severe inversion ankle sprains during high school athletics which were treated with physical therapy and bracing. In the couple of years before being seen in clinic, the patient complained of moderate ankle sprains with menial activities and overall instability of the right ankle joint. Recently this has affected his activities of daily life to the point where he avoids even moderate activity.

Upon physical examination there is tenderness to palpation noted along the anterior ankle joint and along the courses of the ATFL, CFL and deltoid ligaments. There are positive anterior drawer and talar tilt tests when compared to the contralateral side. Plain radiographs do not reveal concerns for osteochondral defects or syndesmotic widening. The Decision was made to obtain MRI to assess the level of ankle synovitis, rule out osteochondral defects, and assess the status of the medial and lateral ankle ligaments. Advanced imaging revealed chronic synovitis throughout the ankle joint with chronic severe attenuation of the ATFL, CFL and anterior fibers of the deltoid ligament. Based on patient’s history, physical examination, and imaging findings, the decision was made to perform a Chrisman-Snook type ATFL and CFL ligament repair with semitendinosus allograft and deltoid ligament repair. The procedure is to utilize a 4.5mm X 250mm semitendinosus allograft and tenodesis anchors (Versagraft and Biocomposite Tenodesis Screws, Arthrex, Naples, FL, USA).

Surgical Technique

After initial arthroscopic debridement through the standard medial and lateral ankle portals to address the ankle synovitis, an incision was made to access the deltoid ligament. A 3cm linear incision to access the medial malleolus, deltoid ligament and medial talar dome was made. Careful dissection was performed to avoid the saphenous vein and nerve. The deltoid ligament was then identified with noticeable hypertrophy and fraying along the anterior fibers. The deltoid ligament was then split transversely with careful dissection off the medial malleolus and medial talar neck. A rongeur was utilized to decorticate the distal tip of the medial malleolus and a guide wire to ream a canal for anchor placement was then introduced. The width of the tendon was then measured to determine appropriate reaming diameter moving forward. It is advised to ream at the same diameter as the tendon or .5mm greater than the diameter. For this specific case the diameter of the allograft measured 5.0mm, and thus a decision was made to ream and utilize a 5.5mm reamer and biotenodesis screw. The biotenodesis screw was then placed with close to 20mm of the allograft tendon buried into the medial malleolus canal.

Before moving on to the next stage of the repair, dissection of the lateral ankle was performed with a standard linear incision measuring 4cm to obtain access to the distal fibula and lateral talus. Care was taken during dissection to avoid the intermediate dorsal cutaneous nerve. Once the ATFL ligament was identified, careful dissection through vertical transection of the ATFL and ankle capsule was performed, just off the ATFL attachments along the fibula. Careful periosseal dissection was carried down through the fibula to reveal its anterior ridge.

Figure 1. Radiographic examination reveals neutral congruent ankle joint free of bony abnormality.

Figure 2. Dissection performed to identify and isolate the deltoid ligament.
Next, attention was directed at the medial aspect of the talus where a guide wire for the reamer was inserted past the lateral cortex of the talus. The starting place for this wire should be at the junction between the articular dome of the talus and the talar neck. This should also be directed parallel to the weightbearing surface of the foot (Figure 9). This start point and directionality is utilized as it allows the surgeon to remain in a wide enough portion of the talus to potentially utilize two anchors if necessary. A 5.5mm reamer was again utilized and the far cortex of the lateral talus was reamed to allow the full allograft to pass in a pull-through technique (Figure 10). A 5.5mm anchor was introduced into this medial talar canal and the ankle was held under anatomic tension with the allograft in a taut position during insertion. Deltoid ligament transection (Figure 3), full thickness dissection of deltoid ligament to reveal enough of the medial malleolus and talus body for anchor placement (Figure 4), decortication of the medial malleolus to allow for complete allograft to bleeding bone interface (Figure 5), guide pin placement for reamer in the medial malleolus (Figure 6), reamer in place for medial malleolus segment (Figure 7), placement of the anchor into the medial malleolus with stitched allograft tendon as close to anchor as possible. This allows as much tendon as possible to follow anchor (Figure 8).
ligament repair was performed in a “pants-over vest” type technique to tighten the once attenuated ligament (Figures 11 and 12).

Attention was next drawn to the lateral malleolus where the anterior ridge of the fibula was decorticated. A 5.5mm biotenodesis screw was placed along the lateral talar canal to complete the talar involvement of the allograft tendon (Figure 13). The standard placement for an anterior fibula anchor was utilized in this technique, which is 1-1.5cm proximal from the distal tip of the lateral malleolus and midline to avoid infiltrating the ankle joint. The directionality should be interior without any deviation in the medial to lateral direction. A guide wire is placed with these tenants in mind and one singular tunnel is utilized in this technique instead of the two convergent tunnel technique (Figure 15). A 5.5mm reamer is then utilized to create a tunnel from the anterior to posterior fibula, fully through the far cortex, to allow for a pull-through technique. The allograft tendon is now pulled through fully (Figures 16-18). Now a 5.5mm anchor is introduced into the anterior portion of the fibula canal. During insertion of the biotenodesis screw the ankle is held at anatomic tension while the allograft is held in a taut position. This completes the ATFL portion of the repair (Figures 14 and 17).

Finally, the last ligament to be reconstructed is the CFL. The subtalar joint and peroneal tendons are identified and visualized in order to be avoided during these next steps. The anterior most portion of the posterior facet of the subtalar joint serves as the insertion site for the guide wire. This guide wire is aimed toward the plantar medial tuberosity of the calcaneal tubercle (Figures 19 and 20). This again is reamed with a 5.5mm reamer all the way to the far cortex of the plantar calcaneus. The allograft tendon is now passed in a pull-through technique, and, under anatomic tension, the final anchor is placed. The CFL has now been

Figure 9. Placement of guide pin for reamer in to talus.

Figure 10. After reaming tendon is pulled through talus and introduced to the lateral ankle.

Figure 11. End to end repair of deltoid ligament in a tighter configuration.

Figure 12. Fully repaired deltoid ligament.

Figure 13. End to end repair of deltoid ligament in a tighter configuration.
repaired. A stab incision is made along the final exit point of the suture and tendon and cut at the level of the skin (Figures 21-24).

Postoperative protocol consisted of two weeks non-weightbearing in a Jones compression splint followed by four weeks of non-weightbearing in a cast. This equals six total weeks of non-weightbearing, followed by an additional four weeks of protected weightbearing in a tall surgical boot with physical therapy. At three months from the date of surgery, the patient was performing activities without limitations.

Discussion

The deltoid, ATF, and CF ligament repairs described in this case allow for a coupled ankle ligament reconstruction that may prevent concomitant ankle deformity or ankle stiffness. The patient in this current case study exhibited a standard and progressive course of lateral ankle instability which developed into chronic ankle instability and rotational ankle instability. With time this allowed the talus to reside in a more anterior and superiorly displaced alignment within the ankle joint. In this new configuration, undue stress is placed on the deltoid ligament, which over time will result in anterior deltoid attenuation in addition to the damage that has already been wrought on the lateral ligaments. The Patient in this case fully understood that a full medial and lateral ankle

Figure 13. Anchor placed into lateral talus with ankle in neutral alignment. This allows deltoid to be reconstructed under anatomic tension.

Figure 14. Guide pin placement into the fibula from anterior to posterior.

Figure 15. Reaming of the fibula through anterior and posterior cortex.

Figure 16. Suture passer utilized to pull allograft through bone tunnel in fibula.
reconstruction was necessary to normalize the forces along the ankle joint.

A decision was made to perform an open ligament repair with one semitendinosus allograft in an attempt to limit inappropriate motion of the ankle in the frontal plane whilst preserving the ankle's sagittal plane motion. This technique couples the repair at the opposite sides of the

Figure 17. Allograft pulled through bone tunnel in fibula with slow and even force.

Figure 18. Allograft tendon along posterior fibula within peroneal sheath.

Figure 19. Guide wire to ream through calcaneus inferior to the subtalar joint and aimed toward the plantar tubercle of the medial tuberosity of the calcaneus.

Figure 20. Direction with which guide wire is placed through calcaneus.

Figure 21. Placement of anchor into the calcaneus. This is again performed with the ankle in neutral alignment.

Figure 22. Care is taken to avoid subtalar joint when placing anchor into the calcaneus.
ankle joint and allows the surgeon to be aware of the tension that is placed along the ankle joint and to respond with minute adjustments before final repair.

The results from this case series are consistent with and add to the current literature on dual reconstruction of deltoid ligament with lateral ankle reconstruction. A majority of the literature that currently addresses this topic regard treatment through arthroscopic repair of the ligaments. To the author's knowledge, this case is the first mention in the literature of an open, coupled repair of the deltoid and lateral collateral ankle ligaments. Due to the limited current available data it is difficult to form conclusive guidelines for medial and lateral ankle ligament repairs, and even less so for those that performed open surgery and with overtightening. Additionally, it is the author's belief that utilizing one tendon to couple the repair of the medial and lateral ligaments allows the surgeon to appreciate the frontal plane alignment of the ankle at critical steps throughout the procedure. This technique is a safe and effective repair that affords the surgeon a greater level of control over the final product of the repair.

Figure 23. Allograft is pulled through calcaneus and tendon graft with suture is cut flush with skin.

Figure 24.

References