Single-graft Lateral Ankle Stabilization Using Biotenodesis Anchors
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Introduction
Lateral ankle instability is a chronic, debilitating condition that commonly develops from an acute injury. Chronic instability has been described as a result of the anatomic changes following the acute injury which predispose the joint to further injury.1,2 The Brostrom procedure was described for repair of the ruptured talofibular ligament (CFL). Modifications have been made to this procedure to reinforce the repair, including incorporation of the capsular structures into the repair for added strength. The modified Brostrom procedure remains the standard treatment for acute tears of the CFL and is still the most common procedure compared, and has been found to provide good to excellent results in 91% of patients at 2-year follow-up.3 Despite the favorable outcomes of the Brostrom procedure, this type of repair is not always possible due to over-attention of lateral soft tissues, or prior surgical injury due to previous surgery.4
When primary repair of torn ligaments is not possible, many surgeons will turn to tendon transfers or bone lugs. More than 50 reconstructive surgical procedures have been described with varying degrees of success and complications. A common long term complication of lateral ankle ligament reconstruction is postoperative stiffness which develops in 5-10% of patients. Other reported complications are wound dehiscence, nerve damage, and recurrent instability. Considering these complications, it may be desirable for the surgeon to address ankle instability with a modification to the Brostrom procedure that allows for repair even when lateral soft tissues are frail or have been previously operated upon.5

Methods
The purpose of this study was to test the stability of a single-graft lateral ankle ligament reconstruction technique in cadaveric specimens. The technique creates a single graft at the approximate location of the axis between the calcaneofibular ligament (CFL) and the anterior talofibular ligament (ATFL) with a free tendon graft. This procedure would be indicated in patients who have failed the Brostrom procedure, or when the Brostrom procedure is not possible due to incomplete damage to lateral soft tissues or prior surgery.

Purpose
The main objective of this study was to test the stability of a single-graft lateral ankle ligament reconstruction technique in cadaveric specimens. The technique creates a single graft at the approximate location of the axis between the calcaneofibular ligament (CFL) and the anterior talofibular ligament (ATFL) with a free tendon graft. This procedure would be indicated in patients who have failed the Brostrom procedure, or when the Brostrom procedure is not possible due to incomplete damage to lateral soft tissues or prior surgery.

Technique
Phase 1: Inert Ligaments
A subcutaneous incision was made overlying the sinus tarsi. Dissection was carried down to the ankle joint capsule. The patellar capsule structures were dissected so as to identify and preserve the ATFL and CFL, which were tagged with suture. The specimens were tested using the Telos Stress Test Protocol.

Phase 2: Sectioned Ligaments
The ATFL and CFL were identified at the previously identified landmarks, tagged with suture, and pulled through their respective drill holes. The specimens were tested using the Telos Stress Test Protocol.

Phase 3: Single Graft
Flap incisions were made, and a tendon graft was harvested from the specimens. The distal end of the graft was attached to the anterior calcaneal process at the sinus tarsi using a 5.5 x 15 mm Arthrex tenodesis anchor. The proximal end of the free tendon graft was attached 10 mm from the tip of the bunion through an anterior po- sition and fixed using a 3.5 x 15 mm Arthrex tenodesis anchor (Figure 2). The specimens were tested using the Telos Stress Test Protocol.

Results
The average anterior displacement index was 17.1º with ligaments intact, 31.0º with ligaments sectioned, and 18.2º with single-graft reconstruction (Figure 4). There was a significant difference between the anterior displacement index of specimens with ligaments sectioned and ligament grafts (p = 0.01). There was no significant difference between talar tilt angle of specimens with ligaments intact and ligament grafts (p = 0.64).

Discussion
The results obtained during the course of this study suggest that lateral ankle ligaments can be successfully repaired using a new single-graft technique in a cadaveric model. The stability of the single-graft ankle stabilization construct is comparable to that of intact lateral ankle ligaments. The single-graft lateral ankle reconstruction differs from anatomical reconstructive techniques in that the calcaneofibular and anterior talofibular ligaments are not reconstructed. Rather, the approximate average axis of these ligaments is stabilized in a single-graft technique. The advantage of this procedure is that it reduces the instability of both the ATFL and the CFL using a single-graft technique that is less invasive and requires less ablation graft than previously described ligament reconstructions. Future work is needed to compare the single-graft technique to anatomic reconstructive techniques. In vivo studies with long term follow up are also needed to examine dynamic stability and sequelae.

References