Introduction

Over 30,000 lateral ankle injuries occur each day in the United States with the potential to cause stretching, partial tears or complete rupture of the lateral ankle ligament complex. Each grade of ligamentous injury has a variety of treatment options available to augment / repair the resulting lateral ankle instability for resolution of symptoms. Each technique has indications depending on the varying severity of the pathology.[2,3,4,5,6,7,8]

Methods

Institutional review board (IRB) approval was obtained. Billing records were searched to identify patients who had undergone ATFL repair / augmentation by the senior author between October 2011 and January 2018. Inclusion criteria dates were established to collect only patients who were greater than 10 months out from surgery at the time data collection started. Patients 18 years of age or older with an acute or chronic ATFL tear not amenable to primary repair requiring graft augmentation using the polyurethane scaffold were included in the study. Patients who had undergone concurrent ligamentous and osseous correction procedures were excluded from the study. Additional exclusion criteria included patients with rheumatoid arthritis, psychiatric diagnoses, history of peripheral tendon operations, and a history of severe foot and/or ankle trauma. There were 17 patients who met the inclusion criteria, however 5 were lost to follow up. All patients who underwent operative intervention failed a period of conservative management, which typically included walker-shoortcast immobilization, bracing, anti-inflammatory medication, and physical therapy. A retrospective chart review was performed to collect demographic data including weight, height, body mass index, gender and chronocity of the lateral ankle injury. The need for revision operation, and associated pre and post-operative office visits was determined. Progress notes were reviewed through the final postoperative visit and complications, continued pain, need for repeat imaging, or repeat operative interventions were recorded. The duration of clinical follow-up was defined as the elapsed time from surgery to the final post-operative office appointment.

Results

Patients without an identifiable lateral ankle injury and greater than 3 months of symptoms prior to the initial office evaluation were considered to have a chronic ATFL tear. Synthetic allolograft ligament augmentation was used at the discretion of the primary surgeon and was used to provide a biologic scaffold to reinforce and assist in ligamentous healing. There were 12 patients who underwent ATFL synthetic allolograft augmentation that met inclusion criteria. The average clinic follow-up time for all patients was 12.04 months (standard deviation [SD] = 4.62). The mean age at the time of surgery was 39 years (range from 19 to 65), 9 were female (75%) and 3 male (25%). Furthermore, 11 of 12 patients had a preoperative MRI report available for review, and 1 patient had a pre-operative CT. All (12/12, 100%) were diagnosed with an ATFL tear per the radiologist MRI/CT report and subsequently underwent operative repair. Only 1 patient had undergone a previous surgical repair of their ATFL injury in the primary care under the primary author. 11 patients (11/12, 91.67%) described an chronic-ankle instability at their first office visit, while 1 patient (1/12, 8.33%) described an unilaterally isolated traumatic inversion ankle sprain years prior to presenting for evaluation. [Table 1]

Surgical Technique

The authors use a traditional open technique with a curvilinear incision oriented from distal fibula to the sinus tarsi. Blunt dissection is utilized to mobilize the fat off the external reimplantum, peroneal sheath and anterior ankle joint capsule. An anterolateral ankle arthrotomy is then created overlying the lateral ankle gutter. In these cases where the ATFL rupture is not amenable to primary trilaminar repair, there is often significant chronic tissue from soft tissue remodeling which is redundant and excess in total. This incision allows for adequate visualization of the dome identifying the superficial and deep portion of the ATFL.

For graft fixation the authors use fixation ranging from 2.8 to 3.5mm suture anchors. Depending on the size of the defect and the amount of augmentation needed, either the 0.5 or 0.7mm wide synthetic Polyglycolic Polyblend polyurethane based urethane strip is selected.

First the distal anchor is advanced into the talocalcaneal neck ensuring it is oriented anterior to posterior. The authors then identify a point just superior to the ATFL attachment and incise the fibular peristemeum. The peristemeum is reflected and the distal anterior tubercle is reamed with a ream. The 2nd ankle anchor is then implanted into the fibula, oriented anterior to posterior, ensuring the ankle joint is not violated.

In conclusion, favorable surgical outcomes have been documented with non-surgical tissue scaffold and completed more than 10 months of post-operative follow up. We acknowledge that using a retrospective case series we were not able to employ the use of generally accepted outcome scoring measures (AOFAS Ankle hindfoot score, etc.). This coupled with our small patient cohort size represents a weakness in our approach in presenting the data. However, with our favorable outcomes we felt this technique warrant general use as this is a largely unendorsed treatment option in the repair of the ATFL.

Discussion

This study focused on the outcomes of the 12 patients who underwent ATFL repair / augmentation with the polyurethane synthetic tissue scaffold and completed more than 10 months of post-operative follow up. We acknowledge that using a retrospective case series we were not able to employ the use of generally accepted outcome scoring measures (AOFAS Ankle hindfoot score, etc.). This coupled with our small patient cohort size represents a weakness in our approach in presenting the data. However, with our favorable outcomes we felt this technique warrant general use as this is a largely unendorsed treatment option in the repair of the ATFL.

Twelve of the 17 (70.59%) meeting our inclusion criteria completed an average 12.04 months follow-up (5 patients being lost to follow-up). All patients were able to return to pre-surgical activities of daily life at final follow-up. Only 1 patient required revision of her principle technique at the time of this study secondary to a traumatic incident.

More than 50 different lateral ankle reconstructive procedures have been described in the literature. In general with ATFL repair anatomic reconstruction is favored against non-anatomic as no functionally relevant tissue is sacrificed and no tendon loss is created. The literature reports excellent or good clinical results in 73% to 95% for the anatomic reconstruction of the lateral ankle. This is due to the histological transformation of the patellar tendon from a tendon to fibroblastic tissue replacing the ligament.[17] In addition, to the biomechanical properties, other factors need to be evaluated for the selection of the appropriate procedure. The possible structural damage or functional failure more than may preclude the autograft, the stability of the transtibial fixation, and the biomechanical and histological changes during the transplant healing process all have to be taken into account.

This synthetic tissue scaffold fibers very much the same way as the peristeal template achieved in anatomic repair allowing for fibroblastic ingrowth and tissue replacement as the graft is absorbed over 5 to 7 years.

In conclusion, favorable surgical outcomes have been documented with non-anatomic repair of the ATFL using synthetic tissue scaffold augmentation. To date, this study represents the largest known cohort of such repairs. The results of the study show the potential benefits of further research and evaluation of this procedure.

References


OhioHealth Grant Medical Center

Grant Medical Center Foot and Ankle Surgery Residency Program, Columbus OH ** Step Lively Foot & Ankle Centers, Columbus OH

Figure 1

Literature Review

In the design of a degradable device for ligament reconstruction, whether a true prosthesis or an augmentation device, many biological and mechanical criteria must be met. High initial strength is needed to prevent mechanical failure prior to tissue ingrowth.[9] In addition, a moderate degradation rate is required to induce ingrowth of organized tissue.[10] If degradation is too rapid, the host tissue may be too weak to support the prosthesis and eventually fail.[11] On the other hand, if the degradation is too slow, stress shielding may occur.[10] Thus, an appropriate material for ligament augmentation/reconstruction should be: (1) compatible with surrounding tissues and allow cell ingrowth; (2) mechanically similar to native ligament; (3) degradable, but keeping at least 50% of its strength and stiffness for at least 9-12 months.

The graft used for this purpose is a porous polyurethane sheet which appears as a scaffold allowing ingrowth of the native tissue. This material has been in use in surgical procedures for over 30 years and more specifically in orthopedic type procedures for approximately 15 years. The polyurethane material has been long term to provide support. The polyurethane graft retains approximately 50% of its strength for 4 years. It is designed to degrade over the course of 5 to 7 years as the host tissue replaces the majority of the graft material.[9]

Integration into the host tissue occurs after 6 months, which promotes the return of the normal physiological properties of the tissue.

This synthetic polyurethane graft was first used in the human field to augment achilles tendon ruptures, rotator cuff repairs, and ACL repairs. In these applications, the existing ligaments and tendons were wrapped and secured into a strip of polyurethane tissue scaffold which then acted as a scaffold to promote healing of the ligament or tendon. With this being a biocompatible synthetic material, there is no risk of collagen rejection or disease transmission.[11,14,15] Groff et al. demonstrated that fibers made of PUUR (polyurethane urethane) based on PCL530 have superior strength and stiffness compared to other polyurethanes used in their study and keep at least 50% of their original tensile strength. In addition, the polyurethane fibers are kept at body temperature making it a suitable degradable ligament graft.[12]

Lijtenstein et al. conducted in vitro, in vivo and mechanical stress testing of degradable PUUR fibers for ACL reconstruction in 2002. They found no evidence of severe fatigue with repeated cyclic loading in mechanical stress tests, and noted the first clear histological signs of degradation of the polymer at 24 months after implantation. They concluded that the mechanical properties of the PUUR band correspond to those of the mature human ACL.[13]