〈 Evolving Techniques 〉

Anatomical Reconstruction of the Spring Ligament Complex

"Internal Brace" Augmentation

Jorge Acevedo, MD, and
Anand Vora, MD

Abstract: *The calcaneonavicular (spring) ligament complex is a critical static support of the medial arch of the foot. Compromise of this structure has been implicated as a primary causative factor of talar derotation leading to the clinical deformity of peritalar subluxation. Few procedures have been described to address this deficiency. The technique we describe here is a simple yet effective method to reconstruct the spring ligament complex that can easily be used in conjunction with other more commonly used procedures for extra-articular reconstructions of this deformity. We believe this procedure allows for a more powerful deformity correction and may decrease dependency on other nonanatomic reconstructive procedures.*

Keywords: flatfoot; posterior tibial tendon; spring ligament; deltoid ligament; calcaneonavicular ligament

Introduction

The calcaneonavicular (spring) ligament complex has been well recognized as one of the most critical static supporters of the medial arch of the foot.[1-5] Its anatomy has been well defined, serving as a "hammock" to the talar head to maintain the reduced position of the talus in its normal anatomical relationships with the calcaneus and transverse tarsal articulations.[2]

Many commonly performed extra-articular reconstructive procedures attempt to correct adult flatfoot deformity using methods to realign bony or soft tissue elements of the foot to achieve talar realignment.[5-13] However, few methods are able to directly address the primary causative factor of talar derotation.

> "The calcaneonavicular (spring) ligament complex has been well recognized as one of the most critical static supporters of the medial arch of the foot."

We describe a simple yet effective method of addressing spring ligament pathology with a primary anatomic repair of the spring ligament and secondary internal fixation augmentation technique replicating both the superomedial and inferomedial bands of the spring ligament. This technique may allow correction of the primary talar derotation deformity and can be easily used in conjunction with other more commonly applied procedures for extra-articular reconstructions. Furthermore, the use of this procedure may decrease dependency on other nonanatomic reconstructive procedures.

Preoperative Planning

Standard clinical and radiographic criteria are used to establish the diagnosis of adult acquired flatfoot. Anatomical reconstruction of the spring ligament complex with the internal brace augmentation is performed in conjuction with other commonly performed extra-articular reconstructive procedures (ie, calcaneal osteotomy, cotton osteotomy, lapidus arthrodesis, etc) as indicated for patients amenable to such correction.

DOI: 10.1177/1938640013499404. From The Center for Bone and Joint Surgery of the Palm Beaches, Royal Palm Beach, Florida (JA) and Illinois Bone and Joint Institute, Chicago, Illinois (AV). Address correspondence to: Anand Vora MD, Illinois Bone and Joint Institute, Chicago, IL; e-mail: dranandvora@gmail.com.

Surgical Technique

After standard debridement and resection of the diseased portion of the posterior tibial tendon, the flexor digitorum longus is harvested for the planned transfer. The floor of the medial flexors and the entire medial static ligament complex is exposed. On completion of all planned bony extra-articular procedures and prior to transfer of the flexor digitorum longus to the medial pole of the navicular, the native spring ligament is anatomically repaired and the internal augmentation technique is performed. An Arthrex (Naples, FL) fibertape construct with swivel lock anchors is used to recreate the inferomedial and superomedial bands of the spring ligament. On appropriate tensioning of the fibertape construct, this technique restores the hammock-like sling of the medial ligament complex and reduces the talus to its anatomic resting position relative to the foot while allowing the native anatomic spring ligament repair to heal under tension.

The spring ligament is either anatomically repaired when torn or transected and advanced if patulous/stretched. If the ligament is ruptured, the tear is completed and a maximally tensioned advancement is performed. When the ligament is stretched, the superior and inferior bands are incised longitudinally and advanced using #2 fiberwire sutures through the midsubstance in a pants-over-vest fashion similar to a classic Brostrum lateral ligament repair procedure. This is definitively tensioned and repaired after the internal fibertape augmentation has been secured to minimize strain on the anatomic tissue repair.

The fibertape internal ligament augmentation is then performed with the proximal limb secured in the exposed sustentaculum tali with a 3.5-mm swivel lock anchor (Figure 1). This is placed by direct visualization and knowledge of the bony anatomic prominence of the sustentaculum. Fluoroscopic guidance is used to confirm appropriate trajectory of the sustentacular drill hole, which is directed approximately 15° plantarly. Care should be taken to avoid penetration of the subtalar joint superiorly and avoid injury to the adjacent soft tissues and neurovascular structures inferiorly. This is easily performed by identifying the flexor hallucis longus tendon and retracting it inferiorly to protect the adjacent neurovascular bundle.

At this point, a single limb of the fibertape construct is used to replicate the superomedial band of the spring ligament by advancing the fibertape from dorsal to plantar in the medial pole of the navicular (Figure 2). The second limb of the fibertape construct is then used to replicate the inferomedial band of the spring ligament by advancing the fibertape from plantar to dorsal in the medial pole of the navicular. This second limb is passed simultaneously with the flexor digitorum longus tendon (Figure 3) and secured under tension using interference screw fixation (Figure 4). The method allows fixation of the transferred tendon and both fibertape limbs through a single tunnel in the navicular (Figure 5).

Once the internal augmentation fibertape construct has been secured,

Figure 1.

(A) Diagramtic representation (left foot) for placement of proximal swivel lock anchor in sustentaculum tali. (B) Medial exposure (left foot) with resected diseased segment of posterior tibial tendon. Swivel lock anchor is being placed in sustentaculum tali with fibertape (oval). Notice attenuated spring ligament just proximal to posterior tibial tendon remnant stump (arrow).

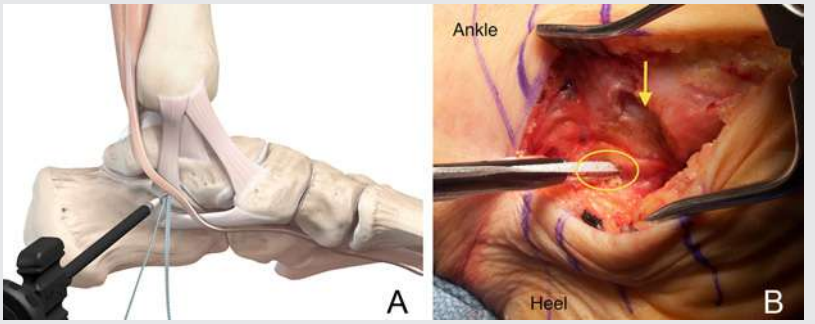


Figure 2.

Passage of superomedial fibertape band from dorsal to plantar direction (oval) in medial pole of navicular (arrow).

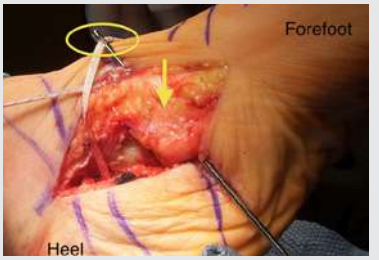


Figure 3.

Passage of inferomedial fibertape band and flexor digitorum longus from plantar to dorsal direction (oval) in medial pole of navicular (arrow).

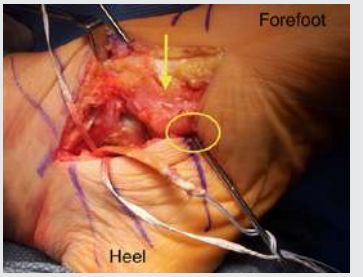
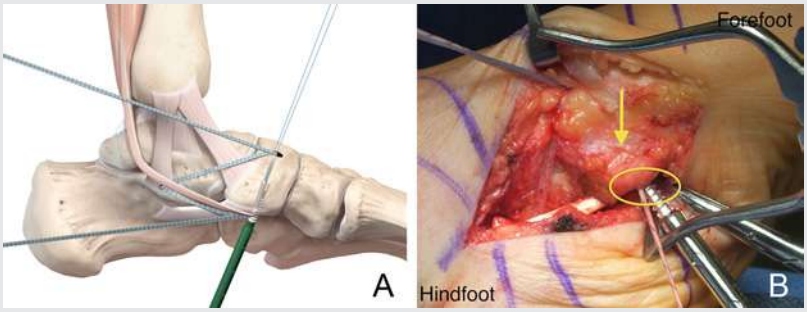


Figure 4.

(A) Diagrammatic representation (left foot) of interference screw fixation technique for tensioning of flexor digitorum longus and both inferomedial and superomedial bands of fibertape with interference screw fixation in medial pole of navicular. (B) Medial exposure (left foot) demonstrating interference screw placement (oval) in medial pole of navicular (arrow).



the anatomic repair of the spring ligament is maximally tensioned. The combination of the fibertape ligament reconstruction augmentation and anatomic spring ligament advancement under maximal tension restores the sling function of the medial ligamentous complex while allowing derotation and reduction of the talus (Figure 6).

Postoperative Management

Patients are immobilized in a short leg splint for 2 weeks until sutures are removed and then transitioned to a non-weight-bearing short leg cast in gravity resting plantar flexion and inversion for an additional 4 weeks. At 6 weeks postoperatively, patients begin an active range of motion and elastic-band strengthening protocol with weight bearing as tolerated in a removable walker boot. At 12 weeks postoperatively, patients are transitioned to regular shoe gear and begin formal physical therapy 2 to 3 times per week for 6 weeks.

Results/Complications

Early results with this procedure have mirrored results with other extra-articular procedures.[9-11] However, the authors have noted less need for additional adjunctive bony procedures given the powerful correction afforded with the internal ligament augmentation using the fibertape construct to protect the medial ligament complex repair. We have equated this construct to an "internal brace" that serves to protect the soft tissues during the healing process. It is our belief that this repair is more anatomic then using a similar concept of internal brace with subtalar arthroereisis techniques while more directly attending to the true anatomic deficiencies.

The authors have performed this technique successfully in 26 patients. These patients had the following additional procedures performed in addition to the spring ligament reconstruction for correction of their flexible flatfoot deformity: All 26 patients had a flexor digitorum longus transfer and resection of the diseased segment of the posterior tibial tendon (with or without proximal side to side tenodesis), 25 patients had a medializing calcaneal osteotomy, 11 patients had a gastrocnemius recession, 10 patients had a medial cuneiform opening wedge Cotton osteotomy, 4 patients had a Lapidus first metatarsocunieform arthrodesis, and 2 patients had a lateral column lengthening calcaneal osteotomy.

One radiographic failure occurred when using an early variation of the technique, which only restored the inferomedial band. Despite the partial recurrence of deformity the patient is painless in a functional orthosis and does not desire further surgery. In the remaining cases, radiographic correction of talonavicular uncoverage and medial column sag as well as clinical alignment has been dramatically improved and maintained in the short-term follow-up.

Summary

The procedure described allows for primary anatomic repair along with a powerful "internal brace" augmentation of the ligament repair using a rigid fibertape construct with a simple reproducible technique. As with any new surgical strategy addressing adult acquired flatfoot deformity, it is difficult to determine what role any single procedure has in achieving correction given most reconstructions involve a combination of procedures. In our experience, we have recognized that a dramatic improvement in talonavicular uncoverage and medial column sag is achieved using this technique. Anecdotally, improvement has been greater than what would be expected with medialinizg calcaneal osteotomy and flexor tendon transfer alone. The technique avoids the need to drill tunnels in the precarious region around the sustentaculum tali and the need for prominent screw/washer placement. As we have become more experienced with this technique, we have found that the role of additional lateral column procedures or subtalar arthroereisis is negligible. We still perform medial column procedures (ie, Cotton osteotomy) when necessary to address any residual supination after hindfoot deformity and soft tissue corrections. The ability of this reconstructive technique to maintain long-term correction is still to be determined. Because of the aforementioned difficulties in studying the efficacy of any single procedure's role in the correction of adult flatfoot deformity, a prospective study to evaluate the

Figure 5.

(A) Diagrammatic construct (left foot) of spring ligament internal brace augmentation and flexor digitorum longus transfer. (B) Medial exposure (left foot) demonstrating tensioned superomedial band of fibertape internal brace construct (arrow). (C) Tensioned inferomedial band of fibertape internal brace construct (arrow). Also note repair and advancement of anatomic spring ligament (oval).

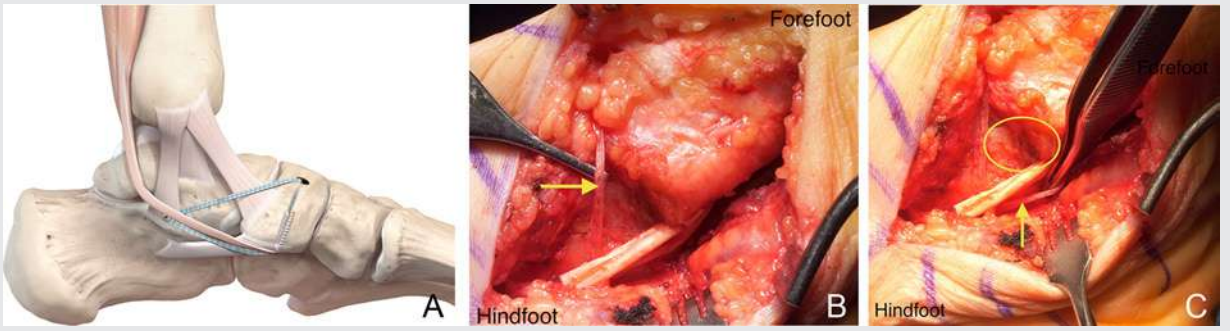


Figure 6.

(A) Preoperative lateral X-ray demonstrating negative talo-first metatarsal angle. (B) Postoperative lateral X-ray demonstrating significant improvement in talo-first metatarsal angle with medializing calcaneal osteotomy, flexor digitorum longus transfer, and spring ligament repair with internal brace augmentation alone.

efficacy of this current technique would prove difficult. The authors are, however, in the process of collecting radiographic and clinical data on all patients with a minimum of 2-year follow-up to determine if improvement in correction is achieved and maintained as compared with historical controls. FAS

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Erratum

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For the article listed above, the following Conflict of Interest Statement should have appeared: Jorge Acevedo and Anand Vora are consultants for Arthrex.

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