Described by Patrick Bull, DO and Adam Halverson, DO *(Columbus, OH)*

STEP 10: A dorsal to plantar tunnel is created in the medial navicular tuberosity. A 4mm tunnel is adequate if only FLEXBAND is utilized for SL reconstruction. With the addition of auto/allograft, a minimum 5 mm tunnel will be necessary.

STEP 11. The appropriate guidewire is centrally placed into the medial navicular tuberosity. Sufficient bone should remain circumferentially around the guidewire to avoid tuberosity blowout during screw insertion. Fluoroscopy must be obtained to confirm proper wire placement (Figures 9&10).

STEP 12: Drill the navicular tunnel.

STEP 13: A Hewson suture passer is used to shuttle the FLEXBAND distal graft limb sutures through the tunnel. One limb will be passed plantar to dorsal (Figure 19) and the other dorsal to plantar (Figure 21). The dorsal to plantar limb must be shuttled deep to the intact PTT.

STEP 14: The two FlexBand limbs are simultaneously tensioned through the navicular tunnel (Figure 22). Maximum tension is applied to both limbs and observed then released. Knowing the maximum, we prefer to apply approximately 50% of maximum graft tension during screw insertion.

Note: *If luggage-tag sutures were used to grasp torn SL margins, these sutures are shuttled through the navicular tunnel and tensioned along with the FLEXBAND.*

If an auto/allograft is also being used (Figure 16), it must be shuttled through the tunnel as well (Figure 18). We recommend passing all plantar to dorsal grafts/sutures first. All dorsal to plantar grafts/sutures are passed second. If the tunnel becomes congested and graft passage is challenging, it is easier to manage when passing the grafts in this recommended sequence.

STEP 15: Once all grafts/sutures are properly shuttled and tensioned, the chosen interference screw is placed from dorsal to plantar (Figure 11).

STEP 16: In some cases, a SL avulsion from the navicular is not adjacent to either of the tunnel apertures. In these cases, a soft tissue suture anchor is placed at the site of SL detachment while taking care to avoid convergence with the previously drilled tunnel.

STEP 17: Following graft/suture tensionning and fixation, the avulsed SL can be tied down to the suture anchor. AnySL pants-over-vest sutures that were placed previously are tied at this time.

When FDL tendon transfer is needed:

- The FDL is harvested using standard technique, exposed to it's intersection with the FHL, and transected. The distal end is then secured with an absorbable grasping stitch.

- The tendon is then passed and tensioned through the navicular tunnel as described above.

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SURGICAL TECHNIQUE
DYNAMIC SPRING LIGAMENT REPAIR UTILIZING
ARTELON® FLEXBAND™ TECHNOLOGY
Described by Patrick Bull, DO and Adam Halverson, DO *(Columbus, OH)*

The plantar calcaneonavicular ligament, or "Spring Ligament" serves to connect the calcaneus and navicular as well as supporting the head of the talus. Containing a considerable amount of elastic fibers, the spring ligament provides elasticity to the arch while bearing the major portion of body weight. Therefore, when the ligament experiences catastrophic injury, reconstruction that is both mechanically and kinematically restorative can be challenging.

Artelon's FLEXBAND matrix is a synthetic bio-textile that functions as a provisional connective tissue scar. Composed of a polycaprolactone/poly (urethane-urea) co-polymer, the hyper-resilient material stabilizes the primary repair and mechanically activates tenocyte protein activation and remodeling throughout the entire tissue healing phase (12-18 months). Furthermore, it slowly transfers the kinematic loading to the native connective tissue over 4 to 6 years while undergoing a simple, non-necrotic dissolution process. This ensures proper kinematics as well as a strong repair.

The technique described here utilizes the unique characteristics of this matrix to achieve an enhanced reconstruction intended to support both the stability and kinematic needs of the native spring ligament.

Two clinical scenarios are included to demonstrate its use and clinical effectiveness.

REQUIRED IMPLANTS AND INSTRUMENTATION:

- Artelon FLEXBAND 0.5 x 16cm x 1
- 5.0 interference screw x 1 for calcaneal tunnel
- 4.0 or 5.0 interference screw x 1 for navicular tunnel

SURGICAL PROCEDURE

STEP 1: A medial incision extending from the inferior tip of the medial malleolus to the medial navicular tuberosity is made. In-line with the incision, the posterior tibial tendon (PTT) sheath is incised and the tendon inspected for pathology.

STEP 2: Next, the PTT is retracted superiorly and inferiorly to facilitate spring ligament (SL) inspection (Figure 1). Areas of degenerated tissue are then identified (Figure 2) and excised.

STEP 3: If tissue allows, sutures for primary SL repair are placed but not tied. Preference is given to a pants-over-vest suture configuration with #0 absorbable suture for mid-substance tears.

Insertional SL detachment tears are grasped with non-absorbable suture using a luggage-tag stitch.

STEP 4: On the back table, a 0.5 x 16cm FLEXBAND is folded in half and 15 mm of the fold is Krackow sutured with #0 absorbable suture. The distal limbs are sutured with #0 absorbable suture in an identical fashion. The resultant “Y” graft is seen in Figures 3&13.

STEP 5: The doubled graft is marked at a length equal to the anticipated interference screw, which was 15mm in both cases.

STEP 6: The guidewire for a 5 mm cannulated drill is placed in the sustentaculum and driven slightly posterior/inferior to avoid subtalar joint penetration (Figures 4, 5,&6).

STEP 7: With the medial ankle supported by a soft bump, the wire is advanced laterally until it exits the skin. A protective clamp should immediately be placed over the exposed tip.

STEP 8: The cannulated drill is then utilized over the wire to create the first bony tunnel (Figure 7).

Note: The depth of the drilling is dictated by the interference screw being used. We prefer to drill 20 mm deep when using a 15 mm long screw.

STEP 9: Using the guidewire’s eyelet, the Krackow stitch on the graft’s doubled portion is shuttled through the sustentaculum tunnel and out the lateral skin (Figure 8 &14). The interference screw is then placed in the sustentaculum to secure the proximal graft (Figure 15).

DYNAMIC SPRING LIGAMENT: Case 1

ARTELON® FLEXBAND™ TECHNOLOGY

Described by Patrick Bull, DO and Adam Halverson, DO (Columbus, OH)

CLINICAL HISTORY:

Case #1 is a 41 yo female that presented 3 months following eversion ankle injury. An appropriate course of rest/ice/elevation/immobilization and eventual physical therapy failed to relieve her pain. On initial exam, point tenderness over the medial talonavicular joint and sustentaculum tali was noted. Non-contrast MRI revealed thickening and attenuation of the midsubstance portion of the superomedial spring ligament complex. PTT and deep deltoid were confirmed intact.

Patient did not have planus foot alignment and was able to perform multiple single leg heel rise maneuvers during clinical exam. Patient did have medial TNJ pain during the test, however.

Stress testing of the spring and deltoid ligament complexes failed to uncover gross laxity. The patient was originally diagnosed with a deltoid ligament sprain but was later referred to our office after failure to improve after 3 months of appropriate conservative care.

Intra-operatively, her injury was found to be within the more superior fibers of the spring ligament, and a robust suture repair was obtained. Therefore, an FDL transfer was determined to be unnecessary in her reconstruction.

Figure 1. Retraction of the PTT to examine the underlying spring ligament.

Figure 2. Sustentacular tear.

Figure 3. The "Y" graft matrix created from a 0.5 x 16cm FLEXBAND.

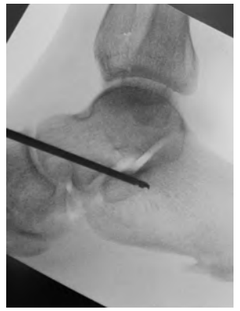

Figure 4. Lateral view confirms plantar and posterior sustentaculum tunnel trajectory.

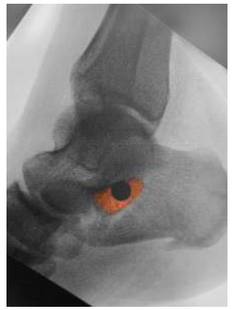

Figure 5. Oblique view down the guidewire confirms sustentaculum placement when combined w Figure 6 image.

Figure 6. Axial calcaneus view, when combined with Figure 5, verifies position

Figure 7. Drilling the calcaneal tunnel.

Figure 8. Shuttling the stiteches of the "folded end" of the FLEXBAND through the calcaneal tunnel.

Figure 9. Lateral view demonstrating appropriate navicular guidewire placement. Must be combined w Figure 10.

Figure 10. Oblique view down the guidewire, when combined with Figure 9, verifies appropriate position.

Figure 11. Passing of the two FLEXBAND arms through the navicular tunnel and placement of fixation from dorsal to plantar.

Figure 12. Final implantation of spring ligament construct.

DYNAMIC SPRING LIGAMENT: Case 2

ARTELON®FLEXBAND™ TECHNOLOGY with FDL Transfer

Described by Patrick Bull, DO and Adam Halverson, DO (Columbus, OH)

CLINICAL HISTORY:

Case #2 was a 35 yo male who also presented approximately 3 months after a work-related ankle twisting injury. He had persistent medial midfoot pain despite an appropriate and exhaustive course of non-surgical post-injury treatment. Non-contrast MRI uncovered a tear of the spring ligament at the sustentaculum attachment. Similar to case #1, no PTT tear or deltoid tear was noted on MRI.

The patient did not have a pes planovalgus deformity.

His deltoid and spring ligaments were stable to stress exam, but pain was present during the maneuver. Tenderness was noted over the SL on multiple exams.

He was referred to our office after failure to see pain relief after 3 months of non-surgical care for a midfoot sprain.

Intra-operatively, it was found that he had a large tear, completely torn off of the sustentaculum. Being of larger stature and working in a manual labor profession, an FDL transfer was utilized along with the FLEXBAND in his reconstruction.

Figure 13. The "Y" graft matrix created from a 0.5 x 16cm FLEXBAND.

Figure 14. Shuttling the folded end of the "Y" matrix into the calcaneal tunnel.

Figure 15. Fixation of the FLEXBAND into the calcaneus.

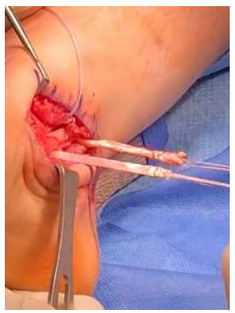

Figure 16. FDL (top) and unsecured limbs of the FLEXBAND (bottom).

Figure 17. Sizing the FDL + FLEXBAND bundle for the navicular tunnel.

Figure 18. Preparing the FDL and plantar FLEXBAND limb to be passed through the navicular tunnel from plantar to dorsal.

Figure 19. FDL/FLEXBAND bundle (top) after being passed through the navicular.

Figure 20. Beginning to shuttle the dorsal FLEXBAND limb through the navicular tunnel from dorsal to plantar. (Tension is maintained on the FDL/FLEXBAND bundle)

Figure 21. Pulling the dorsal FLEXBAND limb into the navicular tunnel.

Figure 22. Tensioning both limbs of the graft complex after transversing the navicular tunnel.

Figure 23. Fixation of the complex within the dorsal navicular.

Figure 24. Final construct of the SL complex.