Flexible Fixation Technique for Subtle Lisfranc Injuries

Ethan R. Harlow,*† MD, Ajit M. Vakharia,† MD, Mikhail Alexeev,† MD, and Shana Miskovsky,†‡ MD
Investigation performed at Department of Orthopaedic Surgery, University Hospitals Cleveland Medical Center, Cleveland, Ohio, USA

Background: Subtle Lisfranc injuries represent a primarily ligamentous Lisfranc complex injury involving the Lisfranc ligament and the medial and middle cuneiform ligaments. Static radiographic displacement or dynamic instability of the medial cuneiform and 2nd metatarsal typically warrants operative intervention to prevent chronic functional pain, allow for timely return-to-sport, and mitigate posttraumatic osteoarthritis. Flexible fixation techniques offer a unique solution to the issues seen with transarticular screws, plates, and arthrodesis for ligamentous Lisfranc injuries.

Indications: We present the case of a 16-year-old female basketball player with a subtle Lisfranc injury sustained during practice. X-rays show isolated widening of the 1st and 2nd metatarsal bases and dynamic diastasis between the medial and middle cuneiforms. Magnetic resonance imaging (MRI) confirmed a rupture of the plantar Lisfranc ligament. After extensive discussion regarding treatment options, the patient and her family decided to proceed with surgical intervention using a suture anchor and button technique to restore stability to the Lisfranc ligament and intercuneiform complexes.

Technique Description: A standardized dynamic examination under anesthesia identifies the extent of the injury. Exposure of the base of the 2nd metatarsal and medial cuneiform is performed. Reduction clamps are applied to restore the intercuneiform relationship and interval between the medial cuneiform and base of 2nd metatarsal. The suture anchor and button construct is placed using fluoroscopic guidance. A final dynamic examination is performed to confirm stability of the construct.

Results: Biomechanical studies have shown that flexible fixation maintains physiologic motion about the Lisfranc articulations and has comparable stability to transarticular screws in cadaveric models of isolated Lisfranc ligament insufficiency. Clinical results are limited but demonstrate excellent postoperative functional outcome scores with very few fixation-related complications at 1 to 3 years.

Discussion: Flexible fixation techniques for subtle Lisfranc injuries offer unique benefits to transarticular screws, plates, and arthrodesis. We highlight the appropriate evaluation of patients with a suspected subtle ligamentous Lisfranc injury, the surgical technique using a suture button and anchor construct, and review postoperative management and expected outcomes based on the present literature.

Keywords: Lisfranc; subtle Lisfranc injury; flexible fixation; athlete; technique

VIDEO TRANSCRIPT

The title of this presentation is "Flexible Fixation Technique for Subtle Lisfranc Injuries."

We will start with our case presentation.

This is a 16-year-old female basketball player who presents with acute right foot pain after a pivoting maneuver during practice. Her examination is significant for tenderness over the 1st and 2nd metatarsal bases, the medial and middle cuneiforms, mild plantar ecchymosis, and pain elicited with and adduction/abduction stress test of the first ray.

This presentation will review subtle Lisfranc injuries, the surgical technique of flexible fixation using a suture anchor and button construct, and its biomechanical and clinic outcomes.

Subtle Lisfranc injuries are low-energy injuries that result from an indirect force via an axial load in the

*Address correspondence to Ethan Harlow, MD, Department of Orthopaedic Surgery, University Hospitals Cleveland Medical Center, 11100 Euclid Ave, Cleveland, OH 44106, USA (email: Ethan.Harlow@uhhospitals.org).

†Department of Orthopaedic Surgery, University Hospitals Cleveland Medical Center, Cleveland, Ohio, USA.

‡Sports Medicine Institute, University Hospitals Cleveland Medical Center, Cleveland, Ohio, USA.

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hyperplanterflexed foot or sustained during a pivoting maneuver. They are the second most common athletic foot injury after metatarsal-phalangeal joint injuries in football players. These injuries are different from "classic" Lisfranc injuries which are the result of high-energy trauma that leads to displaced fractures and dislocations. Subtle Lisfranc injuries represent a spectrum of primarily ligamentous injuries to the Lisfranc ligament complex from partial sprains with no displacement to complete tears with frank diastasis. They can be associated with avulsion fractures such as the "fleck sign" or a fracture of the medial cuneiform. They are defined by their primary involvement of the medial column with variable diastasis of the 1st and 2nd metatarsal bases, rotation of the medial cuneiform in the sagittal plane, and typically a stable naviculocuneiform (NC) joint.

Clinically, patients present with pain and swelling of the midfoot and plantar ecchymosis. Gentle stress of the forefoot into plantarflexion and supination and pronation leads to pain over the 1st and 2nd tarsometatarsal (TMT) areas. Three x-ray views of the foot and bilateral weight-bearing views should be obtained and will typically show subtle widening between the medial cuneiform and base of 2nd metatarsal > 2 mm compared with contralateral side. In addition, widening of the space between the medial and middle cuneiforms suggests intercuneiform rotation or a notch or V-sign on weight-bearing views. Computed tomography may be considered if there are substantial Lisfranc complex fractures and a magnetic resonance imaging (MRI) is ordered routinely for pure ligamentous injuries to define the integrity of the plantar Lisfranc ligament, which is paramount to stability of the midfoot.

In our case, anteroposterior (AP), oblique, and lateral x-rays of the injured foot shows isolated subtle widening of the 1st and 2nd metatarsal bases and a V or notch sign due to mild diastasis of the medial-middle cuneiforms. The remainder of the TMT joints are well aligned, and there is no displacement on the lateral x-ray. Weight-bearing views show these radiographic findings are asymmetric with respect to the intact contralateral foot indicative of a pathologic process. The MRI shows a complete tear of the plantar Lisfranc ligament and bone edema involving the medial and middle cuneiforms.

Operative treatment is typically recommended for any acute subtle ligamentous Lisfranc injury with displacement and dynamic instability on weight-bearing views of the TMT, intercuneiform, and naviculocuneiform joints. Poor results have been reported in patients with these injuries treated nonoperatively with greater than 2 mm of displacement. In addition, MRI evidence of Lisfranc ligament rupture or stretch is an indication for surgery, as this ligament has been shown to be vital to midfoot stability.

Lisfranc injuries are classically treated with open reduction and internal fixation with plates or transarticular screws versus arthrodesis. Transarticular flexible fixation techniques employing the use of suture buttons and anchors have grown in popularity, as they mitigate some of the complications associated with these treatment strategies. They are, namely, obviating need for hardware removal and reducing iatrogenic articular damage associated with transarticular screws. In addition, flexible fixation allows for continued physiologic motion across the Lisfranc articulations which may be functionally beneficial in the athlete seeking timely return to sport and may be a more hospitable environment for ligamentous healing.

We will now show our surgical technique of flexible fixation for subtle Lisfranc injuries using a suture anchor and button construct, the Arthrex Mini FT TightRope (Arthrex Inc; Naples, FL) for intercuneiform fixation, and the Arthrex Mini TightRope (Arthrex Inc; Naples, FL) for medial cuneiform and 2nd metatarsal base fixation. We start with an examination under anesthesia to appreciate the full extent of the injury using an abduction and adduction stress test, which shows dynamic diastasis of the 1st and 2nd metatarsal bases and rotational instability between the medial and middle cuneiforms. This is performed with one hand grasping the calcaneus and the other manipulating the first ray. The naviculocuneiform joint remains congruent as depicted by an unbroken tangent line along the medial aspect of the navicular and the medial cuneiform. No additional instability is seen about the 1st TMT joint and the 3rd-5th TMT joints. If present, the injury may require a more substantial and rigid fixation strategy.

The foot is then elevated with a blanket ramp at the very end of the table. A nonsterile tourniquet is elevated to 280 mm Hg. We utilize large C-arm fluoroscopy to localize the borders of the medial cuneiform and the first webspace. The location of the tibialis anterior tendon is palpated and marked. The landmarks are shown. A dorsal 2 to 3 cm incision is made over the 1st and 2nd TMT joints, positioned slightly lateral to its midpoint, with a 15-blade. We then use careful tenotomy dissection to prevent injury to superficial branches of the deep peroneal nerve which can cause numbness and dysesthesia if damaged. The fascia over the extensor brevis and longus is released with tenotomy scissors. The extensor brevis tendon and muscle belly is then retracted medially to protect the deep neurovascular bundle. The base of the 2nd metatarsal is identified and soft tissue elevated medial and lateral from the bone using a freer elevator. Staying on the medial aspect of the 2nd metatarsal base, a freer is placed into the space between the metatarsals to ensure there is no impinging soft tissue preventing reduction.

In the case of a Lisfranc ligament tear, this instrument should pass freely within the interval. If resistance is present from incarcerated soft tissue, this would need to be removed. A baby Hohmann retractor is placed laterally to develop a potential space for the suture button to flip and rest on the 2nd metatarsal. Once this is done, the medial cuneiform is exposed using an incision just plantar to the longitudinal axis of the bone to limit the amount of periosteal elevation undermining the tibialis anterior insertion. Subperiosteal flaps are elevated anterior and posteriorly, preserving the tibialis anterior insertion. Dissection was performed carefully to preserve the NC and 1st TMT joint capsules to prevent iatrogenic instability.

A small stab incision is then made dorsolaterally with blunt dissection performed down to the lateral cuneiform protecting branches of the superficial peroneal nerve and extensor tendons for placement of a large reduction clamp to the medial cuneiform using fluoroscopic guidance. This clamp vector is placed slightly superior to the horizontal to prevent rotational malreduction of the intercuneiform joint. The V sign or notch sign is reduced. A second clamp is then placed around the 2nd metatarsal and medial cuneiform reducing the diastasis. Anatomic reduction is confirmed on AP and lateral x-rays.

We then proceed with placement of the 1.2 mm guidewire for the Arthrex Mini TightRope using the Bio-Corkscrew FT anchor (Arthrex Inc; Naples, FL). The start point is in the middle of the bone and trajectory aimed 20° degrees superior from the horizontal to stay perpendicular to the joint. The guidewire is advanced to the lateral cortex of the middle cuneiform using fluoroscopic imaging. A lateral view is obtained to confirm reduction and the trajectory of the wire. The 2.7 mm cannulated drill is then used and reamed to the lateral cortex of the middle cuneiform without violating it. A tap is then utilized using two turns forward, one turn backward technique, as the bone quality here is typically excellent. We then placed the TightRope FT (Arthrex Inc; Naples, FL) which utilizes a radiolucent bioabsorbable anchor and is inserted until the radiopaque inserter tip breaches the medial cortex of the middle cuneiform.

Once seated, the fixation of the anchor is assessed with a gentle gradual pulling action, and the Endobutton (Smith & Nephew; Null, TN) is then gently fastened using 3 or 4 half-hitches. X-rays are then performed to confirm reduction and the clamp is removed. The second guidewire is then placed using a more plantar start point heading toward the dorsal-lateral aspect of the base of the 2nd metatarsal and distal to the 2nd-3rd metatarsal articulation. The drill is then used through all cortices, and the Hohmann retractor protects the neurovascular structures laterally. The Mini TightRope is then placed, and the Endobutton is directly visualized as it is flipped on the far cortex, ensuring no soft tissue interposition. The suture is pre-tensioned and then tightened and tied to lock the implant. The clamp is removed and final fluoroscopic views obtained including a dynamic stress examination confirming stability of the medial column. The wounds were then copiously irrigated. The medial cuneiform periosteum is closed with interrupted 2-0 Vicryl mattress suture (Medline; Northfield, IL), followed by 2-0 Vicryl, and skin closed with 4-0 Nylon. The dorsal incision was closed with 4-0 Vicryl suture approximating the extensor hallucis brevis (EHB) and extensor hallucis longus (EHL) fascia and skin closed with 4-0 Nylon suture. The patient is subsequently placed in a short leg splint.

Key pearls of this technique include utilizing a standardized examination under anesthesia to ensure that this fixation strategy adequately addresses the total extent of the injury, preserving or repairing the tibialis anterior insertion during exposure of the medial cuneiform, and ensuring a stable intercuneiform construct by providing orthogonal fixation and not violating the far cortex of the middle cuneiform. When exposing the 1st and 2nd TMT area, protect the superficial branches of the deep peroneal nerve using tenotomy dissection and reflect the EHB tendon medially to protect the deep neurovascular bundle. The construct for the Lisfranc ligament should start slightly plantar on the medial cuneiform and end laterally just distal to the 2nd-3rd metatarsal base articulation with the button sitting directly on the bone.

One of the concerns with this technique is the potential for late mild diastasis. One study identified this in a few patients at 3 years postoperatively with ligamentous Lisfranc injuries, although they speculated that such small diastases may be a result of imperfect radiographic positioning.[5] In addition, no studies have yet to demonstrate that this technique is associated with a reduced risk of post-traumatic osteoarthritis compared with plate or transarticular screw fixation.

At our institution, patients are made non-weight bearing for 4 to 6 weeks with physical therapy started at 2 weeks, although some literature supports early weight-bearing may be safe in these patients. Once patients transition to full weight bearing they are fitted with a carbon fiber plate insert to support the longitudinal arch during rehabilitation.

Return to sport varies and assessments are made in accordance with team policies, but typically our patients are returning to sport at 4 months with unlimited activity starting at 6 months postoperatively.

Biomechanical studies have shown that flexible fixation restores pre-injury motion about the midfoot with comparable stability to transarticular screws in cadaveric models of isolated Lisfranc ligament insufficiency. Patient outcomes are more limited with this technique with a lack of mid- to long-term follow-up, but there is promising early data suggesting that patients have few hardware complications, do not require hardware removal, and rehabilitation may be expedited with early weight bearing. It is important to improve upon the outcomes in adolescents with these injuries treated with transarticular screws and plates as they have a known risk of developing functional pain, hardware complications, and posttraumatic osteoarthritis. A number of prospective studies have shown excellent American Orthopedic Foot and Ankle Scores, potential for safe early weight bearing, and very few fixation-related complications in 1- to 3-year follow-up. This technique has not yet been extensively studied in professional athletes, but there are reports of excellent results seen in both dancers and soccer players returning to competition.

Thank you for listening.

ORCID iD

Ethan Harlow https://orcid.org/0000-0001-9995-5701

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