Lisfranc injury and fixation in ballet dancers and high-level athletes: A Case Series

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INTRODUCTION

Lisfranc injuries are a common problem in the trauma field although it may have subtle findings in an athlete, which can lead to a late presentation. Often, the diagnosis of a midfoot sprain is made and persistent subtle Lisfranc joint tenderness can be noted.[10] In the dancing population, this can be seen with persistent difficulty being en pointe (full weight bearing on extended toes in the classic pointe position). The Lisfranc ligament has been shown to play an important role in the stability in the ballet pointe position, and its disruption can be associated with significant changes in relative alignment while en pointe as well as destabilization of the midfoot without the pointe shoe.[8] These patients will have an inability to perform some or all dance activities. High level, non-dancing athletes generally present with persistent pain and tenderness at the Lisfranc joint despite rest and refraining from activity for a period of time in which a midfoot sprain would be expected to heal.[10]

Lisfranc fracture diagnosis without gross displacement can often be missed and very challenging. In addition to subtle tenderness overlying the Lisfranc space, subtle diastasis may be noted on x-ray though may appear normal on standard radiographs and only be visualized by MRI[10, 16]. Dancers specifically can present with many midfoot problems associated with the strain of the pointe position, which can confound the subtle findings of this injury. The differential diagnosis frequently includes second metatarsal stress fracture, which is a common injury in dancers[8] and especially difficult to differentiate from Lisfranc injury. However, location of tenderness medially at the Lisfranc space suggests Lisfranc injury is more likely than stress fracture. Injection into the Lisfranc space can be used as a confirmatory test if temporary pain relief occurs.

Current standard of care for a displaced Lisfranc fracture is open reduction with internal fixation or primary fusion.[9] This presents specific challenges to professional dancers or high-level athletes, as they often will not tolerate tarsometatarsal fusion or screw fixation. Subsequent arthritis in the second tarsometatarsal joint and Lisfranc joint often seen after screw fixation[6] can be career ending.[4]

A suture button construct has been described for the treatment of Lisfranc injuries. Though screw fixation has been shown to have potentially superior fixation characteristics[1], it is not well tolerated in this population leading to continued interest in the efficacy of alternate constructs for fixation. Suture button constructs have been described to be effective in the treatment of Lisfranc injury and repair.[5]

We report treatment of Lisfranc injuries with suture button fixation in 6 patients who were either professional dancers or high-level athletes. Indications for surgery were complaints isolated to directly over the Lis Franc space. All patients had specific direct point tenderness over the Lis Franc ligament and none over the 2nd metatarsal. X-ray exam was equivocal (>0.5mm delta for subtle widening of the Lis Franc space, and no patient had a diastasis greater than 2mm on stress xray. MRI examination was positive in 2/4 for signal changes at Lis Franc ligament, however normal MRI findings were noted in 2/4 patients. . No patient had signal changes at the base of the 2nd metatarsal for stress fracture.

Surgical technique: An ankle tourniquet was used. The articular margins of the middle cuneiform, medial cuneiform, first metatarsal and second metatarsal were drawn on the skin to help with placement of the incision and the Kirschner wire guidepin. A dorsal incision of approximately 2 cm was made. Careful attention was made to avoid injury of the dorsal cutaneous nerve, which is frequently visualized with this approach[11] and can cause numbness and dysesthesia if damaged. The fascia over the EHL and EHB tendons was incised. Just below these tendons the neurovascular bundle was gently mobilized and carefully protected. The Lisfranc ligament was identified deep to the bundle and assessed for laxity with a Freer elevator.

Under fluoroscopic imaging, 1.6mm Kirschner wires were placed from the medial cuneiform toward the second metatarsal. The trajectory from the medial cuneiform to the second metatarsal was chosen because the third metatarsal can often block access to the reverse trajectory. Ideally the space between the second metatarsal and middle cuneiform would be bisected. The end of the K wire was intended to lie in the space between the second and third metatarsals. Placement too proximally may not allow the button to sit flush on the bone and may not allow for adequate compression. Careful attention was made not to have the medial starting point at the level of the tibialis anterior tendon. Additionally, careful attention was paid not to have a starting point too close to the first tarsometatarsal joint which could fracture into the joint and /or result in less stable fixation. Fluoroscopic imaging confirmed appropriate placement of this K wire. A 2.7 cannulated drill was then used from a medial to lateral (medial cuneiform to 2nd metatarsal) direction.

A suture lasso was then placed after the drill hole was created. The suture button was advanced from the second metatarsal into the medial cuneiform. A small incision was often made to facilitate and confirm the medial button was laying flat as well as confirming no entrapment of the tibialis anterior tendon. The suture button was then tied against the second metatarsal. The direction of insertion of the button was specifically chosen such that the bulk of the knot was not tied on the surface of the medial cuneiform which can be irritating and would be a significant problem with pointe shoes. Fluoroscopic imaging in the lateral projection confirmed that the suture button placement was not too dorsal. Excessive dorsal placement could potentially lead to cortical fracture yet a slightly dorsal position could potentially be advantageous for ease of knot tying. Closure was performed with a running subcuticular closure for additional cosmetic benefit.

Postoperatively, the patient was placed in a short leg splint and kept nonweightbearing for two weeks. After two weeks, the splint was removed and the patient was placed in a cam walker boot for gentle active or passive ankle range of motion. Nonweightbearing was continued for 4 additional weeks (6 weeks total). The patient was then placed in a shoe with an arch support and allowed to transition off crutches gradually over the course of 2 weeks. For dancers, barre work was allowed after 3 months and the dancer was allowed to return to center (full participation) at 6 months. For the other athletes, low impact training was allowed at 3 months, and gradual return to full training and participation was allowed at 6 months.

RESULTS

We treated 6 patients (5 female/ 1 male) with the suture button device (Arthrex Mini tightrope 2.7mm 8911DS, Naples FL USA) . Four patients were professional/elite level ballet dancers and 2 were competitive college level soccer players. All patients were operated on by one of two attending surgeons with experience using the suture-button device. There were no wound healing problems, no incidents of wound dehiscence or other early complications. All patients returned to full activity with no residual deficits by 6 months. Preoperative AOFAS midfoot score was 65 (range 59-72), with most significant complaints of moderate pain and pain with activities of daily living. Postoperative AOFAS midfoot score was 97 (range 90-100). A minimum of 1 year followup was required for inclusion in the study with an average of 23 months (range 12 months – 3.5 years) At most recent follow up, all patients were participating in full professional dance or sporting activities at pre injury level.

DISCUSSION

Lisfranc injury in the population of high-level athletes and dancers is a difficult problem to treat. The diagnosis is often subtle and delayed, and the demands of this population are such that standard of care treatment with screw fixation and fusion may not be tolerated. This population predictably places higher demands on the Lisfranc joint due to the rigor of their activities. In dancers, the specific stresses of positioning in pointe shoes seems to place them at high risk for post traumatic arthritis and complications such as hardware breakage and failure. For this population, suture button fixation may represent an effective alternative to screw fixation and fusion that would allow these athletes to return to full activity and meet the demands of their respective sports.

The goal of fixation has previously been to reduce motion and achieve rigid fixation across the Lisfranc space to allow for primary bone healing. However, biomechanical studies have shown that measurable motion occurs at the Lisfranc joint in the intact, physiologic state.[13] This prompted investigation into non-rigid fixation, so-called “flexible fixation” with a suture button device across this joint. The goal of this fixation is to restore pre-injury level of motion[5] while preventing excessive motion associated with the ligamentous disruption suffered and subsequent associated pain and stresses within the midfoot. Fixation with suture button device has been shown to reduce motion at this joint to pre-injury levels,

similar to gold standard screw fixation with regards to axial and abduction stresses.[14, 15] The restriction of motion to physiologic level with suture-button, coupled with the flexible principle allowing for maintenance of that baseline motion may reduce stress on adjacent joints and serve to protect high demand patients from the post traumatic and post fusion arthritis that has led to intolerance for rigid fixation strategies in this population.

The suture button fixation, specifically the TightRope™ device, has previously been described in several case series for the treatment of Lisfranc injuries.[3, 5] Our results are similar, in that no patients experienced complications and all were able to return to previous level of activity within 6 months. Our series is unique in the addition of the dancing population and specific inclusion of exclusively high-level athletes, supporting the conclusions of the previous case series that this method of fixation is effective, reproducible and prevents the need for subsequent operative procedures due to hardware complications. Additionally, this fixation may have special significance for the high demand patient, high level athlete or dancer who is intolerant of rigid screw fixation and benefits from the restoration of physiologic motion across the Lisfranc joint.

Limitations include the small number of patients, operated on by one of two surgeons at a single institution and short term follow up without a standardized measure of patient outcome. Certainly, long-term studies are needed to elucidate the viability of this fixation when compared to the gold standard screw fixation, as well as potential complications unique to flexible fixation with a suture-button device.

Figure 1: The dorsal cutaneous nerve is predictably in the field and should be avoided. The EHL and EHB tendons are retracted to show the deep peroneal nerve

Figure 2: The guide pin is placed from the medial cuneiform to base of the second metatarsal. Three key elements in pin placement are preferred. 1) Avoidance of the tibialis anterior tendon 2) bisecting the articular surface of the medial cuneiform and 1st intermetatarsal joint 3) avoiding the articulation between the 2nd and 3rd metatarsals while exiting in the space between these two bones.

Figure 3: A passing loop is placed after drill holes are created. Figure 4: The suture button fixation is passed with attention to make the knot on the second metatarsal side to avoid irritation with the dance pointe shoe. A small incision is made medially to confirm the button fixation is not entrapping the tibialis anterior tendon.
Figure 5: Radiographic confirmation of appropriate placement.

Figure 6: Careful attention is made to avoid dorsal cortex disruption as the tendency is for “high” placement of the device.

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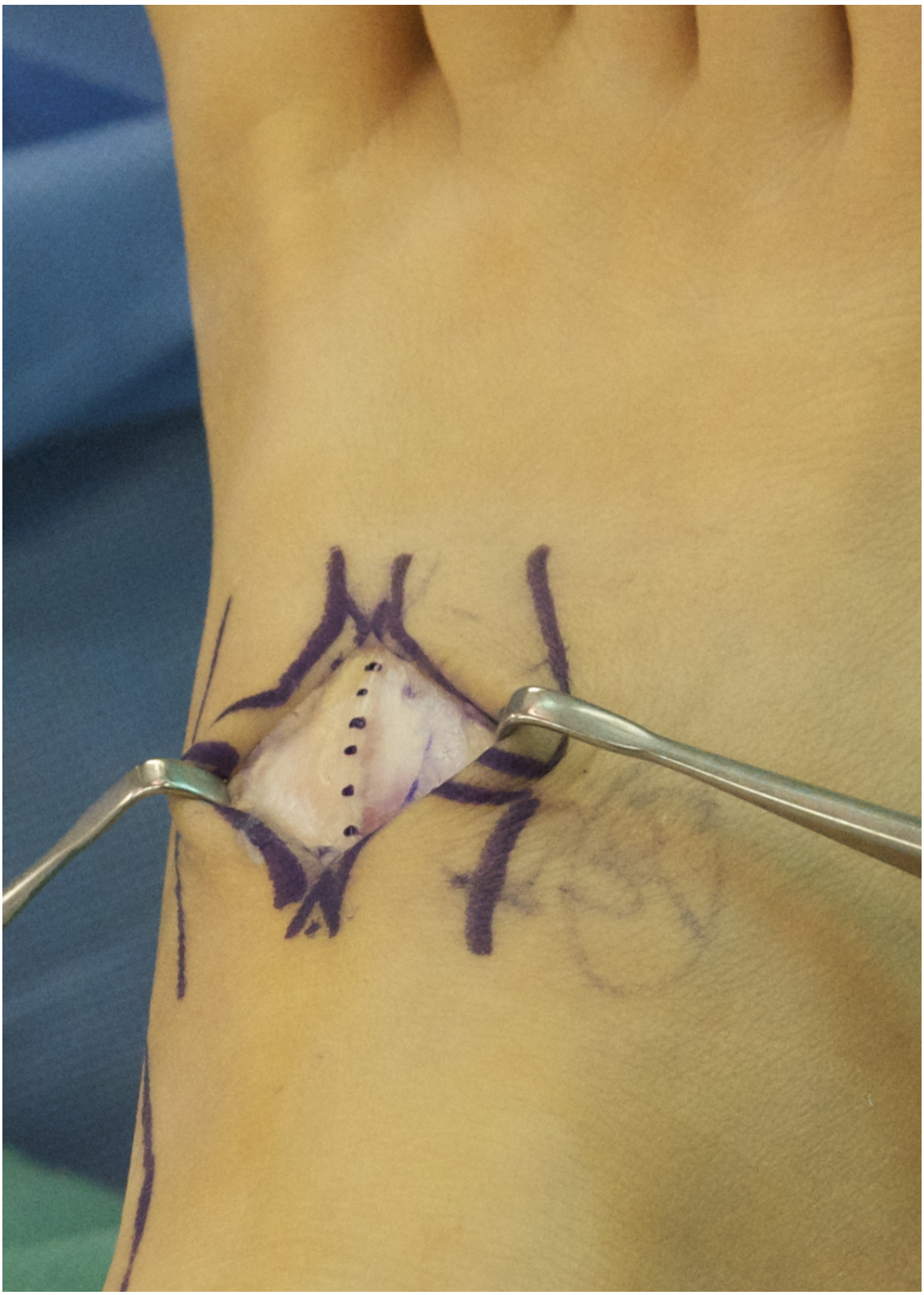

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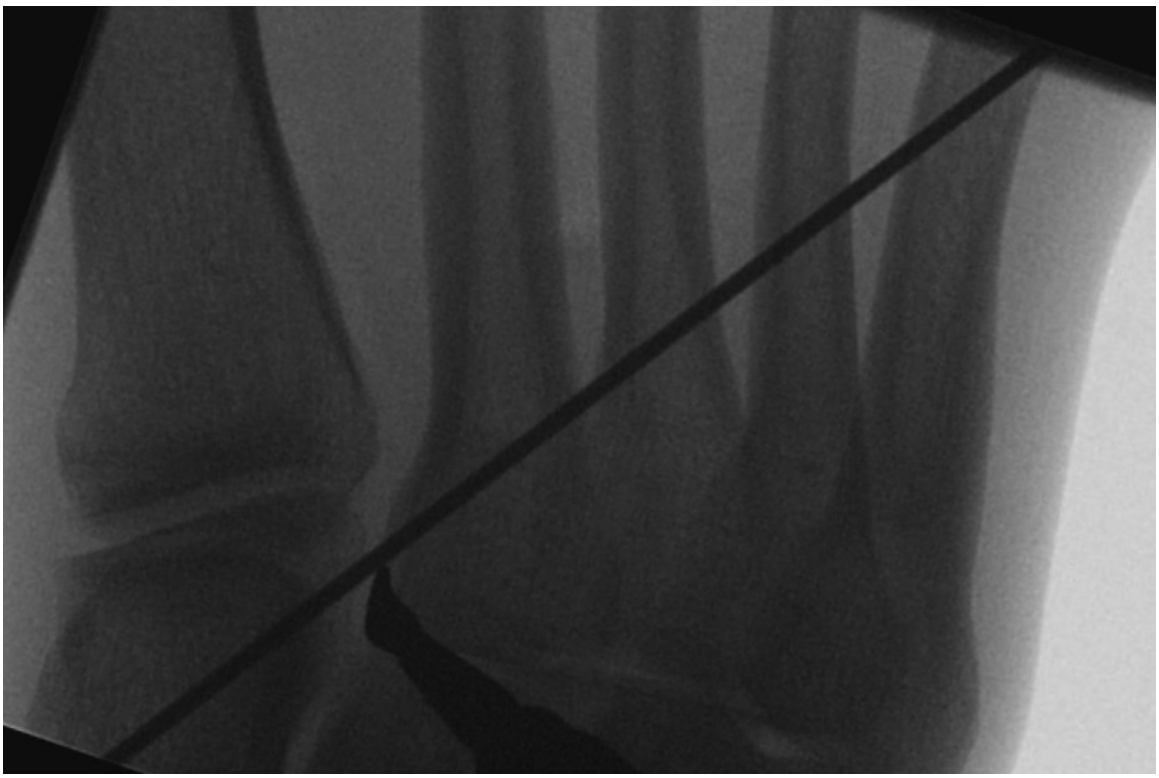

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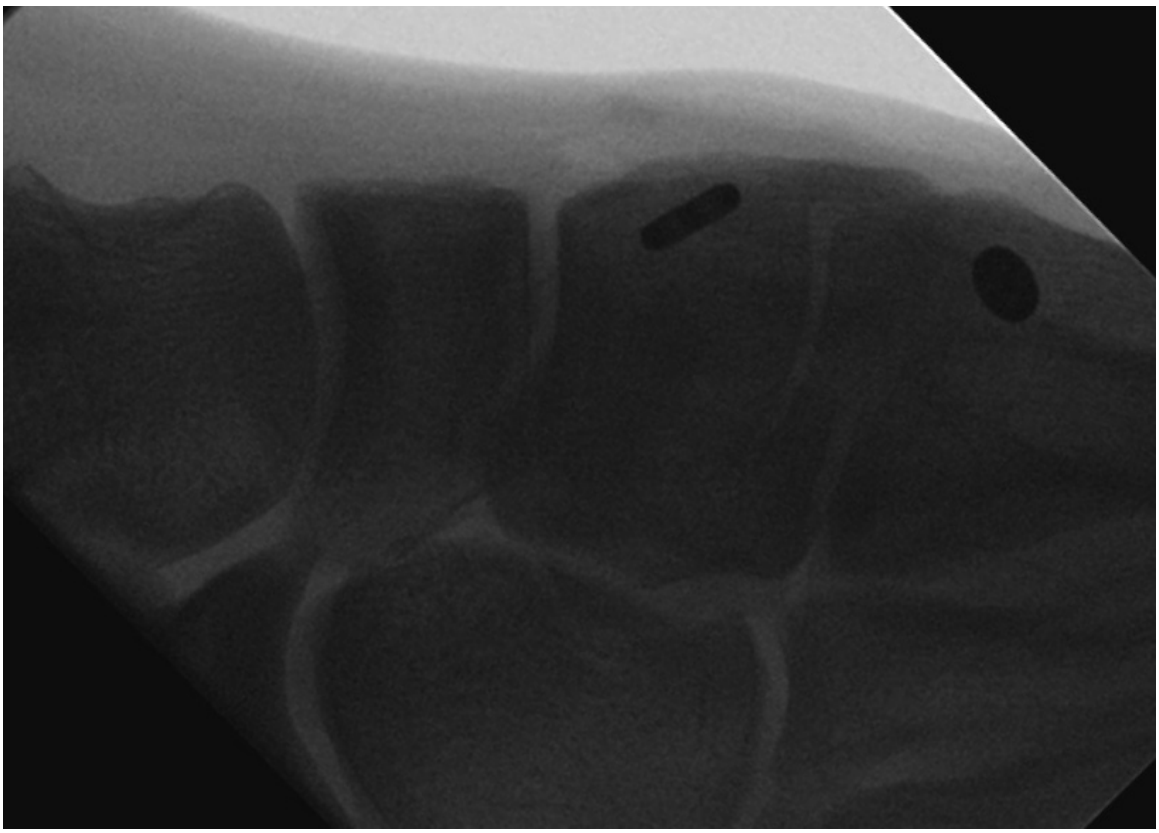

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