CHAPTER **26**

# LISFRANC INJURIES: A Review of Current Literature and Trends

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## INTRODUCTION

The tarsometatarsal articulations are arthroidal joints in the foot, commonly referred to as the Lisfranc joint. The bones of the first, second, and third cuneiforms articulate with metatarsal bases 1, 2, and 3. Laterally, the cuboid articulates with the bases of the fourth and fifth metatarsal bones. This complex, often referred to as a "roman arch," is an asymmetric convex-dorsal curvature that flattens out laterally. This so called arch is designed such that it prevents plantar displacement of the metatarsal bases. Secondary to its configuration, however, the anatomic reduction of injuries can be extremely difficult to achieve without internal fixation. When dorsal ligaments are disrupted, joint displacement can easily occur. At the time of injury, plantar muscles and tendons are left to bowstring across the tarsometatarsal joint, resulting in a shortening of the plantar aspect of the foot. If an injury occurs more laterally, it is essentially affecting the flatter edge of the arch, which results in a less pronounced bowstring effect.[1]

Common to Lisfranc injuries is the disruption of the ligament that courses between the lateral aspect of the first cuneiform and the medial aspect of the base of the second metatarsal. Disruption of this ligament presents as the quarterback of Lisfranc injuries. Coursing as the strongest ligament in the midfoot, any disruption can lead to an isolated diastasis, or numerous configurations of displacement.

Originally describing an injury of cavalry men, these joints were named after an 18th century surgeon and gynecologist, Jacques Lisfranc de St. Martin. He observed men falling off their horse and being drug alongside, with a foot caught in the strap. Forcing the foot into a slow hyperplantarflexion of the forefoot on the rearfoot, the tarsometatarsal joints were easily disrupted.[2] Currently we see this injury result from mechanisms of both high and low velocity impacts. High velocity injuries such as those with car accidents result from drivers slamming their foot on the brake, causing an extreme forefoot plantarflexion. This type of impact will usually disrupt ligamentous support resulting in comminution, frank dislocations, and can be accompanied by neurovascular compromise. It is these high velocity injuries where soft tissue swelling can lead to compartment syndrome.

On the other hand, the low velocity injuries, such as those seen in athletes, will produce more subtle effects. Surfers and equestrians using straps experience injuries as those mentioned by Lisfranc, with hyperplantarflexion of the forefoot on the rearfoot. Football players however, often plantarflex their feet with their metatarsophalangeal joints maximally dorsiflexed. This "lineman's stance" can lead to hyperplantarflexion of the Lisfranc joint and subtle displacement or fracture.[3]

## DIAGNOSIS

Lisfranc injuries remain one of the most commonly missed diagnoses of the emergency department.[4] In the absence of obvious fracture or dislocation, the untrained eye can easily overlook pathology. With undiagnosed pain, patients frequently seek further treatment from that of podiatrists, after leaving the emergency room. It is important to remember these injuries can occur at both high and low impact, so when taking a thorough history, keep in mind Lisfranc disruptions can present themselves in a variety of ways. Patients typically exhibit point tenderness at the site of Lisfranc, however swelling can make it difficult to pinpoint the injury. Commonly there is diffuse tenderness over the midfoot and along the metatarsal bases. Therefore, it is important to specifically palpate the navicular, medial, and middle cuneiforms, the bases of the metatarsals, and the space between the first and second metatarsals. Placing the foot through passive pronation and supination of the forefoot will often elicit pain, as this applies stress to the medial and lateral columns. Occasionally there may be subtle ecchymosis of the plantar midfoot.[3] As always, remember to examine both feet for comparison as well as the possibility of bilateral injuries.

Standard radiographic evaluation should include 3 weightbearing views of the foot; an AP, lateral, and medial oblique. Fractures found at the base of the first 3 metatarsals are very suspicious for an injury of the Lisfranc joint.[3] Displacements between bones of these joints should be carefully examined as well. On an AP view, the medical cortex of the second metatarsal should line up with the medial border of the intermediate cuneiform, and a displacement between the base of the first and second metatarsals of more than 2 mm is the standard for questioning a Lisfranc injury.[5] When looking at a lateral view, the dorsal cortical edge of the first metatarsal should line up with that of the medial cuneiform, as should the dorsal cortical edge of the second metatarsal with that of the intermediate cuneiform.[5] Cadaver studies have shown a 2 mm and 4 mm dorsolateral displacement of the second metatarsal relative to the intermediate cuneiform results in decreased joint contact by 25.5% and 50.6%, respectively.

Observations like these are important to identify and address when formulating a treatment plan. If however, radiographic evaluation lends nothing, it is appropriate to supplement with a magnetic resonance image (MRI) or computed tomography (CT) scan. CT can reveal the specific location and extent of fracture and MRI has proven to be accurate in detecting traumatic injury to the Lisfranc ligament.[6] Typically, if there is any question as to the extent of tarsometatarsal injury, a CT is ordered and the joints are carefully evaluated. The precise condition of joint surfaces is vital information when deciding ORIF versus primary fusion. Using the available diagnosing modalities is crucial to formulating a plan and aids in surgical decision making.

## CURRENT TRENDS IN TREATMENT

Once a definitive diagnosis has been made, the appropriate course of treatment must carefully be chosen. Unfortunately, there is not always a clear answer as to which of the many available treatment options is best suited for your patient. Various classification systems such as Hardcastle and Nunley and Vertullo have identified different fracture and dislocation patterns, however, they do not specifically correlate to treatment plans.[3] Is the patient a 90 year-old who is wheelchair bound, or an athlete wanting to get back in the game? Options include shoegear modification, immobilization, closed reduction with immobilization, closed reduction with percutaneous pinning, open reduction internal fixation, and primary arthrodesis. As with any treatment plan, it is extremely important to look at each patient individually and evaluate them for their best possible outcome.

## DIASTASIS LESS THAN 2 MM

To operate or not to operate is often the first difficult question to answer. Current recommendations suggest a diastasis of less than 2 mm between the bases of the first and second metatarsals is functionally stable and can be treated conservatively.[3] Depending upon the patient, treatment can include a nonweight-bearing cast for 6 weeks, or something as simple as shoe gear modification.[7] Currently, the trend is 6 weeks of a nonweight-bearing cast with progression to a walking boot. The literature suggests the dorsal cuneometatarsal and Lisfranc ligaments play important roles in stabilizing the first cuneiform-second metatarsal joint and thus recommend evaluating regular radiographs to rule out any further diastasis or fracture.[8]

## DIASTASIS GREATER THAN 2MM

Studies highly suggest that outcomes after Lisfranc injuries improve with the quality of tarsometatarsal joint reduction.[5] For those patients whose radiographs reveal a diastasis greater than 2 mm (Figure 1), or for those with obvious fracture, surgical intervention is usually warranted.[3] Closed reduction followed by casting of disrupted ligaments and capsular tissues has shown to have a high potential for further displacement.[9,10] It has even been shown that a primarily soft tissue injury to the tarsometatarsal complex can be worse than a severe fracture dislocation because of the resultant instability. As a result, it is widely accepted that closed reduction followed by casting is insufficient in the majority of Lisfranc dislocations.[9] So, for those patients with a dorsolateral displacement of more than 2 mm between the second metatarsal and intermediate cuneiform, open reduction and internal fixation is indicated.[5]

With advancements in technology, there are various options for surgical management. From percutaneous Kirschner-wire (K-wire) fixation to primary arthrodesis, several methods are currently being utilized. Acute comminuted fractures and unstable subluxations are often managed with K-wires.[1] However, for fleck fractures and more stable dislocations, screws, plates, and suture anchors are all viable options. There are also mini-fixators that can be placed percutaneously to reduce dislocations and stabilize across the Lisfranc complex. Specific fracture patterns and the severity of diastasis must be identified in order to achieve the ultimate goal of anatomic reduction with stable fixation. As to which method of treatment is most appropriate, stable, or strong, this is still a highly debated topic.

Figure 1. Diastasis greater than 2 mm.

Figure 2. Isolated Lisfranc ligament disruption or dislocation that has been stabilized with a single screw.

## ISOLATED LISFRANC LIGAMENT DISLOCATION

Traditionally, an isolated Lisfranc ligament (with or without a fleck fracture) disruption or dislocation has been stabilized with a single screw or K-wire (Figure 2). Screws specifically, are said to provide rigid biomechanical stability and have shown good results with open reduction internal fixation. Screws, however, also have their disadvantages. They require a second surgery for removal, damage articular surfaces, and have the potential for breakage.[11] More recently popularized for this type of injury is stabilization through the use of a suture button. Currently at this institution, the Arthrex Tight Rope (Arthrex Inc., Naples, FL) suture button system is a popular form of fixation when stabilizing an isolated Lisfranc dislocation (Figure 3). First utilized among podiatrists for syndesmotic injuries, the suture button system provides an alternative method of reduction that eliminates the complications of screw fixation.[2] Recently compared with the strength of cannulated screws, studies on the suture button have revealed fixation equivalent to that achieved with a screw.[11] Specifically, the No. 5 fiberwire (used with the suture button) is said to resist diastasis, is unlikely to fatigue or break, and allows for early weight bearing.[12]

Figure 3. Lisfranc dislocation stabilized with a suture button system.

Based on the construct of a braided suture tied over a button, its fixation potential has been said to depend on the specific knot tying technique. Physician variance, however, can be eliminated with the use of bone clamps held in place until the knot is tensioned. Suture buttons do not have to be removed, and therefore do not require a second surgery. It has been suggested, though, that the elasticity of the suture may slack secondary to erosion or tissue remodeling. After 8-12 weeks it is hypothesized that the Lisfranc ligament will have healed, which would be prior to any possible suture erosion.

As compared with screw fixation, screw removal can also be premature to complete biological healing, resulting in re-fracture or dislocation.[11] In the event of failed or broken screw fixation, reports have shown a revisional Lisfranc repair achieved with a suture button and washer.[13] Overall, regardless of the need for a second surgery, some surgeons continue to rely on the consistency of screw fixation and welcome the much cheaper patient cost compared with that of the suture button.

## MULTIPLE FRACTURES AND FRANK DISLOCATIONS

When faced with more than just a dislocation secondary to ligament disruption, multiple fractures and frank dislocations of the midfoot will require more aggressive treatment. The use of one or more screws, external fixators, and even primary fusions are typical. Secondary to high impact injuries, damage can be deleterious and choosing the appropriate therapy is crucial to long term stability. Open reduction allows for the direct visualization and precise anatomic placement of fixation.[1] As a result, the stability afforded from fixation has been shown to minimize swelling and promote healing.[9]

Again, various methods of fixation are available. Studies comparing the use of K-wires versus varied screw placements suggest specific differences in outcome. Using screws to stabilize the medial column provides a more rigid and stable construct, resisting deformation with dorsiflexion, plantarflexion, and lateral loading. This increased stability allows for safe, early mobilization.[1] When looking at the decision of pinning the lateral column versus utilizing screws, no significant difference in stiffness was observed. Being that the lateral column has inherently more motion than the medial column, multiple studies suggest rigid fixation may not be necessary, making temporary K-wires in this area a sufficient option.[9,11]

Understanding long term osteoarthritis along tarsometatarsal joint fractures or simple dislocations is highly predictable; some surgeons advocate initial treatment to include primary fusion.[10] Even stabilizations with cannulated screws can cause significant damage, as severe as fracture, to joint surfaces.[14] Studies comparing long term postoperative AOFAS midfoot scores of patients treated with open reduction internal fixation (ORIF) versus those with primary fusions revealed more favorable results with the latter. At two years postoperative, patients treated with primary fusion (of the medial two or three rays) felt their level of activity was 92% of their pre-injury level, as compared with only 65% in the open reduction group.[10] Primary arthrodesis also resulted in a statistically significant less need for secondary surgery (fixation removal) than the ORIF group. Overall, primary arthrodesis has been suggested to prevent patients from developing further pain and disability.[9]

## COMMINUTED SUBLUXATIONS

When looking at the result of high velocity traumas, the most severe tarsometatarsal joint comminutions and subluxations can seem devastating for the patient. Currently at this institution, a comminuted and subluxed Lisfranc injury is typically stabilized with multiple K-wires (Figure 4). Without enough real estate for screw placement, or sturdy bone for suture buttons, K-wires are an excellent choice to realign the joints and hold corrected positions. Whether percutaneous or buried, getting fracture pieces back as close to anatomic alignment is key. Wires are said to be less traumatic to the articular cartilage, easier to place and easier to remove than screws, however; they are not as rigid and

Figure 4. Comminuted and subluxed Lisfranc injury is stabilized with multiple K-wires.

have a higher rate of failure.[1] Nonetheless, after 8 weeks of bony consolidation, wires can be removed and the patient transitioned into a walking boot. Understanding here, that the wires will eventually be removed, leaving them easily accessible is advantageous. If they are left buried, for example, placing a bend in the wire's tip allows for easy grasp in later removal. And, as previously discussed, it is suggested to forewarn patients of highly predictable post-traumatic osteoarthritis.

## CONCLUSION

Lisfranc injuries can be life changing devastations for anyone. They are often misdiagnosed and difficult to treat. These injuries result in highly predictable osteoarthritis and take compliant non weight-bearing to heal. However, if handled properly, various treatment options can allow patients a return to pre-operative activity levels. It is important as podiatric physicians to be well versed in Lisfranc injuries as we are the frontline for both diagnosing and treatment.

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