Chapter 15
Lisfranc Fracture/Dislocation Treated with ORIF

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Abbreviations

AP Anteroposterior
ORIF Open reduction and internal fixation
TMT Tarsometatarsal

Case Presentation

A 31-year-old male patient presented to the office with pain in his left foot for 3 days secondary to an injury sustained while playing football. He was pushed from the back when his foot was in a plantar-flexed position, suffering from what appeared to be a hyperextension injury to the midfoot. The patient felt a crack/pop sensation followed by severe pain

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and swelling. The patient was non-weight bearing in his left foot but the pain failed to subside for 3 days. On exam, even though there was no evident plantar ecchymosis which would be a sign highly suggestive of a Lisfranc injury, diffuse soft-tissue swelling was documented over the first and second metatarsal bases, and midfoot movements caused significant pain and discomfort. Movement of the ankle joint, fore foot, and hind foot was pain free. His neurovascular exam was normal without any open wounds over the foot, and no signs of compartment syndrome were noted.

Treatment Considerations and Planning

If a Lisfranc injury is suspected, one should obtain anteroposterior (AP), lateral, and oblique radiographs of the foot in order to evaluate congruency of the tarsometatarsal (TMT) complex [1]. The AP view is used to evaluate the first and second TMT joints, the oblique view will allow the evaluation of the alignment of the third and fourth TMT joints, and the lateral view of the foot will be useful for the assessment of dorsal and plantar dislocations of the Lisfranc joint [2]. A Lisfranc injury is diagnosed when the medial base of the second metatarsal is not lined up with medial aspect of the middle cuneiform on an AP view. A pathognomonic radiologic sign is the "*fleck sign*" [3] between the bases of the first and second metatarsals, which indicates an avulsion of the Lisfranc ligament from either the medial cuneiform or the base of the second metatarsal. For patients with a subtle lesion, a stress radiograph consisting of a weight-bearing AP X-ray of both feet may help make the diagnosis of a Lisfranc injury if there is an increased joint space between the first and second metatarsals with respect to the uninjured foot [4]. In order to perform an adequate stress test, the weight should be evenly distributed on both feet, which may be painful for the patient; therefore in some cases using local anesthesia before taking the radiographs may help improve the quality of the test [1]. CT scans are useful among patients with

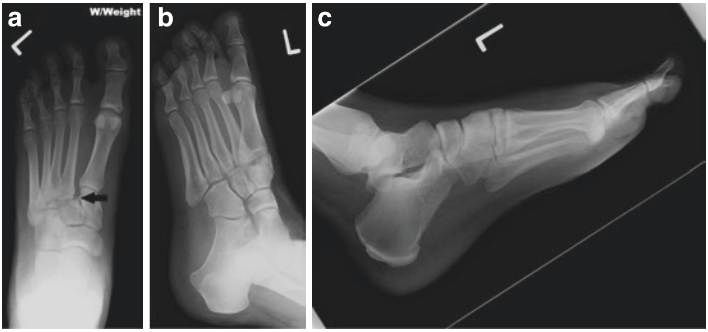

FIGURE 15.1 Radiographs of the patient's left foot taken 3 days after the injury. (**a**) Weight-bearing AP view showing >2 mm diastasis of the first intermetatarsal space and loss of alignment between the medial borders of the middle cuneiform and the base of the second metatarsal. The arrow is showing the *fleck sign*: an avulsion of the Lisfranc ligament from the base of the second metatarsal. (**b**) Oblique view shows congruent third and fourth TMT joints. (**c**) Lateral view showing no dorsal or plantar displacements

complex fractures who require a more accurate delineation of the fracture pattern. If there is no clear evidence of displacement in the X-rays but there is a suspicion of a Lisfranc injury then a MRI may help detect a sprain or rupture of the ligament.

In this case, the standard radiographs including AP, lateral, and oblique views of the left foot were obtained (Fig. 15.1). The AP radiograph revealed findings of 5.5 mm diastasis at the first inter-metatarsal space and a disturbed linear relation between the second metatarsal and the middle cuneiform, both findings consistent with the diagnosis of Lisfranc injury. The lateral three rays of the left foot appeared congruent on the oblique view and there was no evidence of vertical instability on the lateral view.

The first step in the management of any Lisfranc injury is to decide whether surgical fixation is needed. Anatomic reduction and internal fixation is the preferred option for injuries with a diastasis of more than 2 mm at the first metatarsal space [1, 5].

The different fixation options are screws, low profile plates, interosseous sutures, and K-wires, but, regardless of the implant used for fixation, the mainstay of treatment is to obtain an anatomic reduction of the Lisfranc joint, stabilizing the medial and middle columns of the foot while preserving motion of the lateral column [1, 5–7]. The advantages and limitations of various treatment modalities are as follows.

Screws: They remain the most popular treatment option, representing approximately 82% of the implants used for internal fixation of Lisfranc fractures [5]. Compared to fixation with Kirschner pins, small fragment fully threaded screws have better biomechanical features; they achieve superior stabilization and tolerate higher bearing forces without loss of reduction [7, 8]. On the other hand, they are transarticular implants with an inherent risk of causing thermal injury to cartilage possibly resulting in an increased risk of posttraumatic arthritis [9]. Another disadvantage of screws is the necessity for hardware removal. Although most authors suggest that screws should be removed between the third and sixth postoperative months, there is still no clear evidence regarding the indications for removal and when should this surgery be performed [1, 10].

Interosseous suture techniques: Open reduction and internal fixation (ORIF) using suture techniques have been recently developed trying to overcome the problem of damaging the articular surface with screws and possibly decreasing the incidence of posttraumatic arthritis. Studies have shown equivalent stability compared to screws, and suture systems do not require an additional procedure for hardware removal [11, 12]. Theoretically, suture techniques can be effectively used for fixation because they mimic the Lisfranc ligament and can help maintain reduction, making them a suitable treatment option for athletes [2, 13, 14]. There is inadequate evidence to support a routine use of this technique over screws.

Plates: Low-profile plates have been utilized in the treatment of Lisfranc injuries; they are joint-spanning implants and therefore are less likely to cause damage to the articular surface, and they are removed only if the patient becomes symptomatic [1]. The surgical approach and exposure are wider with respect to the approach needed for screws and this can compromise blood supply and soft tissues, potentially affecting bone healing [15]. Although to date there are no clear indications for their use, plates are helpful for ORIF of comminuted fractures [1]. The stability achieved with plates is similar to the stability obtained when using trans-articular screws and loss of reduction with weight-bearing forces is comparable to screws [16, 17].

Based on these factors, the decision was made to perform ORIF with screws.

Intraoperative Tips and Tricks for Reduction and Fixation

The procedure was performed with the patient in a supine position with his knee flexed and using a triangular support in order to allow a plantigrade position of the foot. A dorsal longitudinal incision over the first TMT joint space between the extensor hallucis longus and the extensor hallucis brevis tendons was made. The neurovascular bundle was carefully preserved while exposing the first intermetatarsal space. Under direct visualization, the first TMT joint was tested and found to be unstable, so the first ray was stabilized with an axial screw from the metatarsal to the medial cuneiform and a pointed reduction clamp was then placed across the medial cuneiform to the second metatarsal base to reduce the Lisfranc complex. The Lisfranc screw was placed from the medial aspect of the medial cuneiform to the second metatarsal base and the second metatarsal was additionally stabilized with a screw from the base to the middle cuneiform. Intraoperatively, the third metatarsal was stressed and found to be unstable; hence a screw was placed across the third TMT joint. The lateral column was stable when tested intraoperatively; therefore no further fixation was required. Finally, the quality of the reduction was confirmed clinically and radiographically (Fig. 15.2).

In cases where the joints in the lateral column are found to be unstable, attempts for close reduction and percutaneous fixation can be done. If reduction cannot be maintained,

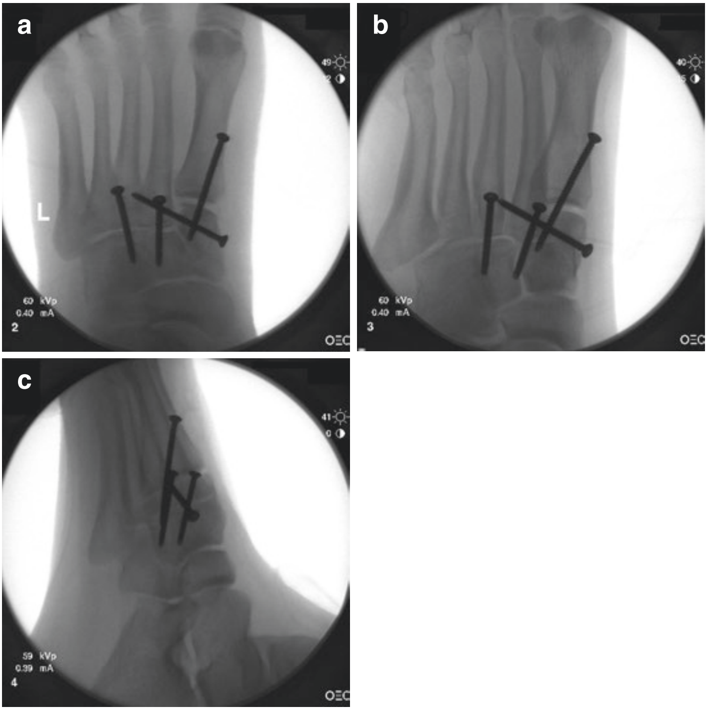

FIGURE 15.2 Fluoroscopic images of the final reduction and fixation of the Lisfranc injury. (**a**) AP view showing fixation with a Lisfranc screw. Note that the medial borders of the second metatarsal and the middle cuneiform are aligned. The first and second metatarsals are fixed to the medial and middle cuneiforms, respectively, using fully threaded screws. (**b**) Oblique view shows the third metatarsal fixed to the lateral cuneiform and congruent fourth and fifth TMT joints. (**c**) No vertical instability documented on the lateral view

or is difficult to achieve by these means, open reduction is required. A dorsal longitudinal incision over the fourth intermetatarsal space will allow access to the third and fourth TMT joints and reduction under direct visualization can be performed. Flexible fixation with Kirschner wires will help maintain reduction without completely restricting motion of the lateral column and they are typically removed after 6 weeks [1, 10].

Key Points/Pearls

- Make longitudinal incisions to address the affected joints: A dorsomedial approach will give access to the first and second TMT joints and a dorsolateral approach will give access to the TMT in the lateral column. *Beware:* Protect skin flaps to avoid necrosis [10].
- If anatomic reduction can't be obtained look for soft-tissue interposition (tibialis anterior tendon) [1, 18].
- The sequence of reduction of Lisfranc fractures should go from proximal to distal and from medial to lateral, reducing and temporarily fixing the medial column first, following reduction of the middle and lateral columns [10, 18].
- Anatomic reduction and rigid fixation of the medial and middle columns + flexible fixation (pins) of the lateral column if needed [19].
- The Lisfranc screw can be placed from the base of the second metatarsal towards the medial cuneiform as the target is bigger [15].
- Avoid using lag or partially threaded screws because they can increase stress across the articular surface [2].
- Always evaluate the quality and stability of the fixation.

Postoperative Protocols and Follow-Up

The patient was kept nonweight bearing in a splint during the first 6 weeks and was encouraged to slowly advance to full weight bearing over the next 4–6 weeks. By the end of 12 weeks the patient was full weight bearing in his regular shoes.

Controversy remains regarding screw removal and the timing of the procedure. Although the patient did not develop hardware-related symptoms, when the risks and benefits of hardware removal were explained, he opted for screw removal and the surgery was performed after 5 months. At 1-year follow-up, the patient reported no complaints and did not have difficulty in carrying out his regular activities. Radiographs obtained revealed a well-aligned foot with well-maintained reduction of the Lisfranc joint and there were no degenerative changes (Fig. 15.3).

FIGURE 15.3 Follow-up X-rays at 3 months and 1 year postoperative. (**a**) and (**b**) AP and oblique views at the third postoperative month showing that the reduction is maintained and no implant failure. (**c**) and (**d**) AP and oblique views at 1-year follow-up. Screws have been removed and reduction of Lisfranc joint has been maintained

Another Mode of Treatment

Here we have a similar clinical scenario of a pure ligamentous Lisfranc injury of the right foot of a male adult sustained while he was practicing football. Additional to the initial set of X-rays, a stress test was performed and demonstrated instability of the Lisfranc complex (Fig. 15.4).

As joint instability was documented, the decision to proceed with surgical treatment was made and the patient underwent ORIF with interosseous sutures. In this case the reduction of the Lisfranc complex was maintained using a tenaculum clamp while a guide wire was placed from the medial cuneiform to the base of the second metatarsal in a percutaneous fashion. After confirmation of the position of

FIGURE 15.4 Shows full weight-bearing AP views of both feet (stress test). The first intermetatarsal joint space is >1 mm wider with respect to the left foot

FIGURE 15.5 Fluoroscopic AP view of the reduced Lisfranc complex and its fixation using and interosseous suture

the guide wire using biplanar fluoroscopy, a drill hole was made using a 2.7 mm drill bit to allow the passage of the tightrope needle. Subsequently, the needle was passed through the drill hole, an anchor was pulled through and engaged on the medial cortex of the medial cuneiform, and the button was tightened down at the base of the second metatarsal (Fig. 15.5). Finally, the stability of the reduction was checked under fluoroscopy and no instability of the TMT joints was evidenced.

During the follow-up period, the postoperative protocol was similar to the one described previously. At his last follow-up, the patient was asymptomatic and tolerated full weight bearing. The X-rays showed a reduced Lisfranc joint and no failure of fixation materials (Fig. 15.6).

FIGURE 15.6 Follow-up X-rays at 3 months postoperative showing maintenance of reduction and no implant failure in both AP (**a**) and lateral views (**b**)

Outcomes

Although there are multiple short- and long-term complications (compartment syndrome, neurovascular injuries, flat foot deformity, and chronic instability), posttraumatic arthritis continues to be the most common problem after Lisfranc injuries [10]. The most important factors contributing to this are the extent of the initial injury and the quality of the reduction after ORIF. Regardless of which implants are used for internal fixation, an anatomic reduction is the main determinant for achieving good clinical outcomes [6]. Although approximately 50% of patients will have arthritic radiographic changes in the follow-up X-rays, not all patients are symptomatic, and only 7–8% require arthrodesis [5].

ORIF of severe fracture dislocations are associated with less pain and less stiffness compared to primary arthrodesis [10, 15]. As discussed, anatomic and stable ORIF can be achieved using either screws or interosseous sutures; however the advantages and limitations of these implants must be considered in order to choose the appropriate implant for each individual patient.

Although current evidence suggests that better clinical outcomes are obtained when primary arthrodesis is performed in patients with purely ligamentous injuries [6, 10] the evidence comparing the use of arthrodesis vs. ORIF with interosseous sutures for treating this type of injury remains scarce. Despite a lack of strong evidence, fixation using interosseous sutures may be advantageous, especially in athletes as it allows early weight bearing, doesn't require hardware removal, and preserves midfoot mobility [2].

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