10 Failed Lisfranc ORIF

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Introduction

Lisfranc injuries typically are injuries to the tarsometatarsal joint complex, specifically between the medial cuneiform and base of the second metatarsal. There are many variations also involving fractures of the base of the metatarsals, intercuneiform ligament disruptions, and cuneiform fractures. In general then, a "Lisfranc" injury may be considered any injury, whether bony or ligamentous, in the region from the naviculo-cuneiform joint through the intertarsal and tarsimetatarsal area, extending distal to the base of the metatarsals. Injuries proximal to this involving the navicular and talo-navicular as well as cuboid and calcaneo-cuboid areas are Chopart injuries. Injuries can range in severity and may be purely ligamentous or contain fractures and/or joint disruptions.

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Injuries to the Lisfranc region may be due to direct high energy mechanisms, sometimes with vascular injury, or due to axial loads applied to a plantarflexed forefoot.

Injuries are often overlooked by initial assessing providers and can be mistakenly labeled a foot "sprain."

Timely initial diagnosis does not necessarily improve outcome and in fact, delay may lead to better surgical results. Accurate diagnosis of a Lisfranc-type injury is made by a thorough physical examination with high suspicion for Lisfranc injury and radiographic imaging. Most often the diagnosis can be made using simple inexpensive means. Expensive imaging is not needed in most instances of Lisfranc injury.

We will review our methods and discuss why and how treatments sometimes fail.

Diagnosis

A keen understanding of the Lisfranc joint and mechanisms of injury are important when correctly diagnosing a Lisfranc injury. At initial presentation to an emergency room, these injuries may be misdiagnosed as a foot "sprain" by an untrained eye.

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Fig. 10.1 Clinical picture of a foot demonstrating plantar ecchymosis

At initial inspection, plantar ecchymosis might be seen, which is a strong indication of a Lisfranc type injury. Soft tissue swelling is also present and should be evaluated to identify possible presence of associated foot compartment syndrome (Fig. 10.1).

Patients may describe extreme pain that seemingly exceeds what might be expected from a common "sprain." They report feelings of severe pain with nausea and an inability to bear weight.

A thorough physical examination may be difficult to perform due to the patient's pain. A gentle examination can be performed but if the pain is too severe, there are other modalities of evaluation described below.

Weight-bearing X-rays are often diagnostic but, as previously described, can be difficult to obtain due to pain. Every effort should be made to have the patient stand on the X-ray plate for imaging as full weight-bearing images are often diagnostic. Any degree of weight-bearing is better than non-weight-bearing images. Contralateral images might also be obtained for comparison. If weight-bearing radiographs are not initially obtained at the time of injury or if there is a question as to whether there is an injury, the patient can have weight-bearing images at the time of their first visit in the office which should be within 1–2 weeks (Figs. 10.2, 10.3, and 10.4).

At the time of injury, it is acceptable to place the patient in a non-weight-bearing splint until clinic follow up.

Fig. 10.2 Weight-bearing AP view of the foot demonstrating the lateral displacement of the first and second TMT joints

Physical Exam

The physical exam begins with thorough inspection and palpation of the affected foot. These injuries are commonly associated with plantar foot ecchymosis. It is important to note any visible bony deformities or, less commonly, open wounds. There will typically be dorsal foot swelling and tenderness to palpation over the tarsometatarsal joint.

An instability test can be performed by grasping the metatarsal heads and applying force while

Fig. 10.3 30-degree oblique view of the foot demonstrating lateral displacement of third metatarsal on lateral cuneiform

the other hand palpates the tarsometatarsal joint. While holding the heel firmly, varus and valgus manipulation by the other hand can elicit pain and gross instability. If the pain is severe, it may not be possible to elicit a gross midfoot instability. If physical exam is too painful, an ankle block or use of propofol in the ER can be used to allow manipulation, with radiographic or mini-fluoro images showing the gross instability (Fig. 10.5).

Less obvious entities including avulsion fractures can be seen on CT scan. This is important to evaluate, as properly selected treatment is dictated by pathology (Fig. 10.6).

Inspect and palpate the lower limb musculature to check for compartment syndrome.

It is also important to perform a Silverskiold exam to test for equinus contracture. If there is a

Fig. 10.4 Lateral view of the foot demonstrating dorsal displacement of the metatarsals

Fig. 10.5 Instability test demonstrating displacement of the Lisfranc joint

contracture, it must be addressed. This will be discussed further in the treatment section.

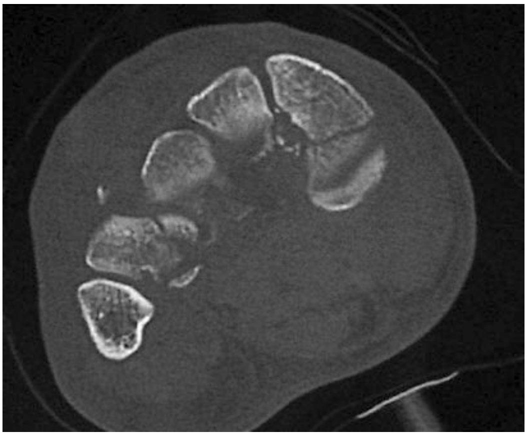

Fig. 10.6 Axial CT scan of the foot demonstrating multiple metatarsal fractures

Technique for Fixation

Approach

The goal for reconstruction is to restore anatomy and function. Pre-op planning is an important tool that can help decide on an appropriate surgical approach, choice of implant, and order of operation. Our surgical approach entails a dorsal double parallel and medial mini incision. The medial incision will give you access to the first tarsometatarsal and medial second tarsometatarsal joint, and the lateral incision will give you access to the lateral second and third tarsometatarsal joint. It is important to work back and forth between the two dorsal incisions, seen in Fig. 10.7a, b, and to not undermine the middle flap. This will help to protect the dorsal flap from damage and necrosis.

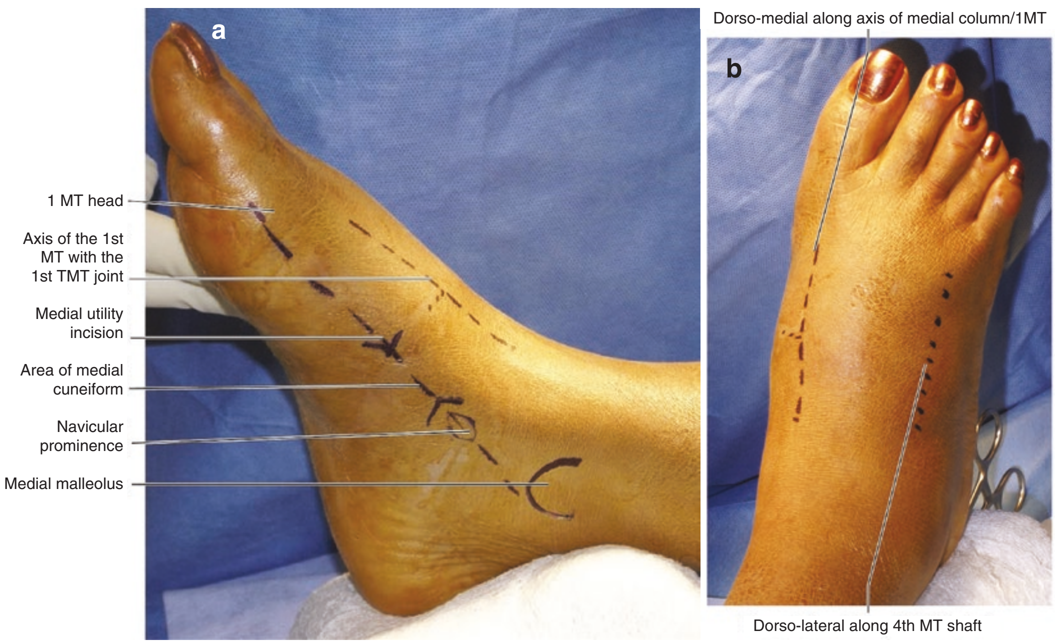

Fig. 10.7 (**a**, **b**) Clinical pictures of right foot demonstrating anatomic landmarks and surgical incisions. (Reprinted from Sands and Swords, © 2018, with permission from Elsevier)

Helpful Hardware/Implants

It is important to gather all appropriate hardware and implants prior to surgery so that there are no intraoperative delays retrieving hardware. Reduction clamps are a vital tool that can be used initially to stabilize the bony structures (Fig. 10.8).

It is important to have multiple drills, ranging from sizes 2.0, 2.5, 2.7, 3.5, and 4.0, as well as smooth 1.6 and 2.0 K-wires. Longer drills are better used by allowing the chuck to be located more distally. If a short bit is used, the chuck, when spinning, can hit the dorsal skin and toes. A wide array of hand instruments, including elevators and pics, should be used to help free up bony margins and maintain appropriate alignment prior to fixation (Fig. 10.9).

There is a wide variety of implants available for fixation but we prefer a 4.0, fully threaded solid screw. This screw provides a low-profile head, a larger shaft compared to 2.7 and 3.5 screws, a 1.25 thread pitch, and a self-tapping tip (Fig. 10.10).

Surgical Tips and Tricks

It is not enough to have the appropriate approach and surgical implants. Proper techniques for fixation are vital for successful outcomes. A pocket hole is used to prevent dorsal cortical breakout as the screw head engages bone. It is important to start the screw at least 2 cm from the joint in order to create a long lever arm (Fig. 10.11).

Fig. 10.8 Synthes point-to-point reduction clamps used in the dorsal double parallel approach

Drill techniques can vary and are important to consider in different pathology. A gliding hole and lag technique should be used for tarsometatarsal compression. When compression is not wanted across the joint, be sure to drill straight through

Fig. 10.9 Synthes hand instruments

Fig. 10.10 Synthes screws sized from top to bottom, 4.5 mm, 4.0 mm, 3.5 mm, 2.7 mm

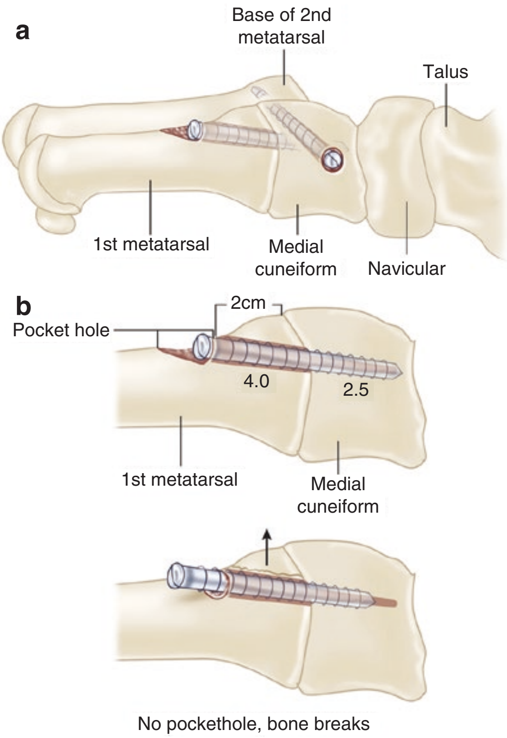

Fig. 10.11 Picture of pocket hole technique. (Reprinted from Sands and Swords, © 2018, with permission from Elsevier)

and avoid a lag technique. As mentioned above, longer screws placed farther from the joint create better leverage. For a fusion of a pure ligamentous injury, proper joint prep leads to increased fusion rates—denuding the area, drilling the subchondral bone, and creating a symmetric joint space—and shear strain relief bone grafting is critical for good fusion outcome. For an open reduction and internal fixation, perfect anatomic reduction is the most important concept.

The order of operation is also important to take in to account. This will be further described later in the chapter, but if an intertarsal injury is found, this should be addressed first.

Open Reduction Internal Fixation

For a fracture-dislocation of the Lisfranc joint, we prefer the dual dorsal parallel and mini medial incision. The medial incision is cheated a bit medial. Deeper dissection follows the interval between the EHL and EHB. These tendons are retracted with a self retaining retractor and a blue pen marker can be used to identify the capsule and periosteum for closure. However, these structures are often disrupted by mechanism of injury.

Step 1

If there is no intertarsal injury, as in this case, we initially pay attention to fixing the second tarsometatarsal joint. Using the medial dorsal incision, closely inspect the medal base of the second metatarsal and clean the corner to remove any soft tissue or loose fragments, taking care to not destroy the sharp corner where the base of the second MT fits into the keystone area. Then, reduce the base of second metatarsal into the corner and hold with a point-to-point reduction clamp that is placed in the mini medial and lateral dorsal incisions. Using the medial incision, a 4.0 drill hole is made through the medial cuneiform and then a 2.5 drill through the base of the second metatarsal under fluoroscopic guidance. Insertion of the 4.0 screw will lag and reduce the base of the second metatarsal into the corner, in optimal position. Alternatively, the lag screw can be paced from the base of the second MT through the dorsolateral incision into the medial cuneiform (Fig. 10.12).

Step 2

Next, we focus on the first tarsometatarsal joint. Through the dorsal medial incision, we can visualize the joint, directly reduce, and provisionally hold with smooth k-wires. A long 2.5 mm drill bit is then passed from distal to proximal through the first tarsometatarsal joint. A 4.0 solid screw is then inserted (Fig. 10.13a, b).

Step 3

Through the dorsolateral incision, attention is turned to the third metatarsal base. A point-to-point reduction clamp is placed with the tips in the medial incision and dorsolateral incision. Again, note that access to the lateral base of the second metatarsal and third metatarsal base is through the dorsolateral incision and not by overly aggressive dissection and lateral pulling through the dorsomedial incision, as it causes soft tissue damage to

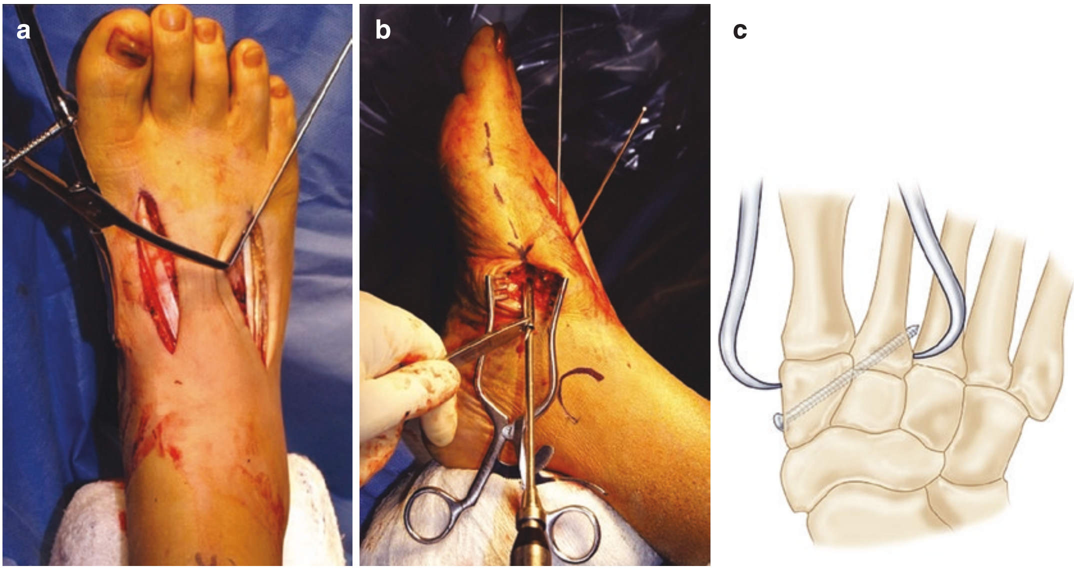

Fig. 10.12 Reduction of the second TMT joint. (Reprinted from Sands and Swords, © 2018, with permission from Elsevier)

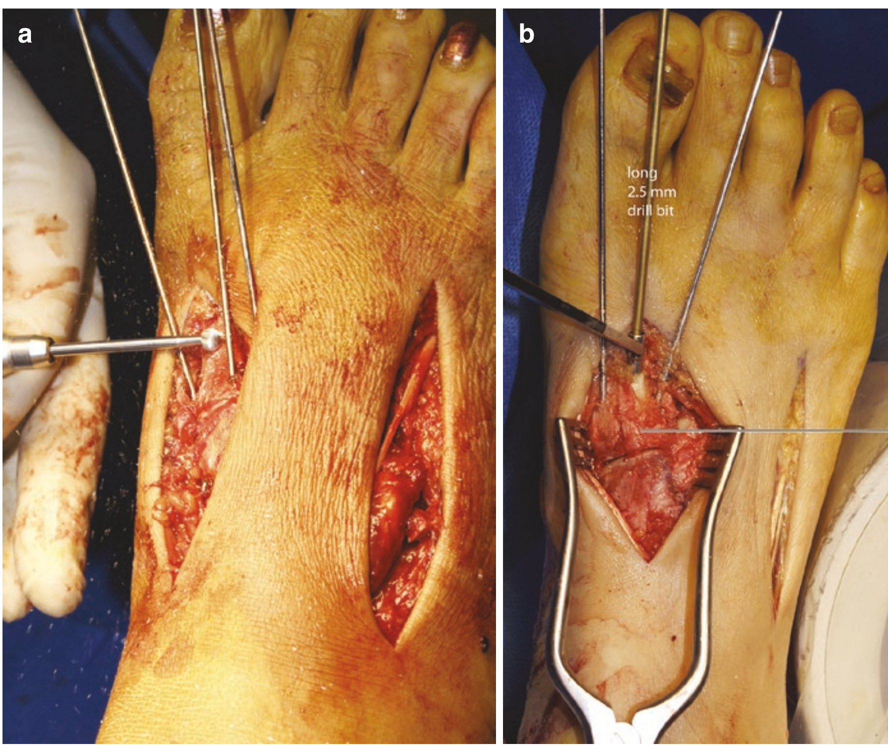

Fig. 10.13 (**a**, **b**) Fixation of the first TMT joint. (Reprinted from Sands and Swords, © 2018, with permission from Elsevier)

Fig. 10.14 Fixation of the base of the third MT. (Reprinted from Sands and Swords, © 2018, with permission from Elsevier)

the bridge and may injure the vascular bundle which is within the flap. Again using a 4.0/2.5 drill combination with a pocket hole on the dorsal base of the third metatarsal, a lag screw is placed from the base of the third metatarsal into the lateral or intermediate cuneiform (Fig. 10.14).

Step 4

The fourth and fifth tarsometatarsal joints often reduce with the more medial reduction. As such, K-wires can be placed from 4/5 metatarsal base into the cuboid under fluoroscopic guidance. More rigid implants can fail and lead to poor outcomes (Fig. 10.15).

Intertarsal Instability

Intertarsal instability can be concomitantly seen with Lisfranc injuries. If this is the case, the goal is to fix the intertarsal instability first. This reduction is initially achieved by placing smooth K-wires (1.6–2.0 mm) from medial to lateral across the unstable joints. Often these injuries are corrected under fluoroscopic indirect reduction. If the injury is more severe and direct reduction is needed, the medial and dorsomedial incision can be extended proximally. Lag technique can be used as these are non-essential non-mobile joints, and, so, stiffness does not lead to loss of function. Screws should be placed after the tarsometatarsal screws have been placed as smaller screws are often needed to stabilize intertarsal injuries. 2.7 or 3.5 screws can be used

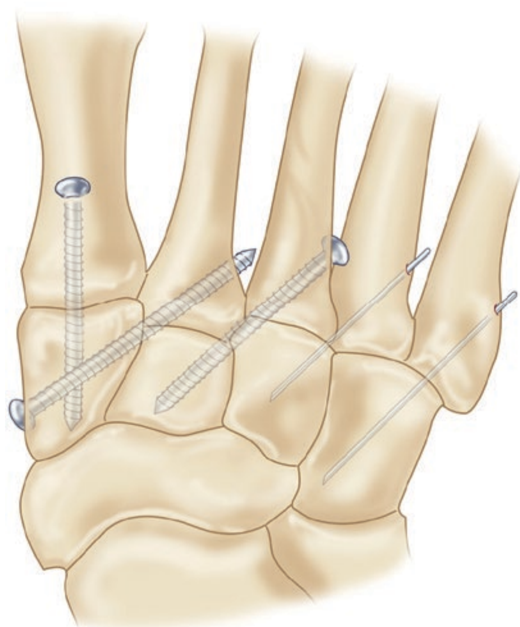

Fig. 10.15 Fixation of the fourth and fifth TMT joint. (Reprinted from Sands and Swords, © 2018, with permission from Elsevier)

transversely if insertion among the criss-cross screw pattern is difficult.

Base of Metatarsal Fracture

Frequently associated with Lisfranc joint disruption are injuries sustained to the base of the second metatarsal. These fragments can be provisionally held in position and reduced with small K-wires coming in perpendicular to the metatarsal shaft. Further, ORIF with screws of all tarsometatarsal joints takes place. Often, the LF ligament, which is attached to the plantar base of the second metatarsal avulses, leading to a triangular plantar fragment. During the reduction, the base of the second metatarsal can be moved a bit lateral and any debris and soft tissue from the inter-fragmentary area is removed. Since the fragment is rigidly held by the ligament and the injury is the avulsion and displacement of the base of the second metatarsal, then reducing this to the intact plantar ligament fragment leads to reduction of the fracture. Fixation of the base of the second metatarsal to the medial cuneiform leads to reduction of the plantar fragment and bone-to-bone healing. As such, it is unnecessary to perform direct ORIF of the plantar fragment.

If there is a more complex fracture on the base of the second and/or third metatarsal, then a spanning plate can be used from the MT shaft onto the cuneiforms.

Equinus Contracture

As part of the initial physical exam, all patients should be examined for equinus contractures. Testing of the uninjured side can suggest that the contracture exists on the injured side as well. This is especially important in purely ligamentous injuries. If not addressed, this can lead to breakdown of the repair. Gastrocnemius release is often needed and is the first step in order of operations. Through a small medial incision at the level of the musculotendinous junction, a speculum can be inserted to visualize the full medial to lateral extent of the fascial plane across the muscle belly. This allows easy visualization and access to releasing the fascial layer.

Why Does It Fail?

Failure of treating Lisfranc injuries can be due to multiple modalities. These include misdiagnosis, intraoperative shortcomings, patient-specific variables, and improper postoperative care. Failure can also be seen in patients who choose to be treated non-operatively.

Intraoperative Shortcomings and Improper Implants

Proper implants and appropriate surgical technique are important for successful outcomes in Lisfranc injuries. What is most cost effective might not be the best option and sometimes it may be necessary to have more than one manner of fixation across the joint. A keen knowledge of the anatomy is important for being able to use implants appropriately, by recognizing that there is a forefoot long bone torsional rotation moment versus a mid-foot bending moment.

In the following case, not only do we see the use of unnecessary and expensive constructs, but we see implant failure due to improper screw placement and lack of appropriate reduction.

Case 10.1

This is a 55-year-old man who suffered a twisting injury to his foot. He was seen at a local ER and sent to a local allied health provider who took him for surgery. Injury films show a stress test indicating a purely ligamentous Lisfranc injury. The allied health provider initially placed the patient in an external fixator, followed by a second surgery placing two cannulated screws. The patient came to our clinic 3 months after surgery with continued pain. The initial technique and implants for fusion was inadequate. We took the patient to the OR for a mid-foot fusion and total Achilles lengthening (Figs. 10.16a, b, 10.17a, b, and 10.18).

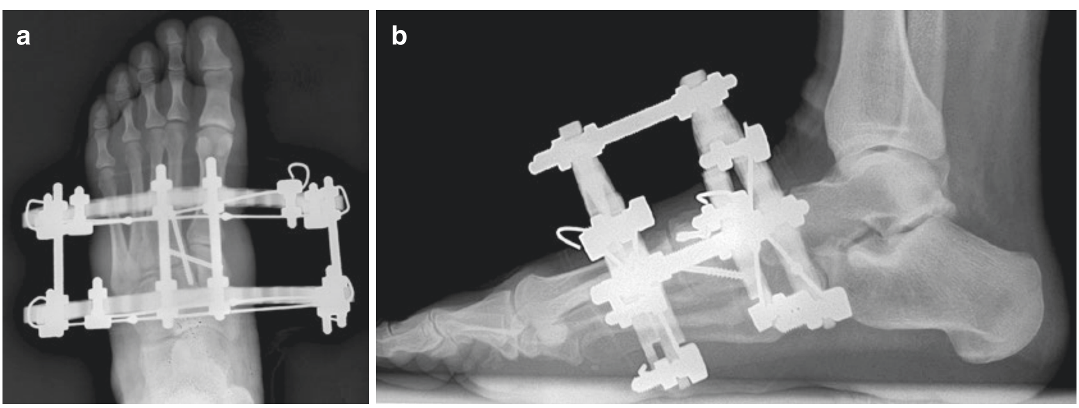

Fig. 10.16 (**a**) AP and (**b**) Lateral X-Ray of left foot showing placement of an external fixator

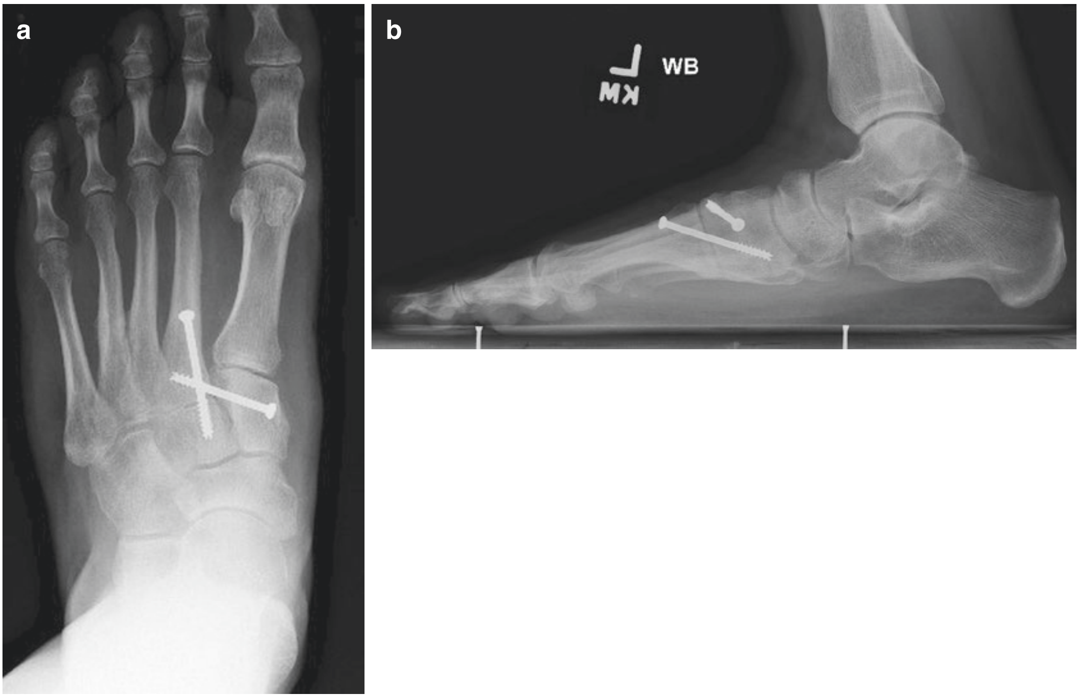

Fig. 10.17 (**a**) AP and (**b**) lateral X-ray of left foot 3 months post-op, demonstrating a non-reduced joint space and improper screw placement

Misdiagnosis

A misdiagnosis in the ED, commonly classified as a "sprained foot" can lead to continued pain and limitations in a missed Lisfranc injury. Similarly, Lisfranc injuries can be improperly treated with closed reduction.

Failure to recognize the injury pattern can lead to improper treatment. For example, in a purely ligamentous injury, treatment with immediate fusion does better than ORIF. Access to advanced imaging may help identify injuries missed on initial evaluation, including plantar avulsion fractures. Occasionally, however, a correct diagnosis of a Lisfranc injury is made, but the severity of the injury is not appreciated and treated improperly. In the following case, we have a patient with a grossly unstable Lisfranc injury. The patient was initially treated improperly, by the provider failing to identify the associated intertarsal injury. We took the patient to the operating room for open reduction and internal fixation through a medial approach and insertion of a mesh plate (Figs. 10.19, 10.20, 10.21, and 10.22).

Subtle injuries can often be overlooked in high performing athletes, and their foot injuries should be thoroughly worked up. Failure to identify these injuries and initiate appropriate treatment can lead to loss of a career in sports (Figs. 10.23a, b, and 10.24).

Cost

There are a variety of implants that can be used to treat a Lisfranc injury, and it is important to understand relevant cost disparities between them. One should not always choose the cheapest option. For example, using screws plus a plate versus only using screws in a husky individual.

Comorbidities

Unrecognized diabetes mellitus and charcot arthropathy. Charcot mid foot often presents as an acute injury but really is a gradual process, and failure to recognize this can lead to improper

Fig. 10.18 Three views of the left foot 6 months after hardware removal and subsequent midfoot fusion and calf gastrocnemius release

Fig. 10.19 Pre-operative injury film of left foot showing first and second intertarsal widening and medial cuneiform abnormality

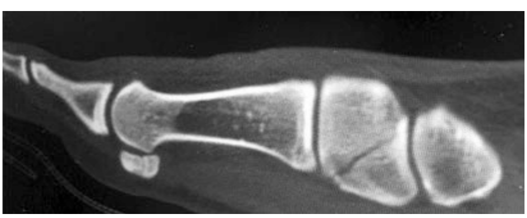

Fig. 10.20 CT scan of left foot showing a minimally displaced fracture at the base of the medial cuneiform

Fig. 10.21 Intraoperative fluoroscopy showing intertarsal instability

Fig. 10.22 AP left foot with plate in place

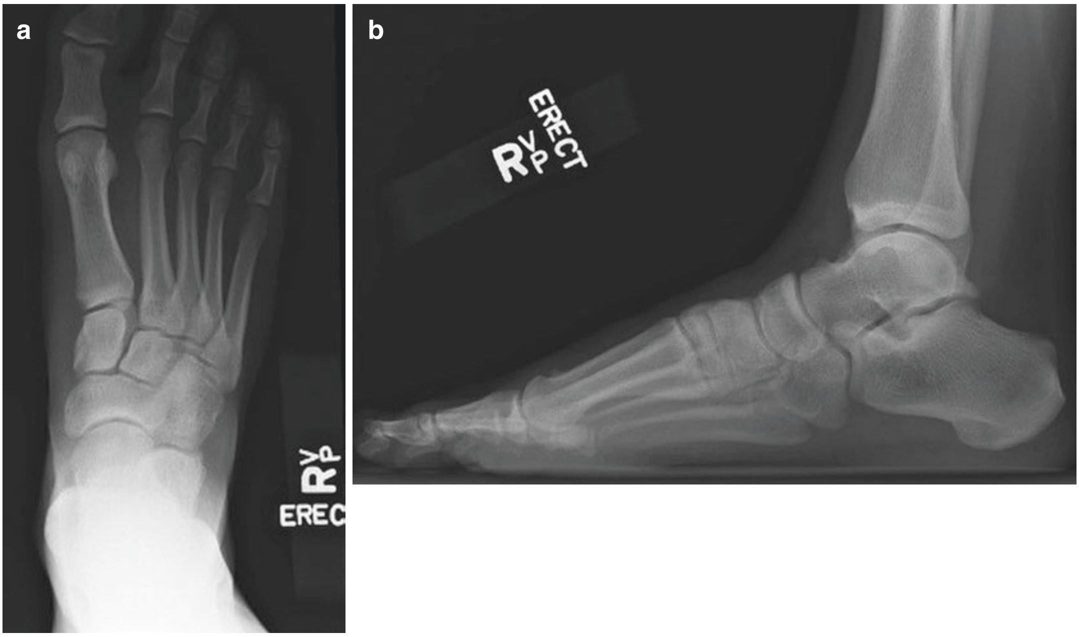

Fig. 10.23 (**a**) AP and (**b**) lateral weight-bearing radiographs of an athlete who suffered an on-field right foot injury. No apparent injury is identified on initial imaging

Fig. 10.24 CT scan of right foot showing a fleck of bone in the Lisfranc joint

treatment with an ORIF versus a more appropriate extensive fusion. It is important to recognize that these cases require a longer period of non-weight-bearing compared to patients without this comorbidity. Metabolic bone disease (renal failure) patients might be best treated non-operatively for the fact that operative techniques most likely will fail.

Postoperative Care

Postoperative care starts intraoperatively by applying a three sided, fluffy splint covered with an ace wrap. The patient will return to clinic in 2 weeks for wound inspection and evaluation of soft tissue swelling. The patient will be non-weight-bearing for 6 weeks with crutches; then transitioned to six more weeks in a cane with a CAM boot or short leg cast. The advantage of a CAM boot is that it allows wound care and gentle active range of motion at the ankle joint. As each injury behaves independently, it has been shown that fractures heal faster than pure ligamentous injuries and might be able to advance to weight-bearing sooner in the postoperative course. At 3 months, transition to a cushioned shoe or molded insert and begin physical therapy, focusing on gait training, range of motion exercises, and lower extremity rehabilitation. Delay weight-bearing to 3 months for patient with charcot arthropathy or metabolic bone disease.

Suggested Readings

1. Aronow MS. Treatment of the missed Lisfranc injury. Foot Ankle Clin. 2006;11(1):127–42.
2. Crates JM, Barber FA, Sanders EJ. Subtle Lisfranc subluxation: results of operative and nonoperative treatment. J Foot Ankle Surg. 2015;54(3):350–5.
3. Kuo RS, Tejwani NC, DiGiovanni CW, Benirschke SK, Hansen ST, Sangeorzan BJ. Outcome after open reduction and internal fixation of Lisfranc joint injuries. J Bone Joint Surg. 2000;82(11):1609–18.
4. Ly TV, Coetzee JC. Treatment of primarily ligamentous Lisfranc joint injuries: primary arthrodesis compared with open reduction and internal fixation. J Bone Joint Surg. 2006;88(3):514–20.
5. Sands AK, Swords MP. Procedure 22: Open reduction and internal fixation of Lisfranc/tarsometatarsal injuries. In: Operative techniques: Foot and Ankle surgery: Elsevier Health Sciences; 2017. p. 172–9.
6. Sangeorzan BJ, Veith RG, Hansen ST Jr. Salvage of Lisfranc's tarsometatarsal joint by arthrodesis. J Foot Ankle Surg. 1990;10:193–200.
7. Teng AL, Pinzur MS, Lomasney L, Mahoney L, Havey R. Functional outcome following anatomic restoration of tarsal-metatarsal fracture dislocation. Foot Ankle Int. 2002;23:922–6.