36 Lisfranc fracture dislocation

36.1 Introduction

The Lisfranc, or tarsometatarsal (TMT), joint is named after Jacques Lisfranc de Saint-Martin (1790-1847), a French Napoleonic-era field army surgeon.¹ He preferred to perform an amputation through this joint as it was faster than cutting through the bone in soldiers who injured a foot as they fell off a horse with the foot caught in the stirrup and developed gangrene. Although Lisfranc did not describe the injuries or mechanism of injury in the tarsometatarsal region, his name is used to describe these injuries.

These high-energy injuries can cause severe deformity due to displaced fractures and/or dislocations at the TMT joint and are often associated with other injuries. Low-energy or primarily ligamentous injuries involving the Lisfranc ligament can be subtle and potentially missed on initial evaluation.² Injuries to the TMT joint complex occur in 1 in 55,000 persons each year in the United States, accounting for approximately 0.2% of all fractures.² These injuries are two to four times more common in men, with an average age at injury in the mid-thirties.³

36.2 Anatomy
The structural support in the midfoot is derived from the skeletal and soft tissue structures. The bases of the first three metatarsals articulate with the three cuneiforms, and the lateral two metatarsal with the cuboid. The trapezoidal shape of the medial cuneiforms and the adjacent bases of the metatarsals create a stable "Roman" arch. The "keystone" is the base of the second metatarsal, which, by being recessed more proximally than the adjacent metatarsal, affords further bony stability in a transverse plane. The capsuloligamentous structures provide soft tissue stability. There are ligamentous attachments between bases of metatarsals and the tarsal bones and between the bases of the metatarsals, except for between the bases of the first and second metatarsal. A strong interosseous ligament — called the Lisfranc ligament — is found between the base of the second metatarsal and the medial cuneiform.

In addition to these, the tendon insertions in the vicinity provide further soft tissue and dynamic stability to a loaded foot. The tibialis anterior tendon inserts onto the dorsum of the first metatarsal base and the medial cuneiform, and the peroneus longus tendon inserts on to the plantar and lateral aspect of the first metatarsal. The anterior tibial tendon can be partially or completely interposed following disruption of the TMT joints and block the reduction. The plantar fascia and the intrinsic muscles provide additional plantar support to first TMT joint complex. Together with the stronger plantar ligamentous structures, they render plantar dislocation of the metatarsal bases much less likely than dorsal dislocation.

The dorsalis pedis artery crosses Lisfranc's joint and courses distally and then plantar between the first and second metatarsal bases to form the plantar arterial arch. The deep peroneal nerve lies adjacent to it and supplies sensation to the first interspace. This neurovascular bundle is at risk at the time of injury and during surgical exposure of the first and second TMT joints. It can also become interposed within the dislocation, placing it at risk during reduction attempts.

### 36.3 Biomechanics

Sagittal plane motion at the fifth TMT joint is about 10 to 20 degrees, with progressively less mobility in the medial joints. The exception is the first TMT articulation, which also allows significant sagittal and coronal plane motion.

### 36.4 Clinical Presentation

Lisfranc fracture dislocation injuries usually present following a high-energy injury. Midfoot deformity due to the resultant displacement is often obvious, along with significant midfoot swelling, ecchymosis, deformity, and radiographic abnormalities. The foot can appear shortened and abducted at the forefoot. The massive foot swelling accompanying these injuries can mask the bone deformity, however.

Many Lisfranc fracture dislocations are associated with other injuries. Closed injuries can lead to compartment syndrome, which should be suspected when the pain is out of proportion with the injury, constant, or not controlled with analgesia.

### 36.5 Pathogenesis
Lisfranc fracture dislocations can occur as a result of a direct or indirect injury. Indirect injuries are a result of a longitudinal force going through the midfoot, such as a fall from a height leading on the forefoot, or forced hyperflexion forces at the midfoot in a motor vehicle accident. Direct injuries are due to a crushing force such as due to a heavy object landing on the foot.

### 36.6 Classification (Staging)

In 1909, Quenu and Kuss\(^6\) first described injuries to the TMT joint based on the direction of displacement at the metatarsotarsal joint. In 1982, Hardcastle et al\(^7\) described a more comprehensive classification and found that prognosis was associated with obtaining joint congruity rather than mechanism of injury. In 1986, Myerson et al\(^8\) classified these injuries into different types to aid in clinical decision making:

- **Type A** - Total incongruity of the TMT joint
- **Type B1** - Partial incongruity affecting the first ray in relative isolation (ie, partial medial incongruity)
- **Type B2** - Partial incongruity in which the displacement affects one or more of the lateral four metatarsals (ie, partial lateral incongruity)
- **Type C1 and C2** - A divergent pattern, with partial or total displacement

In 2001, Chiodo and Myerson\(^9\) presented a classification of these injuries based on the three anatomic columns of the foot:

- The first metatarsal and medial cuneiform joint makes up the medial column.
- The middle column includes the articulations between the second and third tarsometatarsal joints.
- The lateral column consists of articulations between the cuboid and the fourth and fifth metatarsals.

Komenda et al\(^10\) reported that post-traumatic arthritis is more common at the base of the second metatarsal, suggesting that incongruity is better tolerated at the medial and lateral columns. The lateral column, which has the greatest amount of sagittal plane motion, is the least likely to be involved in post-traumatic arthritis.

### 36.7 Physical Examination

Patients often present with the inability to bear weight and with swelling in the midfoot region. Examination of the foot reveals forefoot and midfoot edema, plantar arch ecchymosis, and deformity. The foot feels tense to palpation in a patient with compartment syndrome. Neurovascular status should be evaluated. The dorsalis pedis pulse may not be palpable due to swelling, subluxation, or pain.

### 36.8 Imaging

Three views of the foot should be obtained, including anteroposterior, oblique, and lateral radiographs (Figure 1). Weight-bearing views may be difficult to obtain in a patient with an acute painful foot, but they should be obtained whenever possible. Even a partial or simulated weight-bearing views are preferable to non-weight-bearing views to assess alignment and instability.
The AP views demonstrate malalignment of the first and second TMT joints, whereas incongruity at the third and fourth joints are better visualized on a 30-degree oblique view. It is important to note that the radiographs can show anatomic or mean anatomic alignment with the joints being unstable and, therefore, still requiring surgery.

On the lateral view, the dorsal and plantar aspects of the metatarsals should correspond with the cuneiform and cuboid. A tangential line drawn through the medial aspect of the medial cuneiform and navicular should intersect the first metatarsal base. Lateral weight-bearing radiographs can be used to identify flattening of the longitudinal arch as well as dorsal displacement at the second TMT joint.

![Figure 1. Radiograph showing fracture dislocation at the TMT joints](image)

### 36.9 Conservative Treatment

Conservative treatment is an option for managing undisplaced or minimally displaced fractures with the TMT joints well-aligned. This involves protecting the foot in a splint initially when there is risk of swelling and later in a cast to allow for the injury to heal. It is up to the treating physician to determine that the joints remain stable with weight-bearing radiographs or stress view. Patients should be followed closely with repeat weight-bearing radiographs.

Conservative management is also recommended in patients with a dysvascular foot or those who have other co-morbidities that preclude operative management.

### 36.10 Operative Treatment
The importance of anatomic reduction in maximizing functional outcome was realized as early as the 1950s. Good or excellent results are reported in 50% to 95% of patients with anatomic alignment, compared with 17% to 30% of patients with non-anatomic alignment. Therefore, operative treatment is indicated in unstable and or displaced fracture dislocation injuries. Surgery should be done either within 24 hours before the foot becomes swollen, or when the swelling subsides and skin wrinkles appear, allowing the skin to be pinched (can take up to 2 weeks). More rapid resolution can be obtained with elevation and cryotherapy or intermittent compression therapy.

It is important to obtain accurate reduction of the TMT joints, which often requires an open reduction to remove any interposed tissue such as small fragments bone or ligaments. Congruent and accurate reduction should be assessed both visually and verified using fluoroscopy in different projections. Dorsal approach is used with incisions overlying the joints that need reduction or stabilization.

If all joints need to be visualized, the dorsal approach is through two parallel longitudinal incisions, one placed over the first web space and the other over the third web space (Figure 2). The reduction and fixation is done in a sequential manner, starting with stabilizing the medial column and progressing towards medial and lateral columns. Closed or percutaneous reduction methods can be attempted in injuries with minimal disruption, but if accuracy of reduction of the TMT articulations cannot be achieved, open reduction is required.

![Incision over first web space exposing and showing the disruption of the dorsal capsulo-ligamentous attachments caused by injury](image)

**Figure 2.** Incision over first web space exposing and showing the disruption of the dorsal capsulo-ligamentous attachments caused by injury

Implants are then used to stabilize and maintain the reduction. Fixation with screws is more stable and preferred for stabilizing the medial and middle columns (Figure 3), whereas fixation with K-wire is sufficient for the lateral column. The lateral column TMT joints have more mobility and it is important that this is retained. Strong fixation is avoided in the lateral column to prevent long term stiffness and retain mobility.
Screws inserted across the TMT joints can potentially cause more damage to the articular surface than K-wires. Use of cannulated screws helps to minimize multiple passes as the guidewires can be used to obtain optimal positioning prior to inserting the screw itself.

An option to avoid transarticular screws is to use extra-articular type of fixation. This can be obtained with implants such as small plates or staples applied across the joints to be stabilized (Figures 4-7). An open approach is required for extra-articular fixation with plates, unlike with screws, which are amenable to both open and percutaneous approaches.

**Figure 3.** Anteroposterior radiographs showing stabilization of medial and middle columns with transarticular screws

**Figure 4.** Extra-articular stabilization using a plate across the first TMT articulation
Figure 5. Extra-articular stabilization using a plate across the first and second TMT articulation

Figure 6. Anteroposterior radiograph showing extra-articular stabilization using a plate across the first and second TMT articulation

Figure 7. Lateral radiograph showing extra-articular stabilization using a plate across the first and second TMT articulation
A short leg non-weight-bearing cast is used for the first 6 weeks. An above-ankle boot is used for the next 6 weeks and weight-bearing as able is allowed. K-wires are removed at 6 weeks and screws at 4 months. After the hardware is removed, there is a risk of loss of reduction and, therefore, a weight-bearing radiograph should be obtained in the postoperative period. Prolonged protection in the rocker sole shoe with a molded insert and a carbon plate may be necessary for up to 1 year.

Primary arthrodesis instead of open reduction and internal fixation may be indicated in cases with severe comminution and damage to articular cartilage, pre-existing midfoot arthritis, and delayed diagnosis, as well as in select patients with neuropathic injuries. In a prospective study, arthrodesis did as well as fixation alone in extensor injuries. The physician should take care in assessing the stability and condition of the TMT joint before deciding on fixation or fusion. Some low-energy patients can be treated with a "Lisfranc Screw" and dorsal bridging plates for unstable joints.

### 36.11 Controversy

A clinical study comparing open reduction and temporary internal fixation with arthrodesis in patients with severe (not primarily ligamentous) acute Lisfranc dislocations found that patients who underwent internal fixation alone had less pain. This study also found that stiffness of the forefoot, loss of metatarsal arch, and sympathetic dystrophy occurred more frequently in the complete arthrodesis group. The authors concluded that primary complete arthrodesis of the TMT joint should be reserved as a salvage procedure.

In contrast, a recent prospective, randomized, controlled study appears to show better outcomes in short- and medium-term follow-up after a primary stable arthrodesis of the medial two or three rays compared with open reduction and internal fixation of purely ligamentous Lisfranc joint injuries. The long-term effects following primary arthrodesis on foot function or adjacent joint arthritis are not known.

### 36.12 References


