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An Insight of Management of Lisfranc Fracture

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Abstract

Background: Joint disruptions to the tarsometatarsal (TMT) joint complex, also known as the Lisfranc joint, represent a broad spectrum of pathology from subtle athletic sprains to severe crush injuries. Although injuries to the TMT joint complex are uncommon, when missed, they may lead to pain and dysfunction secondary to posttraumatic arthritis and arch collapse. An understanding of the appropriate anatomy, mechanism, physical examination, and imaging techniques is necessary to diagnose and treat injuries of the TMT joints. Nonsurgical management is indicated in select patients who maintain reduction of the TMT joints under physiologic stress. Successful surgical management of these injuries is predicated on anatomic reduction and stable fixation. Open reduction and internal fixation remains the standard treatment, although primary arthrodesis has emerged as a viable option for certaintypes of TMT joint injuries. Lisfranc injury refers strictly to an injury in which one or more of the metatarsals are displaced with respect to the tarsus. This name is attributed to a French surgeon and gynaecologist of the Napoleonic era who was the first to describe the injury in 1815 and to describe an amputation at that level medical

treatment is reserved for injuries that are anatomically stable and nondisplaced. This type of injury is best labeled as a sprain, though associated fractures in the surrounding bone may be present (eg, metatarsal [MT] fracture.

Keywords: Lisfranc Fracture

Introduction

The combined ligamentous and osseous anatomy of the TMT joint complex is essential for maintenance of the transverse and longitudinal arches of the foot**.(1)**

Osteology

Lisfranc joint complex consists of three articulations including tarsometatarsal articulation, intermetatarsal articulation intertarsal or intercuneiform articulations, columns of the midfoot medial column, includes first tarsometatarsal joint middle column includes second

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and third tarsometatarsal joints, lateral column includes fourth and fifth tarsometatarsal joints (most mobile). **(1)**

Ligaments

The Lisfranc joint is stabilized by numerous ligamentous structures.

- **Lisfranc ligament**
  An interosseous ligament that goes from medial cuneiform to base of 2nd metatarsal on plantar surface, critical to stabilizing the 1st and 2nd tarsometatarsal joints and maintenance of the midfoot arch, Lisfranc ligament tightens with pronation and abduction of forefoot.
- **Plantar tarsometatarsal ligaments**
  Another critical component of the TMT ligamentous complex, divides into deep and superficial bands that insert on the base of the second and third metatarsals, respectively. In general, the plantar ligaments are stronger than the dorsal ligaments, which can have important clinical implications for the pattern of injury.
- **Dorsal tarsometatarsal ligaments**
  Dorsal ligaments are weaker and therefore bony displacement with injury is often dorsal
- **Intermetatarsal ligaments**

Between second-fifth metatarsal bases, no direct ligamentous attachment between first and, second metatarsal **(1).**

Blood Vessels

The main blood supply of the foot is the posterior tibial artery runs beside the posterior tibial nerve. Other arteries enter the foot from other directions. One of these arteries is the dorsalis pedis that runs down the top of the foot. You can feel pulse where this artery runs in the middle of the top of the foot. **(2).**

Nerves:

The main nerve to the foot is the tibial nerve that enters the sole of the foot by running behind the medial malleolus. This nerve supplies sensation to the toes and sole of the foot and controls the muscles of the sole of the foot. Several other nerves run into the foot on the outside of the foot and down the top of the foot. These nerves primarily provide sensation to different areas on the top and outside edge of the foot **(2)**.

Epidemiology

Lisfranc injuries make up only 0.2% of all fractures more common in the third decade Males are two to four times more likely to sustain a Lisfranc injury than females, Lisfranc injuries can be misdiagnosed in up to 20% of cases with resultant long-term malalignment and functional weight bearing difficulties**.** Lisfranc fracture-dislocations are more common in athletes and are increasing in incidence due to growth of high-performance athletic training internationally. **(2)**

Biomechanics

The foot is generally considered to consist of a long medial longitudinal arch and a shorter transverse arch, the latter being most readily defined at the level of the tarsometatarsal joint complex. The transverse arch present at the level of the midfoot consist of cascade of the distal articular surfaces of cuneiforms and cuboid that like a Roman arch, it is stable because its dorsal surface is wider than its plantar circumference **(2).**

The second metatarsal base is inset proximally into the tarsal bones; the base of this metatarsal represents the "keystone" of the metatarsal arch and the cornerstone of reduction of tarsometatarsal injuries. Proximal end of the second metatarsal is tightly recessed between first and third cuneiforms; this mortise configuration effectively locks entire tarsometarsal complex, preventing medial or lateral translation **(2)**.

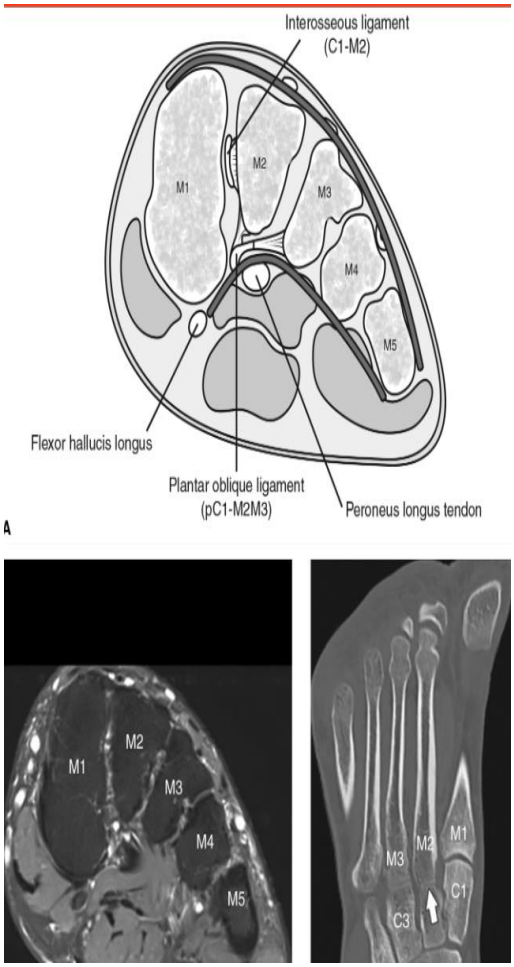

Fig 1: A, Illustration of the Roman arch architecture of the metatarsal bases with thesecond metatarsal as the keystone. The interosseous (C1-M2) and plantar oblique ligaments (pC1-M2M3) are shown. B, Coronal T2-weighted MRI sequence demonstrating the Roman arch configuration of the metatarsal bases. C, Axial long-axis CT cut. The arrow highlights the recessed position of the second metatarsal in the mortise. C1 = medial cuneiform, C3 = lateral cuneiform,M1 = first

metatarsal, M2 = second metatarsal, M3 = third metatarsal, M4 = fourth metatarsal, M5 = fifth metatarsal, Nav = navicular, pC1 = plantarmedial cuneiform. (Panels B and C reproduced with permission from Siddiqui NA, Galizia MS, Almusa E, Omar IM: Evaluation of the tarsometatarsal joint using conventiona radiography, CT, and MR imaging. Radiographics 2014;34[2]:514-531.)

Classifications

Several classification systems have been proposed for TMT joint injuries. Myerson developed the most commonly used system, which incorporates the prior work of Quenu and Guss and Hardcastle

Although this classification system does not predict outcome, it provides a framework for understanding patterns of injury, including patterns of instability that may extend to the intercuneiform or naviculocuneiform joints. **(3)**.

Myerson classification

Myerson modified Hardcastle classification (1986) and called modified Hard castle Classification to produce three groups **(3):**

Type A: Total Incongruity in any plane or direction

Type B: Partial Incongruity/ Homolateral incomplete. This was divided **into type B1:** affects the medial articulation alone and type B2: affects the lateral articulation alone.

Type C: Divergent/ Total or partial displacement when medial and lateral metatarsals are displaced in opposite directions and opposite planes. This was further divided into whether all four (type C2) or fewer (type C1).

Diagnosis

Diagnosis:

Generally, Lisfranc complex injuries from high-energy trauma have obvious clinical and imaging evidence that make it unlikely to miss, the exception being polytrauma patients with distracting injuries. However, diagnosis of low-energy Lisfranc injuries can be difficult without appropriate history, physical examination, and imaging **(Yan et al., 2021)**.

Physical Examination:

On physical examination, swelling and/or point tenderness will be evident around the TMT joint region. Special attention should be paid to identifying any plantar ecchymosis, which is strongly suggestive of Lisfranc injury. Examination should also include provocative maneuvers to evaluate for instability squeezing of the midfoot, pronation, supination, abduction, adduction, single limb weightbearing, and passive motion in sagittal and coronal planes of all 3 columns of the midfoot. In the clinic setting, provocative maneuvers can be performed under fluoroscopy, to help guide diagnosis and treatment **(3).**

Imaging

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All patients with suspected Lisfranc injuries will need standard, 3-view plain films of the foot: -

i. an anteroposterior of both feet on one cassette.
ii. 30-degree internal oblique.
iii. lateral views.

All films should be weight bearing and ideally bilateral for comparison, if tolerated by the patient. With non-weight bearing films, subtle Lisfranc injuries are missed at a reported rate of 20% to 50%. The following signs of instability should be evaluated on the weight bearing plain films **(4).**

1. The medial border of M2 is not aligned with the medial border of C2 on the anteroposterior radiograph

2>2 mm gapping difference is noted between the base of M1 and M2 or between C1 and the base of M2 on the anteroposterior radiograph

3.The medial and lateral borders of M1 are not aligned with the medial and lateral borders of C1 on the oblique radiograph

4.The lateral border of M3 is not aligned with the lateral border of C3 on the oblique radiograph

5.The medial border of M4 is not aligned with the medial border of cuboid on the oblique radiograph

6.Step-off of the dorsal cortex from M1 to C1 on the lateral radiograph

7.The plantar border of C1 dips below the plantar border of M5 on the lateral radiograph

8.“Fleck sign”; any avulsion fragment from the lateral edge of C1 or the medial edge of the base of M2

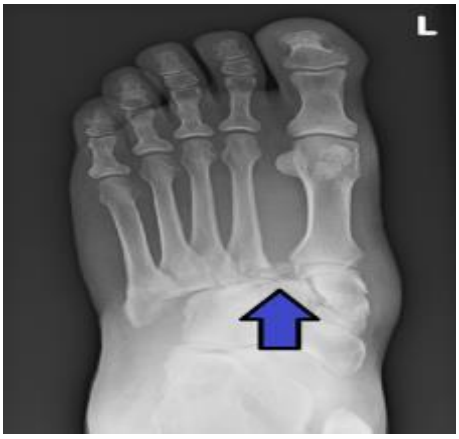

Fig 2: Fleck sign **(4)**

Fig 3 : Radiographic signs of instability: (A) Left foot weightbearing anteroposterior radiograph demonstrating (1) continuity of medial borders of M2 and C2, (2) gapping between M1 and M2 bases, and (9) medial column tangential line. (B) Left foot weightbearing oblique radiograph demonstrating (3) continuity of medial and lateral borders of M1 and C1, (4) continuity of lateral borders of M3 and C3, and (5) continuity of medial borders of M4 and Cu. (C) Left foot weightbearing anteroposterior radiograph demonstrating (8) Fleck sign. (D) Left foot weightbearing lateral radiograph demonstrating (6) continuity of dorsal cortices of M1 and C1 and (7) normal relationship of M5 and C1 plantar cortices**.**

Management

Medical treatment is reserved for injuries that are anatomically stable and nondisplaced. This type of injury is best labeled as a sprain, though associated fractures in the surrounding bone may be present (eg, metatarsal [MT] fracture). An athlete with a stable Lisfranc injury usually cannot compete for the remainder of the season. Early return to high-level activity can lead to chronic pain and progressive arthropathy. Therefore, athletes should be given special consideration. Initial treatment should consist of a well-molded nonweightbearing short leg cast worn for a minimum of 6 weeks. Advancement of ambulation depends on resolution of symptoms. Because many of these injuries initially present with midfoot edema that may help stabilize damaged tissues, all stable injuries should be reexamined

approximately 2 weeks after injury. Weightbearing radiographs should be obtained at 4-6 weeks to ensure continued anatomic alignment. After 6 weeks, progressive weightbearing can be allowed in a well-molded cast, advancing as comfort allows. When full weightbearing in a cast is comfortable, the patient can be advanced to a supportive shoe and reconditioning. The patient can be advanced to an accommodative orthotic with a contoured carbon shank so as to minimize midfoot stress. Combined closed reduction and casting has no role in the treatment of unstable injuries. Constantly maintaining reduction with casting alone has proved too difficult. In addition, interposing soft tissues can impede closed reduction. For example, the anterior tibial tendon can block reduction of a lateral Lisfranc dislocation; similarly, the peroneus brevis tendon can block a medial dislocation reduction. **(1)**

Indications of Non-operative managements:

Indicated for patients without instability.

- Non-displaced ligamentous injury with or without avulsion fracture
- Non-displaced fractures through bases of first, second, or third MT
    - Other relative contraindications to surgery: nonambulatory, insensate foot, rheumatoid arthritis.
    - Immobilize in short leg cast or boot for 6–8 weeks.
    - Initially non-weight bearing, progress to weight bearing as tolerated.
    - Repeat X-Ray to detect osseous displacement around 2 weeks
    - Physical therapy recommended for gait training and balance.
    - Time to full recovery is approximately 4 months. **(2).**

Operative Treatment

There is no consensus for the treatment of stage II. Most orthopedists recommend surgery despite minor displacement, whereas others favor conservative management after checking TMT joint stability. If conservative treatment is preferred, careful clinical surveillance for developing signs of instability is essential. Surgical treatment is indicated for stage III Lisfranc injuries and fracture dislocation. Better outcomes have been shown with early anatomical reduction and stable fixation. Surgery should be performed after swelling has decreased, ideally within 1 to 2 weeks of the initial injury. The goal of treatment is to achieve a painless, stable, and plantigrade foot. Care should be taken in the anatomical reduction of the Lisfranc joint. Closed reduction and percutaneous Kirschner wire (Kwire) fixation suffices in some cases. If closed anatomical reduction cannot be achieved, open reduction and internal fixation surgery with K wires or cortical screws should be performed. When there are comminuted fragments, failure of fixation, or secondary OA, arthrodesis is preferred. Medial and middle column fixation is typically performed. If

reduction is achieved, lateral column fixation is usually unnecessary and is associated with improved outcomes **(3; 4)**

Closed reduction and percutaneous fixation:

This comprises closed reduction (reduction by manipulation of bone through the skin) and the use of percutaneous (through the skin) Kirschner wires or cannulated screws to hold the reduction. Use of this method has been reported for simple tarsometatarsal fractures. Closed reduction and percutaneous fixation is the least invasive surgical option but lack of direct visualisation of these generally complex injuries means that it is generally considered for simple tarsometatarsal fractures. Generally, closed reduction is considered ineffective in achieving congruity **(6).**

Open reduction and internal fixation (ORIF):

Open reduction (manipulation of bone after surgical exposure of the fracture) and internal fixation is considered the standard treatment for most Lisfranc injuries. The techniques of ORIF vary; for example, Kirschner wire fixation, standard AO screw fixation (3.5 mm, 4.5 mm), bioabsorbable polylactide screws and dorsal plate fixation **(7)**. A combination of techniques has often been used, particularly Kirschner wires fixation across the more mobile 4th and 5th tarsometatarsal joints and rigid screw fixation across the medial 1st, 2nd and 3rd joints. Although a more invasive procedure than closed reduction, open reduction and internal fixation (ORIF) facilitate better assessment and manipulation of the dislocated anatomy and more accurate fixation of the reduced parts, included articular fractures. The use of dorsal plates (e.g., one‐fourth tubular plate) seems to have the theoretical advantage of rigid fixation without transarticular screws avoiding damage to the articular cartilage. Given it is a more drastic procedure, which substantially alters foot mechanics, primary arthrodesis is typically reserved for more substantial injuries, where there are major questions on whether fixation that restores the anatomy is sufficient for a satisfactory long‐term outcome **(8)**.

Primary arthrodesis:

Primary (initial procedure) arthrodesis (or fusion) of the midfoot involves fusing or stiffening the tarsometatarsal joint complex using pins, plates and screws so that the damaged bones heal into one continuous piece of bone. This procedure has been traditionally reserved as a salvage procedure for severely comminuted fractures and gross instabilities that have been considered at significantly high risk of post‐traumatic arthritis **(8)**.

Postoperative care:

Following surgery, the foot is generally placed in a well‐padded dressing with a plaster around the foot and lower leg or a removable boot for two weeks, when any sutures are

removed. Patients remain non‐weight bearing in a short leg cast or boot for an additional 4 to 10 weeks, depending on the injury and surgery. When used, temporary K‐wires are typically removed at six weeks or before weight‐bearing is allowed, in order to prevent pin breakage **(8)**.

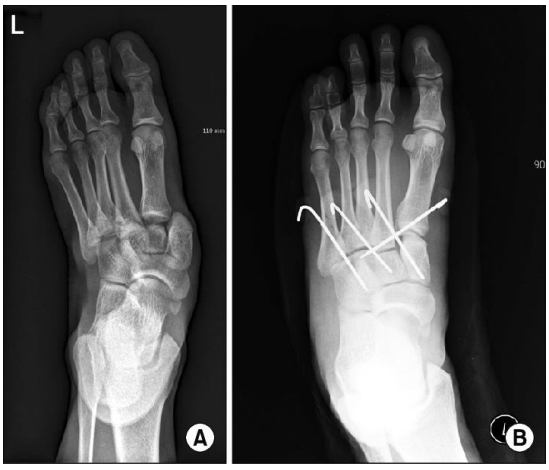

Fig. 4: K-wire fixation of displaced Lisfranc joint fracture **(6).**

Fig. 5: Plate fixation **(Matar et al., 2017).**

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