Original Research Article

Tarsometatarsal Lisfranc Injuries: A diagnostic challenge.

Abstract

Introduction: Lisfranc injuries are often difficult to diagnose and treat causing long term disability without proper management. Lisfranc injuries refer to bony or ligamentous compromise of the tarsometatarsal and intercuneiform joint complex. Improper treatment of these fractures might lead to negative outcomes such as soft tissue necrosis, posttraumatic arthritis, and arch abnormalities. This study aims to help in diagnosis and treatment of tarsometatarsal Lisfranc injuries.

Materials and method: Study comprises of 10 patients diagnosed with Lisfranc injury. All of them were treated with open reduction and internal fixation. Post-operatively, all patients were assessed using AOFAS midfoot scale for outcome after the surgery and scores were recorded at each follow up and final results were evaluated after 1 year of surgery.

Observation and Results: Mean AOFAS midfoot score was 82 at the end of one year. Majority of the patients had AOFAS score of more than 80. Majority of patients had B2 type of fracture according to Meyerson Classification.

Conclusion: Anatomical reduction is the key for the treatment of lisfranc injuries, therefore, open reduction and internal fixation is necessary to provide good outcome.

Introduction:

Lisfranc injuries refer to bony or ligamentous compromise of the tarsometatarsal and intercuneiform joint complex. The injury is named after Jaques Lisfranc de Saint-Martin, a French army field surgeon (1). Lisfranc injuries mainly result from being crushed under a heavy object, traffic accidents, or falling from a height and

are represented by severe Lisfranc joint fracture-dislocation with serious soft tissue injuries. Low-energy trauma, including falls from standing and athletic injuries, accounts for approximately one-third of Lisfranc injuries. Improper treatment of these fractures might lead to negative outcomes such as soft tissue necrosis, posttraumatic arthritis, and arch abnormalities (2).

Pathoanatomy:

The Lisfranc joint consists of the articulations between the metatarsals and the three cuneiforms and cuboid (fig 1). Its osseous architecture and soft-tissue connections are critical to the stability of the foot. The Lisfranc articulation can be divided into three longitudinal columns (3). The medial column consists of the medial cuneiform and first metatarsal. The middle column is composed of the middle and lateral cuneiforms and the second and third metatarsals. The lateral column is made up of the cuboid and fourth and fifth metatarsals. The second metatarsal is recessed proximally, serving as the “keystone” of the Lisfranc joint (4) (fig 2).

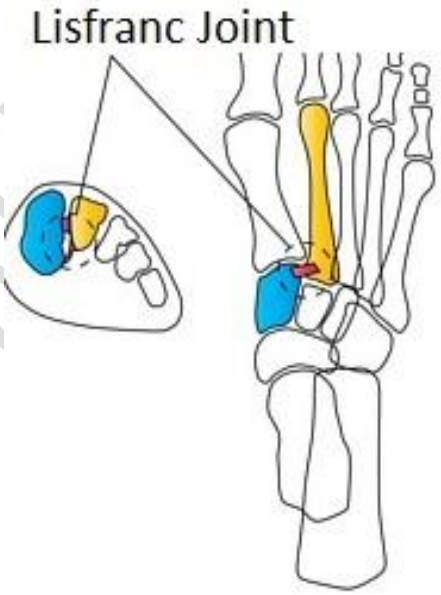

Figure 1 Diagram showing Lisfranc Joint

The Lisfranc ligament is one of the most important ligaments in foot and runs from the plantar medial cuneiform to the base of the second metatarsal. While the second through fifth metatarsals are interconnected by inter-metatarsal ligaments, there is no inter-metatarsal connection between the first and second

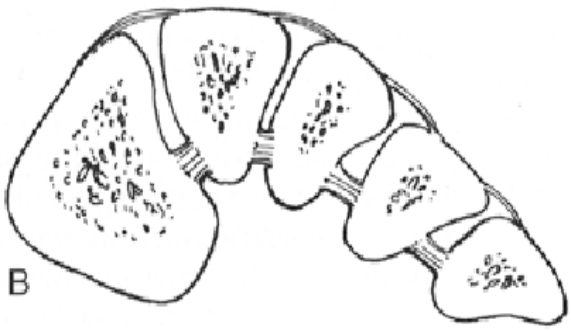

Figure 2 Keystone of 'Roman' Arch

metatarsals. Thus, the Lisfranc ligament effectively connects the medial column to the lateral four metatarsals. Injury to this ligament can destabilize the entire forefoot as well as the Lisfranc articulation (5).

The pathoanatomy is individually specific and highly variable and may consist of a pure ligamentous injury, a pure bony injury (fracture), or a combination. Lisfranc injuries result from both indirect and direct trauma. Direct injuries, including crush injuries and other highenergy mechanisms, are frequently associated with signiftcant soft-tissue trauma, vascular compromise, and compartment syndrome. There are two common indirect mechanisms of Lisfranc injury: forced external rotation, or twisting of a pronated foot and axial loading of the foot in a fixed equinus position (4). In a twisting injury, forceful abduction of the forefoot causes dislocation of the second metatarsal and lateral displacement of the lateral metatarsals. Axial loading of the foot with the ankle and metatarsophalangeal (MTP) joints in plantarflexion is another mechanism for a Lisfranc injury (4).

Classification:

Quenu and Kuss divided the Lisfranc fracture dislocation into three groups based on radiographic findings: homolateral, isolated, and divergent (Figure 3), which was further modified by Myerson et al.:

- Type A: Total incongruity in any plane or direction.
- Type B: Partial incongruity/homolateral incomplete.

This was divided into type B1, which affects the medial articulation alone, and type B2, which affects the lateral articulation alone.

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

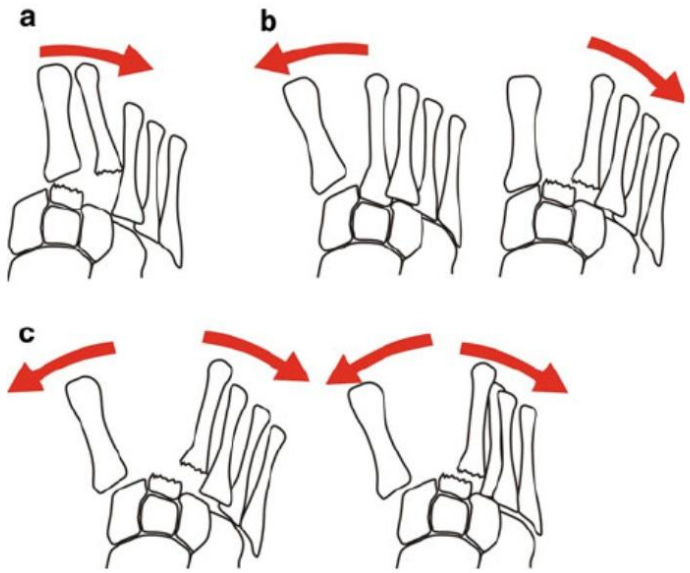

Figure 3 Meyerson Classification of Lisfranc Injury

Diagnosis:

Patients typically present with diffuse pain and swelling in the midfoot and an inability to bear weight. The overlying soft tissue envelope should be inspected, as plantar ecchymosis at the midfoot is highly suggestive of a Lisfranc injury (1). Tenderness to palpation of the midfoot and reproduction of pain with passive motion of the forefoot are suggestive of a Lisfranc injury (1).

Initial radiographic evaluation consists of antero-posterior (AP), oblique, and lateral views of the foot, Lisfranc injuries are misdiagnosed on plain radiographs (6). On a weightbearing AP view of the foot, the medial and lateral borders of the first metatarsal should perfectly align with the medial cuneiform; the medial border of the second metatarsal should align with the medial border of the middle cuneiform(fig 4) . On a weightbearing oblique view of the foot, the medial border of the third metatarsal should perfectly align with the medial border of the lateral cuneiform; the medial border of the fourth metatarsal should align with the medial border of the cuboid (fig 5). On a weightbearing lateral view of the foot, the entire medial and middle columns of the foot should symmetrically align with the long axis of the talus (fig 6). Lateral radiographs may reveal dorsal

dislocation or subluxation of the TMT joints (5) .Lateral weight-bearing films should be examined for loss of arch height and subluxation of TMT joints. Disruption of any of these relationships is generally indicative of a Lisfranc injury (1).

Figure 4 Lines on AP view radiograph comparing normal and injured foot

Figure 5 Lines on oblique view radiograph comparing normal and injured foot

Figure 6 Lines on lateral view radiograph comparing normal and injured foot

Other signs of Lisfranc injury include avulsion fractures of the second metatarsal base or medial cuneiform ("fleck sign") and more than 2.7 mm of diastasis between the first and second metatarsals(7). Diastasis between the first and second TMT joints, if greater than 2 mm compared to the contralateral side, is indicative of ligamentous Lisfranc injury(8).

Computed tomography (CT) scanning may also be beneficial with a subtle Lisfranc injury, particularly in a polytrauma patient to detect any displacement or loss of normal architecture and is highly diagnostic for Lisfranc injury. Magnetic resonance imaging (MRI) may be beneficial in the instance of a subtle Lisfranc injury, particularly if a patient is unable to tolerate weightbearing radiographs. Disruption of the so-called Lisfranc ligament on MRI is highly suggestive of an unstable mid-foot injury (9) .

Unstable injuries that are misdiagnosed or inadequately treat- ed generally go on to a poor result with persistent pain, activity limitations, and progressive post-traumatic arthritis in the involved joints (6,10) , generally necessitating arthrodesis as salvage (11,12) . Delayed diagnosis may be treated by ORIF (without arthrodesis) in the absence of post-traumatic arthritis (13), although there may be potential for late collapse or recurrence of deformity.

Material and Methods:

This study was conducted at a tertiary centre from 2016 to 2019. Patients who came in outpatient or emergency department who were diagnosed as lisfranc injury based on clinical, plain radiographs and CT scan findings were included in the study.

Preoperative physical examinations should include assessment of dorsalis pedis and posterior tibial pulses, integrity of skin and extent of swelling.

Occasionally tendon may be entrapped which is evident by uncorrectable position of toes. it is important for swelling to be reduced prior surgery. It should be done emergently only in case of compartment syndrome or a compound injury preventing the skin integrity. Also, if there is a gross instability, early stabilization will help soft tissue to heal.

Surgical technique:

Patient is positioned in supine position with a roll beneath greater trochanter to rotate the limb internally from hip joint into neutral position. Second roll is placed beneath the popliteal fossa to keep the knee in flexion which allows planter flexion of foot for appropriate imaging. A longitudinal incision is made in web space between 1st and 2nd fingers. Care is taken to avoid damage to dorsal cutaneous nerves1st tarsometatrsal joint is exposed between long and short hallux extensor tendons. Typically, there is significant haemorrhage in this area.

Usually, capsule is enfolded in the joint and should be removed from joint space and reserved for reapproximation. Displacement is most commonly dorsally and laterally, hence reduction is achieved by planter and medial force. When 1st metatarsal is reduced relation to medial cuneiform, a k-wire is placed across the joint to prevent loss of reduction prior to definitive fixation. K-wire is placed slightly off the definitive fixation area. Before reducing 2nd metatarsal, check for disruption between middle and medial cuneiform.

If 1st and 2nd inter-tarsal instability is found, it should be stabilized before tarsometatarsal repair, because it is difficult to stabilize metatarsal over unstable tarsal.

Medial and middle cuneiform should be reduced together with reduction clamps and a 3.5mm screw is placed from medial cuneiform to middle cuneiform. Entry point of drill over medial cuneiform should be in middle of dorsal 1/3rd because middle cuneiform is smaller in both dorso-plantar and proximal to distal directions. Also, it helps to keep the screw out of way that will traverse the tarso-metatarsal joints. Next, 2nd metatarsal base is reduced into mortise between the

three cuneiforms. This is accomplished by directly reducing the base of 2nd metatarsal against intermediate cuneiform.

Occasionally, part of base of 2nd metatarsal is avulsed by Lisfranc ligament, which might block reduction of 2nd metatarsal. Hence, the fragment is pushed plantarly by medially. Once it is reduced, large pointed clamp is placed to retain the reduction and compression. K-wire is placed to maintain the reduction. Then a k-wire is placed at periphery to maintain joint reduction. Here, fixation can be achieved by using a cortical screw or a 'figure of 8' plate between medial cuneiform and 2nd metatarsal which serves the function of the lisfranc ligament. This plate is fixed using 3.5mm cortical screws.

Now, the position of 1st metatarsal is reassessed in relation to medial cuneiform and if there is any displacement it is reduced and fixed with k-wire, and then fixed with 3.5mm cortical screw . This screw is need not be parallel to planter surface because shape of medial cuneiform is greater in dorsoplantar direction. Also this screw should start 15-20mm from the joint for adequate purchase in cuneiform.3rd and 4th tarso-metatarsal joint should be evaluated. If 3rd requires fixation and 4th does not then it can be done by same incision. If 4th also requires reduction and fixation then a 2nd incision is taken on dorsum of the fourth parallel to 1st incision .3rd metatarsal base should be reduced 1st and fixed using a cortical screw. 4th and 5th tarsometatarsal joints are quite mobile. Hence, any definitive fixation may increase chances of breakage of screws. Hence, in case of 2nd, 3rd, 4th metatarsal fracture it should be temporarily fixed using k-wires till scar capsule is formed at the joint, that is, for 4-6 weeks (Fig 7). Also, additional K wires or screws can be used for more stable fixation depending on the instability pattern noted on table. (Fig. 8,9)

Figure 7 Post Operative Radiographs showing Lisfranc injury fixation method

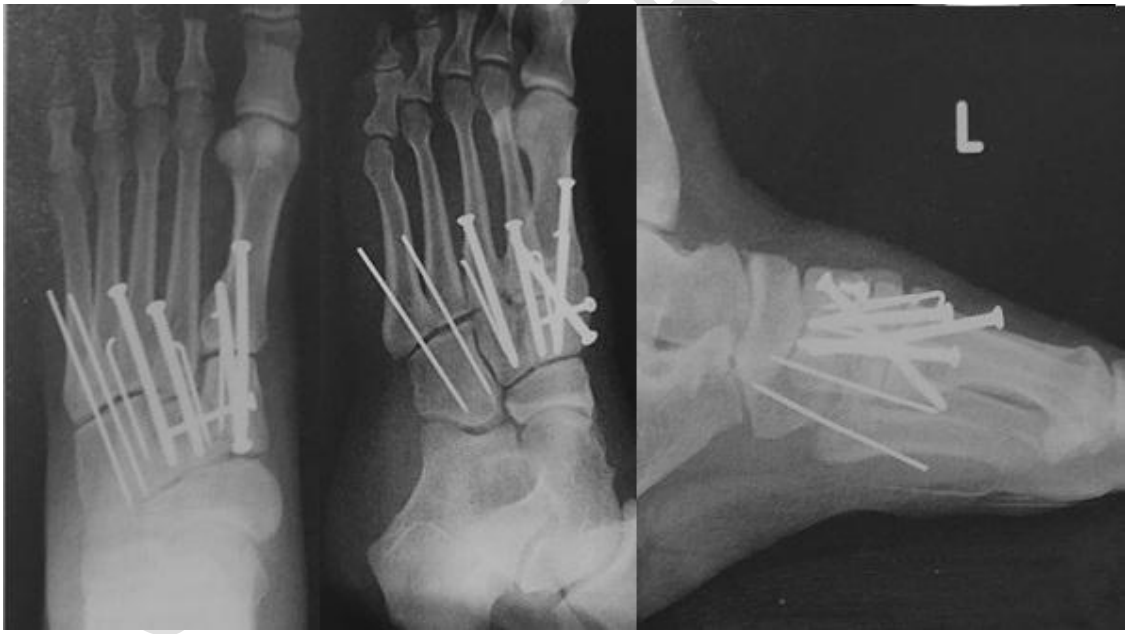

Figure 8 Alternative fixation method - A

Figure 9 Alternative fixation method - B

POST OPERATIVE PROTOCOL

The patient is given below knee slab post-operatively. Sutures are removed on 12th or 14th day. After suture removal, patient is given below knee non weight bearing cast for 4-6 weeks. At the end of 6 weeks, cast is removed along with 4th and 5th metacarpal k wire and image is taken. It includes AP, oblique and lateral views of foot in simulated weight bearing and alignment and fracture healing is assessed. After this partial weight bearing is started and active ankle range of motion exercise along with foot movements are started. Gradually over period of next 4 weeks, it is advanced to full weight bearing. Also, for better foot and ankle physiotherapy swimming and static exercise bicycling is encouraged. Swelling usually persists for few months hence compression stocking or crepe bandage is helpful. Patient is asked to avoid jumping or sports activities for at least 9-12 months. Patient can resume normal pre-injury activities after 1-2 years depending upon degree of articular surface injury, amount of trauma and quality of bone.

Post-operatively, all patients were assessed using AOFAS midfoot scale for outcome after the surgery and scores were recorded at each follow up and final results were evaluated after 1 year of surgery. (Fig. 10)

Non-surgical treatment

There is only one circumstance in which non-surgical treatment is indicated, they are Lisfranc ligament sprains, which are stable and non-displaced lesions that correspond to stage I of the Nunley and Vertullo classification. They can be treated non-surgically with a plaster boot without weight-bearing for six weeks (14). In this study, none of the patients were treated conservatively.

Results:

This study had 8 male and 2 female patients diagnosed with lisfranc injury. Mean age of patients was 38 years. 70% of patients had B2 type of fracture i.e. partial incongruity with lateral displacement (Myerson classification). Average duration from admission to surgery was 4 days.

Mean duration for initiation of range of movement exercises at ankle joint was 2.5 months. Mean duration of full weight bearing walking was 4 months. Patients were given medial arch support during early weight bearing period, mean duration for use of medial arch support was 8 months.

Mean AOFAS midfoot score at 6 months was 62.5. However, at the end of 1 year, mean AOFAS midfoot score was 82. Hence there was a significant improvement of the foot function by 1 year. 70 % of patients had mean AOFAS score of more than 80.

None of the patients had signs of compartment syndrome on admission. None of the patients needed fasciotomy. None of the patients had any vascular compromise. One patient had post-operative superficial wound infection which healed spontaneously by 3 weeks using routine antibiotics and dressing without any need of secondary surgery or debridement. None of the patients required implant removal. None of the patients had implant breakage.

Figure 10. One year follow up radiograph showing retainment of alignment and intact implants.

Figure 11. Clinical pictures showings ankle movements and maintained arch

Discussion:

Lisfranc injuries are often difficult to diagnose and treat causing long term disability without proper management.

Good alignment and restoration of length and arches of foot and retainment of this reduction is the main of treatment. By means of open reduction, it is easier to achieve reduction and alignment; however, to retain them, there is a need of primary arthrodesis at the tarso-metatarsal joints. Here, anatomical reduction is one of the most important factors as non-anatomical reduction is the main cause of negative prognosis (15)

For the purpose of arthrodesis, 3.5mm cortical screws were used; however, Lisfranc ligament was restored with the help of a 'figure of 8' plate which prevented the need of cross arthrodesis in most cases. As in majority of the cases, there was partial incongruity, lateral metatarsals were fixed temporarily using k wires and permanent arthrodesis was not needed. K wires were removed at 6 weeks as scar capsule is formed at the joint which provides adequate stability and retain the reduction for lateral metatarsals. However, 2nd metatarsal being the keystone of roman arch, mere scar tissue is not adequate for stability; hence arthrodesis is necessary for medial and middle metatarsals.

Post operatively, use of medial arch support is advised till arthrodesis is achieved. This is because allowing weight bearing will lead to increased stress over the cortical screws which might lead to their breakage because of which entire

transverse arch might collapse. As arthrodesis is expected to achieve by 6 months, patients can stop using medial arch support after that, however, it has to be confirmed radiologically before arch support is discontinued. Early ankle and toes movements should be initiated as early as at 6 weeks because surgery at the dorsum of foot might lead to formation of abundant cicatrisation. Hence, any delay in initiation of movements might lead to joint stiffness.

Conclusion:

Lisfranc injuries are often difficult to diagnose and treat. Anatomical reduction is the key for the treatment of lisfranc injuries. Hence, open reduction with primary arthrodesis remains the gold standard for treatment which can achieve good functional outcome to a near pre-injury level.

References

1. Clare MP. Lisfranc injuries. *Curr Rev Musculoskelet Med*. 2017;10(1):81–85. doi:10.1007/s12178-017-9387-6
2. Nithyananth M, Boopalan PR, Titus VT, Sundararaj GD, Lee VN. Long-term outcome of high-energy open Lisfranc injuries: a retrospective study. J Trauma. 2011;70:710–6.
3. Peicha G, Labovitz J, Seibert FJ, et al. The anatomy of the joint as a risk factor for Lisfranc dislocation and fracture-dislocation. An anatomical and radiological case control study. J Bone Joint Surg Br. Sep 2002;84(7):981-985.
4. Diagnosis and Management of Lisfranc Injuries and Metatarsal Fractures HEATHER E. GOTHA, MD; CRAIG R. LAREAU, MD; TODD A. FELLARS, MD
5. Watson TS, Shurnas PS, Denker J. Treatment of Lisfranc joint injury: current concepts. J Am Acad Orthop Surg. Dec 2010;18(12):718-728.
6. Goossens M, DeStoop N. Lisfranc's fracture-dislocations: etiology,radiology, and results of treatment. Clin Orthop Relat Res.1983;176:154–62.
7. Faciszewski T, Burks RT, Manaster BJ. Subtle injuries of the Lisfranc joint. J Bone Joint Surg Am. Dec 1990;72(10):1519-1522.

8. Aronow MS. Treatment of the missed Lisfranc injury. Foot Ankle Clin. Mar 2006;11(1):127-142, ix.
9. Raikin SM, Elias I, Dheer S, Besser MP, Morrison WB, Zoga AC. Prediction of midfoot instability in the subtle Lisfranc injury. Comparison of magnetic resonance imaging with intraoperative findings. J Bone Joint Surg Am.2009;91:892–9.
10. Curtis M, Myerson M, Szura B. Tarsometatarsal injuries in the athlete. Am J Sports Med. 1994;21:497–502.
11. Sangeorzan BJ, Veith RG, Hansen ST. Salvage of Lisfanc's tarsometatarsal joints by arthrodesis. Foot Ankle Int. 1990;4:193–200.
12. Komenda GA, Myerson MS, Biddinger KR. Results of arthrodesis of the tarsometatarsal joints after traumatic injury. J Bone Joint SurgAm. 1996;78A:1665–76.
13. Cassinelli SJ, Moss LK, Lee DC, Phillips J, Harris TG. Delayed open reduction internal fixation of missed, low-energy Lisfranc injuries. Foot Ankle Int 2016
14. N unley JA, Vertullo CJ. Classification, investigation, and management of midfoot sprains: lisfranc injuries in the athlete. Am J Sports Med 2002;30(6):871–878.
15. Demirkale I, Tecimel O, Celik I, Kilicarslan K, Ocguder A, Dogan M. The effect of the Tscherne injury pattern on the outcome of operatively treated Lisfranc fracture dislocations. Foot Ankle Surg. 2013;19:188–93.