Lisfranc Injuries: Assessment, Diagnosis and Management

Abstract

Lisfranc injuries account for only 0.2% of orthopaedic injuries, yet if missed the long-term consequences of arthrosis and acquired foot deformity can be devastating. This review article takes a systematic approach to assist trainees understand the biomechanics of the foot, and the pathoanatomy of Lisfranc injuries. The classification of Lisfranc injuries will be reviewed, and issues of the management of these fracture-dislocations will be debated.

Introduction

Lisfranc injuries are a specific group of injuries that lead to the instability of the Lisfranc joint. Instability results either through fracture-dislocations involving the base of the second tarsometatarsal, or through disruption of the Lisfranc ligament. The actual mechanism that leads to Lisfranc injuries can be either direct or indirect. Injuries can significantly impact the stability of the foot and, if missed, the consequences can be severe with resultant deformity that can cause long-term disability. Lisfranc injuries are uncommon and account for 0.2% (frequency can vary between 0.1% to 0.9%) of all orthopaedic injuries (English, 1964) (Aitkin et al, 1963). Injuries vary widely in their presentation, and the bony architecture of the midfoot is difficult to interpret on plain radiographs thus making Lisfranc injuries challenging to diagnose and manage. This article illustrates the relevant biomechanics of the foot, the mechanism of the injury, and the treatment options to restore the anatomy and biomechanical function of the foot following injury.

Anatomy and biomechanics

The bony anatomy of the midfoot joints form a structure like a Roman arch (Figure 1). The concavity on the plantar aspect of the foot formed by this rigid bony configuration creates a protected space for neurovascular structures, preventing them from being compressed during weight bearing activities. The articulation of the middle cuneiform with the second metatarsal is often described as the ‘keystone.’ A Lisfranc injury is the disruption to this ‘keystone.’ Disruption can be soft tissue injury, for example injury to the ‘Y’ shaped ligament (named the Lisfranc ligament), or a bony injury to the base of the second metatarsal that can lead to a fracture-dislocation (Peicha et al, 2002).

It should be noted that there is no inter-metatarsal ligament between the first and second metatarsal bones. The stability between these two metatarsi is provided by both the Lisfranc ligament, and the articulation of the proximal end of the second metatarsal with the middle cuneiform which is also recessed into a mortise by the medial and lateral cuneiforms (Peicha et al, 2002). The Lisfranc ligament is a strong Y-shaped ligament that connects the medial cuneiform and base of the second metatarsus on the plantar aspect of the foot; it provides stability between the medial and middle cuneiforms in addition to stability from the second metatarsal base to the medial cuneiform (Figure 2). The Lisfranc ligament maintains alignment between the metatarsal and tarsal bones. Disruption of this ligament causes instability at the ‘keystone’ of the arch and therefore destabilises the bony arch as a whole leading to its collapse. It is also important to consider that whilst the Lisfranc joint is an inherently stiff construction, there are micro-movements at the level of each joint, and the amount of mobility at the tarso-metatarsal level increases from medial to lateral. This serves two main objectives:

1. It provides the stiffness needed for load transfer from the ankle to the toes.

2. It allows for an even load to be distributed between the metatarsal heads during the stance phase of gait (Ouzounianet al, 1989).

Aetiology

Lisfranc injuries are more common amongst men, and have a peak incidence around 30 years of age. The actual mechanism can be either direct or indirect. Direct injuries, for example crush injuries, can cause significant variation in patterns of injury; these injuries are more likely to be associated with compartment syndromes. Indirect injuries result typically from an axial load applied to the longitudinal axis of the foot with an associated rotational and compressive force that act through a hyper plantar flexed forefoot. This compression and valgus force leads to the metatarsal bases typically being displaced in a dorsal/lateral direction. Indirect injuries often result from sporting accidents, road traffic accidents, and falls from height.

Clinical Assessment

Patients with a Lisfranc injury will often present complaining of severe pain and inability to weight-bear. They often have swelling throughout the midfoot, and medial plantar bruising which is pathognomonic for Lisfranc injuries. Palpation may elicit tenderness over the tarsometatarsal joint. Crush injuries often present with a swollen foot that can be associated with compartment syndrome. In these patients, the pain will be out of proportion to the clinical findings and there will be significant pain on passive flexion and extension. Occasionally, Lisfranc injuries may be subtle and have less severe symptoms on presentation.

Imaging and classification

Plain radiographs are the initial imaging of choice. There are five radiographic signs (Figure 3) associated with Lisfranc injuries and midfoot instability found on the antero-posterior, true lateral and oblique images. These are:

1) Widening of the space between the first and second metatarsi (antero-posterior view)

2) Evidence of bony fragment in the first intermetatarsal interval (fleck sign) (antero-posterior view) (Arntz et al 1988)

3) Discontinuity of a line drawn from the medial base of the second metatarsal to the medial side of the middle cuneiform (antero-posterior view)

4) Dorsal displacement of the proximal base of the first or second metatarsal (lateral view)

5) Failure of the medial side of the third and fourth metatarsi to line up with the lateral cuneiform and cuboid bones respectively (oblique view)

Weight-bearing views are recommended where possible. Standard plain radiographs provide a static image, however, weight-bearing films provide an opportunity to assess dynamic instability. This is a valid test to assess for any diastasis between the first and second metatarsi bases (Figure 4). Further imaging such as CT scans (Figure 5) are particularly helpful for operative planning as well as determining associated injuries that need to be addressed. MRI scans may be used to assess purely ligamentous injuries.

There are a number of classifications for Lis Franc injuries. In 1909 Quenu and Kuss described three patterns of injury at the tarso-metatarsal joint which are homolateral, isolated or divergent (Figure 6). Modifications for this classification were first introduced by Hardcastle (1979) based on the three-column concept and includes Type A (total incongruity), Type B (partial incongruity), or Type C (as divergent) (Hardcastle et al, 1982). Myerson later went onto subdivide the Hardcastle classification further into B1/B2 and C1/C2 (Myerson et al, 1986). Of these classification systems, the Quenu and Kuss classification is often used for its simplicity and ease of reproducibility.

Management

In principle the overall aim of the management of Lisfranc injuries is to restore the stability of the mid-foot which is essential for weight-bearing activity. In 2001, Chiodo and Myerson presented a classification to assess the stability of the foot based on the three anatomic columns. The three-column theory describes the three functional units of the tarsometatarsal articulation (Figure 7). 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 (Chiodo et al, 2001). There is a significant difference within the degree of movement between the different columns that has important implications in the treatment of these injuries with respect to the type of fixation. It was Komenda et al who 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 (Komenda et al, 1996). These papers provide a sensible framework when deciding how much absolute stability and relative stability to attribute to fixing the different columns.

Nonsurgical treatment is only recommended when there is no dislocation or subluxation at the Lisfranc joint, and the anatomical relations between the mid-tarsal bones have been maintained. A historic value of 2mm is often quoted as the upper limit of what the widening between the first and second metatarsi should be, however this is still excessive and further investigations such as weight-bearing views of the contra-lateral foot, CT or MRI should be considered to rule out a Lisfranc injury. Nonsurgical treatment typically consists of a period of non-weight bearing in a below knee cast for 6-12 weeks, followed by a rehabilitation programme. (Lattermann et al, 2007).

Surgical treatment is indicated for displaced fractures, mid-foot subluxation or dislocation, and inter-metatarsal widening between the first and second metatarsi. There are a number of operative options including open reduction and internal fixation, and primary fusion. In high energy injuries with extensive soft tissue damage, application of an external fixator can be used as part of a staged approach to the management of Lisfranc’s injuries. (Kadow et al, 2014).

Closed reduction and K-wire fixation is rarely used because it is difficult to gauge the success of reduction using this technique due to the limitations of a percutaneous technique. This technique also has a number of associated risks that include pin-site complications, pin migration, and failure of treatment after the removal of K-wires.

Open reduction and internal fixation is the preferred operative treatment. It allows for a more accurate reduction, and typically involves application of inter-metatarsal screws, dorsal plates or a combination of both (Figure 8). Recently introduced low profile locking plates provide increased rigidity of the construct and can cause less soft tissue irritation. Primary arthrodesis has been recommended in primarily ligamentous injury and fracture dislocations with severe articular surface damage. However, randomised studies have shown comparable outcome results between primary arthrodesis and open reduction and internal fixation (Ly et al. 2006) (Coetzee et al, 2007) (Henning et al, 2009).

More recently, novel surgical techniques for the management of chronic subtle injuries of the Lisfranc joint have been described. One such example is ligament reconstruction with single bone tunnel technique for chronic symptomatic subtle injury of the Lisfranc joint in athletes using autologous grafts where all athletes returned to high level activities (Miyamoto et al 2015). The use of dual tightropes has also been described using adjustable suture buttons to connect the medial cuneiform to the second metatarsal base, and connect the medial cuneiform to the middle cuneiform (Crates et al 2012).

Poor management of Lisfranc injuries may lead to a number of complications that will have notable consequences for the patient. These can include stiffness in the foot affecting normal gait, arthritis, complex regional pain syndrome, and loss of tarso-metatarsal arch which can manifest as a widened foot or as a permanent pes planus.

Conclusion

A Lisfranc injury is the disruption to the ‘keystone’ of the midfoot. This can be either a soft tissue injury or a bony injury to the base of the second metatarsal that leads to instability. These injuries are uncommon and account for approximately 0.2% of all orthopaedic injuries with the main demographic being men of an average age of 30 years. Patients often present complaining of severe pain and an inability to weight-bear. On examination, they will have swelling throughout the midfoot and medial plantar bruising. If missed, Lisfranc injuries can have long term consequences that can be devastating. In order to avoid these injuries, appropriate static and dynamic images are necessary, along with further images such as CT or MRI scans for operative planning. In general, open reduction and internal fixation is the mainstay of management for these injuries. It is essential to have a thorough understanding of the biomechanics and the anatomy of the foot to allow the clinician to identify the problem, and to apply appropriate management in order to give the patient the best possible clinical outcome.

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