Lisfranc injuries

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Abstract

Purpose of review The purpose of this review is to discuss key anatomic and pathoanatomic factors, treatment principles, and patient outcomes of Lisfranc injuries.

Recent findings Although open reduction and internal fixation (ORIF) remains the current gold standard of treatment, ORIF with primary arthrodesis has become increasingly popular in recent years, both for pure ligamentous and for bony–ligamentous injuries. Return to activity and competitive sports as well as overall patient outcomes have been further defined, suggesting that most patients are able to return to near pre-injury level if properly diagnosed and appropriately treated.

Summary Considerable controversy remains as to the optimal method of treatment of Lisfranc injuries and may ultimately be defined by activity-specific or sport-specific criteria.

Keywords Lisfranc injury · Tarsometatarsal joint complex · Midfoot injury

Introduction

Lisfranc injuries refer to bony or ligamentous compromise of the tarsometatarsal and intercuneiform joint complex and include a spectrum of injuries ranging from a stable, partial sprain to a grossly displaced and unstable fracture or

fracture–dislocation of the midfoot. Ironically, the injury is named after Jaques Lisfranc de Saint-Martin, a French army field surgeon, who actually described a traumatic amputation through the midfoot. What follows is a review of the relevant anatomy, pathoanatomy, clinical evaluation, and current management techniques for Lisfranc injuries.

Anatomy

The bony elements of the medial three tarsometatarsal joints (medial, middle, and lateral cuneiforms and first, second, and third metatarsal bases, respectively) feature a unique trapezoidal shape in cross section, creating a concave arrangement plantarly resembling a Roman arch. The second metatarsal is recessed between the medial and lateral cuneiforms in the transverse plane and is positioned at the apex of the Roman arch in the coronal plane. It thus functions as the keystone of the entire midfoot complex (Fig. 1).

The tarsometatarsal joints are stabilized by dorsal and plantar tarsometatarsal ligaments. Dorsal and plantar intermetatarsal ligaments provide further stability between the second through fifth metatarsal bases. There are no intermetatarsal ligaments between the first and second metatarsals, which may predispose the area to injury. The Lisfranc ligament courses from the plantar portion of the medial cuneiform to the base of the second metatarsal.

The medial column refers to the first tarsometatarsal and navicular–medial cuneiform articulations; the middle column includes the second and third tarsometatarsal joints and articulations between the navicular and middle and lateral cuneiforms, respectively.

The unique bony arrangement of the medial midfoot imparts inherent bony stability to the medial and middle columns of the foot, which in combination with the stout plantar

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Fig. 1 The second metatarsal keystone. Note that the second metatarsal base is proximally recessed relative to the first and third metatarsal bases (*black arrow*)

ligaments prevents plantar displacement of the metatarsal bases and facilitates the weightbearing function of the first ray. The medial three tarsometatarsal joints and the adjacent intercuneiform and naviculocuneiform articulations (medial and middle columns) have limited inherent motion, making these joints non-essential to normal foot function and therefore relatively expendable (Fig. 2a).

The fourth and fifth tarsometatarsal (lateral column) joints have distinctly more inherent motion and are critical in accommodation of the foot to uneven surfaces. These joints are considered essential joints to normal foot function and therefore non-expendable (Fig. 2b).

Pathoanatomy

Lisfranc injuries are generally the result of a high-energy injury, such as a fall from a height or a motorcycle or motor vehicle accident, but, depending on the position of the foot, may also result from a relatively lower-energy injury, such as with competitive sports or a slip and ground-level fall. These injuries result from a combination of axial load and dorsiflexion, plantarflexion, abduction, or adduction (or variable combinations thereof) of the midfoot. The pathoanatomy is individually specific and highly variable and may consist of a pure ligamentous injury, a pure bony injury (fracture), or a combination.

While the injury classically includes the first and second tarsometatarsal joints and Lisfranc joint, there may be involvement of all five tarsometatarsal articulations, extension into the intercuneiform joints, or even fracture lines into the navicular or cuboid proximally or metatarsal shafts or necks distally. In pure ligamentous patterns, the stability of the injury depends on the status of the plantar tarsometatarsal ligaments.

Fig. 2 Normal weightbearing radiographs of the foot. **a** A/P view. **b** Oblique view. **c** Lateral view

Disruption of these stout structures makes the injury, by definition, unstable.

Partial injuries (sprains) occur as a result of lower energy and are more common with axial load and plantarflexion, such as in competitive sports. In this instance, the plantar tarsometatarsal ligaments remain intact, making the injury, by definition, stable.

Clinical evaluation/diagnostics

A thorough history and physical examination is the foundation of clinical evaluation and is of paramount importance with Lisfranc injuries. As with most conditions of the foot and ankle, the adage of “where does it hurt and what (structure) lives there?” should be followed. Distinct details of the exact injury mechanism should be ascertained, including position of the foot, direction of force, and extent of energy involved. 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. Tenderness to palpation of the midfoot and reproduction of

pain with passive motion of the forefoot are suggestive of a Lisfranc injury.

Initial radiographic evaluation consists of non-weightbearing anteroposterior (AP), oblique, and lateral views of the foot, which, depending on the extent of intra-articular displacement, may provide sufficient diagnostic information. A high index of suspicion must be maintained, as historically up to 20% of unstable Lisfranc injuries are misdiagnosed on plain radiographs [1].

Fluoroscopic stress views may be helpful in more subtle injuries; however, these studies are painful and may require anesthesia. This author therefore prefers weightbearing radiographs of the foot for more subtle injuries; comparison weightbearing radiographs of the contralateral foot may also be obtained where necessary. A shorter second metatarsal may anatomically predispose a patient to a pure ligamentous Lisfranc injury in the instance of midfoot trauma [2].

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. 2a). 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. 2b). 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. 2c). Disruption of any of these relationships is generally indicative of a 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 midfoot injury [3].

Computed tomography (CT) scanning may also be beneficial with a subtle Lisfranc injury, particularly in a polytrauma patient or a patient with multiple extremity injuries that preclude weightbearing radiographs, and to delineate proximal fracture line extension into the navicular, cuboid, or cuneiforms.

Treatment

Stable injuries

Stable injuries (partial sprains, extra-articular fractures) are treated non-operatively, typically with temporary boot immobilization. A soft orthotic and compression stocking may be added for comfort where needed. Patients are allowed to weightbear to tolerance and perform a gentle range of motion exercises and may transition to regular shoe wear when pain

allows, typically after 4–6 weeks. Weightbearing radiographs should be repeated 2 to 3 weeks after the injury to ensure against late displacement. These injuries often require prolonged recovery time; however, patients can generally expect full recovery and return to activity with minimal long-term implications [4].

Misdiagnosis

Unstable injuries that are misdiagnosed or inadequately treated generally go on to a poor result with persistent pain, activity limitations, and progressive post-traumatic arthritis in the involved joints [1, 5], generally necessitating arthrodesis as salvage [6, 7]. Chronic Lisfranc injuries (treated late) have historically been associated with less optimal outcomes relative to those properly diagnosed and treated at the time of injury, likely because of the effects of malalignment and abnormal load distribution across the involved joints prior to treatment. These chronic injuries may therefore be more amenable to open reduction and internal fixation (ORIF) with primary arthrodesis than attempted ORIF alone. Delayed diagnosis may be treated by ORIF (without arthrodesis) in the absence of post-traumatic arthritis [8], although there may be potential for late collapse or recurrence of deformity.

Unstable injuries

Surgical management is indicated for unstable (displaced) injuries of the midfoot, including pure ligamentous, bony, or variable combinations. Any dislocation-producing tension on the overlying skin and soft tissue envelope should be immediately reduced and immobilized. Temporary external fixation may be utilized in the event of a high-energy injury, particularly if provisional alignment cannot be maintained in a splint [9]. Definitive surgery is generally delayed 10 to 14 days to allow adequate resolution of soft tissue swelling.

Open reduction internal fixation

Open reduction and internal fixation (ORIF) with transarticular screw fixation has long been considered the gold standard [10]. The placement of transarticular screws arguably further damages the articular surfaces of the involved joints. Fracture comminution or intra-articular extension, not uncommon given the variability of the injury patterns, may also preclude transarticular fixation. Bridge plate fixation may provide a workable alternative in providing definitive stability while avoiding iatrogenic articular damage. There remains considerable controversy as to the optimal implant size, implant type (stainless steel, titanium, or bioresorbable), whether or not to remove definitive implants, and the optimal timing of implant removal.

ORIF with primary arthrodesis

ORIF with primary arthrodesis (of the involved joints) has become increasingly popular in the past 10 years, particularly for pure ligamentous patterns. The basis of primary arthrodesis as a treatment method relates to the prolonged healing time of the ligamentous injury relative to a bony injury and the non-essential function of the involved medial and middle column joints, such that there is limited inherent motion within these joints normally. ORIF with primary arthrodesis therefore necessitates only limited loss of motion and function through these joints. The long-term effect of loss of these non-essential joints is unknown, and there may be potential for adjacent joint arthritis over time. To date, there are no reports of adjacent joint arthritis following ORIF with primary arthrodesis. ORIF with primary arthrodesis has been associated with lower hardware removal rates, generally because ORIF alone often necessitates hardware removal as part of treatment.

Initial studies suggested that over 90% of patients were able to return to pre-operative level of activity following primary arthrodesis [11] and that primary arthrodesis significantly reduced the rate of both planned and unplanned secondary surgeries relative to ORIF alone [12]. ORIF with primary arthrodesis also appears to yield good results for combined bony and ligamentous patterns [13].

More recently, Smith et al. performed a meta-analysis comparing ORIF alone to ORIF with primary arthrodesis [14•]. The authors found that ORIF with primary arthrodesis was associated with a lower reoperation rate for hardware removal relative to ORIF alone, but there was no difference in revision surgery rates, patient-reported outcomes, or risk of non-anatomic alignment between the two groups.

This author has treated all Lisfranc injuries with ORIF with primary arthrodesis over the past 10 years and has anecdotally noted a similar experience as Ly and Coetzee [11], with generally consistent pain relief and return to function relative to ORIF alone (Fig. 3a–c).

Return to activity/competitive sports

Return to physical activity and competitive sports following Lisfranc injuries has been an area of considerable interest of late. MacMahon et al. reviewed 38 patients with Lisfranc injuries treated by ORIF and primary arthrodesis and specifically assessed the return to sports and physical activity based on a sports-specific patient questionnaire [15•]. They found that the majority of patients in their study were able to return to their previous physical activities. Compared to pre-injury, patient levels of participation were the same or improved in 75%, while the difficulty with participation was the same as pre-operatively in 66%.

Fig. 3 Radiographs of a 21-year-old Division I college football player treated by ORIF with primary arthrodesis for a pure ligamentous Lisfranc dislocation. **a** Original A/P injury radiograph—note asymmetry through the first and second tarsometatarsal joints (black arrows). **b** Final weightbearing A/P view. **c** Final weightbearing lateral view. He returned to play at 5 months post-injury

Deol et al. reported on the time to return to training and competition in a series of 17 consecutive professional rugby and soccer players with unstable Lisfranc injuries requiring surgical treatment [16]. All but one was able to return to training and full competition at an average of 20.1 and 25.3 weeks, respectively. Soccer players were able to return to competition significantly faster than rugby players; those with ligamentous injuries returned significantly faster than those with bony injuries.

McHale et al. performed a data analysis on a consecutive series of 28 professional football players with Lisfranc injuries over a 10-year period, specifically assessing the return to competition and athletic performance following treatment [17]. Ninety-three percent of the athletes were able to return to play at an average of 11.1 months following injury. Although the athletic performance of both offensive and defensive players with a Lisfranc injury declined relative to pre-injury, the level of decline was not statistically significant relative to control groups.

Lastly, Dubois-Ferriere et al. retrospectively reviewed 61 patients with Lisfranc injuries treated surgically over a 21-year

period, with an average follow-up of 10.9 years [18•]. They found that most patients were able to return to their previous level of function and employment. Seventy-two percent had radiographic evidence of post-traumatic arthritis; 54% were symptomatic.

Future directions

Considerable controversy remains regarding the optimal method of treatment of unstable Lisfranc injuries, as well as multiple other aspects of management of these injuries. Further studies are needed to potentially clarify many of these remaining questions. Additional studies may ultimately address whether or not treatment among athletes should be position-specific or sport-specific.

Conclusions

Lisfranc injuries represent a spectrum of injury, ranging from a partial ligamentous sprain or non-displaced fracture to grossly displaced, unstable ligamentous or osteoligamentous injury. While ORIF remains the gold standard currently, ORIF with primary arthrodesis has become increasingly popular. Patients with a Lisfranc injury can generally anticipate a good outcome with return to near pre-injury level, provided the injury is accurately diagnosed and appropriately treated.

Compliance with ethical standards

Conflict of interest Michael P. Clare declares that he has no conflict of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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