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REVIEW ARTICLE

Current concept review on Lisfranc injuries

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ABSTRACT

Injuries of the tarsal-metatarsal joints are known as Lisfranc injuries. Direct Lisfranc injuries are generally caused by a crush injury to the mid-foot, whereas indirect injuries occur by twisting–for example, after falling from a height or walking into a hole in the ground. As many as 20% of such injuries may be missed by routine X-ray. In this article, we review the anatomy, classification, diagnosis, treatment, complications, and prognosis of Lisfranc injuries, to alert surgeons, particularly trauma surgeons, to the radiological signs and management of this type of injury.

中文摘要

列士弗蘭克氏創傷的現代概念綜述

陳智輝、周肇平

跗蹠關節創傷被稱為列士弗蘭克氏（Lisfranc）創傷。列士弗蘭克氏創傷一般直接由壓擊引致足底中部受傷，或間接由扭傷引起，如從高處墮下或被地面凹陷處絆倒。列士弗蘭克氏創傷的報導雖不常見，但實際有近百分之二十的病例未能從一般X射線檢驗中顯示出來。本文嘗試從解剖學、分類、診斷、併發症、及預後等不同層面作討論，從而提醒外科醫生，特別是創傷科醫生，注意此類創傷的X射線照片徵象及其處理。

INTRODUCTION

In 1815 Jacques Lisfranc[4] first described a forefoot amputation through the tarsal-metatarsal joints. The procedure was quick to perform and injuries involving this joint became known as Lisfranc injuries.[3,17] Lisfranc injuries are infrequently reported (0.18% of all skeletal injuries); however, as many as 20% may be missed on routine dorsal-plantar and lateral view X-rays.[7] These missed injuries are often associated with chronic pain and disability–for example, because of incomplete reduction or redislocation following inadequate treatment. Road traffic accidents and falls with crush injury are the most common causes of Lisfranc injuries. Accordingly, the diagnosis and treatment of Lisfranc injuries should be part of the trauma surgeon's expertise.

ANATOMY

The Lisfranc joint is stable only if the osseous elements and the strong ligamentous structures are intact. The bones of the tarsus and metatarsus are arranged in an arcuate fashion to form the longitudinal and transverse arches. In the coronal plane, the transverse plantar arch is asymmetrical, and cross over the metatarsal base, cuneiformses, and cuboid bones. The bases of the three cuneiforms are wedge-shaped, being widest dorsally and forming a Roman arch configuration (Fig. 1). The middle cuneiform holds the highest position in this arch. The trapezoidal dove-tail shape of the second metatarsal base is surrounded by five adjacent bones in a tight mortise that provides distinct stability to the entire tarsal-metatarsal articulation. For this reason,

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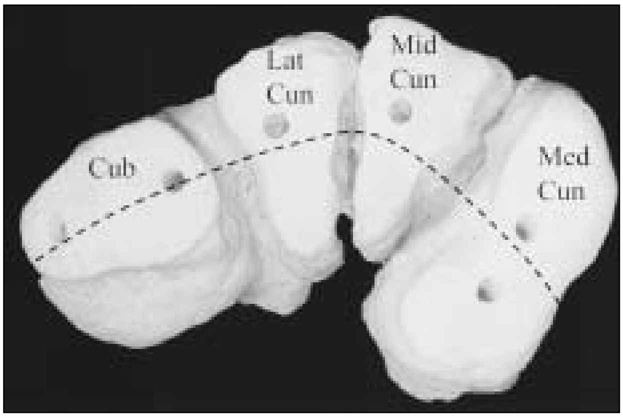

Figure 1 Coronal profile of the three cuneiforms and cuboid illustrating a parabolic curved longitudinal arch, with the middle cuneiform at the apex.

Figure 2 Plantar view of the foot, illustrating the strong ligament between the medial cuneiform and the second metatarsus (arrow), and the absence of ligament between the middle cuneiform and the second metatarsus.

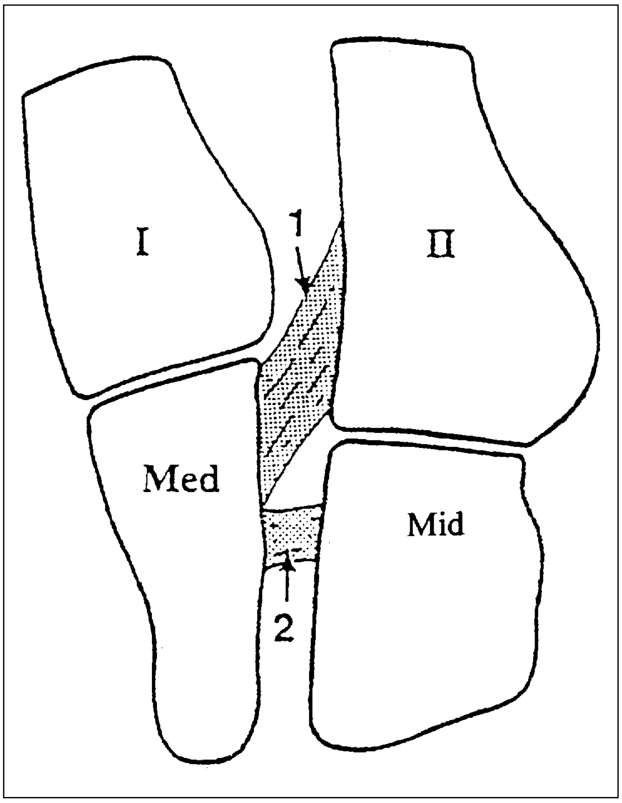

Figure 3 The tarsal-metatarsal articulation of the first and second rays, showing Lisfranc's ligament (1) and an inter-cuneiform ligament (2).
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pure tarsal-metatarsal dislocation is rarely seen and injuries frequently involve fractures through the second metatarsal base.

In the longitudinal arch, individual tarsal-metatarsal articulations form four separate columns; each cuneiform articulates with the first three metatarsals, and the cuboid articulates with the fourth and fifth. The plane of motion of these joints varies among individuals.[10] The fourth and fifth metatarsals move more in both the sagittal and longitudinal plane than do the rest. The second metatarsus is held rigidly in the mortise, whereas the first metatarsus is considerably more mobile, thereby providing functional movement of pronation and supination, as well as its sagittal plane motion.[15]

The stability of the Lisfranc joint is more dependent on the strong ligaments between the tarsus and metatarsus than the bony configuration. The 12 ligaments can be grouped into dorsal, plantar, and interosseous. In the dorsal plane, one ligament runs from each metatarsal base to its respective cuneiform or cuboid facet. There are two more from the second metatarsal base to the medial and lateral cuneiforms, thus further enhancing stability. The plantar ligaments are stronger; there is a broad thick rectangular ligament between the medial cuneiform and first metatarsus. The strongest plantar ligament arises from the inferio-lateral surface of the medial cuneiform, which attaches to the bones of the second and third metatarsus (Fig. 2). There is no plantar ligament between the middle cuneiform and the second metatarsal base. The remaining lateral plantar ligaments vary in size and strength.

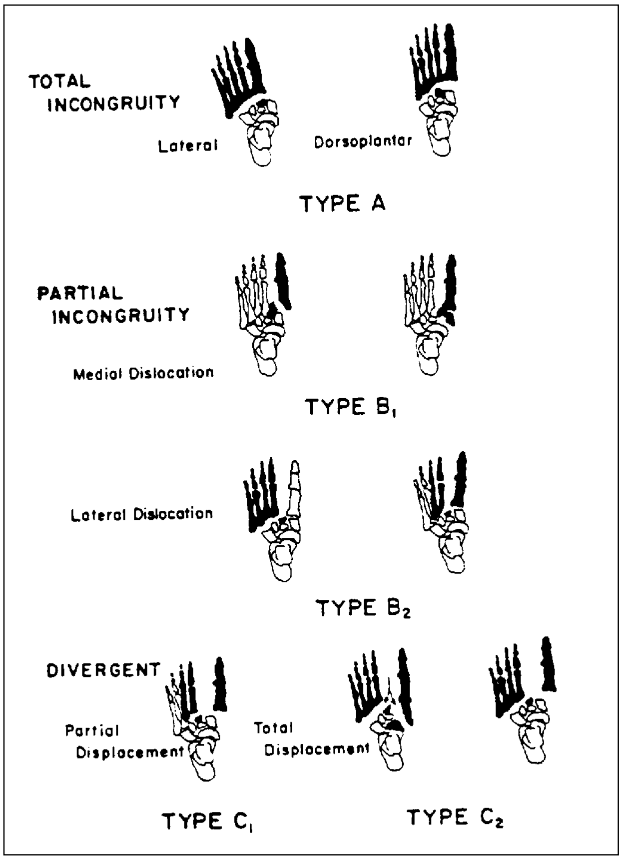

Figure 4 Classification of tarsal-metatarsal injuries, based on segmental patterns of injury and the forces involved in producing the fracture dislocation.
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Figure 5 Dorsal-plantar and oblique radiographs of the foot showing the malalignment of the corresponding tarsus and metatarsus.

Interosseous ligaments are found in the first three inter-cuneiform-metatarsal spaces. The strongest ligament arises from the lateral surface of the medial cuneiform and inserts on the lower half of the medial surface of the second metatarsal base. This is known as the Lisfranc ligament (Fig. 3).[1,7,11] The Lisfranc ligament is strong and measures about 1.0 cm in length and 0.5 cm in thickness. The inter-metatarsal ligament has a variable morphology. There is no inter-metatarsal ligament between the first and second metatarsus. The Lisfranc ligament and the mortise effect created by the base of the second metatarsus provide most of the stability of the entire tarsal-metatarsal articulation.

The secondary stabilisers of the tarsal-metatarsal joints are soft tissue structures that we predominantly located on the plantar aspect of the foot. These structures include the plantar fascia, intrinsic muscles, and tendons. The insertions of the peroneal, and the anterior and posterior tibialis tendons significantly reinforce the stability of the tarsal-metatarsal joints.

CLASSIFICATION OF INJURIES

Most Lisfranc injuries are caused by direct or indirect forces.[2] Direct injury generally involves a crush injury to the mid-foot – for example, a direct blow from a heavy load. There is no particular pattern to the injury, but fracture dislocation usually occurs in the direction of the force applied.

Indirect injury occurs as a result of twisting – commonly, a rotational force on a plantar flexed forefoot. This twisting can occur after falling from a height, or walking into a hole in the ground. The weaker dorsal ligaments are unable to resist the tension and rupture, thereby resulting in a dislocation of the Lisfranc's joint. Injury can also result from a combination of causes.

Quen and Kuss[16] devised the most widely accepted and simple to use classification of Lisfranc injuries, in which

Figure 6 Dorsal-plantar radiograph of the foot showing associated fractures and dislocation of the distal metatarsals and metatarsal-phalangeal joints.

Figure 7 Dorsal-plantar, oblique **(A)** and lateral radiographs **(B)** showing authors' preferred method of fixation of Lisfranc's injuries. Note anatomical reduction of all tarsal-metatarsal joints.

injury patterns are categorised as homolateral, isolated, or divergent. Hardcastle et al[8] and Myerson[12] further classified these injuries to aid treatment planning (Fig. 4). The three basic types of incongruity are included. Type A has a total incongruity of the tarsal-metatarsal joints in any plane or direction. Type B-1 has a partial incongruity in which there is a medial displacement of the first ray. Type B-2 has a partial incongruity in which there is a lateral displacement of the lateral rays. Type C has a divergent pattern with the first ray displaced medially and, simultaneously, the lateral rays displaced laterally in any pattern. This classification illustrates joint incongruity and segmental instability and is helpful in pre-operative planning.

DIAGNOSIS

Most fractures or dislocations of the Lisfranc joint are easily diagnosed, provided that a high index of suspicion is maintained. Minor subluxations, however, are often missed. Localised tenderness at the Lisfranc joints during gentle passive pronation or pain on abduction of the forefoot appear to be specific to this injury. If injury to the mid-foot is suspected, dorsal-plantar, true lateral, and 30° oblique radiographs of the foot should be ordered. Weight-bearing and stress film with screening intra-operatively is useful in doubtful cases.

A few points should be noted with regard to the radiological features of Lisfranc injuries:

1. The medial cortex of the second metatarsal base and the medial cortex of the middle cuneiform

Figure 8 Malalignment and post-traumatic arthritis—late sequelae of an inadequately treated Lisfranc's injury.

should appear in line on a dorsal-plantar radiograph. Likewise, the medial cortex of the fourth metatarsal base and the medial cortex of the cuboid should appear in line on an oblique radiograph. The dorsal cortex of the second metatarsal base and the dorsal cortex of the middle cuneiform should appear in line on a true lateral radiograph. Any deviations indicate a pathological displacement (Fig. 5);

2. A widening between the bases of the first and second metatarsus, or widening between the middle and medial cuneiforms are consistent findings in Lisfranc joint subluxation;
3. The widening of the first and second metatarsal base associated with a small fracture at the base of the second metatarsus–that is, the "fleck sign"[8]–indicates an avulsion fracture of the Lisfranc ligament and suggests instability;
4. Associated fractures and dislocations at the distal metatarsus, metatarsal-phalangeal joint, and cuboid are common (Fig. 6); and
5. A radiograph may be normal if a pure dislocation has been reduced spontaneously. The use of computed tomography can accurately detect articular cartilage injury if the displacement is more than 2.0 mm.[6]

TREATMENT

Lisfranc injuries are invariably associated with substanial soft-tissue injury and swelling. Thus, performing the advantages of an adequate closed reduction are invariably lost when soft-tissue swelling subsides.

The authors advocate the use of open reduction and internal fixation for all unstable injuries, particularly if an intra-articular fracture is present. Closed reduction and percutaneous fixation should be reserved for simple spontaneously reduced disruptions.

A dorsal longitudinal incision along the second metatarsus provides adequate visualisation for all cuneiform-metatarsal joints; a lateral incision along the fourth metatarsus is supplementary if the lateral ray remains unstable after reduction of the medial rays. Reduction should be first accomplished by relocating the second metatarsal base into its keystone position. The surgeon should be alert for bone fragments avulsed with the Lisfranc ligament. The tibialis anterior tendon may be trapped within the fracture and thus prevent reduction. The fracture can be fixed temporarily with 1.2-mm diameter K-wires. Alignment can be confirmed radiographically. A cortical screw is now preferred to maintain anatomical reduction, because it achieves better stability.[5] Transarticular screws of 3.5-mm diameter do not produce any short-term ill effects; the screw should not be lagged. The authors recommend the insertion of one screw across the dislocated medial cuneiform-metatarsal joint in a retrograde manner, and another screw from the medial aspect of the first cuneiform obliquely into the base of the second metatarsus. The lateral fourth and fifth rays occasionally require fixation and 2.0-mm K-wire fixation is recommended (Fig. 7A&B).

Postoperatively, a short leg cast should be applied until wound healing has occurred. The patient should be non–weight-bearing for 6 weeks. Progressive weight-bearing can commence following ligament healing; weight-bearing should be painless and no resubluxation should be evident on standing radiographs. No form of functional bracing for instability is required; however, an optional arch support may relieve mild residual pain. Removal of implants is recommended after 6 weeks to 6 months, to avoid implant breakage.[10]

COMPLICATIONS AND PROGNOSIS

Early or late complications can occur. Soft tissue damage can result in open injuries, skin degloving, or compartment syndrome[13] of the foot; all demand immediate surgical intervention. Surgical debridement, fasciotomy (pressure in central or interosseous compartment >30 mm Hg[14]), and skin grafting are commonly required. Direct vascular injury can occur at the time of injury or during surgery but rarely results in ischaemia of the foot due to the presence of a dual blood supply to the plantar arches. Sensory impairment is common, however, presumably due to superficial or deep peroneal nerve damage.

Late complications include residual deformities and traumatic arthritis (Fig. 8).[1,9] The degree of post-traumatic arthritis of the Lisfranc joints is directly related to the degree of chondral damage and the residual malalignment.[11] Pain-free, fully functional weight-bearing walking is achievable only if a stable and anatomical reduction of the injured Lisfranc joint is performed.

In Conclusion, Lisfranc injure is a diagnosable and treatable condition, provided trauma surgeons are aware of the pitfalls in the diagnosis and fixation methods.

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