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Complications of missed or untreated Lisfranc injuries

Terry Philbin, DO[a,b,*], Gary Rosenberg, MD[c], James J. Sferra, MD[d]

[a]*Orthopedic Foot and Ankle, 6200 Cleveland Avenue, Suite 100, Columbus, OH 43231, USA*
[b]*University of New England School of Medicine, 11 Hills Beach Road, Biddeford, ME 04005-9599, USA*
[c]*Kaiser Permanente, 4747 Sunset Boulevard, Los Angeles, CA 90027, USA*
[d]*Section of Foot and Ankle Surgery, Department of Orthopaedic Surgery/ A40, 9500 Euclid Avenue, Cleveland, OH 44195, USA*

Jacques Lisfranc (1790–1847), a French surgeon in Napoleon's army, described amputations through the tarsometatarsal joint secondary to infection [1]. He never wrote about fracture-dislocations of the midfoot, but his name has been used historically to describe injuries in this area. During equestrian times, tarsometatarsal injuries were common after falling from a horse with the foot caught in the stirrup.

Injuries to the tarsometatarsal joints are relatively common. They constitute approximately 0.2% of all fractures and occur in 1 person per 55,000 yearly [2–4]. According to Myerson et al [5], 67% of all tarsometatarsal joint injuries are the result of motor vehicle accidents; crushing injuries and falls from heights account for most of the rest. Vuori and Aro [6] reported that up to one third of Lisfranc injuries are caused by low energy trauma. Athletic injuries to the midfoot are being seen with increasing frequency [7,8]. Approximately 20% of Lisfranc injuries can be misdiagnosed or simply missed which can lead to potentially significant sequelae [5].

Anatomy

The osseous anatomy of the Lisfranc joint consists of five metatarsals that articulate with three cuneiforms and the cuboid. The tarsometatarsal joints are

* Corresponding author. Orthopedic Foot and Ankle, 6200 Cleveland Avenue, Suite 100, Columbus, OH 43231, USA.
E-mail address: Philbsgoirish@aol.com (T. Philbin).

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divided into three columns. The medial column consists of the first ray, the middle column consists of the second and third rays, and the lateral column consists of the fourth and fifth rays. The medial three metatarsals articulate with the medial, middle, and lateral cuneiforms, respectively. The fourth and fifth metatarsals articulate with the cuboid. The second metatarsal is recessed between the medial and lateral cuneiforms which provides the stability to the Lisfranc joint. The trapezoidal shape of the cuneiforms and metatarsals form an arch that helps to prevent dorsal displacement [9–12]. Significant dislocation usually does not occur unless the second metatarsal base area is disrupted [13]. In addition to the osseous anatomy, the ligaments of the tarsometatarsal joint provides significant stability to Lisfranc's joint [14]. The metatarsals are bound together by the intermetatarsal ligaments, except between the first and second metatarsals. The second metatarsal is attached to the medial cuneiform by the oblique Lisfranc's ligament. The dorsal and plantar transverse ligaments enhance stability between the transverse tarsal joints. The plantar transverse ligaments are stronger than the dorsal counterpart. An inherent weakness exists because of the lack of ligaments between the first and second metatarsals and the less strong dorsal transverse ligaments. This allows most dislocations to occur in a dorsal and lateral direction.

Mechanism of injury

The mechanism of injury is either direct or indirect [4,11,15–18]. Indirect injuries are more common. Unstable Lisfranc ligamentous injuries are caused by an externally rotated force on a pronated forefoot [5,19]. Because of the inherent weakness in the tarsometatarsal joints, a hyperplantar flexion force will usually displace dorsally more than plantarly.

Classification

Several classifications have been used to describe Lisfranc injuries. Quenu and Kuss [20] described the first in 1909. In 1982, Hardcastle et al [4] modified this classification and denoted three basic types of injury: total incongruity, partial incongruity, and divergent. The systems reported in the literature tend to help more with preoperative planning and less with prognosis, thus no one system is considered the standard. Curtis et al [8] reported on a series of Lisfranc injuries in athletes and classified the ligamentous injuries according to the American Medical Association's Standardized Nomenclature of Athletic Injuries. First and second degree sprains were defined as partial ligamentous tears with clinical findings of focal pain, swelling, and no instability on examination or with fluoroscopy and normal radiographs. Third degree sprains were defined as complete ligamentous tears with diastasis seen on radiographs, indicating instability.

Diagnosis

Lisfranc injuries are generally easy to recognize, yet can be subtle. The injury can be overlooked in patients with multiple traumas and in cases where the diastasis spontaneously reduces. Physical examination typically reveals edema and tenderness in the forefoot [21]. The plantar ecchymosis sign may be present [22]. A thorough neurovascular examination should be performed to rule out deficiencies that are seen in compartment syndrome secondary to direct and crush type injuries [23]. Curtis et al [8] described the passive pronation and abduction test in which pain in the midfoot was increased with gentle, passive pronation and abduction of the forefoot. Standard radiographs, including three views of the foot should be obtained [10]. In the presence of symptoms and normal radiographs, stress radiographs or weight-bearing films should be considered [24,25]. Subtle injuries might require bilateral weight-bearing films.

Typical radiographic findings of Lisfranc injuries include diastasis between the bases of the first and second metatarsals or the second and third metatarsals; a shear fracture at the second metatarsal, in which the base remains attached to the cuneiform; and impaction fractures of the cuboid, the medial cuneiform, or the navicular [26]. The normal diastasis between the first and second metatarsals can be up to 2.6 mm [27]. Myerson et al [5] described the fleck sign as an avulsion fracture that is seen at the second metatarsal base or from the medial cuneiform which is present 90% of the time. Lateral weight-bearing radiographs, in which there is flattening of the longitudinal arch, can be helpful in assessing the subtle Lisfranc injury [27]. Computed tomography can help delineate fracture patterns and identify subtle malalignments [28]. CT scanning may be useful to identify intra-articular bone fragments and soft tissues interposed in fracture fragments.

Treatment

The best results in the treatment of tarsometatarsal injuries are achieved with stable anatomic reduction [14,21,29]. Stable, nondisplaced injuries can be treated with cast immobilization and protected weight bearing. Injuries that are deemed to be unstable require open reduction and internal fixation. Curtis et al [8] treated stable tarsometatarsal injuries in a below-the-knee cast until patients were symptom free. Unstable injuries were treated with open reduction internal fixation. Patients were nonweight bearing for 10 to 12 weeks. Screw removal was performed between 12 to 16 weeks followed by gradual return to activity. Much of the controversy associated with these injuries is based on the timing of surgery. Surgery is best performed within the first 24 hours following the injury or should be delayed until edema has decreased in such a way to minimize wound complications [26]. The literature has little information about the timing of open reduction internal fixation of Lisfranc injuries when the injury is no longer acute. In 1982, Hardcastle et al [4] described several cases with good results of open reduction up to 6 weeks after injury. Two patients who were treated after 6 weeks had only fair results. It was

concluded that open reduction should probably not be attempted more than 6 weeks after injury. In 1988, Arntz et al [30] reported their results for open reduction internal fixation of tarsometatarsal injuries (95% good or excellent results in patients in whom anatomic reduction was achieved). All of the patients were operated on within 4 weeks of the injury. Kuo et al [31] found no difference in the outcome scores between acute and delayed (more than 6 weeks; 3 patients) surgery in patients who received open reduction internal fixation of Lisfranc injuries. Patients with purely ligamentous injuries had poorer outcomes.

Good results have been achieved with open reduction internal fixation performed up to 6 weeks after injury. It was reported, however, that results of open reduction internal fixation 6 weeks after injury may be poor secondary to extensive soft tissue dissection, articular destruction caused by joint malalignment, and poor stabilization because of rounding of the ligament edges [25].

Gueramy and Karges compared the results of open reduction internal fixation in patients with acute diagnosis with the results from patients with delayed diagnosis (more than 6 weeks) of Lisfranc injuries (Tim Gueramy, MD, personal communication, 2002). The ages of the 55 patients ranged from 25 to 75 years old. Follow-up averaged 49.4 months. Thirteen of the patients (23.6%) had surgery after 6 weeks of injury with an average time to surgery of 31.8 weeks. The American Orthopedic Foot and Ankle Score (AOFAS) postoperative score for the patients with acute diagnosis was 73.5; four out of 42 patients (9.5%) required midfoot arthrodesis at a later date. The AOFAS postoperative score for the group that had delayed diagnosis was 64; three out of 13 patients (23%) required a midfoot arthrodesis at a later date. All of the patients that had a delayed diagnosis sustained pure ligamentous injuries without fractures. This study showed that open reduction internal fixation can be successful after 6 weeks in patients with a delayed diagnosis.

Open reduction and internal fixation of tarsometatarsal injuries that require surgery can be accomplished with Kirschner wire or screw fixation. In certain cases, external fixation may be needed. Many complications were reported with the use of Kirschner wire fixation, including pin migration, pin tract infections, and loss of reduction [30]. Arntz et al [30] described 41 Lisfranc injuries that were treated by open reduction and screw fixation. The advantage of screw fixation is rigid reduction with gentle compression across the joint. The investigators found no residual subluxation or dislocation after screw removal during postoperative follow-up.

Poor results occur after Lisfranc injuries that lack anatomic reduction, have significant fracture comminution, and when the diagnosis is missed or significantly delayed. The incidence of posttraumatic arthritis following tarsometatarsal injury ranges from 0% to 58% [32]. Radiographic findings and severity of injury are not predictive of which patients will develop arthritis. Brunet and Wiley [33] reported that symptoms following Lisfranc injury can improve up to 1.3 years following injury, whereas Wilppula [34] reported that symptoms can improve up to 4 years after injury [34]. Adelaar [35] described forefoot stiffness, loss of metatarsal arch, intrinsic contracture, and increased metatarsal head pressure as

Fig. 1. Mildly displaced medial cuneiform fracture/nonunion. A 400-pound weight fell on the foot 6 months earlier. (A) AP view. (B) Oblique view. (C) Lateral view. (D) CT scans reveal comminution of the fracture and joint incongruity at the first and second TMT. Status post first and second TMT fusion and intercuneiform fusion. (E) AP view. (F) Oblique view. (G) Lateral view.

Fig. 1 (*continued*).

complications of tarsometatarsal injuries. Most commonly, planus or planovalgus deformities will occur; cavus deformity is a less common result.

Patients may develop ankle or lateral impingement pain secondary to these deformities. Patients who develop these complications, as well as arthritis, can be treated with orthotics, stiff-soled shoes, and rocker bottom soles [36]. Pain, shoe-fitting problems, and skin breakdown can occur over bony prominences. Custom shoewear can be necessary to accommodate prominences within the foot.

Patients who fail nonoperative treatment of posttraumatic tarsometatarsal arthritis may become candidates for arthrodesis (Fig. 1). The literature describes several ways to perform Lisfranc arthrodesis, including bone graft with staples, bone graft with Kirschner wires, dowel technique, and screws with or without bone graft. At the time of fusion, medial or lateral column lengthening may need to be performed by way of cortical bone grafts to address deformities that have arisen (Fig. 2).

Sangeorzan et al [36] reviewed 16 patients who had salvage tarsometatarsal arthrodesis after failing nonoperative treatment. Good to excellent results were achieved in 69% of the patients; the other patients had fair or poor results.

Johnson and Johnson [32] reported on 15 patients who had a dowel-graft arthrodesis after failing nonoperative treatment. The patients had a fusion

Fig. 1 (*continued*).

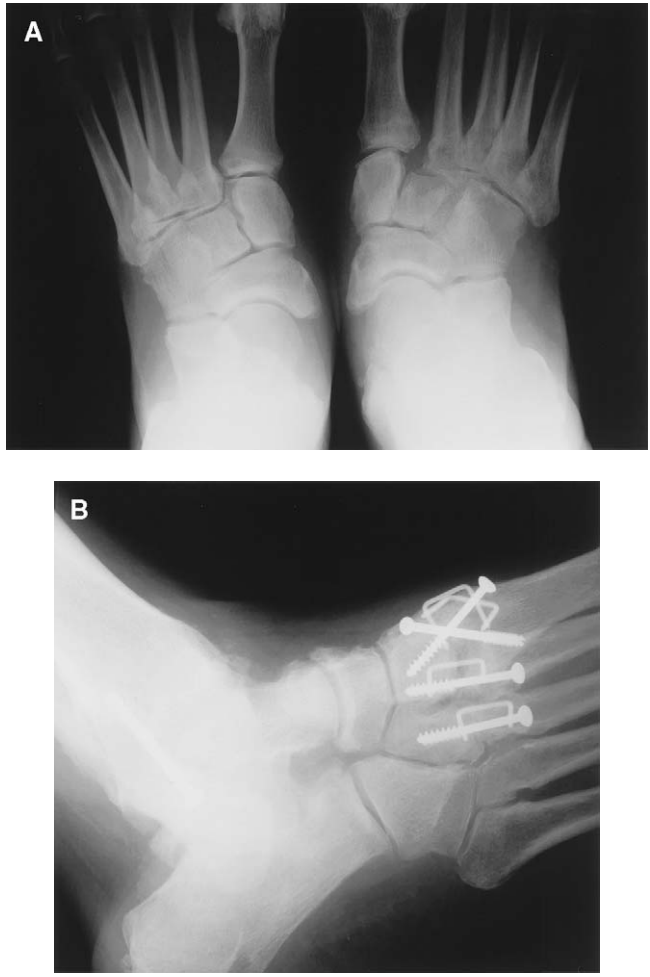

Fig. 2. (A) Lisfranc injury undiagnosed for 6 months. Now with foot abduction and developing pes planus. Postop first, second, and third TMT fusion. (B) Oblique view. (C) Lateral view.

performed in situ. Eighty-five percent of the patients had satisfactory pain relief. Two patients developed painful nonunion. Goosens and DeStoop [9] reported that fusion was performed in three out of 20 patients who suffered from painful degenerative arthritis. Bone graft was used and staples were the choice of fixation. All three patients had good results and returned to work.

Granberry and Lipscomb [37] advocated primary fusion whenever it was necessary to perform an open reduction of an unstable fracture-dislocation. Arntz et al [30] reported that primary fusion might be an option in a minority of patients with severe articular damage.

Fig. 2 (*continued*).

Konenda et al [38] reviewed the results of 32 patients who had an arthrodesis of the tarsometatarsal joints after traumatic injury. The midfoot fusions were performed at a mean of 35 months after injury. They were evaluated at a mean of 50 months following fusion. The American Orthopaedic Foot and Ankle Society midfoot rating scale was significantly improved postoperatively. The investigators concluded that realignment of the midfoot during fusion contributed to improved results over fusion in situ [38].

Summary

Injuries to the Lisfranc complex are fairly common. Delayed treatment or missed diagnosis of these injuries can lead to significant complications. Nonoperative treatment and salvage surgery can help to relieve sequelae that are associated with tarsometatarsal arthritis following traumatic injury.

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