Lisfranc Injury in a National Hockey League Player: A Case Report

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Abstract

Tarsometatarsal joint dislocations and fracture-dislocations are uncommon injuries most frequently resulting from high-energy trauma as encountered in crush injuries, falls, and motor vehicle accidents. Although less common in athletes, this injury is being recognized with greater frequency and may carry a poor prognosis for return to high levels of competition. These injuries present a considerable challenge to orthopedic surgeons caring for athletes because of the prolonged period of recovery often required [1,2,5, 6,12]. The literature contains descriptions of this injury in football players, gymnasts, tennis players, and track and field athletes [2,5,9]. To our knowledge, no report of such a Lisfranc injury to a hockey player has been described. This is a case report of a National Hockey League player that sustained a Lisfranc injury requiring surgical stabilization, but was able to return to elite hockey play.

Case Report

A twenty-nine-year-old male National League Hockey player sustained an acute injury to his left foot while participating in off-season, land-based lower extremity cross-over running drills. After placing an axial load on his foot in a plantar-flexed and inverted position, the patient felt a snap in his midfoot and developed immediate pain and swelling. He was seen immediately by an orthopedic surgeon who obtained anteroposterior, lateral, and oblique radiographs as well as stress-views which revealed a diastasis of the first and second metatarsal bases with subluxation of the first and second tarsometatarsal joints (see **Figs. 1** and **2**). Of additional note, was the observation of a prior, healed, first metatarsal shaft fracture. The patient was placed in a short-leg posterior splint, kept non-weight-bearing, and referred to his team orthopedic surgeons for further management.

On physical examination, the patient had edema, ecchymosis, and tenderness to palpation of the medial midfoot at the level of the first, second, and third tarsometatarsal joints. He was neurovascularly intact and had no evidence of ankle or subtalar joint pathology. A diagnosis of Lisfranc joint dislocation involving the first, second, and third tarsometatarsal joints was made and treatment options discussed. Given the unstable nature of his ligamentous injury and his career as a professional hockey player, open reduction and internal fixation were deemed optimal management.

The patient was taken to the operating room, general anesthesia was induced, and a supplemental ankle block was placed with 20 cc of 0.5% bupivicaine (Abbott Laboratories; North Chicago, IL, USA) without epinephrine. A dorsal medial longitudinal incision was made over the first metatarso-cuneiform joint and the dorsal capsule of the first metatarsal joint reflected. The first metatarsal base was found to be plantar-flexed with significant instability, and no evidence of significant intra-articular pathology. The joint was reduced and provisionally fixed with a 0.062 in. Kirschner wire and a second incision was made parallel and approximately three to four centimeters lateral to this over the space between the second and third metatarsal bases. The extensor digitorum brevis muscle was divided in line with its fibers and the second and third metatarsal joints were exposed. Both of these joints were found to be notably unstable with lateral subluxation of the second metatarsal base. Sequential reduction of the second and third metatarsal bases was performed with a large reduction forceps, and provisional fixation was ob-

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Bibliography
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Fig. 1 a to **c** Weight-bearing anteroposterior, oblique, and lateral views demonstrating subtle Lisfranc injury.

tained with two additional 0.062 in. Kirschner wires. Fluoroscopic confirmation of anatomic reduction of the tarsometatarsal joints was obtained and each tarsometatarsal joint was fixed with a fully-threaded 3.5-mm Bionix absorbable SmartScrew® (Linvatec, Largo, FL, USA) from distal to proximal [13, 14]. It was believed the bioabsorbable screws would allow re-

Fig. 2 a Comparison weight-bearing anteroposterior radiograph demonstrating diastasis between first and second metatarsal bases.

Fig. 2b Stress-view demonstrating diastasis and avulsion fragment.

turn to play without the need for a second operation for hardware removal. Fluoroscopic and radiographic confirmation of reduction and fixation was perfomed and revealed excellent stability and alignment without the need for additional fixation across the medial and middle cuneiforms. The patients wounds were irrigated and closed in standard fashion and he was placed in a non-weight-bearing short-leg splint.

Postoperatively, the patient was kept in a splint for two weeks followed by a cast for four additional weeks. At the six-week postoperative visit, he was placed in a walker boot with a compression sleeve and a custom total-contact foot orthotic was fabricated. He began a physical therapy protocol to advance to full weight-bearing in the walker boot with exercise bicycling, and walking and running in a pool. Active assisted and passive range of motion exercises for the toes, subtalar, and ankle joints were initiated. At ten weeks postoperatively, he transitioned from the walker boot to a regular athletic shoe with the custom total-contact foot orthotic. At this point, he began a return to a skating program and was able to return to practice and competition by fourteen weeks postoperatively. He was not limited at the time of return to play except for decreased stamina. At the end of the season, we obtained weight-bearing radiographs at 10 months

Fig. 3 Ten-month follow-up weight-bearing comparison anteroposterior radiograph.

that confirmed maintenance of the reduction (**Fig. 3**). He continued to play professional hockey with other teams and the injury did not limit him in the future, and he reported no future problems both on or off the ice with the foot.

Discussion

Anatomy

The tarsometatarsal joint complex, or Lisfranc joint, consists of a series of diarthrodial articulations between the bases of the five metatarsals and the three cuneiforms and cuboid. The bony architecture of the joint forms a three-dimensional framework of self-locking elements that ensure the stability of the tarsometatarsal joint and contribute to the longitudinal arch of the foot. The medial and lateral cuneiforms and cuboid lie in a single curvilinear plane, while the intermediate cuneiform and its articulation with the second metatarsal base are slightly recessed, forming the apex of the longitudinal arch. This configuration forms a mortise for the articulation of the second metatarsal and the intermediate cuneiform, which is often cited as the "key" to the stability of the Lisfranc joint [5,9]. Stability is further maintained by the plantar transverse intermetatarsal ligaments which bind the bases of the second through the fifth metatarsal bones. However, these ligaments do not connect the first and second metatarsal bases. Instead, a single large ligament, commonly referred to as Lisfranc's ligament, runs from the medial cuneiform to the base of the second metatarsal and serves to stabilize the base of the second metatarsal in the "key" wedge created by the intermediate cuneiform and first metatarsal. This cuneiform – second metatarsal connection – represents a weak link in the ligamentous architecture of the midfoot, yet it serves as a crucial element of midfoot stability and is highly susceptible to injury [5,6]. Injuries to the first, second, and third tarsometatarsal joints and surrounding structures classically result in two predictable anatomic consequences: diastasis between the first and second metatarsals and flattening of the longitudinal arch.

Mechanism of injury

The Lisfranc ligament and injury were named for Jacques Lisfranc, a field surgeon under Napoleon, who first described amputation through the tarsometatarsal joint in 1815. Early reports of Lisfranc injuries were attributed to cavalry officers who fell from a horse with a foot trapped in the stirrup. A similar mechanism of injury has been described in windsurfers [2]. Today, most injuries to the Lisfranc joint occur following motor vehicle accidents, falls, and crush injuries to the dorsum of the midfoot [5,8]. While high-energy injuries often involve extensive damage to both the tarsometatarsal joint and surrounding tissues, Lisfranc injuries sustained by athletes often consist of isolated damage to the Lisfranc complex [12].

Lisfranc injuries have been classified as direct (e.g., crush injury, gunshot wound) and indirect in nature. The latter is believed to occur with a complex combination of plantar-flexion, pronation and external rotation [7,9,11]. Athletic injuries are generally due to indirect trauma which can further be subdivided into abduction injuries and plantar flexion injuries. Abduction injuries occur when the forefoot is forcefully abducted with the hindfoot fixed, laterally displacing the metatarsals as in a sail boarding or equestrian accident [5]. More common, however, are the plantar-flexion twisting injuries that occur when a rotational axial load is applied to a plantar flexed foot [2,5,6,8]. This load may be external or produced by the weight of one's own body. A common scenario in football occurs when an athlete is tackled from behind, and the opposing player inadvertently exerts downward pressure on the heel of a planted and plantar flexed foot, resulting in dorsal buckling of the metatarsal joint. Similarly, a prone player's plantar flexed foot may be fallen upon during a pile-up [6]. The axial load may also be applied by the weight of the body, as when a gymnast dismounts and lands on their forefoot with the foot in extreme plantar flexion [5,6]. In each of these scenarios, the metatarsal joint is axially compressed, putting considerable tension on the dorsal ligamentous framework of the midfoot and the key to its stability – the Lisfranc complex. Further flexion or concomitant twisting of the midfoot results in disruption of the ligament, and potential diastasis or fracture-dislocation of the associated bony elements.

Treatment

Little debate now exists concerning the optimal treatment of displaced Lisfranc injuries encountered in motor vehicle accidents, crush injuries, and falls. In 1988, Arntz reported a 95% success rate in a series of 40 patients in treating injuries to the tarsometatarsal joint when anatomical reduction had been achieved by open reduction and internal fixation (ORIF) with AO screws [1]. Since that time, several other studies have supported this data, indicating that anatomic reduction is crucial to an excellent outcome [2,4,8,10]. Myerson and others support the claim that any diastasis greater than 2 mm should be treated with ORIF [7,8]. However, in the majority of these studies, the subjects sustained injuries that differ considerably from those commonly encountered in athletes. Studies relating to high energy injuries must be utilized with caution when applied to athletes who typically sustain lower energy indirect injuries. Additionally, the athletic population requires a higher level of recovery for an acceptable result. While these low energy injuries are often less severe than their high velocity counterparts, the crucial role of the midfoot architecture to stance and stability can make recovery to competitive function a prolonged and difficult process.

Treatment results of Lisfranc injuries in athletes are less clearly delineated in the literature, and no consensus exists regarding optimal treatment and long-term prognosis [5]. In this population, many of these injuries are purely ligamentous with subtle radiographic evidence of instability that may limit prompt diagnosis. As a result, a high index of suspicion based on clinical findings in the history and physical exam are critical, and comparison weight-bearing or stress radiographs have been advocated to facilitate the identification of subtle diastasis between the first and second metatarsal bases [12]. Shapiro et al. presented a series of nine isolated ruptures of Lisfranc's ligament in competitive athletes with average 34.1-month follow-up [12]. The authors demonstrated an average 2.6-mm diastasis between the first and second metatarsal bases (range: 2 – 5 mm) with no flattening of the longitudinal arch on lateral weight-bearing radiographs. Seven of the nine athletes were treated with a removable splint for 4 – 6 weeks followed by progressive weight-bearing starting between 4 – 6 weeks. One patient (with the widest diastasis, 5 mm) opted for operative management with open reduction and internal fixation, and one patient was noncompliant with treatment recommendations. Return to play for the group averaged 14.7 weeks. While this data suggests that purely ligamentous injuries may be treated nonoperatively, further study is needed with particular attention to the significance of the degree of diastasis.

Nunley et al. have devised a classification scheme for low energy Lisfranc injuries and describe three stages [9]. Stage I injuries correspond to sprain of the Lisfranc ligament with no diastasis between the first and second metatarsal rays and no arch height loss, but increased tracer uptake on bone scan. Stage II sprains exhibit a diastasis of 1 – 5 mm, but no arch height loss. Stage III injuries exhibit diastasis and arch height loss as represented by a decrease or inversion of the distance between the plantar aspect of the fifth metatarsal and the plantar aspect of the medial cuneiform on a weight-bearing lateral radiograph. The recommended treatment for stage I injuries includes a non-weight-bearing fiberglass cast for 6 weeks followed by gradual return to function in a custom-molded orthosis if pain free. For stage II and III injuries, however, closed or open reduction and internal fixation is recommended. Nunley et al. reported on a series of 15 patients, seven with stage I injuries and eight with stage II injuries, all treated according to this scheme, with 93% achieving excellent results. Return to play after surgery averaged 14.4 weeks. This series, however, included two athletes with 2 – 5-mm diastasis and no arch height loss that were unable to participate in sports 4 and 10 months following conservative treatment as recommended by the Shapiro model. These athletes were treated with late ORIF and both were subsequently able to return to their respective sports.

Curtis et al. support the contention that any Lisfranc injury with diastasis should be treated operatively by presenting a study of 19 athletes treated for Lisfranc injuries [2]. They classify the injuries as first and second degree (no diastasis between the first and second metatarsal rays), third degree (radiologic diastasis) and frank fracture or dislocation. In their study, 7 of 9 patients with no diastasis (first or second degree injuries) treated nonoperatively achieved an excellent or good result with a mean return to play of 3 months. However, two of the nine patients, one treated with cast immobilization and the other untreated, were unable to return to sports. Three patients with third degree sprains were evaluated. Two were treated with ORIF resulting in a good and excellent result, while the remaining athlete treated with cast immobilization was unable to return to sports, and eventually required arthrodesis. Seven patients sustained a fracture or dislocation. Three were treated with ORIF and had excellent results. An additional three of these patients were treated with cast immobilization. One experienced excellent results while the remaining two experienced fair results characterized by persistent pain that required orthotic support. From this data, Curtis et al. concluded that poor results were most commonly correlated with delayed diagnosis or inadequate treatment characterized by nonoperative treatment of unstable injuries.

Burks et al. take a different approach to the classification of low velocity Lisfranc injuries [5]. They focus on the importance of longitudinal arch height loss as manifested by reversal in the medial cuneiform – fifth metatarsal relationship on a lateral weight-bearing radiograph. In a series of 15 patients suffering low velocity injuries, they found the presence and degree of diastasis to have little bearing on prognosis. Rather they found that the only factor that consistently predicted outcome was the presence of arch height loss. They recommend 6 – 8 weeks of casting and splinting for those injuries with preserved arch height, but ORIF for injuries with arch height loss.

The treatment of Lisfranc injuries in athletes is a subject of considerable debate, particularly with regard to the optimal treatment of injuries with minimal to moderate diastasis. However, the literature collectively supports the chosen treatment for our patient. The patient exhibited diastasis, arch height loss, and an avulsion fracture. The diastasis and arch height loss have both been cited as independent criteria for use of ORIF and leave little question as to proper management of such an injury.

While limited research exists regarding treatment of Lisfranc injuries in athletes, the data does not include mention of such an injury sustained by a hockey player. After reviewing the common mechanisms of Lisfranc injury, this fact is not surprising. Injury to the Lisfranc ligament typically involves extreme plantar flexion, twisting and axial loading with subsequent dorsal buckling of the midfoot. The skate provides considerable support for the foot, making this injury extraordinarily unlikely while wearing it. The boot configuration of the skate forbids the plantar flexion necessary to allow the weight of the body to axially load the foot. The rigidity of the skate does not allow the pathologic flexion of the midfoot that may disrupt the Lisfranc ligament, so even if taken down from behind or involved in a pile-up, a skater is unlikely to suffer such an injury. It is of little surprise that the injury suffered by our patient was incurred while performing calisthenics and not while on the ice.

It might also have been expected that our patient return to his respective sport more quickly than an athlete with a Lisfranc injury whose sport requires unprotected running and leaping. Not only would a hockey player be less likely to reinjure the foot while skating as indicated above, but the act of skating might be expected to be less painful than that of running or jumping. Other sports where the foot is rigidly immobilized such as skiing may also be easier to return to. In a study by Wiss et al., 11 patients with previous Lisfranc injuries underwent gait analysis [15]. Even 19 months after injury, all of these patients exhibited a limp. The limp was attributed to a shortened period of weight transfer from the midfoot to the forefoot secondary to pain inhibition. The motion of ice skating is a gliding motion that minimizes impact and compression. The horizontal aspect of the foot is relatively maintained as the entire blade of the skate contacts the ice. This configuration minimizes and temporizes weight transfer though the midfoot, and thus might be thought to result in less pain than running or jumping. This may allow a skater an earlier pain-free return to activity and a better prognosis for full recovery as demonstrated by this case report.

References

1 *Arntz CT, Veith RG, Hansen ST.* Fractures and fracture-dislocations of the tarsometatarsal joint. J Bone Joint Surg 1998; 70-A: 173 – 181
2 *Curtis MJ, Myerson M, Szura B.* Tarsometatarsal joint injuries in the athlete. Am J Sports Med 1993; 21: 497 – 502
3 *Faciszewski T, Burks RT, Manaster BJ.* Subtle injuries of the Lisfranc joint. J Bone Joint Surg 1990; 72-A: 1519 – 1522
4 *Kuo RS, Tejwani NC, Digiovanni CW et al.* Outcome after open reduction and internal fixation of Lisfranc joint injuries. J Bone Joint Surg 2000; 82-A: 1609 – 1618
5 *Mantas JP, Burks RT.* Lisfranc injuries in the athlete. Clin Sports Med 1994; 13: 719 – 730
6 *Meyer SA, Callaghan JJ, Albright JP et al.* Midfoot sprains in collegiate football players. Am J Sports Med 1994; 22: 392 – 401
7 *Myerson MS.* The diagnosis and treatment of injuries to the Lisfranc joint complex. Orthop Clin North Am 1989; 20: 655 – 664
8 *Myerson MS, Fisher RT, Burgess AR et al.* Fracture dislocations of the tarsometatarsal joints: end results correlated with pathology and treatment. Foot Ankle 1986; 6: 225 – 242
9 *Nunley JA, Vertullo CJ.* Classification, investigation, and management of midfoot sprains: Lisfranc injuries in the athlete. Am J Sports Med 2002; 30: 871 – 878
10 *Richter M, Wippermann B, Krettek C.* Fractures and fracture dislocations of the midfoot: occurrence, causes and long-term results. Foot Ankle Int 2001; 22: 392 – 398
11 *Rutledge EW, Templeman DC, de Souza LJ.* Evaluation and treatment of Lisfranc fracture-dislocation. Foot Ankle Clinics 1999; 4: 603 – 615
12 *Shapiro MS, Wascher DC, Finerman GA.* Rupture of Lisfranc's ligament in athletes. Am J Sports Med 1994; 22: 687 – 691
13 *Thordarson DB.* Lisfranc ORIF with absorbable fixation. Tech Foot & Ankle Surg 2003; 2: 21 – 26
14 *Thordarson DB, Huvitz G.* PLA screw fixation of Lisfranc injuries. Foot Ankle Int 2002; 23: 1003 – 1007
15 *Wiley JJ.* The mechanism of tarso-metatarsal joint injuries. J Bone Joint Surg 1971; 53: 474 – 482
16 *Wiss DA, Kull DM, Perry J.* Lisfranc fracture-dislocations of the foot: a clinical kinesiological study. J Orthop Trauma 1998; 1: 267 – 274