TECHNIQUE

Treatment of Lisfranc Injuries in the Athlete

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ABSTRACT

Lisfranc injuries in the athlete can be challenging problems for the treating physician. The injury pattern can range from the very subtle ligament tear with diastasis to complicated fracture–dislocations. Proper treatment requires careful examination and use of imaging studies. Patients exhibiting fractures with displacement or subluxation generally require operative fixation because restoration of anatomic position is a key to a successful outcome. The main long-term complication is posttraumatic arthritis of the mid foot. Although the treatments vary from case to case, the goal when managing Lisfranc injuries in athletes remains universal: a return to sports at or near the preinjury level.
Keywords: Lisfranc, tarsometatarsal, sports medicine, midfoot sprain

HISTORICAL PERSPECTIVE

Injuries to the tarsometatarsal region are commonly referred to as *Lisfranc injuries*, named after the Napoleonic-era surgeon who described amputations through these joints. Injuries in this area can range from complex, displaced fracture–dislocations to subtle subluxations or sprains of the tarsometatarsal joints. The high-energy injuries are seen frequently with motor vehicle accidents, falls from marked heights, and crushing accidents. The lower energy injuries commonly involve indirect mechanisms, including axial forces on a plantarflexed foot and twisting. In the sport of sailboarding, the added factor of having the foot strapped onto the board slightly alters the mechanism of injury. Sailboarders are injured in sudden backward falls that force the fixed forefoot into equinus and damage the dorsal stabilizers of the tarsometatarsal joints.

In general, Lisfranc injuries are uncommon, with an incidence of approximately 1 in 50,000 of all orthopaedic trauma requiring treatment.[1] These injuries are even more rare in athletes and can be dismissed easily as a "simple sprain" unless the healthcare provider has a high index of suspicion. Curtis et al.[2] reviewed 19 patients with tarsometatarsal injuries sustained during athletic activities ranging from baseball to sailboarding. In their series, six patients were injured in basketball, five while running, four while windsurfing, and the rest in cricket, soccer, or gymnastics. Historically, most of these injuries were treated conservatively with immobilization, but no consensus exists on the best method of treatment of the athlete with a Lisfranc injury. Meyer et al.[3] treated 23 football players (24 injuries) with midfoot sprains (including three injuries with diastasis) with immobilization, limited weight bearing depending on the severity of the injury, and gradual return to athletics using a specific rehabilitation program and a protective orthosis. Shapiro et al.[4] also used nonoperative treatment in seven of nine athletes with subtle Lisfranc injuries and had good long-term results, even though the patients averaged 14.5 weeks before return to competition. Curtis et al.,[2] on the other hand, recommended surgical treatment of midfoot injuries with displacement. This retrospective review of 19 athletes found poor results in the injuries with displacement that were treated nonoperatively, and one patient eventually required a midfoot arthrodesis. More recently, attention has been directed at obtaining and maintaining an anatomic reduction of the tarsometatarsal complex by open reduction and internal fixation, because most believe prognosis depends on the ability to restore the preinjury alignment and mechanics.[5–10]

INDICATIONS/CONTRAINDICATIONS

Proper clinical assessment of these injuries requires a thorough understanding of the underlying anatomy, the biomechanics, and the mechanism of injury. A thorough history often reveals the mechanism of injury. Patients complain of pain in the midfoot region, which can vary

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greatly in severity depending on the degree of injury. Pain with weight bearing is a common feature, and the patient is unable to run, cut, or jump on the involved foot. Tenderness at the base of the first and second metatarsals is an important finding in subtle diastasis. Tenderness over the articulation between the fourth and fifth metatarsals with the cuboid may be the only objective finding in the patient with a lateral tarsometatarsal injury.[11] Subtle Lisfranc injuries may sometimes show the "plantar ecchymosis sign," implying the potential for notable injury to the tarsometatarsal ligaments.[12] Provocative tests can also be helpful in diagnosing Lisfranc injuries. The two most frequently used tests are side-to-side compression of the mid foot and dorsal/plantar deviation of the first metatarsal head while stabilizing the second metatarsal. Pain is produced at the mid foot when the tests are positive. Shapiro et al.[4] found these two provocative tests to be positive in all athletes with a rupture of the Lisfranc ligament. Testing the joints by manipulation can sometimes disclose excessive movement indicative of instability. More often, passive pronation of the mid foot elicits the most pain and reproduces the patient's symptoms.[3] In the athlete suspected of having a severe injury to the mid foot who will not allow an adequate examination in the office or training room, examination under anesthesia, including stress radiographs, is warranted.

There are few definitive indications for surgical intervention of Lisfranc injuries in athletes based on well-performed outcome studies. For this reason, controversy exists on the best method of treatment. The classifications used to describe tarsometatarsal injuries do not include all injury patterns and are not very useful in establishing prognosis or dictating treatment. Therefore, we state that our indications for surgery include those patients with any diastasis between the first and second metatarsal bases exceeding 2 mm. This includes intraarticular fractures with more than 2 mm of articular step-off. Further surgical indications include loss of the longitudinal arch, midfoot instability determined clinically or radiographically, displaced fracture–dislocations, and lateral column disruption. Of course, compartment syndrome, open injuries, and deformities that are endangering the soft tissue necessitate emergent operative treatment. The only contraindication to surgical intervention in the athlete is severe soft-tissue compromise in the foot that interferes with surgical incisions, and this problem is usually overcome with time and elevation. Although the senior author (T.O.C.) has seen asymptomatic football players in the National Football League combine with radiographic evidence of diastasis between the first and second metatarsal bases suggesting previous injury, we have also seen this same diastasis result in career-ending midfoot arthritis. Whether the arthritis is the result of the malalignment of the tarsometatarsal region and/or the initial trauma to the articular cartilage or both is unknown, but we think that an anatomic reduction and stabilization is warranted to give the athlete the best chance of returning to his/her sport. This surgical group has included football players who resumed professional careers and collegiate athletes who returned to competition at the same level.

■ PREOPERATIVE PLANNING

Before surgical intervention for tarsometatarsal injuries, a thorough radiographic evaluation is mandatory. In the radiographic assessment of patients with Lisfranc injuries, close attention to bony alignment is necessary to avoid overlooking subtle signs of marked injury. Many normal radiographic parameters have been established, and the use of weight-bearing radiographs for these measurements is important (Fig. 1). Minor changes in the relationship of the metatarsal and tarsal bones reflect a major loss of capsular and ligamentous integrity. On the anteroposterior view, the continuity of the lateral base of the first metatarsal and the lateral portion of the medial cuneiform and the medial base of the second metatarsal and the medial aspect of the middle cuneiform can be appreciated. On the oblique view, the medial bases of the third and fourth metatarsals should line up with the medial aspect of the lateral cuneiform and medial cuboid respectively. The average distance between the first and second metatarsal bases in uninjured feet measures 1.3 mm, and diastasis can be neglected easily. When this measurement is 2 mm or more, a diastasis is considered to be present, and further confirmation is demonstrated by an increase of 1 mm or more in this interval when compared with radiographs of the injured side.[13] It is also important to search for small avulsion fractures such as those at the second metatarsal base, because they can indicate serious ligamentous injury. Fracture–dislocations within the tarsal bones must not be overlooked. Faciszewski et al.[13] have recommended the use of weight-bearing lateral radiographs to assess the longitudinal arch, assessing the relationship between the plantar aspect of the medial cuneiform and the plantar portion of the fifth metatarsal. In their series, when the medial cuneiform was plantar to the fifth metatarsal, reflecting a loss of the longitudinal arch, poor results followed. They did not find a correlation between the amount of diastasis and the end result. We have been unable to confirm these conclusions and disagree with the statement that "the extent of the diastasis does not correlate with the patient's functional result."[13] Stress radiographs with pronation–abduction and supination–adduction can assist in disclosing subtle grades of tarsometatarsal instability. Because of the overlapping nature of the small bones in

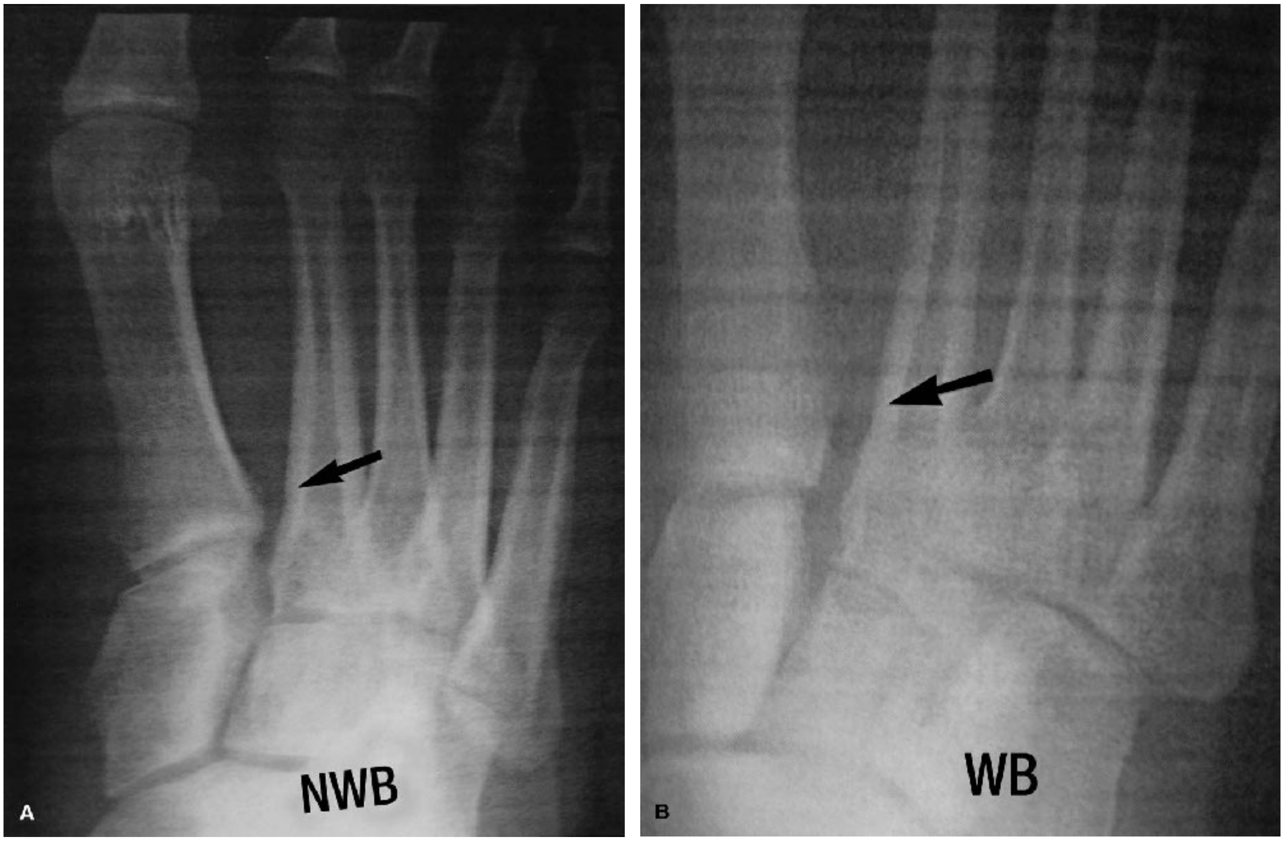

FIG. 1. **(A)** Initial radiograph of injured mid foot taken with the patient nonweight bearing (NWB). **(B)** Weight-bearing (WB) radiograph of the same foot demonstrates marked diastasis (**arrow**).

the mid foot and their varying joint congruity, comparison radiographs can be helpful. The standard of care for preoperative assessment is computed tomography. The computed tomographic scan done with 1 to 2-mm cuts in the horizontal and axial planes (with or without sagittal plane reconstructions) assists in properly defining the bony injury. Magnetic resonance imaging is the best method for delineating the purely ligamentous soft-tissue trauma to the mid foot and is particularly useful in cases of subtle diastasis or lateral column injury. This has become a standard study for the professional athlete with a midfoot injury.

TECHNIQUE

Because there are a variety of Lisfranc injuries, ranging from the subtle disruptions to the complex tarsometatarsal fracture–dislocations, there is no universal operative technique. These injuries must be addressed individually and stabilized according to the injury pattern. Even though the particular fixation may vary from case to case, the goal of anatomic reduction and stability with plans for return to sporting activities at the pre-injury level should remain constant. Although some authors recommend closed reduction and percutaneous fixation for certain Lisfranc injuries, we advocate open reduction and rigid fixation with direct visualization for possibly comminuted articular fragments and soft tissue interposed in the tarsometatarsal joints. The patient is placed supine on the operating table with a roll beneath the ipsilateral hip to rotate the involved leg to neutral. Any form of anesthesia may be used, but a regional block is helpful for postoperative analgesia. Intraoperative radiographs and fluoroscopy are essential with either a regular or mini C-arm. A thigh tourniquet is applied and elevated after the leg is prepared and draped in a sterile fashion. An 8-cm longitudinal incision is made dorsally centered between the first and second metatarsal bases. Blunt dissection is carried down through the extensor hallucis longus/brevis interval, and the neurovascular bundle is identified and protected with retraction laterally in most circumstances. This approach allows excellent exposure of the first to third tarsometatarsal joints and associated tarsometatarsal bones to evaluate for dislocations and fractures. A second longitudinal incision centered over the fourth metatarsocuboid joint and paralleling the first incision can be made to gain access to the third to fifth tarsometatarsal joints and associated tarsometatarsal bones for evaluation. The incision is carried sharply through skin and subcutaneous tissue protecting the branches of the superficial peroneal nerve, and the extensor digitorum brevis muscle is split in line with its fibers. Of course, emergent compartment releases, when indicated, must be performed before any fixation. The fractures that are amenable to fixation are stabilized with plates, screws, and/or pins. The injured joints are debrided of hematoma, bone fragments, and soft tissue. The articular cartilage is assessed for damage and factored into the prognosis. Next, the second metatarsal base is reduced from its usual subluxed/dislocated dorsolateral position to its normal "keystone" position using bone-reducing forceps. Once reduced, the second metatarsal is stabilized with a 4.5-mm cortical lag screw or a fully threaded 4.0-mm cannulated cancellous screw over a guide pin from the medial cuneiform through the second metatarsal base at an angle of 45 deg, in line with Lisfranc's ligament. The screw is placed through a medial stab incision made through the skin followed by blunt dissection down to bone to protect the anterior tibial tendon. All reductions and implant positioning are checked with intraoperative radiography. If the second metatarsal base is comminuted, the screw should be advanced to the third metatarsal as described by Hansen[14] (Fig. 2). For the subtle Lisfranc injury in the athlete, this reduction and stabilization of the second metatarsal may be all that is required. If needed, the first metatarsal is reduced to the medial cuneiform and stabilized with a 3.5-mm cortical lag screw or a 4.0/4.5-mm cannulated cancellous or cortical screw. A notch is made in the dorsal cortex of the first metatarsal with a burr approximately 2 cm distal to the joint to protect the bridging cortex and to help with near perpendicular screw placement (Fig. 3). The screw is placed parallel to the sole of the foot and is usually approximately 35 to 45 mm in length. If the third tarsometatarsal joint needs to be reduced, the third metatarsal can be stabilized to the lateral or middle cuneiform with the same type of screws as used previously. Because the fourth and fifth tarsometatarsal joints are extremely mobile, we recommend 0.062-in. K-wire fixation after reduction when the Lisfranc injury extends laterally. Intertarsal injuries must not be overlooked, and these must be treated similarly to tarsometatarsal injuries with reduction and fixation using screws. When possible, an attempt is made to repair any dorsal tarsometatarsal capsule/ligament tears or avulsions (especially Lisfranc's ligament) using suture anchors for avulsion injuries. At the conclusion of the procedure, permanent radiographs are obtained to verify anatomic reduction and appropriate implant placement. The skin is closed with interrupted, horizontal mattress sutures and a bulky, compressive dressing is applied with a well-padded splint.

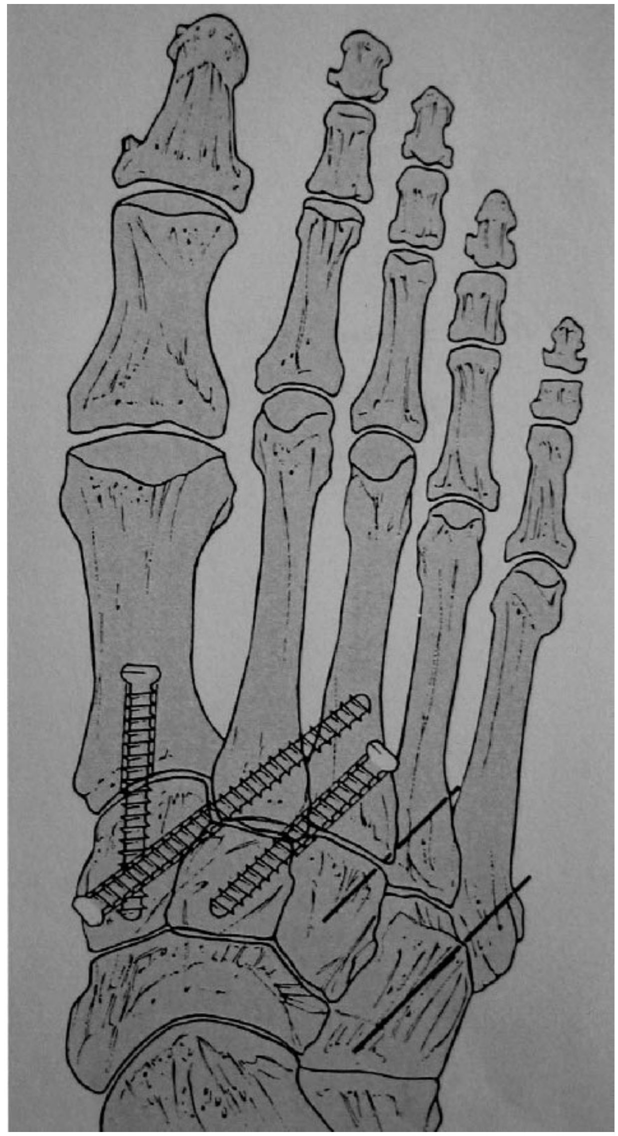

FIG. 2. Fixation of acute Lisfranc injuries. (Reprinted with permission. Source: Hansen ST Jr. Foot injuries. In: Browner BD, Jupiter JB, Levine AM, et al., eds. *Skeletal trauma*. Philadelphia: WB Saunders, 1992:1959–91.)

■ RESULTS

In a review of the literature, when anatomic reduction is achieved with all types of tarsometatarsal injuries, 50 to 95% of patients have good or excellent results.[5–10] This is compared with 17 to 30% good or excellent results for patients without anatomic alignment.[5–10] Although some authors have not found a correlation between reduction and functional outcome, we think that there is enough evidence to support anatomic reduction with the knowledge that, because of the articular injury, an anatomic reduction may still have a less than optimal outcome. Unfortunately, there is a paucity of literature specifically addressing this injury in athletes.

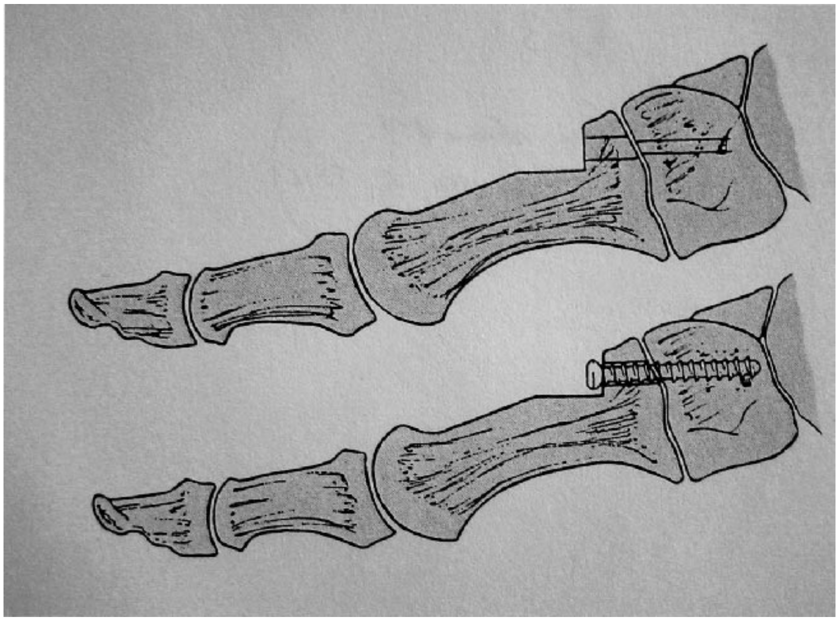

FIG. 3. Notching of the proximal first metatarsal and fixation to the medial cuneiform. (Reprinted with permission. Source: Hansen ST Jr. Foot injuries. In: Browner BD, Jupiter JB, Levine AM, et al., eds. *Skeletal trauma*. Philadelphia: WB Saunders, 1992:1959–91.)

■ CASE REPORTS

J.B., a professional football player, injured his right foot during a game when he was hit while his foot was plantarflexed and planted on the turf. He had immediate swelling and pain, and he was unable to bear weight on this extremity. His examination was consistent with a Lisfranc injury with diffuse midfoot swelling and tenderness. Radiographs revealed a first metatarsal base fracture, second tarsometatarsal joint dislocation, third and fourth tarsometatarsal fracture–dislocations, intertarsal joint dislocation between the middle and lateral cuneiforms, and a cuboid dislocation (Fig. 4). Computed tomography was performed to define better the extent of the bony injury. He was taken to the operating room and underwent open reduction and internal fixation of his injuries. No fixation was deemed necessary for the nondisplaced, first metatarsal base fracture. A 4.5-mm cannulated screw was placed from the medial cuneiform to the second metatarsal base. The intertarsal cuneiform dislocation was stabilized with a 4.0-mm cannulated screw with a washer in a lateral-to-medial direction. The third tarsometatarsal fracture–dislocation was stabilized with a 4.0-mm cannulated screw from the third to the second metatarsal bases. The cuboid was reduced and stabilized to the reduced fourth and fifth tarsometatarsal joints with 0.062-in. K-wires. Lisfranc's ligament and the dorsal tarsometatarsal ligaments were repaired with nonabsorbable sutures. The dorsal ligaments and periosteum at the fourth tarsometatarsal joint were avulsed from the cuboid and repaired with a suture anchor. The reduction and screw placement was verified with radiographs, and the skin was closed with nylon sutures (Fig. 5). J.B. was placed into a bulky, compressive dressing with a short-leg splint. He remained nonweight bearing for 8 weeks. At his 1-week postoperative visit, his sutures were removed and he was placed into a fracture boot to allow toe and ankle range of motion. The two lateral pins were removed at 6 weeks. The patient began to bear weight progressively until he was full weight bearing in the boot by 12 weeks postoperatively. At 5 months postoperatively, J.B. was taken to the operating room for removal of the Lisfranc screw. He was jogging 2 weeks after the screw removal. By postoperative month 6, he gradually returned to athletics with a rigid-sole shoe without complaints, and he resumed play in the National Football League. He has maintained reduction of the tarsometatarsal injuries but has some early posttraumatic midfoot arthritis on radiographs (Fig. 6).

■ COMPLICATIONS

The primary complication of Lisfranc injuries is the long-term problem of posttraumatic midfoot arthritis, and varying degrees of arthritic changes on radiographs may be seen in as many as 100% of patients. As stated previously, this complication can occur from the articular damage despite anatomic reduction and stabilization of the tarsometatarsal complex. Frequently, the common radiographic findings of arthritis are asymptomatic or mildly painful, and the athlete can still resume sports with a rigid-sole shoe and/or an arch support. Pain unresponsive to conservative treatment may require an arthrodesis of the affected joints. Compartment syndrome and skin necrosis are more acute complications of Lis-

FIG. 4. **(A, B)** Anteroposterior **(A)** and lateral **(B)** injury radiographs. A first metatarsal base fracture, second tarsometatarsal joint dislocation, third and fourth tarsometatarsal fracture–dislocations, intertarsal joint dislocation between the middle and lateral cuneiforms, and a cuboid dislocation are seen.

FIG. 5. **(A, B)** Anteroposterior **(A)** and lateral **(B)** postoperative radiographs. A 4.5-mm cannulated "Lisfranc" screw stabilizes the medial cuneiform to the second metatarsal. The intertarsal dislocation is reduced and stabilized with a 4.0-mm cannulated screw and washer, and the third tarsometatarsal fracture–dislocation is reduced and stabilized with a 4.0-mm cannulated screw from the third to the second metatarsal bases. The cuboid is reduced and stabilized to the reduced fourth and fifth tarsometatarsal joints with 0.062-in. K-wires.

FIG. 6. **(A, B)** Anteroposterior **(A)** and lateral **(B)** radiographs at the 6-month postoperative visit. The "Lisfranc" screw and K-wires have been removed. Alignment of the tarsometatarsal complex remains anatomic and the arch is maintained. There appears to be some early posttraumatic midfoot arthritic changes.

franc injuries that require fasciotomies and coverage procedures respectively.

POSTOPERATIVE MANAGEMENT

After open reduction and internal fixation of the Lisfranc injury, the patient is placed in a bulky, compressive dressing with a short-leg splint and is kept non-weight bearing. Approximately 1 week after surgery, the sutures are removed and a fracture boot is applied with the patient kept nonweight bearing for a total of 6 to 8 weeks. During this period of time, the patient can remove the boot and work on toe, subtalar, and ankle range of motion. Percutaneous pins are usually removed in the clinic 6 weeks postoperatively. At approximately 8 weeks postoperatively, progressive weight bearing in the boot is begun, and the transition from the boot to a rigid-sole shoe occurs as the patient tolerates. We generally remove the Lisfranc screw around postoperative month 4 to 6, depending on the radiographs and clinical course of the athlete. After recovery from the implant removal, the athlete can begin to return slowly to athletic participation when strength and conditioning permit.

POSSIBLE CONCERNS/FUTURE OF THE TECHNIQUE

One of the surgical trends in the future of Lisfranc injury treatment may be the use of bioabsorbable fixation. The obvious advantage to these implants is the avoidance of a second surgery for removal. Some of the opponents of bioabsorbable screws/pins for tarsometatarsal stabilization cite inadequate strength of the fixation over the time required for ligament healing. Also, there remains concern over reaction to bioabsorbable material, which can cause pain and swelling. Late reconstruction of tarsometatarsal injuries with tendon grafts is an emerging concept.

In conclusion, the management of Lisfranc injuries in the athlete is described including surgical technique and postoperative care. The treating physician must have a high index of suspicion for this injury when clinically appropriate, and stress radiographs may be needed to define further the injury for subtle disruptions. Although there is no universal fixation pattern for these injuries, the common goal of anatomic reduction and stabilization remains. It is important to note the articular damage intraoperatively, because this trauma correlates with long-term prognosis as well. The long-term goal with any treatment modality for Lisfranc injuries in the athlete is a return to sports at the preinjury level.

REFERENCES

1. Mantas JP, Burks RT. Lisfranc injuries in the athlete. *Clin Sports Med* 1994;13:719–30.
2. Curtis MJ, Myerson M, Szura B. Tarsometatarsal joint injuries in the athlete. *Am J Sports Med* 1993;21:497–502.
3. Meyer SA, Callaghan JJ, Albright JP, et al. Midfoot sprains in collegiate football players. *Am J Sports Med* 1994;22:392–401.

4. Shapiro MS, Wascher DC, Finerman GAM. Rupture of Lisfranc's ligament in athletes. *Am J Sports Med* 1994;22: 687–91.
5. Arntz CT, Veith RG, Hansen ST Jr. Fractures and fracture–dislocations of the tarsometatarsal joint. *J Bone Joint Surg Am* 1988;70A:173–81.
6. 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: 225–42.
7. Perez BR, Rodriguez MC, Canosa SR, et al. Tarsometatarsal fractures and dislocations. *J Orthop Trauma* 1988; 2:188.
8. Resch S, Stenstrom A. The treatment of tarsometatarsal injuries. *Foot Ankle* 1990;11:117–23.
9. Kuo RS, Tejwani NC, Digiovanni CW, et al. Outcome after open reduction and internal fixation of Lisfranc joint injuries. *J Bone Joint Surg Am* 2000;82A:1609–18.
10. Richter M, Wippermann B, Krettek C, et al. Fractures and fracture dislocations of the midfoot: occurrence, causes and long-term results. *Foot Ankle Int* 2001;22:392–8.
11. Clanton TO. Athletic injuries to the soft tissues of the foot and ankle. In: Coughlin MJ, Mann RA, eds. *Surgery of the foot and ankle*, 7th ed. St. Louis: Mosby, 1999:1090–209.
12. Ross G, Cronin R, Hauzenblas J, et al. Plantar ecchymosis sign: a clinical aid to diagnosis of occult Lisfranc tarsometatarsal injuries. *J Orthop Trauma* 1996;10:119–22.
13. Faciszewski T, Burks RT, Manaster BJ. Subtle injuries of the Lisfranc joint. *J Bone Joint Surg Am* 1990;72A:1519–22.
14. Hansen ST Jr. Foot injuries. In: Browner BD, Jupiter JB, Levine AM, et al., eds. *Skeletal trauma*. Philadelphia: WB Saunders, 1992:1959–91.