LISFRANC FRACTURE — DISLOCATION UPDATE 1988

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Introduction

The tarsometatarsal joints form a bony arc from medial to lateral across the foot similar to a stone arch. This osseous configuration combined with an extensive ligamentous support network and "key-stone" nature of the recessed second metatarsal base provide a significant amount of stability to the midfoot joint complex (Fig. 1). The reported incidence of dislocation and fracture of the Lisfranc's joint is less than 1% of all fractures. The severity may range from an occult subluxation to a grossly malaligned fracture-dislocation.

Fracture dislocation of the Lisfranc joint complex is reportedly misdiagnosed approximately 20% of the time. The morbidity associated with this injury is great. Severe edema and hematoma formation following the injury is a frequent occurrence and necessitates the use of Doppler ultrasound for identification of pedal arteries. Damage to the perforating vessels and arterial spans leading to circulatory compromise and amputation have been reported. Other complications include severe post-traumatic degenerative arthritis, reflex sympathetic dystrophy and painful osseous prominences. Prevention of these complications requires accurate diagnosis and prompt treatment.

Anatomic Consideration

Full knowledge of the regional anatomy is essential for appreciation of the osseous and soft tissue damage that occurs. The mechanism of this injury, the injury patterns, and technique for reduction are fully dependent on the osseous and ligamentous relationships.

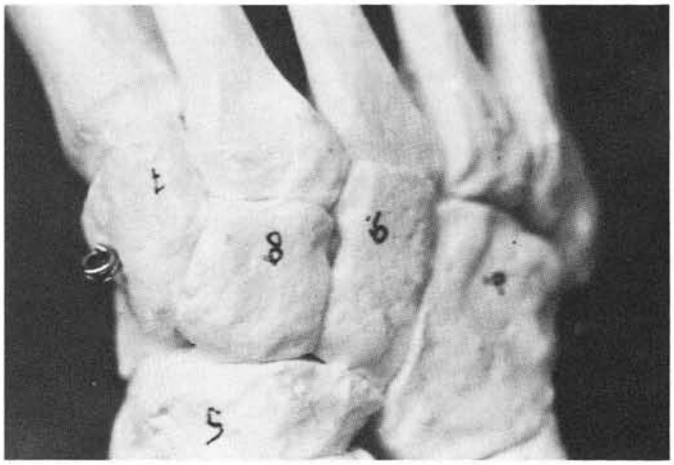


Fig. 1. Tarsometatarsal joints configuration is similar to stone arch. Recessed position of second metatarsal confers added stability to this joint

The metatarsals are bound to one another by a series of transverse dorsal and plantar ligaments as well as intermetatarsal ligaments. The one exception is the lack of ligamentous attachment between the first and second metatarsals. This anatomic fact is responsible for the injury pattern where the four lesser metatarsals dislocated laterally as a unit leaving the first metatarsl unaffected. It has been proposed that the pattern of dislocation of the first metatarsal is dependent upon the lesser four metatarsals.

The ligaments that tether the metatarsus to the lesser tarsus are disrupted during this injury. The ligaments are stronger plantarly than dorsally. The dorsal medial ligament attaching the medial cuneiform to the first metatarsal is the largest ligament at this level. During open repairs of this injury, it is often possible to primarily repair this ligament. Probably the most significant ligament of the tarsometatarsal joint is the interosseous ligament that attaches the medial cuneiform to the second metatarsal base. This structure is commonly designated the Lisfranc's ligament and is responsible for the production of an avulsion fracture off the medial aspect of the second metatarsal (Figs. 2, 3). The remaining ligaments are either disrupted or avulsed from their attachments creating multiple small flake fractures.

The inherent osseous stability of the tarsometatarsal joint was previously mentioned. The convex shape formed by the metatarsal-lesser tarsus articulations from medial to lateral combined with the dorsal to plantar wedged shape of the articulations creates added stability both in the transverse and sagittal planes.

Classification of Injury

Numerous classifications of this injury have been proposed in the literature based upon mechanics of injury, direction of force and resultant injury pattern. No particular study specifically addressed the injury pattern in light of surgical repair and end results. Hardcastle and associates describe a comprehensive classification that was based upon injury pattern of metatarsal displacement (Fig. 4). They report that the amount of displacement will influence the degree of fixation and prognosis. The classification system is simple to apply and based upon the radiographical appearance.

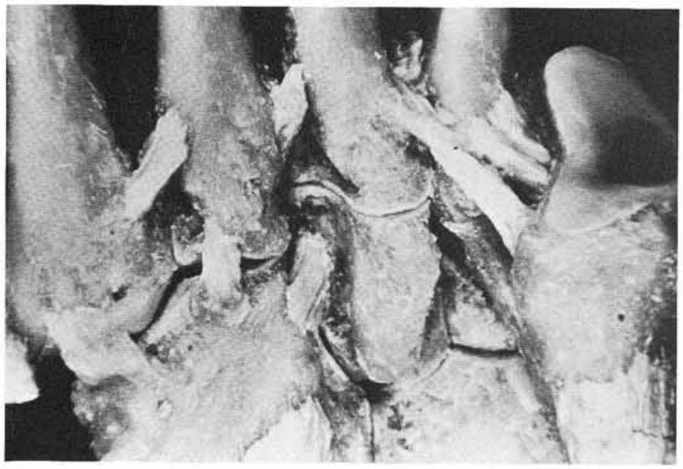


Fig. 2. Lisfranc's ligament attaches medial cuneiform and medial aspect of second metatarsal base

Type A — Total: Total incongruity of the entire tarsometatarsal joint. The displacement may occur in the sagittal or transverse planes.

Type B — Partial: Partial incongruity of the joint complex in either sagittal, transverse planes, or both. Partial injuries may exist and are of two types.

> *Medial displacement* affects the first metatarsal either in isolation or combined with displacement of one or more of the second, third, or fourth metatarsals.
>
> *Lateral displacement* involves one or more of the four lesser metatarsals while the first is unaffected.

Type C — Divergent: There may be partial or total incongruity of the joint. The first metatarsal is displaced medially and any combination of the lateral four metatarsals is displaced laterally in either the sagittal or transverse planes or both.

Mechanics of Injury

Two mechanisms of tarsometatarsal joint injury have been postulated: *direct* and *indirect*.

The *direct mechanism* involves a crushing force concentrated at the dorsum of the foot with a variable pattern of load, direction, and velocity resulting in a variety of fracture-dislocation patterns.

The *indirect mechanism* is the least understood and most variable. Wiley in 1971 performed cadaver studies and proposed that there were two main forces associated with the indirect mechanism; forefoot abduction and forced forefoot plantar flexion. The foot is usually injured while in a plantarflexed or equinus-type position. A traumatic abductory force is applied to the forefoot which produces an excessive amount of shear stress at the second metatarsal base. This results in either a transverse base fracture of the second metatarsal or an avulsion fracture

Fig. 3. Avulsion fracture of medial aspect of base of second metatarsal is generated by Lisfranc's ligament. Also shown is fracture of medial cuneiform

of the medial aspect of the second metatarsal base. The avulsion fragment is usually attached to the Lisfranc ligament. If the abduction force continues the lesser metatarsals may shift laterally as the lateral tarsometatarsal ligaments fail and rupture. Occasionally the severe adductory force will result in a distal cuboid compression fracture.

Diagnosis

The diagnosis of tarsometatarsal fracture dislocation requires little insight with obvious clinical and radiographic evidence. This is contrasted to the diagnosis of an occult, reduced fracture-dislocation which requires a high index of clinical suspicion because of the long term sequellae of a missed diagnosis.

Often the patient recalls an audible snap or pop after experiencing a forced plantar flexion or direct injury mechanism. The patient may relate stepping off of a curb, slipping on the stairs, or stepping in a hole. The indirect mechanism more often occurs in a motor vehicle accident where the plantarflexed foot sustains a longitudinal force against the floor board.

In both, physical exam will reveal gross edema over the entire forefoot and midfoot region. There will be marked palpatory tenderness over the tarsometatarsal joints. Identification of pedal pulses must be performed. If the dorsalis pedis and posterior tibial artery cannot be palpated, a Doppler ultrasound must be used. Excessive range of motion at the tarsometatarsal joint may be present.

Standard diagnostic roentgenograms should be performed on the foot and ankle and comparison views may also be warrented. If initial radiographs appear superficially normal, careful scrutiny may discern the pathognomonic sign of a relocated tarsometatarsal joint fracture dislocation. Attention should be directed to the first metatarsal base which may reveal a slight diastasis between the first

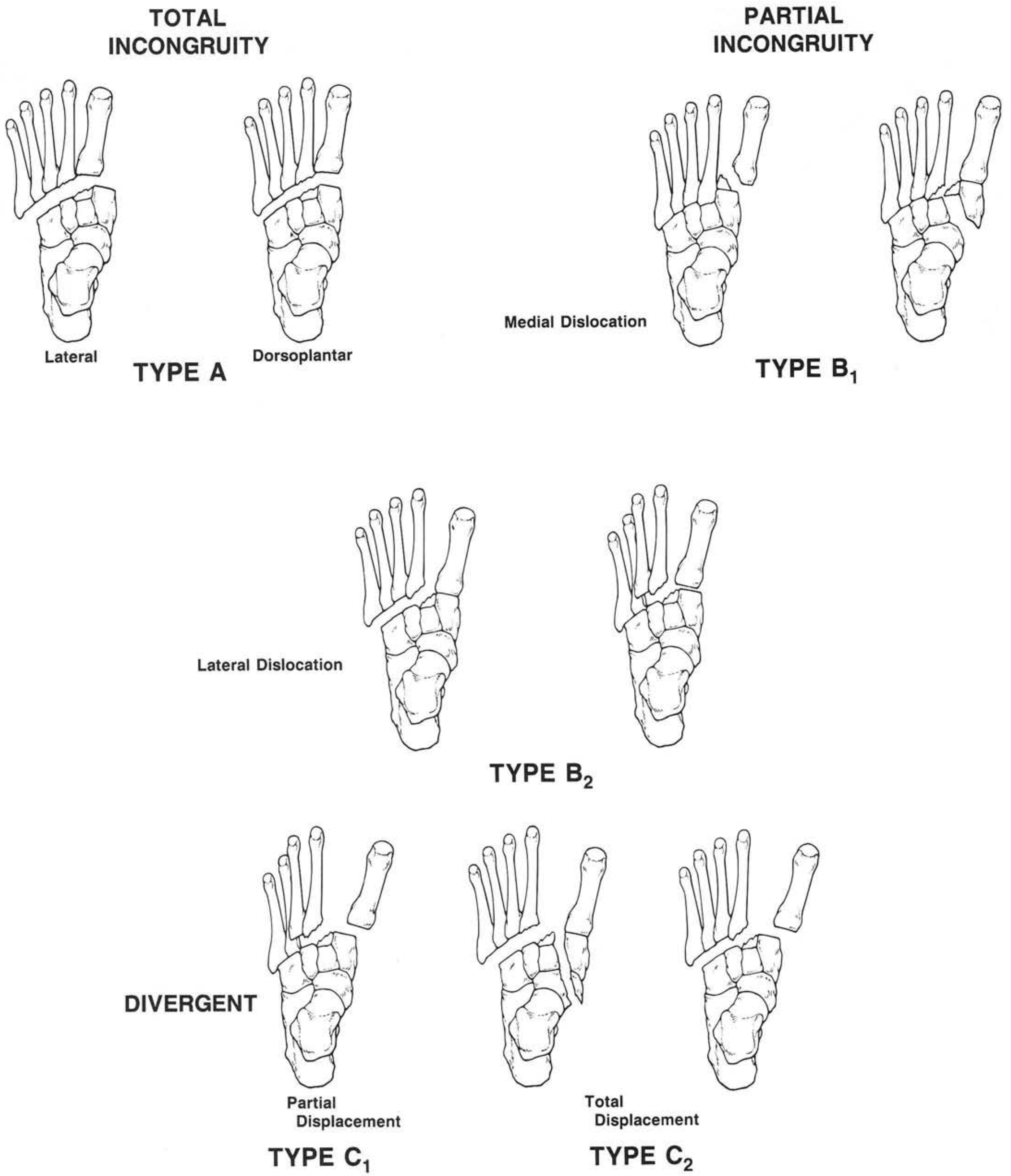


Fig. 4. Artist's interpretation of Hardcastle and associates classification of Lisfranc's joint injuries

and second metatarsals. Careful examination of the second metatarsal base may highlight a small avulsion fragment diagnostic of dislocation at this level. One should also follow the cortical margins of the metatarsals and their adjacent tarsal bones. The most consistant relationship appears to be the medial cortical margin of the second metatarsal and medial edge of the second cuneiform (Fig. 5).

A compression fracture of the cuboid may also be diagnostic of the lateral displacement type of tarsometatarsal fracture dislocation.

If standard radiographs prove negative but clinical symptoms persist, stress radiographs should be performed. Stress radiographs, in the transverse or sagittal plane, may be performed under local anesthesia or general anesthesia for a more accurate diagnosis (Fig. 6).

Treatment

The literature concerning appropriate treatment combines all injuries under the heading of Lisfranc dislocation regardless of the injury pattern. Some authors have noted differences among the injury patterns and the type of treatment that was rendered. The best functional results are provided through accurate anatomic alignment whether open or closed. Wire fixation has proven to maintain alignment following reduction. Closed reduction with casting of the unstable joints has not proven effective. Factors that will influence the outcome of the injury are delay in diagnosis, amount of displacement, local soft tissue injury, and finally quality and maintenance of initial reduction.

At Doctors Hospital the staff approahces treatment of this injury initially with closed reduction. Anesthesia combined with muscle relaxation is usually required. Distal forefoot traction is applied against countertraction of the heel. The forefoot is suspended from the operating room table by Chinese finger traps and tape with countertraction weights applied to the heel (Fig. 7). Manipulation may then be attempted to reposition the second metatarsocuneiform articulation. Once relocation is verified radiographically, percutaneous wire stabilization may be employed.

Soft tissue interposition between osseous segments or even fracture comminution may prevent anatomic reduction. Tibialis anterior and peroneus longus have been described in the literature as interposing between osseous articulations and preventing anatomic realignment.

Should closed reduction methods fail, open reduction is indicated. Open reduction is also indicated for inspection of pedal blood vessels if circulatory compromise is present.

The operative approach employs longitudinal curvilinear incisions to help prevent further compromise (Fig. 8). The first incision is usually placed medially over the first metatarsocuneiform joint with adequate distal exposure. Recent experiences have demonstrated that the dorsal medial ligament of this joint can be separated from the joint capsule during the dissection process. A second dorsal incision is commonly placed just over the articulation of the second and third metatarsal bases and articulating cuneiforms. Inspection of the second metatarsocuneiform joint must be performed and any osseous fragments found to be within the joint excised. A similar approach is utilized for the fifth metatarsocuboid joint.

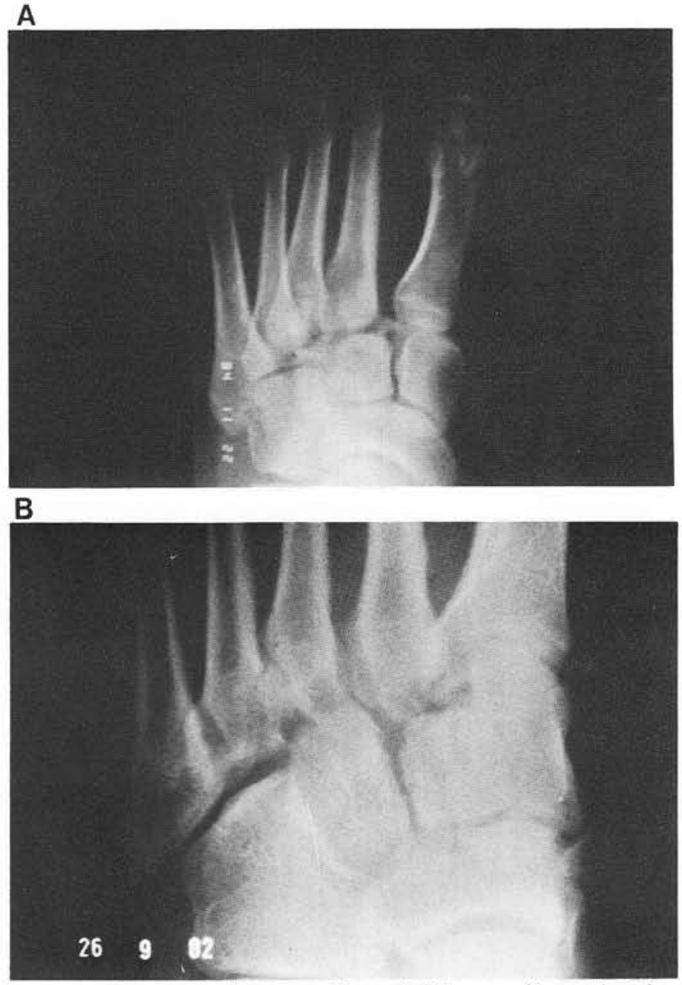
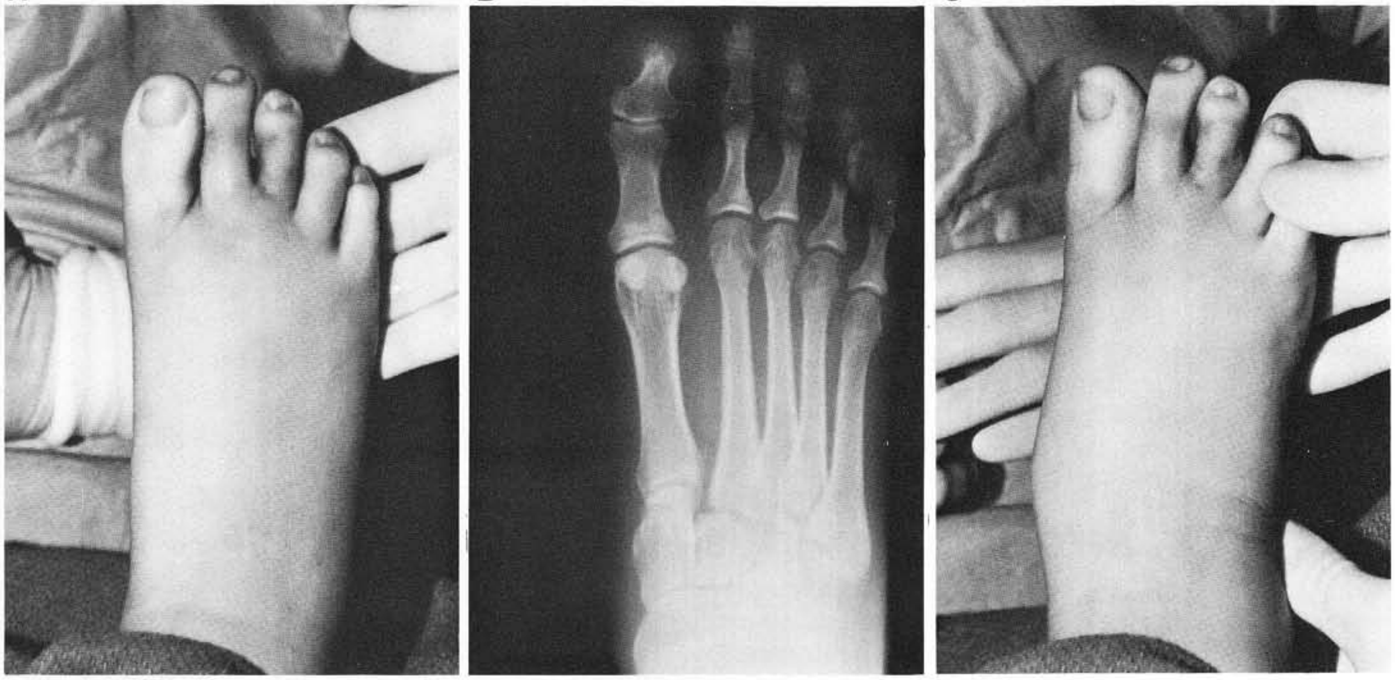


Fig. 5. A. & B. Dorsoplantar and lateral oblique radiographs of type C injury. Careful scrutiny of medial cortical margin of second metatarsal and cuneiform will reveal a diastasis and avulsion fracture

Once anatomic alignment has been accomplished, wire stabilization is employed under direct visualization (Fig. 9). The technique for wire stabilization depends primarily upon the injury pattern. It has been noted in several cases that instability exists at the intercuneiform articulations. Cases with cuneiform instability require wire stabilization of the cuneiforms from medial to lateral prior to stabilizing the metatarsus on the tarsus.

In type A injuries, stabilization using two wires is common but depends on the stability of the second metatarsocuneiform joint. If severe dislocation is present at this

A B C



D

Fig. 6. A. & B. Clinical and radiographic demonstration of Lisfranc injury Type C with marked edema and pathognomonic diastasis of first and second metatarsal. **C. & D.** Excessive motion is present clinically at the tarsometatarsal articulation. Abduction stress radiograph reveals gross dislocation

Fig. 7. Closed manipulative reduction of Lisfranc's injury using finger traps and heel weights

level the surgeon may encounter difficulty stabilizing the first metatarsocuneiform joint. Initial stabilization of the second metatarsocuneiform joint has been found to create a significant amount of stability to the entire joint complex, permitting greater ease of medial and lateral stabilization in those cases. In general, two wires are used for Type A injuries, one medially across the first metatarsocuneiform joint and one laterally across the fifth metatarsal cuboid joint (Fig. 10).

The medial type B injuries have been noted to be extremely unstable and usually require two medial fixation wires. The lateral type B injuries usually require a lateral wire through the fifth metatarsocuboid articulation. Type C injuries are extremely unstable and often require three or more wires for fixation. Cuneiform disruption seems to occur more often with this injury.

After radiographic confirmation of alignment, soft tissue repair is completed. Recent experience with this injury has shown that primary repair of the dorsomedial ligament of the first metatarsocuneiform joint and its capsule is quite possible (Fig. 11). The need for delayed closure may exist if severe edema or extensive trauma to the soft tissues exists.

Compressive dressings are applied following reduction until edema and the vascular status has stabilized. This is

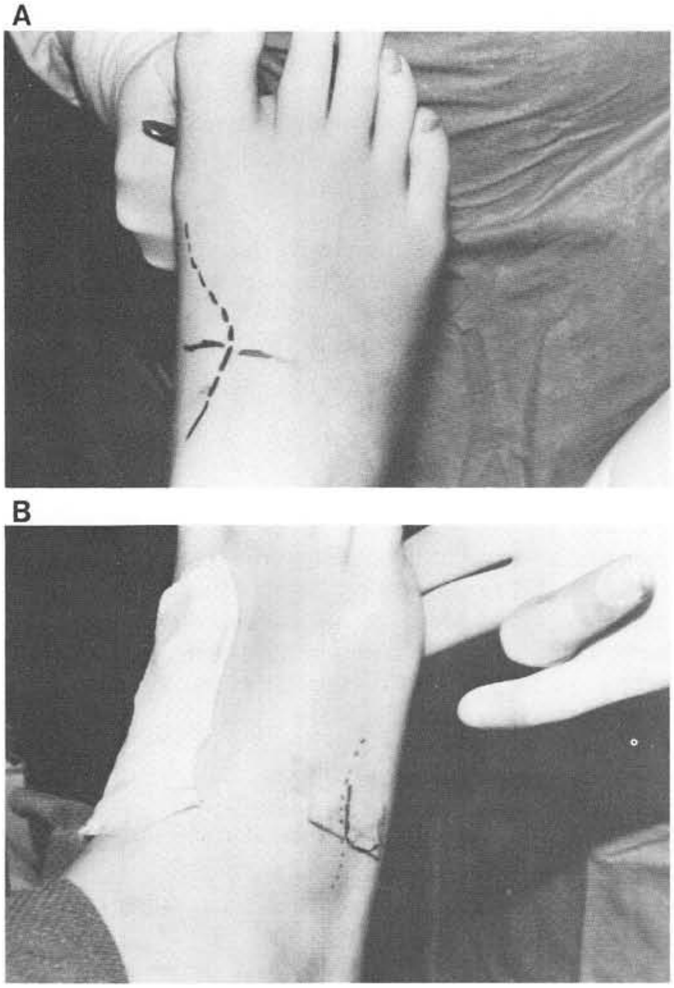


Fig. 8. A. & B. Operative technique employs longitudinal curvilinear incisions to decrease vascular compromise and facilitate surgical exposure

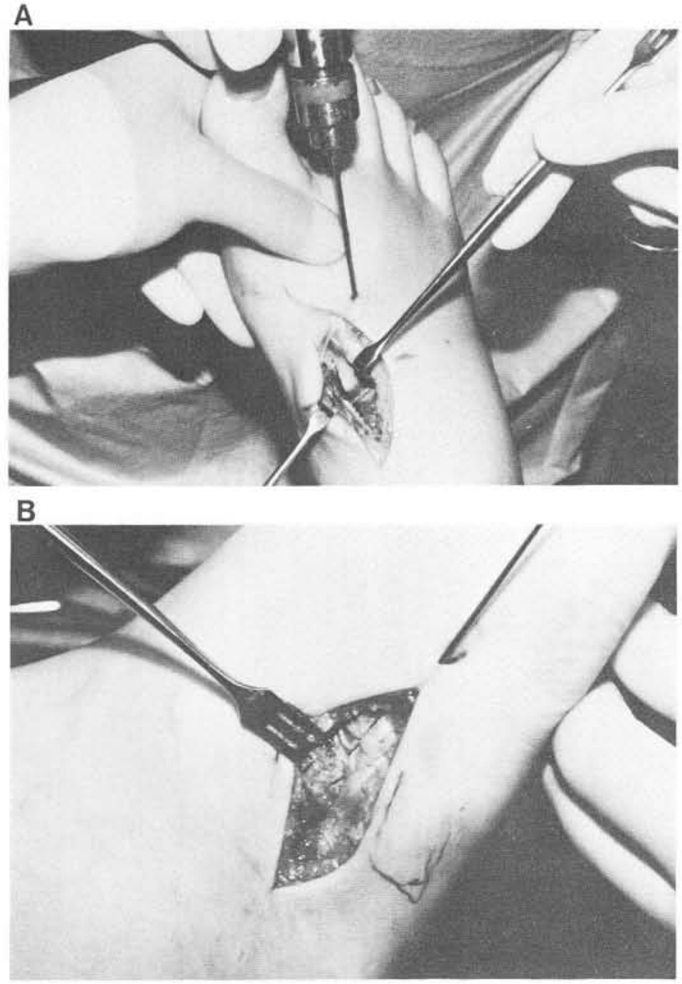


Fig. 9. A. & B. Anatomic alignment is directly visualized while percutaneous pinning with Kirschner wires is performed

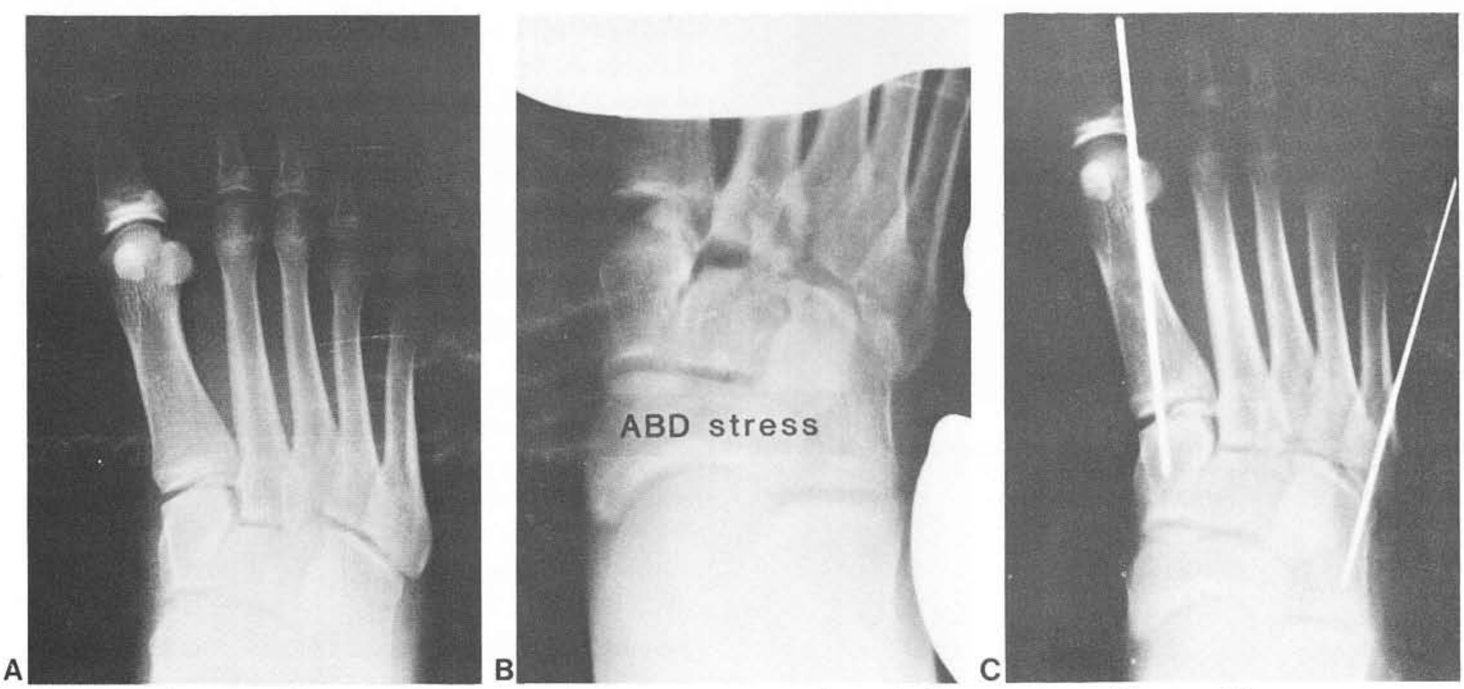
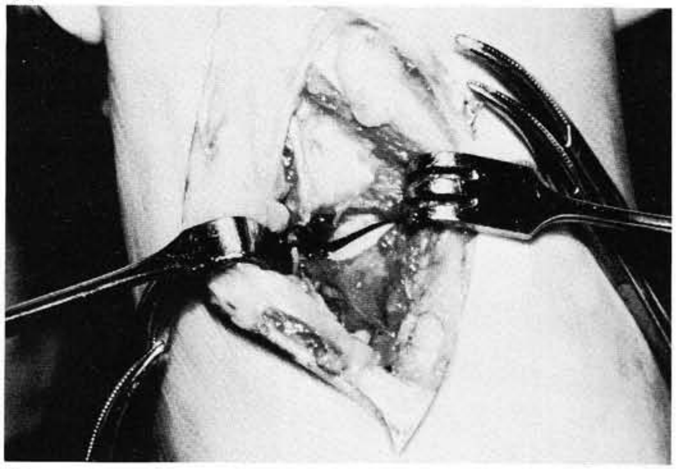
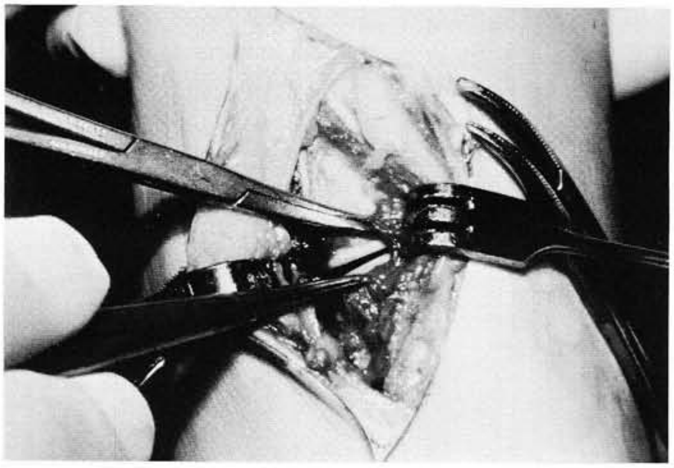


Fig. 10. A. Radiographic demonstration of occult Lisfranc dislocation. **B.** Abductory stress exam reveals total lateral displacement of metatarsals on lesser tarsus. **C.** Postoperative radiograph demonstrating stabilization of first metatarsocuneiform joint and fifth metatarsocuboid joint

A



B



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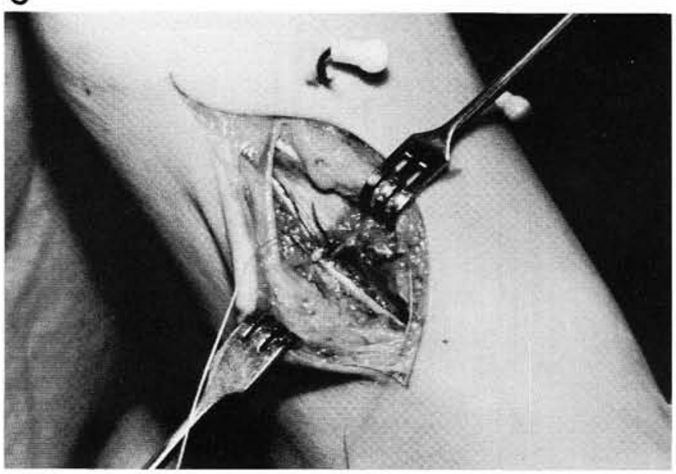

Fig. 11. A. & B. Identification of dorsomedial ligament of first metatarsocuneiform joint. **C.** Primary repair of ligament and capsule. Note percutaneous wire stabilization.

dependent on the extent and severity of the injury, usually 5 to 14 days. Below the knee casting is then employed for 6 to 12 weeks. Wire removal is possible between 6 and 8 weeks. Weightbearing may begin after cast removal with supportive shoegear. Careful monitoring for redislocation is extremely important.

A number of complications have been previously mentioned. In old injuries where there are severe destructive changes and pain, or deformity, arthrodesis of the involved tarsometatarsal joints is indicated and may be performed in a variety ways.

Summary

Fracture-dislocation of the Lisfranc joint complex is a relatively uncommon injury. Diagnosis of the grossly edematous and painful foot with radiographic changes is not difficult. The occult disruption of this joint complex requires a high index of suspicion. Accurate anatomic reduction at initial presentation has produced the most satisfactory results. Surgical intervention in acute and chronic cases may be warranted.

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