INJURIES TO THE TARSOMETATARSAL JOINT
INCIDENCE, CLASSIFICATION AND TREATMENT

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Injuries to the tarsometatarsal (Lisfranc) joint are not common, and the results of treatment are often unsatisfactory. Since no individual is likely to see many such injuries, we decided to make a retrospective study of patients from five different centres. In this way 119 patients with injuries of the Lisfranc joint have been collected. This paper classifies these injuries and describes their incidence, mechanism of production, methods of treatment, results and complications. Sixty-nine of the patients attended for review: 35 of these had been treated by closed methods, 27 had had an open reduction and seven patients had had no treatment.

On the basis of our study we suggest that these injuries should be classified according to the type of injury rather than the nature of the deforming force and that their treatment be based upon this classification. It seems that, whatever the severity of the initial injury, prognosis depends on accurate reduction and its maintenance.

The tarsometatarsal joint, at which the bases of the five metatarsals articulate with the three cuneiforms and the cuboid, was named after Lisfranc, a French surgeon serving in the Napoleonic Army, who described amputation through that joint (Cassebaum 1963).

Dislocation and fracture-dislocation are both rare and are said to occur at the rate of one person per 55 000 per year (Aitken and Poulson 1963; English 1964). They result from direct or indirect forces (Rainaut, Cedard and d’Hour 1966) acting upon or through the Lisfranc joint. Although the anatomy and the various mechanisms of the injury have been well described (Gissane 1951; Aitken and Poulson 1963; Jeffreys 1963; Wiley 1971; Bonnel and Barthélémy 1976), there is considerable difference of opinion regarding classification and treatment (Böhler 1958; Granberry and Lipscomb 1962; Wilppula 1973; Engelhardt and Ganz 1975). The purpose of this present study was to try to clarify both.

CLASSIFICATION

Previous classifications have been based on the mechanisms of injury (Francesconi 1925; Jeffreys 1963; Wilson 1972; Bonnel and Barthélémy 1976). These mechanisms are complex and varied. Direct forces may crush the metatarsals displacing them plantarwards, with secondary medial or lateral displacement, depending on the nature of the applied force. With indirect rotational

Fig. 1
Classification of Lisfranc injuries (modified from Quenu and Küss 1909).

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forces the foot must be in plantarflexion for dislocation to occur (Wiley 1971). The dorsal aspect of the Lisfranc joint is unable to resist tensile forces of any magnitude, in contrast to the much stronger soft-tissue support on the plantar aspect. Forces applied to the plantarflexed foot may be angular or rotational; since they are applied at a point distant from the joint they are collectively called indirect forces. A displacement affects one or more of the lateral four metatarsals but the first metatarsal is not affected.

Type C: Divergent. There may be partial or total incongruity. On an anteroposterior radiograph the first metatarsal is seen to be displaced medially, while any combination of the lateral four metatarsals may be displaced laterally. Sagittal displacement occurs in conjunction with the coronal displacement.

Such classifications give information regarding the nature of the deforming force but their value is limited since they do not provide information which would influence treatment. Our study shows that treatment and prognosis depend not so much on the direction of the causal force as upon whether there is incongruity (partial or total) of the tarsometatarsal joint.

The classification described by Quenu and Küss (1909) has the virtue of being simple to apply. It divides the injuries into three groups (homolateral, isolated and divergent) but does not include every variety of displacement. Their classification forms the basis for the one we now present (Fig. 1), upon which treatment can be based. Type A: Total. There is incongruity of the entire tarsometatarsal joint. Displacement is in one plane which may be sagittal, coronal or combined.

Type B: Partial. There is incongruity of part of the joint. Again the displaced segment is in one plane which may be sagittal, coronal or combined. Partial injuries are of two kinds whose treatment and prognosis differ: 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 affects one or more of the lateral four metatarsals but the first metatarsal is not affected.

Fig. 2
Concomitant injuries involving the foot in 119 cases of Lisfranc injury.

MATERIAL AND METHODS
For this retrospective study the notes and radiographs of patients with injuries of the tarsometatarsal joint treated between 1965 and 1978 in the Accident Departments at Graz, Klagenfurt, Vienna, Linz and Salzburg, were reviewed. There were 119 patients with adequate documentation and radiographs; of these, 69 attended for review, between 18 months and 12 years after the injury. The incidence of these injuries was approximately one person per 60,000 of the population each year.

There were 86 men and 33 women with a mean age of 39 years.

Forty-five injuries were due to industrial accidents, 48 to road traffic accidents, 10 occurred at sport and 16 involved a fall from a height, a twisting injury or a household accident. In addition to the tarsometatarsal injury, there were often fractures in other parts of the same foot.

Figure 2 shows both the incidence of the different segments that were dislocated and that of concomitant fractures of other bones.

Only in those patients who were operated upon was it possible to assess plantar or dorsal displacement accurately. In many of the patients who were not operated upon, oblique radiographs, which could have shown displacement (Böhler 1958; Bonnel and Barthélemy 1976) were not available.

Treatment. The initial treatment at all five centres was to attempt closed reduction either by manipulation under general anaesthesia, or by using skeletal traction (Böhler 1958). Percutaneous Kirschner wire fixation was used if the reduction was clinically unstable. Open reduction was performed when congruent closed reduction was not achieved. In 14 cases where there was an associated open wound its care was considered the primary object of treatment.
Table 1. Treatment and results

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Treatment</th>
<th>Results</th>
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<tbody>
<tr>
<td>A. Total</td>
<td>Closed</td>
<td>Good</td>
<td>9</td>
<td>1</td>
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<tr>
<td></td>
<td>Operative reduction</td>
<td>Fair</td>
<td>6</td>
<td>3</td>
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<td></td>
<td>Poor</td>
<td>3</td>
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<tr>
<td>B. Partial</td>
<td>Closed</td>
<td>Good</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Medial</td>
<td>Operative reduction</td>
<td>Fair</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Lateral</td>
<td>Closed</td>
<td>Good</td>
<td>10</td>
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<td></td>
<td>Operative reduction</td>
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<tr>
<td>C. Divergent</td>
<td>Closed</td>
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<td></td>
<td>Operative reduction</td>
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The patient with above-knee amputation has not been included in these results.

Of the 119 patients, primary closed reduction was successful in 69; 43 required open reduction (which, in 16 cases was performed 2 to 12 weeks after injury); and seven patients were left untreated.

The subsequent management was in most instances the same, whether reduction was by closed or open methods. A plaster cast, open anteriorly, was applied and the leg elevated. Two weeks later a below-knee walking plaster was applied. Where internal fixation had been used, progressive weight-bearing was allowed unless prevented by other injuries. The cast and any Kirschner wires were removed six to eight weeks after injury. An arch support or surgical shoe was then fitted and worn for three to six months. Most patients liked surgical shoes, but few wore the supports.

Assessment. We graded results as good, fair or poor on the basis of residual pain, function, gait, deformity and radiological features. “Good” implied that symptoms were trivial or absent, the patient could stand on tip-toe, had a normal gait, no deformity, and a radiograph which showed at most minimal degeneration. “Fair” implied moderate pain on activity, difficulty standing on tip-toe, a limp, a foot of reasonably good shape, and slight to moderate radiographic evidence of degeneration. “Poor” implied marked pain which affected the ability to walk, inability to stand on tip-toe, limp, deformity, and radiographic evidence of moderate to severe degeneration.

Obviously not all patients were in the same group for every one of these features, so an overall assessment was used. Table 1 summarises the relationship between our classification, the treatment used and the end result.

RESULTS

Type A: Total (22 patients). There were 15 good, four fair and three poor results in this group. In one case where reduction was held in a plaster cast without any Kirschner wires, redisplacement occurred (Figs 3 to 10). In eight patients closed reduction was held with percutaneous Kirschner wires, and all obtained good results. Open reduction was performed in 12 patients; three had fair...
and three had poor results. One patient with a fair result had redisplaced after closed reduction and plaster; open reduction was not performed until three months after injury. A second patient with a fair result had a total medial and dorsal displacement with open fractures of the cuboid bone; his postoperative course was complicated by sepsis. The third patient with a fair result had dorsolateral displacement with fractures of the second, third and fourth metatarsals which were reduced, but only a single Kirschner wire was used for stabilisation; at review he had a cavus deformity with associated pain in the Lisfranc joint and a limp.

Two of the poor results in this group were in patients who required early amputation of the forefoot for ischaemia. The third patient with a poor result had a total dislocation medially, with associated fractures of the navicular and medial cuneiform. Redislocation occurred in plaster following the initial closed reduction and a second reduction was performed two weeks later; although this was anatomically accurate and was held with percutaneous Kirschner wires, he developed severe degenerative changes.

Comment. In this type of injury, forefoot ischaemia and redisplacement after closed reduction without fixation are the main causes of unsatisfactory results.

Type B: Partial (43 patients). There were 30 good, 11 fair and two poor results. There was little difference between those treated by closed and those treated by open methods; nor did the direction of displacement (plantar or dorsal) affect the results. When the first metatarsal was openly reduced two patients had a good result and three fair. Two patients with fair results were men aged 48 in whom delayed open reduction and Kirschner wire fixation had been performed two and eight weeks respectively after the injury (Figs 11 to 16; 17 to 22); both soon redisplaced with consequent pain, mild deformity and severe osteoarthritis. The other patient had open reduction and stabilisation with a single Kirschner wire as a primary procedure; however, at follow-up redisplacement was evident.

Two patients with fair results had had a closed reduction held with a single percutaneous Kirschner wire; at follow-up there was clinical evidence of deformity, though when redislocation occurred is unknown.

The two poor results, when only a single metatarsal was displaced (Type B lateral injuries), were treated by

![Fig. 11](image1.png)
![Fig. 12](image2.png)
![Fig. 13](image3.png)
![Fig. 14](image4.png)

Figures 11 and 12—Type B. There is medial displacement involving the first three metatarsals. The diastasis between the first two cuneiforms was due to interposition of the tibialis anterior tendon. Note the large articular fragment from the first metatarsal (L).

![Fig. 15](image5.png)
![Fig. 16](image6.png)

Figures 13 and 14—Open reduction was necessary and the anteroposterior and lateral radiographs show satisfactory alignment held with Kirschner wires. Figures 15 and 16—At five years the result is fair, with mild degenerative changes.
closed reduction and plaster. At review dorsal angulation was apparent at the fracture site and was associated with metatarsalgia.

Comment. Redisplacement in the lateral group resulted from failure to use Kirschner wire stabilisers. Displacement, with or without fracture of the first metatarsal, is an unstable injury and redisplacement occurred unless more than one stabilising wire was used (Figs 23 to 27). Type C: Divergent (three patients). Only three patients with this rare injury were reviewed. One had a good

Figures 17 and 18—Type B. This patient had medial and plantar displacement of the first metatarsal. Note the concomitant fractures of the metatarsal shafts. Figures 19 and 20—Open reduction was necessary because of inadequate closed reduction, and was stabilised with Kirschner wires. Figures 21 and 22—Anteroposterior and lateral radiographs four years later show mild degenerative changes localised to the metatarsocuneiform joint, with malunion of the fractures of the metatarsal shafts.

Figures 23 and 24—Type B showing dislocation of the lateral three metatarsals. The second metatarsal has not been displaced although this was an indirect rotational injury. Figures 25 and 26—Position of the percutaneous Kirschner wires following adequate reduction by closed methods. Figure 27—Lateral photograph of the same foot showing the deformity which may result if dorsal displacement recurs.
Figures 28 and 29—Type C. This injury was due to an indirect force. There is medial displacement of the first metatarsal and lateral displacement of the second and third. Figures 30 and 31—Open reduction was necessary. Good alignment was obtained and held by internal fixation. Figures 32 and 33—Four years later the alignment of the foot is good and degenerative changes only mild.

Figure 34—Type C. Direct injury (open). The first metatarsal was carried in by the patient. Concomitant injuries to the metatarsophalangeal joints are also seen. Figure 35—After open reduction with osteosynthesis, a delayed split-skin graft was performed. Figures 36 and 37—Eighteen months later a “fair” result has been achieved with revascularisation of the first metatarsal. The deformity of the four lateral metatarsals resulted from inadequate reduction and stabilisation at the time of operation.
result; the initial closed reduction was inadequate and open reduction was performed two weeks after injury, when the swelling had subsided (Figs 28 to 33). The patient with a fair result (Figs 34 to 37) had a severe open crushing injury with complete devascularisation of the first metatarsal, which the patient brought into hospital; open reduction, reimplantation and osteosynthesis with a small AO plate was performed. His postoperative course was uncomplicated but he developed a painful valgus deformity of the hallux. His final outcome is unknown as he was seen only a few weeks after an operation to correct the hallux valgus.

The third patient had a poor result. Closed reduction failed, but, at operation, there was marked comminution involving the Lisfranc joint and an adequate reduction was not obtained, so this injury was treated without fixation.

DISCUSSION

Since the time of Lisfranc, the causes of injury to the tarsometatarsal joint have changed; road accidents and industrial injuries are now the commonest. The most common segmental displacement in our series was one involving only the first metatarsal and resulting from a direct crushing force or an indirect pronation force acting on a fixed forefoot in equinus. This contrasts with previous reports where either dorsolateral displacement of all five metatarsals (Aitken and Poulson 1963; Cassebaum 1963; Wilson 1972), or of the four lateral metatarsals (Wilppula 1973) were the commonest injuries.

Radiographs in three planes (anteroposterior, lateral and 30-degree oblique) are essential in order to diagnose the initial displacement and also to assess whether reduction is sufficiently accurate. Unhappily, in many of our cases oblique views had not been taken. It is also important to include the entire foot and ankle, otherwise concomitant injuries may be missed.

Our study defined three patterns of displacement and our classification is based on that of Quénu and Küss (1909). This has, however, been expanded to include plantar and medial displacement injuries, and dislocations where four metatarsals are involved. This modified classification is simple to apply and gives information regarding prognosis and treatment.

Complications

The complications which accounted for most of the unsatisfactory results were vascular impairment, redisplacement, skin complications (necrosis or cicatrisation if transverse or plantar incisions were used), and osteoarthritis.

At follow-up we were often unable to diagnose early redisplacement (within six weeks) because radiographs were not available. In four of the 27 patients reviewed who required open reduction the operation became necessary because of redisplacement after the initial closed reduction and plaster. A further case, in which redisplacement was diagnosed nine days after the initial closed reduction, was successfully treated by a further closed reduction and percutaneous wires. In these five cases, redisplacement had occurred before the patients had been allowed to take weight. A further five patients with clinical and radiological evidence of redisplacement were seen, but it was not possible to ascertain when this had occurred. When Kirschner wires had been used to stabilise the reduction, redisplacement occurred only in Type B medial injuries where the first metatarsal was displaced (at least three cases) and in Type C injuries (two cases); in all these, only a single wire had been used to stabilise the medial segment.

Kirschner wires are undoubtedly valuable as stabilisers. In their absence redisplacement may follow when, as the swelling diminishes, the plaster becomes loose. The strong plantar muscles and tendons bowstring across the tarsometatarsal joint and, on contraction, shorten the plantar aspect of the foot, leading to displacement if the dorsal ligaments have been torn. This bowstring effect is less marked in the more lateral injuries where the curvature of the Lisfranc joint is less. In those injuries with plantar displacement the peroneus longus tendon acts as a deforming force, depressing the medial side of the tarsometatarsal joint and elevating the lateral side.

Osteoarthritis is an almost inevitable sequel of tarsometatarsal displacements because of damage to the articular surface at the time of injury (Jeffreys 1963). It is usually confined to the displaced segment and may be associated with the formation of an exostosis, particularly on the dorsum of the foot. Moderate to severe degenerative changes in the Lisfranc joint occurred in approximately 30 per cent of our patients.

Treatment

With regard to treatment, we feel that, whenever there is displacement, closed reduction should be attempted. It is best achieved by longitudinal traction in the line of the foot and must be checked radiographically. Providing reduction is adequate it should be stabilised with percutaneous wires. With Type A injuries (total incongruity) one Kirschner wire is placed from the first metatarsal to the medial cuneiform bone, and a second placed laterally from the fifth metatarsal to the cuboid. Of the Type B injuries (partial displacements) those of the lateral segment need only a single Kirschner wire. But if the first metatarsal is displaced, the injury is inherently unstable and two wires are needed. With Type C injuries (divergent displacements) one or two Kirschner wires are used to stabilise the medial fragment, with another single wire for the lateral displacement.

It is clear from the results in our series that when an adequate reduction can be achieved by closed methods, open reduction, as advocated by some authors (Gissane 1951; Jeffreys 1963; Engelhardt and Ganz 1975), is not necessary. Early closed reduction is unlikely to succeed where there is soft-tissue interposition, marked commi-
nution, or a large articular fragment. Diastasis between the medial and intermediate cuneiform bones suggests interposition of the tibialis anterior tendon. In such cases and, indeed, whenever closed reduction is inadequate, open reduction should be performed as soon as possible and certainly within six weeks of the injury.

The absolute indication for open reduction is vascular insufficiency that does not improve after closed reduction. We suggest the technique advocated by Gissane (1951), where both dorsalis pedis and posterior tibial arteries are explored. In the two cases of forefoot ischaemia in our series, open reduction was performed but the posterior tibial artery was not explored and gangrene developed.

For open reduction in the absence of ischaemia, the longitudinal incisions advocated by Aitken and Poulson (1963) give adequate exposure. The first incision is between the first and second metatarsals, and the second (if a second is needed) is made more laterally over the tarsometatarsal joint. With these incisions skin necrosis and contracture, which may follow transverse or plantar incisions, do not occur. A single midline incision also may lead to necrosis because excessive skin retraction is necessary to obtain access.

In several cases good results followed open reduction up to six weeks after injury. However, the two patients treated by open reduction and fixation after this period had only fair results. It is probably better not to attempt reduction after six weeks.

Primary arthrodesis is advocated by Granberry and Lipscomb (1962) and by Bonnel and Barthélémy (1976). We have had no experience with this procedure but it is possible that it may have a place in those injuries where there is considerable comminution and where maintenance of reduction by internal fixation is difficult. Niederecker (1956) recommended arthrodesis of the metatarsocuneiform joint as a standard procedure in all dislocations involving the first metatarsal. Certainly in our series redisplacement sometimes occurred when only a single Kirschner wire was used, and we therefore recommend using two wires.

With regard to after-care, previous reports recommend non-weight-bearing for a period of at least six weeks after injury. We found, however, that taking weight as soon as the swelling subsided (approximately two weeks) did not seem to affect the final outcome, provided the foot was protected in a plaster cast and reduction stabilised by internal fixation.

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