Mismanaged, misdiagnosed lisfranc injuries: long-term follow-up

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Introduction
Dislocations and fracture-dislocations of the tarsometatarsal joints are disabling injuries that present difficult therapeutic problems. Early recognition is imperative. Most studies cite that up to 20% of injuries are missed or misdiagnosed at first presentation; this number could be as high as 40%.

Patients and methods
This study included all patients who presented with misdiagnosed or mismanaged Lisferanc injuries to Suez Canal University Hospital during the period from May 2002 to March 2006. Patients' outcomes were assessed using the American Orthopedic Foot and Ankle Society midfoot score. A total of 19 patients were available at the end of the study.

Results
The mean age of the patients was 34.05±11.76 years including 17 (89.5%) men and two (10.5%) women. There were 17 patients with combined injury (ligament and bone) and two patients with pure ligamentous injury. The patients were distributed according to the modified Hardcastle classification. There were nine (47.4%) patients with type B lateral fractures; two of these showed fleck sign, six (31.6%) patients with type A lateral fracture, three (15.8%) patients with type C total fracture dislocation, and one (5.3%) patient with type C partial fracture. Four (21.1%) patients were managed after the first week of injury, nine (47.4%) patients were managed between the second week of injury and the seventh week, and six (31.6%) patients were managed after the seventh week of the injury. Four (21.1%) patients developed osteoarthrosis at the end of follow-up.

Conclusion
Lisferanc injuries are reported to be the most commonly missed injury. Once diagnosed, anatomical reduction and stable fixation is the standard principle governing the treatment of these injuries.

Keywords:
foot, fracture dislocation, lisfranc injuries

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Introduction

Injuries of the tarsometatarsal articulation encompass a wide spectrum ranging from mild sprains or subtle subluxations to widely displaced debilitating injuries. A study found statistically significant anatomical abnormalities in the normal foot of patients with contralateral Lisfranc fracture-dislocations. This abnormality is best described as a shallow recessed mortise in the second metatarsal, which suggests that patients who do have a Lisfranc fracture-dislocation may have underlying anatomical abnormalities in the feet that might predispose them to contralateral injury [1,2]. The classification of this injury is not prognostic for the result. Myerson's modification of the original classification of Quenu and Kuss [3] and Hardcastle *et al.* (1979) is presented because it incorporates more proximal injuries into the medial column of the foot [4]. Subtle injuries through the intercuneiform region and the naviculocuneiform joint are probably more common than previously thought. Type A injuries involve displacement of all five metatarsals with or without fracture of the base of the second metatarsal. The usual displacement is lateral or dorsolateral, and the metatarsals move as a unit. In type B injuries, one or more articulations remain intact. Type B1 injuries are medially displaced, sometimes involving the intercuneiform or the naviculocuneiform joint. Type B2 injuries are laterally displaced and may involve the first metatarsal–cuneiform joint. Type C injuries are divergent injuries and can be partial (C1) or complete (C2) [5]. These generally are high-energy injuries, associated with significant swelling, and prone to complications, especially compartment syndrome. Dislocations and fracture-dislocations of the tarsometatarsal joints are disabling injuries that present difficult therapeutic

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problems. Early recognition is imperative and is based on a familiarity with the important anatomic features of this joint, mechanism of injury, high index of suspicion, and subtle radiographic changes that often accompany these lesions [6].

Once diagnosed, injuries are classified to proceed with the best way of treatment, which varies according to the severity of injury, ranging from conservative treatment, closed versus open reduction, internal versus external fixation, up to arthrodesis. Most studies cite that up to 20% of injuries are missed or misdiagnosed at first presentation; this number could be as high as 40%. One author extends this argument to the extreme, claiming that 'Lisferanc injuries have been reported to be the most commonly missed injury in the emergency rooms' [7–10].

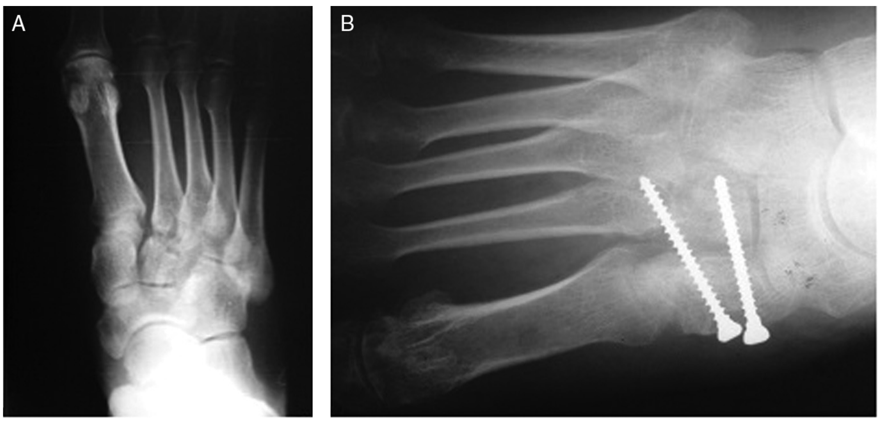
Patients and methods

This is a prospective study and the aim of this study was to describe the long-term results of surgical management of misdiagnosed or mismanaged Lisferanc foot injuries and its effect on the outcome and prognosis of injured feet. All patients who presented with misdiagnosed or mismanaged Lisferanc injuries to Suez Canal University Hospital during the period from May 2002 to March 2006 were included in this study. Both sexes and all age groups were included in this study. Patients' outcomes were assessed using the American Orthopedic Foot and Ankle Society (AOFAS) midfoot score. A total of 19 patients were available at the end of the study. Student's (unpaired sample) '*t*' test, one-way analysis of variance test, and Fisher's exact test (*F*) were used for analysis of the collected data.

Results

A total of 19 patients were included in this study, 17 (89.5%) men and two (10.5%) women. The mean age of the patients was 34.05±11.76 years (range: 19–63 years). A total of 10 (52.6%) patients were injured in the right side, whereas nine (47.4%) patients were injured in the left side. There were 14 (73.7%) patients with closed injury, four (21.1%) patients with open injury, and one (5.3%) with open injury with soft tissue loss. There were 17 (89.5%) patients with combined injury (ligament and bone) and two (10.5%) patients with pure ligament injury. These two patient with pure ligament injury were diagnosed by radiographic imaging. Patients with only a fleck sign (an avulsion fracture of the Lisfranc ligament) were considered to have a purely ligamentous injury. There were 11 patients who had been involved in road traffic accidents [57.9% motor car accident (MCA)], four patients who fell from height [21.1% falling from height (FFH)], and four who fell on the ground [falling on the ground (FOG) 21.5%]. The patients were distributed according to the modified Hardcastle classification. There were six (31.6%) patients with type A lateral fracture, nine (47.4%) patients with type B lateral fractures, two of them showed a fleck sign, three (15.8%) patients with type C total fracture dislocation, and one (5.3%) patient with type C partial fracture. There were six (31.6%) patients with associated injuries. One patient had ipsilateral fracture of the tibia, one had ipsilateral fracture of the acetabulum, one had contralateral fracture of the patella, one had contralateral fracture of the tibia, one had a fracture of the proximal phalanx of the index, and one had ipsilateral fracture of both bone forearm and the tibia. Four (21.1%) patients were managed after the first week of injury, nine (47.4%) patients were managed

Figure 1



(a) A preoperative plain radiographic anteroposterior view of a 63-year-old male patient with Lisfranc fracture-dislocation type B1 according to the Hardcastle classification. (b) A 1.5-month postoperative plain radiographic anteroposterior view of the same patient after fixation by screws (note that compression across the fixed joint was not needed).

Table 1 Summary of patients' data

Cases	Age	Sex	Side	Cause	Type	Nature	Classification	Time	Associated	Treatment	Reduction	OA	Follow-up	AOFAS
1.	45	Male	Left	FFH	Closed	Combined	A lateral	6	No	OR+K-wire	Anatomical	No	6	78
2.	25	Male	Right	MCA	Open	Combined	B lateral	7	Yes	OR+screws	Anatomical	No	6	86
3.	63	Male	Left	FOG	Closed	Combined	C total	8	No	OR+K-wire and screws	Anatomical	Yes	12	94
4.	34	Female	Right	FFH	Closed	Combined	A lateral	3	No	OR+K-wire and screws	Anatomical	No	6	73
5.	26	Male	Right	MCA	Closed	Combined	C total	8	No	OR+K-wire and screws	Anatomical	No	24	88
6.	23	Male	Right	MCA	Crushed	Combined	A lateral	3	No	OR+K-wire and screws	Anatomical	Yes	16	63
7.	28	Female	Left	MCA	Closed	Combined	B lateral	8	Yes	OR+screws	Anatomical	No	13	82
8.	62	Male	Left	FOG	Closed	Combined	B lateral	9	No	OR+screws	Anatomical	NO	21	60
9.	25	Male	Right	MCA	Closed	Combined	B lateral	4	No	OR+K-wire and screws	Anatomical	No	11	96
10.	32	Male	Right	MCA	Closed	Combined	C total	6	No	OR+K-wire and screws	Anatomical	No	16	88
11.	33	Male	Right	MCA	Open	Combined	C partial	9	Yes	OR+K-wire and screws	Anatomical	Yes	12	84
12.	29	Male	Left	FFH	Closed	Combined	B lateral	8	No	OR+screws	Nonanatomical	Yes	6	48
13.	30	Male	Right	MCA	Closed	Pure ligament	B lateral	1	No	Percutaneous screws	Anatomical	No	12	100
14.	37	Male	Right	FFH	Closed	Combined	A lateral	7	No	OR+screws	Anatomical	No	6	94
15.	35	Male	Right	FOG	Closed	Combined	A lateral	4	No	OR+K-wire and screws	Anatomical	No	24	60
16.	30	Male	Left	FOG	Closed	Combined	B lateral	1	No	OR+screws	Anatomical	No	25	73
17.	19	Male	Left	MCA	Open	Combined	B lateral	1	Yes	OR+K-wire and screws	Anatomical	No	30	82
18.	30	Male	Left	MCA	Closed	Combined	A lateral	1	Yes	OR+screws	Anatomical	No	22	92
19.	41	Male	Left	MCA	Open	Pure ligament	B lateral	2	Yes	Percutaneous screws	Anatomical	No	15	100

AOFAS, American Orthopedic Foot and Ankle Society; FFH, falling from a height; FOG, falling on the ground; MCA, motor car accident; OA, osteoarthritis.

Table 2 Comparative analysis of the American Orthopedic Foot and Ankle Society score results for assessed cases in the different subgroups

Subgroups	Patients (*n*=21)	AOFAS score		*P*	Tests
		SD	Average		
Age					
<30	7	16.557	77.86	0.782	ANOVA
30–39	8	13.342	83.00		
40–49	2	15.556	89.00		
>50	2	24.042	77.00		
Sex					
Male	17	15.617	81.53	0.545	*t*
Female	2	6.364	77.50		
Types					
Closed	13	13.276	82.92	0.039	ANOVA
Open	4	8.165	88.00		
Crushed	1	–	63.00		
Neglected	1	–	48.00		
Nature					
Pure ligament injury	2	0	100	0.054	*t*
Combined injury	17	14.084	78.88		
Associated injuries					
Isolated injury	13	16.691	78.08	0.097	*t*
Multiple trauma	6	7.090	87.67		
Time					
<1 week	4	11.758	86.75	0.544	ANOVA
1–7 weeks	9	14.396	82.00		
>7 weeks	6	17.933	76.00		
Reduction					
Anatomical	18	12.868	82.94	0.017	*t*
Nonanatomical	1	–	48.00		
Osteoarthrosis					
Present	4	20.694	72.25	0.187	*t*
Absent	15	12.789	83.47		

ANOVA, analysis of variance; AOFAS, American Orthopedic Foot and Ankle Society; Nonparametric analyses for data evaluation, using Student's (unpaired sample) '*t*' test, and one-way analysis of variance, SD considered significant when $P<0.005$.

between the second week of injury and the seventh week, and six (31.6%) patients were managed after the seventh week of injury. Nine (47.4%) patients were treated with open reduction and fixation with K-wires and screws, seven (36.8%) patients were treated with open reduction and fixation with screws only, two (10.5%) patients were treated with closed reduction and percutaneous fixation with screws (Fig. 1a and b), and one (5.3%) patient was treated with open reduction and fixation with K-wires only because of soft tissue loss. At the end of the follow-up, only four (21.1%) patients developed osteoarthrosis, whereas 15 (78.9%) patients were free from osteoarthrosis. According to the scoring system, six (31.6%) patients achieved excellent results, six (31.6%) patients achieved good results, three (15.8%) patients achieved fair results, and four (21.1%) patients had poor results. The patients showed a mean AOFAS score of 81.11±14.85 (range: 48–100).

There were no statistically significant relations between age and sex and the final score. There was a statistically significant relation between type of injury and the final score. Patients with closed injuries had a mean final score of 82.92, whereas patients with crushed injuries had a mean final score of 63.00. There was no statistically significant relation between time lapse between injury to management and the final score. There was a statistically significant relation between the quality of reduction (anatomical vs. nonanatomical) and the final score. Patients with anatomical reduction have a mean final score of 82.94, whereas patients with nonanatomical reduction had a mean final score of 48.00. There was no statistically significant relation between the development of osteoarthrosis and the final score (Tables 1–3).

Discussion

Lisfranc injuries account for 0.2% of all fractures [11]. They were classified by Quénu and Küss into homolateral, divergent, and isolated groups. The system was later modified by both Myerson *et al*. [4] and Hardcastle *et al*. [5], who classified the injuries into

Table 3 Comparative analysis of the results for assessed cases, among the different subgroups; nonparametric analyses for data evaluation using Fisher's exact test (*F*)

Subgroups	Patients (*n*=21)	AOFAS score		*P*	Tests
		Satisfactory results	Unsatisfactory results		
Age					
<30	7	5	2	0.545	Fisher's exact test
30–39	8	7	1		
40–49	2	2	0		
>50	2	1	1		
Sex					
Male	17	13	4	1	Fisher's exact test
Female	2	2	0		
Types					
Closed	13	11	2	0.091	Fisher's exact test
Open	4	4	0		
Crushed	1	0	1		
Neglected	1	0	1		
Nature					
Pure ligament injury	2	2	0	1	Fisher's exact test
Combined injury	17	13	4		
Associated injuries					
Isolated injury	13	9	4	0.255	Fisher's exact test
Multiple trauma	6	6	0		
Time					
<1 week	4	4	0	0.777	Fisher's exact test
1–7 weeks	9	7	2		
>7 weeks	6	4	2		
Reduction					
Anatomical	18	15	3	0.068	Fisher's exact test
Nonanatomical	1	0	1		
Osteoarthrosis					
Present	4	2	2	0.178	Fisher's exact test
Absent	15	13	2		

AOFAS, American Orthopedic Foot and Ankle Society.

total incongruity, partial incongruity, and divergent patterns. Although these classification systems were descriptive, we believed that they were not prognostic and that they did not direct treatment decisions. Anatomical reduction and stable internal fixation has become the standard principle governing the treatment of tarsometatarsal fracture-dislocations. Most authors have agreed that stable anatomical reduction leads to optimal results [4]. Our study supports this concept as patients with anatomical reduction had a significantly better average AOFAS score ($P<0.05$).

There are many treatment options, including closed reduction and casting, closed reduction and percutaneous fixation, open reduction and internal fixation, open reduction and external fixation, and primary arthrodesis. Closed reduction with casting does not maintain an adequate reduction in the acutely injured patient; therefore, for most patients, surgical stabilization with Kirschner wires or screw fixation is preferred [12]. Myerson *et al.* [4] suggested criteria for operative reduction if the closed reduction fails to reduce the space between the bases of the first and the second metatarsals and medial and middle cuneiforms to 2 mm or less. To the active individual or athlete, a 2 mm gap may be unacceptable, and anatomic alignment and reduction must be obtained [13]. The talometatarsal angle should not be greater than 15°, and there should be no displacement of the metatarsals in the dorsoplantar plane [14].

One important element of this treatment was that all components of the injury of the tarsometatarsal joint were reduced surgically. Although periarticular fractures were frequently recognized on preoperative radiographs, intra-articular and osteochondral fractures, which were present in more than half of the patients, often were not. In addition, it was found that the joint capsule and fragments of other soft tissue were frequently entrapped in the joint. Under direct inspection, it was found that these displaced fragments of bone and torn soft tissue often prevent reduction. Because full reduction requires replacement of these fragments and debridement of the soft tissue, we believe that surgical exploration and reduction is the only reliable way to ensure restoration of the congruence of the surfaces of the joint. Swelling was the main cause of delay in this series. The other reason was preparing the patients with major illness for the operation. However, in this study, there was no statistically significant difference in the timing of surgery (time lapse between injury and management). Some authors claimed that good results had been obtained with open reduction as late as 6 weeks after injury. After 6 weeks, the success rate of surgery is diminished by multiple factors: extensive soft tissue dissection and destruction of the articular surface because of malposition; they believed that fusion is the treatment of choice in such cases [12].

In most cases of this study, the Trevino *et al*. [14] approach was used, which is an extensile dorsomedial approach to the midfoot, with an optional lateral incision. The advantages of this approach are that it allows exposure of the medial two-thirds of the midfoot, avoids the dorsal prominence, and enables visualization of both superficial and deep peroneal nerves. There is controversy about which method of fixation is best. There are proponents of Kirschner wire fixation [15], whereas others rely on screw fixation [12]. In the first few cases, we found a high rate of failure when Kirschner wires were used because the fixation was not rigid; there is an increased risk of pin breakage with early weight bearing, and protruding pins increase the risk of infection and need for premature removal, which leads to loss of reduction. Since then, we have used rigid fixation in the medial column. Screw fixation is stronger and allows a more stable construct. In our study, screws were placed without compression (setscrews). We believed that compression across a reduced joint was unnecessary and that it increased the risk of degenerative changes. The screws had to be maintained in the corrected joint position to allow the fractures and soft tissues to heal. The screws must be left in place for a minimum of 12 weeks. In our study, screws were left as long as the patients did not complain.

Trevino *et al*. [14] currently recommend anatomic reduction and do not accept any malreduction, diastasis, or malalignment of the metatarsals. Incomplete reduction of the fracture or dislocation, or redislocation after inadequate treatment, frequently results in permanent disability in the form of chronic pain, deformity, and difficulty with wearing shoes [14]. The findings of the study support the premise that anatomical reduction is critical for optimum results. There was a statistically significant relation between reduction and the final score. Patients with anatomical reduction had a mean final score of 82.94, whereas patients with nonanatomical reduction had a mean final score of 48.00.In our study, patients with closed injuries had a mean final score of 82.92 and patients free from open injuries had a mean final score of 88.29, whereas patients with crushed injuries had a mean final score of 63.00 and patients with neglected injuries had a mean final score of 48.00, where the P value was 0.039 ($P<0.05$). This is consistent with the fact that the patients with direct injuries (crush) and patients with additional midfoot injuries or open injuries seem to fare less well than those with closed or isolated tarsometatarsal foot injuries. It has been reported that the degree of post-traumatic arthritis is directly proportional to the degree of gross damage to the articular surface that had been identified at the operation and the adequacy of reduction [15]. In our study, it was found that patients with anatomical reduction had a significantly lower prevalence of post-traumatic osteoarthritis and a significantly better average AOFAS outcome score than patients without nonanatomical reduction.

Conclusion

Lisferanc injuries are reported to be the most commonly missed injury. Once diagnosed, anatomical reduction and stable fixation is the standard principle governing the treatment of these injuries.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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