Management of Lisfranc injuries of the foot

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Background
The term 'Lisfranc injury' strictly refers to an injury where one or more of the metatarsals are displaced from the tarsus. The term is more commonly used to describe an injury to the midfoot centered on the second tarsometatarsal joint. The injury is named after Jacques Lisfranc de St. Martin (1790–1847), a French surgeon and gynecologist who first described the injury in 1815. 'Lisfranc injury' encompasses a broad spectrum of injuries, which can be purely ligamentous or involve the osseous and articular structures. They are often difficult to diagnose and treat, but if not detected and appropriately managed, they can cause long-term disability.

Aim
The aim of this work was to evaluate the proper management of lisfranc injuries and identify the best method of diagnosis and treatment.

Patients and methods
This is a prospective study that included 15 patients with Lisfranc injures of the foot who presented to the Emergency Department of Al-Azhar University Hospitals (Al Hussein and Sayed Galal Hospitals) between January 2016 and June 2017 and followed up for 3–9 months, with an average of 6 months. Fractures were classified according to the Myerson's and Hardcastle classification. All patients were treated by emergency surgery by screws or Kirschner wires (K-wires). The American Orthopaedic Foot & Ankle Society (AOFAS) functional scale was used to assess results in the midfoot and patient satisfaction was also evaluated.

Results
After a mean 6 months of follow-up, the mean score on the AOFAS scale was 81.8, with a high level of satisfaction in nearly all patients. The results obtained with screw fixation were similar to those with K-wires.

Conclusion
Like most authors, the best results are obtained by the early reduction and fixation of the injury. The authors rule out nonoperative treatment and favor an ORIF procedure with Kirschner wires and screws, provided that the condition of the soft tissues allows it. The results obtained with K-wires were similar to those found in screw fixation, and anatomic reduction is the main predictor of outcome in patients with Lisfranc fracture dislocations.

Keywords:
foot, fracture dislocation, Lisfranc

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Introduction

The term 'Lisfranc injury' strictly refers to an injury where one or more of the metatarsals are displaced from the tarsus. The term is more commonly used to describe an injury to the midfoot centered on the 2nd tarsometatarsal joint [1]. The injury is named after Jacques Lisfranc de St. Martin [2] (1790–1847), a French surgeon and gynecologist who first described the injury in 1815. He also described an amputation at this level [3]. 'Lisfranc injury' encompasses a broad spectrum of injuries, which can be purely ligamentous or involve the osseous and articular structures. They are often difficult to diagnose and treat, but if not detected and appropriately managed, they can cause long-term disability [4]. The fracture dislocation of the tarsometatarsal joint is a relatively infrequent injury (occurring in 1/55 000 people per year) [5]. However, it can have devastating long-term effects for the patient. At present, the most common mechanisms of injury are high-energy mechanisms, vehicle accidents, and occupational accidents [6]. It is an injury that often occurs in multiple trauma patients or associated with other injuries of the lower limbs, due to which it may be overlooked or its diagnosis deferred [7].

The most widely accepted treatment is anatomic reduction of the dislocation, be it by open or closed

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methods, and fixation of the dislocation using the Kirschner wire (K-wire) [8], 3.5 mm screws, [9] or dorsal plates [10]. Primary arthrodesis, according to several authors, must be used in cases of great comminution and displacement, or it could also be the treatment chosen in this kind of injury [11].

The aim of this study was to evaluate the results of the treatment of Lisfranc fracture dislocations in our hospital between January 2016 and June 2017 in relation to the type of fixation used, to identify whether a preferable method exists, and which are the negative prognosis factors.

Patients and methods

This is a prospective study of 15 patients with recent Lisfranc injures of the foot and who were followed up for 3–9 months, with an average of 6 months. There were 12 men and three women. Their ages ranged from 16 to 38 years, with an average age of 25.6±4.7 years. The left foot was involved in nine patients and the right foot was involved in six patients. Injury mechanisms were as follows: were due to fall from height in eight patients, due to road traffic accidents in six patients, and due to indirect trauma in one patient. There were four isolated Lisfranc injuries; 11 patients had associated injuries. The injuries were classified by Myerson's modification of Hardcastle classification (12), The injuries were type B2 (partial lateral) in five patients, type B2 (total lateral) in four patients, type B1 in three patients, type C1 in two patients, and type A (lateral) in one patient. There were 14 closed injuries and one open injury. The open injury was classified according to the method of Gustilo and Anderson into type II after approval was obtained from the Hospital Ethics Committee. An informed consent was obtained from all the patients.

Myerson's classification [12]

Type A (total incongruity):

Lateral or dorsoplantar dislocation of the first to fifth metatarsals.

Type B (partial incongruity):

B1: medial dislocation of the first metatarsal.
B2: lateral dislocation of the second to fifth metatarsals.

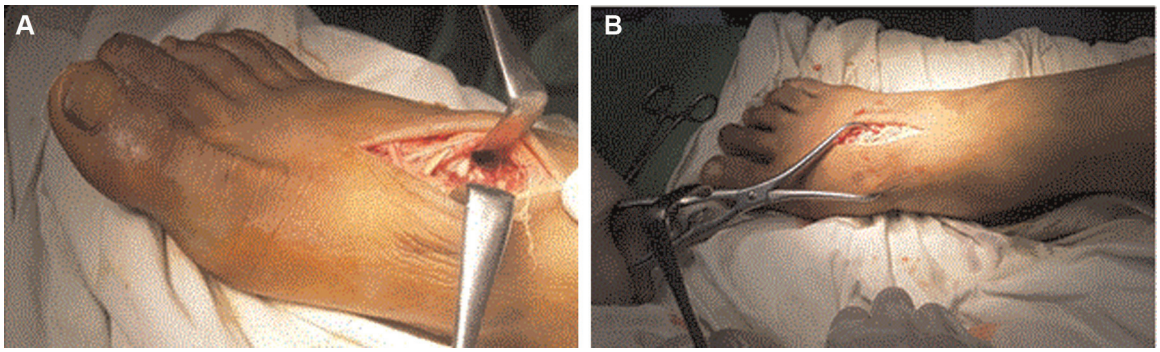
Type C (divergent):

C1: partial displacement of any of the second to fifth metatarsal laterally and the first metatarsal medially.
C2: total displacement of the second to fifth metatarsals laterally and the first metatarsal medially

Surgical technique

A dorsal longitudinal incision was made between the first and the second metatarsal. The extensor hallucis longus tendon, deep peroneal nerve, and dorsalis pedis artery were identified and retracted as a unit (Fig. 1). Small irreducible fragments were debrided from the joint. The first tarsometatarsal joint was aligned by reducing the medial border of the medial cuneiform to the medial border of the first metatarsal. The second metatarsal was then reduced to the medial border of the middle cuneiform. The joints were fixed with K-wires or cannulated screws were placed from the proximal medial corner of the medial cuneiform into the base of the second metatarsal (Lisfranc screw). A second screw was then introduced in a retrograde retrograde manner dorsally from the metaphysis of the second metatarsal into the intermediate cuneiform. Countersinking is used to prevent cortical avulsion when the screw head abuts

Figure 1



(a) Subcutaneous tissue dissection and the extensor hallucis longus tendon are retracted medially; the extensor hallucis brevis tendon together with the neurovascular bundle are carefully retracted laterally. (b) Pointed reduction forceps grasping the medial cuneiform from plantar and medial and the base of the second metatarsal from dorsal and lateral reduce the residual displacement of the second TMT.

with the cortical bone during compression. Usually, the two crossing screws are introduced using a lag screw technique starting with the distal to proximal screw. Next, the third tarsometatarsal (TMT) joint is reduced and fixed with a distal to proximal screw.

Postoperatively, the limb was placed in a below-knee plaster splint with the ankle in a neutral position for 2 weeks until suture removal. Nonweight bearing was allowed for the next 6 weeks. K-wires were removed at the sixth–eighth week. Full weight bearing was then allowed gradually. Screws were not removed (Figs 2 and 3).

At the end of follow-up, the results obtained were analyzed according to the functional value scale, with 0 to 100 points using the American Orthopaedic Foot & Ankle Society (AOFAS) midfoot score; 90–100 points were considered to indicate excellent results, 80–89 points were considered to indicate good results, 65–79 points were considered to indicate fair results, and less than 65 points were considered to indicate poor results.

We finally classified patients into two groups according to the treatment they had received (screw or wire) and in relation to factors that could possibly lead to a negative prognosis.

The use of bioabsorbable (e.g. polylactide) screws, dorsal plating, suture endobutton fixation, and primary arthrodesis was limited due to difficulty of the technique, cost, and difficulty in acquiring them.

Results

In this prospective study, we treated 15 adult patients with recent lisfranc injuries of the foot. Twelve patients were treated by open reduction and fixation by K-wires that were removed after (8–12) weeks. Three patients were treated by open reduction and fixation by cannulated screws.

These 15 patients were prospectively followed up for an average period of 3–9 months.

The average age of the patients in this series was 25.6 ±4.7 years (range: 16–38 years), 87% of whom were males (13 males and two females).

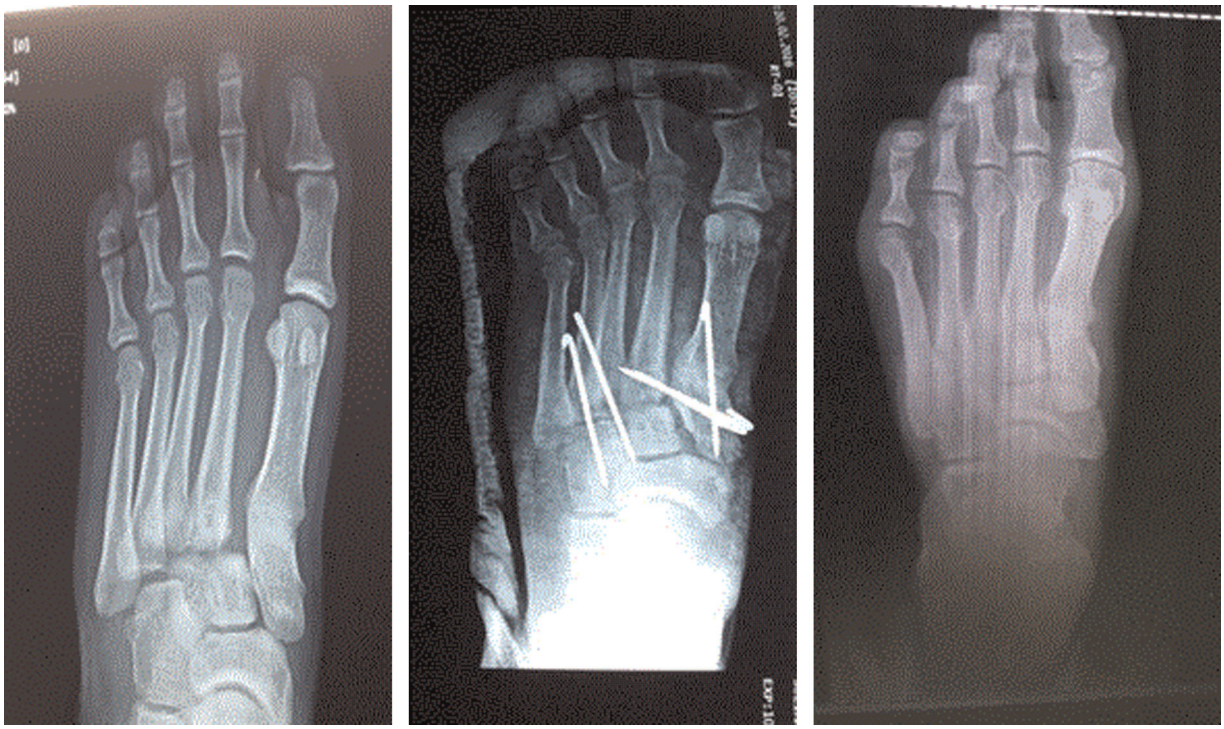
The left foot was affected in nine patients (60%), whereas the right foot was affected in six patients (40%).

A total of 53.3% of the injuries were caused by falls from height, being the most common etiology (eight patients), followed by high-energy traumas and vehicle

Figure 2

A male 35-year-old patient presented with lisfranc injury type B2 following fall from height. Initial radiography (a), immediate postsurgical radiography (b) and at the end of follow-up, no loss of reduction (c) was observed.

Figure 3



A male 28-year- old patient presented with lisfranc injury type B2 following fall from height. Initial radiography (a), immediate postsurgical radiography (b), at the end of follow-up, and after removal of Kwires (c) were obtained.

accidents (six patients). Simple falls produced injuries in one patient.

The injuries were classified by Myerson's modification of Hardcastle classification; there was one type A injury (6.7%), 12 type B injuries (20% B1, 33.3% B2 partial lateral and 26.7% B2 total lateral) and two type C injuries (13.3% C1).

In all the cases, except one, the injury was closed and there were no bilateral injuries or cases of pure dislocation.

The reduction was open in all patients. The reduction was stabilized with K-wires in 12 patients and with cannulated screws in three patients. A postsurgical cast splint for immobilization was placed in all the patients for an average period of 10 weeks, initiating progressive partial loading at 8 weeks on average.

In two patients, reduction was not considered to be anatomical, since the distance between the base of the first and the second metatarsals was greater than 3 mm. In the remaining patients, the distance was inferior to 3 mm.

The mean total was 81.8 points, which was obtained using the AOFAS midfoot score; four patients achieved excellent results, six patients achieved good results (more than 80 points), five patients achieved fair results and no patient showed poor results. In terms of the subjective evaluation of the patients, one patient presented with continuous intense pain, another patient complained of moderate pain and in seven patients, the pain was mild; the remaining patients reported no pain and 12 patients (80%) were satisfied with the results.

No statistically significant differences were found in terms of the age and mechanism of injury, the scoring being similar in all the groups. This leads us to conclude that the age and mechanism of injury are not in themselves factors for a negative prognosis as has been commonly considered.

The patients who did not present with associated injuries showed mean scores of 89.25 points, whereas those who had injuries in the lower limbs obtained a score of 79.09 points.

In terms of the results in relation to the type of injury, type C obtained the lowest scores, 67, on average.

In terms of the type of reduction, higher scores were obtained with anatomical reduction, 83.46, than with the nonanatomical reduction, 71.

Also, the patients were divided into two groups according to the kind of treatment that they received, obtaining scores of 84 for those with screws and 81.25 for those with K-wires using the AOFAS midfoot score.

The results for immobilization, nonweight bearing, secondary osteoarthritis, and other complications were similar in the two groups.

Osteosynthesis material was removed in 13 patients (86.6%).

Calcaneus fractures were the most common associated injury in four patients (27%), followed by cuneiform fractures in three patients (20%).

With respect to the complications that were found, there was one case of paresthesia at the level of the first finger that resolved spontaneously.

One broken of osteosynthesis material after healing in a patient treated with cannulated screws.

Superficial infection was observed in two patients (13%), who were treated with intravenous antibiotics, followed by oral antibiotics for 5–10 days.

Wound defect was observed in one patient (6.66%), who was treated by daily dressing and antibiotics.

Subluxation was observed in one patient, (6.66%), who was treated by conservative treatment for up to 9 months.

No compartment syndrome, deep vein thrombosis, vascular insouciance, stress fracture, or post-traumatic arthritis, and chronic instability were noted (Table 1).

Discussion

Injuries of the tarsometatarsal joint are rather infrequent, but they may cause pain and permanent disability due to their location and the high demand when standing and walking.

In our study, the age of the patients ranged from 16 to 38 years, with a mean of 25.6±4.7 years. In Sánchez-Gómez *et al.* [6], the average age was 36 years (range:

Table 1 Main data of the 15 patients in our study

No.	Sex	Age	Side	Mode of trauma	Associated Fracture	Myerson's modification of Hardcastle classification.	Open or closed	Anatomical Reduction	Implants	Duration of fixation (weeks)	Complications	AOFAS (100)
1	M	35	Rt	FFH	Isolated injury	B2	Closed	Anatomical	Screws	Not removed		95
2	M	28	Lt	FFH	# calcaneus	C1	Closed	Anatomical	Wires	12	Infection	67
3	M	28	Lt	FFH	# tibia	B2	Closed	Anatomical	Wires	12		85
4	M	30	Rt	FFH	Isolated injury	B2	Closed	Anatomical	Wires	8		90
5	M	18	Lt	RTA	#navicular	B1	Closed	Anatomical	Wires	8		90
6	M	22	Rt	RTA	# calcaneus	B2	Closed	Anatomical	Wires	10		85
7	M	16	Lt	Direct	# navicular	B1	Closed	Anatomical	Wires	12		74
8	F	28	Lt	RTA	# cuneiform	A	Closed	Anatomical	Wires	12		82
9	M	28	Lt	RTA	# MTB	B2	Closed	Anatomical	Wires	12		85
10	M	22	Lt	Indirect	Isolated injury	B2	Closed	Anatomical	Screws	Not removed	Broken screws	90
11	F	20	Rt	FFH	# calcaneus	B2	Closed	Anatomical	Wires	8		75
12	M	37	Rt	RTA	# cuneiform	B1	Closed	Anatomical	Wires	8		85
13	M	38	Lt	FFH	# calcaneus	B2	Open	Non anatomical	Wires	12	Infection	75
14	M	24	Rt	FFH	# cuneiform	C1	Closed	Non anatomical	Screws	40	Loss of reduction	67
15	F	27	Lt	Crushed	Isolated injury	B2	Closed	Anatomical	Wires	10		82

AOFAS, The American Orthopaedic Foot & Ankle Society; F, female; FFH, falll from height; Lt, left; M, male; R, right; RTA road traffic accident.

14–66 years) and in Pereira *et al*. [13], the age of the patients ranged from 17 to 50 years, with a mean of 31.53 years. The mean age range of the patients in our study was close to that in the study of Pereira *et al*. [13] Age is not a significant prognostic factor as all patients in our study were young adults.

A total of 87% the patients were males (13 males and two females). The higher male to female ratio in our study may be due to the fact that most of the females in our study were household sedentary workers.

The left foot was affected in 60% of the patients; side is not a significant prognostic factor.

The mechanisms of injury can be direct or indirect, falls from height being the most common cause in our study. In Sánchez-Gómez *et al*. [6], high-energy trauma was the most common cause of injury.

Calcaneus fractures were the most commonly found injury in our study, found in 27% of the patients. In Irfan Latoo *et al*. [8], metatarsal fractures were the most common injury, found in 30% of the patients. The higher calcaneus fractures in our study may be due to the fact that the most common cause of injury is fall from height.

Patients with associated injuries, chiefly in the lower limbs, also have a more unfavorable prognosis due to a longer period of immobilization, nonweight bearing, and longer delay in rehabilitation.

In our study, most of the Lisfranc injuries (80%) were type Hardcastle type B, followed by type C (13%). In Irfan Latoo *et al*. [8], type B injuries were the most common Lisfranc injuries (60%). Also, in Pereira *et al*. [13], type B Lisfranc fractures were the most common Lisfranc injuries (80.94%) among Lisfranc fracture dislocations. However, in Sánchez-Gómez *et al*. [6], type A injuries (53.8%) were the most common, followed by type B injuries (34.6%).

There is controversy about which method of fixation is the best. Some surgeons prefer K-wire fixation, while others rely on screw fixation.

In our study, we used open reduction and internal fixation by K-wires and cannulated screws for the treatment of lisfranc injuries.

The use of bioabsorbable screws, dorsal plating, suture endobutton fixation, and primary arthrodesis was limited due to the difficult technique, cost, and difficulty in acquiring them.

In terms of the number and placement of wires or screws, we recommend first treating the instabilities of cuneiforms or tarsometatarsal surface joints. Subsequently, one wire or screw should be placed to fix the median cuneiform to the base of the second metatarsal and another one to fix the base of the second metatarsal to the medial cuneiform. The fourth and fifth metatarsals can be fixed to the cuboid by K-wires. Finally, the 1st metatarsal is fixed to the median cuneiform.

Our mean total score was 81.8 points, which was obtained using the AOFAS midfoot score; 66.6% of our patients obtained a score equal to or above 80 points on the AOFAS scale, and 80% were satisfied with the result. These data are similar to those found in other series; for example in the study of Sánchez-Gómez *et al*. [6], the AOFAS score was 85.38 points and in the study of Ghate *et al*. [9], the mean AOFAS midfoot score was 77.5.

The most important prognostic factor is directly related to achievement of correct reduction. It has been shown that patients with an adequate anatomic reduction obtain a higher score in the AOFAS functional scale and present a lower prevalence of post-traumatic arthrosis.

K-wire were removed at 8–12 weeks in our study, while in the study of Irfan Latoo *et al*. [8], K-wires were removed at a mean of 8 weeks.

The complication in our study included loss of reduction in one case. The percentage of loss of reduction with K-wires was lower in our study as we immobilized the foot for a longer duration in a short leg cast (mean 10 weeks).

Two patients developed superficial wound infection; both occurred within 1 week of surgery and responded well to antibiotics and daily dressings. In Nithyananth *et al*. [14], there was no loss of alignment on plain radiographs.

In our study, K-wire fixation was performed because it is a safe method, easy to use, rapid, inexpensive, and minimally invasive, and an average AOFAS midfoot score of 81.25 was obtained. However, there is an increased risk of redisplacement and redislocation when K-wires are removed early as well as pin-site infection and k-wire migration. With screw fixation, an

average AOFAS midfoot score of 84 was obtained, but there are several disadvantages with the use of screw fixation for Lisfranc injuries. Since the screws are transarticular, their placement further damages the articular cartilage of the joints that an attempt is being made to preserve. Screw breakage can occur, and the distal portion of the screw is difficult to remove and may be left behind. Because of the risk of screw breakage, early foot and ankle range-of-motion exercises and weight bearing may be delayed, which may potentially delay a patient's functional recovery time. The most serious problem is that the incidence of post-traumatic arthritis is relatively high, which may adversely affect the patient's quality of life quality.

Latoo *et al*. [8] confirmed this result in 20 patients with Lisfranc injuries treated with open reduction and K-wire fixation. The average duration of follow-up was 1–3 years.

Some authors have advocated using screw fixation. Sánchez-Gómez *et al*. [6] reviewed 26 patients between 1995 and 2006; the results obtained with screw fixation were slightly better than those obtained with the use of K-wires.

Conclusion

(1) The best results are obtained by early reduction and fixation of the injury.
(2) We favor an ORIF procedure with K-wires and screws, provided that the condition of the soft tissues allows it.
(3) The results obtained with K-wire fixation were similar to those found with the use of screw fixation.
(4) Anatomic reduction is the main predictor of outcome in patients with Lisfranc fracture dislocations.

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Conflicts of interest
There are no conflicts of interest.

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