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## Management of open lisfranc joint injuries: A prospective study

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### Abstract

**Background:** The orthopaedic literature is bleak when it comes to the management of open Lisfranc fracture-dislocations. The role of K wire fixation has been widely debated in closed injuries, however, their application in open injuries is still not well documented.

**Methods:** We conducted a prospective study over two years from 2018 to 2020 assessing the role of K wire fixation in open Lisfranc fracture-dislocations, soft tissue healing, the functional and radiological outcome at 1-year follow-up and the complications. A total of 10 patients were enrolled, out of which 7 were males and 3 females, all of which were followed up for a minimum period of one year. The mean age was 38.5 years (range 26-55 years) and the commonest cause of injury was a motor vehicular accident (80%).

**Results:** They were classified based on modified Hardcastle system (8 were type 2B and 2 were type 1) and modified Gustilo-Anderson classification system (7 were type IIIa and 3 were type II). The same surgical principle was followed in all patients which included thorough debridement, wash, open reduction through the wound site and fixation using multiple Kirschner (K) wires. This was followed by split-thickness skin grafting in 8 patients and mere primary closure in 2 patients. 4 patients had fracture comminution and yet we were able to achieve an anatomical reduction in 9 out of 10 patients. The wounds healed at a mean of 15.3 days (range 12-26 days), K wires were removed at a mean of 64.9 days (range 56-84 days), and the patients were able to return to their daily activities at a mean of 81 days (range 65-112 days). The average American Orthopaedic Foot and Ankle Society score was 92.2 (range 70-100). There were no reported complications such as osteomyelitis, abnormal gait, chronic pain, instability, or deformity.

**Conclusion:** K wire fixation and aggressive soft tissue management can be considered to be the go-to treatment in cases of open Lisfranc fracture-dislocations, irrespective of comminution, as they provide adequate maintenance of alignment and minimal damage to the pre-existing soft tissue compromise. Thorough debridement and diligent post-operative management give a favourable outcome even if the non-anatomical reduction is achieved.

**Keywords:** Foot, K-Wire, Lisfranc, Fracture

### Introduction

Orthopaedic history suggests that William Hey, in 1799 was the first person to report amputation through the tarsometatarsal (TMT) joints, primarily the cuneiforms<sup>[1]</sup>. However, the method of rapid and simplified TMT amputation was first described by Jacques Lisfranc de Saint-Martin, a French surgeon in 1815, whose name, ever since has been associated with this injury. He stressed the importance of the Lisfranc ligament, expressing it to be the most crucial factor in the management of such cases and the event of amputation through the TMT joint<sup>[2]</sup>. Lisfranc injuries comprise the entire array of traumatic TMT joint afflictions from a mere ligamentous injury to fracture-dislocations. The severity depends on the mode of trauma which ranges from low-velocity injury in athletes to high-velocity motor vehicular accidents (MVA) or crush injuries<sup>[3]</sup>.

Although the exact incidence statistics of this injury is still not well established, the literature suggests a 0.2%<sup>[4]</sup> incidence among all injuries with only 12.5% of them being open injuries<sup>[5]</sup>. The understanding that approximately 20% of these injuries go undiagnosed despite radiographic investigation is attributed to the tendency of this injury to undergo spontaneous reduction, leaving behind residual instability and pain<sup>[6]</sup>.

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The advancement in radiological imaging, such as Computerised tomography (CT) scans and Magnetic Resonance Imaging (MRI) has aided significantly in the diagnosis as well as an understanding of this injury, subsequently complimenting its management [7]. The catastrophic potential of mismanaged Lisfranc injuries makes it imperative to diagnose them and treat them early.

The general understanding is that a good anatomical reduction is vital for stabilization of the Lisfranc joint complex which eventually results in good functional outcome and decreased residual morbidity to the patient [6, 8, 9, 10, 11]. While the efficacy of conservative management has long been disproved owing to the loss of reduction upon subsidence of swelling, the surgical aspect of management is still up for debate [11]. Some advocate the use of K-wire fixation with or without percutaneous screw fixation whereas others opt for open reduction and internal fixation using bridge plates either exclusively or supplemented by screws/ K-wires [3, 7, 8, 12]. In cases of compound injuries, internal fixation has always been considered a deterrent to the soft tissue healing process and eventual bony union. The literature is bleak in terms of prospective studies done exclusively on compound Lisfranc fracture-dislocations. Hence, we carried out the aforementioned to assess the role of K-wire fixation as a definitive tool for the management of such injuries in terms of patient-related outcome measures (PROM), radiological outcome, soft tissue healing and time taken for the union.

#### Method and patients

Ten consecutive patients with compound Lisfranc fracture-dislocation diagnosed clinically and radiologically from January 2018 to January 2019 were included in the study. Patients with other concomitant isolated fractures of the forefoot, talus and calcaneum were excluded. Patients having diabetes mellitus, thyroid disorder, long-term history of steroid intake, and those presenting after 48 hours of the injury were not included. Mean age of the patients was 38.5 years (range 26-55 years), which included 7 males (70%) and 3 females (30%). 8 (80%) of these patients suffered from a motor vehicular accident (MVA) while 2 (20%) from crush injury in the form of being run over or fall of a heavy object. 6 (60%) patients presented with the injury in the left foot and 4 (40%) in the right foot.

All the patients were given a thorough wash in the emergency

department and detailed history taking and evaluation were done for injuries to other limbs, thoracic, abdominal or pelvic structures. They then underwent plain radiography (X-ray) of the affected foot in anteroposterior, lateral and oblique views and the fracture-dislocation pattern was classified accordingly based on modified Hardcastle classification [6]. Modified Gustilo-Anderson classification was applied based on clinical findings upon presentation [13]. All the patients had either type II (30%) or IIIA (70%) compound fracture-dislocations. All 10 patients underwent surgery within 48 hours of sustaining the injury. The chronology of surgical intervention remained the same in all cases namely thorough debridement and wash, followed by open reduction through the wound site, confirmation of satisfactory anatomical reduction under fluoroscopy guidance and fixation using 1.5mm, 1.8mm or 2mm Kirschner (K) wires. K wires were passed longitudinally in line with the shaft of the first metatarsal till the navicular followed by another K wire obliquely from the navicular into the base of the 2nd metatarsal. Intermetatarsal (Owens *et al*) and axial K wires into individual metatarsals for associated shaft fractures were inserted as deemed necessary by the operating surgeon [14]. The wound was then managed by primary closure or split-thickness skin grafting (STSG), as required. The K wires were buried into the skin as much as possible and the patient was continued below knee slab and intravenous antibiotics postoperatively.

K wires were removed after a mean period of 64.9 days (range 56 to 84 days) during follow-up on an outpatient basis. The time to wound healing was considered when the staples/ sutures were removed or until the taking up of the graft (mean = 15.3 days). Patients were made to weight-bear gradually and strengthening exercises were advised. Comfort footwear was suggested wherever the pain exacerbated on weight-bearing for a long period. Follow-up was done in all the patients for a minimum period of 1 year. The functional assessment was done using the American Orthopaedic Foot and Ankle Society Score's (AOFAS) midfoot scale [15]. Radiological evaluation and adequacy of reduction were done using the aforementioned X-ray series based on the criteria elucidated by Myerson *et al*. [11]. Immediate post-operative X rays were used as a comparison tool for verifying loss of reduction in X rays taken during the final follow-up. No secondary loss of reduction was noted. (Figure 1, 2, & 3)



Fig 1: Pre-operative and Post-operative Clinical photos of Case 1



Fig 3: Pre-operative, Post-operative, and X-rays after removal of K-wires (75 days post-op) of Case 2



**Fig 2:** Pre-operative, intra-operative, immediate post-operative and 2 months post-operative x-rays of foot

## Results

A maximum number of patients belonged to Hardcastle and Myerson type B2 fracture (n=8) while other two were classified as type A. Among them, 7 had Gustilo-Anderson (GA) type IIIA injury (all 7 belonged to Hardcastle type B2 fracture) while 3 had modified Gustilo-Anderson type II injury. 2 patients required Split-Thickness skin grafting. The wounds healed at a mean of 15.3 days (range 12 to 26 days) with no reported soft tissue infection or osteomyelitis until the last follow-up. K-wires were removed at a mean of 64.6 days i.e. 10.3 weeks (range 62 days or 8.6 weeks to 84 days or 12 weeks) after radiological and clinical confirmation of joint stability and associated fracture union.

The functional outcome was measured using the AOFAS

midfoot scoring system. The mean score was 92.2 (range 70 to 100). Out of 10, 9 patients had excellent outcome measure (score  $\geq$  90) while one had a fair result (score = 70). No patient had any kind of gait disturbance. There was no complaint of residual pain in any patient apart from 1, who complained of mild pain following strenuous activity and was subsequently advised comfort footwear following which the pain ameliorated. A mild degree of midfoot malalignment was noted in 2 patients but it did not affect the daily activities of either patient in any way. Mean return to daily activity was 81 days (range 65 to 112) No radiological evidence of loss of reduction noted in any patient with 1 patient showing the non-anatomical reduction. All patients were able to resume their pre-injury jobs and lifestyle without any limitation. (Table 1)

**Table 1:** Statistics summary

Sr. No.	Age (in years)	Sex	Mechanism	Hardcastle type	Gustilo-Anderson type	Additional Soft tissue intervention	Wound healing (in days)	K-wire removal (in days)	AOFAS score at 1-year F/U (out of 100)	Reduction	Return to daily activity (in days)
1.	28	M	MVA	B2	IIIA	Nil	15	58	98	Anatomical	74
2.	38	M	CRUSH	B2	II	Nil	13	59	93	Anatomical	72
3.	54	M	MVA	A	II	Nil	12	56	100	Anatomical	66
4.	55	F	MVA	B2	IIIA	Nil	13	65	90	Anatomical	68
5.	26	M	MVA	B2	IIIA	Nil	14	72	95	Anatomical	89
6.	32	F	MVA	A	II	Nil	13	60	98	Anatomical	76
7.	42	M	CRUSH	B2	IIIA	STSG	26	84	70	Non-anatomical	112
8.	30	M	MVA	B2	IIIA	Nil	13	56	95	Anatomical	65
9.	36	M	MVA	B2	IIIA	STSG	21	76	90	Anatomical	106
10.	44	F	MVA	B2	IIIA	Nil	13	63	93	Anatomical	82
MEAN	38.5	-	-	-	--	-	15.3	64.9	92.2	-	81

M: Male

F: Female

MVA: Motor vehicle accident

AOFAS: American Orthopaedic Foot and Ankle Society score

## Discussion

Lisfranc injuries involve direct or indirect trauma to the TMT complex which comprises of three columns, the medial (1st metatarsal (MT) and medial cuneiform), the middle (2nd-3rd MT and middle and lateral cuneiform) and the lateral (4th-5th MT and cuboid) [16]. These injuries have been rarely reported in orthopaedic literature with the current trend of incidence standing at a debatable 0.2% of all fractures [17]. This is despite the understanding that a fifth of all such injuries is missed on initial assessment [6]. Considering the chronically debilitating sequelae and complications of mismanaged or missed Lisfranc injuries such as foot instability, pain, vascular compromise, malunion, deformity and arthritis, it is essential to have a high degree of suspicion in all cases of foot pain following trauma, irrespective of the mode of injury [18]. Ecchymosis and swelling over the plantar aspect of the midfoot, tenderness upon palpation or extreme pain on abduction and pronation of the forefoot and midfoot with the

hindfoot fixed should considerably raise the possibility of a Lisfranc injury. An X-ray series of the foot in the AP, oblique, lateral (preferably weight-bearing) generally reveals diastasis between the first and second MT. Nine out of ten cases show the "fleck" sign [6]. Modalities such as the CT scan and MRI are even more sensitive in diagnosing undisplaced fractures, stress fractures or isolated Lisfranc ligament injury [18].

High-energy trauma is more often than not, the cause for Lisfranc fracture-dislocations (58%) and it is often accompanied by considerable soft tissue insult. MVA and crush injuries account for the maximum number of such cases with the latter leading to more severe injuries [18]. Although closed injuries constitute the majority of the cases (87.5%), open injuries require more aggressive management. The classification of foot fractures has evolved from Quénu and Küss' three-column concept [19] to Hardcastle *et al.* classification [20] in 1982, to modification of the Hardcastle classification 4 years later by Myerson *et al.* [6] Similarly, the

preferred management of such injuries has also undergone an evolution from closed reduction and cast application to K wire fixation to the use of screws to bridging plates.

The advent of casting died down owing to the loss of reduction upon subsidence of swelling. K wiring reinforcement remained the preferred choice for some time until reports of early removal causing collapse and recurrence of dislocation surfaced<sup>[6]</sup>. This was pioneered by the study of Arntz *et al* in 1988 who suggested the use of screw (3.5mm or 4mm) fixation, to obtain better mechanical stability<sup>[21]</sup>. This result was reinforced by multiple studies that followed in the literature. As anatomical reduction has widely been considered to be paramount in achieving the good final functional outcome, we tried to achieve the same in all our patients<sup>[22, 23]</sup>. Even though all our patients had compound fracture-dislocations with some of them even having comminution (40%), we managed to achieve an anatomical reduction in 9 (90%) of the patients. However, 15% patients in the study by Arntz *et al.*<sup>[21]</sup> required K wire fixation due to the degree of comminution and 70% patients who had open Lisfranc injury in the study by Chandran *et al* in 2006 required fixation by K wires<sup>[24]</sup>.

We conducted a prospective study over 2 years, exclusively studying open Lisfranc fracture-dislocations. We assessed the role of K wire fixation in these injuries due to the ability of the K wires to cause minimal additional soft tissue compromise and damage to the intra and peri-articular structures such as the joint capsule as elucidated by Myerson *et al*, especially in comminuted fractures. Another advantage was the ability to prevent a second surgical intervention as the removal could be done on OPD basis. We also evaluated the functional and radiological outcome at one-year follow-up of all patients along with the average time taken for the wound to heal and for the patient to return to his daily activities. The modified Hardcastle classification and Gustilo-Anderson classification<sup>[18]</sup> were used for segregation of fracture patterns and the midfoot scale of AOFAS was used for the functional outcome assessment owing to its established high inter-observer reliability<sup>[25]</sup>. We noted 80% of patients had Hardcastle type 2B injury while the rest had type 1 injury. Out of this 80 %, 7 (87.5%) had GA type IIIa wound with rest having type II wound. STSG was needed in 2 patients. Primary closure with diligent dressing was sufficient in others.

Wound healing was achieved at a mean of 15.3 days and K wires removed at a mean 64.9 days. The patients were able to return to their daily activities at an average of 81 days. The AOFAS score was excellent (>89) in 90% of patients with one patient scoring a fair result (70/100). All patients bar one had a plantigrade foot and completely painless foot whereas all had a stable foot and ankle with no reported osteomyelitis, loss of reduction, the constant need for comfort footwear, gait abnormality, chronic pain due to malunion, cosmetic derangement or loss of range of motion. All the patients in our study (100%) have returned to their pre-injury occupations and can lead a normal life.

Our study is limited by the small sample size which may indicate how rarely this injury occurs and the lack of a long-term follow-up of these patients to study the role of degeneration or spontaneous fusion of the joints as a result of these injuries. The fact that foot is one of the toughest parts of the body to achieve soft-tissue coverage following such compound injuries, did not considerably hinder our totalitarian management of this condition. We did not have sufficient sample size or follow-up period to ascertain

prognostic factors associated with the good and bad prognosis.

### Conclusion

We strongly suggest that orthopaedic surgeons suspect Lisfranc injuries when a patient presents with post-traumatic pain in the midfoot and forefoot irrespective of it being an open or a closed injury. In cases of open injuries, swift action is needed to diagnose the condition using clinical evaluation and confirmation by the available imaging modalities. If present, they are to be treated at the earliest with aggressive soft-tissue management as it holds the key for the final outcome. K wire fixation provides more than adequate maintenance of alignment of the three columns of the foot even if the fractures are comminuted. A stable, painless foot can be obtained using just K wires with timely intervention and good pre-operative and post-operative management.

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