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Short Term Assessment of Surgical Treatment of Lisfranc Fracture Dislocation

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ABSTRACT

Background: Lisfranc fractures are rare injuries, with reported incidence of 0.2% of all fractures and 1/55,000 per year incidence in the population. These are reported to occur 2–4 times more commonly in men, and the peak incidence is in the third decade of life.

Objective: This study was aimed to assess the functional outcome of using open reduction and internal fixation in management of ligamentous Lisfranc injuries.

Patients and Methods: This prospective operative study was conducted on 18 patients with Displaced Lisfranc injury admitted to the Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, during the period from February 2021 to August 2021. The diagnosis was made by medical history taking, clinical examination and radiological assessment.

Results: The mean operation time was 140.0±27.43 minutes with minimum 90 and maximum 200 minutes and mean hospital stay was 4.38±1.33 with minimum 3 and maximum 8 days. The mean healing time 8.38±2.45 with minimum 6 and maximum 16 weeks. The most prevalent complication was infection (22.2%), Transient numbness (5.6%), Delay healing (5.6%), Loss reduction (5.6%) and overall complicated cases were 5 cases 27.8%.

Conclusion: It could be concluded that anatomical reduction of Lisfranc injury can be achieved by open reduction and internal fixation with the Kirschner wires (K-wires) and Cannulated Screws.

Keywords: Lisfranc, Midfoot, Open reduction, Internal fixation.

INTRODUCTION

Lisfranc injury refers strictly to an injury in which one or more of the metatarsals are displaced with respect to the tarsus [(1)]. Lisfranc injuries are infrequent, at approximately 0.2% of all fractures, although in 20% of cases they are not diagnosed or are diagnosed late [(2)].

However, early, and accurate diagnosis of these injuries are fundamental requirements for their appropriate treatment and to prevent long-term sequelae. Men are two to four times more likely to suffer a Lisfranc joint injury, possibly because they participate more frequently in high-speed activities. These injuries are common in the third decade of life. The majority (87.5%) are closed injuries and are becoming more frequent in athletes, in whom it is common to see subtle Lisfranc injuries [(3)]. These are injuries that have occurred in sports such as soccer, gymnastics and running [(4)].

Lisfranc injuries, which disrupt the strong midfoot ligaments supporting the arch, require immediate surgical intervention to prevent complications such as compartment syndrome and amputation. On clinical examination, patients can present with edema, point tenderness, and decreased function [(5)]. The dorsal drawer test of the medial column will elicit a “clunk” compared with the contralateral side, and the passive midfoot pronation abduction test will yield positive results [(6)].

On radiographic evaluation, Lisfranc injuries commonly show an increased asymmetric joint space at the naviculocuneiform joint and first and second metatarsal bases. The notch sign, in which a small notch appears in the lateral aspect of the medial cuneiform, might also be seen [(7)].

Conservative treatment includes midfoot stabilization and movement restriction. For Lisfranc injuries without displacement on weight bearing radiographs, the use of cast immobilization for 6 to 12 weeks is common. Modern surgical treatments include closed reduction and immobilization, closed reduction and percutaneous pinning, and open reduction with percutaneous pinning or screw fixation [(8)].

This study was performed to assess the functional outcome of using open reduction and internal fixation in management of ligamentous Lisfranc injuries.

PATIENTS AND METHODS

This prospective operative study included a total of 18 patients with displaced Lisfranc injury admitted to the Department of Orthopedic, Faculty of Medicine, Zagazig University, during the period from February 2021 to August 202. Patients were 4 males and 14 females, aged 39-70 years and the mean age was 56.77±8.17 years.

Ethical Consideration:

Written informed consent was obtained from all participants and the study was approved by the Research Ethical Committee, Faculty of Medicine, Zagazig University (ZU-IRB). The work has been carried out in accordance with The Code of Ethics of

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the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria: Age; 18-70 years old. Gender; both male and female. Displaced Lisfranc injury when displacement is greater than 2 mm, between the first and second metatarsals on weight bearing anteroposterior foot radiograph.

Exclusion criteria: Patient underwent a subsequent surgery that confounded meaningful postoperative outcome analysis. Patients< 18 or >70 years. Infected fractures. Medical co-morbidities such as diabetes, liver disease, or chronic renal disease**.**

Pre-operative:

All patients underwent full history taking, local and general clinical examination, Radiographic images (weight bearing anteroposterior, oblique, and lateral x-rays). Laboratory investigations included: Complete blood count (CBC), PT, PTT, random blood sugar, Liver and Kidney function tests, HIV, HBsAg and HCV Abs. Surgical procedure was recorded, including type of surgery, duration of operation and complications. Operative treatment was performed by open reduction and internal fixation under regional block.

Surgical technique:

The operation was performed with the patient lying in a supine position, the entire leg is prepared from the level of the knee down and draped to isolate it in a sterile fashion. A single dose of an antibiotic was administered intravenously for prophylaxis against infection, a sterile tourniquet was applied at the level of the ankle and inflated after exsanguination, a triangular support was used under the knee to keep the foot positioned plantigrade on the operating table, plantigrade positioning of the foot enables the surgeon to achieve a better orientation for intraoperative imaging and to direct drill holes and insert implants, such as screws. This technique also helps the surgeon to work on the foot, with minimal manual assistance required to hold the foot. The pattern of injury dictates the exposure required and the placement and number of incisions.

Two or three longitudinal incisions over the midfoot.

The first is over the medial border of the foot centered at the base of the first ray, the second is between the first and second metatarsal bases, and the third over the fourth metatarsal base.

The skin bridges between these incisions are usually narrow, and the incisions must be kept short to avoid vascular compromise. This can result in poor visualization of the joints and excessive retraction leading to neuromas and skin necrosis. Accurate placement of the incision may be aided by the use of fluoroscopy, the medial incision on the skin is placed just lateral to the extensor hallucis longus tendon, the author avoids going through the tendon sheath. Further dissection should proceed with extreme care to protect the sensory branches of the superficial peroneal nerve, the deep peroneal nerve, and the interspace between the bases of the first and second metatarsal and the dorsalis pedis artery Intraoperative fluoroscopy in multiple projections and application of stress in multiple directions at various joints in the midfoot help unmask any instability not otherwise evident. After subperiosteal exposure of the involved joints, reduction and stabilization is performed in a sequential manner.

Reduction of joints sometimes requires debridement to remove any interposed fragments of bone, cartilage, or soft tissues such as capsuloligamentous structures or tendons. A large bone clamp is applied with one limb of the clamp inserted over the medial aspect of the medial cuneiform through a small incision and blunt dissection down to the bone, and with the other limb of the clamp inserted through an existing wound or through a small incision and blunt dissection over the lateral aspect of the base of the second metatarsal. This clamp holds the reduction between the medial cuneiform and the base of the second metatarsal. Through the previous exposure, both the metatarsocuneiform and naviculocuneiform articulations of the first ray must be stabilized if injured. The medial column is stabilized first and then the middle column and lastly the lateral column.

The first TMT joint is debrided and reduced, then provisionally stabilized using a guidewire placed dorsally 1.5 cm distal to the articulation and directed plantarly and proximally.A guide wire for the cannulated drill is inserted in a dorsolateral to plantar medial direction from the base of the second metatarsal into the medial cuneiform under fluoroscopic guidance, a third pin was placed from medial to lateral between the medial and middle cuneiforms if required.

If adequate reduction is seen, 4- or 4.5-mm cannulated screws are inserted over these pins starting with the "Lisfranc screw" , which is the screw between the medial cuneiform and the second metatarsal base.

Screws placed into the metatarsal bases should be countersunk to avoid fracture into the adjacent joints, lag screws should not be excessively tightened to avoid unnecessary compression of the joint surfaces. Screw fixation has been shown to have lower rates of redisplacement and faster return to weight bearing postoperatively compared with Kirschner wire (K-wire) fixation, small fragment (3.5 mm) cortical screw fixation and 4- or 4.5-mm cannulated screws are recommended for the first, second, and third TMT joints. The screws are removed at 4 months but occasionally can be left longer. Placing ‘‘Lisfranc’s screw’’ from the second metatarsal into the medial cuneiform provides stability to the tarsometatarsal joint complex equal to that achieved with the traditional orientation of screw insertion in opposite direction. Cannulated screws can also be used for fixation of tarsometatarsal or intercuneiform joints of the medial and middle columns. Guidewires for the cannulated screws are driven from the base of the first metatarsal to the first cuneiform and similarly in the second ray, if necessary, and also between the cuneiforms. Fully threaded screws avoid compression across the joints.

Staples/Locking Plates

Extra-articular stabilization can be achieved by implants that do not need to traverse for spanning adjacent bones, a compression staple or mini two-hole plate or staple with locking screws, such as the Claw Plate™, can then be used across the intercuneiform or tarsometatarsal joints of the medial or middle column. The Claw Plate™ is essentially a low-profile staple that has holes at either end instead of limbs, these holes take screws and lock their heads. The body of the staple has a diamond-shaped gap, which when stretched brings the screws together, the staples or screws should be inserted under fluoroscopic guidance, K wires are used to stabilize the lateral 3 columns if necessary. Longer locking plates available in different lengths or shapes, such as the letter "H" are also available to span 2 or more joints in the medial and middle columns (Fig. 1).

They can be used to span joints more proximally, such as the naviculocuneiform joint if instability extends proximally. The stability of the lateral column is assessed next. If necessary, these joints are reduced and held with K wires.

Dorsal plating can be considered for bridging fixation of comminuted fractures with bony fragments in the TMT joints and total ligamentous injuries and as an alternative surgical treatment in certain cases, such as joint damage and loss of fixation. The concern for joint damage resulting from screw fixation across the TMT joints is eliminated, plating provides prolonged fixation, wound problems are not more common with plating than with wire fixation. The surgeon can elect to leave the plate in place, hand plating sets are often useful for this technique, and dorsal plate fixation has been shown to be as biomechanically sound as screw fixation.

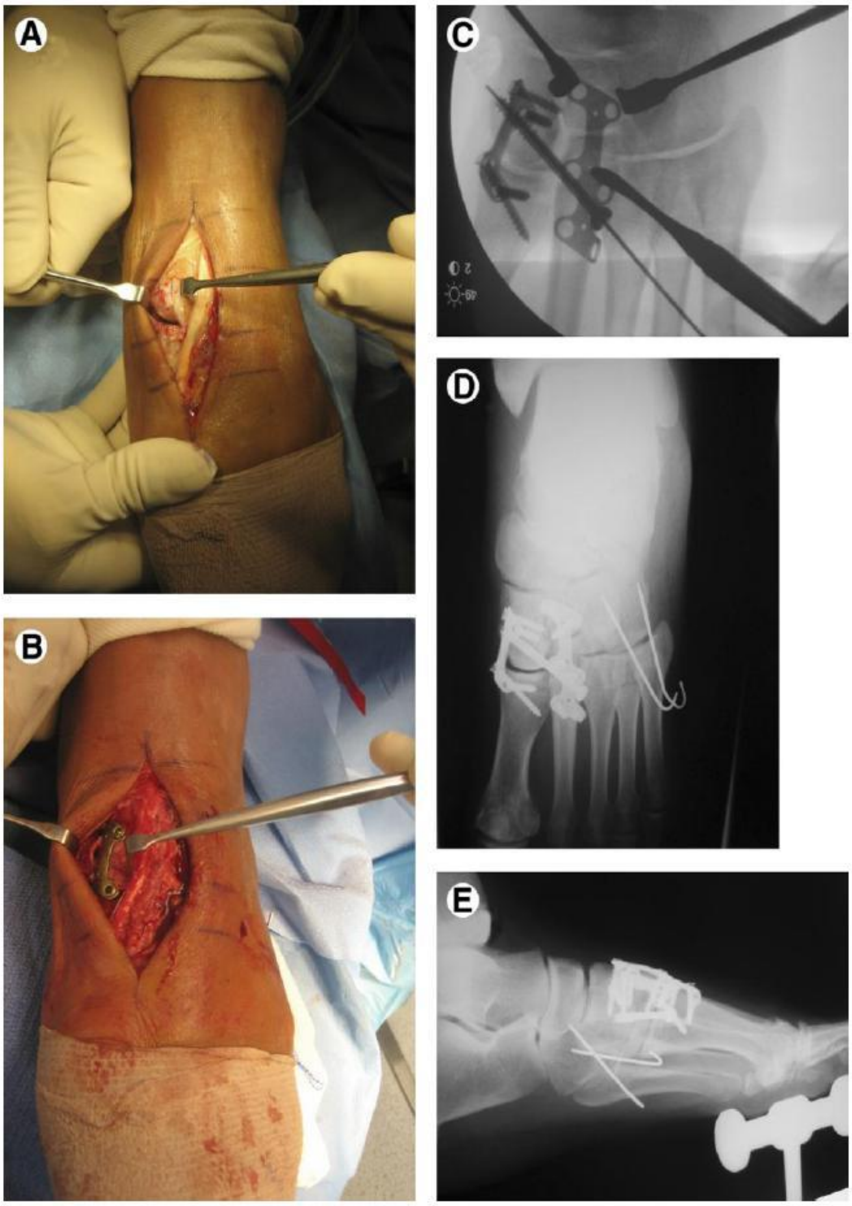

Fig. (1): Intraoperative images. Photographs showing (A) instability of the first ray at metatarso-cuneiform joint(B) stabilization with a locking plate. (C) showing further stabilization with a cannulated screw and another locking plate over the second ray. (D and E) after extra-articular stabilization of Lisfranc injury.

Post-operative follow up:

Following surgical treatment patients were splinted for two weeks, nonweight-bearing in a bivalved cast and encouraged to remove the cast daily for ankle and toe range of motion exercises. At six weeks post-surgery, a standing x-ray was reviewed to check maintained alignment. begin weight-bearing as tolerated. Twelve weeks postoperatively, a second x-ray further was done to assess alignment and healing. patients were placed in a boot and weaned out as tolerated. Formal physical therapy at this point was started. On each follow-up, patients were subjected to clinical and radiological assessment.

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software.

Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) **(**Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD , the following tests were used to test differences for significance;. difference and association of qualitative variable by Chi square test (X^2) . Differences between quantitative independent groups by t test. P value was set at <0.05 for significant results & <0.001 for high significant result.

RESULTS

Table (1): age and sex distribution among studied group (N=18)

		Age (years)	
Mean± SD		**56.77±8.17**	
Median (Range)		**57.5 (39-70)**	
		N	**%**
Sex	**Male**	**4**	**22.2**
	Female	**14**	**77.8**
	Total	**18**	**100.0**

Table (1) shows that this study included 18 patients with mean age of 56.77±8.17 (rang 39-70), they were 14 female (77.8%) and 4 males (22.2%).

Table (2): Injury characters distribution among studied group (N=18)

		N	%
Joint injury	**-VE**	**12**	**66.7**
	+VE	**6**	**33.3**
Myerson classification	**I**	**5**	**27.8**
	IIA	**10**	**55.6**
	IIB	**2**	**11.1**
	III	**1**	**5.6**
	Total	**18**	**100.0**

Table (2) shows that 33.3% had joint injury, and regard Myerson classification the majority were class IIA with 55.6% then grade I with 27.8% and IIB 11.1% and only one case III with 5.6%.

Table (3): Operation time and hospital stay distribution among studied group (N=18)

	Operation time/minutes	Hospital stay DAY
Mean± SD	**140.0±27.43**	**4.38±1.33**
Median	**140.0**	**4.0**

Table (3) shows that the mean operation time was 140.0±27.43 minutes with minimum 90 and maximum 200 minutes and mean hospital stay was 4.38±1.33 with minimum 3 and maximum 8 days.

Table (4) : Healing time distribution among studied group (N=18)

	Healing time /weeks
Mean± SD	**8.38±2.45**
Median	**8.0**

Table (4) shows that the mean healing time 8.38±2.45 with minimum 6 and maximum 16 weeks

Table (5): Complication distribution among studied group (N=18)

		N	%
Infection	**-VE**	**14**	**77.8**
	+VE	**4**	**22.2**
Implant failure	**-VE**	**18**	**100.0**
	+VE	**0**	**0.0**
Transient numbness	**-VE**	**17**	**94.4**
	+VE	**1**	**5.6**
Delay healing	**-VE**	**17**	**94.4**
	+VE	**1**	**5.6**
Loss reduction	**-VE**	**17**	**94.4**
	+VE	**1**	**5.6**
Overall complication	**-VE**	**13**	**72.2**
	+VE	**5**	**27.8**
	Total	**18**	**100.0**

Table (5) shows that the most prevalent complication was infection (22.2%), Transient numbness (5.6%), Delay healing (5.6%), Loss reduction (5.6%) and overall complicated cases were 5 cases 27.8%

Table (6): outcome assessed by AOFAS distribution among studied group at different times (N=18)

	AOFAS _POST	AOFAS _3M	AOFAS _6M	AOFAS _12M	P
Mean ± SD	46.55 ±4.74	73.55± 6.55	84.77 ±3.87	92.61 ±3.95	0.00 **
Median	48.0	76.0	85.0	95.0	

Table (6) shows that the mean AOFAS score significantly increase with time of follow up where it was 46.55±4.74 postoperative, after 3 months was

73.55±6.55, after 6 months was 84.77±3.87 and after 12 months was 92.61±3.95 with a high significant difference

Table (7): satisfaction distribution among studied group at different times (N=18)

		N	%
Satisfaction	**Not**	**3**	**16.7**
	Satisfied	**15**	**83.3**
	Total	**18**	**100.0**

Table (7) shows that 15 patients (83.3%) were satisfied and only 3 patients (16.7%) were not satisfied

DISCUSSION

The current study included 18 patients with mean age of 56.77±8.17 (rang 39-70), they were 14 female (77.8%) and 4 males (22.2%). The result was nearly agreed with the study of **Ren *et al.***[9] who reported that he study population consisted of 38 (62.3%) male and 23 (37.7%) female patients, with a mean age of 39.4 (range 19-64) years. While **Li *et al.*** [10] reported that among 10 cases of Lisfranc injuries, there were 6 (60%) males and 4 (40%) females with mean age 32 years ranging 25-45 years.

The current study showed that 33.3% had joint injury, and regard Myerson classification the majority were class IIA with 55.6% then grade I with 27.8% and IIB 11.1% and only one case III with 5.6%.

Wang *et al.* [11] found that of 15 patients with Lisfranc injuries, according to Myerson classification there was one patients (6.6%) with type A, 10 patients (66.6%) type B2, 3 patients (20%) type C1 and one patients (6.6%) with type C2.

Kumaran *et al.* [12]**,** reported that among 15 patients with Lisfranc injuries, fractures were classified as Type A(n=2, 13.3%), type B (n=10, 66.7%), and TYPE C(n=3, 20%)

The current study showed that the mean operation time was 140.0±27.43 minutes with minimum 90 and maximum 200 minutes and mean hospital stay was 4.38±1.33 with minimum 3 and maximum 8 days. **Liu *et al.*** [13] found that the average time duration for the first-stage operation was 138.9 minutes while the mean hospital stay was 13.34 days

The current study showed that the mean healing time 8.38±2.45 with minimum 6 and maximum 16 weeks. **Fan *et al.*** [14]**,** reported that the mean fracture healing time was 9.8 weeks (range: 8–13 weeks).

The current study showed that the most prevalent complication was infection (22.2%), Transient numbness (5.6%), Delay healing (5.6%), loss reduction (5.6%) and overall complicated cases were 5 cases 27.8% which nearly similar to the study of **Kohli *et al.*** [15] who reported that of 27 patients with Lisfranc injuries complication were recorded in 6 patients (22.2%), superficial wound infection in 2 patients (7.4%), loss of reduction (early postoperator) in one patient (5.9%), delayed discharge in one patient (3.7%), compromised wound healing in one patient (3.7%) and Transient numbness in one patient (3.7%).

Cochran *et al.* [16] reported that of the 18 patients in the ORIF group, complications included 4 with permanent deep peroneal nerve sensory changes and 2 superficial infections that occurred after implant removal, both were successfully treated with oral antibiotics.

The current study showed that the mean AOFAS score significantly increase with time of follow up where it was 46.55±4.74 postoperative, after 3 months was 73.55±6.55, after 6 months was 84.77±3.87 and after 12 months was 92.61±3.95 with a high significant difference. Which in agreement with the study of **Fan *et al.*** [14]**,** who reported that AOFAS score increased from 58.69 to 82.31 after follow with a highly significant differences. Also, **Ren *et al.*** [9] reported that the median AOFAS score in the surgical treatment group was 89.9± 3.7 (range 85-97) after 6 months follow up.

Qu *et al.* [17]**,** reported that the AOFAS midfoot scoring system was applied for functional evaluation at 6 and 12 months after surgery. The average scores at 6 and 12 months were 69.2 (55–86) and 88.2 (68–95) with a high significant difference ($P < 0.001$).

The current study showed that 15 patients (83.3%) were satisfied and only 3 patients (16.7%) were not satisfied. Which in agreement with the study of **Ahmad *et al.***[18], who studied the outcome of early open reduction and internal fixation of 20 cases of Lisfranc injuries using AOFAS-M score found that Good to fair results were seen in 90% cases (n=18).

Pereira *et al.* [19] reported that among 19 patients with Lisfranc injuries, 3 patients (15.8%) were Excellent, 6 patients (31.6%) were good, 3 patients (15.8%) were fair and 7 patients (36.8%) were poor

CONCLUSION

It could be concluded that anatomical reduction of Lisfranc injury can be achieved by open reduction and internal fixation with the Kirschner wires (K-wires) and Cannulated Screws. Normal structure of Lisfranc joint is regained to a great extent; injured ligaments were also repaired. Therefore, this method offers excellent curative effect and can avoid postoperative complications and improve the patients' quality of life.

RECOMMENDATIONS

Further study should be carried out with larger groups of patients and with longer duration follow up are required to long term results and to validate the results of this study.

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Conflict of Interest: Nil.

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