Assessment of Surgical Treatment of Lisfranc Fracture Dislocation

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ABSTRACT

Background: Lisfranc injuries result from disruption of the lisfranc ligament which runs from the lateral aspect of the medial cuneiform to the medial aspect of the base of the second metatarsal on the plantar aspect. It is the strongest ligament of the foot, and injury to this results in disruption of the tarsometatarsal (TMT) articulation. This study aimed to assess the functional outcome of using open reduction and internal fixation in management of ligamentous lisfranc injuries. Patients and Methods: The study population consisted of 14 female (77.8%) and 4 males (22.2%) with mean age of 56.77±8.17 (rang 39-70). All the cases were Displaced Lisfranc injury and the diagnosis was made by medical history taking, careful physical examination and further confirmed by stress view radiographs. Results: this study showed 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%. 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. Conclusion: 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

With the fast development of society and economies, the incidence of lisfranc injuries has increased rapidly (1). The lisfranc joint is a complex multi-joint system, composed of bone joints, ligaments, tendons and muscles to form the transverse and longitudinal arches of the foot (2). Due to the characteristics of complex anatomic structure and being easily masked by other severe combined injuries, the misdiagnosis rate is as high as 20%, which has been a difficult problem for orthopedics surgeons (3). In addition, the inappropriate treatment of lisfranc injuries can easily lead to a decline and even loss of foot function. Prompt diagnosis and treatment is essential for Lisfranc injuries (4).
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. Lisfranc injuries result from disruption of the lisfranc ligament which runs from the lateral aspect of the medial cuneiform to the medial aspect of the base of the second metatarsal on the plantar aspect. It is the strongest ligament of the foot, and injury to this results in disruption of the tarsometatarsal (TMT) articulation (5).

The spectrum of these injuries varies from low-energy sports injuries to high-energy crush injuries. There is a wide variation in these injuries with pure ligamentous injuries to comminuted forefoot and midfoot fracture dislocations. These injuries are caused by axial loading of hyper plantarflexed foot. These can also be caused by high-velocity trauma. These are increasingly reported as being caused by twisting injuries or minor trips and falls. Up to 24% of these injuries are missed or frequently diagnosed late (6).

Untreated, delayed treatment, or inadequately treated injuries result in poor functional outcome for the patient in proportion to the severity of the initial injury (7). This results in substantial pain, midfoot arthritis, pesplanus deformity, decreased function, and loss of quality of life. Secondary arthrodesis may be used to treat these injuries, but the outcome is poorer, the longer the treatment is delayed. Prompt diagnosis and early treatment is, therefore, essential in ensuring good outcome in these injuries (5).

Early diagnosis with proper clinical examination and weight-bearing radiographs is important. There is a wide range of opinions regarding the treatment of these injuries. The treatment varies from closed reduction and immobilization, closed reduction and percutaneous K wire fixation, open reduction and internal fixation (ORIF) with transarticular screw (TAS) or extraarticular fixation with joint-sparing surgery by dorsal bridging plate (DBP) (8,9). 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 on 18 patients who Displaced lisfranc injury from February 2021 to August 2021 was conducted. Patients were treated in the Orthopedic Surgery Department, Faculty of Medicine, Zagazig University. The study was approved by the local Ethics committee, and a signed consent obtained from patients. Inclusion criteria were: 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), Routine Operative Labs, Complete blood picture, PT, PTT and INR, 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 were 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. 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 (fig. 1).

![Fig.1: Photograph demonstrating two longitudinal incisions overlying the first intermetatarsal space and fourth metatarsal.](image)

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. 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. 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 guidewire 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. (fig. 2)

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.
Fig. 2: Intraoperative fluoroscopic picture showing a partially threaded cannulated screw inserted from a lateral to medial direction.

Post-operative follow up:

Following surgical treatment patients were splinted for two weeks, non-weight-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 (X2). 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

Figure (3) showed 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%).

Fig 3: age and sex distribution among studied group

Table (1) 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%.
Table (1): injury characters distribution among studied group (N=18)

<table>
<thead>
<tr>
<th>Joint injury</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>-VE</td>
<td>12</td>
<td>66.7</td>
</tr>
<tr>
<td>+VE</td>
<td>6</td>
<td>33.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Myerson classification</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5</td>
<td>27.8</td>
</tr>
<tr>
<td>IIA</td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>IIB</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table (2) 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.

Table (2): Operation time and hospital stay distribution among studied group (N=18)

<table>
<thead>
<tr>
<th>Operation time/minutes</th>
<th>Hospital stay DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean± SD</td>
<td>140.0±27.43</td>
</tr>
<tr>
<td>Median (Range)</td>
<td>140.0 (90-200)</td>
</tr>
<tr>
<td></td>
<td>4.0 (3-8)</td>
</tr>
</tbody>
</table>

Table (3) showed that the mean healing time 8.38±2.45 with minimum 6 and maximum 16 weeks

Table (3) : Healing time distribution among studied group (N=18)

<table>
<thead>
<tr>
<th>Healing time /weeks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean± SD</td>
<td>8.38±2.45</td>
</tr>
<tr>
<td>Median (Range)</td>
<td>8.0 (6-16)</td>
</tr>
</tbody>
</table>

Figure (4) 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%
Table (4) 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

Table (4): outcome assessed by AOFAS distribution among studied group at different times (N=18)

<table>
<thead>
<tr>
<th></th>
<th>AOFAS_POST</th>
<th>AOFAS_3M</th>
<th>AOFAS_6M</th>
<th>AOFAS_12M</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean± SD</td>
<td>46.55±4.74</td>
<td>73.55±6.55</td>
<td>84.77±3.87</td>
<td>92.61±3.95</td>
<td>0.00*</td>
</tr>
<tr>
<td>Median (Range)</td>
<td>48.0 (35-55)</td>
<td>76.0 (55-80)</td>
<td>85.0 (75-90)</td>
<td>95.0 (85-98)</td>
<td>*</td>
</tr>
</tbody>
</table>

Figure (5) showed that 15 patients (83.3%) were satisfied and only 3 patients (16.7%) were not satisfied

Fig. 4: Complication distribution among studied group

Fig. 5: satisfaction distribution among studied group at different times
DISCUSSION

The current study included 18 patients with mean age of 56.77±8.17 (range 39-70), they were 14 female (77.8%) and 4 males (22.2%). Which in agreement with the study of Ren et al., (10) 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. (11) 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%.

Kohli et al., (5) who found that of 27 patients with lisfranc injuries, according to Myerson classification there was 2 patients (7.4%) with type A, 19 patients (70.4%) with type B2 and 6 (22.2%) patients with type C2.

Liuet al.(12) reported that according to the Hardcastle-Myerson classification system, there was one patient (4.75%) type A1 case, one patient (4.75%) type A2, 2 patients (9.5%) type B1, 12 patients (57.2%) type B2, 2 patients (9.5%) type C1, and 3 patients (14.3%) type C2.

Kumar and Kunjappan(13) reported that distribution of sample by criteria of fracture classification, Type A in one patients (5%), Type B1 in 13 patients (65%), Type B2 in 4 patients (20%) and Type C1 in 2 patients (10%).

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., (12) 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., (5) 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%).

Li et al., (11), reported there was statistical significance between preoperative score (7.89 ± 0.34) and score at postoperative 8 weeks (0.67 ± 0.13). According to the AOFAS score, 5 cases were defined as excellent, 3 cases as good and 2 cases as fair. During follow-up, there was no wound infection or complications except for osteoarthritis in 2 cases.
Haveri et al. (15) reported that 90% of patients 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.

The current study showed that the mean AOFAS score significantly increased 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 up with a highly significant difference. Also, Ren et al. (10) reported that the median AOFAS score in the surgical treatment group was 89.9 ± 3.7 (range 85-97) after 6 months follow up.

Haveri et al. (15) reported that the AOFAS score was excellent (>89) in 90% of patients with one patient scoring a fair result (70/100).

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. (16), 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).

Kumaran et al. (17), reported that Functional outcome was graded according to AOFAS scores as Excellent (Scores 85-100), Good (Scores 70-84), Fair (Scores 50-69), Poor (Scores<50). Thus, ‘Excellent’ outcome was seen in 6 patients (n=6),’Good’ outcome was noted in 7 patients (n=7),’Fair’ outcome was noted in 3 patients (n=3) while none of the patients had ‘Poor’ outcome.

Kumar and Kunjappan (13) reported that functional outcome was assessed using American Foot and Ankle Society Score (AOFAS) score and was the mean score was 80.4 with 20% having excellent score and 55% having good score. Poor score was seen only in 2 cases.

**CONCLUSION**

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.

**REFERENCES**


