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Original Article

Evaluation of mid-term clinical and radiologic outcomes after open reduction and internal fixation of Lisfranc fracture-dislocations: A case series

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Abstract

Aim: To evaluate the mid-term clinical and radiologic outcomes after surgical treatment of Lisfranc fracture dislocations.
Material and Methods: Twenty unstable Lisfranc joint fracture dislocation patients treated with open reduction and internal fixation (ORIF) were evaluated retrospectively. Kirschner wire, screw or a combination of Kirschner wire (K-wire) and screw fixation were used in the internal fixation. American Orthopedic Foot and Ankle Society - Midfoot Scale (AOFAS-MS) score, Maryland foot score, Visual Analog Scale (VAS) and SF-36 survey were obtained at the last follow-up. Nonunion, implant failure, reduction quality and the degree of posttraumatic arthritis were evaluated on the AP, lateral and oblique foot radiographs. The outcome measures included the Kellgren-Lawrence grading of osteoarthritis and the Stein's criteria for anatomic reduction.
Results: The mean follow-up duration was 3.7±1.4 years. Mean AOFAS and Maryland foot scores were 75.3±1.72 and 71.8±2.3, respectively. Nonunion was developed in three patients (15%) and posttraumatic arthritis was observed in 7 patients (35%).
Conclusion: Good overall clinical and radiologic outcomes can be obtained in the mid-term follow up after open reduction and internal fixation of Lisfranc fracture dislocations. However, higher-energy injuries such as open fracture-dislocations and Myerson type C2 injuries have poor outcomes.

Keywords: Fracture dislocation; lisfranc; open reduction; arthritis.

INTRODUCTION

Tarsometatarsal (TMT) and inter-cuneiform joints are called as Lisfranc complex (1). Lisfranc complex injuries constitute 0.2% of all bone injuries (2). High-energy injuries resulting from direct or indirect trauma as motor vehicle accidents, falls, collisions and crush injuries are possible reasons of Lisfranc complex injuries. Due to the complex structure of the Lisfranc joint, the lesion may be in different shapes as a single TMT joint involvement or the lesion may extend to all of the five TMT joints and proximally reach the inter-cuneiform joints. Although one-third of TMT joint injuries are not noticeable during initial evaluation in retrospective studies (3,4) fracture dislocation of TMT joint can be easily diagnosed due to foot deformity with advanced swelling (5). There is a high potential of substantial disability and development of posttraumatic osteoarthritis due to Lisfranc injuries (6). Prompt diagnose and appropriate treatment with anatomic reduction and stable internal fixation are recommended to avoid devastating complications in unstable TMC injuries (7). In the literature, several studies reported diverse clinical and radiologic outcomes after ORIF for Lisfranc fracture dislocations (3,7,8). The goal of this study was to evaluate the mid-term clinical and radiologic outcomes after open reduction and internal fixation of Lisfranc fracture dislocation in a series of patients.

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MATERIAL and METHODS

After institutional review board approval, medical records of 46 patients who underwent ORIF for Lisfranc fracture dislocations between 2012 and 2017 due to Lisfranc joint fracture dislocation were evaluated. Patients with previous foot trauma or surgery, neurovascular disorder, rheumatoid arthritis, bad quality of radiographic images, and postoperative follow-up period of less than 24 months were excluded. After exclusions, 20 patients were included. Medical records of patients were reviewed to identify patient demographics, additional injuries and morbidities, time from injury to treatment, type of injury, as well as injury mechanism. Radiographic images at the first presentation, immediate postoperative period and the follow-up were evaluated. Injuries were classified according to the Myerson Classification (9,10).

Stein's criteria were used to evaluate anatomical reduction (11). Kellgren-Lawrence osteoarthritis grading was used for the assessment of osteoarthritis (12). Intermetatarsal angle (1st and 2nd metatarsal) (IMA 1-2), first metatarsus-talus angle and first metatarsus-calcaneus angle were evaluated. Clinical outcomes were evaluated with AOFAS Midfoot Score (13), Maryland Foot Score (14), SF-36 survey (15), and Visual Analogue Scale (VAS). AOFAS score is based on a 0 to 100-point scale, with a score of 100 indicating the most optimal function; SF-36 survey is a short questionnaire with 36 items used to measure physical health scaled from 0 to 100, with higher scores indicating better functional outcome. VAS from rated pain levels 0 (no pain) to 10 (worst pain). Maryland Foot Score consists of function, pain, cosmesis and the range of motion scales of the ankle, subtalar, midfoot, and metatarsophalangeal joints. One hundred total points are possible; 90–100 points were regarded as excellent, 75–89 as good, 50–74 as fair and <50 points regarded as poor. Postoperative complications (wound problems, infection, nonunion, implant failure, etc.) were noted.

Surgical Procedure

Surgical procedures were performed under regional or general anesthesia, in the supine position with tourniquet application. In all cases, provisional closed reduction was performed. ORIF was performed immediately in patients with compartment syndrome. A long dorsal longitudinal and/or lateral incision was used in the surgical approach. K-wire, screw or combined (K-wire and screw) fixation was used in the fixation (Figure 1). Appropriately sized K-wires or screws were inserted across the Lisfranc joints under fluoroscopic guidance. All rays were stabilized in a distal to proximal direction perpendicular to the Lisfranc joint surfaces. A short leg splint was applied in all cases. All patients were administered intravenous antibiotics for 24 hours. Load bearing was restricted for 6 to 8 weeks in all patients.

Statistical Analysis

The mean, standard deviation, median, lowest and highest values, frequency and ratio were used in the descriptive statistics. Shapiro-Wilk test was used in the measurement of the variables' distribution. Chi-square test, two-sample t-test and One-way ANOVA test were used for the inter-group comparisons. Data were analyzed using IBM Statistics SPSS 22.0 (Chicago, IL, USA). $p < 0.05$ was considered statistically significant.

RESULTS

Our study population included 14 (70%) male and 6 (30%) female patients. The mean age was 42.7±2.64. The right foot was affected in 11 patients (55%), while left foot in 9 patients (45%). The mean duration of follow-up was 3.7±1.4 years (range, 2 to 7 years). Patient, fracture-dislocation and surgical intervention characteristics were shown in Table 1. Second metatarsus was the most involved fracture which was observed in 8 (40%) patients. The third metatarsus was involved in 6 patients (30%), and fourth metatarsus in 4 patients (20%). Cuboid bone was involved in 4 cases (20%), the navicular bone in 4 cases (20%), and the cuneiforms in 5 (25 %) cases. In addition, 10 patients (50%) had other extremity fractures. The mean time from injury to surgery was 2.85±0.66 days (range, 0 to 4 days). At the early postoperative period, 4 patients (20%) had wound problems. Of these, one case required a fasciocutaneous flap to cover the wound. Other patients underwent debridement and primary or secondary wound closure. Early postoperative infection was observed in one patient and it was treated with debridement and i.v. antibiotic therapy. Complex regional pain syndrome was developed in 8 patients (40%).

Mean IMA of 1-2 metatarsus was 16.5±0.9°. The mean 1st metatarsus-talus angle was 13.2±0.5°. The mean 1st metatarsus-calcaneus angle was 16.2±0.6°. When AOFAS score results were evaluated, there was no statistically significant difference according to gender, cause of injury, and method of fixation and ($p>0.05$) (Table 2). Patients >35 years old and with C2 type injury, open injury and treated with double incision had significantly worse outcomes ($p=0.012$, $p=0.034$, $p=0.002$, and $p=0.036$, respectively). Nonunion (Figure 2) was significantly higher in patients who had presented with fall from height ($p=0.016$) and open injury ($p=0.003$), treated with double incision ($p=0.038$) and underwent a combined procedure ($p=0.034$) (Table 2). All of 3 patients with nonunion and instability had been treated with open reduction and combined fixation. Radiologic results were similar according to the sex, age and method of reduction ($p>0.05$). Meyerson type C fractures had significantly worse clinical ($p=0.034$) and radiologic ($p=0.001$) outcomes (Table 2). The results of Maryland score, VAS and posttraumatic arthritis in different subgroups were summarized in Table 3.

Table 1. Summary of patient demographics, clinical and radiologic outcomes

Sex	Age	Side	Cause of injury	Meyerson type	Injury type	Fixation Method	Follow-up (year)	AOFAS score	VAS score	Maryland score	Posttraumatic arthrosis	Kellgren-Lawrence grading	Nonunion
M	32	R	TA	B2	OPEN	Screw	3	70	5	78	NO	0	NO
F	61	R	TA	A	CLOSED	K-Wire	2	85	3	82	YES	3	NO
M	46	R	FFH	B1	CLOSED	Combined	4	80	6	75	NO	0	NO
M	53	L	TA	B1	CLOSED	Combined	2	72	4	76	NO	0	NO
M	29	L	FFH	B1	CLOSED	Screw	1	77	6	70	YES	3	NO
M	55	R	TA	B2	CLOSED	Screw	1	72	2	74	NO	0	NO
M	63	L	FFH	B2	CLOSED	Screw	2	80	4	85	YES	2	NO
M	44	L	SI	B2	CLOSED	Screw	2	72	3	70	NO	0	NO
F	36	R	SI	B1	CLOSED	Combined	4	85	4	85	NO	0	NO
F	51	R	TA	A	CLOSED	K-Wire	3	78	1	72	NO	0	NO
M	47	L	FFH	C2	OPEN	Combined	5	62	8	54	YES	3	YES
F	33	L	SI	B1	CLOSED	Screw	2	78	6	76	NO	0	NO
F	39	R	TA	C1	CLOSED	Screw	1	72	3	68	NO	0	NO
M	55	R	TA	C1	CLOSED	Screw	4	85	4	78	NO	0	NO
M	43	L	TA	B1	CLOSED	Screw	2	80	3	75	NO	0	NO
F	52	R	FFH	C1	OPEN	Combined	4	62	8	50	YES	3	YES
M	28	L	TA	A	CLOSED	K-Wire	3	74	5	68	NO	0	NO
M	32	L	TA	B2	CLOSED	Combined	5	85	7	80	YES	3	NO
F	35	R	FFH	C2	OPEN	Combined	2	60	9	48	YES	4	YES
M	21	R	SI	B1	CLOSED	K-Wire	1	78	3	72	NO	0	NO

M: Male, F: Female, R: Right, L: Left, TA: Traffic accident, FFH: Fall from high, SI: Sports injury

Table 2. AOFAS Midfoot score and nonunion rates in sub-groups

Prognostic Parameter n.%	AOFAS scoreMean + SD	p	Nonunion rate n.%	p
Age				
<35 7.35%	78.3+6.67	0.012 *	1.33.3%	0.220 *
>35 13.65%	69.7+6.47		2.66.6%	
Gender				
Male 6.30%	76.1 6.2	0.530 *	1.33.3%	0.224 *
Female 14.70%	73.6+10.9		2.66.6%	
Cause of injury				
TA 10.50%	77.3+6.1		0.0%	
FFH 6.30%	70.1+9.7	0.195 **	3.100%	0.016 **
SI 4.20%	78.2+5.3		0.0%	
Classification				
A 3.15%	79.0+5.5			
B1 7.35%	78.5+3.9	0.034 **		
B2 5.25%	75.8+ 6.4			0.001 **
C1 3.15%	73.0 +11.5	A. C2: 0.044 ** B1. C2: 0.023 **	1.33.3%	
C2 2.10%	61.0+1.4		2.66.6%	
Type of soft tissue damage				
Open 4.20%	63.5+4.43	0.002 *	3.100%	0.003*
Closed 16.80%	78.3+4.94		0.0%	
Method of fixation				
Screw 9.45%	76.2+5.1		0.0%	
K – wire 4.20%	78.7+4.5	0.380 *	0.0%	0.034 **
Combine (screw + k-wire) 7.35%	72.2+4.1		3.100%	
Method of reduction				
Open 3.15%	74.7+7.98	0.327 *	3.100%	0.432 *
Closed 17.85%	79.0+5.56		0.0%	
Type of incision				
Single 11.55%	78.5+5.4	0.036 *	0.0%	0.038 *
Double 9.45%	71.4+5.5		3.100%	

*: t test, **: Anova test, TA: Traffic accident, FFH: Fall from high, SI: Sports injury

Table 3. Marylad score, VAS and Posttraumatic arthritis in sub-groups

Prognostic Parameter n.%	Maryland score Mean+SD	p	VAS score Mean+SD	p	Posttraumatic arthritis n,%	p
Age						0.5*
<35 7.35%	70.2+10.7	0.7 *	73.7+6.0	0.2 *	2.28.6%	
>35 13.65%	72.6+10.5		75.0+5.9		5.71.4%	
Gender						
Male 6.30%	73.3+7.1	0.4 *	76.2+3.9	0.4*	4.57.1%	0.6*
Female 14.70%	68.1+15.9		70.6+7.9		3.42.9%	
Cause of injury						
TA 10.50%	75.1+4.7		76.8+3.2		2.28.6%	FFH, TA: 0.017** FFH, SI: 0.012**
FFH 6.30%	63.6+15.1	0.11 **	69.6+8.1	0.73 **	5.71.4%	
SI 4.20%	75.7+6.6		76.5+2.5		0.0%	
Classification						
A 3.15%	74.0+7.21	0.04 **	75.3 +3.0	0.016 **	1.14.3 %	0.32**
B1 7.35%	75.5+4.7	A, C2: 0.03 ** B1, C2: 0.01** B2, C2: 0.01**	77.4 +2.2	A, C2: 0.01 ** B1, C2: 0.02** B2, C2: 0.04 **	1.14.3 %	
B2 5.25%	77.4+5.7		76.8+3.3		2.28.6%	
C1 3.15%	65.3+14.1		70.6+10.0		1.14.3 %	
C2 2.10%	51.0+4.2		64.0+2.8		2.28.6%	
Type of soft tissue damage						
Open 4.20%	57.5+13.8	0.002*	65.5+6.1	0.04*	3.42.9%	0.06*
Closed 16.80%	75.3+5.4		76.8+2.9		4.57.1%	
Method of fixation						
Screw 9.45%	74.8+5.2		75.7+2.5		2.28.6 %	
K – wire 4.20%	73.5+5.9	0.3 *	75.5+2.5	0.5 **	1.14.3 %	0.8 **
Combine (screw + k-wire) 7.35%	66.8+15.5		72.5+9.5		4.57.1%	

*: t test, **: Anova test, TA: Traffic accident, FFH: Fall from high, SI: Sports injury

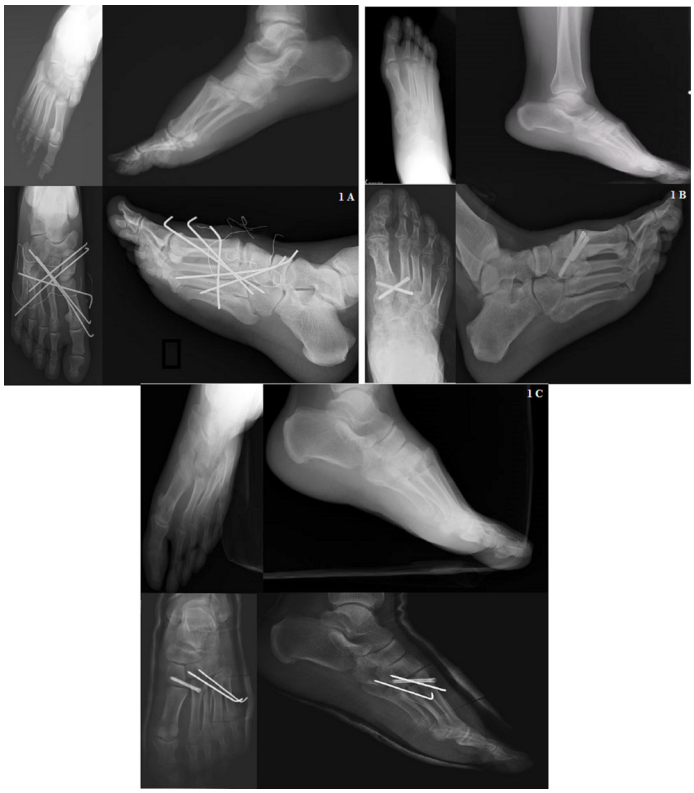

Figure 1. Preoperative and postoperative X-ray examples of 3 different fixation methods. 1A, K-wire fixation. 1B, screw fixation. 1C, screw and K-wire fixation

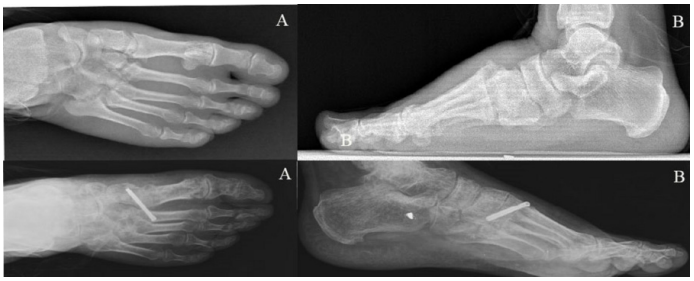

Figure 2. Radiographic examples of nonunion (A) and posttraumatic osteoarthritis (B)

DISCUSSION

The most important findings of this study were that although we obtained satisfactory mid-term clinical and radiologic scores in operatively treated Lisfranc joint fracture dislocation injuries, the patients with higher-energy injuries as open injury, Myerson type C2 injuries and the injuries treated with double incision had significantly poorer results. Some studies have argued that the radiologic outcome measures often do not correlate with the functional outcome measures (16). Parallel to this, some of our clinical and radiologic results were not correlated. Although younger patient's age has not been reported as a prognostic factor for better clinical outcomes (17,18). In our study, we observed that patients under 35 years of age had better clinical outcomes.

However, radiologic outcomes were not affected. Only fall from height and combined K-wire and screw fixation affected the radiologic results negatively.

In epidemiological studies, Lisfranc injuries were generally associated with tarsal or metatarsal bone fractures, 2-4 times more common in men, undergoing automobile trauma and are more seen around the third decade of life (19). In accordance with the literature, Lisfranc fracture-dislocation injuries occurred predominantly in males (70%) in our series. Automobile or motorcycle accidents were the most common injury mechanism (50%). The others were fall from height (30%) and sports injuries (20%). Of the 20 cases, 14 (85%) presented closed injuries and 4 (15%) had open injuries. Sobrado et al. found that seventy-eight percent of the patients had fractures associated with an injury to the Lisfranc complex, as the most prevalent associated fracture was of the second metatarsal (38%), the third metatarsal was involved in 33% of cases, followed by the fourth metatarsal (21%) (20). In accordance with this study, second metatarsus was the most prevalent fracture in 8 patients (40%), third metatarsus was involved in 6 patients (30%), and fourth metatarsus in 4 patients (20%), respectively.

Acute management of Lisfranc injuries is challenging. In unstable injuries, prompt diagnose and appropriate treatment with anatomic reduction and stable internal fixation are recommended to avoid devastating complications as progressive arch collapse, arthritis, and chronic pain (7). There are lots of fixation methods as open/closed reduction with K-wire, screw, plate fixation or arthrodesis (1,21,22). To the best of our knowledge, the best surgical treatment for Lisfranc fracture dislocations has not been reported (9,23–25). Lau et al. reported no additional radiologic benefits when comparing plate or screw fixation for Lisfranc fracture dislocations (17). In addition, they reported worse radiologic outcomes in patients treated with the combination of plates and screws. It was possibly owing to more complex fracture patterns (26). We observed similarly worse radiologic outcomes in patients treated with the combine procedure (K-wire + screw). In their study including fracture dislocation or dislocation of Lisfranc joint, Richter et al. found no significant differences in the clinical scores for age (< 35 years and _> 35 years), gender, cause of the injury (motor vehicle accident or other) and method of treatment (27). In contrast, we found better clinical and radiologic outcomes in younger patients.

Some authors advocate screw fixation, while others suggest K-wire fixation (28,29). Implant failure has been reported in patients with K-wire fixation (29). Screw fixation provides a strong and stable structure (30). Some authors do not recommend compressive screwing due to development of arthritis risk (7). In our study, we did not use compressive screwing, we obtained satisfactory mid-term clinical and radiologic outcomes in patients treated with K-wire, screw or both. Worse radiologic results occurred with the combine procedure (K-wire + screw) possibly owing to more complex fracture patterns. Posttraumatic arthritis developed in 7 patients (35%), 4 of them (20%) were treated with combined procedure, 2 (10%) with only screw fixation and 1 (5%) with only K-wire, respectively.

Most orthopedic surgeons recommended surgical reduction as soon as possible after the injury. For severe injuries, surgical reduction within the first 24 hours is recommended (25). However, a delay of up to 2 weeks might be appropriate if the patient is multi-traumatized or soft tissue is not suitable for surgical intervention (31). Poor functional outcomes were reported in patients who underwent ORIF after 6 weeks (25). We tried to apply as fast and effective treatment as possible with anatomic reduction and stable internal fixation to avoid devastating complications. The mean time from injury to surgery was 2.85±0.66 days.

Vascular damage, acute compartmental syndrome, skin necrosis, and superficial infections are the most frequent acute complications of Lisfranc injuries (32). The most common long-term complication is chronic pain secondary to posttraumatic osteoarthritis (Figure 2), instability or incongruence of the Lisfranc articulation (3,20,22). In a recent study, Pigott et al. found that the most common complication was posttraumatic arthritis in 7 patients (15.6%), followed by complex regional pain syndrome in 5 patients (11.2%), broken hardware in 5 patients (11.2%), and infection in 1 patient (2.3%) (34). In our study, 4 patients (20%) had skin problems at the early postoperative period. An early postoperative infection was observed in one patient (5%) and treated with debridement and iv antibiotic therapy. It was almost similar to reported in the literature which was reported between 4.8% and 7.3% (8,35). Posttraumatic arthritis was developed in 7 patients (35%). Nonunion and broken hardware was observed in 3 patients (15%). Complex regional pain syndrome was developed in 8 patients (40%).

There are some limitations to be acknowledged. The study design is retrospective in nature. Lack of a control group including another treatment modality such as primary arthrodesis makes our results less meaningful. Also, our study population was relatively small and the mean duration of follow-up time is 3.7±1.4 years. Long-term clinical and radiologic outcomes may be different from mid-term and future studies including larger patient numbers and evaluating long-term outcomes are needed.

CONCLUSION

Although good overall clinical and radiologic outcomes can be obtained in the mid-term follow up after open reduction and a stable internal fixation in patients with Lisfranc fracture dislocations, higher-energy injuries such as open fracture-dislocations and Myerson type C2 injuries have poor outcomes.

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