Benha Journal of Applied Sciences (BJAS) **print: ISSN 2356–9751**
Vol.(8) Issue(12) (2023), (69-80) **online : ISSN 2356–976x**
http://bjas.bu.edu.eg

Outcome of Plate Fixation in Treatment of Lisfranc Injuries

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Abstract
Background: Lisfranc The complicated anatomy and probable long-term effects of these injuries make diagnosis and treatment challenging, notwithstanding their infrequency. The purpose of this research was to evaluate the radiological and clinical results of using plates and screws to treat Lisfranc injuries. Methods: The Kafr Elsheihk health insurance facility in Egypt and the Adan hospital in Kuwait were the sites of this prospective cohort research. From October 2021 to September 2023, the field research was carried out. A thorough preoperative evaluation was conducted on 20 patients who presented with Lisfranc injury. This evaluation included clinical, radiological, and demographic information. Dorsal plate fixation using different kinds of plates, as described in the operating method, was the mainstay of surgical treatments. Radiographs, complications, and functional outcomes were evaluated as part of an organised follow-up for patients after surgery. Standardized grading systems such as AOFAS and FAOS were used for this purpose. Statistical analysis revealed that AOFAS scores were significantly lower for smokers compared to nonsmokers (P value 0.005). Nonetheless, the AOFAS score does not vary significantly by gender, comorbidity status, or trauma type (P value) (0.316, 0.170& 0.974 respectively). Smokers' FAOS scores are much lower than non-smokers' (P value 0.005). Nonetheless, the AOFAS score does not vary significantly by gender, comorbidity status, or trauma type (P value) (0.212, 0.235& 0.908 respectively). Conclusion: Dorsal plate fixation is the way to go for stable anatomical reduction and great functional results after these injuries, thus it's time to stop using conservative approaches and start using surgery. Improved patient outcomes and lower long-term problems may be achieved with a thorough approach to detecting, categorising, and surgically treating Lisfranc injuries, as advocated for in this study.

Keywords: Fixation, Lisfranc Injuries, Treatment, and Plate

1. Introduction

The Each of the five metatarsal bases meets the tarsal bones (cuboid, three cuneiforms, and one more) at the Lisfranc joint. The integral keystone is the depressed second metatarsal base, which provides great intrinsic osseous stability. The midfoot becomes stiff due to this stability. The thick oblique ligament that runs from the base of the second metatarsal to the plantar aspect of the first cuneiform is known as the Lisfranc ligament proper (1).

There is no transverse metatarsal ligament connecting the first and second metatarsal bones (1), therefore maintaining the integrity of this ligament is crucial for stability at the tarsometatarsal articulation. Additionally, There is less intrinsic bone stability while standing because to the TMT joints' plane being almost perpendicular to the ground (2).

As a medical definition, a "Lisfranc injury" is defined as a displacement of the metatarsals relative to the tarsus. A French gynaecologist and surgeon from the Napoleonic period who described the first amputation at that level in 1815 is said to have given the procedure its name (3).

Although they only account for around 0.2% of all fractures, 20% of cases go undiagnosed or have a delayed diagnosis because of a Lisfranc injury. However, in order to treat these injuries properly and avoid long-term complications, early and precise diagnosis is essential (4).

An important finding is a misalignment of the second tarsometatarsal joint, which may be seen as a dorsal step-off sign on the lateral view or the second metatarsal base displaced laterally on the AP view. Another irregularity is a gap wider than 2 millimetres between the bases of the first and second metatarsals (5).

Direct or indirect mechanisms might cause injury to the Lisfranc joint. Direct Lisfranc injuries are rare but may happen when the Lisfranc joint takes a direct hit, but indirect mechanisms, such as axial loading or twisting on a plantarflexed foot, are more prevalent (6).

Arthritis, deformity, residual ligamentous instability, and related soft-tissue damage may cause persistent pain and functional loss after ligament injuries or fracture-dislocations (Lisfranc injury) affecting the tarsometatarsal (TMT) joints. Injuries involving low-energy sports and high-energy crushes are potential culprits. Injuries may range from being completely ligamentous to also include metatarsal, cuneiform, navicular, and cuboid fractures, depending on the level of force (7).

Restoring the foot to its pre-injury level of function while minimising discomfort is the main objective of therapy (8).

There is mounting evidence that a key component in attaining a desirable functional result is the preservation of anatomical alignment (9).

Open reduction and internal fixation (ORIF) using transarticular screws has long been considered the gold standard of therapy (10).

However, dorsal bridge plating has proved increasingly popular as a means to prevent further joint injury caused by screw penetration (11).

As a stopgap measure over the medial column of the tarsometatarsal joint, plates were first detailed in 2003. Plates, as opposed to screws, provide more stable fixation, cause less movement under static and cyclic loads, and protect the tarsometatarsal joint from further injury, according to recent cadaveric investigations (12).

This research set intended to determine how well plate and screw fixation of Lisfranc injuries worked in terms of clinical and radiological results.

Methods and patients

The hospitals in Egypt and Kuwait that participated in this prospective cohort research were Kafr Elsheihk health insurance and Adan, respectively. From October 2021 to September 2023, the field research was carried out. This prospective research comprised 20 individuals who came in with Lisfranc injury. All patients gave their written agreement, and the research was greenlit by the medical school's ethical committee.

Acute traumatic Lisfranc injuries of the foot and being an active adult were the inclusion criteria.

Patients did not qualify if they were considered to be in the paediatric age group, had a very complicated fracture pattern, were openly fractured with soft tissue loss and/or neurovascular injuries, had multiple medical conditions that made surgical intervention impossible, were chronically neglected, had insensitive feet, had inflammatory arthritis, were not ambulatory, were actively infected, or had a severe vascular deficit affecting the lower limb that was involved.

Clinical examination, radiographic assessment, personal history, and historical history were all part of the preoperative evaluation process for all patients.

A diagnostic evaluation was carried out, which included standard All patients were completely cognizant when they arrived for examinations such as pulse, blood pressure, pallor, degree of consciousness, etc. Check for evidence of compartmental syndrome, vascular disease, neurological disease, skin problem, and other local issues.

Procedure for operation: Under either spinal or general anaesthesia, with the use of an image intensifier and antibacterial prophylaxis, patients were placed in a supine posture and procedures were carried out with a tourniquet.

Our method included either a single or double incision. Two incisions will be made in advance for this procedure. The first tarsometatarsal joint is located in the middle of the medial incision, which runs straight across the extensor hallucis longus (EHL) tendon. The first and second tarsometatarsal joints may be accessed via it.

The third tarsometatarsal joint serves as the focal point for the lateral incision. Additionally, it exposes the fourth and fifth tarsometatarsal joints when stretched, which is useful in some situations. It is crucial to handle soft tissues with extreme care and keep full-thickness soft tissue flaps in place because to the restricted amount of soft tissue covering the midfoot.

Approach to surgery: Fracture treatment in the foot requires a methodical strategy that begins with comprehensive imaging studies to identify fracture patterns and joint dislocations (X-rays and CT scans). Starting with the unaffected side, the surgeon uses the C-arm to locate the 1st TMTJ, remove any interpositions of tissue, and position the metatarsal correctly. The second and third metatarsals are then reduced and fixed using a reduction clamp and other specialised instruments to ensure exact alignment. A combination of direct vision and fluoroscopy may be used to check anatomical alignment after temporary fixation using K-wires. Focus is on fixing any misalignment or displacement of individual bones. To keep the joints from rubbing against one another, a dorsal locking plate is used for stabilisation. Also, using locking screws to avoid accidentally elevating the metatarsals is essential when applying distal radial plates, and adapting to the foot's structure is crucial. Accurate reduction and hardware placement are ensured by repeated inspections during the procedure, which culminate in reassessment from several imaging perspectives before the incision is closed.

Careful irrigation and suturing of the EHL tendon sheath and joints are part of the post-operative wound closure process. The next step is a layered closure that secures the skin and

subcutaneous tissues. On top of that, a slab that extends below the knee and sterile dressings are put to ensure appropriate healing and protection.

Prevention of edoema and compartment syndrome, pain control with Pethidine or nonsteroidal anti-inflammatory drugs (NSAIDs), and antibacterial intravenous Rocephin for two days make up the standard post-operative care protocol. While wearing a slab, it is important to take Clexane while in the hospital and aspirin after discharge to avoid deep vein thrombosis. Before and throughout the weeks leading up to discharge, the patient will have wound inspections, dressing changes, and stitch removal. Transitioning from a non-weight-bearing state to full weight-bearing one takes about 10 to 12 weeks, with radiographs verifying the improvement along the way. None of the participants included in the study had any hardware removed. Resuming regular activities and footwear is suggested to patients progressively as they feel comfortable.

After surgery, all patients were reassessed every two weeks for the first month, and then monthly for the next three months. Radiographic examination, quality of reduction assessment, functional result, and return to pre-injury activities were all part of the final evaluation. Complications were also assessed, and AOFAS and FAOS ratings were used. Follow-up visits included an X-ray.

Evaluation of outcomes: Patients had clinical examinations and had their ankle range of motion documented at the last follow-up appointment. Patients were evaluated using the American Orthopedic Foot and Ankle Society (AOFAS) score, which takes into account factors such as the presence of swelling, inflammation, infection, pain, instability, and the results of varus and valgus stresses compared to the healthy side. Plain X-rays of the ankle and foot were also taken.

Data analysis using statistics

Statistical Package for the Social Sciences (SPSS) version 28 was used for data management and analysis. When applicable, medians, ranges, standard deviations, and means were used to summarise numerical data. Numbers and percentages were used to summarise the categorical data. We used the percentages and statistics to make educated guesses about how often it happened. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to examine the normality of the numerical data. For numerical variables that did not follow a normal distribution, the Mann-Whitney U test was used to compare the two sets of data. For variables that did not follow a normal distribution, the Kruskal-Wallis test was used for comparisons involving more than two groups. All tests were two-tailed, and a probability (p-value) < 0.05 is deemed significant, in order to quantify the strength of relationship between non-normally distributed measures, Spearman's correlation coefficients were computed (13).

Results

The average age of the 20 trauma victims in our research was 34 ± 10 years. Men constituted the bulk of the cases (70 percent). Smoking was present in 20% of the patients. Out of the total number of patients, four (20%) had hypertension and two (10%) had diabetes. In terms of the form of trauma, road traffic accidents accounted for half of the cases, falls from heights for 20%, twisting for 15%, falling on stairs for 10%, and direct trauma for only one patient. When it came to the side that was impacted, half were on the right and half were on the left. Listing 1

Table (1) Participants' socioeconomic status

	n=20 (%)
Age in years (Mean ± SD)	34 ±10
Sex	
Female	6 (30)
Male	14 (70)
Special habits	
Smoker	4 (20)
No	16 (80)
Medical history	
DM	2 (10)
HTN	4 (20)
No	14 (70)
Mode of trauma	
Direct trauma	1 (5)

Falling on the stairs	2 (10)
Fall from a height	4 (20)
Road traffic accidents	10 (50)
Twisting	3 (15)
Side affected	
Left	9 (45)
Right	11 (55)

SD: Standard deviation

Plates When it came time for fixation, two patients (10 percent) were fastened using a variaxe distal radius plate, forty percent utilised a miniplate, and fifty percent used anatomical plates. Eighty percent of patients do not have any problems after surgery, and only four cases do (one complicated by deep venous thrombosis, one by saudex atrophy, one had superficial infection and brocken screw and finally one had superficial wound wound infection and saudex atrophy). Ipsilateral tibial fixation has been related with damage in a single case. The summer is peak injury season for bones, with the months of June and July accounting for 40% of all bone injuries and 20% of all injuries occurring in any given month. A total of 79 out of a possible 90 points on the American Orthopaedic Foot and Ankle Society's (AOFAS) scale, and 78 out of a possible 90 points on the FOOT & Ankle outcome scale (64-89). Second Table

Table (2) Clinical data of study participants

	n=20 (%)
Plate Used	
Anatomical plate	10 (50)
Miniplate	8 (40)
Variaxe distal radius plate	2 (10)
Complications	
DVT	1 (5)
Saudex atrophy	1 (5)
Superficial infection/ brocken screw	1 (5)
Superficial wound infection, saudex atroph	1 (5)
No	16 (80)
Associated Injuries	
Ipsilateral fx tibia	1 (5)
No	19 (95)
Month of injury	
January	1 (5)
Febraury	2 (10)
March	1 (5)
April	2 (10)
May	1 (5)
June	4 (20)
July	4 (20)
August	2 (10)
November	1 (5)
December	2 (10)
	Median (range)
AOFAS	79 (65-90)
FAOS	78 (64-89)

An age-related decline in AOFAS&FAOS is associated with a moderate to excellent negative association (P value 0.001&0.014 respectively). Third Table

Table (3) Age-related relationships with (AOFAS score& FAOS score)

	Age		
Variable	**r**	**P value**	**Interpretation**
AOFAS	-0.67	0.001	Significant good negative correlation
FAOS	-0.54	0.014	Significant moderate negative correlation

A significant P value is less than 0.05, and the correlation coefficient, denoted as r, might vary from -1 to +1.

There Compared to nonsmokers, smokers have a significantly lower AOFAS score (P value 0.005). Nonetheless, the AOFAS score does not vary significantly by gender, comorbidity status, or trauma type (P value) (0.316, 0.170& 0.974 respectively). Chapter 4

Fig. (4) Correlation between AOFAS score and several factors

	AOFAS	
	Median (range)	**P value**
Sex		
Female	81 (72-90)	0.316
Male	77 (65-87)	
Special Habits		
Smoker	70 (65-75)	0.005
No	80 (69-90)	
Medical history		
DM	76 (72-80)	0.170
HTN	75 (65-77)	
No	81 (68-90)	
Mode of Trauma		
Direct trauma	77 *	0.974
Falling on the stairs	76 (72-80)	
FFH	78 (75-82)	
RTA	81 (65-90)	
Twisting	77 (72-82)	

*****A significant P value less than 0.05 indicates that just one instance had direct trauma.

Smokers' FAOS scores are much lower than non-smokers' (P value 0.005). Nonetheless, the AOFAS score does not vary significantly by gender, comorbidity status, or trauma type (P value) (0.212, 0.235& 0.908 respectively). Section 5

Table (5) FAOS score correlation with various variables

	FAOS	
	Median (range)	**P value**
Sex		
Female	80 (74-89)	0.212
Male	77 (64-85)	
Special Habits		
Smoker	70 (64-74)	0.005
No	80 (64-89)	
Medical history		
DM	75 (70-80)	0.235
HTN	74 (70-77)	
No	80 (64-89)	
Mode of Trauma		
Direct trauma	76*	0.908
Falling on the stairs	77 (74-79)	
FFH	77 (74-85)	
RTA	80 (64-89)	

The only example with direct trauma is 77 (70-79) twisting, and a P value less than 0.05 is deemed significant. A Presentation of the Case

After suffering direct damage to the foot from a heavy object's fall, a 25-year-old male patient with no smoking history and a history of acute Lisfranc injury was brought to the hospital with a Tscherne Type I soft tissue injury. During this time, the patient's leg was raised and a splint was placed behind the knee.

The operation was carried out four days subsequent to the injury. A reduction was performed by securing the second ray to the base of the second metatarsal bone using a mini-plate and a screw that extended from the medial cuniform.

The patient's postoperative phase went smooth, and they were sent home for outpatient follow-up on the very next day of surgery. Stitches were removed two weeks following surgery, at which time the patient also had a check X-ray.

The patient was able to return to full-time work after experiencing a painless aligned ankle and normal foot arches at the last follow-up. He is pain-free, able to walk and climb stairs with ease. Based on the AOFAS grading system, his ankle score was 77 and his FAOS score was 76, indicating a reasonable functional outcome.

Fig. (1) X-rays taken before surgery.

Fig. (2) Ct scan taken before surgery

Step 3: Surgical Positioning (sterile wedge used).

Fig. (4) Approach to surgery and fixation using plates and screws while keeping the neurovascular bundle intact.

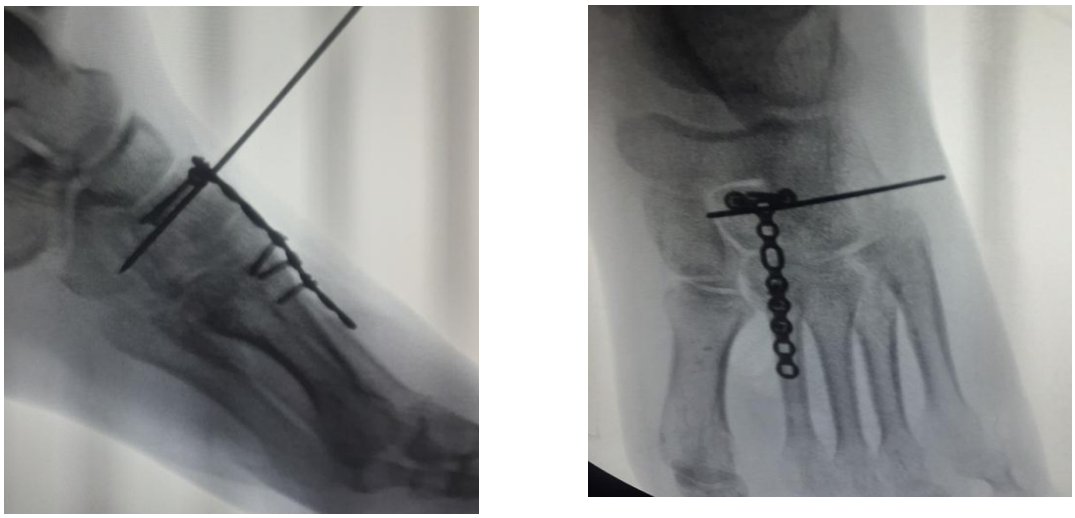

Fig. (5) Pictures taken of the patient's C-arm from the front and posterior perspectives during surgery

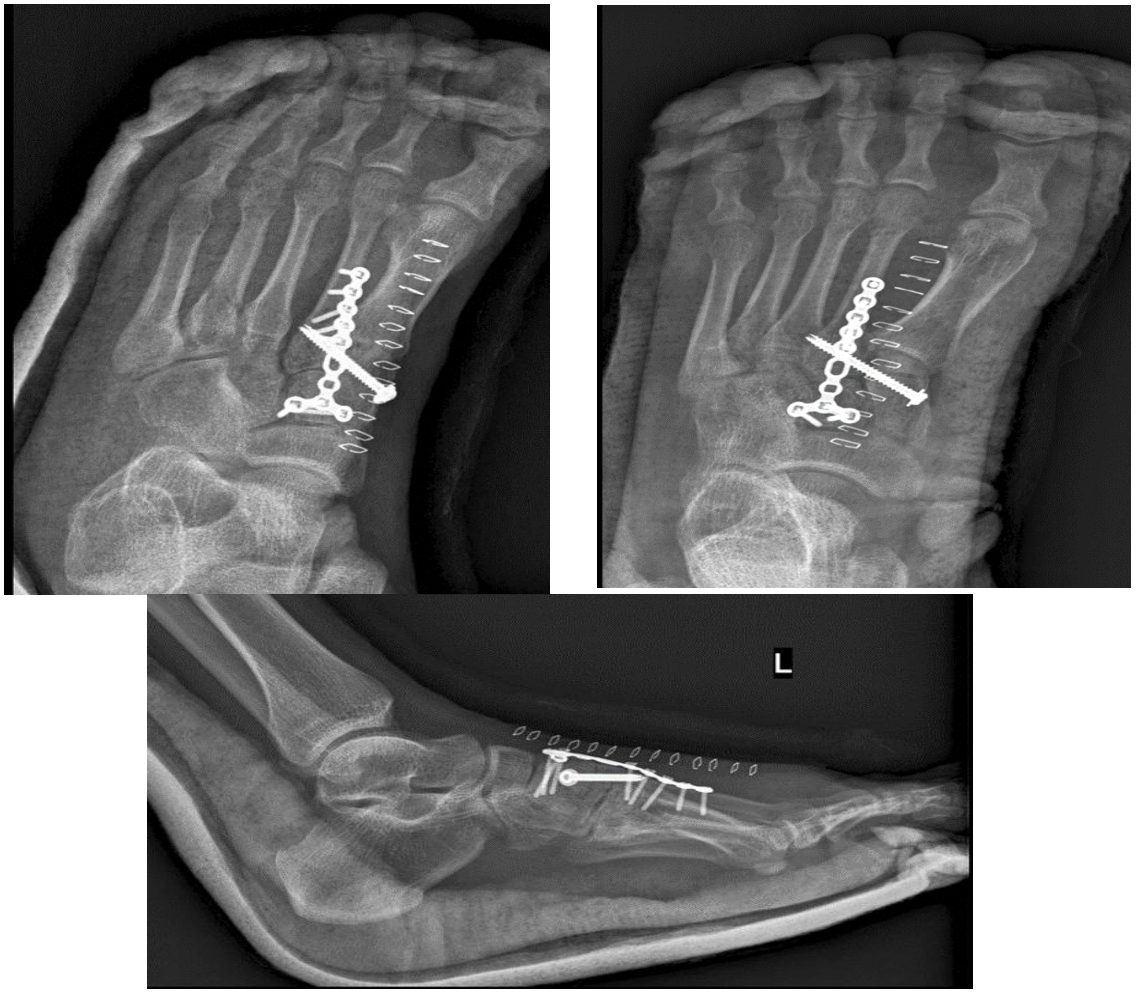

Fig. (6) X-ray taken after surgery.

Fig. (7) The X-rays taken two weeks after the operation, both in the anterior and posterior planes, before to and after the removal of the clips

Illustration (8) X-rays taken six weeks after the operation.

Fig. (9) Figurative X-rays taken twelve weeks after surgery

Fig. (10) The intact arch of the foot is seen in the shot while standing on tiptoes.

4. Discussion

Lisfranc injury is a rare occurrence, occurring 9.2 times per 100,000 people per year and constituting just 0.1 to 0.9% of all fractures (14).

The complicated structure of the midfoot makes diagnosis and identification of minor instances using X-ray alone challenging, which likely accounts for the first missed diagnosis of around 20% of Lisfranc injuries, according to studies (15).

In order to lessen the likelihood of severe long-term impairment, it is critical to identify and treat Lisfranc injuries promptly. These injuries should raise red flags since they are often undetectable due to their subtlety or opacity. We advise getting weight-bearing radiographs and stress views when there's reason to suspect anything is wrong but no obvious abnormalities on plain radiographs. There is consensus in the literature that achieving the best possible result requires anatomic reduction of the Lisfranc joint (16).

Stable and painless plantigrade foot is the ultimate aim after foot and ankle injuries. Reducing the size of the Lisfranc complex anatomically is crucial for stabilisation after Lisfranc injury (17).

The gold standard for treating acute Lisfranc injuries used to be open reduction and internal fixation (17).

Iatrogenic articular cartilage degradation may be lessened with plate fixation as compared to transarticular fixations such as K-wires and screw fixations. Another benefit of plates over transarticular screws is that the latter are difficult to remove without causing more damage to the joint, and their distal threads are usually intra-articular, which means they might cause extra damage to the joint cartilage when moved. On the other hand, it may not be essential to remove

a broken joint plate if the joint can still move. In the event that the screws that were placed through the plate break, the distal threads will remain in the metatarsals or cuneiforms, where they will not irritate any more soft tissues or articular cartilage. Alternatively, specialised tools may remove the screws without touching the joint. Vecchio et al. assert that plate fixation reduces the risk of morbidity and allows for early weight-bearing after surgery, which in turn reduces joint stiffness, muscle atrophy, and disuse osteopenia (18).

Twenty patients with Lisfranc injuries who underwent surgical plate fixation at Kuwait's Kafr Elsheikh health insurance facility and Adan hospital were the subjects of the current clinical investigation.

The bulk of the patients included in this research were men, and their mean age was 34 ± 10 years old (70 percent).

Road traffic accidents accounted for half of all injuries, with falls from heights coming in at 20%, twisting injuries at 15%, stair falls at 10%, and direct trauma at 1%. (5 percent).

With a range from 65 to 90, the included patients in this research had an average AOFAS score of 79.

Fifty percent of patients were fastened with anatomical plates, forty percent with miniplates, and ten percent with Variaxe distal radius plates. Eighty percent of patients do not have any problems after surgery, and only four cases do (one complicated by deep venous thrombosis, one by Saudex atrophy, one had superficial infection and broken screw and finally one had superficial wound infection and Saudex atrophy). Ipsilateral tibia fixation has only been related with damage in one case. The summer is peak injury season for bones, with the months of June and July accounting for 40% of all bone injuries and 20% of all injuries occurring in any given month. A total of 79 out of a possible 90 points on the American Orthopaedic Foot and Ankle Society's (AOFAS) scale, and 78 out of a possible 90 points on the FOOT & Ankle outcome scale (64-89).

An age-related decline in AOFAS&FAOS is associated with a moderate to excellent negative association (P value 0.001&0.014 respectively).

When comparing smokers with nonsmokers, the AOFAS score is much lower for smokers (P value 0.005). Nonetheless, the AOFAS score does not vary significantly by gender, comorbidity status, or trauma type (P value) (0.316, 0.170& 0.974 respectively).

Smokers' FAOS scores are much lower than non-smokers' (P value 0.005). Nevertheless, the FAOS score does not change significantly based on gender, comorbidities, or trauma modality (P value) (0.212, 0.235& 0.908 respectively).

We found similar results to those published by Hu et al., who found that the plate fixation group averaged 83.1 points on the AOFAS midfoot score while the screw fixation group averaged 78.5 points (7).

Plate fixation resulted in better functional outcomes than transarticular screws, according to Van Koperen et al (19).

Results are more affected by the accuracy of the anatomical reduction, not the fixation implant choice, according to a research by Lau et al. that compared functional results after transarticular screws, dorsal bridge plating, and combination therapy (20).

Functional outcomes after acute Lisfranc injuries were better in the dorsal plate group than in the trans-articular screw fixation group, according to a retrospective study by Kirnzer et al.; the researchers also noted that, depending on the quality of reduction, the plate group had better functional outcomes (21).

The short period of the follow-up was the primary drawback of the current investigation.

5. Conclusion

For Lisfranc injuries, the best course of therapy is plate fixation, which leads to stable anatomical reduction and improved functional results. Improved patient outcomes and lower long-term problems may be achieved with a thorough approach to detecting, categorising, and surgically treating Lisfranc injuries, as advocated for in this study.

Funding sources

Public, commercial, or non-profit funding entities did not provide any particular grant for this study.

Work contributed by the author.

Each author had an equal say in writing the study.

Problems with potential bias

Complete absence of bias

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