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Reduction and Fixation of Metatarsal neck Fracture by Metaizeau's technique

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Abstract

Background: Metaizeau's technique can be applied to reduce the displaced metatarsal head distally from the fracture in an easier way and to keep the fracture site closed, as compared with retrograde Kirschner wires. **Aim:** we aimed to evaluate the outcomes of the reduction and fixation of metatarsal neck fracture by metaizeau's technique. **Methods:** This study was a prospective interventional study. The study was conducted at the orthopedics department at Sohag General Hospital. This study was performed in the period between May 2022 and April 2023. 20 patients with displaced metatarsal head fractures were included. **Results:** Pain, function, maximum walking distance, walking surfaces, Gait abnormality, Sagittal motion, hind foot motion, ankle-hind foot stability, alignment and total score were significantly better 6- and 12-months post operation than 2 months (P value <0.05). **Conclusion:** Metaizeau's technique is a valid alternative to retrograde Kirschner wires fixation in the treatment of displaced metatarsal neck fractures. **Keywords: Reduction; Fixation; Metatarsal; Fracture; Metaizeau's technique**

Introduction

Metatarsal fractures (MF) represent about 88% of all fractures involving foot and ankle, amounting up to 35% of all foot fractures and up to 7% of all skeletal injuries. These types of lesions have been frequently reported in second through fifth decade of life , but children also appear to be affected, accounting up to 61% of all fractures of the foot and occurring in the fifth Metatarsal (41%) and the first Metatarsal (19%) by anatomical exposure. **(1)**

MF can be caused as an isolated injury or, associated with other metatarsals fractures or Lisfranc joint injuries. Both direct and indirect traumas can lead to MF but, result from low-energy trauma; However, high-energy crush injuries may occur quite frequently, involving soft tissues and resulting up to 1% of all metatarsal open lesions. **(2)**

MF can occur at any level of the metatarsal bone and there is no specific classification. Proximal metaphyseal and central metatarsal base fractures are sometimes associated with Lisfranc injuries. **(3)**

Percutaneous antegrade surgical treatment is a valid alternative to retrograde technique, with a lower incidence of complications such as risk of infection or chondral damage in the MTFJ caused by plantar position and crossing of the wire through the proximal phalanx base. **(4)**

The goal of treatment was to achieve a correct reduction of fracture, to avoid prolonged disability and preservation of both soft tissues and bony alignment. Metaizeau's technique in these fracture of the metatarsal bone respect the soft tissues surrounding the fracture and the periostium at the fracture site.

Patients and Methods

This study was a prospective interventional study. The study was conducted at orthopedics department at Sohag General Hospital. This study was performed in the period between May 2022 and April 2023. 20 patients with displaced metatarsal head fractures were included.

Inclusion criteria: Patients with displaced fracture neck metatarsals 2nd, 3rd, and 4th metatarsals.

Exclusion criteria: Poly-traumatized patient, patient with fracture first and fifth metatarsal bone, fracture shaft metatarsal bone, open fractures of the foot, intraarticular fracture of metatarsals, lisfranc fracture and segmental fracture of the metatarsal

Methods:

All patients were subjected to the followings:

Metaizeau's technique: Metaizeau’s technique was applied to reduce the displaced metatarsal head distally from the fracture in an easier way and to keep the fracture site closed. The diameter of the Kirschner wires to be used should be related to the size of the fractured metatarsal medullar cavity. It drove the Kirschner wire anterograde, with the help of an X-ray image intensifier. The Kirschner wire was driven through the endomedullar cavity from the proximal metaphysis, progressing anterogradely towards the displaced distal epiphysis. Once it reached the fracture site, it tried to thread the metatarsal head with the bent distal end of the Kirschner wire. Subsequently, It rotated the wire 180 to direct its end to the dorsum of the foot so as to provoke a translation effect on the metatarsal head in order to obtain the head reduction, and maintained this reduction with the Kirschner wire. Open reduction was unnecessary all fractures, leaving the fracture site untouched, and preserving the soft tissues, which will collaborate in the healing process of the fracture.

Postoperative treatment: Postoperatively, no weight bearing in a splint during the first 2 week was allowed. progressive weight bearing cast for the next 2 weeks was permitted after clinical signs consolidation, pain and tenderness subsidence, and after 4 weeks we removed the cast and set the patient walking without cast but with crutches if needed, and the Kirschner wires were removed 6 weeks following the operation. **Figure (1)**

Figure (1): Postoperative radiograph showing intramedullary fixation with Metaizeau's technique

Postoperative follow up: Outpatient follow-up was conducted immediately post-operative until achieving the union. It was done 4, 8, 24 weeks and 12 months post-operatively. **Figure (2)**

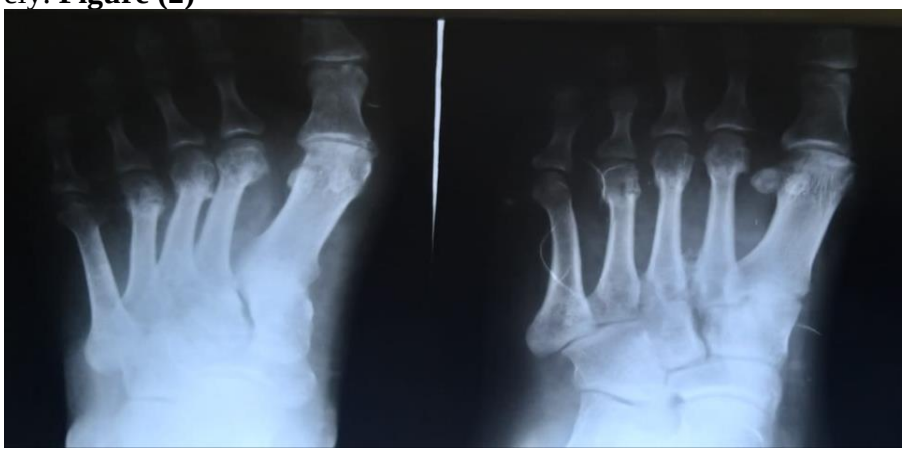

Figure (2): Radiographic consolidation of the metatarsal displaced head fractures after 8 weeks, showing a correct alignment, no angular deviations, and no shortening of the metatarsal bones.

Postoperative evaluation: Clinically: neurological and vascular assessment, deformity and stiffness evaluation were done. **Radiological:** x-ray imaging was performed in the 4^{th}, 8^{th} and 24^{th} postoperative weeks to evaluate the alignment and anteroposterior and oblique views of the foot.

Ethical considerations: The study was approved by the Ethics Committee of Faculty of Medicine, Sohag University. There are adequate provisions to maintain privacy of participants and confidentiality of the data are as follows: The patients were given the option of not participating in the study if they did not want to. We put code number to each participate with the name and address kept in a special file. We hide the patients name when we use the research. We used the results of the study only in a scientific manner and not to use it in any other aims.

Statistical Analysis: was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative parametric data were presented as mean and standard deviation (SD). Qualitative variables were presented as frequency and percentage (%).

Results

This study planned to use Metaizeau's technique in 20 with displaced metatarsal head fractures. This study was performed in the period between May 2022 and April 2023.

Table (1): Demographic data of the studied patients

		N=20
Age (years)	**Mean ± SD**	27.1 ± 12.11
	Range	10 _ 50
Sex	**Male**	12 (60%)
	Female	8 (40%)

The age of the studied patients ranged from 10 to 50 years with a mean value (± SD) of 27.1 (±12.11) years. There were 12 (60%) males and 8 (40%) females **(Table 1).**

Table (2): Fracture characteristics of the studied patients

		N=20
Side affected	**Right**	14 (70%)
	Left	6 (30%)
Number of fractures	**Single**	10 (50%)
	Multiple	10 (50%)
Fracture pattern	**Oblique**	6 (`30%)
	Spiral	8 (`40%)
	Transverse	6 (`30%)
Fracture location	**Neck**	20 (100%)

The side affected of fracture was right in 14 (70%) patients and left in 6 (30%) patients. Number of fractures was single in 10 (50%) patients and was multiple in 10 (50%) patients. Fracture pattern was oblique in 6 (`30%) patients, spiral in 8 (`40%) patients and transverse in 6 (30%) patients. 20 (100%) patients had fracture in neck **(Table 2).**

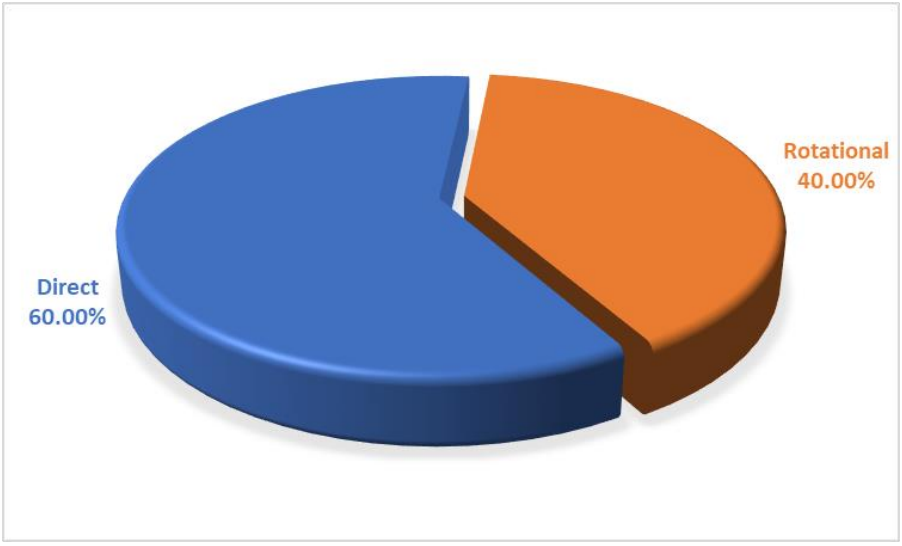

Figure (3): Mechanism of injury of the studied patients

Table (3): Surgical outcome in the studied patients

		N= 20
Time of surgery (min)	**Mean ± SD**	54.7 ± 13.78
	Range	31 _ 82
Time of union (weeks)	**Mean ± SD**	5.8 ± 1.48
	Range	4 _ 8
Time to wire removal (weeks)	**Mean ± SD**	5.8 ± 1.48
	Range	4 _ 8
Time to ROM start (weeks)	**Mean ± SD**	3.5 ± 0.51
	Range	3 _ 4
Time to weight-bearing (weeks)	**Mean ± SD**	2.4 ± 0.5
	Range	2 _ 3

Time of surgery of the studied patients ranged from 31 to 82 min with a mean value (± SD) of 54.7 (±13.78) min. Time of union of the studied patients ranged from 4 to 8 weeks with a mean value (± SD) of 5.8 (±1.48) weeks **(Table 3).**

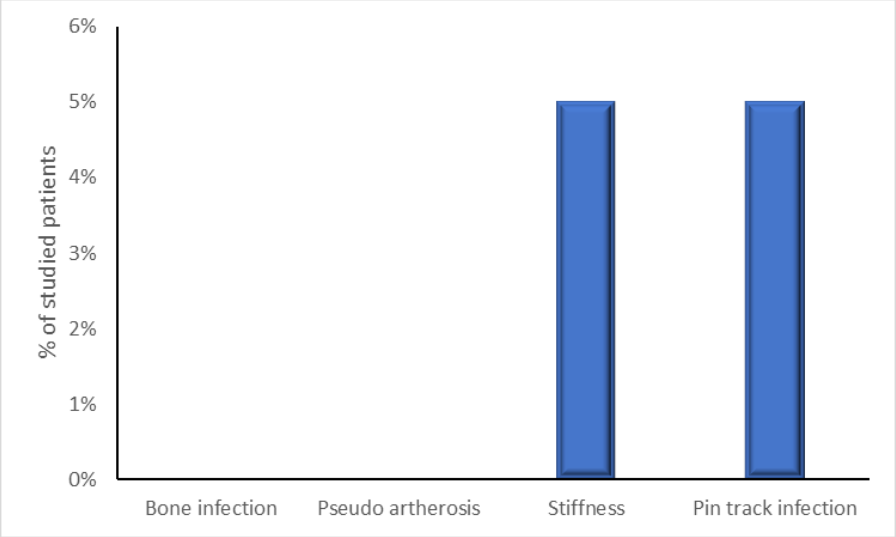

Figure (4): Complications of the studied patients

Table (4): AOFAS score in the studied patients

	2 months post operatively	6 months post operatively	12 months post operatively	P1	P2
Pain	20 (20 - 30)	40 (30 - 40)	40 (40 - 40)	**<0.001***	**<0.001***
Function	0 (0 - 4)	7 (4 - 7)	10 (9.25 - 10)	**<0.001***	**<0.001***
Maximum walking distance	2 (0 - 2)	4 (2 - 4)	5 (5 - 5)	**<0.001***	**<0.001***
Walking surfaces	1.5 (0 - 3)	3 (3 - 5)	5 (5 - 5)	**<0.001***	**<0.001***
Gait abnormality	2 (0 - 4)	4 (3 - 5)	8 (8 - 8)	**0.008***	**<0.001***
Sagittal motion	4 (0 - 5)	4 (4 - 5)	8 (8 - 8)	**0.031***	**<0.001***
Hind foot motion	3 (0 - 6)	4.5 (3 - 6)	6 (6 - 6)	**<0.001***	**<0.001***
Ankle-hind foot stability	0 (0 - 0)	8 (0 - 8)	8 (8 - 8)	**<0.001***	**<0.001***
Alignment	0 (0 - 5)	5 (5 - 5)	10 (8.75 - 10)	**<0.001***	**<0.001***
Total score	36.5 (28.75 - 46.5)	62.5 (57 - 68.25)	80 (74 - 85)	**<0.001***	**<0.001***

Data are presented as median (IQR). P1: P value between 2_months and 6_months, P2: P value between 2_months and 12_months.

Pain, function, maximum walking distance, walking surfaces, Gait abnormality, Sagittal motion, hind foot motion, ankle-hind foot stability, alignment and total score were significantly better 6- and 12-months post operation than 2 months (P value <0.05) **(Table 4).**

Case: 31 years old male with fracture neck of second and third metatarsal, the mode of trauma was twisting injury. He was operated on 2nd day.

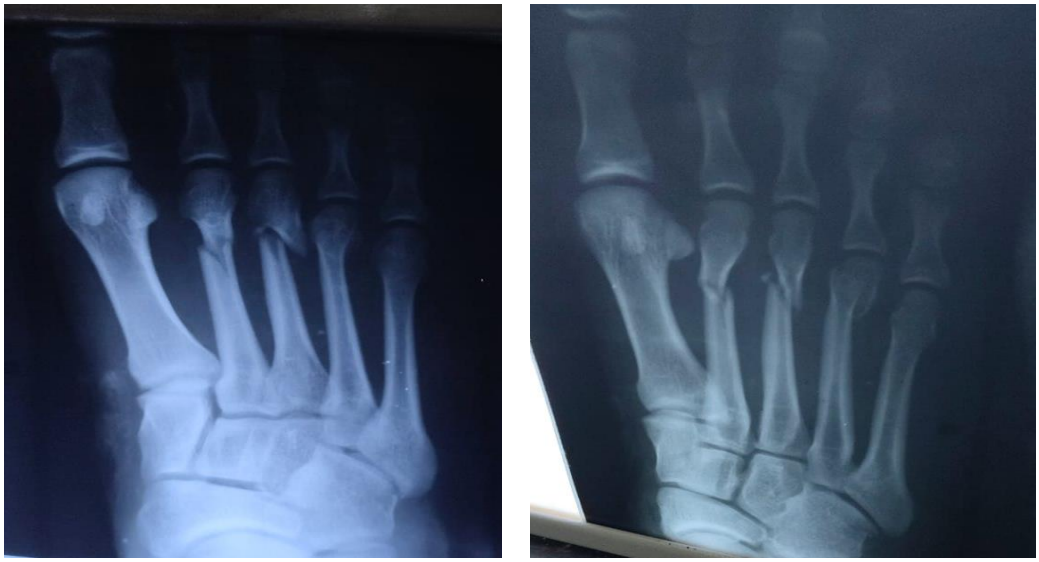

Figure (5): AP and oblique views of the patient pre-operatively.

Figure (6): AP and Oblique views of the patient immediate post- operative

Figure (7): AP and Oblique views after 6 months, the fracture are united and patient is walking full weight bearing.

Discussion

In the current study, it was found that the age of the studied patients ranged from 10 to 50 years with a mean value (± SD) of 27.1 (±12.11) years. There were 12 (60%) males and 8 (40%) females.

In agreement with our results, **Mohamady et al.** [5] reported that the mean age of the studied patients was 30 ±10 years. There was a male predominance (80.0%), while females were 20%.

In the present study, it was found that the side affected of fracture was right in 14 (70%) patients and left in 6 (30%) patients. The number of fractures was single in 10 (50%) patients and was multiple in 10 (50%) patients. The fracture pattern was oblique in 6 (`30%) patients, spiral in 8 (`40%) patients and transverse in 6 (30%) patients. 20 (100%) patients had fractures in neck.

These results were compatible with **Mohamady et al.** [5] who reported that about two-thirds (65.0%) had left side affection. Three-quarters of the patients had multiple fractures (75%). The most frequent fracture pattern was the spiral pattern (35.0%), while the least frequent was the comminuted pattern (15.0%). The most frequent fracture location was the neck (45.0%), while the least frequent was the sub-capital (15.0%).

The current findings regarding mechanism of injury clearly revealed that, it was direct in 12 (60%) patients and rotational in 8 (40%) patients.

This was in accordance with **Mohamady et al.** [5] who reported that the most common mechanism of injury was foot twist (30%), followed by direct trauma and falling down (25% for each). RTA was the least frequent mechanism (20%).

In the current study, it was found that time of surgery of the studied patients ranged from 31 to 82 min with a mean value (± SD) of 54.7 (±13.78) min. Time of union of the studied patients ranged from 4 to 8 weeks with a mean value (± SD) of 5.8 (±1.48) weeks. **Mohamady et al.** [5] stated that the median time of surgery was 30 minutes and ranged from 15 to 120 minutes. The mean time to radiological union, wire removal, ROM start, and weight-bearing were 8 weeks, 11 weeks, 3 weeks, and 5 weeks, respectively.

In the present study, regarding complications, stiffness occurred in 1 (5%) patient, bone infection and pseudo arthrosis didn't occur.

Mohamady et al. [5] revealed that only two patients had skin complications, and four patients had stiffness. About two-thirds of the patients (60.0%) reported a mild verbal rating scale.

Bryant et al. [6] reported that the main complication after plate and screws fixation is a relatively high proportion of patients (30%) who had hardware irritation or awareness of the fracture. The majority of patients though did not want the plate removed. They also found that metatarsal fractures that were treated with this method, took approximately three weeks longer time to heal as opposed to K-wire intramedullary nailing techniques. The current findings regarding AOFAS score in the studied patients clearly revealed that pain, function, maximum walking distance, walking surfaces, Gait abnormality, Sagittal motion, hind foot motion, ankle-hind foot stability, alignment and total score were significantly better 6- and 12-months post operation than 2 months.

Hettchen et al. [7] indicated that the AOFAS score ranged from 62 to 100 points. It took 10 shortenings to get rid of one incidence of skin irritant. There were no signs of pseudoarthrosis, subsequent fracture dislocation, or nail breaking.

Aguado et al. [8] revealed that they presented seven fractures treated anterograde with progressive weight-bearing after 2 weeks. Open reduction was unnecessary in all cases. This technique permitted correct control of the distal fracture fragment, obtained good reduction of the metatarsal heads without opening the fracture site, and

with no lesion of the capsuloligamentous metatarsophalangeal joint structures. They obtained the radiographic healing of all and showed correct alignment.

Zarei et al. [(9)] presented a case series of 34 patients, who were treated with open ante/retrograde intramedullary nailing technique. Open reduction of the fracture was performed and the K-wire was introduced through the fracture and directed distally, exiting the metatarsal head and skin. **Bryant et al. [(6)]** studied the union rate and hardware removal rate for a group of 45 patients (75 metatarsal fractures in total), who were treated with plate and screws fixation. Authors' indications for plate and screws fixation were gross angulation, more than 50% displacement, or fracture comminution. Nine out of 75 fractures were comminuted and in eight out of 45 patients the first metatarsal was involved.

Goel et al. [(10)] conducted a study on closed transverse pinning for reduction and fixation of metatarsal neck fractures. This technique was used in patients with multiple metatarsal neck fractures with displacement.

In conclusion, K-wire intramedullary nailing fixation techniques represent the best option of surgical management for metatarsal neck fractures, especially for those with minimal or no comminution. K-wiring can achieve optimal reduction and fixation of fracture with less surgical trauma, leading to a significantly quicker recovery as compared to the plate and screws method of fixation.

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