SHORT-TERM FUNCTIONAL OUTCOMES OF PATIENTS WITH METATARSAL FRACTURES FOLLOWING INTRAMEDULLARY K-WIRE OSTEOSYNTHESIS AT MUHIMBILI ORTHOPAEDIC INSTITUTE

D. Cosmas, MD, MMed, **M. Muhamedhussein**, MD, MMed, FCS (ECSA), MPH, MBA (Healthcare), **F. Mrita**, MD, MMed and **G. Njambilo**, MD, MMed, Orthopaedics Department, Muhimbili University of Health and Allied Sciences, P.O. Box 65001, Dar es Salaam, Tanzania and Muhimbili Orthopaedics Institute, P.O. Box 65474, Dar es Salaam, Tanzania

Correspondence to: Dr. Dismas Cosmas, Orthopaedics Department, Muhimbili University of Health and Allied Sciences, P.O. Box 65001, Dar es Salaam, Tanzania. Email: diconksmas@gmail.com

ABSTRACT

Background: Metatarsal fractures are common orthopaedic injuries, constituting up to 35% of all foot fractures. Intramedullary K-wire osteosynthesis is frequently used for their management. Despite its widespread use, functional outcomes following this treatment remain underexplored in our setting.

Objective: To determine the short-term functional outcomes of patients with metatarsal fractures after intramedullary K-wire osteosynthesis at Muhimbili Orthopaedic Institute (MOI).

Methods: This was a prospective cohort study conducted at MOI. Patients aged 18 years and above with AO/ICI Type A metatarsal fractures treated with K-wire osteosynthesis were enrolled. Functional outcomes were assessed using the Maryland Foot Score at 12 weeks postoperatively. Statistical analysis was performed using STATA 17, with a significance level set at $p<0.05$.

Results: A total of 33 patients were included. The mean age was 30 ± 11.71 years, with 90% being male. Over half (57.58%) achieved good functional outcomes, while 3.03% experienced treatment failure. Pain levels were minimal in 75.75% of participants, and 70% demonstrated good mobility. No statistically significant associations were found between functional outcomes and independent variables.

Conclusion and Recommendations: Intramedullary K-wire osteosynthesis for metatarsal fractures results in favorable short-term functional outcomes. However, further multicenter studies with larger sample sizes and longer follow-up periods are recommended to assess long-term recovery trends.

Key words: Metatarsal fractures, Intramedullary Kirschner wire, Maryland foot function score

INTRODUCTION

Metatarsal fractures are among the most frequent foot injuries, often resulting from trauma or repetitive stress. They account for a significant proportion of foot fractures, with high incidence rates reported in both active and sedentary populations. These fractures can result from direct trauma, such as falls, crush injuries, or sports-related impacts, or indirect forces like twisting mechanisms that lead to stress fractures. The first, fifth, and central metatarsals are the most commonly affected, with varying treatment strategies based on the type and location of the fracture (1,2).

The primary goal of treatment for metatarsal fractures is to restore alignment, maintain foot biomechanics, and ensure proper weight distribution across the forefoot. Conservative management is often preferred for non-displaced fractures; however, surgical intervention is necessary for displaced or unstable fractures (3). Intramedullary K-wire osteosynthesis is a widely used surgical technique due to its minimally invasive nature, cost-effectiveness, and ability to provide stable fixation while preserving soft tissue integrity (4).

Despite the widespread adoption of K-wire osteosynthesis, data on its functional outcomes remain limited, particularly in low-resource settings. While some studies have demonstrated good functional recovery with early mobilization, others have highlighted complications such as malunion, infection, and hardware-related discomfort. Understanding the short-term functional outcomes following this procedure is essential for optimizing treatment protocols, improving patient care, and guiding future research.

This study aims to evaluate the short-term functional outcomes of patients who underwent intramedullary K-wire osteosynthesis for metatarsal fractures at Muhimbili Orthopaedic Institute. By assessing pain levels, mobility, and overall functional recovery at 12 weeks postoperatively, we seek to provide valuable insights into the effectiveness of this treatment modality and identify potential areas for improvement.

MATERIALS AND METHODS

Study design

This was a prospective cohort study. This study followed patients with displaced AO/ICI Type A metatarsal fractures treated with K-wire fixation and measured their functional outcomes 12 weeks post-surgery.

Study area

The study was conducted at Muhimbili Orthopaedics Institute (MOI), in Dar es Salaam, Tanzania. The region accounts for about 10% of Tanzania's population. MOI has a bed capacity of 362 beds which is the leading institution that provides equitable, affordable, accessible quality services of orthopaedics, neurosurgery, and trauma management, training, and research in East and Central Africa by using efficient and effective hospital management systems and modern technologies supported by trained staffs. The hospital is suitable for this study since it is estimated to receive about 500 trauma patients per month.

Study population

Patients aged 18 years and above were treated at MOI for metatarsal fracture by intramedullary K wire fixation during the study period.

Study period

The study was carried out between June 2023 and May 2024.

Sampling strategy

All available adult patients with metatarsal fractures who underwent K-wire osteosynthesis were approached.

Inclusion criteria

All patients aged 18 years or older with displaced Type A metatarsal fractures (extra-articular fractures) according to the AO-ICI classification were treated with K-wire osteosynthesis at MOI during the study period.

Exclusion criteria

- Patients with pathological metatarsal fractures.
- Re-fractures, non-union, or malunion of a previous metatarsal fracture.
- Patient with associated other foot injuries such as Lisfranc, Chopart, vascular, tendon, and nerve injuries.
- Polytrauma patients with an Injury Severity Score (ISS) of 15 or higher.
- Patients unable to provide informed consent due to mental incapacity.
- Metatarsal base fractures, comminuted shaft fractures, and articular fractures (AO/ICI types B and C).

Data collection process

All eligible patients were informed about the study at the emergency and outpatient departments, and those who gave their consent were enrolled.

Information about age, sex, and injury pattern including whether an open or closed injury was captured, there was a review of the affected limb's radiographs, whereby fracture type which is AO-ICI type A (both open and closed), and the modality of treatment were recorded.

Patients who were recruited at the Emergency Department or patients who were recruited before the 12th week post-treatment, patient contacts and next of kin contacts (phone number, emails, and local address) were collected and saved for the completion of the MFS questionnaire, control X-rays reviewed by investigator together with the radiologist to establish reduction status, the reduction was termed acceptable reduction if a metatarsal alignment was within 10 degrees of normal angulation, less than 3mm of displacement, and no rotational malalignment. Patients were then evaluated at their follow-up clinic on the 12th week. The questionnaire with the MFS scoring tool captured information on the level of pain, walking distance, and functional mobility status.

Ethical issues

Ethical clearance from IRB of The Muhimbili University of Health and Allied Sciences (MUHAS) was sought and thereafter approval from the management of MOI was obtained. The participants received an explanation of the study's objectives and were allowed to ask questions. The participants were made aware of their right to remain anonymous, both during and after the study, and confidentiality was preserved. The practices used adhered to the standards outlined by the MUHAS Research and Publication Board.

RESULTS

A total of 33 patients with metatarsal fractures AO/ ICI Type A treated with intramedullary K – wire osteosynthesis at MOI were available for analysis. The mean age of participants was 30 years with a Standard Deviation (SD) of ±11.71 years. The age range of the participants was between 18 to 62 years. More than half of the participants 25 (75.76%) were below 35 years. The majority of participants 30 (90.91%) were male. The majority of the participants resided in Kinondoni municipality, 15 (45.45%) (Table 1).

Table 1

Socio-demographic characteristics

Demographic variable	Frequency N=33	(100%)
Sex		
Male	30	90.91
Female	3	9.09
Age group (years)		
18 – 35	25	75.76
>35	8	24.24
Mean (S.D)	30 (±11.71)	
District of residency		
Bagamoyo	1	3.03
Ilala	9	27.27
Kinondoni	15	45.45
Mkuranga	3	9.09
Temeke	3	9.09
Zanzibar	2	6.06

In most cases, time to surgery was more than 24 hours 22 (66.67%), and there were cases of other associated injuries such as amputation, crush injury, and ipsilateral and contralateral limb injuries. MTC had the highest prevalence of mechanism of injury 31 (93.9%), and cases of the motorcyclist had the highest prevalence. The right limb was more affected 21 (63.64%), and most fractures were open 31 (93.94%). Most of the cases stayed 3-7 days post-operative 21 (63.64%), and did not do physiotherapy 23 (69.7%). Most of the patients had the K-wire removed less than 6 weeks 22 (66.67%) (Table 2).

Table 2

Clinical characteristics of patients with metatarsal fracture treated by intramedullary K-wire osteosynthesis

Variable	Frequency N= 33	(100%)
Time to surgery		
Within 24 hours	11	33.33
24 - 72 hours	22	66
Other associated injury		
Traumatic toe amputation	3	9.09
Crush injury	2	6.06
None	21	63.64
Contralateral limb fracture	3	9.09
Ipsilateral limb fracture	4	12.12
Mechanism of injury		
Fell on a slippery surface	1	3.03
Football match injury	1	3.03
MTC as pedestrian	6	18.18
MTC as motorcyclist	13	39.39
MTC as passenger	12	36.36
Side affected		
Left	12	36.36
Right	21	63.64
The pattern of AO/ICI Type A fractures.		
Open	31	93.94
Closed	2	6.06
Metatarsal bone with fracture		
5th metatarsal	2	6.06
Both metatarsals	16	48.48
Central metatarsals	14	42.42
1st metatarsal	1	3.03
Reduction status		
Accepted	30	90.91
Not accepted	3	9.09
Post-operative hospital stays		
3 – 7 days	21	63.64
>7 days	12	36.36
Physiotherapy		
Yes	10	30.3
No	23	69.7
Time to K-wire removal		
<6 weeks	22	66.67
6 – 9 weeks	10	30.3
>9 weeks	1	3.03

More than half of the patients 57.58% achieved a high level of functional outcome post-treatment, as evidenced by the 'Good' category on the Maryland Foot Score (MFS). Notably, only one participant (3.03%) experienced treatment failure, receiving a 'Failure' score on the MFS. Regarding pain levels, a significant proportion of patients (75.75%) reported experiencing only 'Slight' pain post-treatment. When assessing functional mobility, most patients (70%) demonstrated 'Excellent and Good' functional mobility outcomes following their treatment (Table 3).

Table 3

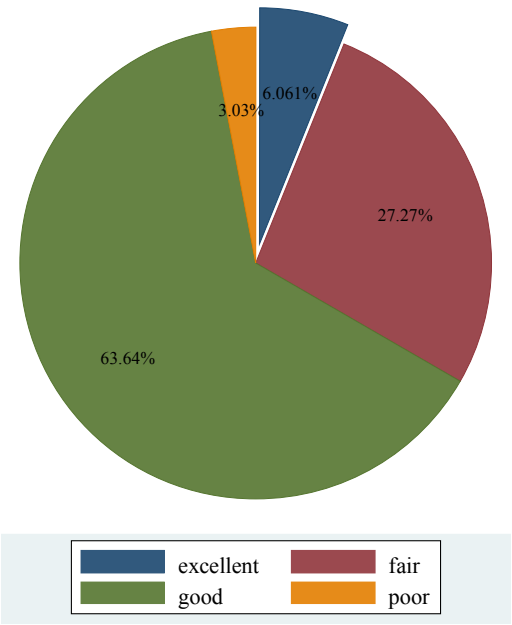
Patients' reported outcomes table

Variable	Frequency N= 33	(100%)
MFS score		
Excellent	3	9.09
Good	19	57.58
Fair	10	30.3
Failure	1	3.03
Pain level score		
Slight	25	75.75
Mild	5	15.15
Moderate	1	3.03
None	2	6.06
Functional mobility		
Excellent	2	6.06
Good	21	63.64
Fair	9	27.27
Poor	1	3.03

The results indicate that patients aged 18-35 years are almost two times more likely to have good functional outcomes than those with the age of above 35 years, but this did not reach statistical significance (p = 0.57) and after adjusting for others this was still not significant (Figure 1).

Figure 1

The functional outcome of MFS



Male patients had a COR of 0.65 (95% CI: 0-8, p=0.74) and an AOR of 0.59 (95% CI: 0.03-9, p=0.70) compared to female patients. Patients who underwent surgery within 24 hours had a COR of 0.83 (95% CI: 0.19-3.57, p=0.80) and an AOR of 0.73 (95% CI: 0.15-3.36, p=0.68) more likely to have a better functional outcome as compared to those who had surgery after 24 hours, Although statistically not significant. Patients with ipsilateral limb injuries had a COR of 9.6 (95% CI: 0.8-114.1, p=0.07) and an AOR of 11.8 (95% CI: 0.85-16, p=0.05), indicating a trend of 11 times towards poorer outcomes but not statistically significant. Patients who did not receive physiotherapy had a COR of 1.5 (95% CI: 0.34-6.9, p=0.56) and an AOR of 0.77 (95% CI: 0.11-5, p=0.79) compared to those who received physiotherapy. Patients with K-wires removed within 6-9 weeks had a COR of 2.62 (95% CI: 0.56-12.1, p=0.21) and an AOR of 3.2 (95% CI: 0.61-16.6, p=0.16) (Table 4).

Table 4

Factors associated with functional outcomes among patients with metatarsal fractures following intramedullary K-wire osteosynthesis

Variable	Category	COR 95% CI; P-value	AOR 95% CI; P-value
Age (years)	18 – 35	1.5 (0.30 – 7.43): 0.62	1.6 (0.31 – 8.16): 0.57
	36 +	ref	ref
Sex	Male	0.65 (0 – 8): 0.74	0.59 (.03 - 9): 0.70
	Female	ref	ref
Time to surgery	Within 24 hours	0.83 (.19 - 3.57): 0.80	0.73 (.15 – 3.36): 0.68
	More than 24 hours	ref	ref
Other associated injury	Contralateral limb Fractures	6.4 (.47 – 86.3): 0.16	9.9(.62-155):0.1
	Crush injury	1	1
	Ipsilateral limb fractures	9.6(.8-114.1):0.7	11.8(.85-16):0.05
	Traumatic toe Amputation	6.4(.47-86.3):0.16	7.6(.47-12):0.15
	None	ref	ref
Side affected	Right	2.8 (0.64 - 12): 0.16	2.6 (0.61 – 11.8): 0.18
	left	ref	ref
Type of fracture	Open	1	1
	Closed	ref	ref
Bone with fracture	Central metatarsal	1.25 (.28 - 5.4): 0.76	1.22 (.25 - 5.8): 0.79
	5th metatarsal	1	1
	1st metatarsal	1	1
	Both	ref	ref
Post-op hospital stays	3- 7 days	2.8 (.64 - 12):0.16	2.7 (.56 -12.8):0.21
	More than 7 days	ref	ref
Physiotherapy	No	1.5 (0.34-6.9): 0.56	0.77(.11-5):0.79
	Yes	ref	ref
Time to K-wire removal	6-9 weeks	2.62(.56 - 12.1)0.21	3.2(.61 - 16.6): 0.16
	>9 weeks	1	1
	<6 weeks	ref	ref

DISCUSSION

The study aimed to evaluate the functional outcomes of patients with metatarsal fractures treated with intramedullary K-wire osteosynthesis at Muhimbili Orthopaedics Institute (MOI). The Maryland Foot Score (MFS) was used to assess these outcomes; the primary objective of this study was to determine the functional outcomes of patients who underwent intramedullary K-wire osteosynthesis for metatarsal fractures at MOI. This section also explores specific objectives: to determine socio-demographic characteristics, pain levels and functional mobility in patients with metatarsal fractures post intramedullary K-wire osteosynthesis by using the Maryland Foot Score at the 12th week. Furthermore, to determine factors associated with functional outcomes.

Socio-demographic characteristics of patients

This study found that 90.91% of the patients were male, consistent with previous studies attributing this to greater male involvement in high-risk activities and occupations (5). The majority of patients (75.76%) were aged 18-35 years, highlighting the vulnerability of younger adults to these injuries, particularly due to high physical activity levels and occupational hazards such as motor traffic crashes (6). Most patients were from urban districts, particularly Kinondoni and Ilala, reflecting the higher incidence of trauma-related injuries in metropolitan areas with better healthcare access (7).

Functional outcomes

Functional outcomes were assessed using the Maryland Foot Score, with 57.58% achieving 'good' outcomes and 9.09% rated as 'excellent.' These findings align with regional and global studies that report favorable recovery rates post-K-wire fixation (8). Pain levels were low, with 82% of patients experiencing minimal to no pain by 12 weeks, demonstrating the effectiveness of this surgical technique in pain management (3,9). Furthermore, 70% of patients achieved 'good' to 'excellent' functional mobility, comparable to global data on similar interventions (10).

Factors influencing functional outcomes

Age, sex, and the timing of surgery did not show statistically significant associations with functional outcomes. However, patients with associated ipsilateral limb fractures exhibited poorer recovery trends, emphasizing the complexity of multiple injury management although not statistically significant. Open fractures and multiple metatarsal involvement also correlated with slightly worse outcomes but were not statistically significant, aligning with global literature on the challenges of treating more severe fractures (11).

Physiotherapy played a beneficial role, although not statistically significant, in improving mobility and functional recovery. Additionally, patients who had their K-wires removed within 6 weeks showed better outcomes, suggesting that early hardware removal may reduce complications and enhance recovery. Post-operative hospital stays longer than seven days was associated with poorer outcomes, likely reflecting increased injury severity and complications, however, both of them were not statistically significant (12,13).

CONCLUSION AND RECOMMENDATIONS

The study highlights the effectiveness of K-wire osteosynthesis for managing metatarsal fractures in the short term. Further research with extended follow-up and larger sample sizes is necessary to optimize treatment protocols and improve patient outcomes.

REFERENCES

1. Sarpong, N.O., Swindell, H.W., Trupia, E.P. and Vosseller, J.T. Republication of "Metatarsal fractures." *Foot Ankle Orthop*. 2023; **8**(3): 45 - 49.
2. Samaila, E.M., Ditta, A., Negri, S., Leigheb, M., Colò, G. and Magnan, B. Central metatarsal fractures: A review and current concepts. *Acta Biomed*. 2020; **91**(Cm):36–46.
3. Stavrakakis, I.M., Tourvas, E.A., Magarakis, G.E., Sperelakis, I.V.., Kristan, A. and Tosounidis, T.H. Operative treatment of acute shaft and neck lesser metatarsal fractures: a systematic review of the literature. *Eur J Orthop Surg Traumatol* [Internet]. 2021; **31**(7):1263–71. Available from: https://doi.org/10.1007/s00590-020-02869-y

4. Patel, V., Deshpande, S.V., Goel, S., Suneja, A. and Jadawala, V.H. Intramedullary Kirschner wire fixation for metatarsal fractures: a comprehensive review of treatment outcomes. *Cureus*. 2024; **16**(4):1–13.
5. Sawe, H.R., Mfinanga, J.A., Lidenge, S.J., Mpondo, B.C.T., Msangi, S., Lugazia, E., *et al.* Disease patterns and clinical outcomes of patients admitted in intensive care units of tertiary referral hospitals of Tanzania. *BMC Int Health Hum Rights* [Internet]. 2014; **14**(1):26. Available from: http://www.biomedcentral.com/1472-698X/14/26
6. Mcharo, B. Motorcycle crash: injuries pattern and associated factors among patients treated at Muhimbili Orthopaedic Institute. MUHAS repository 2012.
7. Simplice, K.V. Prevalence and patterns of traunatic foot injuries at Mulago hospital. Makere University repository. 2012.
8. Pflüger, P., Zyskowski, M., Völk, C., Kirchhoff, C., Biberthaler, P. and Crönlein, M. Functional outcome of 111 metatarsal fractures following conservative in comparison to operative treatment. *Unfallchirurg.* 2022; **125**(4):288–294.
9. Kelsch, G. and Ulrich, C. Intramedullary k-wire fixation of metacarpal fractures. *Arch Orthop Trauma Surg*. 2004; (June 2000):523–526.
10. Berk, T.A., Smeeing, D.P.J., van der Vliet, Q.M.J., Leenen, L.P.H., Hietbrink, F., van Baal, M.C.P.M., *et al*. The use of patient-reported outcome measures in the literature on traumatic foot fractures: A systematic review. *Injury*. 2022; **53**(6):2366–72.
11. Cakir, H., Van Vliet-Koppert, S.T., Van Lieshout, E.M.M., De Vries, M.R., Van Der Elst, M. and Schepers, T. Demographics and outcome of metatarsal fractures. *Arch Orthop Trauma Surg*. 2011; **131**(2):241–245.
12. Jiang, J.T., Ye, T.B., Zhu, S.B. and Chen, C. Surgical treatment for isolated closed multi-metatarsal fractures: At least 2-year outcomes in 79 feet. *J Foot Ankle Surg*. 2023; **63**(2) :165-170.
13. Shenghua Zhang , Kun Yang , Qi Wang, *et al.* Treatment of fractures of metatarsal shaft using a cemented K-wire frame. *J Foot Ankle Surg*. 2020; **60**(1) 42-46.