

Original Article**Functional Outcome of Metacarpal Fractures Managed by Internal Fixation with Miniplate and Screws: A Cross-Sectional Study**Santosh Thapa¹, Dhiraj Singh¹, Oshan Shrestha², Ashish Rajthala¹, Ranjib Kumar Jha¹¹ Department of Orthopaedics, Nobel Medical College Teaching Hospital, Biratnagar, Nepal² Department of Surgery, Manmohan Cardiothoracic Vascular and Transplant Center, Katmandu, NepalArticle Received: 19th August, 2024; Accepted: 24th November, 2024; Published: 31st December, 2024DOI: <https://doi.org/10.3126/jonmc.v13i2.74450>**Abstract****Background**

Metacarpal fractures account for up to 40% of all hand fractures. This is commonly encountered among the general population, labour workers, and sportsmen. The appropriateness of the intervention in such cases becomes very important for treatment, rehabilitation, and an early return to work. The objective of this single-centre prospective study is to assess the outcomes of mini-plates and screws in the management of metacarpal shaft fractures.

Materials and Methods

This study was conducted among patients with metacarpal fractures. Ethical clearance was obtained before the commencement. This study included the patients that presented to the institution and got operated on from May 19, 2023, to May 18, 2024. The primary outcomes of this study were range of motion and quick disabilities of the arm, shoulder and hand (quick DASH) score. The data was analysed using the SPSS 20 software.


Results

A total of 22 patients met the inclusion criteria, out of which 14 were males and eight were females. The mean age of patients was 30.22 ± 8.93 years, and the most commonly affected digit was the middle finger (31.8%), commonly affected hand was the right hand (63.6%), and the most common mechanism of injury was fall (45.5%). Range of motion and quick disabilities of the arm, shoulder and hand (quick DASH) score improved significantly at six months when compared to those at three months.

Conclusion

Mini-plate and screws are effective methods of managing metacarpal fractures. It can be employed for good functional outcomes and fewer complications.

Keywords: Bone plates, Bone screws, Hand injuries, Metacarpal bones

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Introduction

The human hand, which can be taken as the most important instrument used in daily life, performs a wide range of tasks, from fine motor work to gross motor activity [1]. As the metacarpals are the skeleton for the lever system of flexion and extension of the hand, fracture of the metacarpals hinders this mechanism, making it hard for active workers or even for carrying out daily activities [2]. Metacarpal fractures account for about 40% of all hand fractures and are common among the general population, active labour workers, and sportsmen [3,4].

The appropriateness of the intervention becomes very important for treatment, rehabilitation, and an early return to work. A correct anatomical reduction that permits early mobility is essential. A common evidence-based consensus on first-line management is lacking and the modality chosen is dependent upon the operating surgeon [5]. The use of Kirschner wires for percutaneous pinning is a common modality, but mini-plates and screws are emerging as it allows firm fixation and early mobility, offering benefits in terms of functional outcome.

The objective of this prospective study is to assess the outcomes of mini-plates and screws in the management of metacarpal shaft fractures.

Material and Methods

This single centre prospective study was conducted in Nobel Medical College Teaching Hospital which is a tertiary level referral centre. This study included the patients that presented to the institution and got operated from May 19, 2023, to May 18, 2024. Ethical clearance was obtained from the regulating body (Institutional Review Committee of the institute) with the reference number 814/2023. A written informed consent was taken from the patients after explaining the nature of the study and the consent for publication of their data was taken. Inclusion criteria of this study were patients of age equal or more than eighteen years, patients who sustained metacarpal fracture, undergone operation at the study institution, completed follow-up till six months, and those providing consent. While, the exclusion criteria were patients of age less than eighteen, undergone surgery at different centre, and patients who did

not complete six months follow-up. Total population sampling, a non-probability sampling method, was applied in this study and all the patients that undergone surgery during the study period were assessed for the eligibility. A study tool with structured questionnaire was prepared for the data collection. This study tool included headings like demographic details (age and sex), details of fracture (digit involved, mode of injury, type of fracture and configuration of fracture), and outcomes [range of motion and quick disabilities of the arm, shoulder and hand (DASH) score]. Age, range of motion, and quick DASH score were the continuous variables while all others were categorical variables. Range of motion was assessed by using goniometer, at 3 months and 6 months after the surgery, from extended to flexed position of hand (0 to 90 degrees). The Quick DASH score was used to assess the subjective outcome of the surgery at 3 months and 6 months. This quick DASH questionnaire is a validated tool that include eleven questions that are used to compute a score [6]. Quick DASH score of 0-5 is excellent, 6-15 is good, 16-35 is satisfactory, and above 35 is a poor outcome [7]. The surgical procedure applied for all the participants of the study was the same. All received regional anaesthesia for surgery and prophylactic antibiotics thirty minutes before the incision. A tourniquet was applied to the arm, and dorsal approach was taken during the surgery. The fracture was reduced, and 2 mm mini-plates and screws were used for rigid fixation. After the closure, a below-elbow volar slab was applied, and mobilisation was started after two days, and the slab was removed after two weeks. Categorical variables of this study were analysed and presented using frequency and proportion. For continuous variables, normality of the data was assessed by Shapiro-Wilk test and statistical test was chosen accordingly. Normal data was presented using mean with standard deviation (SD) and skewed data was presented using median with interquartile range (IQR). Paired t test was used to compare the outcome of 3 months and 6 months for normal data and Wilcoxon signed-rank test was used for skewed data. The data was analysed using the Statistical Package for the Social Sciences (SPSS) version 20 software.



Results

A total of 27 patients presented with metacarpal fractures during the study period, but only 22 of them met the inclusion criteria of this study. Out of the 22 included participants, 14 were males and eight were females, with a mean \pm SD age of 30.22 ± 8.93 years. The most commonly affected digit was the middle finger (31.8%), commonly affected hand was the right hand (63.6%), and the most common mechanism of injury was fall (45.5%). In this study, the majority of patients had a closed type of fracture and a fracture in a transverse configuration. The details of the demographic variables and details of injury are given in Table 1.

Table 1: Demographic details of the participants

Variables	Sample group (N= 22)	
	n	%
Sex		
Male	14	63.6
Female	8	36.4
Finger involved		
Index	5	22.7
Middle	7	31.8
Ring	5	22.7
Small	5	22.7
Hand involved		
Right	14	63.6
Left	8	36.4
Mechanism of injury		
Fall	10	45.5
Road traffic accident	8	36.4
Punching	2	9.1
Sports injury	2	9.1
Fracture type		
Open	4	18.2
Closed	18	81.8
Fracture configuration		
Transverse	13	59.1
Spiral	9	40.9

The Shapiro-Wilk test was used to assess the normality of the variables, and the normality test showed that the range of motion at three and six months had a normal distribution. While quick DASH at three and six months showed that the variables had a skewed distribution, the mean \pm SD range of motion at three and six months was 73.77 ± 3.90 degrees and 85.05 ± 2.75 degrees, respectively. Similarly, the median (IQR) quick DASH score at three and six months was 13.63 (9.09–18.75) and 4.54 (2.27–6.71), respectively.

The paired t test was used to compare the range of motion outcome at three and six months, and it was found that the improvement in the range of motion was statistically significant [$t(21) = -13.37$, $p\text{-value} = < 0.05$]. And when the Wilcoxon signed rank test was used for the quick DASH outcome, it was found that the subjective symptoms of the patients also improved significantly ($Z = -4.054$, $p\text{-value} = < 0.05$). The details of these outcomes are presented in Table 2. The post-operative period was uneventful for all the patients and, none developed stiffness.

Table 2: Analysis of the main outcomes

Variable	Sample group (N= 22)		p-value
	At 3 months	At 6 months	
Range of motion (mean \pm SD)	73.77 \pm 3.90	85.05 \pm 2.75	< 0.05 ^a
Quick DASH [median (IQR)]	13.63 (9.09-18.75)	4.54 (2.27-6.81)	< 0.05 ^b

a: Paired sample t test; b: Wilcoxon signed rank test

Discussion

The use of pinning with wires or open reduction and internal fixation with plates have both been used as viable modality of management for one of the most commonly encountered hand fractures, the metacarpal fracture. The use of plates to fix the metacarpal breaks was first reported by Kilbourne et al. in 1958 [8]. As the metacarpals act as the skeleton for the lever system of flexing and extending the hand and fracture, which directly affects daily human activities, treatment modality needs to address that. This option of fixing more firmly and allowing early mobility has been growing since then.

Metacarpal plating, when plate is placed along the dorsal midline of the fracture, offers greater biomechanical stability compared to other alternative treatment modalities. Furthermore, plating also allows early mobility, which makes early hand physiotherapy possible, lowering the chances of post-operative stiffness and enabling an early return to work [5,9,10]. Mini-plates and screws are shown to give stronger hand grip power compared to other modalities, which may be attributed to the stability they provide and the early mobilization/physiotherapy they allow [5,11]. Also, the median load to fail plate fixation was about ten times more than it takes to fail other modalities [12]. A meta-analysis that



compared the outcomes of mini-plate fixation with Kirschner wire showed that the mini-plate fixation had lesser blood loss during the surgery, had significantly more patients with excellent/good outcomes, had early mobilization, had faster recovery, had better range of motion, and had fewer complications [9]. As the management of metacarpal fractures with mini-plates has been shown to provide faster recovery, early mobilization, fewer complications, better range of motion, and better hand grip power, this ensures an early return to work for the active workers, a lesser financial burden of healthcare costs, an early return to normal life, and a better quality of life.

In this study, we found that males had more incidence of metacarpal fractures compared to females. This finding is in line with the findings of other studies [11,13]. Other studies have hinted that the most frequently involved digit is the small finger but, in our study, we found that the involvement of middle finger was more frequent. The most common mechanism of injury identified by the present study was fall injury, and this finding is similar to the findings of other national and international studies [5,13]. Another national study has shown that road traffic accidents are the most common cause [14]. Other mechanism of injury besides fall and road traffic accidents included punching, and sports injury. Metacarpal fracture that is due to punching and involves the fifth metacarpal is termed as Boxer's fracture. In this study we had two of such cases. In the present study, we assessed the outcomes of mini-plates and screws for 22 metacarpal fractures. The outcome of interest of this study was range of motion and quick DASH score and the patients were followed up to six months. This study found out that the range of motion at three and six months was 73.77 ± 3.90 degrees and 85.05 ± 2.75 degrees respectively and this improvement was statistically significant. Similarly, the median (IQR) quick DASH score at three and six months was 13.63 (9.09–18.75) and 4.54 (2.27–6.71) respectively and this too was statistically significant. This improvement in outcome is similar to the findings of the study conducted by Ahmed et al [5]. The median quick DASH score at three months indicated a good outcome, and the median quick DASH score at six months indicated an excellent outcome (quick

DASH score of 0-5 is excellent and 6-15 is good). The post-operative period for all the patients was uneventful. The findings of the present study pointed towards the positive functional outcome of metacarpal fractures managed by internal fixation with mini-plate and screws. This study, however, had a smaller sample size, and the follow-up period was only six months. Also, outcomes like hand grip strength, objective assessment of fine motor work and gross motor work, fracture healing time, and return to work could not be studied. These were the limitations of this study.

Conclusion

Mini-plate and screws are effective methods of managing metacarpal fractures. Mini-plate and screws provide positive improvement in the range of motion and subjective symptoms of the patients. Mini-plate and screws can be employed for good functional outcomes and fewer complications.

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Conflict of interest: No conflict of interest.

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