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Functional outcome of metacarpal and phalangeal fractures treated with open reduction and internal fixation using plates and screws in a tertiary level hospital

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ABSTRACT

Introduction: Metacarpal and phalangeal fractures are common injuries encountered in orthopaedic practice. Traditionally, these fractures needing operative treatment have been managed with closed reduction and percutaneous pinning with various wire positions/configurations. Operative treatment, plate and screw fixation provides superior biomechanical strength compared to k wire.

Objectives: To evaluate the functional outcome of metacarpal and phalangeal fractures treated with open reduction and fixation with screws with or without plates.

Methodology: The study was conducted in KMC Teaching Hospital, Sinamangal, Department of Orthopaedics. The study included 36 metacarpal and 11 phalangeal fracture cases in 38 patients. All included patients were operated with open reduction and internal fixation with 1.5 mm mini plate systems. Both metacarpal and phalangeal fracture were treated with dorsal approach. Patients were discharged on second post operative day after wound inspection. Functional outcome was evaluated with DASH scoring system at six weeks, three months, and six months post operatively.

Results: Out of 38 patients two were lost to follow-up. Among 36 patients at six weeks post-surgery, average DASH score was 63.18±15.3. This score improved to an average of 32.62±16.15 and 4.23±5.97 at three months and six months respectively. Among 44 bones fixed, 31 bones showed radiological union at the end of three months. One case did not show union at six months.

Conclusion: Mini plate and screw constructs provide superior biomechanical strength. Hence, rigid stable fixation provided by plating allowed early mobilization and achieved good functional results. Proper preoperative planning and sharp dissection with meticulous handling of soft tissue minimize complications.

Keywords: Disabilities of the Arm, Shoulder and Hand (DASH) score; Metacarpal and phalangeal fracture; Open Reduction Internal Fixation with mini plate and screw.

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INTRODUCTION

Metacarpal and phalangeal fractures are common injuries accounting for up to 42% of injuries around the hand and wrist.[1,2]. Many of these fractures which are undisplaced or minimally displaced can be treated conservatively.[3] Operative treatment is recommended for fractures with over five degrees of rotation, more than 50 % fracture translation, or more than six mm of shortening.[4]

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Traditionally, metacarpal and phalangeal fractures needing operative treatment were managed with closed reduction and percutaneous pinning with various wire positions/configurations. The advantage of closed reduction and percutaneous k-wire fixation is less chances of post-operative wound infections. Fracture healing is not an isolated goal, functional result is of paramount importance.[5]

With advents in metallurgy and implant design, small 1.5 mm stainless steel or titanium plate and screw systems have become popular. Plate and screw constructs provide superior biomechanical strength compared to k wires (intramedullary or crossed).[6–8] The strength of a plate and screw construct provides up to 20 times the strength required to withstand physiological loads.[9] Six cortices of bone fixation on either side of a fracture were deemed necessary. This study aims to elucidate whether four cortices of locked fixation on either side of the fracture is equivalent to the current gold standard of six cortices of nonlocked fixation on either side of the fracture. If so, less dissection to insert shorter plates with fewer screws could be used to stably fix these fractures. Rigid stable fixation provided by plating allowed early mobilization and achieved good functional results.[4] This study aims to evaluate the functional outcome of metacarpal and phalangeal fractures treated with Open Reduction Internal Fixation (ORIF) with plates and screws.

METHODOLOGY

This study was non-randomized single arm trial conducted in Kathmandu Medical College Teaching Hospital (KMCTH), Sinamangal, Department of Orthopaedics. Patients with history of trauma to the hand with fractures of the metacarpal and phalangeal bones were enrolled in the study. Patients with fractures of metacarpal and phalanges presenting within 2 weeks of injury were included. Pathological fractures, concurrent tendon/neurovascular injuries, concurrent injury to any part of same limb, compound fractures and patients lost to follow up were excluded from study.

Study was conducted from July 2023 to June 2024 after getting approval from institutional review committee of KMCTH (ref no. 12052023/08). The study included 36 metacarpal and 11 phalangeal fracture cases in 38 patients. All included patients were operated with open reduction and internal fixation with 1.5 mm mini plate systems. For metacarpals, dorsal approach was used with skin incision directly over the metacarpals, retracting the extensor tendon to one side and direct incision over the metacarpal periosteum. For phalangeal fractures, dorsal approach was used with the extensor tendon/central slip being incised at the centre and the two halves being retracted to either side. After fixation was complete, integrity of fixation under full range of motion was inspected to verify ability of fixation to withstand early active post-operative mobilization.

Post operatively, wound inspection was done on the 2nd day. Gentle range of motion exercises were allowed for the metacarpophalangeal joint (MCPJ) and interphalangeal joint (IPJ) of the concerned digit as soon as oedema and pain subsided (between 3-7th day postoperatively). Skin sutures were removed at 2nd weeks post operatively. X rays were obtained immediate post operatively, at 2nd weeks, 6th weeks, and 3rd months post operatively.

Functional outcome was evaluated with Disabilities of Arm, Shoulder, and Hand (DASH) scoring system at 6th week, 3rd month, and 6th month post operatively.

All data were entered into Microsoft excel data sheet and analysed with Statistical Package for the Social Sciences (SPSS) 25 version. The quantitative variables were calculated in terms of mean, standard deviation and qualitative variables were expressed as frequencies and percentages. For this study, mean and standard deviation was used to show continuous data. Comparison of DASH score at different follow up was done using Repeated Measure ANOVA. P value < 0.05 was considered statistically significant.

RESULTS

In this study total 38 patients were selected. ORIF with mini plate and screws fixation was done for metacarpal fracture and phalangeal fractures. Only 36 patients completed required follow up to the period of six months and two patients lost for follow-up.

The commonest mode of injury was assault and self-fall i.e. 15 (41.7%) (Table 1). The mean age of the patients was 25.9±9.9 years with male predominant of 33 (91.7%) (Table 2). At six weeks post-surgery, the average DASH score was 63.18±15.3. This score improved to an average of 32.62±16.15 at three months post-surgery. The average DASH score at six months of assessment was 4.23±5.97 showing significant improvement with p – value < 0.01 (Table 3). One case did not show union at end of six months and two patient lost in follow up after last visit at 6 weeks.

Table 1: Distribution of participants according to mode of injury (MOI)

MOI	n (%)
Assault	15 (41.7)
Crush	1 (2.8)
RTA	5 (13.8)
Self-fall	15 (41.7)

Table 2: Distribution of participants according to sex

Sex	n (%)
Female	3 (8.3)
Male	33 (91.7)

Table 3: Comparision of DASH score mean and standard deviation at follow up.

DASH Score	(n)	Mean ± SD	p- value
6 weeks	36	63.18 ± 15.31	<0.001*
3 Months	36	32.62 ± 16.16	
6 Months	36	4.23 ± 5.97	

p-value significant at <0.05, * = Repeated measure ANOVA

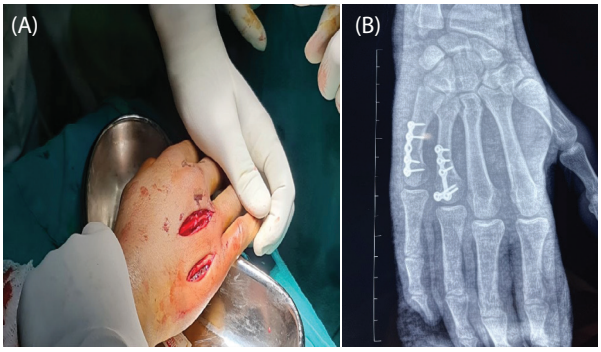

Figure 1: (A) intraoperative image of plate and screws fixation (B) post-operative x-ray image

DISCUSSION

The treatment of metacarpal and phalangeal fractures has evolved significantly in recent times. Conservative management of these fractures was the norm formerly, simply because effective methods of stable fixation were not available.

However, the importance of early mobilization in fractures in the hand have been well documented. Conservative management entails immobilization for prolonged periods, possibly leading to stiffness. Methods such as buddy strapping have been shown to be an acceptable compromise that provide reasonable stabilization while permitting movement to avoid stiffness.

K wires have been a time tested and reliable method of fixation of metacarpal and phalangeal fractures. They are available in fine sizes, and provide enough stability. However, they are difficult to use in certain fracture configurations and locations, and often have to be placed through tendons or joints, which may cause stiffness or produce secondary problems/deformities. Additionally, k wires also carry the risk of pin tract infections. Dreyfuss and his colleague, in his study compared mini plate and screws with pinning technique for metacarpal shaft fracture.[4]

In this study there was male predominance with 91.7% which was similar to study conducted by Madaway et al. and Raghavendra et al. which showed 93.3% and 80% male predominance respectively. Fixation with plates and screws have lately gained popularity with the availability of mini 1.5 mm fixation systems. Plates are available in various lengths and shapes such as L, T, and Y shaped heads, which are appropriate for fractures of different configurations in various parts of the bone. In this study, 38 patients with 47 fractures were treated with mini plate and screws fixation. Similarly, study was done by Sridhar and colleague in 48 patients with metacarpal fracture.[13] 92% of reviewed patients had excellent recovery of total active flexion.[3]

Although ORIF with mini plate and screws requires incision and soft tissue dissection, with proper atraumatic technique and sharp dissection, tissue trauma and hence scarring can be kept to a minimum. In this study, there were no cases of surgical site infection in patients. A good reduction with stable plate and screw fixation will allow early mobilization (within a few days post-surgery), due to which stiffness can me minimalised and the patient is able to regain full early range of motion, allowing earlier return to sport and heavy manual work.[4] Also, unlike a k- wire in which a part of the implant is outside the skin, plate and screw fixation allow the implant to be completely buried inside, which can actually reduce the infection rate as it avoids the problem with pin site infections and skin problems that might occur with k wires.[4]

Plate fixation was found to be advantageous to pin fixation in several parameters such as grip strength, range of motion, residual rotation, and DASH scores. In a study by Dreyfuss, patients were found to have DASH

scores of 10.5 for plate and screws and 15.6 for pinning.[4] Similarly, in this study at final follow up DASH score was 4.23 ± 5.97 which showed excellent outcome following mini plate and screws fixation. Eight percentage loss in grip power for two mm metacarpal shortening.[10] Intramedullary fixation has higher incidence of loss of reduction, nail penetration into the joint, and tendon irritation.[11] In this study, there were no any complications like loss of reduction, shortening but one bone (4th MC) did not unite even at the end of six months and needed to be re operated (re fixation with bone grafting). Two patients required early implant removal (before one year post operatively) due to implant impingement on tendons during movement. All patient had good range of motion with grip strength at final follow up. Similar, result was seen in study by Gupta and his colleague in patients who had undergone plate and screw fixation.[12]

CONCLUSION

Mini plate and screw constructs provide superior biomechanical strength. Hence, rigid stable fixation provided by plating allowed early mobilization and achieved good functional results. Careful preoperative planning, proper atraumatic technique and sharp dissection, meticulous soft tissue handling help in achieving good results and minimize complication.

Conflict of interest : None
Source (s) of support : None

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