

## Prospective Comparative Study of Functional Outcome of Management of Metacarpal Fracture with Plating and K Wiring

Manas Pusalkar<sup>1</sup>, Shivraj Konde<sup>2</sup>, Santosh Borkar<sup>3</sup>, Vijith Hegde<sup>4</sup>, Nikhil Kulkarni<sup>5\*</sup>

<sup>1</sup>Assistant Professor, Department of Orthopaedics, M.I.M.E.R Medical College and Dr. BSTR Hospital, Talegaon, Pune-410507

<sup>2</sup> Associate Professor), Department of Orthopaedics, M.I.M.E.R Medical College and Dr. BSTR Hospital, Talegaon, Pune-410507

<sup>3</sup>Professor, Department of Orthopaedics, M.I.M.E.R Medical College and Dr. BSTR Hospital, Talegaon, Pune-410507

<sup>4</sup> Junior Resident, Department of Orthopaedics, M.I.M.E.R Medical College and Dr. BSTR Hospital, Talegaon, Pune-410507

<sup>5</sup>Junior Resident), Department of Orthopaedics, M.I.M.E.R Medical College and Dr. BSTR Hospital, Talegaon, Pune-410507

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Received: 19-12-2023 Revised: 21-12-2023 / Accepted: 14-01-2024

Corresponding author: Dr. Nikhil Kulkarni

Conflict of interest: Nil

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### Abstract

**Introduction:** Metacarpal and phalangeal fractures constitute a significant portion of musculoskeletal injuries, often resulting from roadside accidents and machine-related incidents. Achieving optimal functional outcomes in hand injuries remains challenging, considering the potential for disability due to sensory loss, decreased strength, and impaired flexibility. This study aims to evaluate the clinical and radiological outcomes of metacarpal fractures treated with Open Reduction Internal Fixation (ORIF) using plating and Closed/Open Reduction Internal Fixation employing K-wire fixation.

**Material and Methods:** A prospective comparative study was conducted at a tertiary care hospital from December 2020 to November 2022. Twenty patients with metacarpal fractures in each group underwent either K-wire fixation (Group 1) or ORIF with plating (Group 2). K-wires were removed after 4 weeks, and follow-ups were conducted at 2 weeks, 4 weeks, 6 weeks, 3 months, and 6 months to assess radiological union, range of motion (ROM), grip strength, and Disability of Arm, Shoulder, and Hand (DASH) scores. Qualitative data were presented as frequencies and percentages, and associations were evaluated using statistical tests.

**Results:** A significantly shorter time to fracture union in the plating group compared to the K-wire group was observed. Moreover, the plating group demonstrated better range of motion and grip strength at 6 weeks, 3 months and 6 months post-surgery. Functional outcomes, assessed by the DASH questionnaire showed excellent results in the plating group compared to the K wire group.

**Conclusion:** Our findings indicate that healing time was significantly less in plating group compared with K wire group. The range of motion and grip strength was better in plating group. Notably, the plating group demonstrated better functional outcomes and a lower incidence of post-operative complications.

**Keywords:** Metacarpal, Plating, K wire, DASH questionnaire.

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### Introduction

Metacarpal and phalangeal fractures account for 18 to 44 percent of musculoskeletal fracture, with phalangeal fractures comprising of 1% of hand fractures in normal population. [1,2] Two major causes of these fractures are roadside accident and machine injuries. [3,4,5] Optimal functional results are not easy to achieve in hand injuries Hand injury may cause significant disability from loss of sensation, loss of strength and flexibility.[6,7]

Considerable judgment is required to select the appropriate modality. A closed approach is preferred in stable and undisplaced hand fractures. Surgery is inevitable in unstable and displaced hand fractures. [8] Out of various treatment options available for internal fixation, K-wires and plate fixations predominates. [9] Operative treatment of solitary metacarpal fractures is reserved for displaced fractures with significant shortening, rotation or

both.[10] K wire was the first fixation material to be used in the clinic, and intramedullary fixation with K wire has many advantages, such as being economical, minimal invasive, and easily available. However, after years of practice, intramedullary fixation with K wire was found to have disadvantages such as its unreliable fixation effect and high occurrence of surgical sequelae. [11]

Complications associated with k wire include infection, non-union, malunion and that with plating includes implant failure, implant irritation, skin necrosis[12]. Results of the previous studies comparing these two treatment modalities was equivocal. [13-15] The present study was thus planned to evaluate the clinical and radiological outcome of patients of metacarpal fractures with Open Reduction Internal Fixation (ORIF) with Plating and Closed / Open Reduction Internal Fixation with K Wire.

### Materials and Methods

A Prospective comparative study was carried out at Department of Orthopaedics at a tertiary care hospital for two consecutive years from December 2020 to November 2022. Patients with metacarpal fractures requiring surgical treatment were enrolled in study after taking written and informed consent. Institutional Ethics Committee approval was taken.

Two groups were enrolled in the study. Group 1 consisted of 20 metacarpal fractures operated with K-wire fixation. Group 2 consisted of 20 metacarpal fractures treated with Open reduction and plating. Patients with displaced metacarpal fracture who presented to our hospital were given two surgical

options of K-wire and plating after they agreed to participate in this study. Pros and cons of each surgical technique was explained to the patient by the members of operating team. Patients were operated according to the described surgical technique of K-wire or Open reduction with plating as soon as patients were fit for operative procedure. Inclusion criteria included closed displaced metacarpal fractures, age above 18 years and fracture less than 3 weeks old. Intraarticular fractures, comminuted fractures (more than >3 parts), pathological fractures and compound fractures were excluded from this study.

For plating of metacarpal fractures following technique was followed:-

For a single metacarpal fixation we used the dorsal incision which was centred over the metacarpal directly. In cases when there were adjacent metacarpal fractures we utilised the dorsal incision between the two metacarpals. Care was taken to protect the dorsal sensory skin branches throughout the procedure. Extensor tendon to the associated digit was retracted. Subperiosteal dissection was carried out to expose the fracture site which was cleaned of haematoma and debris. Fracture was reduced and provisionally fixed by 'K' wire and a plate utilised to stabilise the fracture. 2.4 mm system Locking Compression Plate or 2.4 mm Locking compression T plate or 2,4 mm Locking compression condylar plate was used in our series. An attempt was made to close periosteum over the plate to reduce the contact of extensor tendon and the plate. Confirmation of the screw sizes was done by fluoroscopy. Closure of subcutaneous layer was done with the help of polyglactin absorbable sutures.



Figure 1: Pre operative A.P and Oblique X ray of hand



Figure 2: Post operative A.P and Oblique X ray of hand



**Figure 3: Dorsal approach for 2<sup>nd</sup> metacarpal shaft fracture**



**Figure 4: Application of plate using dorsal approach**

For K-wire fixation of metacarpal fractures following technique was followed:-

Out of 20 patients in K wire group, 18 patients were managed by Closed reduction and K-wire fixation while 2 patients required open reduction and approach for the open reduction was similar as described in the plating group

Closed reduction in patients of metacarpal neck fracture was performed by using Jahss manoeuvre by flexing the MCP and PIP joint and applying dorsally directed pressure on the metacarpal head through the proximal phalanx to control excessive angulation. Closed reduction for metacarpal shaft fractures was done by digital manipulation and traction under fluoroscopy guidance. Insertion of K wires was done using two different techniques. For the Bouquet technique a small incision was taken

proximally over the metacarpal base. Tendons and any neurovascular structures encountered were protected. A 0.062 inch K-wire was used to create a pilot hole in base of metacarpal. A 0.054 inch K wire was then placed with a slight bend on the tip and was gently advanced distal to the fracture site. Another K-wire was bent on the tip and advanced in similar fashion K-wire was bent and cut.

Retrograde K wire technique was used for metacarpal shaft fractures. The incision was taken over the MCP joint and the extensor tendon was split in the middle which was repaired later. Then a K wire of size 0.059 inch was selected and was inserted through the dorsal portion of metacarpal head and passed across the fracture site. The procedure was done under fluoroscopic guidance.



**Figure 5: Pre op AP view of hand revealing displaced 5<sup>th</sup> metacarpal neck fracture**



Figure 6: Pre op oblique view of hand revealing displaced 5<sup>th</sup> metacarpal neck fracture



Figure 7: Post op AP view of hand revealing K wire fixation of 5<sup>th</sup> metacarpal neck fracture



Figure 8: Post op oblique view of hand revealing K wire fixation of 5<sup>th</sup> metacarpal neck fracture

Appropriate Post Op. X-Ray - AP, Oblique view were taken. Occupational therapy aiming for gentle finger mobilisation was started after second day of surgery. Dressings were done on day 2 of surgery followed by suture removal on day 14. Patients were discharged from the hospital once they were comfortable. K-wire was removed after 4 weeks. First follow up was done after 2 weeks for suture removal. Second follow up for k-wire group was done at 4 weeks for removal of the K-wires. Third

follow up was done at 6 weeks with X-Ray AP and oblique views to evaluate union and ROM, Grip strength, Follow up at 3 months and 6 months was done to assess the ROM, grip strength and DASH Questionnaire. The final outcome of study was analysed by DASH score after 6 months of follow up.

All the data was noted down in a pre-designed study proforma. Qualitative data was represented in the form of frequency and percentage. Association

between qualitative variables was assessed by Chi Square test with Continuity Correction for all 2 X 2 tables and Fisher's exact test for all 2 X 2 tables.

Quantitative data was represented using Mean  $\pm$  SD. Analysis of Quantitative data between the two groups was done using unpaired t-test if data passed 'Normality test' and by Mann-Whitney Test if data failed 'Normality test'. A p-value  $< 0.05$  was taken as level of significance. Results were graphically represented where deemed necessary. SPSS Version 21.0 was used for most analysis and Microsoft Excel 2010 for graphical representation.

## Results

**Table 1: Demographic characteristics**

| Characteristics             | Plating group   | K-Wire group  |
|-----------------------------|---|---|
| Gender                      | Female:4<br>Male:16   | Female:5<br>Male:15   |
| Age(years)                  | 36.95   | 38.85   |
| BMI                         | 23.16   | 23.55   |
| Injured Dominant hand       | 18  | 16  |
| Mode of injury              | Assault:7<br>Fall:4<br>vehicle accident:14                            | Assault:3<br>Fall:2<br>vehicle accident:10                            |
| Fractured metacarpal digits | Index finger:4<br>Little finger:7<br>Middle finger:3<br>Ring finger:6 | Index finger:4<br>Little finger:7<br>Middle finger:2<br>Ring finger:7 |
| Anatomical location         | Base:1<br>Neck:2<br>Shaft:17  | Base:2<br>Neck:3<br>Shaft:15  |

Location of fracture of metacarpal in K-wire group was shaft in 75% patients, neck in 15% patients and base in 10% patients while location of fracture of metacarpal in plating group was shaft in 80% patients, neck in 12.5% patients and base in 7.5% patients (p=0.72).

Mean age of the cases in plating group was 36.95 and mean age for K-wire group was 38.85 years (p=0.54).

There were 5 females in plating group and 4 females in K-wire group out of 20 patients in each group (p=1.0).

Mode of injury in K-wire group was 75.0% road traffic accident, fall 20% and assault was 5% and mode of injury in plating group was 80.0% road traffic accident, fall 10.0% and assault was 10% (p=0.59).

Most common site of fracture in K-wire group was little finger (35%) and ring finger (35%) followed by index (20%) and long finger (10%) while most common site of fracture in plating group was little finger (35%) and ring finger (32.5%) followed by index (20%) and long finger (12.5%) (p=0.96).

**Table 2: Statistical analysis of operative time, hospital stay and functional outcome**

| Characteristics                               | Plating group  | K-wire group   |
|---|----------------|----------------|
| Operative time(mins)                          | 73.57          | 29.45          |
| Hospital stay(days)                           | 4.72           | 2.89           |
| Range of motion at 3 months(in degrees)       | 89.00(SD=7.12) | 77.77(SD=9.86) |
| Average DASH Score at six months follow up    | 5.35           | 15.82          |
| Grip strength at six months follow up(in lbs) | 110.45         | 96.3           |
| Radiological healing(weeks)                   | 7.2            | 9.8            |

Mean time to treatment from injury was 3.23 days with no difference between study groups (p=0.279). Mean duration of surgery (73.57 vs 29.45 mins) and hospital stay (4.72 vs 2.89) days was comparable in plating and K-wire group.

Mean time to fracture union was significantly shorter in cases managed by plating as compared to K wire (7.2 vs 9.8 weeks).

The mean range of motion at Metacarpophalangeal joint of plating group was 46.64, 57.06 and 81.05 at

2 weeks, 6 weeks and 3 months respectively while the mean range of motion of K-wire group was 42.65, 51.30 and 73.61 at 2 weeks, 6 weeks and 3 months respectively.

Improvement in mean range of motion was more pronounced in plating group as compared to K-wire group with significant difference at 6 weeks and 3 months (p<0.01)

The mean grip strength as checked by dynamometer in pounds of plating group was 17.38, 24.60 and

,52.55 at 2 weeks,6 weeks and 3 months respectively while the mean grip strength of K-wire group was 15.15,20.24 and 39.61 at 2 weeks,6 weeks and 3 months respectively.

Significant improvement of grip strength at final follow up at 6 months was noted in both groups.

Improvement in mean grip strength was more pronounced in plating group as compared to K-wire group with significant difference at 6 weeks and 3 months(p<0.01).

Functional outcome was graded as per DASH questionnaire and was graded into 4 categories which were excellent, good, fair, poor. Functional outcome in our series was excellent, good, fair, poor in 6,8,4,2 cases respectively in K-wire group while functional outcome was excellent, good, fair, poor in 14,5,1,0 cases respectively in plating group(p=0.34).

Excellent to good functional outcome was seen in 95% cases of plating as compared to 70% cases of k-wire. Fair to poor outcome was noted in 30% cases of k-wire and 5% cases of plating group respectively (p<0.01).

**Table 3: Comparison of recovery at 6 months follow up as measured by dash score**

| Results      | Plating group(N=20) | K-wire group(N=20) |
|--------------|---------------------|--------------------|
| Excellent    | 14                  | 5                  |
| Good         | 5                   | 8                  |
| Satisfactory | 1                   | 4                  |
| Poor         | 0                   | 3                  |

There were 2 cases of delayed union and 4 cases of infection and no case of implant loosening in k-wire group while there were no case of delayed union, 1 case of infection and 1 case of implant loosening in

plating group. Infection was significantly higher in K wire group compared to the plating group(p<0.01) All the infections noted in K-wire group were superficial pin tract infections which responded to oral antibiotics.

**Table 4: Complications**

| Characteristics                   | Plating group(N=20) | K-wire group(N=20) |
|-----------------------------------|---------------------|--------------------|
| Infection                         | 1                   | 4                  |
| Delayed union                     | 0                   | 2                  |
| Implant loosening                 | 0                   | 2                  |
| Stiffness of fingers at MCP joint | 2                   | 6                  |

**Discussion**

Metacarpal and phalangeal fractures are often neglected or regarded as trivial injuries. Optimal functional results are not easy to achieve in hand injuries. Hand injury may cause significant disability from loss of sensation, loss of strength and flexibility. Considerable judgment is required to select the appropriate modality. A closed approach is preferred in stable and undisplaced hand fractures. Surgery

is inevitable in unstable and displaced hand fractures. Out of various treatment options available for internal fixation, K-wires and plate fixations predominates.

Results of the previous studies comparing these two treatment modalities was inconclusive. The present study was thus planned to evaluate the clinical and radiological outcome of patients of metacarpal fractures with Plating and K Wire.

Our study was in line of the previous study done by Ahmed Z et al. in terms of longer operative time for plating group and longer hospital stay[. 16]However the previous study done by Fuzhou Lv et al. revealed more operating time in the K-wire group.[17] Our study was comparable to previous studies done by

Ahmed et al.in terms of clinical presentation. Most common location of fractures was observed as shaft followed by base and then neck.The results of our study showed that fracture healing time of plating group was significantly shorter than K-wire group which matched the previous study done by Fuzhou Lv et al. The incidence of post-operative complications in our study in plating group was lower than that in K-wire group with a statistically significant difference. In the previous comparative study done by Ozer et al. [18] the clinical results were similar in K-wire and plating group however there was need of second operation to remove the plate in few patients of plating group. In our study the clinical results were significantly better in plating group in terms of grip strength of hand, DASH score and time of union.

Our research has some limitations. It was a single centered comparative study and a multicentric study with longer follow up will be needed to verify whether the findings of our study are universally accepted. Other limitations were the narrow number of patients, without randomization and inclusion of different anatomical locations of metacarpal fractures.

## Conclusion

Present study observed that open reduction and internal fixation of fracture metacarpal with locking plate is a better option than k-wire fixation. It effectively provides patients with better stability, which promote faster fracture healing and early joint function recovery. Better functional outcome was observed after plating along with lower incidence of post-operative complications.

Hence, we conclude that plate fixation is more effective than k-wire fixation in the management of metacarpal fractures.

However ours was a prospective cohort comparative study with small sample size and not a randomized control trial hence further randomized control trials for comparison between the two groups will be needed in the future to come at a definitive conclusion to decide which treatment method is better.

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