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# MANAGEMENT OF METACARPAL FRACTURE TREATED WITH CLOSED INTRA-MEDULLARY PRE-BENT K-WIRE INSERTION USING BOUQUET TECHNIQUE

**Orthopaedics**

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## ABSTRACT

**Background:** Metacarpal fractures are among the most common fractures majority of which are treated conservatively. There are numerous indications and techniques for operative fixation. The purpose of this research is to study the management of metacarpal fracture treated with intramedullary pre-bent K-wires using Bouquet technique. **Materials and Method:** 100 patients aged between 18-60years, with 100 closed metacarpal fractures involving shaft and neck region, which were ≤2weeks old, were included in this study. Radiograph of the involved hand anteroposterior (AP) and oblique views were obtained. Postoperative immobilization and rehabilitation regimen were followed for all the patients. Outcome assessment was done using Visual analogue score (VAS), Disabilities of the arm, shoulder and hand (DASH) score, Total active movement (TAM) and grip strength. Radiographs were taken at regular intervals. Descriptive statistical analysis was done using MS Excel 2019. **Result and Observations:** Out of 100 patients, 73 were male, with overall mean age of 31.76±10.46 years. Right side was affected in 63 patients, however the dominant side was involved in 73 cases. Metacarpal shaft was involved more often (77/100 cases). Most common cause was sports injury. At final follow-up, mean post-op VAS was 0.33±0.54, mean post-op DASH score was 2.44±3.91, mean TAM score was 232.33±22.38º and the mean grip strength was 94.37±6.53%. Pin tract infection was seen in 13 patients; pin loosening in 10 patients and partial stiffness in 7 patients. **Conclusion:** The proposed technique is simple, minimally invasive, less time consuming and provides satisfactory stabilization for early union. This fixation technique also showed good functional and radiographic outcome with few complications.

## KEYWORDS

Metacarpal fracture, Intramedullary pre-bent K-wire, Bouquet technique, Total active motion, Foucher's technique, metacarpal shaft fracture, metacarpal neck fracture.

## INTRODUCTION

Trauma to the hand is very common resulting in metacarpal fractures and dislocations.[1] Hand is prone to a variety of injuries especially in industries, agricultural fields and adding to this are increased road traffic accidents (RTA) leading to increase in incidence of phalangeal and metacarpal fractures. Unfortunately, metacarpal and phalangeal fractures are often neglected or regarded as trivial injuries.[2]

Metacarpal fractures are divided into fractures of metacarpal head, neck and shaft. Treatment is based on which metacarpal is involved and location of the fracture. Metacarpal fracture accounts for 40% of all hand fractures. Neck of metacarpal is the most common site of fracture and fracture of neck of the 5th metacarpal is the most frequently encountered.[3] The usual mechanism of injury is direct blow to the hand or rotational injury with axial load. Common causes of the fracture are falls, sporting incidents, RTAs and fighting. Any one of the metacarpals can be fractured and sometimes more than one is fractured. The little finger and the thumb metacarpals are the most frequently fractured[1]. Most of the metacarpal fractures are always functionally stable either before or after closed reduction (CR) and fare well after applying protective splint and early mobilization. The closed treatment has a poor reputation due to problems of malunion, stiffness, and sometimes loss of skin and other soft tissues.

Therefore, selection of the optimum treatment depends on a number of factors, including fracture location, fracture geometry, deformity, whether they are open or closed, and fracture stability.[4] Various modalities of treatment in use for metacarpal fracture are non-operative closed reduction and immobilization with POP slab/cast, whereas operative fixation techniques include percutaneous K-wire, cerclage wiring, plating, lag screws, tension band wires and external fixators.[5-8] Among these techniques, K-wire fixation is very popular due to simplicity of the procedure and minimal soft tissue interference.[9]

In 1975, the "Bouquet" technique of closed anterograde nailing of metacarpal fractures using multiple small pre-bent K-wires was introduced by Foucher. The technique avoided both opening the fracture site and injury to the soft tissues around the metatarso phalangeal joint.[10] This technique Reserves both carpometacarpal and metacarpophalangeal joints and spares the extensor hood and the tendon.[11] In this study we have used Foucher's "Bouquet" technique. With the elastic pre-bent K wire acting as a three-point fixation, adequate stability is achieved to commence early mobilization. Abundant periosteal callus is generated due to minimal soft tissue dissection, avoidance of periosteal stripping and flexible fixation as opposed to rigid fixation; thereby encouraging fracture healing.[9]

## AIM AND OBJECTIVES:

To study the clinical, radiological and functional outcome of intramedullary pre-bent K– wire insertion using Bouquet technique in metacarpal fracture in terms of VAS, union time, grip strength, DASH score and TAM.

## MATERIALS AND METHOD:

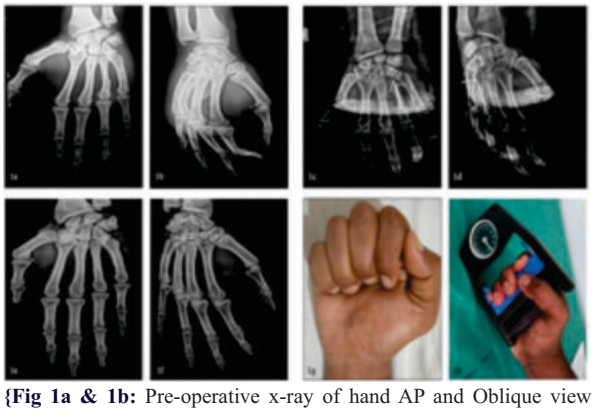
This 2 year hospital based prospective study conducted between Jan 2021 and Dec 2022 in the Department of Orthopaedics, AMCH, Dibrugarh, Assam, included 100 patients aged between 18 and 60 years with fracture of metacarpal shaft or neck. Pre- operative radiograph of hand AP view and Oblique view was obtained to diagnose the metacarpal fracture (Fig 1a & 1b). All metacarpal fractures were treated with closed intramedullary pre-bent k-wire

using Bouquet technique (Fig 1c & 1d). Patients were followed up at 2nd, 4th, 6th, 8th, 12th, 24th week and at 12 months. Post-operatively, operated hand was immobilized using POP slab in intrinsic plus position for initial 2 weeks, followed by mobilization of proximal interphalangeal joint was begun immediately after surgery whereas the metacarpophalangeal joint mobilization was started after 2 weeks under supervision when the splint was removed. Under the supervision of hand therapist, gentle range of movements was commenced and physiotherapy was continued for 2 months. All cases were followed up for minimum period of 12 months. Fracture union was assessed using AP and Oblique view radiograph of operated hand at each follow up and K-wires were removed once union was achieved (Fig 1e & 1f). Outcome was assessed using VAS, DASH score, TAM score (Fig 1g), Grip strength (Fig 1h). The functional outcome was graded according to TAM score as Excellent (260-220), Good (219-180), Fair (179-130) and Poor (<130). Descriptive statistical analysis was done for the data collected using Microsoft Excel 2019.

**Surgical Technique:**

A blunt 1.2 mm K-wire was beveled at one end and the tip was bent into a skid shape 10º at 5mm and 20º at 1cm from the tip. A gentle traction and manipulation of distal segment was done in order to achieve the alignment and reduction for metacarpal shaft fractures. In case of metacarpal neck fractures, Jahss maneuver was carried out. Following reduction of the fracture, a 2 cm skin incision was made on the dorsal aspect of the hand over the base of the fractured metacarpal. Then, an oblique drill hole was made over the dorso-medial cortex of the base of the metacarpal using a 3.2 mm drill bit to facilitate the entry of the K-wires. With traction on the digit, the T piece mounted pre-bent K-wire was then inserted in an antegrade manner, first into the medullary canal of the proximal metacarpal fragment and then pushed into the distal fragment across the fracture site following manipulation of distal fragment, under image intensifier.

The final position of the K-wire was checked under C- Arm intraoperatively. Similarly, another 1.2mm pre-bent K-wire was inserted successively through the same entry point into the medullary canal in divergent direction so that they appeared as a flower bouquet in the metacarpal head. The proximal ends of the wire were bent and cut, leaving sufficient length for secondary removal of the K-wires. The skin incision was closed and a light dressing was applied. In all metacarpal fractures, the hand was put in an intrinsic plus position splint (80º MCP joint flexion and IP joint full extension).



**{Fig 1a & 1b:** Pre-operative x-ray of hand AP and Oblique view showing displaced 4th metacarpal shaft fracture. Fig 1c & 1d: Immediate post-operative x-ray of hand AP and Oblique view showing intra-medullary pre-bent K- wire fixation of 4th metacarpal fracture. Fig 1e & 1f: X-ray of hand AP and Oblique view showing union of 4th metacarpal fracture at final follow-up. Fig 1g: Total active movement of hand at final follow-up. Fig 1h: Grip strength of hand at final follow-up.}

**Table 1: Outcome measures and their mean value and range at the final follow-up**

| OUTCOME MEASURES | MEAN VALUE AT FINAL FOLLOW-UP |
|---|---|
| UNION TIME | 5.93 ± 1.43 weeks (4-8 weeks) |
| VAS | 0.33 ± 0.54 (0-2) |
| DASH | 2.44 ±3.91 (0.0-13.3) |
| TAM | 232.33º ± 22.38º (170º-260º) |
| GRIP STRENGTH | 94.37 ± 6.53% (75-100%) |

**Table 2: Tam Grade**

| TAM GRADE | NO. OF CASES | PERCENTAGE % |
|---|---|---|
| EXCELLENT | 77 | 77 |
| GOOD | 20 | 20 |
| FAIR | 03 | 3 |
| POOR | 0 | 0 |

## RESULT AND OBSERVATION

Out of 100 patients, 73 were male and 27 were female, with mean age of 31.76 ± 10.46 years (18- 60 years). Right side was affected in 63 patients however the dominant side was involved in 73 cases. Out of 100 metacarpal fractures, in 77 patient's, metacarpal shaft was the site of fracture and in 23 patients, metacarpal neck was the site of fracture. Out of 100 cases, 47 cases (47%) involved 5th metacarpal, 26 cases (26%) involved 4th metacarpal, 20 cases (20%) involved 3rd metacarpal and only 7 cases (7%) involved 2nd metacarpal. Most common cause was sports injury. Other causes were RTA and fall of heavy object. Average time from injury to surgery was 4.96 ± 2.22 days. The mean duration of surgery was 29.5 ± 6.97 minutes. Fracture union was achieved in all cases at the mean union time of 5.93 ± 1.43 weeks (4-8 weeks). Mean post-operative VAS was 0.33 ± 0.54, the mean post-operative DASH score was 2.44 ±3.91, the mean TAM was 232.33º ± 22.38º (range: 170º-260º). The range of grip strength was 75-100%, with mean of 94.37 ± 6.53%, compared with the contralateral normal hand (Table 1). At final follow up, the average grip strength was 46.13 ± 11.78 kg (range: 21-56 kg) in the operated hand, compared to 48.36 ± 10.49 kg (range: 28-56 kg) in the contralateral normal hand. In terms of TAM, 77% of cases showed excellent outcome (Table 2 & Chart 1).

## DISCUSSION

The primary goal of treatment in metacarpal fracture is to achieve acceptable alignment, stable reduction, unrestricted motion, bony union and an excellent functional outcome in a minimally invasive method[12]. In our study, out of 100 patients, males were affected more with the maximum number of cases seen in the age group of 20-29 years. The age group and gender preponderance were attributed to the lifestyle and outdoor activities of the study population. These findings were comparable with that of the study conducted by **Fayaz W. Memon et al[11], Gonzalez et al[13], Kelsch and Ulrich[14], Faraj and Davis[15]**. Out of 100 metacarpal fractures, right hand was involved in 63 patients and left hand was involved in 37 patients. However, dominant hand was involved in 73 patients. Similar results were observed by **Elsersawy et al[1]** and **Elmowafy et al[16]**. The most common mode of injury was sports injury, seen in 40% of cases, followed by RTA and fall of heavy object. The finding in our study also correlates with the findings reported **by Elsersawy et al[1], Mohammed et al[9], Kelsch and Ulrich[14], Javali et al[17]** and **Ganjale[18]**. The mean post- operative VAS was 0.33 ± 0.54 and similar results were seen by **Zhang et al[19], Tank et al[20]**, and **Kim et al[21]**. The mean post-operative DASH Score was 2.44 ± 3.91. The results were comparable to the findings of the studies conducted by **Elmowafy et al[16], Javali et al[17], Ramsey HC et al[22], Carlo Biz et al[23]**, and **SK Lee et al[24]**. Radiologically, the mean union time was 5.93 ± 1.43 weeks. The union time noticed by **Elsersawy et al[1], Elmowafy et al[16], Mockford et al[25]**, and **Liew et al[26]** correlates with our study. The range of grip strength was 75-100%, with mean of 94.37 ± 6.53%, compared with the contralateral normal hand. The results were comparable to the findings of the studies conducted by **Liew et al[26]** and **Manueddu and Dellasanta[27]**. The TAM score ranged from 170º to 260º, with mean of 232.33º ± 22.38º. The results obtained in our study correlates with that of the studies conducted by **Elmowafy et al[16]**, and **Chatterjee et al[28]**. We observed only few complications in our study like pin-tract infections, pin loosening and partial stiffness which were managed conservatively with oral antibiotics.

## CONCLUSION

Closed or minimally invasive fixation with flexible antegrade intramedullary pre-bent K-wire described by Foucher is a safe and simple procedure. As the K-wire is pre-bent, it provides three-point fixation and the rotational stability. The proposed surgical technique is cost-effective and results in less soft tissue injury, lesser operating time, quick pain relief, satisfactory stabilization, easy return to work and easy removal of implant under local anesthesia as an outpatient department procedure.

## CONFLICT OF INTERESTS:

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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