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## Metacarpal shaft fracture fixation with intramedullary k-wire: Surgical and Clinical outcomes

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### Abstract

**Background:** Metacarpal fractures are among the most common fractures. The majority of metacarpal shaft fractures can be treated conservatively. There are numerous indications for operative treatment and various fixation techniques. The purpose of this prospective study was to assess the surgical and clinical outcomes of metacarpal shaft fractures using intramedullary fixation by K-wire (Kirschner wire).

**Materials and Methods:** 15 cases of Metacarpal shaft fractures underwent surgery with Intra medullary fixation by K-wire. The study was conducted from March 2015 to February 2016 admitted to Navodaya Medical College and research center, Raichur. We evaluated the DASH score to determine the outcomes.

**Results:** All fractures got united in our study and all patients were available for follow up. Two superficial wound (pin site) infections noted which healed with intravenous antibiotic treatment and regular pin site dressing. There were no major complications noted. All patients regained full flexion at the MCP and IP joints but two patients had a mild extensor lag of about 10°. At final follow up the mean DASH score in our study was 4.3 (range: 0-7.2).

**Conclusion:** Closed or minimally invasive fixation with Kirschner wire (k-wire) is a safe method and can be performed with minimal complications. It can be seen as good choice in selective metacarpal shaft fractures.

**Keywords:** kirschner wire (k-wire), metacarpal shaft fractures, intramedullary fixation

### 1. Introduction

Hand fractures are common presentation in Emergency Department <sup>[1]</sup> and metacarpal fractures constitute 30% of hand fractures <sup>[2]</sup>. The peak incidence of metacarpal shaft fractures is between 20 and 40 years <sup>[3]</sup>. Fractures of the metacarpal shaft occur as a result of axial loading, torsion, or direct falls and are classified as transverse, oblique, or comminuted. The majority of metacarpal shaft fractures can be treated conservatively <sup>[4]</sup>. Numerous indications for operative treatment include malrotation, angulation, longitudinally shortening, multiple fractures and fractures with associated soft tissue injuries or bone loss <sup>[5-9]</sup>. Fixation techniques involve the use of K-wires, intramedullary nails, circlage wires, plating, lag screws, tension band wires, and/or external fixators <sup>[10, 11]</sup>. Of these Kirschner wire (K-wire) fixation is a popular choice due to the simplicity of the procedure and the minimal soft tissue interference <sup>[12]</sup>. Orbay and Touhami invented an intramedullary k-wire fixation method that enhances rotational and longitudinal stability by locking the proximal end of the metacarpal <sup>[13]</sup>. The recent evidence-based review by Friedrich and Vedder <sup>[14]</sup> suggested that IM fixation is an attractive option for metacarpal fracture treatment.

This study was taken to assess the surgical and clinical outcomes of metacarpal shaft fractures using Intra-medullary k-wire fixation technique.

### 2. Materials and Methods

It is a prospective study of 15 patients carried out from march 2015 to February 2016 admitted to Navodaya Medical College and research center, Raichur, after approval from institutional ethical committee. A detailed history was elicited from the patients and after thorough clinical history and physical examination, standard radiographs were performed in the anteroposterior (AP), oblique and true lateral views. Patients were recruited according to particular inclusion and exclusion criteria.

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**2.1 Inclusion criteria**

1. Patients above 18 years and less than 60 years age.
2. Metacarpal shaft fractures (simple transverse or oblique fractures/spiral fractures) with a angulation of more than 30° or with a shortening of more than 3 mm or Fracture with minimum 2 cm displacement

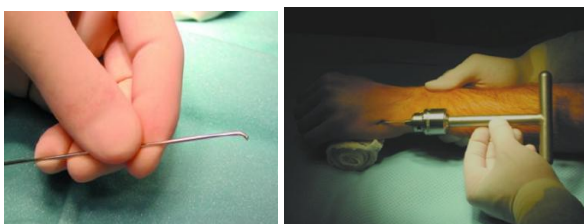
**2.2 Exclusion criteria**

1. Multi-fragmentary fractures, intra articular fracture
2. Multiple fractures and Open fractures
3. associated fractures of shoulder, elbow, or wrist
4. Thumb metacarpal fractures.

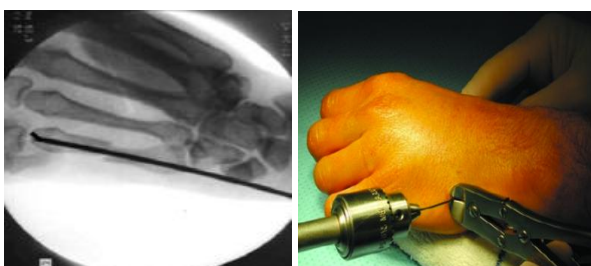
Patient characteristics (age, hand dominance, and gender), patterns of fracture, and preoperative radiographic parameters were collected. The subjects participating in this study received a thorough explanation and gave informed consent. Then patients were subjected to intramedullary fixation with K-wire by the closed/open reduction method under Image intensifier control.

**2.3 Surgical technique**

In all cases surgery was performed with the patient under peripheral anesthesia (Brachial block), with a pneumatic tourniquet and image intensification. Under image intensifier, an initial entry point is made at the base of the involved metacarpal using a 2.5 mm drill wire dorsally and proximally near the base for the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> metacarpal bones and for the 5<sup>th</sup> metacarpal, the incision was made medially near the ulnar side of the base of the 5<sup>th</sup> metacarpal, according to Foucher [12]. A single K-wire is pre-bent (Figure 1) at distal ends and either a 1.6 or a 2.0 millimeter (mm) K-wire depending on the metacarpal dimensions, is used. It was gently inserted and then advanced in an antegrade direction in the canal up to the fracture site. The fracture was then held reduced by longitudinal traction under fluoroscopic guidance, and the K-wire advanced with a clock-wise-anticlockwise movement to facilitate penetration into the distal epiphysis until the curved ends of the wires entered the subchondral bone (figure 2, 3). The distal angulation of the first wire was oriented dorsally. At the proximal side, the wires were then bent 90°, cut (Figure 4), and buried subcutaneously or left outside. The small wound was sutured with two sutures after careful hemostasis. A light dressing is applied and the patient is given advice about pin site care.



**Fig 1:** K-wire prebent at distal tip **Fig 2:** K-wire insertion and guidance across fracture site



**Fig 3:** C-arm guidance for inserting k-wire, **Fig 4:** k-wire bent and cut

Post operatively, the wound and fixation were reviewed on 2<sup>nd</sup> day and gentle range of movements exercises were commenced, if tolerated. Patients were assessed clinically and radiologically. Ranges of movements at the metacarpophalangeal (MCP) joint and inter phalangeal (IP) joint were assessed as well as the presence of any rotational deformity. Fracture union was confirmed on AP, oblique and lateral hand radiographs. Subsequently the wire is removed around four–six weeks when radiological evidence of fracture healing is visualized in the outpatient clinic or in the operating theatre if the wire has been buried. Any complications from the procedure including pin site problems were noted.

Clinical assessments were performed at 3, 6, 9 and 12 months postoperatively. These assessments included ROM and DASH score. The DASH questionnaire consists of 30 items: 21 address the ability to perform specific activities and nine address symptoms. DASH responses are scored from 0 to 100, and higher scores indicate greater patient disability [15].

**3. Results**

All the patients were available for follow up in our study. Out of the 15 patients, 12(80%) were male and 3(20%) were females. All patients were right hand dominant and in all but 3 patients had dominant side injury. Mean age was 34 (19–56) years and mean follow up was 8 (6–12) months. Mean interval between the injury and operation was 3 days (1–6). Out of 15 patients, 5 (33.33%) had punch injury, 4 (26.66%) patients met road traffic accident, 3(20%) patient sustained injury in sport activity and 3(20%) had injury due to fall. Patient demo-graphic and clinical data are presented in Table 1. The type of fracture was oblique in seven, transverse in four, and spiral in four patients (Table 2).

**Table 1:** Demographic and clinical characteristics of 15 patients who underwent intramedullary fixation with k-wire

Characteristic	No. (%)
Age in years (mean)	34(19–56) years
Male	12 (80%)
Female	3 (20%)
Fall injury	3 (20%)
Road traffic accidents	4 (26.66%)
Punch injury	5 (33.33%)
Sports activity	3 (20%)

**Table 2 :** Type of metacarpal shaft fractures

	2 <sup>nd</sup> Metacarpal	3 <sup>rd</sup> Metacarpal	4 <sup>th</sup> Metacarpal	5 <sup>th</sup> Metacarpal	Total
oblique	1	2	4	1	8
transverse	-	2	-	2	4
spiral	-	-	2	1	3

The location of the metacarpal shaft fracture was eleven diaphyseal and four metacarpal neck fractures. The mean angulation measured was 48.4° (range 35° to 70°) and in addition, five patients also had rotational deformity. The time to surgical intervention from the injury date was a mean 3 days (range 1 to 6 days). All the wiring procedures were performed by closed method except in two cases open reduction was performed as closed reduction failed after repeated attempts. The mean duration of surgery was 44 minutes (range 33-50 minutes).

All fractures proceeded to radiological bony union without rotational or severe angulation deformities. The wire was extracted in all patients at a mean period of 5.4 weeks (range four to seven weeks). Radiographic course of a fifth metacarpal shaft fracture of a 25 year old patient is depicted

in the (Figure 5, 6 and 7). Two superficial wound (pin site) infections noted which healed with intravenous antibiotic treatment and regular pin site dressing. All patients regained full flexion at the MCP and IP joints but two patients had a mild extensor lag of about 10°. At final follow up the mean DASH score in our study was 4.3 (range: 0-7.2) none of the patients had pain or clinically detectable rotational deformity or stiffness, and they reported satisfaction with their resulting appearance. All patients had full range of movements with good hand grip.



Fig 5: Pre-op x-ray



Fig 6: Immediate post



Fig 7: x-ray after implant removal

**4. Discussion**

Among various closed metacarpal fractures, transverse and short oblique fractures of the metacarpals are very common. Many treatment methods have been adopted for fracture of metacarpals including conservative by closed reduction, closed reduction and k wire fixation, open reduction and internal fixation with miniplate and external fixture application. Among the various surgical options, intramedullary K-wire osteosynthesis of the metacarpal bones is preferable because of the simplicity of the technique, limited operating room time, and minimum soft-tissue dissection and scarring [16]. The Kirschner wire can be safely used to reduce and stabilise metacarpal fractures. The technique of using multiple K wires for metacarpal fractures was introduced by Foucher [12].

In our study consisting of 15 cases we used Intramedullary k-wire technique as this may minimize the requisite immobilization period of other Kwire techniques, while conserving the technical facileness that K-wire fixation provides. We used a single wire of adequate diameter which was pre-bent to act as an elastic support. By bending, it provides a three point fixation and adequately stabilizes the metacarpal fragments so that the mobilization can be started earlier. In addition this procedure is relatively simple, with reduced operating times, minimal radiation exposure and can be performed as day case surgery thereby reducing hospital costs [17]. In our study 80% were male and 20% were female. The average age was 34 years (SD: 19 to 56 years). A study by SJ Moon has similar comparable data with Mean age 28 yrs (15-49) [18]. In another study by bahubali aski, age ranged between 18 to 46 years with mean age of 27 years [19]. In another study by Carlo biz there were 39 men and 10 women with a mean age of 37.46 years (range, 18-74 years) [20]. As similar with other studies males were predominant patients [18, 19, 20]. IN our study mean interval between the injury and operation was 3 days (1-6), mean duration of surgery was 44 minutes (range 33-50 minutes) and mean follow up of was 10 (6-15) months. In comparision study by SJ moon injury to sugery day was 4 days (1-16), mean duration of surgery was 48 minutes and mean follow up of was 11[18].In another study by Carlo biz, Patients were operated after a mean period of 1.67 days (range, 1-5 days),mean operation time was 40.81min (range 25-70) [20].

We encountered no major complications like delayed union, nonunion, Migration /perforation of k-Wires but had minor complications of superficial pin entry infections in two patients which healed with intravenous antibiotic treatment and regular pin site dressing and two patients had extensor lag of 10 deg at final follow up. IN a study by bahubali aski Pin tract infection observed in 2 patients, two cases had malaligment of 15deg [19]. In another study by Ramsey H. Chammaa *et al.*, two superficial infections were noted and one major complication of refracture was present [21].

At final follow up the mean DASH score in our study was 4.3 (range: 0-7.2) which was consistent with results of other studies as depicted in Table 3.

**Table 3:**

Sl. No	Study	DASH score* (mean)
1	Our Study	4.3(range: 0-7.2)
2	Carlo Biz {20}	4.17 (0-18.33)
3	Ramsey HC <i>et al</i> [21]	4.6 (range : 0-6.9)
4	SK Lee <i>et al</i> [22]	6.7 (range, 0-21)

\* Disabilities of Arm, Shoulder and Hand score

## 5. Limitations

There are some limitations of the study that should be considered. The primary limitation of our study was that it was a small prospective study including a small number of patients and done at a single center. Larger randomized controlled trials are needed to further evaluate outcomes and complications Kirschner wire in Metacarpal shaft fractures. We interpreted our results in comparison with those of the studies in the literature that used other methods. However, the outcomes achieved with the technique in this study were favourable.

## 6. Conclusion

Closed or minimally invasive fixation with kirschner wire (k-wire) is a safe method and can be performed with minimal complications. This method of fixation of metacarpal shaft fractures should result in less soft tissue injury, shorter operating time, satisfactory stabilization, quick pain relief, early return to work and easy implant removal under local anaesthesia as an outpatient department procedure. It can be seen as good choice in selective metacarpal shaft fractures.

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