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# Functional outcome of closed metacarpal shaft fractures managed by low-profile miniplate osteosynthesis: A prospective clinical study

Raghavendra Venkatesh, Shivakumar Kerakkanavar<sup>1</sup>

## Abstract:

**BACKGROUND:** Fractures of the metacarpal bones of the hand are one of the most frequently encountered orthopedic injuries constituting between 14% and 28% of all visits to the hospital. They can be treated conservatively or surgically depending on the nature of injuries, fracture pattern, and the fracture stability.

**OBJECTIVES:** This study was done to assess the functional outcome of metacarpal fractures managed by low-profile miniplate fixation.

**METHODS:** Thirty patients with closed metacarpal shaft fractures were managed by open reduction and internal fixation with mini fragment plate fixation in our hospital between 2012 and 2015. Radiographs of affected hand both anteroposterior and lateral views were obtained before surgery, after surgery, and at follow-ups. Early active motion was begun in all cases postoperatively. Patients were permitted to use their hands in daily activities 4 weeks after surgery. For objective assessment, total range of joint motion was measured. Rotational deformity of the fingers was assessed.

**RESULTS:** There were 24 male and 6 female patients. The mean age was 30 years. Transverse fracture pattern was the most common. Nearly 70% of cases had an excellent result, 20% patients with good results, and 10% had a fair result. Finger stiffness was the most frequently encountered complication.

**CONCLUSION:** Open reduction and low profile miniplate fixation in metacarpal fractures obtain an anatomical and stable reduction, fracture union, and early mobilization to avoid the loss of function.

## Keywords:

Finger stiffness, metacarpal fracture, plates and screws

## Introduction

Hand is a specialized structure interacting with the environment and is especially sensitive to functional impairment. Fractures of the metacarpal bones of the hand are one of the most frequently encountered orthopedic injuries (14-28%) of all visits to the hospital.<sup>[1]</sup> They can be treated conservatively or surgically depending on the nature of injuries, fracture pattern, and the fracture stability.

Most metacarpal fractures are treated conservatively.<sup>[1,2]</sup> If closed methods fail

to achieve or maintain reduction when there is angulation, rotation, or shortness because of the location (intra-articular vs. extra-articular), surgery could be performed.

To maintain hand function, man's most important tool, the treatment of choice in recent years has shifted from predominantly conservative measures to more surgical procedure. Kirschner wires are the most commonly used fixation materials after closed or open reduction. However, late initiation of movement resulting in a stiff hand, pin tract infection, and pin migration are the disadvantages of this method.<sup>[3]</sup>

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Department of  
Orthopaedics,  
Vydehi Medical  
College, <sup>1</sup>Department  
of Orthopaedics,  
Rajarajeshwari Medical  
College and Hospital,  
Bengaluru, Karnataka,  
India

## Address for correspondence:

Dr. Shivakumar  
Kerakkanavar,  
Department of  
Orthopaedics,  
Rajarajeshwari  
Medical College and  
Hospital, Bengaluru,  
Karnataka, India.  
E-mail: skumardoc@  
gmail.com

A stable fracture fixation dictates early mobilization. When compared with the wiring method, plates and screws provide a stable fixation in metacarpal fractures and thus allow for early mobilization preventing adhesions and thus provide a good functional outcome. Fracture healing in the hand is not an isolated goal; rather the functional result is of paramount importance.

In this prospective clinical study, we have tried to assess the functional outcome of metacarpal fractures managed by low-profile miniplate fixation.

## Methods

Patients admitted to a regional trauma center between January 2013 and May 2016 with a diagnosis of only displaced midshaft metacarpal fractures were included in the study group.

Open fracture, thumb metacarpal, intra-articular fracture extension, metacarpal neck fracture, and patients with other fractures in the same upper extremity were excluded from the study.

Radiographic evaluation included anteroposterior and oblique radiographs of affected hand were obtained.

The medically fit patient was then taken up for surgery after valid written consent.

All patients were operated in supine position and under regional/general anesthesia. Parts painted and draped under all aseptic precautions.

A dorsal longitudinal incision was made, and the fracture was exposed with adequate soft tissue dissection. Excessive soft tissue dissection and periosteal sleeving were avoided. A low profile 2.0 mm miniplate was applied with fixation of at least four cortices, two on each side of the fracture.

In oblique or spiral type of fractures, those fractures suitable for interfragmentary screw fixation were initially fixed with interfragmentary screws, and then, by plate fixation. The plates and screws were covered with periosteum and soft tissues, and wound is closed in layers.

Short-arm splint was applied in functional position until the edema and pain subsided, and the extremity was elevated for the first 24–48 h.

Depending on the general condition of the patient, type of fracture and fixation method, active finger, and metacarpophalangeal joint motion were initiated on the 2<sup>nd</sup> postoperative day. Based on these same factors, the patients were allowed to use their hands

in daily activities after the 4<sup>th</sup> postoperative week, and in activities requiring force, till there is complete radiological fracture union.

Regular clinical and radiological follow-up was done at an interval 4, 8, 12, and 24 weeks. At the follow-up, attention was paid to complications such as stiffness, malunion, nonunion, and hardware prominence [Figures 1 and 2].

During the final follow-up, total range of motion was assessed and compared with the normal extremity. Fracture Union, angulation, and shortness were assessed radiologically. Superficial infection was encountered in two patients and finger stiffness in three patients.

## Results

There were 24 male and 6 female patients in this study. The mean age was 28 (19–54) years. Mean follow-up was 20 (6–32) months.

Road traffic accidents are the major mode of injury in our series, followed by self-fall and assault. Right-sided fourth metacarpal (42%) is most commonly involved in our series.

The fracture pattern was oblique in 12 patients, transverse in eight, spiral in six, and comminuted in four patients [Graph 1]. In our study, superficial infection was encountered in two patients, which were treated with appropriate antibiotics and regular dressing. There were no cases with nonunion, malunion, implant prominence, and skin necrosis.

In this study, three patients (10%) developed stiffness of the fingers, of which one patient had associated proximal phalangeal fracture which was operated with open reduction internal fixation (ORIF) with k-wire fixation, this patient was not cooperative for physiotherapy.

Among these three patients with stiffness, one patient had signs of tenosynovitis, and hence, the hardware was removed with a second operation once the fracture had healed after 3 months postindex surgery.

Results were graded as:

### Excellent: Grade I

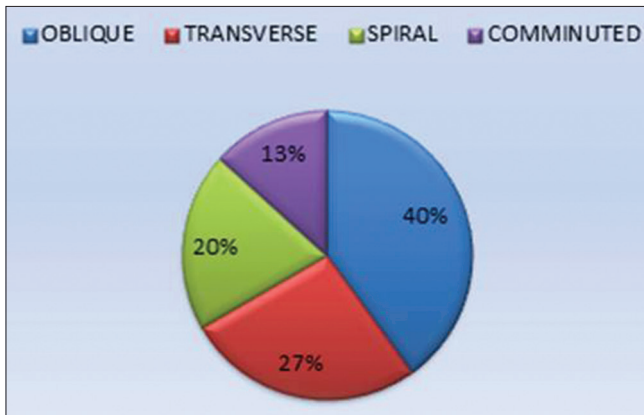
- Pain-free union
- No symptoms or signs
- No angular or rotational deformity
- Range of movements at interphalangeal joints 75°–100°
- Total active movement (TAM) >250°s (TAM refers to the additive sum of flexion at the metacarpophalangeal joint, proximal and distal interphalangeal joint minus the extension deficit at the same joints).



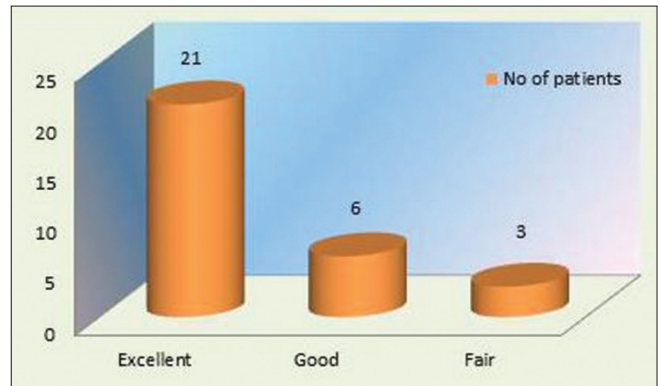
Figure 1: A case of 2<sup>nd</sup> metacarpal fracture treated with open reduction internal fixation with mini plate and screws with excellent functional results



Figure 2: A case of 5<sup>th</sup> metacarpal fracture treated with open reduction internal fixation with plate and screws with excellent functional results



Graph 1: Fracture pattern



Graph 2: Clinical results

### Good: Grade II

- Occasional pain at the fracture
- Mild edema
- Clinically united
- Range of movements at interphalangeal joints at least 60°
- Minimal rotatory or angular deformity
- TAM >180°.

### Fair: Grade III

- Painful movements
- ROM at IP joints <50°
- Deformity
- TAM <120°
- Pain at fracture site.

In this study, 21 patients (70%) had excellent result, 6 patients (20%) with good results, and remaining three patients (10%) had fair result [Table 1 and Graph 2].

## Discussion

“Hand fractures can be complicated by deformity from no treatment, stiffness from overtreatment, and both

Table 1: Clinical result

| Results   | No of patients | Percentage |
|-----------|----------------|------------|
| Excellent | 21             | 70.00      |
| Good      | 6              | 20.00      |
| Fair      | 3              | 10.00      |

deformity and stiffness from poor treatment” as stated by Barton.<sup>[4]</sup>

“Too often these fractures are treated as minor injuries and major disability results” as stated by Lipscomb.<sup>[2]</sup>

Historically, undisplaced fractures are treated conservatively with good results, whereas conservative method of treatment of unstable displaced fractures is associated with increased incidence of loss of fracture reduction, stiffness, and loss of hand function so displaced unstable fractures as to be operated for better results.<sup>[5]</sup>

Early and appropriate physiotherapy other than accurate reduction and fixation affects recovery of hand mobility and function.<sup>[6]</sup>

Earlier metacarpal fractures were treated with ORIF with k-wire although operative time was shorter, the incidences of loss of reduction and penetration to the metacarpal-phalangeal joint were much higher.

Tekkis *et al.*<sup>[7]</sup> found that patients treated with ORIF using a 4-holed mini fragment plates and screws gave better long-term results.

Prokuski and Eglseder<sup>[8]</sup> have reviewed that ORIF of the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> metacarpal achieved better reduction and fixation by miniplates and screws. Main outcome of grip strength and wrist and finger range of motion are above 280°.

Gupta *et al.*<sup>[6]</sup> concluded that surgical stabilization of metacarpal and phalangeal fractures of hand seems to give good functional outcome as compared to conservative treatment.

With improved materials, implant designs, and instrumentation, ORIF with plates and screws has gained popularity. Plates for the metacarpals are low profile, easy to contour and cut, and come in a variety of configurations.

A dorsal approach was used in all patients, and excessive soft tissue or periosteal dissection was avoided. The plates were applied from the dorsal aspect of the metacarpals and to four cortices, with two on each side of the fracture. An additional interfragmentary compression screw was applied in especially long oblique fractures.

Many factors, such as delicate handling of tissues, preservation of gliding planes for tendons, prevention of infection, and early and appropriate physiotherapy other than accurate reduction and fixation, affect recovery of good mobility.

In this series, all metacarpal fractures were closed injury, and compound fractures were not included in this study.

ORIF of metacarpal fractures with plate and screws provides two basic objectives of rigid internal fixation:

1. Maintenance of precise alignment of fracture
2. Facilitation of early active motion, thus minimizing stiffness.

The technique of plate fixation in the hand is well documented, but there are many drawbacks. Stern and Wieser<sup>[9]</sup> stated that main disadvantage of plate was their size and wide exposure necessary for plate fixation and

this may involve extensive periosteal stripping. Plate is usually placed under the extensor apparatus and can interfere with tendon gliding.

Fusetti *et al.*<sup>[10]</sup> have reviewed complications of plate fixation for metacarpal fractures. In a follow-up of 129 consecutive patients with 157 metacarpal fractures treated by open reduction and internal fixation, fusetti concluded that despite technical advances in implant material, design, and instrumentation, plate fixation of metacarpal fractures remains fraught with complications and satisfactory results.

Despite early active motion, finger stiffness was a most frequent complication.

Probable causes of stiffness include:

- Initial fracture severity
- Soft tissue mobilization necessary to apply plate
- Plate interference with tendon excursion
- Patient cooperation for physiotherapy.

In our series, three patients had stiffness, and two patients had superficial infection, which was controlled by intravenous antibiotics.

There were no cases with nonunion, malunion, skin necrosis, hardware prominence, etc.

In this study, 21 patients (70%) had excellent result, 6 patients (20%) with good results, and remaining 3 patients (10%) had fair result as compared to other studies by Nalbantoğlu *et al.*<sup>[11]</sup> (excellent 62%, good 14%, and fair 13%), Page and Stern<sup>[12]</sup> (excellent 40%, good 24%, and fair 7%), and Gupta *et al.*<sup>[6]</sup> (excellent 47%, good 47%, and fair 7%).

## Conclusion

The use of low profile miniplates in metacarpal fractures provides a stable fixation and allows early movement, hence excellent functional results.

However, stiffness of hand joints, especially metacarpophalangeal joint is of major concern and physiotherapy plays a major role to combat stiffness.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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## Conflicts of interest

There are no conflicts of interest.

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