

# A prospective study on surgical management of metacarpal shaft fractures using mini plates and screws

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## Abstract

**Background:** Accurate open reduction and internal fixation of metacarpal fractures are required in unstable fractures where closed treatment technique yield poor functional outcome which usually is less than 5% of hand fractures.

Mini plates and screws when used in properly selected cases provide rigid fixation allowing early mobilization of joints and hence good functional outcome.

**Patients and methods:** In 25 patients with closed metacarpal shaft fractures treated with mini plates and screws between December 2017 to December 2019 at Vijayanagara institute of medical sciences Ballari. The functional outcome was assessed using Disability of Arm, Shoulder and Hand (DASH) score and Visual Analog Score (VAS) over a period of two years in prospective manner.

**Results:** In our study of metacarpal shaft fractures treated with plate osteosynthesis all the cases showed bone union (100%). The functional result is Excellent in 84% of the patients (21 of 25 cases), good in 12% of cases (3 of 25 Cases), poor in 4% of cases (1 of 25 cases). 2 patients developed superficial wound infection which settled with daily dressing and antibiotics and this does not affect the final outcome.

**Conclusions:** Plate and screw fixation is a good option for treating closed metacarpal shaft fractures, where other modalities of fixation are less effective, the rigid stable fixation provided by plating withstands load without failure allowed early mobilization and achieved good functional results.

**Keywords:** Metacarpal fracture, mini plate and screws, internal fixation

## Introduction

Fractures of bones of the hand are among the commonest fractures in humans, however their management varies wide within the totally different regions of the world. This variability is due to many reasons, including availability of resources, social factors, geographic constraints, surgeon preference and experience, and local practice patterns. Developing countries are more likely to apply less expensive methods of managing hand fractures.

Fractures of the metacarpal bones of the hand constitutes between 14-28% of all visits to the hospital following trauma by various means like assault, road traffic accidents, industrial accidents, agricultural accidents etc. <sup>[1]</sup>. Too often these metacarpal fractures are neglected or treated as minor injuries and results in major disability and deformity with permanent disability and handicap <sup>[2, 3]</sup>.

Hand fractures are often sophisticated by deformity from no treatment, stiffness from over treatment and each deformity and stiffness from poor treatment <sup>[4]</sup>. Fracture healing within the hand isn't AN isolated goal rather the functional result is of paramount importance <sup>[5]</sup>.

Recent studies have shown smart useful results with operation of metacarpal fractures using

miniplates and screws as compared to the conservative treatment or K –wire fixation. This study involves evaluating functional outcome of metacarpal fractures treated with miniplates and screws<sup>[6]</sup>.

## Material and Methods

Our prospective study consists of 25 cases of metacarpal fractures admitted to VIMS Hospital attached to Vijayanagar Institute of Medical Sciences, Ballari between December 2017 to December 2029. The work was approved by institutional medical ethics committee. A written informed consent was obtained from all the patients.

### Inclusion criteria

1. Age more than 18 years.
2. Physical fitness for surgery
3. **Sex:** Both male and female

### Exclusion criteria

1. Age less than 18 years.
2. Patient not willing or medically unfit for surgery
3. Compound injury

### Indications

Indications for plate fixation of the metacarpals are

1. Multiple fractures with gross displacement
2. Displaced diaphyseal transverse, short oblique, or short spiral fractures
3. Comminuted intraarticular and periarticular fractures -displaced
4. Comminuted fractures with shortening or malrotation or both

### Method of collection of data

Patients with metacarpal fractures are selected after clinical and radiological analysis during the period of study from Dec 2017 to Dec 2019. All the patients selected for study will be examined according to protocol, associated injuries noted and clinical and lab investigations carried out in order to get fitness for surgery.

Consent of the patient will be taken for surgery. Patient will be followed till Union is achieved clinically as well as radiologically.

Time required for union, range of motion of surrounding joints and complications occurred before / during / after surgery will be studied in detail. 25 cases were studied without any sampling procedure

### Surgical procedure – open reduction internal fixation with plate osteosynthesis

Tourniquet was used in all the cases before surgery Metacarpal fractures are approached by dorsal incision made on radial border for the first and second metacarpal, ulnar border for the fifth metacarpal.

For the 3rd and 4th metacarpals the approach is made using a dorsal longitudinal incision made between these bones. Then extensor tendons were retracted and anatomical reduction of the fracture fragments are carried out. Reduction is held using point reduction forceps or a stabilizing K wire. Interfragmentary lag screws were used in long spiral and oblique fractures. Plate configuration were chosen according to the fracture pattern (straight plate for shaft fractures, T or L configured plates were used for periarticular fractures) and fixed with screws.

Meticulous attention was carried out in soft tissue dissection and adequate soft tissue coverage (periosteum) was made over the plate to avoid irritation to overlying extensor tendon. Thorough wound wash was given and wound closed without drain. Splinting of the hand was done with a volar below elbow slab.

**Post-operative protocol**

Hand was kept in elevation for 24-48 hours for controlling pain and swelling. Wound was inspected at second post-operative day. Thereafter, active mobilization of fingers started and increased progressively within the limits of pain tolerance. Patients were discharged on 5th post-operative day and physiotherapy carried out on outpatient basis. Sutures were removed on 10<sup>th</sup> postoperative day.

Follow up was done at 4th, 6th and 8th weeks and assessed for clinical progress in terms of range of movements and radiological evaluation done to note fracture union or any loss of reduction.

**Evaluation of outcome**

For evaluating functional outcome of unstable metacarpal fractures treated with plate osteosynthesis, we use used the Disability of Arm, Shoulder and Hand (DASH) score <sup>[7]</sup>, Visual Analog Score (VAS) and Total Active Flexion (TAF) scoring system <sup>[8, 9]</sup>.

This system takes into account the degree of flexion at metacarpophalangeal joint, proximal and distal interphalangeal joints for digits (2-5), for thumb the degree flexion at metacarpophalangeal and interphalangeal joint.

Extensor deficit is measured in degrees and the total active flexion score is the sum of flexion at metacarpophalangeal joints and interphalangeal joints minus the extensor deficit.

**TAF from MCPJ to DIPJ: digit 2-5**

Degree of felxion	Rating
220-260	Excellent
180-220	Good
130-180	Fair
<130	Poor

**TAF from MCPJ and IPJ: thumb**

Degree of felxion	Rating
120-140	Excellent
100-120	Good
70-100	Fair
<70	Poor

**Dash score**

Dash score	Rating
90-100	Excellent
80-89	Good
70-79	Fair
<70	Poor

**Visual analog scale**

Score	Grade
10-9	Worst possible pain
8-7	Lot of pain
6-4	Considerable pain
2-3	Little pain
0-1	No pain

## Results

25 patients were included in this study. 9 patients had multiple metacarpal fractures (36% cases). Right hand was involved in 17 of the patients (68%). 3 out of 25 were female patients (12%). All the 25 patients who underwent open reduction and internal fixation with plate osteosynthesis for unstable metacarpal fractures achieved bone union (100%). In most of the cases bony union was seen between 9-11 weeks, average period being 10.2 weeks (range 8-12 weeks). Spiral and oblique fractures united at 9 weeks, transverse and comminuted fractures united at around 12 weeks.

Functional outcome assessed by DASH SCORE (Disability of Arm, Shoulder and Hand score, Visual Analog Score (VAS) and TAF (Total Active Flexion) score was excellent in 20 patients (80%), good in 3 patients (12%), fair in one patient (4%), poor in one patient (4%). The overall results are satisfactory.

2 patients developed superficial wound infection, both were the case of multiple metacarpal fractures (both of these case had involvement of two metacarpal). Both these cases with superficial infection settled with daily dressing and antibiotics. 2 patients had stiffness of metacarpophalangeal and interphalangeal joints and both were cases of multiple metacarpal fractures for whom physiotherapy was continued and patients showed improved range of motion, and the results in these patients are fair & poor.

None of the patients in our study developed tendon irritation, this is due to extra cautious effort taken to cover the plate (low profile plate) with soft tissue (periosteum) for free gliding of overlying extensor tendon. No cases had angular or rotational displacement of fractures. No cases had implant breakage.

None of the patients required implant removal.

### I. Age distribution

Age group varied from 20 years to 70 years with mean age of 45 years. Incidence of fracture was observed maximum between 20-50 years.

**Table 1:** Age distribution

Age group	Number of cases	Percentage
20-29	5	20
30-39	8	32
40-49	8	32
50-59	2	8
60-70	2	8

Among the 25 cases, males were predominant

**Table 2:** Sex distribution

Sex	Number of case	Percentage
Male	22	88
Female	3	12

**Table 3:** Side of injury

Sex	Right	Left	Bilateral	Total
Male	14	8	0	22
Female	3	0	0	3
Percentage	60	40	-	-

Commonest mode of injury being Road Traffic Accident (RTA)

**Table 4:** Mode of injury

Mode of injury	Number of cases	Percentage
RTA	13	52
Assualt	5	20
Trauma	7	28

Single metacarpal involvement being the most common accounting for 70% of the cases.

**Table 5:** Number of metacarpal involved

Number of metacarpals involved	Number of case	Percentage
1	16	64
2	8	32
3	1	4
4	0	-
5	0	-

Spiral fracture pattern being most common accounting for 40%

**Table 6:** Fracture pattern

Fracture pattern	Number of cases	Percentage
Spiral	10	40
Oblique	9	36
Transverse comminuted	6	24

**Table 7:** Time interval between injury and surgery

Time interval(days)	Number of cases	Percentage
<2	5	20
>2	20	80

4 Cases developed complications. Infection seen in 16% (2 out of 25 cases). Stiffness seen in 16% (2 out of 25 cases).

**Table 8:** Complications

Complications	Number of cases	Percentage
Infection	2	16
Stiffness	2	16
Mal union	-	-
Non union	-	-
Implant breake	-	-
Tendon irritation	-	-

In most of the cases bony union was achieved in 6-7 weeks accounting for 65%.

**Table 9:** Union time

Duration in weeks	Number of cases	Percentage
8-9	14	56
10-11	5	20
>12	6	24

### Analysis of functional outcome

The functional outcome was assessed using Disability of Arm, Shoulder and Hand(DASH)score and Visual Analog Score(VAS) the following results were obtained.

**Table 10:** Dash score- overall result

Grading	No. of cases	Percentage
Excellent	20	80
Good	3	12
Fair	1	4
Poor	1	4

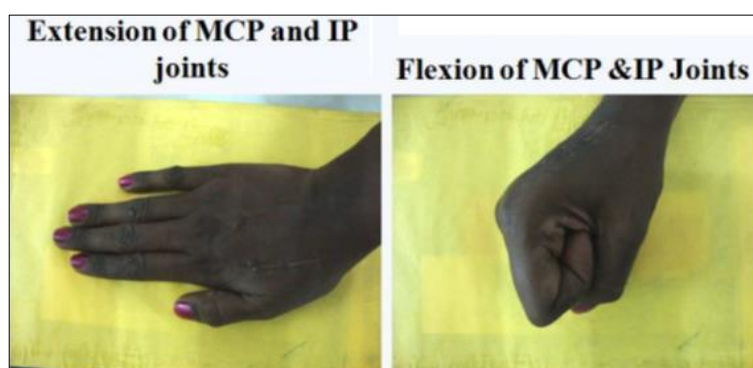
**Table 11:** VAS score

Grading	No. of patients	Percentage
No pain	2	8
Little pain	20	80
Considerable pain	3	12
Lot of pain	0	-
Worst pain	0	-

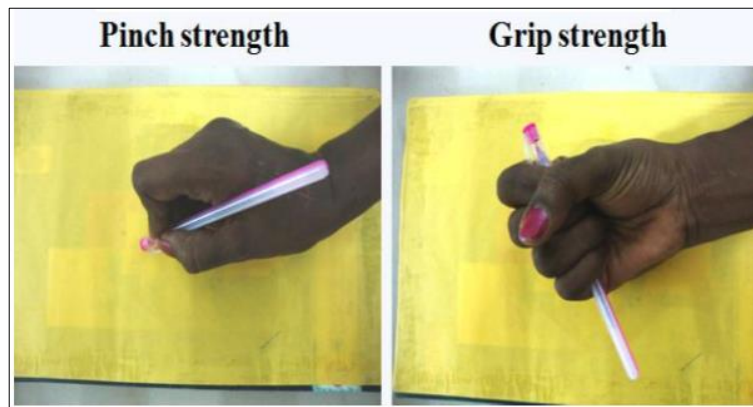
### Clinical pictures



**Fig 1:** Pre and post-operative x ray



**Fig 2:** Range of movements



**Fig 3:** Strength assessment

## Discussion

Most of the metacarpal fractures are stable before or after closed reduction and are managed successfully by conservative method of protective splinting followed by early mobilization [10, 11]. Only a small percentage of metacarpal fractures are unstable and in these patients the functional results following closed treatment are unsatisfactory. These are the cases indicated for open reduction and internal fixation which are usually less than 5% of hand fractures [12, 13]. James *et al.* [14] reported that closed method used in treatment of unstable fractures had loss of function in 77% of fingers.

Open reduction and internal fixation with K wire [1] is one of the treatment modalities in these unstable fractures but they provide less rigid fixation and are rotationally unstable, there is increased association of pin tract infection and problems due to protruding ends of K-wire are significant.

Interosseous wiring with K- wire although provides rigid fixation equivalent to plating are useful only in transverse diaphyseal fractures.

Metacarpal fractures can be fixed with external fixator [15-19]. Report by Shehadi *et al.* [16] showed full return of total range of motions in up to 100% of metacarpal fractures treated with external fixator. This mode of fixation is useful in compound metacarpal fractures with bone loss. But the routine use of external fixator is discouraged as there is loosening of construct following pintract infection leading to loss of fixation and there is difficulty in constructing and applying the fixator.

Intramedullary fixation with prebent K- wires were used for transverse and short oblique fractures [20, 21, 22, 23]. They provide comparable functional outcome with plate and screw fixation. But there is incidence of loss of reduction, penetration of metacarpophalangeal joint by hardware, thus necessitating a second surgery for hardware removal.

There are many literature studies showing satisfactory results of unstable metacarpal and phalangeal fractures treated with AO miniplate and screws [24, 25-34].

A study by Souer *et al.* [36] showed good functional outcome by total active motion more than 230 degree in 18 of 19 patients for whom plate fixation was done in closed unstable metacarpal fractures. Another study by Gupta *et al.* [1] showed excellent functional outcome with total active movements more than 230 degree in all of his patients of unstable metacarpal fractures treated with plate fixation. Another study by Dabezies Schutte [27] showed no complication in 27 unstable metacarpal fractures treated with plate fixation. Low complication rate seen in our study was similar to these results.

In our study on 25 patients, 2 patients developed superficial wound infection. In both of these cases of superficial infection, there was wound discharge on second post-operative day which settled with daily dressing and antibiotics and this does not affect the final outcome. 2 Patients with multiple metacarpal fractures developed finger stiffness and one case had fractures in all the four metacarpals and the other had fracture involving two metacarpals.

Eventually all patients had improved ROM following physiotherapy.

In metacarpal shaft fractures, plate fixation is a better option for several reasons<sup>[9]</sup>:

1. They provide stable fixation in all unstable metacarpal fractures thus allowing early mobilization of fingers
2. Shortening seen in multiple metacarpal fractures which are corrected by plating restores the power of interossei muscle thereby retaining the grip strength of hand.
3. Multiple metacarpal fractures are usually associated with severe soft tissue injury. In these unstable metacarpal fractures, treatment with plate osteosynthesis provides anatomical reduction of fracture with rigid stabilization allowing early mobilization of joints without loss of reduction thus preventing stiffness and yields good functional results.

In our study of metacarpal shaft fractures treated with plate osteosynthesis all the cases showed bone union (100%). The functional result assessed by Disability of Arm, Shoulder and Hand(DASH) score showed excellent result in 80% of the patients (20 of 25 cases), good in 12% of cases (3 of 25 cases). Stable and rigid fixation provided by mini plates and screws allowed early mobilization of fingers thereby preventing stiffness and achieved overall good functional results. Although there were 8% (2 cases) of superficial infection, all settled with regular dressing and antibiotics without affecting final functional outcome.

## Conclusion

Plate and screw fixation is a good option for treating closed unstable metacarpal fractures, where other modalities of fixation are less effective, the rigid stable fixation provided by plating which withstands load without failure allowed early mobilization and achieved good functional results. Detailed clinical and radiological assessment of fracture, careful preoperative planning, meticulous dissection, precision in surgical technique (coverage of plate with soft tissue) and choosing the correct implant (low profile plate) are critical in achieving good results and minimising the complication.

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