# Management of oblique and spiral metacarpal fractures with mini plate and screw versus screws only

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**Received:** 8 November 2021
**Revised:** 24 November 2021
**Accepted:** 1 January 2022
**Published:** 31 May 2022

**The Egyptian Orthopaedic Journal** 2022, 57:26–32

**Background**
Fractures involving the tubular bones of the hand are the most frequent of all skeletal injuries. The choice of treatment depends on a variety of clinical and radiological factors. The goal of treatment is restoration or preservation of the hand function.
**Objectives**
To compare the results of mini plate plus screw versus screw only in oblique and spiral metacarpal fractures.
**Patients and methods**
This is a randomized clinical trial that included 40 patients with oblique and spiral metacarpal fractures who divided into two groups according to management: either fixation by mini plate and mini screws (20 patients) or fixation by mini screws only (20 patients). Quick-DASH and total active motion (TAM) scoring systems were used to evaluate all patients on 4th, 12th, and 24th weeks postoperative.
**Results**
The mean value of TAM score in the mini plate group was significantly higher than screws only group at 4th week postoperative ($P$=0.007) while it was nonsignificantly higher at 12th and 24th week postoperative. Also, the mean value of DASH score in the mini plate group was significantly lower than screws only group at 4th week postoperative ($P$=0.0001) while it was nonsignificantly lower at 12th and 24th week postoperative. The total number of complicated patients in the mini plate group was 2 patients (10%) while it was 5 patients (25%) in the screw only group with significant difference between both groups ($P$=0.0001).
**Conclusion**
Although mini plate and screw group showed early mobilization of the affected hand and has significant Quick-DASH and TAM scores at 4th week postoperative, both groups revealed the same functional outcomes at the end of follow-up.

**Keywords:**
mini plate and screw, oblique and spiral metacarpal fractures, screws only

Egypt Orthop J 57:26–32

1110-1148

## Introduction

The human hand is a highly sophisticated tool of sensibility and apprehension. It is a sensor that receives information from the environment—sharp/dull, smooth/rough, hot/soft, with such sensitivity that the blind can read with their fingertips. This tool can undertake an ultimate variety of prehensile tasks. If hand injury or disease occurs, it affects the sensory input and the motor output of this marvelous tool [1,2].

Fractures involving the tubular bones of the hand are the most frequent of all skeletal injuries. They constitute more than 10–20% of all injuries seen in the emergency room. Despite their evident importance, they are often regarded as trivial injuries and are neglected [3].

The goal of treatment of metacarpal fractures is restoration or preservation of hand function. To achieve this goal, the surgeon must choose a method to achieve and maintain reposition of the fracture, alignment, length restoration, and articular congruity that will offer the least soft tissue damage and accelerate the mobilization of the injured part by early achievement of fracture stability [4,5].

The choice of the method of treatment depends on a variety of clinical and radiological factors, stability as well as patient-related factors as age, occupation, socioeconomic status, motivation, and presence of other associated injures or medical condition. Other factors that should be considered include available equipment and surgeon's skills. Although failure to gain union with metacarpal fractures is unusual, the

correction of angular or rotational deformity, tendon adhesion, or articular dysfunction continues to challenge even the most experienced surgeon [6]. The rationale of this study is to optimize the functional outcomes after fixation of oblique and spiral metacarpal fractures by mini plate plus screws versus screws only.

## Patients and methods

This prospective comparative study was carried out at Orthopedic Department, Suez Canal University Hospital and Helwan University Hospital during the period from September 2018 to January 2021. This study included 40 patients with oblique and spiral metacarpal fractures who were divided into two groups according to management: either fixation by mini plate and mini screws (20 patients) or fixation by mini screws only (20 patients).

Both genders (skeletal mature patients) aged 18 years or above and acute traumatic oblique or spiral metacarpal fracture were enrolled in the current study. However, transverse metacarpal fractures, implant failure, non-united fractures, mal-united, and previous surgery, open fractures, and associated neurovascular injury were excluded from the study.

### Ethical approval

The Ethical Committee of Suez Canal University approved this study and permitted us to review patients.

### Informed consent

All eligible participants were informed about study's objectives, methodology, and possible side effects. A written informed consent was obtained from every eligible participant prior to study enrollment.

### Methods

*Preoperative measures*

(1) After clinical evaluation and confirmation of the diagnosis by history, clinical examination, and radiological assessment, the injured limb was protected by a below elbow slab.
(2) Operation was done within 48 h from the occurrence of the trauma.
(3) Ampicillin-sulbactam was used as prophylactic antibiotic.

*Intraoperative measures*

(1) General or regional anesthesia was used.
(2) Tourniquet control was done.

**Figure 1**

Dorsal approach, extensor tendon retraction, reduction with clamp.

**Figure 2**

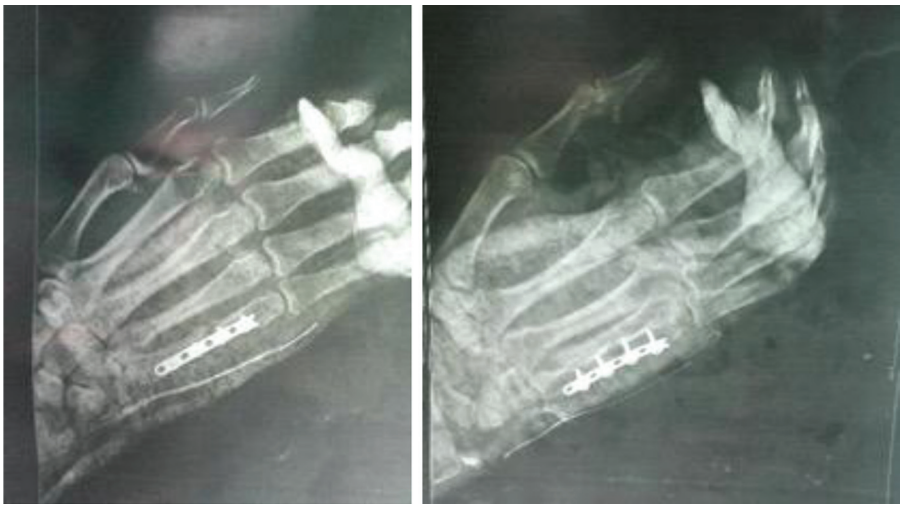
Dorsal approach, plate fixation.

(3) Under complete aseptic condition, the following procedure was done

Dorsal approach to the metacarpals was followed by retraction of the extensor tendon, cleaning the fracture site from any soft tissue deposited and open reduction of the fracture and maintaining the reduction with pointed reduction forceps (Fig. 1).

Either mini plate and mini screws 2.4 mm (Figs. 2–4) or mini screws 2.4 mm (Figs. 5 and 6) with countersink were used in fixation of the fracture. Finally, closure of skin was only by 3/0 nonabsorbable polypropylene sutures.

**Figure 3**



Antero-posterior and oblique views for plate fixation of fifth metacarpal.

**Figure 4**

Plate fixation of fourth metacarpal fracture.

*Postoperative measures*

(1) The hand was protected by a below elbow slab from the elbow to fingertips for 3 weeks in both groups (Fig. 7).
(2) All patients were warned to report immediately if there any discharge from the surgical wound occurred or excessive soaking on the slab.

*Evaluation*

Quick-DASH [7] and total active motion (TAM) scoring systems [8] were used to evaluate all patients on 4th, 12th and 24th week postoperative; we also used the x-ray of the antero-posterior and oblique views with clinical correlation on the affected hand in the follow-up to assess the bone union.

**Statistical analysis**

Comparison between the study groups was done using Yates-corrected $\chi^2$ equation. *P* values less than 0.05 was considered statistically significant. All statistical calculations were done using the computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, Illinois, USA) version 15 for Microsoft Windows.

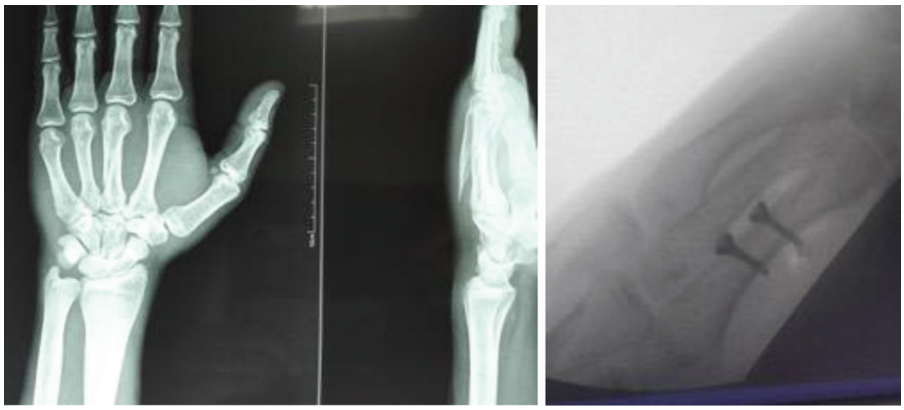
## Results

A total of 40 patients with oblique and spiral metacarpal fractures enrolled in this study, mean age in the mini plate and screws only groups was 34.5±5.54 and 36.4±9.39 years, respectively. Majority of the patients in both groups were males, 11 (55%) and 12 (60%) patients, respectively. Two patients had multiple metacarpal fractures: one had fractures in the second and third metacarpals, and the other had fractures in the second, third, and fourth metacarpal bones. Twenty-seven of the patients had a fracture in their right hands (67.5%), while 13 had fractures in the left hands (33.5%). Of the metacarpal fractures, 24 were oblique and 19 spiral.

Tables 1–3 show that the group operated with the mini plate and screws had a significant shorter time to return to work. The mean value of TAM score in the mini plate group was significantly higher than screws only group at 4th week postoperative (*P*=0.007) while it was nonsignificantly higher at 12th and 24th week postoperative. Also, the mean value of DASH score in the mini plate group was significantly lower than in the screws only group at 4th week postoperative (*P*=0.0001) while it was nonsignificantly lower at 12th and 24th week postoperative.

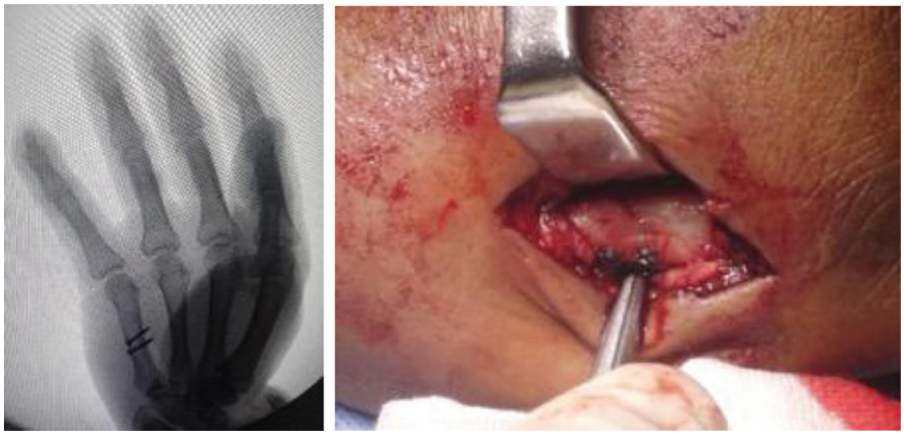
Considering correlation between outcome and gender in the mini plate group, mean of TAM score was 247

**Figure 5**



Screws fixation of third metacarpal fracture.

**Figure 6**



Screws fixation of fifth metacarpal fracture.

**Figure 7**

Hand protections by below elbow slab.

±8.33 in male patients while it was 251.1±6.82 in female patients, the quick-DASH score was 1.27 ±0.32 in male patients while it was 1.23±0.38 in female patients, the male patients returned to works after 36.2±2.25 days while the females returned after 36.8±2.78 days. In the screws only group, mean of TAM score was 238.0±6.45 in male patients while it was 240.3±13.5 in female patients, the quick-DASH score was 2.03±0.20 in male patients while it was 2.0 ±0.15 in female patients, and the male patients returned to work after 44.7±3.28 days while the females returned after 47.0±4.14 days (Table 4).

As regards correlation between TAM and affected hand, the mean TAM score in mini plate group in the right hand was 249.5±8.07 and in the left hand was 246±6.92, while in screws only group it was 239.5 ±10.36 in the right hand and 236±5.65 in the left hand (Table 5).

As regards postoperative complications, the mini plate group patients had no complications postoperative like nonunion, displacement, loss of sense, and rupture of

**Table 1 Basic characteristics in both the study groups**

| | Mini plate *N*=20, *N* (%) | Screws only *N*=20, *N* (%) | *P* value |
|---|---|---|---|
| Age (year) | | | |
| Mean±SD | 34.5±5.54 | 36.4±9.39 | 0.530[a] |
| Range | 24–41 | 20–49 | (NS) |
| Gender | | | |
| Male | 11 (55) | 12 (60) | 0.593? |
| Female | 9 (45) | 8 (40) | (NS) |
| Occupation | | | |
| Employee—non-worker | 14 (70) | 15 (75) | 0.715? |
| Hand worker | 6 (30) | 5 (25) | (NS) |
| Fracture side | | | |
| Right | 15 (75) | 12 (60) | 0.241? |
| Left | 5 (25) | 8 (40) | (NS) |
| Fracture type (*n*=43) | | | |
| Oblique (*n*=24) | 13 (30.2) | 11 (25.6) | 0.426? |
| Spiral (*n*=19) | 10 (23.3) | 9 (20.9) | (NS) |

(NS), no statistically significant difference; SD, standard deviation. [a]Student's *t*-test. [b]$\chi^2$ test.

**Table 2 Comparison between groups regarding operation and return-to-work time**

| | Mini plate *N*=20 | Screws only *N*=20 | *P* value |
|---|---|---|---|
| Operation time (min.) | | | |
| Mean±SD | 40.24±1.42 | 38.51±2.63 | 0.086[a] |
| Range | 30–50 | 25–50 | (NS) |
| Time to return to work (days) | | | |
| Mean±SD | 36.50±2.40 | 45.71±3.70 | 0.0001[a] |
| Range | 32–40 | 41–50 | |

(NS), no statistically significant difference. [a]Student's *t*-test.

**Table 3 Comparison between groups regarding TAM and Quick DASH scores**

| | Mini plate *N*=20 | Screws only *N*=20 | *P* value |
|---|---|---|---|
| TAM score | | | |
| 4 weeks | | | |
| Mean±SD | 248.78±7.73 | 239.0±9.74 | 0.007[a] |
| Range | 238–260 | 222–260 | |
| 12 weeks | | | |
| Mean±SD | 250.6±8.34 | 245.0±6.32 | 0.09[a] |
| Range | 240–260 | 238–260 | NS |
| 24 weeks | | | |
| Mean±SD | 255.45±3.56 | 251.78±7.45 | 0.06[a] |
| Range | 247–260 | 245–260 | NS |
| Grade at 24 weeks | | | |
| Excellent | 5 (25%) | 4 (20%) | 0.613[b] |
| Good | 15 (75%) | 16 (80%) | NS |
| Quick-DASH score | | | |
| 4 weeks | | | |
| Mean±SD | 1.25±0.34 | 2.02±0.18 | 0.0001[a] |
| Range | 0.97–1.80 | 1.80–2.30 | |
| 12 weeks | | | |
| Mean±SD | 1.14±0.26 | 1.35±0.43 | 0.076[a] |
| Range | 1.01–1.70 | 1.03–1.90 | NS |
| 24 weeks | | | |
| Mean±SD | 1.12±0.22 | 1.23±0.18 | 0.089[a] |
| Range | 0.95–1.50 | 1.05–1.40 | NS |

(NS), no statistically significant difference; SD, standard deviation; TAM, total active motion. [a]Student's *t*-test. [b]$\chi^2$ test.

extensor tendon, but one patient had wound soiling and was treated by antibiotics and it was completely eradicated after 1 week and another one patient developed delayed bone union and the patient healed at 4th month postoperative. However, in the screws only group the rate of infection was higher, there were 3 patients who were also eradicated completely by parenteral antibiotics for 1 week; 2 patients developed delayed union: the first one healed at the 3rd month and the second healed at the 4th month, but there was no complications like nonunion, displacement, loss of sense, and rupture of extensor tendons; the total number of complicated patients in the mini plate group was 2 patients (10%) while it was 5 patients (25%) in the screws

**Table 4 Correlation between outcome and gender among the mini plate and screw groups**

| | Mini plate group | | | | Screw group | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | *t*-test | *P* value | Male | Female | *t*-test | *P* value |
| TAM | 247.0±8.33 | 251.1±6.82 | −0.997 | 0.339 NS | 238.0±6.45 | 240.3±13.5 | −0.429 | 0.339 NS |
| Quick-DASH | 1.27±0.32 | 1.23±0.38 | 1.75 | 0.091 NS | 2.03±0.20 | 2.0±0.15 | 0.372 | 0.717 NS |
| Time to return to work (days) | 36.2±2.25 | 36.8±2.78 | 0.208 | 0.838 NS | 44.7±3.28 | 47.0±4.14 | −1.136 | 0.278 NS |

NS, no statistically significant difference; TAM, total active motion. [a]Student's *t*-test

**Table 5 Correlation between TAM and hand affected in both groups**

| Affected hand | TAM mini plate group | | TAM screw group | |
|---|---|---|---|---|
| | Mean±SD | *P* value | Mean±SD | *P* value |
| Right | 249.5±8.07 | 0.504[a] NS | 239.5±10.36 | 0.657[a] NS |
| Left | 246±6.92 | | 236±5.65 | |

NS, no statistically significant difference; SD, standard deviation; TAM, total active motion. [a]Student's *t*-test.

**Table 6 Distribution of postoperative complications in both groups**

| Complications | Mini plate *N*=20 | | Screws only *N*=20 | | *P* value |
|---|---|---|---|---|---|
| Infection | 1 | 5% | 3 | 15% | 0.002[a]* |
| Delayed union | 1 | 5% | 2 | 10% | 0.013[a]* |
| Nonunion | 0 | 0% | 0 | 0% | 1.000[a] (NS) |
| Displacement | 0 | 0% | 0 | 0% | 1.000[a] (NS) |
| Loss of sense | 0 | 0% | 0 | 0% | 1.000[a] (NS) |
| Rupture of extensor tendon | 0 | 0% | 0 | 0% | 1.000[a] (NS) |
| Total | 2 | 10% | 5 | 25% | 0.0001[a]* |

NS, no statistically significant difference. *Statistically significant difference. [a]$\chi^2$ test.

only group with significant difference between both groups (*P*=0.0001; Table 6).

## Discussion

Metacarpal fractures accounts for 30% of hand fractures. Fractures of the metacarpal shaft present due to axial loading, torsion, or direct falls and are divided into transverse, oblique, spiral, or comminuted. All metacarpal fractures are always presented with edema and deformity and inadequate treatment may result in functional loss in the hand and disability [9]. The main aim of treatment is restoration of length, correction of rotational deformity, if present, promoting adequate stability, proper soft tissue management, and early initiation of movement to reach the full normal range of movement.

Mini plate plus screw or K wires may be used for fixation in the surgical treatment of metacarpal and phalangeal fractures. Fixation with mini plate plus screw yields a more rigid stabilization in comparison to the fixation obtained with K wires. This rigid fixation may enable earlier mobilization, which may help us in minimizing the period of immobilization [10].

In this study, both groups showed matching for the mean age, gender, and occupation. Mean age in the mini plate and screws only groups were 34.5±5.54 and 36.4±9.39, respectively. Majority of patients in both groups were males, 11 (55%) and 12 (55%) patients, respectively. Twenty-seven of the patients had a fracture in their right hand, while 13 had fractures in the left hand. Of the metacarpal fractures, 24 were oblique and 19 spiral.

In the study by Başar *et al.* [11], patients were included and were operated due to a diagnosis of displaced, irreducible, unstable, rotational short and long oblique–spiral metacarpal, and proximal phalangeal fracture, with the mean age of patients with a metacarpal fracture 29.6 years (range 18–45 years; 3 females, 18 males).

Our results revealed nonsignificant higher operative time in the group with mini plate (30–50 min) with an average of 40 min than the mini screw group (25–50 min) with an average of 38 min. This could be attributed to the more surgical maneuvers held in this group, which is in agreement with the study by Başar *et al.* [11].

In our study, no patient developed nonunion, displacement, or loss of sense or rapture of extensor tendons; however, 3 patients in mini screws group had wound soiling infection, which were managed and completely eradicated by antibiotics, and 2 patients had delayed union and they developed union after 3 months and 4 months after the surgical fixation. However, only 1 patient had a wound soiling, which was also controlled by antibiotics, and only 1 patient had delayed union and the patient developed union after 4 months after the surgical fixation.

In the study by Başar *et al.* [11], there are no complications of displacement in the fracture line; implant failure, distal loss of sense due to nerve damage, malunion, and rupture of the extensor tendon were observed in the postoperative follow-up of the patients. There were 2 patients (patients treated with mini plate plus screw for fracture of the 5th metacarpal and 2nd proximal phalangeal bones) who showed soiling in the wound dressing but there was no active drainage. Infection relieved after 3–5 days of treatment with antimicrobial agent. Bone union was observed in all patients in the last control examination.

Another study declared that in the mini-plate group no bone nonunion occurred. Moreover, patients with closed fracture did not suffer from postoperative infection. Patients with open fracture suffered from infection to different degrees at three fracture sites [8].

In our study, the mini plate plus screw group showed early mobilization of the affected hand as it had significant shorter time to return to work.

In the current study, the mean value of TAM score in the mini plate group was significantly higher than in screws only group at 4th week postoperative while this significance disappeared at 12th and 24th week postoperative. Also, the mean value of DASH score in the mini plate group was significantly lower than in the screws only group at 4th week postoperative; however, this significance disappeared at 12th and 24th week postoperative.

This agreed with Başar *et al*. [11] who used the TAM and DASH score for evaluating their patients in both groups and they declared that, regarding the TAM at the last control examination, no significant difference was detected between patients with metacarpal fractures treated with mini plate plus screw and those treated with screw only ($P>0.05$).

Surgical dissection is crucial in the management of metacarpal fractures. More surgical traumas to the soft tissues during dissection probably lead to more separation of the periosteum and consequently poor outcomes. The skin incision done in low-profile mini plate surgical fixation to place the plate to the dorsal aspect of the metacarpal bone is longer in comparison to the skin incision of fixation with screws only. Also, soft tissue trauma and even periosteal separation during dissection is more frequent in fixation with mini plate and screws. This may be expected to negatively affect the treatment outcomes.

Our study has some points of strength as it is a prospective study and the cases were done by the same team. However, there are some limitations for this study such as small sample size and the unavailability of the hand dynamometer, which resulted in the inability to assess and compare the postoperative grip strength of the hand.

## Conclusion

We can conclude that patients with oblique or spiral metacarpal fractures and operated with mini plate and screws revealed matched functional outcomes to those operated with screws only. However, mini plate and screws patients showed early mobilization of the affected hand and shorter time to return to work.

#### Financial support and sponsorship

Nil.

#### Conflicts of interest

There are no conflicts of interest.

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