

Results of Fixation of Oblique and Spiral Fractures of Metacarpals and Phalanges of the Hand by Interfragmentary Mini Screws

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Abstract

Background: Surgical treatment is preferred in metacarpal and phalangeal fractures in general can be treated surgically with K-wires, screws or hand plates. Lag screws are the implant of choice for this type of fractures. The aim of this work is to evaluate the outcome of fixation of oblique and spiral fractures of phalanges and metacarpals of the hand by interfragmentary mini screws. **Patients and methods:** Eighteen oblique and spiral fractures were included in this study with 6 metacarpals and 12 phalangeal fractures. Eight spiral and 10 oblique fractures were followed up for 15 to 31 weeks. Gender distributed as seven females and 11 males with Patients' mean age of 35 (range 19 - 51) years old. In range of motion, functional and radiological results of treatment of oblique and spiral metacarpal and phalangeal fractures by open reduction and internal fixation using interfragmentary mini screws were evaluated. **Results:** In our study, the mean value of TAM score for both metacarpals and phalanges at the end of follow up (mean 23.1 weeks) was $87\% \pm 11.6$. Final range of motion assessment revealed three (16.7%) fair, two (11.1%) good and thirteen (72.2%) excellent results. There was statistically insignificant difference between the side of the affected hand with phalangeal and metacarpal fractures and end results of final follow up. **Conclusion:** Oblique and spiral hand fractures have special characters. They are the result of torsional forces and can cause rotational mal-alignment. Inter-fragmentary mini Lag screws fixation represents a very good method for dealing with such rotationally unstable fractures.

Keywords: Metacarpals fractures, Interfragmentary Mini Screws, Phalanges, TAM score

INTRODUCTION

The goal of treatment for these fractures is the return of painless function to the hand. This is best achieved through anatomic reduction of intra-articular fractures, restoration of extra-articular anatomic relationships, and stable fixation with minimal soft-tissue disruption that potentially allows early range of motion. Special attention must be paid to length and rotation of the fractured digit as loss of length may affect the function of the tendons and rotation may result in overlap and scissoring of digits (1,2).

For the vast majority of hand fractures, the return of painless hand function can be achieved with non-operative management. Some, like isolated non-displaced

phalangeal fractures, are inherently stable and may require only buddy taping to provide modest protection and to encourage range of motion to prevent stiffness. Others, like fifth metacarpal neck fractures, can usually be acceptably closed-reduced and maintained in a cast or splint for a few weeks (3)

However, there are many fractures of the hand that cannot be maintained in an anatomic position with non-operative means. This may be due to the bony anatomy of the fracture, such as a long oblique of metacarpals and phalangeal fracture, or to the deforming forces of the intrinsic and extrinsic musculature, such as a first metacarpal base fracture (4).

Open reduction and internal fixation with lag screws is technically demanding but provides inter-fragmentary compression. It avoids the risk of soft tissue dissection (5). The main advantages of these implants are the added stability provided by fracture compression and the resultant or independent neutralization of bending, rotational and shear forces acting upon the fracture site. These features help to ensure timely fracture healing and to allow earlier and more intensive digital rehabilitation (6).

Therefore, this study was aimed to evaluate the outcome of fixation of oblique and spiral fractures of phalanges and metacarpals of the hand by interfragmentary mini screws.

PATIENTS AND METHODS

All Patients included in this study were managed and followed up at Zagazig University hospital and Zagazig general hospital in the period from April 2020 to November 2020. A 18 oblique and spiral metacarpal and phalangeal fractures presented in 18 patients were managed by open reduction and internal fixation using mini Interfragmentary screws with lag technique. The patients were informed by the surgical intervention and written consents were obtained.

Inclusion and exclusion criteria

The patients criteria included in this study were a Spiral displaced metacarpals or phalanges (8 patients), oblique displaced metacarpals or phalanges (10 patients), closed fractures (17 patients), open fractures with minimal tissue laceration (one patient), skeletally mature patients (18 patients) and recent within 2 weeks of trauma (18 patients). While, a non-displaced fractures, comminuted fractures, fractures associated with tendon injuries and significant neurovascular injuries, high grade open fractures and fire arm injuries were excluded from this study.

Personal history was inquired about and included age, gender, occupation, medical comorbidities and special habits of medical importance as smoking and drug abuse. History about the trauma was carefully taken. Patients were asked about the mode and time of trauma. Patients were systemically examined for other injuries than the affected hand by trauma team. Local examination of the affected hand was performed to identify initial deformity and evaluate skin condition, edema of the hand, any soft tissue or tendon injuries, neurological and vascular status. Assessment of rotation clinically through fingers flexion was done.

The main demographic data of the studied patients were recorded including the mean age of patients was 35 ± 8.36 (range 19-51) years old. There were 11 (61.1%) males and 7 (38.9%) females. Dominant hand was affected in 16 patients (88.9%) and

non-dominant hand was affected in 2 (11.1%). the most affected group were office workers 8 (44.4%), then there was 5 (27.8%) of manual workers and 5 (27.8%) of not working patients. Twelve (66.7%) were not smokers and six (33.3%) were smokers.

Operative treatment:

Surgical operations in this study were carried out for 16 patients (88.9%) under general anesthesia and two (11.1%) had intravenous regional anesthesia (Bier block). Mini screws set was used to fix 18 oblique and spiral metacarpal and phalangeal fractures using lag technique (**Figure 1**). In case of using a preliminary pin fixation, entry of the pin was selected to be replaced by a screw finally. The reduction and alignment was checked for angulation, displacement or rotation. Rotation was checked by passively flexing the fingers and checking mal-alignment of the finger in the form of scissoring. Internal fixation of the fracture was done according to AO rules. A minimal distance between the apex of the fracture and the screw head was determined to be at least equal to the screw head diameter. The screw direction aimed to be perpendicular to fracture plane to avoid any displacement when the screw was tightened. At first the 1.5 mm drill bit was used to drill both cortices then the 2 mm drill bit was used to drill the near cortex only forming a gliding hole that apply fracture compression as the screw tightened. The screw head was countersunk to reduce soft tissue irritation and allow maximal contact area with the bone, distributing the forces from the screw head more widely than a non-sunk head (**Figure 2**).

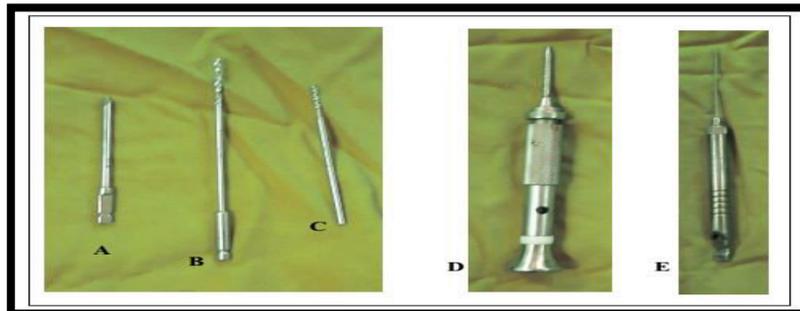


Fig. (1): Mini screws set. A) Countersink. B) 2 mm drill bit. C) 1.5 mm drill bit. D) Screw driver. E) Depth gauge

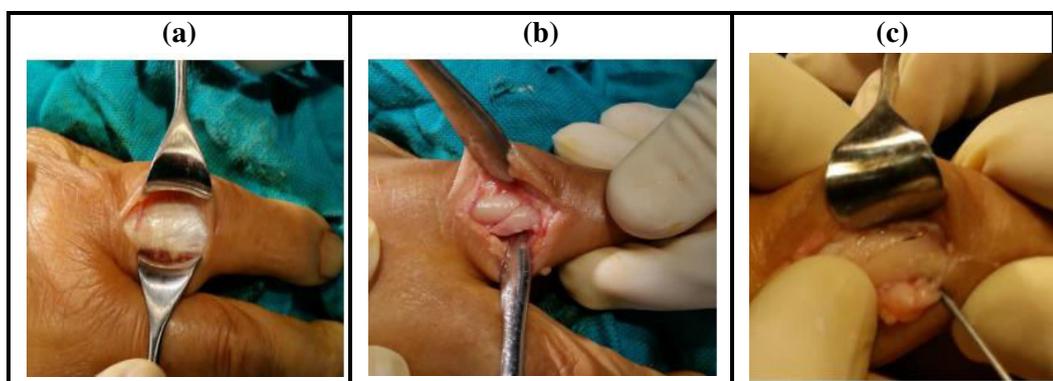


Fig. (2): Operative technique of phalanx fracture (a) Dorsal skin incision for proximal phalanx and extensor tendon exposure, (b) Retraction of extensor tendon and fracture exposure, (c) Preliminary fixation of phalanx fracture by a pin

Postoperative protocol:

Patients included in this study were followed up for a mean period of 23.1 (range 15-31) weeks. Patient were checked for pain relief, edema subsidence, any wound complications, clinical deformity, restored range of motion and hand daily function. TAM score was evaluated. Serial X-rays at 1st, 3rd and 6th weeks postoperatively were checked for any mal-alignment, implant failure and fracture union.

Statistical analysis:

Data were then imported into (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean \pm SD, the following tests were used to test differences for significance, difference and association of qualitative variable by Chi square test (X^2) and also repeated measures by chi square or sign test . Differences between quantitative independent groups by t test, paired groups by paired t, P value was set at <0.05 for significant results & <0.001 for high significant result.

RESULTS

The present study included 18 fractures, 5 (27.8% of all fractures of the study) affected medial three metacarpals. Fourth and fifth metacarpals were affected with two fractures each (40% of metacarpal fractures each) and third metacarpals were affected with one fracture only (20%) (**Table 1**).

Hand Phalanges of medial four fingers were affected in thirteen patients (72.2% of all fractures of the study). Proximal phalanges of little fingers were the most frequently affected with four fractures (30.8% of all phalangeal fractures). Proximal phalanges of ring fingers were affected in three patients (23%), Proximal and middle phalanges of index fingers were affected in two patients for each of them (15.4% for each) and Proximal and middle phalanges of middle fingers were affected in one patient for each of them (7.7% for each) (**Table 2**).

In this study, six fractures (33.3%) had intra-articular extension. Five of them were phalangeal fractures and one were metacarpal (**Table 3**).

The mean value of TAM score for both metacarpals and phalanges at the end of follow up (mean 23.1 weeks) was $87\% \pm 11.6$. Final range of motion assessment revealed three (16.7%) fair, two (11.1%) good and thirteen (72.2%) excellent results (**Figure 3**).

In this study, there was statistically insignificant difference between the side of the affected hand with phalangeal and metacarpal fractures and end results of final follow up ($P=0.73$) (**Table 4**).

Table (1): Distribution of metacarpal bone fractures.

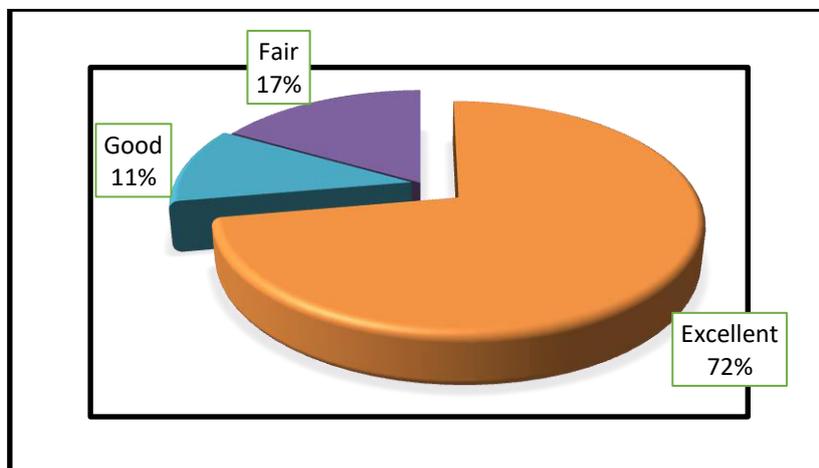
Distribution	No.	% of metacarpals	% of all fractures
3 rd Metacarpal	1	20%	5.6%
4 th Metacarpal	2	40%	11.1%
5 th Metacarpal	2	40%	11.1%
Total	5	100%	27.8%

Table (2): Distribution of phalangeal bone fractures.

Distribution	No.	% of phalanges	% of all fractures
PP Index finger	2	15.4%	11.1%
MP Index finger	2	15.4%	11.1%
PP Middle finger	1	7.7%	5.5%
MP Middle finger	1	7.7%	5.5%
PP Ring finger	3	23%	16.6%
PP Little finger	4	30.8%	22.2%
Total	13	100%	72.2%

Table (3): intra-articular extension.

Intra-articular fracture	No.		%
No	12		66.7
Yes	6	Metacarpal	1
		Phalangeal	5
Total	18		100

**Fig. (3): TAM score of Final Follow up.****Table (4): Relation between hand dominance and results:**

Dominance		Favorable		Unfavorable		X ²	P
		Ex.	good	fair	poor		
Not dominant	N	Ex.	good	fair	poor	0.6	0.73

affected hand		1	1	0	0		
	%	(2) 100.0%		(0) 0.0%			
Dominant affected hand	N	Ex.	good	fair	poor		
		12	1	3	0		
	%	(13) 81.2%		(3) 18.8%			

DISCUSSION:

Oblique and spiral fractures of the hand with the fracture length more than the diameter of the bone or isolated corner articular fractures may be especially amenable to lag screw fixation (7). Functional recovery and minimizing morbidity are the fundamental goals of rehabilitation. Early digital motion and tendon gliding exercises are important. Fracture stability limits pain and allows the more rapid and intense implementation of exercises (8).

Eighteen fractures in eighteen hands were included in this study. An oblique and spiral metacarpal and phalangeal fractures by open reduction and internal fixation using inter-fragmentary mini screws were evaluated.

Our results are in agreement with **HakanBaşar et al. (9)** who evaluate the results of treatment of oblique and spiral metacarpal and phalangeal fractures with mini screws only compared to mini plates plus screws. Forty-three patients were included in their study. Compared with our study, they had a larger number of patients due to the longer duration of their study (between 2007 and 2010). They also used two different techniques for fixation; the thing that necessitated a large number of patients for comparative study. In their study, the mean age of patients with a phalangeal fracture was 33.8 years (ranged from 20 to 50 years; 4 females, 18 males), and the mean age of patients with a metacarpal fracture was 29.6 years (ranged from 18 to 45 years; 3 females, 18 males). Also, the same study record a 14 of the metacarpal fractures were oblique and 10 spiral fractures, 14 of the phalangeal fractures were oblique and 8 spiral fractures.

Nalbantoglu et al. (10) evaluate the functional results of open reduction and low-profile plate or screws fixation in the treatment of 17 patients with phalangeal fractures. Eleven fractures only were oblique or spiral fractures which fixed with screws only that met this study's criteria. Their study recorded 17 patients (5 females and 12 males) with a mean age of 33 years ranged from 17 to 48 years. There were 14 proximal and four middle phalangeal fractures, including seven oblique, four spiral, one transverse, and six comminuted fractures. seven fractures were treated with a mini plate and screws, and 11 fractures with mini screws.

Also, **Roth et al. (11)** showed 26 male and 10 female patients. The mean age was 28 (ranged from 7 to 55) years old (78). This study also records four metacarpal, 24 proximal phalanges, 8 middle phalanges, and one distal phalanx fractures that had open reduction and internal fixation. Twenty-three of these fractures (62%) were

intra-articular. The follow-up period averaged 13 (4 –72) months. The radiologic follow up period averaged 7 (4 –10) weeks. In addition, **Rashed et al. (1)** revealed a high incidence of dominant hands fractures as our study however this study showed no significant predominance of dominant .

In our study, the mean TAM score percentage for phalangeal fractures fixed by mini screws was $87.2\% \pm 12.008$ and the favorable results of phalangeal fractures represented 84.6% of all 13 phalangeal fractures with a significant correlation between TAM score and functional end results in our study and **Nalbantoglu et al. (10)** study. The percentage of favorable cases in both studies runs closely to each other with better results of using mini screws only than using plates plus screws in their indications which approves that using of mini lag screws in oblique and spiral fractures of phalangeal fractures achieved us good results and satisfying outcome **(10)**.

CONCLUSION:

Oblique and spiral hand fractures have special characters. They are the result of torsional forces and can cause rotational mal-alignment. Inter-fragmentary mini Lag screws fixation represents a very good method for dealing with such rotationally unstable fractures.

No Conflict of interest.

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