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Original Article

## Intramedullary Compression Screw Fixation of Metacarpal and Phalangeal Fractures.

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### Article information

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### ABSTRACT

**Background:** Metacarpophalangeal fractures are the second most common fractures of the upper limb after distal radius fractures. These fractures represent 40% of all upper extremity fractures.

**Aim of the work:** The aim of this work is to examine the outcome (clinical and functional) of intramedullary headless screw (IMHS) fixation for metacarpal and phalangeal fractures.

**Patients and methods:** This is a prospective case series, which was conducted on (20) patients with (20) fractures admitted from emergency department of Al-Zahraa University hospital and Al-Ahrar Teaching Hospital, Sharkia. All were evaluated clinically in a systematic pattern (history, clinical examination (general and local hand examination), laboratory investigations and radiological workup. All were treated by IMHS for metacarpophalangeal fractures. Follow up visits were performed for at least 3 months after surgery. The outcome was evaluated clinically (functional outcome) and by x-ray imaging (radiological union). The results of the last follow up visit was included in the statistical analysis.

**Results:** The patient age ranged from 20 to 55 years with an average of 35.76 years and 7 patients were females. Manual worker was the commonest occupation (20.0%), while diabetes and smoking were the commonest risk factors. Fight was the commonest mode of injury (30%). DASH score was significantly reduced at 6 months than corresponding values at 3 months ( $1.26 \pm 1.65$  vs  $2.88 \pm 3.07$ ;  $p < 0.05$ ). The extension lag 6 weeks after surgery was significantly reduced when compared to values at 2 weeks postoperatively ( $2.64 \pm 5.03$  vs  $16.18 \pm 6.00$ , respectively). The return to work was achieved within 5 to 8 weeks, while radiographic union was completed 5-12 weeks after surgery. Complications were reported among 6 patients (30.0%), which were mild and treated conservatively.

**Conclusion:** Intramedullary Compression Screw Fixation is a relatively safe and effective treatment option for the Metacarpal and Phalangeal Fractures.

**Keywords:** Hand; Surgery; Regional Pain; Disability; shoulder; Total Active Motion



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## INTRODUCTION

The most proximal bones of the hands are known as metacarpals. It acts as a stable platform for the palmar neurovascular structures and phalanges <sup>(1)</sup>. Along their length, the metacarpals constitute a volar concave arc along their whole length. The flares of the arc are at the bases and the necks. The base of metacarpal bone articulates with the distal row of the carpals. The head of the metacarpal is cam-shaped. It articulates with the proximal phalanx base, by a condylar joint. This joint allows different movements (e.g., flexion, extension, radial and ulnar motion) <sup>(2)</sup>.

The metacarpophalangeal fractures are common. It represents the most prevalent injury in the emergency room and constitutes nearly 30% of hand fractures and 18% of all fractures lower than the elbow <sup>(3)</sup>. About 70% of these fractures occurred in the twenties and thirties (i.e., second and third decades of life) <sup>(4)</sup>. The phalangeal fractures are the commonest in the hand, especially the proximal phalanx fractures are responsible for 38% of all phalangeal fractures <sup>(5)</sup>. The treatment approaches for meta-carpophalangeal fractures are diverse. For example, the stable fractures could be treated with orthoses or early protected mobilization with a higher rate of success <sup>(6)</sup>.

On the other side, the unstable fractures are successfully treated with one of different operative methods. Several criteria determine the surgical treatment approach. These approaches include Screws, Kirschner wires (K-wires) or osteosynthesis plates. These approaches may be associated with a wide range of complications. This depends on the features of the fractures, patient data and surgical approach itself. In addition, the osteosynthesis material also affected the outcome <sup>(7)</sup>.

Irrespective of the higher rate of successful treatment, the outcomes are sometimes disappointing, especially in treatment of open, long spiral or fractures associated with severe trauma <sup>(8)</sup>.

## THE AIM OF THE WORK

The aim of the study is to evaluate the results (clinical and radiological) in patients treated with intramedullary headless compression screw fixation for metacarpophalangeal fractures.

## PATIENTS AND METHODS

This is a prospective case series, which was conducted on (20) patients with (20) fractures admitted from emergency department of AL- Zahraa University hospital and the residual in Al-Ahrar Teaching Hospital, Sharkia. The study had conducted at the time from January 2022 to January 2023. It included fracture metacarpals and phalanges (15 Metacarpals & 5 phalanges) which were treated by intramedullary headless screw fixation (IMHS), whether isolated or associated with other body injuries.

**Clinical evaluation:** The clinical assessment was performed by asking about the full medical history of the current condition and past history of surgery, any disease or similar conditions. A stress was directed to the data about the fracture itself (e.g., the

mode of trauma, duration between injury and treatment, associated injuries, first aids and received medications before admission). In addition, a full systematic clinical examination was performed in two phases; the first is the general examination and the second (may be called local examination), was directed to the injured hand. The sensory affect was tested by pin prick, while vascularity was tested by refill test, and all data was documented. After that, a venous blood sample was drawn and prepared for different laboratory tests (e.g., CBC, PT, PC, INR, renal and hepatic function tests). Finally, radiological workup was done and it was in the form of X rays of the hand AP lateral and oblique views.

For all subjects, we used intramedullary headless screws (IMHS) (2.4 mm and 3 mm for middle phalanges; 3 mm and 4 mm for proximal phalanges and metacarpals of titanium headless compression screws. The average length of a metacarpal is around 6.0 cm. The medullary canal is wider in the 5th metacarpal than the rest of metacarpals. The operative data were recorded and documented.

**Statistical Analysis:** the collected data were coded to assure the confidentiality of the patients. Data was used only for the purpose of the research. Continuous data were expressed by their arithmetic means and standard deviations, regardless of the normality of distribution. On the other hand, qualitative data were summarized by the relative frequency and distributions. Values after surgery compared over two points of time were compared by the paired samples "t" test. P value < 0.05 was set as the margin of statistical significance.

## RESULTS

Patient demographics are presented in table (1). The patient age ranged from 20 to 55 years with an average of 35.76 years. They were 7 (35.0%) females and 13 males (65.0%). The most frequent occupations were manual workers, housewives, driver, mechanic, and software engineer (20.0%, 20.0%, 15%, 10.0% and 10%, respectively). Diabetes and smoking were the commonest risk factors (30.0% and 25.0%, respectively). The majority of patients were right-handed (80.0%). The commonest mode of trauma was fight, heavy objects and motor bike accident and finally fall to ground (30.0%, 30.0%, 25.0% and 15.0% respectively) (Table 2).

Postoperative assessment showed that, DASH score was significantly reduced at 6 months than corresponding values at 3 months (1.26±1.65 vs 2.88 ±3.07; p < 0.05). In addition, the extension lags 6 weeks after surgery was significantly reduced when compared to values at 2 weeks postoperatively (2.64±5.03 vs 16.18±6.00, respectively). The return to work was achieved after 5 to 8 weeks, while radiographic union was proofed 5-12 weeks after surgery (Table 3).

Complications were reported among 6 patients (30.0%). There were no significant differences between complicated and non-complicated cases regarding smoking, diabetes mellitus, hernia and hypertension (Table 4).

Clinical and radiographic results of 2 cases were reported in figures (1-10). Figures (1 to 6) represented 45 years old, male, working as manual worker and exposed to the fracture by direct trauma involved in a brawl and presented 18 days after injury. By inspection, there was significant bruises and edema at the lateral aspect of the right hand. In addition to mal-rotation of the little finger. The x-ray revealed long oblique fracture of the 5th metacarpal with significant rotation (Figure 1), displacement and shortening. This represented unstable fracture that required to be fixed. An IMHS 50 mm in length and 3 mm in diameter was used. Figure (2) is an intraoperative image showed the incision and rotation check after insertion of the screw.

We ensure that fixation is stable and the pain decreased dramatically. Figure (3) presents X-ray one week after surgery, while figure (4) presents X-ray, two weeks after surgery. Both revealed maintained adequate reduction. The slab and stitches were removed and active range motion was permitted.

At the end of the fourth postoperative week follow-up x-rays (figure 5). At this follow up check there was no tenderness or pain, TAM ranged between 180° and 200° and there was an extension lag of about 15°. At this stage the patient returned to his daily activities. Figures (6) showed the clinical results 12 weeks after surgery. The extension lag was 0° and TAM is 260°, x-rays show complete union of the fracture and full return to work and his daily activities with almost full power. Figures (7 to 10) represented a 24 years old male, working as a mechanic, and he was hit by a heavy object to his right hand. Figure (7) revealed a long spiral fracture in the third metacarpal with significant shortening and rotation.

Eight weeks follow up after surgery (figures 9, 10) showed complete radiological union (figure 9) with full range of motion (Figure 10) and dash score was zero and TAM was 20

**Table (1):** Demographic data and characteristics of the studied patients

		Total no. = 20
<b>Age</b>	Mean ± SD	35.76 ± 9.45
	Range	20 – 55
<b>Sex</b>	Female	7 (35%)
	Male	13 (65%)
<b>Occupation</b>	Manual worker	4(20%)
	Housewife	4(20%)
	Mechanic	2(10%)
	Driver	3(15%)
	Software engineer	2(10%)
	Site engineer	1(5%)
	Delivery man	1(5%)
	Carpenter	1(5%)
	Nurse	1(5%)
	Cocker	1(5%)
<b>Risk factors</b>	Free	4(20%)
	Smoking	5(25%)
	Diabetic	6(30%)
	Hernia	2(10%)
	HTN	3(15%)
<b>Handedness</b>	Right	16 (80%)
	Left	4 (20%)

**Table (2):** Mode of trauma among the studied patients

Mode of trauma	Total (no = 20)
Motor bike accident	5 (25%)
Heavy object	6 (30%)
Fight	6(30%)
Fall to ground	3(15%)

**Table (3):** Postoperative assessment and functional results of the studied patients.

		Total no. = 20
<b>Dash 3 months</b>	Mean±SD	2.88 ± 3.07
	Min.-Max.	0 – 12
<b>Dash 6 months</b>	Mean ±SD	1.26 ± 1.65 *
	Min.-Max.	0 – 5
<b>TAM</b>	Mean ±SD	237.94 ± 27.73
	Min.-Max.	150 – 265
<b>Extension lag 2 weeks (degree)</b>	Mean±SD	16.18 ± 6.00
	Min.-Max.	5 – 30
<b>Extension lag 6 weeks (degree)</b>	Mean ±SD	2.64 ± 5.03 #
	Min.-Max.	0 – 20
<b>Return to work (wks)</b>	Mean ±SD	5.59 ± 0.87
	Min.-Max.	5 – 8
<b>Time to immobilize (days)</b>	Mean ±SD	11.59 ± 4.03
	Min.-Max.	0 – 15
<b>Radiographic union (wks)</b>	Mean ±SD	6.88 ± 1.87
	Min.-Max.	5 – 12

(\*) Indicates significant reduction of DASH score at 6 months compared to values at 3 months. (#) indicates significant reduction of extensive lag at 6 weeks compared to values at 2 weeks.

**Table (4):** Relation between occurrence of complications and risk factors of the studied patients

	Non-complicated	Complicated	Test	P-
	N = 14	N = 6		
<b>Smoking</b>	4(28.6%)	1 (16.7%)	0.31	0.57
<b>DM</b>	4(28.6%)	2 (33.3%)	0.04	0.83
<b>Hernia</b>	1 (7.1%)	1 (16.7%)	0.42	0.51
<b>Hypertension</b>	2 (14.3%)	1 (16.7%)	0.020	0.80



**Figure (1):** Showed oblique 5<sup>th</sup> metacarpal fracture



**Figure (2):** Intra-operative pictures showing the incision & rotation check after insertion of the screw



Figure (3): One week follow up x-ray



Figure (7): Long spiral fracture of the third metacarpal

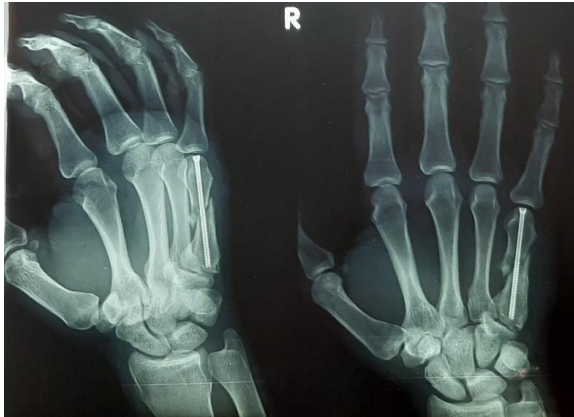


Figure (4): Two weeks follow up x-rays



Figure (8): Intraoperative x-ray images after insertion of the screw



Figure (5): Four weeks follow up x-ray



Figure (9): Eight weeks follow up x-ray



Figure (6): Six months follow up showing range of motion, TAM, rotation of the little finger



Figure (10): Six months follow up full range of motion, full flexion and no mal-rotation

## DISCUSSION

A strict adherence to surgical approaches is mandatory to gain good results, with reduction of potential disadvantages. It is thus of crucial importance to understand fracture biomechanics, pattern and the best method of fixation, provided that, a good primary stability without shortening, rotation or kneeling of metacarpal head is achieved.

This can be achieved with proper preoperative planning, using the correct approach and proper diameter and length of the screw. The insertion area, with respect to loading area of the articular surface of the metacarpal head is another key factor for success<sup>(9-13)</sup>.

In the current work, we assessed the clinical and radiological outcome of closed reduction with internal fixation by IMHS. Overall, the results of the current work are satisfactory with a complete radiological union and low rate of mild complications. These complications were treated conservatively and no need for further intervention.

As in the current work, **Ruchelsman *et al.***<sup>(14)</sup> reported results of a retrospective study of a consecutive series of 39 patients (34 men and 5 women), the mean age was 28 years (range 16-66 years), who were treated with IMHS fixation for acute displaced metacarpal neck and shaft fractures at a single center between 2010 and 2014. They reported a satisfactory outcome with active motion after the first week. They followed up their patients for 3 to 33 months (average 13 months). At a minimum of 3 months follow up, the 20 patients reached this time achieved a full composite flexion. The extensor lag was resolved by the end of the third week of follow up.

A full active metacarpophalangeal joint extension was reported by all patients. The grip strength was comparable to the contralateral healthy hand, and no need for further surgery. A shaft re-fracture was reported for 2 subjects due to exposure to blunt trauma after full union with the screw in place. Six weeks after surgery, all patients achieved radiographic union, with no arthrosis at the latest follow up visit. Just one patient reported clicking with joint motion. However, there was no need for further intervention. Authors concluded that, IMHS fixation is a safe and reliable treatment approach for metacarpal neck/ subcapital and axially stable shaft fractures, permitting early postoperative motion without affecting the overall union rates<sup>(14)</sup>.

**Jann *et al.***<sup>(15)</sup> analyzed the results of acute unstable metacarpal fractures for 20 digits. They were treated with IMHS without immobilization. Seventeen digits had full ROM, except for one digit with a head fracture of the second metacarpal bone. This patient had a 25° extension lag. The average grip strength in all patients was around 93% of the contralateral healthy hand. No infections, nonunion, rotational deformities or complex regional pain syndrome was reported. The removal of the screw was indicated in one patient due to proximal migration.

**Giesen *et al.***<sup>(16)</sup> reported on 31 consecutive extra-articular

unstable fractures of the middle or proximal phalanges. An intra-articular approach (retrograde) was performed for 17 and 5 fractures of the proximal and the middle phalanges, respectively. An antegrade (a trans-articular approach) was performed in 7 and 2 fractures of proximal and middle phalanges, respectively. The clinical and radiological healing was reported between 28 and 43 days after surgery. The mean TAM was 222°. The average extension deficit for the proximal inter-phalangeal (PIP) joint was 8° (range, 0–20°).

**Gaspar *et al.***<sup>(17)</sup> described 10 acute proximal phalangeal fractures treated with antegrade IMHS. At the end of follow up, the average TAM was 258° and the mean post-operative Quick-DASH score was 3.9. No complications were reported and additional interventions were indicated.

Chondral damage is one of the commonest concerns with the use of IMHS for fixation of acute metacarpophalangeal fractures. The antegrade fixation from the base of the proximal phalanx is associated with less Chondral damage compared with the retrograde technique<sup>(18)</sup>. **ten Berg *et al.***<sup>(19)</sup> used a quantitative 3-D computed tomography (CT) to evaluate the starting point of the joint, surface area, and subchondral volumes used during IMHS fixation of metacarpal neck fractures. They used retrograde intramedullary insertion of 2.4- and 3.0-mm HCS and 1.1-mm Kirschner wires for fixation of the metacarpal neck fracture in 3-D models and from CT scans of the proximal phalanx head of 16 adult patients. They reported that the volume of the screws head in the metacarpal bone has a relatively low relevance (4% for 2.4 mm and 5% of the total joint surface for 3.0 mm screw).

**Poggetti *et al.***<sup>(20)</sup> used IHCS to treat metacarpal bone fractures of 25 patients (24 males and one female). They used wide-awake anesthesia and percutaneous insertion of intramedullary titanium headless screw fixation (3 mm in diameter). No open reduction was indicated. Early active mobilization started soon after surgery (0–3 days). All fractures showed complete healing with less than 5° of rotational or axial deformities. The return to work was achieved by all patients at an average of 2.38 weeks (0.5– 6 weeks) after surgery. No complex regional pain syndrome (CRPS) was reported. In addition, other complications (e.g., tendon or nerve injuries, infection, protrusion of the screw, mobilization) were not reported. The radiological healing was observed on 4-6 weeks (average 4.36 weeks). The functional recovery showed that, the M2DASH score ranged between 0 and 5 (the average 0.6). The average TAM was 250.8 degree; ranged between 220 and 260 degrees; the average grip strength was 42.24 kg (ranged between 33 and 42 kg).

The last follow up visit showed satisfactory outcome with acceptable ROM at all meridians. Fixation was adequate for all subjects, and no protrusion of screws was reported. In addition, no other complications were recorded (e.g., loss of reduction, malunion or malrotation, infection, migration of the screw or CRPS among others). The average return to daily activities was 2.38 weeks (4-8 weeks)<sup>(20)</sup>.

In the study by **Del Piñal *et al.***<sup>(21)</sup>, an extension lag more than

30 degrees at PIP was detected by two patients and only one patient reported a concomitant flexor tendon injury. These results are quite different than the current work and this may be explained by different inclusion criteria and different sample size.

### Conclusion:

The current work showed that, the use of Intramedullary Compression Screw Fixation is a relatively safe and effective treatment option for the Metacarpal and Phalangeal Fractures. However, due to study limitation of small sample size, the obtained results must be treated cautiously and future wide scale studies are recommended.

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None to be disclosed

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