

Management of Metacarpal and Phalangeal Bone Fractures of the Hand

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ABSTRACT

Background: Hand fractures are one of the most common fractures presenting at accident and emergency units. Because of the complexity of the hand; management of hand fractures can be very challenging. Fixation of hand fractures can be done by multiple methods including percutaneous K-wires fixation and open reduction and internal fixation with either interosseous wiring or mini plate and screws. This comparative clinical study is to review the indications and long term results of each method.

Methods: Thirty patients with hand fractures were included in our study, ten of them treated with percutaneous K wire fixation (group A), another ten patients were treated with open reduction and internal fixation with interosseous wiring (group B) and the last ten patients were treated with open reduction and internal fixation with miniplate and screws (group C). The duration of this study was for eleven months with patient's age ranging from 15-50 years old. The type of surgical intervention used was determined according to the fracture pattern.

Results: All patients treated in this study had clinical and radiological union by the 10th week. Patients treated with percutaneous K wire fixation had better range of movement and earlier return to work with less complications than patients treated with open reduction and internal fixation with interosseous wiring or mini-plate and screws.

Conclusion: Percutaneous fixation of unstable metacarpal and phalangeal fractures is a reliable and safe method for the majority of fracture patterns with higher ROM and less complications in comparison with the other two methods.

Key Words: Metacarpal – Phalangeal – Bone fractures – Hand.

INTRODUCTION

Hand fractures are the most common fractures presenting at accident and emergency units. Appropriate evaluation at first presentation, as well as during their management, can significantly prevent both morbidity and disability to a patient [1].

Increasingly sophisticated advances has been made in operative techniques on the skeleton of the hand, in particular the development of stable fixation with mini screws and plates has expanded the application of open reduction and internal fixation in metacarpal fractures. Tension band wiring also is a simple, predictable method for internal fixation. Nevertheless, many single closed fractures can be reduced by closed manipulation and protected in a functional position with splinting, bracing, casting or a percutaneous pinning technique with excellent results [2].

Because of the complexity of the hand, frequency of complications following hand fractures including stiffness, malunion, nonunion and associated soft tissue injury; management of hand fractures can be very challenging. Fixation of hand fractures can be done by multiple methods including percutaneous K-wires fixation and internal fixation with either interosseous wiring fixation or mini-plate and screws. The choice of fixation method depends on the location, geometry, pattern of the fracture, associated injuries, and the surgeon's preference [3].

The correct diagnosis and management of hand fractures and associated injuries are very challenging, this comparative clinical study is designed to review the indications and compare the long term outcome of each method.

PATIENTS AND METHODS

This prospective, non-randomized clinical study included thirty patients presented with metacarpal and phalangeal hand fractures, admitted to Al-Azhar University Hospital and Helmia Military

Hospital between September 2016 and August 2017. Patients were fully informed about the procedure. Written consents were obtained. Patients were divided into 3 groups. Ten patients were treated with percutaneous K wire fixation (group A), another ten patients were treated with open reduction and internal fixation with interosseous wiring (group B) and the last ten patients were treated with open reduction and internal fixation with mini-plate and screws (group C).

Inclusion criteria:

- Traumatic hand fractures with significant displacement, rotation, angulation and/or instability.
- Patients aged 15-50 years.
- Both sexes.

Exclusion criteria:

- Age extremes.
- Chronic co-morbid diseases.
- Auto-immune diseases.
- Bleeding disorders.
- Pathological fractures.
- Poly-traumatized patients.
- Fractures with no significant displacement, rotation, angulation or instability.

Preoperative evaluation:

Each patient was evaluated clinically, radiologically and by other preoperative laboratory investigations to confirm fitness for general anesthesia and appropriate method of surgical intervention was determined according to the proposed indications. The default method of management is percutaneous fixation of the fracture using K wires unless there is an indication for ORIF as the following.

Indications of ORIF using interosseous wiring: Closed oblique phalangeal or metacarpal shaft fracture, replantation and intra-articular fracture, replantation, failed closed reduction.

Indications of ORIF using mini-plate and screws: Multiple fractures, condylar fracture, segmental bone loss, multifragmentary articular and peri-articular fracture with displacement and/or rotation, failed closed reduction.

Operative managements:

Thirty patients were submitted to three different fixation modalities according to the indications in each method and divided into three groups.

Operative technique:

A- Percutaneous K wiring:

Metal used: Kirschner wire with thickness ranging from 0.8mm to 1.2mm.

After hand sterilization and hair shaving, the fracture is held in place with a towel clamp. Rotation is verified by checking for abnormal crossing of the fingers with flexion of the MP and IP joints. The first wire was inserted as a guide wire perpendicular to the fracture line followed by insertion of a second wire crossing or parallel to the first wire. The reduction and K-wire placement are verified under C-arm imaging and the finger is taken through a ROM. For comminuted or unstable metacarpal fractures, we also inserted K-wire through the metacarpal head into the proximal phalanx. K-wires were cut off just beneath the skin or left protruding and bent 90 degree to minimize inward migration. A sterile dressing is applied, and the finger and adjacent neighboring finger are splinted and placed in the safety position (wrist 30 degrees dorsiflexion, MP joint 80 degrees flexion).

Post operative: Pins are removed at six weeks and then the finger is protected with buddy taping for another three weeks before allowing full ROM.



Figs. (1,2): Showing 21 years old male patient presented with shaft fracture of the middle phalanx of the left middle finger, managed with closed reduction and percutaneous fixation with two crossing K wires.

B- Interosseous wiring:

Metal used: 0.5mm monofilament stainless steel wire.

Dorsal incisions are preferred and then splitting the extensor tendon for visualizing fracture site. Placing the K-wires perpendicular to the fracture

plane to make holes in the fractured bone. Removing the wires and inserting 0.5mm dentate wire through the first hole. Dragging the wire using a clamp and twist it around the fractured bone. Inserting the wire through the other hole. It can be made in a figure of eight shaped tension band or as an encircling wire. Tightening of the wire and closure of skin after haemostasis. A sterile dressing is applied, and the finger and adjacent neighboring finger are splinted and placed in the safety position (wrist 30 degrees dorsiflexion, MP joint 80 degrees flexion).

Post operative: Splinting for 3-4 weeks before allowing full active movements.



Figs. (3,4): Showing 20 years old male patient presented with fracture base of the proximal phalanx of the left ring finger, managed with open reduction and internal fixation with interosseous wiring.

C- Miniplate and screws:

Metal used: 2.0-2.4mm locking titanium mini-plates (>3 holes), 2.0-2.2 cortical and locking screws.

Lazy S dorsal skin incision is preferred for exposure of phalangeal and metacarpal fractures. Care was taken to preserve the dorsal longitudinal venous system. The extensor tendon is split longitudinally for exposure of proximal phalangeal fractures. The periosteum is longitudinally incised and elevated to expose the fracture. To reduce spiral and oblique fractures we exposed the sharp proximal and distal fracture spikes. Reduction was maintained with reduction clamps or towel clips. Application of the plate and placement of the screws, then closure of the wound. A sterile dressing is applied, and the finger and adjacent neighboring finger are splinted and placed in the safety position (wrist 30 degrees dorsiflexion, MP joint 80 degrees flexion).

Post operative: Hand is kept in a splint for a week before allowing active range of movement.



Figs. (5,6): 31 years old male patient presented with fracture shaft of the right 5th metacarpal bone, managed with open reduction and internal fixation with mini-plate and screws.

All patients were submitted for post operative splinting in the functional position and physiotherapy was allowed after removal of the splint for three months. Follow-up protocol included clinical and radiological evaluation to assess pain, tenderness, range of movement, return to work, complications, clinical and radiological union. Post-operative A-P and lateral X-ray was done every two weeks for 1st month then every month for 6 successive months.

Patients' age in this study ranged from 15 to 45 years old with mean age 23.2 years old. 25 patients involved in this study were males and 5 patients were females. Patients involved were twenty six dominant hand involvements and the non-dominant hand was affected in four patients. Direct injury (impaction, crushing) was responsible for fractures in twenty eight patients and indirect trauma (twisting injury) was responsible for fractures in two patients.

RESULTS

This study consists of thirty patients presented with metacarpal and phalangeal fractures. They were classified into three groups according to the method they were treated with.

The range of motion (ROM) was classified into two types: Active and passive movement. Both active and passive were measured in the medial 4 fingers at the metacarpophalangeal joint, proximal

interphalangeal joint and distal inter phalangeal joint while in the thumb it was measured at metacarpophalangeal and interphalangeal joints. Post-operative active range of motion (ROM) for each joint was calculated and compared according to type of fixation as shown in Table (1). Patients treated with K wires fixation had a better ROM when compared to the patients treated with other methods.

Table (1): Post operative active ROM.

	Group (A)	Group (B)	Group (C)
MP	90	85.3	75.3
PIP	89.9	74.6	70.2
DIP	68.5	52	50.1
TAM	246.3	219.3	215.2

Union was detected clinically starting from 4 to 8 weeks and the results in the three groups were compared as shown in Table (2). Clinical union was earlier in group C when 8 patients showed clinical union at 4 weeks post operative while 7 patients and 5 patients showed clinical union at 4 weeks in group B and C respectively.

Table (2): Clinical union.

Clinical union	Group (A)	Group (B)	Group (C)
4 weeks	5	4	8
6 weeks	4	3	1
8 weeks	1	0	1

Radiological union was detected starting from 6 to 10 weeks and the results in the three groups were compared as shown in Table (3). It was earlier to occur in group A when 8 patients showed complete union at 6 weeks while 7 patients and 6 patients showed radiological union at 6 weeks in group B and C respectively.

Table (3): Radiological union.

Radiological union	Group (A)	Group (B)	Group (C)
6 weeks	8	7	6
8 weeks	2	2	4
10 weeks		1	

In our study 27 patients (90%) were able to go back to work, 3 patients (10%) were unable to go back to work due to movement restriction. During this study we faced a number of complications; in group A: One case developed pin tract infection and was treated by curettage and continuation of

antibiotics. One case had partial stiffness of MCP joint and was treated with physiotherapy, while in group B: Two cases were complicated with tendon adhesions. One case of them had stiffness of MP joint managed by physiotherapy with better results. In group C: One case was complicated with wound dehiscence and needed removal of plate and screws. Two cases were complicated with adhesions and decreased ROM.

DISCUSSION

This study was a prospective study of 30 consecutive patients started from September 2016 till August 2017 at Al-Azhar University Hospital and Helmia Military Hospital to compare between three different methods of metacarpal and phalangeal fracture fixation: Percutaneous k wire fixation versus open reduction and internal fixation using interosseous wiring versus open reduction and internal fixation using mini-plate and screws. The choice of the method of management was according to the fracture pattern and the indication of each method proposed in this study.

Somboon reported 112 consecutive patients and they had randomized study comparing percutaneous fixation versus open reduction and internal fixation of unstable proximal phalangeal fracture during July 2006 to December 2008. There were 89 males and 23 females, with mean age 28.2 years, while in our study patients were 25 males and 5 females with mean age 23.2 years.

He used dorsal approach for ORIF and active movement was advised taking care not to afford stresses at the fracture site and bulky dressing for 3 to 5 days aiming for active mobilization for all cases as early as possible according to pain tolerance. In our study the same approach was used but active movement was allowed after 1 week in ORIF and after 4-6 weeks in percutaneous fixation.

In Somboon study; Union occurred in 95% of patients and time of union ranged from 8 to 20 weeks with mean average 12 weeks, while in our study union occurred in all patients and was classified into clinical union which ranged from 4 to 8 weeks and radiological union which ranged from 8 to 10 weeks [4].

AlQattan reported 78 consecutive patients and compared percutaneous fixation versus open reduction and internal fixation of unstable proximal phalangeal fracture during January 1994 to December 2006. There were 78 men (industrial workers), with age ranging from 20 years to 48 years with mean age 33 years. All of his patients had industrial

injuries with no report about the exact mode of trauma or the fracture morphology, while in our study; the patients were 25 males and 5 females and were classified according to the mode of trauma, direct injury (impaction, crushing) was responsible for fractures in twenty eight patients and indirect trauma (twisting injury) was responsible for fractures in two patients, the patients included in our study were industrial and non industrial workers.

He used k-wires in both percutaneous and open fixation, while in our study we used k-wires only in percutaneous fixation and interosseous dentate wires (0.4mm) or mini-plate and screws in ORIF. All of his patients had clinical union coming with our results [5].

Thakur study showed dominant hand involvements (58%). The non-dominant hand was affected in (42%), while in our study hand dominance was twenty six dominant hand involvements (86%), the non-dominant hand was affected in four patients (14%).

In Thakur study indications of surgery stated were skeletally mature, compound fractures, multiple fractures, angulations more than 10° in A/P view and 20° in lateral view, multi-fragmentary fractures, severely displaced fractures, irreducible-fractures and intra-articular fractures. In the contrary we stated that the default technique to be used in hand fractures is percutaneous k-wire fixation and stated the indications for ORIF with mini-plate and screws or with interosseous wiring.

Hard ware used in Thakur study was K-wires 0.028 inch, 0.35 inch, 0.45 inch and 0.62 inch while the mini DCP size was 1.5mm straight mini DCP and screws were 1.5mm screws, while in our study the metal used was K-wire ranging from 0.8mm to 1.2mm, 0.5mm monofilament stainless

steel wire, 2.0 -2.4mm locking titanium mini-plates (>3 holes), 2.0-2.2 cortical and locking screws.

In our study, Postoperative active range of motion (ROM) for each joint was calculated and compared in each method of fixation but Thakur didn't state post operative ROM as a follow-up criteria [6].

Conclusion:

We found out that percutaneous fixation of unstable metacarpal and phalangeal fractures is a reliable and safe method for the majority of the fracture types giving a higher ROM and less complications in comparison with ORIF, this study recommend usage of percutaneous K wire fixation unless there is an indication for ORIF as in multi-fragmentary articular and peri-articular fractures, bicondylar fractures, segmental bone loss, re-plantation or when closed reduction fails.

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