Original Article

HOW TO AVOID HAND STIFFNESS IN METACARPAL FRACTURES?

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Abstract
Objective: The purpose of this study was to evaluate the incidence of hand stiffness and range of motion in patients with metacarpal fractures treated with internal fixation by low profile osteo-synthesis (Mini-plates).

Materials and methods: A prospective study including thirty-six patients with metacarpal fracture was carried out in the period between June 2018 and June 2019 at Sohag University Hospital. All these 36 patients underwent internal fixation of metacarpal fracture by mini-plates. Evaluation of pain measured on a visual analog scale (VAS), active range of motion (ROM); and grip strength and postoperative follow up is up to one year.

Results: Group of patients including thirty-six patients with metacarpal bone fractures underwent internal fixation by mini plate, the mode of trauma was Motor car accident in 26 cases (72.2%) and Assault in six cases (16.7%) hitting hard objects was in 4 cases (11.1%). No complications were reported in our cases except one case (2.8%) with wound dehiscence which improved with daily dressing and good antibiotics.

Conclusion: Mini-plate and screws fixation of metacarpal fractures produces anatomical reduction of fractures with stabilization that is rigid enough to allow early mobilization, thereby preventing stiffness and hence good functional results.

Keywords: Metacarpal, Mini plate, Motor car accident, Hand, fracture.

1. Introduction

Traumatic injuries to the hand represent a large proportion of work presenting to emergency departments and hand surgery units [1]. Metacarpal fractures are second most common fractures in the hand. The incidence of metacarpal fractures is 8.4 per 10,000 person-year [2]. These may present as isolated fracture, multiple metacarpal fractures or in combination with bony injuries to other extremity. The metacarpal fractures constitute 18-44% of hand fractures [3,4]. Metacarpal fractures are a common presenting problem to the hand surgeon. During surgical treatment, anatomic reduction is very important [5,6]. A biomechanical cadaveric study shows that as much as 8% loss of grip power may result from every 2 mm of metacarpal shortening. A few degrees of mal-rotation may lead to digital overlap when a fist is made [7,8]. The superficial presence of the bone and the use of hand for evasive action to trauma make the metacarpals as commonly fractured bones. The metacarpal fractures occur more common in men who constitute up to 85% of the patients [3,9]. The fifth metacarpal is the most common metacarpal to get fractured [10]. The metacarpal fracture can be classified depending upon the site as fracture of head, neck, shaft or base of the metacarpal. The fracture pattern may be classified as transverse, short oblique, long oblique or comminuted one [11,12]. Usually these fractures are...
managed either conservatively or by Kir-
schner (K) wire fixation. K-wire fixation
may be complicated by pin site infection,
protruding or prominent wires and require
prolong immobilization [13]. The nonunion,
mal-union and joint stiffness, which may
result from external immobilization or
percutaneous K-wire fixation, is avoided
by the rigid internal fixation with mini-
plate and screws in metacarpal fracture.
[13,14]. The use of plate for fixation of
metacarpal fractures was first documented
in 1958 [15]. Rotational alignment, cor-
rection of dorsal angulation and shortening,
stable rigid fixation and early mobilization
are most important goals in management
of metacarpal fractures [16,17]. The aim
of this study was to evaluate the usefulness
of open reduction and internal fixation
with mini-plate and screws to evaluate
the symptomatic improvement and early
recovery of functions.

2. Materials and methods
This prospective study was concluded on
36 cases of variable ages and sex (30
males and 6 females) which were presented
to orthopaedic & traumatology department
at Sohag university hospital in the period
from June 2018 till June 2019., the study
was done on patients suffering from met-
acarpal fracture with ages between 18 to
60 years the mean age was 32.3 years.
The causes of metacarpal fractures are
different and variable mostly, motor car
accidents. Motor car accident was the
cause in 26 patients (72.2%), six patients
(16.7%) Assault injury and in four patients
(11.1%) the cause was hitting hard object.
Inclusion criteria were: (1) fracture of the
neck or shaft of the metacarpal with unac-
cepted angulation and/or any rotational
deformony were the indications for surgical
intervention (2) irreducible or unstable
fracture patterns. We excluded patients with
complex injury, severely comminuted
fracture and bony defects. Metacarpal
fractures were in the dominant hand in
24 patients and 12 patients in the non-
dominant hand. Right hand was affected
in 22 patients and the left hand was
affected in 14 patients. There were 18
patients with neck fracture (seven were
transverse, five with minimal comminution
and six with oblique fracture) and 28
shaft fracture (fourteen were transverse,
ten oblique and four with wedge fracture).
As regard the affected metacarpal, the 5th
metacarpal was the most affected one 22
patients five of them were related to
other metacarpal bone fracture. The next
common was the 4th metacarpal in 12
patients six of them associated with other
metacarpal fracture, the 2nd metacarpal in
8 patients and the 3rd metacarpal was
isolated fracture in 2 patients and involved
in 3 patients. The general condition of
patients with acute major injuries were
assessed concerning hypovolemia, associ-
ated orthopaedic or other systemic injuries
on admission and resuscitative measures
were taken accordingly. All patients rec-
eived analgesics in the form of I.M
injections and antibiotics intravenously.
Full clinical assessment was performed
including detailed history relating to age,
sex, handedness, occupation, mode of inj-
ury, past and associated medical illness.
Examination of the affected hand for de-
gree of angulation, rotation and shortening
was done. The hand was immobilized in
extended below elbow slab. Routine inv-
estigation including blood picture, pro-
thrombin time and concentration, random
blood sugar and serum creatinine were
done for all patients. All patients were
evaluated clinically and radiographically
to assess the extent of injury. X-ray was
taken in two views (antero-posterior &
oblique). The subjective evaluation incl-
uded the assessment of range of motion
(ROM), extension lag, radiographic union.
Patients were also asked about the
duration of disability and rehabilitation,
functional restriction at work or sport
and symptoms of pain. Postoperative
follow up was to average 9 months (6 to
12 months).
2.1. Surgical technique
All the procedures were performed with the patients positioned in supine position on the operating table with the injured hand on side radiolucent table perpendicular with the patient body. The procedure was performed under brachial plexus block anesthesia (regional anesthesia). After the landmarks have been identified and marked on the skin, the limb was exsanguinated, and the tourniquet was inflated to 250 mmHg. A direct longitudinal incision over the fractured metacarpal on the dorsal aspect of the hand a little bit lateral in case of 2nd MCP fracture, a little medial in case of 5th MCP fracture and in between 3rd & 4th MCP bones in case of 3rd or 4th MCP fracture. In cases of multiple metacarpal fracture one incision between every two adjacent metacarpals this is done to avoid incision marks over the plate. After dissection of the subcutaneous tissue the extensor tendon was retracted away then a longitudinal incision of the intrinsic fascia was done to expose the fractured metacarpal, after debridement of the fracture site and reduction a low profile mini plate was applied on the dorsal aspect of the metacarpal. Use of the proper contour according to the location of the fracture allowed each fragment to be fixed. Smooth gliding of the flexor tendon was checked against the protruding screw tip at the volar surface of the bone during the passive range of motion (ROM) of the finger. Adequate soft tissue coverage was ensured over the plate by closure of all fascia of the intrinsic muscle over the plate, the subcutaneous tissue was sutured and closure of the skin by simple interrupted sutures. After surgery the hand was immobilized in below elbow slab for two weeks in functional position. I.V antibiotics were prescribed for one week followed by one week on oral antibiotics with oral analgesics. The patients were discharged in the same day of surgery unless other injuries require hospital stay. After 2 weeks the stitches and the slab were removed. Light work was allowed for 6 weeks and full work was allowed at 8 weeks after surgery. The patients were followed up clinically and radiologically at 6 and 8 weeks of operation initially and then monthly for 1 year to assess the union at the fracture site, range of motion of the involved finger, ability to touch the distal palmer crease with the involved finger, ability to write or work without pain, presence or absence of any deformity and radiological evidence of union at the fracture site. Normal range of movement was taken as MCP of 0–90 degree. Cases were classified according to the range of motion of MCH joint movement into excellent (ROM more than 80 degree), good (ROM 60-80 degree), poor (ROM 40-60 degree), bad (ROM less than 40 degree).

2.2. Statistical analysis
The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 25). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

3. Results
The present study included 36 patients with metacarpal fracture, 30 were male and 6 were female. The average age of the patients was 32.3 years (18-60 years). Road traffic accident was the cause of the fracture in 26 patients (72.2%), Assault in six patients (16.7%) and in four patients (11.1%) the cause was hard trauma. the patients were followed up for at least 6 months. Four cases were lost for follow up and the remaining 32 cases were evaluated as in tab. (1).
Results were evaluated every two weeks after discharge. All patients applied a below elbow slab for 2 weeks and Light work was allowed for 6 weeks and full work was allowed at 8 weeks after surgery. No complications of displacement in the fracture line implant failure, distal loss of sense due to nerve damage, mal-union and rupture of the extensor tendon, osteonecrosis and sudeck atrophies were observed in the postoperative follow-up of the patients. Dehiscence in the wound dressing was observed in only one patient but there was no active drainage, this disappeared with daily dressing and good antibiotics. Bone union was observed radiologically in all patients with closed fracture in a mean of 6 weeks (range 5-7 weeks). Clinical and radiological results were excellent in 28 cases with closed fracture (as regard pain and function) there was no limitation of motion of the metacarpophalangeal joint. The mean range of motion of MCPH joint was 89 degrees (80-90 degree) with no angular or rotational deformity were observed in any patient. In addition, all four compound cases achieved bony union at an average period of 8 weeks. Two of them had excellent results with full range of motion at metacarpophalangeal joint with no angular or rotational deformity. The other two cases were associated with other injuries but achieved good results at the end of follow up. Four cases had good range of motion at the metacarpophalangeal joint (60-80 degrees) and two cases had fair range of motion at metacarpophalangeal joint (40-60 degree) which improved by physiotherapy for one to two months. At the final follow up all patients regained full flexion at metacarpophalangeal joint and interphalangeal joint with no extension lag. One case had 2mm shortening. One case had sensory disturbance at the dorsum of the hand. No cases had infection at operation wounds or mechanical irritation of the skin or extensor tendons.
3.1. **Examples cases**

**Case (1)**

34 years old male patient came to our ER with simple transverse fracture 2\(^{nd}\), 3\(^{rd}\), 4\(^{th}\) & 5\(^{th}\) MCB of left hand due to assault trauma. After full clinical examination X-ray antero-posterior and oblique views were done, fig. (1-a). Extended below elbow slab and full laboratory investigation were done. Dorsal platting was done through 2 separate incisions one between 2\(^{nd}\) & 3\(^{rd}\) and the other between 4\(^{th}\) & 5\(^{th}\), fig. (1-b). We put the hand in extended below elbow slab for 2 weeks after 2 weeks we removed the slab and the stitches. Radiological union achieved after 1.5 months’, fig. (1-c). The patient suffered from sensory disturbance at the dorsum of the hand improved spontaneously. The patient’s follow up after one year was excellent with full range of motion, fig. (1-d).

**Figure (1)** a. X-ray preoperative, b. X-ray postoperative, c. ROM after 1 year, d. X-ray after 1 year.

**Case (2)**

24 years old male patient came to our outpatient clinic with compound fracture 4\(^{th}\) & 5\(^{th}\) MCB due to motor car accident. After full clinical examination X-ray antero-posterior and oblique views were done, fig. (2-a). Extended below elbow slab and full laboratory investigation were done. Dorsal platting was done through one incision between 4\(^{th}\) & 5\(^{th}\) MCB after good wash and debridement. We put the hand in extended below elbow slab for 2 weeks. Wound dehiscence resolved by daily dressing and antibiotics. Radiological union achieved after 1.5 months’, fig. (1-b). The patient’s follow up after 8 months was excellent with full range of motion, figs. (1-c & d).
4. Discussion

The aim of this study was to evaluate the results of open reduction and internal fixation with mini-plate and screws for the management of metacarpal fractures. These fractures are generally managed conservatively. Some orthopedic surgeons, prefer fixation with K-wire. However, rigid fixation cannot be achieved by K-wire. Further, pin infection, deformity, non-union and joint stiffness are common when managed with K-wire [18,19]. Internal fixation with Kirschner wire, tension band technique and isolated screws produces weaker fixation than mini-plate and screws. Mini-plate and screws fixation of unstable metacarpal fractures produces anatomical reduction of fractures with stabilization that is rigid enough to allow early mobilization, thereby preventing stiffness [20,21]. Plate fixation in closed multiple metacarpal fractures is necessary for several reasons. Firstly, metacarpal length is very likely to be reduced in multiple metacarpal fractures. This is more evident when a border metacarpal is involved, as it cannot rely on the adjoining metacarpals to hold it out to length. Definite guidelines for acceptable metacarpal shortening are lacking [22]. However, it is recognized that shortening as well as loss of the transverse arch, which result from multiple displaced metacarpal fractures. Plate fixation and anatomical reduction are very important in metacarpal rotation as one degree of metacarpal fracture rotation has been shown to produce 5° of fingertip rotation [11,23]. These factors that can compromise normal hand function by altering interosseous muscle anatomy and flexion and extension force ratios, both of which can lead to an asynchronous, non-integrated grasp resulting in reduced grip strength [22]. Plate fixation for metacarpal shaft fractures was found to be statistically advantageous in several parameters as compared to other varieties of treatment. These included grip
strength, digital range of motion, residual rotation, and DASH scores. Radiographic fracture reduction was achieved equally in all groups. Operative time was significantly longer for surgical plate implantation as compared with other methods of treatment [16, 24]. Several authors have noted a large number of satisfactory outcomes after plate fixation of metacarpal fractures (Dabezies and Schutte, 1986; Ford et al., 1987; Hastings, 1987). Other authors have noted complication rates of up to 35% with plate fixation (Fusetti et al., 2002; Page and Stern, 1998; Stern et al., 1987). These studies must be interpreted cautiously as they include open and closed fractures, single and multiple fractures, combinations of metacarpal and phalangeal fractures and the use of implants not designed specifically for use in the hand [25, 26]. Fusetti et al. (2002) are the only authors to report a series of multiple metacarpal fractures (19 patients) they speculated that the higher incidence of complications in their series of patients with multiple metacarpal fractures was related to the higher-energy trauma sustained by these patients [27]. Our data show that good outcome can be expected after plate fixation in closed multiple metacarpal fractures utilizing hardware specifically designed for use in the hand, provided the principles of internal fixation in the hand are followed at the final follow up all patients regained full flexion at metacarpophalangeal joint and interphalangeal joint with no extension lag. We agree with Hastings (1987) and Stern (2000) in that we think that the poor results published on plate fixation are not related to the plates, but stem from inappropriate patient selection, failure to apply biomechanical principles, faulty technique, poor soft tissue handling and inadequate functional aftercare [22, 28]. The stable fixation with mini-plate and screws provides good functional results. Active mobilization can be started immediately after surgery; edema, fibrosis and scar formation can be reduced; and tendon gliding can be preserved [21].

5. Conclusion
Mini-plate and screws fixation of unstable metacarpal fractures produces anatomical reduction of fractures with stabilization that is rigid enough to allow early mobilization, thereby preventing stiffness and hence good functional results.

References


