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Evaluation of surgical management of metacarpal fractures – A prospective clinical study

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Abstract

Introduction: Metacarpal fractures constitutes between 14-28% of all visits to the hospital following trauma. Too often these metacarpal fractures are neglected or treated as minor injuries and results in major disability and deformity with permanent crippling of fine movements. A stable fracture fixation helps in restoring early mobilization. Early mobilization can prevent adhesions and is the key to good clinical outcome.

Materials and Methods: Thirty patients with metacarpal fractures were surgically fixed with k-wire or plate and screw in our trauma centre. 24 males and 6 female patients were part of the study. The mean age was 38 years. Radiographs of affected hand, both AP & Lateral views were obtained before surgery, post- surgery, and at follow-ups.

Results: Male patients in their 3rd decade following a road traffic accident fracturing right hand 4th metacarpal shaft was the common presentation. Transverse fracture pattern was most common. 70% of cases had excellent result, 20% patients with good results and 10% had fair result. Finger stiffness was the most frequently encountered complication.

Conclusion: Displaced metacarpal fractures treated surgically by plate and screw or k-wire gives good result in terms of union, functional recovery and prevent stiffness. CRIF with k-wire shows faster union, faster recovery and lesser stiffness compared to ORIF with k-wire and plates and screws. Multiple metacarpal fractures in same hand treated surgically gives better results than those treated conservatively. Metacarpal fractures fixed rigidly with plate and screw can be mobilized much earlier than those with k wire fixation.

Keywords: Finger stiffness, K-wire, plates and screws

Introduction

Fractures of the metacarpal bones of the hand are one of the most frequently encountered orthopaedic injuries constituting between 14-28% of all visits to the hospital following trauma by various means like self fall, assault, road traffic accidents, industrial accidents, agricultural accidents ^[1].

Too often these metacarpal fractures are neglected or treated as minor injuries and results in major disability and deformity with permanent crippling of fine movements.

Metacarpal fractures can be complicated by deformity from no treatment, stiffness from over treatment and both deformity and stiffness from poor treatment ^[2].

“Too often these fractures are treated as minor injuries and major disability results” as stated by Lipscomb ^[3].

Fracture healing in the hand is not an isolated goal; rather the functional result is of paramount importance.

Many factors, such as delicate handling of tissues, preservation of gliding planes for tendons, prevention of infection and early and appropriate physiotherapy other than accurate reduction and fixation affect recovery of good mobility.

In this prospective clinical study we have tried to analyse various mechanism and patterns of metacarpal fractures and their surgical management, functional outcomes, and complications following surgical treatment.

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Materials and Methods

Patients admitted to a regional trauma center between January 2015 and May 2016 with a diagnosis of a displaced metacarpal fractures were prospectively observed and included in the study group.

Thorough clinical history was elicited from the patient and / or attendants to reveal the mechanism of the injury and the severity of the trauma, site of the incident, circumstances about which the injury occurred.

Comprehensive examination, not only of the injured limb, but also of all the limbs, to avoid missing the other associated injuries.

Radiographic evaluation included antero posterior and oblique radiographs of affected hand were obtained.

Out of total 30 cases, 15 cases of Metacarpal fractures were treated with K-wire of which 3 cases were ORIF and 12 cases were CRIF and 15 cases were treated by ORIF with plate and screws.

In 15 cases of metacarpal fractures CRIF was the preferred technique however in 3 cases where closed reduction failed, procedure was converted to open reduction and internal fixation.

The medically fit patient was then taken up for surgery after valid written consent.

Hand and distal half of forearm was scrubbed with savlon solution. Pneumatic tourniquet was used in all patients after esanguination of blood. Operative site painted with betadine solution.

Internal fixation with plates and screws

A linear incision measuring about 4-5cm was made centring over the fracture site dorsally. Superficial fascia and extensor tendon were retracted, dorsal interosseous muscle was retracted after incising the periosteum, fracture site was identified.

The fracture was reduced with reduction forceps. The chosen plate contoured to the dorsal surface of the metacarpal if necessary. The reduction was maintained over which plate is fixed through screw hole adjacent to the fracture site. The drill bit 2.0mm in size and the screws of 2.7 mm in size were used.

Anatomical reduction was achieved and maintained by an assistant while the first drill hole on the other side of the fracture was drilled away from fracture. After measuring the depth and tapping the hole, second screw was inserted. Both the screws were terminally tightened, then remaining screws were placed.

The wound is closed in layers and sterile compression bandage applied.

Internal fixation with kirschner wires

Metacarpal fractures are reduced by closed methods under c-arm or by open methods and are internally fixed by k-wires.

In 15 cases of metacarpal fractures CRIF was the preferred technique however in 3 cases where closed reduction failed, procedure was converted to open reduction and internal fixation, these cases were mostly during initial phase of the study.

Reduction was achieved by dorsal pressure over the fracture site and a dorsal push on the metacarpal head on the flexed digit.

After reduction of fracture kirschner wire was inserted into the metacarpal head through the metacarpophalangeal joint which was held in full flexion.

When k-wire was well across the fracture site, wrist was flexed and wire insertion continued until the wire made it's

exit dorsally distal to the wrist.

Then K-wire was extracted proximally until its distal end was out of head of the metacarpal, metacarpophalangeal joint is put through full range of motion, confirming the withdrawal of k-wire, then k-wire is cut at the distal end and it is bent to prevent proximal migration.

Proper rotational alignment was determined in relationship to the other fingers by flexing the other fingers to see that it points to the scaphoid tubercle.

Post-operative period

Active movements of fingers were advised as early as possible and aggressive hand physiotherapy within patient's pain limit is instituted.

The wound inspected on 2nd post operative day. Sutures were removed on 10th or 12th day depending on the condition of the wound.

Follow up

At 4 weeks, clinical examination was done regarding tenderness at fracture site and movements of the affected metacarpo phalangeal joints and inter phalangeal joints. X-rays were analysed for any signs of callus formation, and assess the implants position.

In Patients treated with k-wire, at the end of 6 weeks k-wire was removed under local anaesthesia in out patient department.

Regular clinical and radiological follow up was done at an interval 8 weeks and 12 weeks. At the follow up, attention was paid to complications like, stiffness, malunion, non-union.

By 24 weeks, complete consolidation of fracture site was seen radiologically in all cases (figure 1-2). No patient was lost to follow up.



Fig 1



Fig 2

Results

This study consisted of 30 cases of metacarpal fractures treated surgically by internal fixation with mini plates and screws (15 cases), k-wire fixation (15 cases). Following observations were made from the data collected.

Table 1: Age distribution

Age group (years)	Number of patients	Percentage
20-30	12	40.00
31-40	8	26.66
41-50	4	13.30
>50	6	20.00
TOTAL	30	100

The age group of the patients in our study ranged from 20 yr to 56 yr (mean 38 yr). Majority of the patients were in the age group of 20-30 years (40%).

Most of our patients were male (80%). It reflect the general population which visit our both out patient as well as the emergency trauma section.

In our series, there is a right handed (73.33%) predominance compared to the left side.

Mode of injury in majority of cases was Road traffic accidents (50.00%), followed by self fall (26.66%).

Fourth metacarpal was most commonly involved in our series. In our study metacarpal shaft was involved in majority of cases (20 metacarpal shafts) constituting 66% of all cases and there was no metacarpal head fracture in any of the cases.

Majority of shaft was transverse type (16 cases) and all neck cases was transverse fractures, so transverse fracture pattern was seen in majority of cases in our study.

In our study out of 30 cases majority of patients i.e 15 patients were treated with ORIF with mini plate and screws constituting about 50%

Complications

In this study 2 patients treated with ORIF with k-wire fixation had superficial infection, which were treated with appropriate antibiotics and regular dressing.

In this study three patients (13%) developed stiffness of the fingers, Out of which one patient had associated proximal phalangeal fracture which was operated with ORIF with k-wire fixation, this patient was not co-operative for physiotherapy and 2 cases were operated with ORIF with plate and screws.

There was no cases with nonunion, malunion, skin necrosis, hardware prominence.

Grading of results

Results of the operated metacarpal fractures were graded accordingly.

1. Excellent: Grade-I

- Pain free union.
- No symptoms or signs.
- No angular or rotator deformity.
- Range of movements at interphalangeal joints 75° - 100°
- Total active movement (TAM) greater than 250°. (TAM refers to the additive sum of flexion at the metacarpophalangeal joint, proximal and distal interphalangeal joint minus the extension deficit at the same joints).

2. Good: Grade - II

- Occasional pain at the fracture.
- Mild oedema

- Clinically united.
- Range of movements at interphalangeal joints atleast 60°
- Minimal rotatory or angular deformity,
- TAM > 180°.

3. Fair: Grade-III

- Painful movements
- ROM at IP joints <50°
- Deformity
- TAM < 120 deg
- Pain at fracture site.

Table 2: clinical results

Result	No of patients	percentage
Excellent	18	60.00
Good	9	30.00
Fair	3	10.00

In this study 18 patients (60%) had excellent result, 9 patients (30%) with good results and remaining 3 patients (10%) had fair result.

Discussion

Hand is a specialized structure interacting with the environment, is especially sensitive to functional impairment. The prime functions of hand are feeling (sensitivity) and motion. Hand performs the mechanical functions of hook, as in tilting a book from a shelf; grasp, as in picking it up; pinch, as in turning its pages. The loss or diminution of any of these functions is a serious blow.

The incidence of metacarpal fractures is most common in males and peaks between age 10 and 40 years a time when athletic and industrial exposure is the greatest.

Fracture healing in the hand is not an isolated goal; rather the functional result is of paramount importance.

In this clinical study of surgical treatment of 30 cases of metacarpal fractures, the analysis of the results were made in terms of age of patients, sex distribution, laterality of fracture, mode of violence, analysis of the types of fracture, method of reduction and fixation, and complications.

Patients studied in this series were between the age of 20-56 yrs with maximum incidence being involving the productive age group 20-30 yrs (40%) in comparison to study by fusseti C *et al.* [4] median age was 33yrs. and another study by kelesh G and Ulrich C [5], median age was 24yrs.

In our series majority of the patients were males, 24 patients (80%) as compared to study by fusseti C *et al.* [4] (79%), kelesh G and Ulrich C [5] (92%).

Right handed predominance in 22 cases (73.32%) compared to the left side is seen in our study which is comparable to study by fusseti C *et al.* (74%).

In our series all metacarpal fractures were closed injury and compound fractures were not included in this study.

Mode of injury in majority of cases is RTA, 15 cases (50%) followed by self fall on outstretched hand, 8 cases (26.62%) and assault, 7 cases (23.18%) as compared to study by kelesh G and Ulrich C (45%) fall on outstretched hand was most common mode of injury.

Metacarpal shaft was involved in 20 cases (66%) as compared to studies by Gupta R. *et al.* [1] metacarpal shaft fracture constituted 60%. 5 cases were metacarpal base fracture and 3 cases were metacarpal neck fracture Transverse fractures were the most commonly observed pattern in this study, 11 cases of metacarpal shaft and 3 cases of metacarpal neck were transverse type.

Among the many surgical methods open reduction and intramedullary k-wire osteosynthesis of metacarpal bones stands out because of the simplicity of the method and the fact it puts least strain on sliding tissue however stiffness of finger and pin tract infection were much higher.

ORIF of metacarpal fractures with plate and screws provide two basic objectives of rigid internal fixation

- a) Maintenance of precise alignment of fracture
- b) Facilitation of early active motion thus minimizing stiffness.

The technique of plate fixation in the hand is well documented but there are many drawbacks. Stern *et al.* [6] stated that main disadvantage of plate was their size and wide exposure necessary for plate fixation and this may involve extensive periosteal stripping. Plate is usually placed under the extensor apparatus and can interfere with tendon gliding.

In this study out of 30 cases, 15 patients (50%) were treated with ORIF with plate and screws.

Closed reduction with subsequent intramedullary k-wire (CRIF) under image intensifier produce good functional result in long term. With low rate of complication CRIF with k-wire under image intensifier can be recommended for stabilization of metacarpal fracture and implant removal at outpatient department is the further advantage.

In this study out of 12 patients were treated with CRIF with k-wire fixation (40%).

In this study 2 patients treated with ORIF with k-wire fixation had superficial infection, which were treated with appropriate antibiotics and regular dressing.

Despite early active motion, stiffness was most frequent complication.

Probable causes of stiffness includes

- Initial fracture severity
- Soft tissue mobilization necessary to apply plate
- Plate interference with tendon excursion
- Patient co-operation for physiotherapy.

In this study three patients (10%) developed stiffness of the fingers, Out of which one patient had associated proximal phalangeal fracture which was operated with ORIF with k-wire fixation, this patient was not co-operative for physiotherapy and 2 cases were operated with ORIF with plate and screws for 2nd and 3rd metacarpal fractures.

There was no cases with nonunion, malunion, skin necrosis, hardware prominence etc.

In this study 18 patient (60%) had excellent result, 9 patients (30%) with good results and remaining 3 patients (10%) had fair result as comparable to other studies by Kirsch B, *et al.* [7] (excellent 62%, Good 14%, fair 13%), Mannen *et al.* [8] (excellent 40%, Good 24%, fair 7%), Ouellette *et al.* [9] (excellent 35%, Good 34%, fair 10%) and Gupta *et al.* [11] (excellent 47%, Good 47%, fair 7%).

Out of 3 cases operated with ORIF with k-wire fixation 1 case had good result and rest of 2 cases had fair result (both patient had proximal phalangeal fracture). Out of 15 cases operated with ORIF with plate and screw fixation 9 cases had excellent result and 5 cases had good result and one case with three metacarpal fracture had fair result. 12 cases operated with CRIF with k-wire fixation all patient had excellent result.

All-though in this study sample size is small (30 cases), With low rate of complication, CRIF with k-wire under image intensifier can be recommended for stabilization of metacarpal fracture, intraoperative image intensifier radiation is the only drawback and implant removal at outpatient department is the further advantage.

Conclusion

Metacarpal fractures treated by plates and screws gives rigid fixation following which early mobilization of joints of hand can be done early, thereby preventing stiffness.

Fractures treated with CRIF with k-wire show faster union, faster recovery of daily activities and lesser stiffness compared to ORIF with k-wire and plates and screws.

Displaced metacarpal fractures treated surgically by plate and screw or k-wire gives good result in terms of union, recovery of daily activities and prevent stiffness.

Multiple metacarpal fractures treated surgically gives better results than those treated conservatively. Metacarpal fractures treated with Mini plate and screw fixed rigidly can be mobilized much earlier than k wire fixation.

Displaced metacarpal fractures treated by plates and screws or k-wires gives better results than those treated conservatively in terms of union, recovery of daily activities and stiffness especially in cases of displaced and multiple metacarpal fractures. However stiffness of hand joints especially metacarpophalangeal joint is of major concern and physiotherapy plays a major role to combat stiffness.

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