

FUNCTIONAL OUTCOME OF CLOSED METACARPAL FRACTURES TREATED WITH MINI FRAGMENT PLATES AND SCREWS

P. V. Pugalenth¹, K. Ravichandran², N. Thanappan³, J. Maheswaran⁴, D. Sivaraman⁵

¹Professor, Department of Orthopaedics, Madurai Medical College, Madurai.

²Assistant Professor, Department of Orthopaedics, Madurai Medical College, Madurai.

³Associate Professor, Department of Orthopaedics, Madurai Medical College, Madurai.

⁴Assistant Professor, Department of Orthopaedics, Madurai Medical College, Madurai.

⁵Postgraduate Student, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai.

ABSTRACT

BACKGROUND

Metacarpal fractures are common in adolescents and young active individuals. Mostly these are treated by conservative methods. In unstable fractures where closed reduction and final outcome are unsatisfactory, there are multiple surgical options for treating metacarpal fractures like K-wire fixation, interosseous wiring, plate osteosynthesis, etc. In this study, we assess functional outcome of closed metacarpal fractures treated with plates and screws.

MATERIALS AND METHODS

Between 2014 and 2016, 20 cases of closed metacarpal fractures were studied. Fracture was approached by dorsal incision. Plate configurations were chosen according to the fracture pattern (straight plate for shaft fractures, T or L configured plates were used for periarticular fractures) and fixed with screws. Post-operative physiotherapy and followup carried out.

RESULTS

In our study, all the cases showed bone union (100%). The functional result assessed by American Society for Surgery of the Hand (ASSH) Total Active Flexion score showed excellent result in 80% of the patients (16 of 20 cases), good in 10% of cases (2 of 20 cases). Stable and rigid fixation allowed early mobilisation of fingers thereby preventing stiffness and achieved overall good functional results. Although there were 10% (2 cases) of superficial infections, all settled with regular dressing and antibiotics without affecting final functional outcome. The overall results are satisfactory.

CONCLUSION

Plate and screw fixation is a good option for treating closed unstable metacarpal fractures, where other modalities of fixation are less effective. The rigid stable fixation provided by plating which withstands load without failure allowed early mobilisation and achieved good functional results.

KEYWORDS

Metacarpal Fractures, Mini Fragment Plates and Screws.

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BACKGROUND

Aim of the Study

Metacarpal fractures are common in adolescents and young active individuals. Functional outcome of these fractures depend upon severity of injury and the achievement of treatment. Mostly these are treated by conservative methods^[1]. Unstable fractures^[2] where closed reduction and final outcome are unsatisfactory are treated by operative measures. There are multiple surgical options for treating metacarpal fractures like K-wire fixation,^[3] interosseous wiring,^[4] plate osteosynthesis,^[5] etc.

In this study, we assess functional outcome of closed metacarpal fractures treated with plates and screws using

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Corresponding Author:

Dr. P. V. Pugalenth,

#No 45, West Cross, Shanmugapuram,

Karupayurani (Po), Madurai-20.

E-mail: drpugalortho@gmail.com

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the American Society for Surgery of the Hand (ASSH) Total Active Flexion (TAF) score.

Objectives of the Study

1. To study the various mechanisms and pattern of metacarpal fractures and their surgical management with plates and screws.
2. To study the functional outcome of metacarpal fractures treated surgically.
3. To study the technical difficulties and complications of metacarpal fractures treated surgically.

Inclusion Criteria

1. Age more than 18 years.
2. Physical fitness for surgery.
3. Sex- Both male and female.

Exclusion Criteria

1. Age less than 18 years.
2. Patient not willing or medically unfit for surgery.
3. Compound injury.

Indications

- Indications for plate fixation of the metacarpals are-
1. Multiple fractures with gross displacement.
 2. Displaced diaphyseal transverse, short oblique, or short spiral fractures.
 3. Comminuted intraarticular and periarticular fractures – displaced.
 4. Comminuted fractures with shortening or malrotation or both.

MATERIALS AND METHODS

Source of Data

Adult patients with metacarpal fractures admitted to Govt. Rajaji Hospital, Madurai will be taken up for study after obtaining the consent.
 Period of Study- From Sep. 2014 to Sep. 2016.

Design of the Study- Prospective.

Method of Collection of Data

Patients with metacarpal fractures are selected after clinical and radiological analysis during the period of study from Sep. 2014 to Sep. 2016

All the patients selected for study will be examined according to protocol, associated injuries noted and clinical and lab investigations carried out in order to get fitness for surgery.

Consent of the patient will be taken for surgery. Patient will be followed till Union is achieved clinically as well as radiologically.

Time required for union, range of motion of surrounding joints and complications before/during/after surgery will be studied in detail.

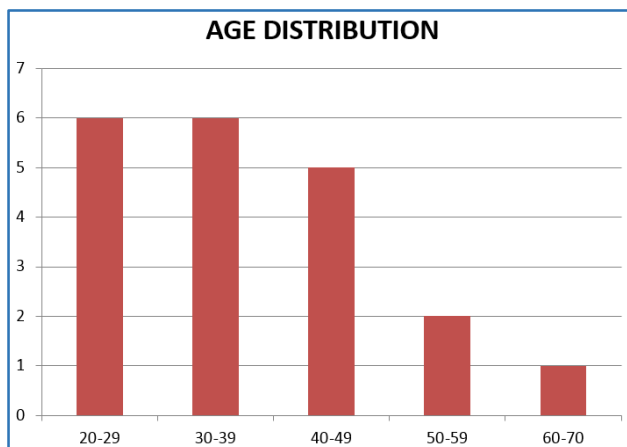
Minimum of 20 cases was studied.

Age Distribution

Age group varied from 20 years to 70 years with mean age of 45 years. Incidence of fracture was observed maximum between 20 - 50 years.

Age group	Number of cases	Percentage
20 - 29	6	30
30 - 39	6	30
40 - 49	5	25
50 - 59	2	10
60 - 70	1	5

Age Distribution

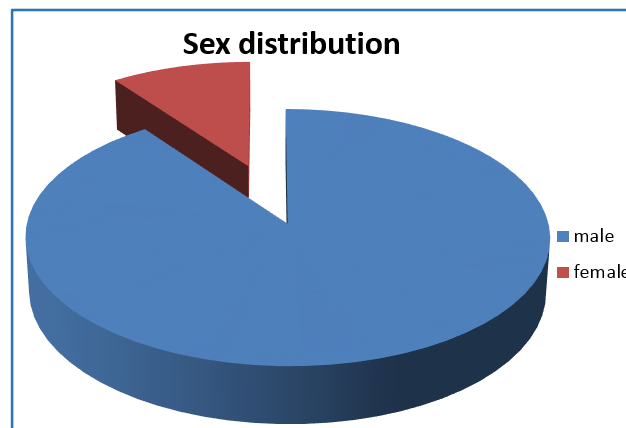


Sex Distribution

Among the 20 cases, males were predominant.

Sex	Number of Cases	Percentage
Male	18	90
Female	2	10

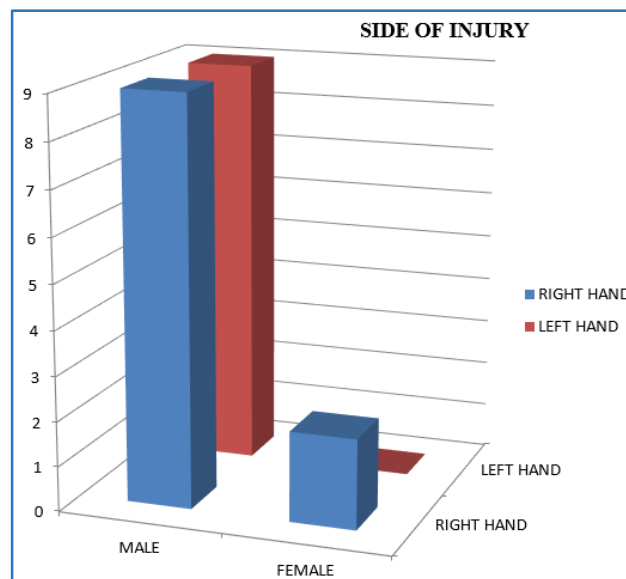
Sex Distribution



Side of Injury

Sex	Right	Left	Bilateral	Total
Male	9	9	0	18
Female	2	0	0	2
Percentage	55	45	-	-

Side of Injury

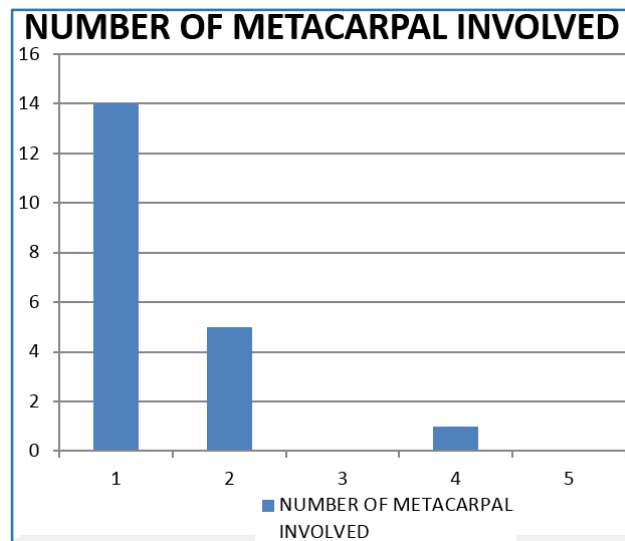
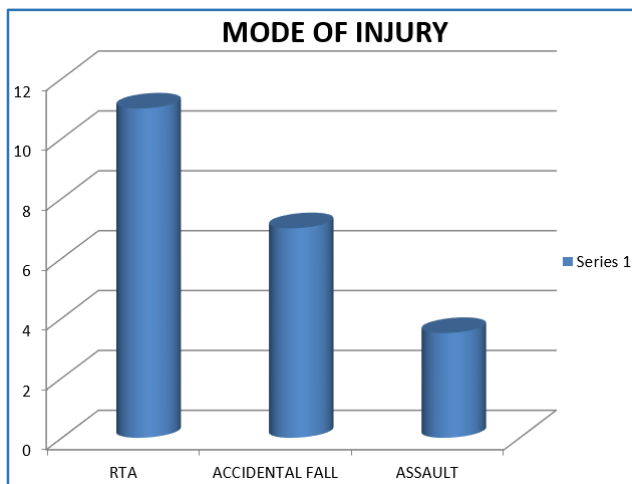


Mode of Injury

Commonest mode of injury being Road Traffic Accident (RTA).

Mode of Injury	No of Cases	Percentage
RTA	11	55
Accidental Fall	7	35
Assault	2	10

Mode of Injury



Classification of Fractures

Fracture Location	No. of Cases	Percentage
Head	-	-
Neck	2	10
Shaft	16	80
Base	2	10

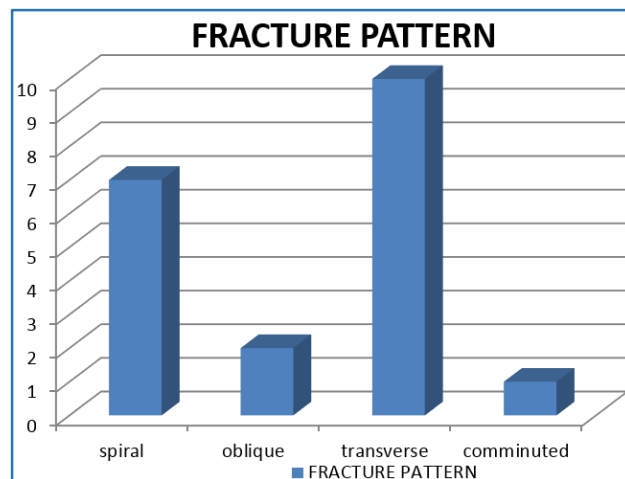
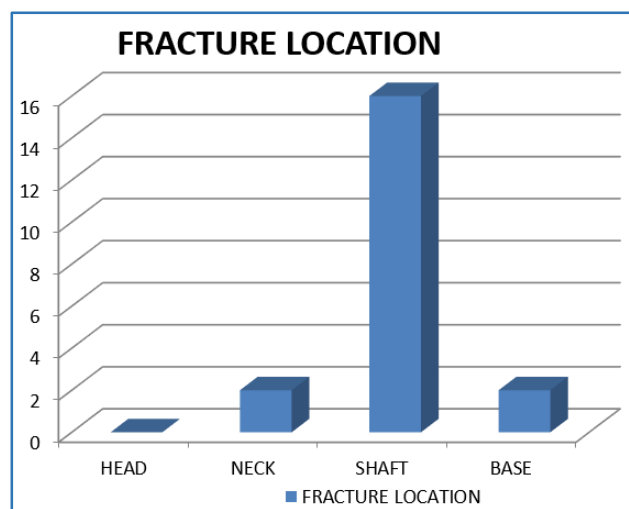
Classification of Fractures

Fracture Pattern

Transverse fracture pattern being most common accounting for 50%.

Fracture Configuration	Number of Cases	Percentage
Spiral	7	35
Oblique	2	10
Transverse	10	50
Comminuted	1	5

Fracture Pattern



Number of Metacarpal Involved

Single metacarpal involvement being the most common accounting for 70% of the cases.

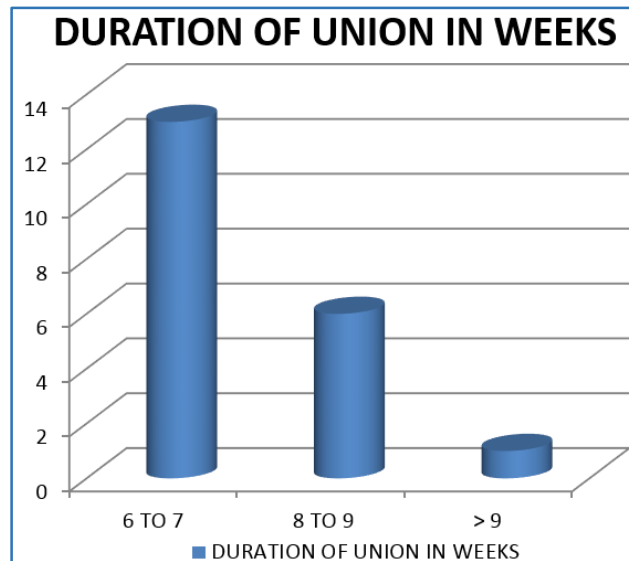
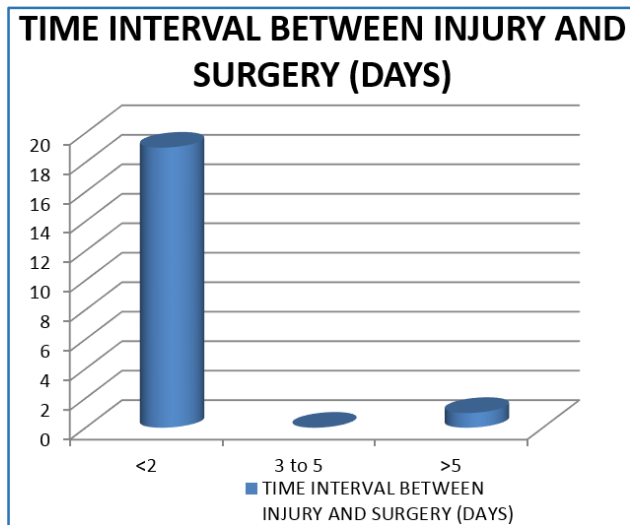
No. of Metacarpals Involved	No. of Cases	Percentage
1	14	70
2	5	25
3	0	-
4	1	5
5	0	-

Number of Metacarpals Involved

Time Interval between Injury and Surgery

Time Interval (Days)	No. of Cases	Percentage
< 2	19	95
3-5	0	-
>5	1	5

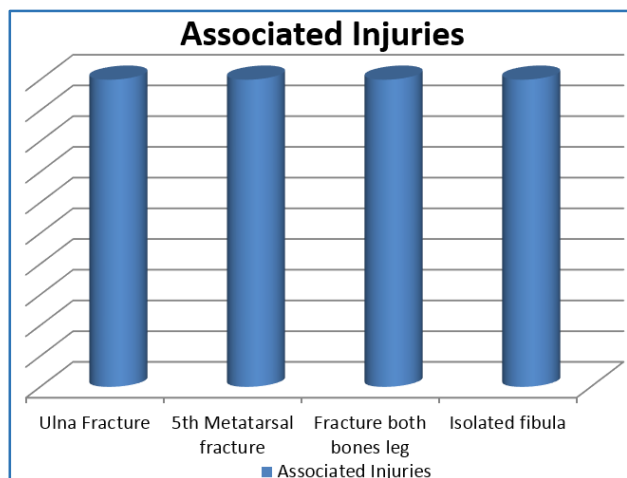
Time Interval between Injury and Surgery



Associated Injuries

4 Cases had associated other bony injuries.

Fracture of shaft of ulna	-	1
Fracture of shaft of 5 th metatarsal-	1	
Fracture of both bones, leg	-	1
Isolated fibular fracture	-	1



Complications

4 Cases developed complications. Infection seen in 10% (2 out of 20 cases). Stiffness seen in 10% (2 out of 20 cases).

	No. of Cases	Percentage
Infection	2	10
Stiffness	2	10
Tendon Irritation	-	
Non-Union	-	
Mal-Union	-	
Implant Breakage	-	
Complications		

Union Time

In most of the cases bony union was achieved in 6-7 weeks accounting for 65%.

Duration in Weeks	No. of Cases	Percentage
6-7	13	65
8-9	6	30
>9	1	5
Union Time		

Pre-Operative Preparation

Base line blood investigations, x-rays –pre-op, post-op.

A minimum of two views – anteroposterior and oblique – are mandatory for assessing-

1. Degree of angulation.
2. Amount of shortening.
3. Presence of comminution.

Procedure and Postoperative Protocol

All patients were admitted in casualty department and were resuscitated. If there were any major associated injuries they were treated accordingly at first. After the general condition of the patient improved, radiographs – anteroposterior and oblique views were taken. Fracture reduced in closed manner at first under sedation and volar below elbow slab was applied. Unstable fractures were taken up for surgery – open reduction and internal fixation with plate osteosynthesis.

Most of the cases were taken up for surgery on the 1st or 2nd day of admission. Patients who were associated with major injuries were taken up for surgery between 5 to 7 days after admission.

Surgical Procedure– Open Reduction Internal Fixation with Plate Osteosynthesis

Tourniquet was used in all the cases before surgery.

Metacarpal fractures are approached by a dorsal incision^[6] made on radial border for the first and second metacarpal, ulnar border for the fifth metacarpal. For the 3rd and 4th metacarpals, the approach is made using a dorsal longitudinal incision made between these bones. Then extensor tendons were retracted and anatomical reduction of the fracture fragments are carried out. Reduction is held using point reduction forceps or a stabilising K wire. Interfragmentary lag screws were used in long spiral and oblique fractures. Plate configuration were chosen according to the fracture pattern (Straight plate for shaft fractures, T or L configured plates were used for periarticular fractures)^[7] and fixed with screws. Meticulous attention was carried out in soft tissue dissection and adequate soft tissue coverage (Periosteum) was made over the plate to avoid irritation to overlying extensor tendon. Thorough wound wash was given and wound closed without drain. Splinting of the hand was done with a volar below elbow slab.

Post-Operative Protocol

Hand was kept in elevation for 24-48 hours for controlling pain and swelling. Wound was inspected at second post-operative day. Thereafter, active mobilisation of fingers started and increased progressively within the limits of pain tolerance. Patients were discharged on 5th post-operative day and physiotherapy^[8] carried out on outpatient basis. Sutures were removed on 10th postoperative day.

Followup was done at 4th, 6th and 8th weeks and assessed for clinical progress in terms of range of movements and radiological evaluation done to note fracture union or any loss of reduction.

Clinical Pictures

Case 1



Pre-op X-ray

After Fixation



Extension of MCP and IP Joints

Flexion of MCP & IP Joints



Pinch Strength

Grip Strength

Case 2



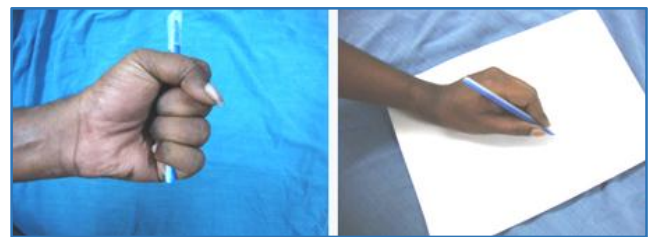
Pre-op

Fixation with #Union



Extension of MCP, IP joints

Flexion of MCP, IP Joints



Grip Strength

Pinch Strength

Case 3



Pre-op

Fixation with Bone Union



Extension of MCP, IP Joints

Flexion at MCP, IP Joints

Case 4



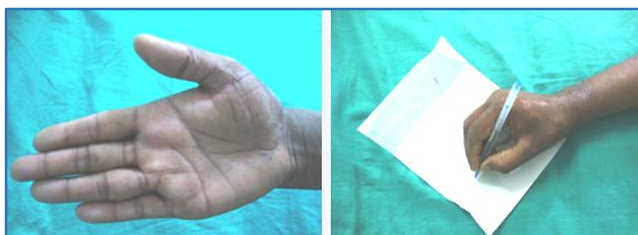
Pre-op

After Fixation



Adduction of Thumb

Flexion of Thumb



Extension of Thumb

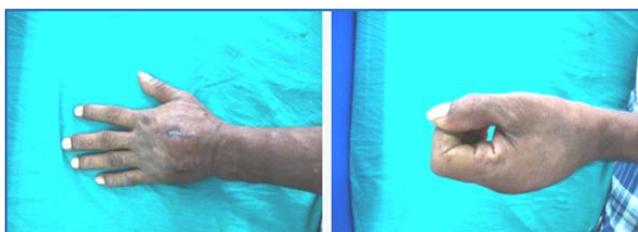
Pinch Strength

Case 5



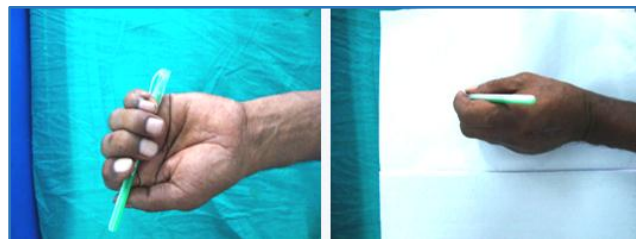
Pre-op

After Fixation



Extension of MCP, IP Joints

Flexion at MCP, IP Joints



Grip Strength

Pinch Strength

Case 6



Pre-op

After fixation



Extension of MCP, IP Joints

Flexion at MCP, IP Joints



Grip Strength

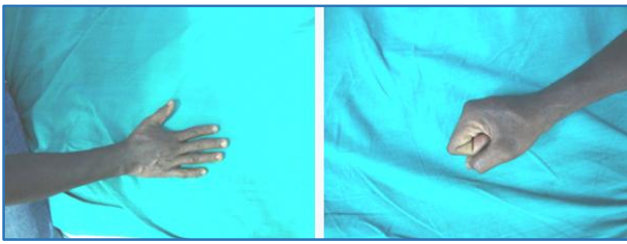
Pinch Strength

Case 7



Pre-op

After Fixation



Extension of MCP, IP Joints

Flexion at MCP, IP Joints



Extension of MCP, IP Joints

Flexion at MCP, IP Joints

Case 8



Pre-op

After Fixation



Extension of MCP, IP Joints

Flexion at MCP, IP Joints



Grip Strength

Pinch Strength

Case 9



Pre-op

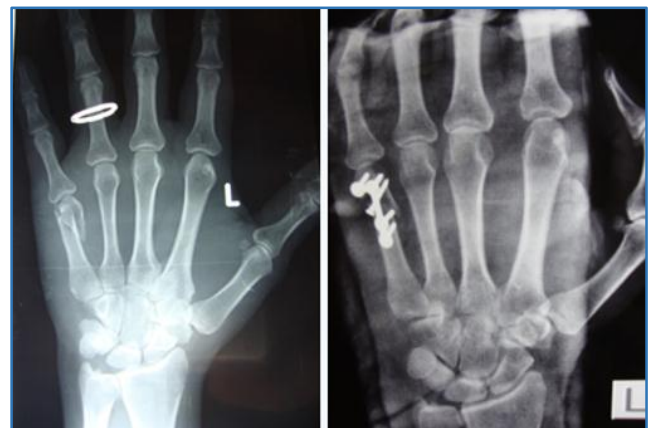
After Fixation



Grip Strength

Pinch Strength

Case 10



#Neck of 5th Metacarpal

After Fixation



Extension of MCP & IP Joints

Active Flexion of MCP & IP Joints

Pitfalls and their Management

Infection

Two cases developed wound infection, both were superficial infections. Pus culture for sensitivity was sent in two cases and treated with appropriate antibiotics and regular dressings. The superficial infections subsided with treatment for 3 weeks and none of the cases required implant exit.

Finger Stiffness

2 Patients with multiple metacarpal fractures developed finger stiffness and one case had fractures in all the four metacarpals and the other had fracture involving two metacarpals. The patients were put on strict regimen involving active

mobilisation exercises. Eventually, all patients had improved range of movements following physiotherapy.

Complications



Wound Infection



Stiffness

RESULTS

20 patients were included in this study. 6 patients had multiple metacarpal fractures (30% cases). Right hand was involved in 11 of the patients (55%). 2 out of 20 were female patients (20%). All the 20 patients who underwent open reduction and internal fixation with plate osteosynthesis for unstable^[2] metacarpal fractures achieved bone union (100%). In most of the cases, bony union was seen between 6-8 weeks, average period being 7.2 weeks (range 6-12 weeks). Spiral and oblique fractures united at 6 weeks, transverse and comminuted fractures united at around 8 weeks.

Functional outcome assessed by ASSH (American Society for Surgery of the Hand) TAF (Total Active Flexion) score was excellent in 16 patients (80%), good in 2 patients (10%), fair in one patient (5%), poor in one patient (5%). The overall results are satisfactory.

2 patients developed superficial wound infection, both were the case of multiple metacarpal fractures (both of these cases had involvement of two metacarpals). Both these cases with superficial infection settled with daily dressing and antibiotics. 2 patients had stiffness of metacarpophalangeal and interphalangeal joints and both were cases of multiple metacarpal fractures for whom physiotherapy was continued and patients showed improved range of motion, and the results in these patients were fair & poor.

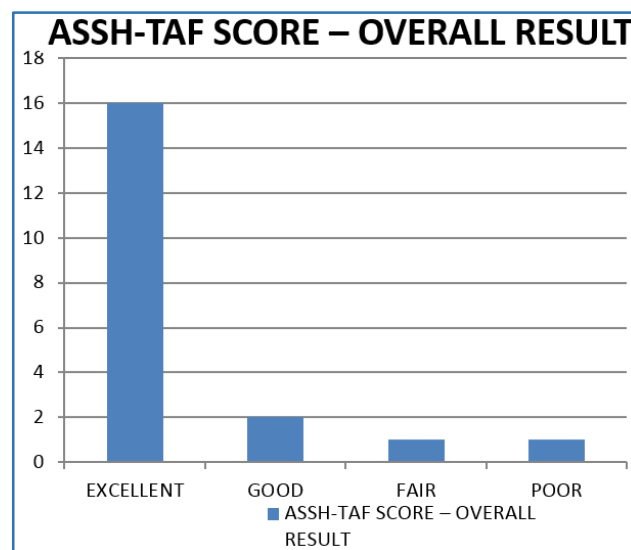
None of the patients in our study developed tendon irritation, this is due to extra cautious effort taken to cover the

plate (low profile plate) with soft tissue (periosteum) for free gliding of overlying extensor tendon. No cases had angular or rotational displacement of fractures. No cases had implant breakage. None of the patients required implant removal.

Analysis of Functional Outcome

The functional outcome was assessed using American Society for Surgery of the Hand (ASSH) Total Active Flexion Score (TAF) and the following results were obtained.

Grading	No. of Cases	Percentage
Excellent	16	80
Good	2	10
Fair	1	5
Poor	1	5
ASSH-TAF Score – Overall Results		



DISCUSSION

Most of the metacarpal fractures are stable before or after closed reduction and are managed successfully by conservative method of protective splinting followed by early mobilisation.^(1,8) Only a small percentage of metacarpal fractures are unstable and in these patients the functional results following closed treatment are unsatisfactory. These are the cases indicated for open reduction and internal fixation which are usually less than 5% of hand fractures.^(6,9) James et al⁽¹⁰⁾ reported that closed method used in treatment of unstable fractures had loss of function in 77% of fingers.

Open reduction and internal fixation with K wire⁽¹¹⁾ is one of the treatment modalities in these unstable fractures but they provide less rigid fixation and are rotationally unstable, there is increased association of pin tract infection, and problems due to protruding ends of K-wire are significant. Interosseous wiring with K- wire although provides rigid fixation equivalent to plating is useful only in transverse diaphyseal fractures.

Metacarpal fractures can be fixed with external fixator.⁽¹²⁻¹⁶⁾ Report by Shehadi et al⁽¹³⁾ showed full return of total range of motions in up to 100% of metacarpal fractures treated with external fixator. This mode of fixation is useful in compound metacarpal fractures with bone loss. But the routine use of external fixator is discouraged as there is loosening of construct following pin tract infection leading to

loss of fixation and there is difficulty in constructing and applying the fixator.

Intramedullary fixation with pre-bent K-wires was used for transverse and short oblique fractures.⁽¹⁷⁻²⁰⁾ They provide comparable functional outcome with plate and screw fixation. But there is incidence of loss of reduction, penetration of metacarpophalangeal joint by hardware, thus necessitating a second surgery for hardware removal.

There are many literature studies showing satisfactory results of unstable metacarpal and phalangeal fractures treated with AO mini plate and screws.⁽²¹⁻³²⁾ A study by Souer et al⁽³³⁾ showed good functional outcome by total active motion more than 230° in 18 of 19 patients for whom plate fixation was done in closed unstable metacarpal fractures. Another study by Gupta et al⁽¹¹⁾ showed excellent functional outcome with total active movements more than 230° in all of his patients of unstable metacarpal fractures treated with plate fixation. Another study by Dabezies Schutte⁽²⁵⁾ showed no complication in 27 unstable metacarpal fractures treated with plate fixation. Low complication rate seen in our study was similar to these results.

In our study on 20 patients, 2 patients developed superficial wound infection. In both these cases of superficial infection, there was wound discharge on second post-operative day which settled with daily dressing and antibiotics and this does not affect the final outcome. Two patients with multiple metacarpal fractures developed finger stiffness and one case had fractures in all the four metacarpals and the other had fracture involving two metacarpals. Eventually, all patients had improved ROM following physiotherapy.

In Unstable Metacarpal Fractures, Plate Fixation is a Better Option for Several Reasons,⁽³⁴⁾

1. They provide stable fixation in all unstable metacarpal fractures, thus allowing early mobilisation of fingers.
2. Shortening seen in multiple metacarpal fractures which was corrected by plating which restores the power of interosseous muscles thereby retaining the grip strength of hand.
3. Multiple metacarpal fractures are usually associated with severe soft tissue injuries. In these unstable metacarpal fractures, treatment with plate osteosynthesis provides anatomical reduction of fracture with rigid stabilisation allowing early mobilisation of joints without loss of reduction, thus preventing stiffness and providing good functional results.

In our study of unstable metacarpal fractures treated with plate osteosynthesis, all the cases showed bone union (100%). The functional result assessed by American Society for Surgery of the Hand (ASSH) Total Active Flexion score showed excellent result in 80% of the patients (16 of 20 cases), good in 10% of cases (2 of 20 cases). Stable and rigid fixation provided by mini plates and screws allowed early mobilisation of fingers thereby preventing stiffness leading to overall good functional results. Although there were 10% (2 cases) of superficial infections, all settled with regular dressing and antibiotics without affecting final functional outcome.

CONCLUSION

Plate and screw fixation is a good option for treating closed unstable metacarpal fractures, where other modalities of

fixation are less effective, the rigid stable fixation provided by plating which withstands load without failure allowed early mobilisation and achieved good functional results.

Detailed clinical and radiological assessment of fracture, careful preoperative planning, meticulous dissection, precision in surgical technique (coverage of plate with soft tissue) and choosing the correct implant (low profile plate) are critical in achieving good results and minimising the complications.

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