



EVALUATION OF FUNCTIONAL OUTCOME IN METACARPAL FRACTURE FIXED WITH CLOSED REDUCTION AND INTERNAL FIXATION WITH KIRSCHNER-WIRE

Orthopaedics

Dr. Abhi Sharma

Dr. Arun H. S

Dr. Prabhu E

Dr. Sandesh
Agarawal

Dr. Arun Kumar
SP

ABSTRACT

Background: Metacarpal fractures occur very frequently. Many a times these fractures are missed or treated as minor injuries which can lead to major disability and deformity. Percutaneous pinning with Kirschner wires (K-wires) is a widely used surgical option for extra-articular metacarpal fractures. It is less invasive, versatile, and requires less operative time as compared with other techniques. **Material and Methods:** A prospective, observational and hospital-based study conducted at R. L. Jalappa Hospital and Research Centre, Sri Devaraj Urs Medical College, Tamaka on patients with closed metacarpal fractures from October 2019 to April 2021. Clinical data was collected and evaluated with post-procedure functional outcomes with disabilities of the arm, shoulder and hand score (DASH score), range of motion at metacarpo-phalangeal using joint total active motion (TAM) and pain using Visual Analog Score. **Results:** In the study majority of subjects were in the age group <30 years (33.3%) with 82.1% were males and 17.9% were females. most common mode of injury was RTA in 74.4%, most common part of Metacarpal involved was shaft (56.4%). VAS score at the end of 6 month 53.8% had mild pain, 2.6% had moderate pain and 43.6% had no pain. 43.6% had excellent, 46.2% had good had poor range of motion. At the end of 6 months DASH score was 15.03 ± 4.869 . Median score was 15, minimum score was 10 and maximum score was 30. **Conclusions:** Restoration of total normal function of hand in treatment of hand fractures is extremely important and conservative or minimally invasive treatment procedures have been observed to aid in this than surgical interventions. It was noticed in the study that Intramedullary K-wire fixation which is a minimally invasive method for stabilizing metacarpal fractures is the best treatment option for metacarpal fractures as it provides excellent functional outcome with less complications. The technique does not affect gliding properties of surrounding soft tissue which is required for restoration of normal function of hand.

KEYWORDS

metacarpals, K-wire, Closed Reduction, VAS Score, TAM Score, DASH Score.

INTRODUCTION

The hand has been recognized as the symbol of man's power, outward reflection of his inner mind, the precise instrument of his perception, in fact the indispensable tool of his inheritance and independent livelihood. The incidence of metacarpal fractures is most common in males between an age group of 10 to 40 years, a time when athletic and industrial exposure is the greatest. Metacarpal fractures constitute around 14-28% of all visits to the hospital following trauma by various means like assault, road traffic accidents, industrial accidents, agricultural accidents etc.¹

Many times, metacarpal fractures are missed or undertreated which results in major disability, deformity with permanent disability and handicap.^{2, 3} Metacarpal fractures can lead to deformity if left untreated, stiffness from over treatment and both deformity and stiffness from poor treatment. Fracture healing in the hand alone shall not be the only goal as functional outcomes have equal importance.^{4,5}

Plates and screws provide excellent stability but require marked soft tissue dissection and may cause extensor tendon adhesions with a scar dorsally over the hand. Intra-medullary fixation provides sufficient stability at the fracture site with minimal soft tissue dissection and potentially less tendon irritation.⁶

Most of the open fractures, closed oblique or comminuted fractures in the hand need surgical stabilization Percutaneous pinning with K-wires under image intensifier is a widely used surgical option for extraarticular metacarpal fractures. It is less invasive and versatile as compared with other techniques. With improved materials, implant designs and instrumentation, ORIF with plates and screws has gained popularity. Plates for the metacarpals are low profile, easy to contour and come in a variety of configurations.

Need For Study:

The aim of every orthopedic surgeon is to achieve adequate fracture healing along with satisfactory functional outcome. Good functional outcomes other than accurate reduction depends on factors such as delicate handling of tissues, preservation of gliding planes for tendons,

prevention of infection, early and appropriate physiotherapy.

Our hospital is a tertiary Care hospital in rural area where most of the patients belong to economically challenged background and cannot afford expensive surgeries. Closed reduction and internal fixation with K-wire is relatively less expensive and can be afforded by rural population.

There is paucity of documented literature showing functional outcome of metacarpal fracture treated with closed reduction and internal fixation with K-wire. In this prospective study we will evaluate various metacarpal fractures and functional outcome following surgical treatment with closed reduction and internal fixation with K-wires.

MATERIALS AND METHODS:

Study design:

This is a prospective, observational, and hospital-based study conducted in the department of R.L. Jalappa Hospital and Research Centre attached to Sri Devaraj URS Medical College, Tamaka, Kolar from October 2019 to April 2021. The sample size is estimated based on overall functional outcome results as 64% in a study by Dr. Rahmat ali et al, considering the margin of error as 15% the estimated sample size is 39 cases of metacarpal fractures. The study was approved by the institutional ethics committee and informed written consent was obtained from all the study participants, with confidentiality maintained.

Inclusion criteria:

Patients of age between 18 to 60 years presenting to R.L. Jalappa Hospital attached to Sri Devaraj Urs Medical College Patients aged between 18-60 years with single/multiple metacarpals bone fracture presenting to the OPD or casualty within 2 weeks will be taken up for the study.

Exclusion criteria:

Metacarpal fracture associated with phalanx fracture, Comminuted fracture, Compound fractures, Pathological fractures.

Data collection: After obtaining informed consent from the patients who agree to be part of the study, demographic data, history, clinical examination and details of investigations will be recorded in study proforma and the patient will undergo closed reduction and internal fixation with Kirschner wire under wrist block and aseptic precautions. post-op evaluation by x-ray (AP and oblique view) at immediate post-op. Range of motion with goniometer at the metacarpophalangeal joint (TAM score), pain with Visual Analog Scale (VAS), the functional outcome with Disability of Arm Shoulder and Hand (DASH) score at immediate post-op, 1st month, 2nd month, and 6th month.

Statistical Methods:

Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Non-normally distributed quantitative variables were summarized by the median and interquartile range (IQR). P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests. MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data.

Follow up: post op evaluation by x-ray (AP and oblique view), measuring range of motion with goniometer at metacarpo-phalangeal joint using Total Active Motion score (TAM score), pain with VAS and functional outcome with DASH score.

RESULTS: A total of 39 subjects were included in the final analysis.

Table 1: Age Distribution Of Subjects

Age	Count	%
<30 years	13	33.3%
31 to 40 years	12	30.8%
41 to 50 years	9	23.1%
51 to 60 years	5	12.8%
Total	39	100.0%

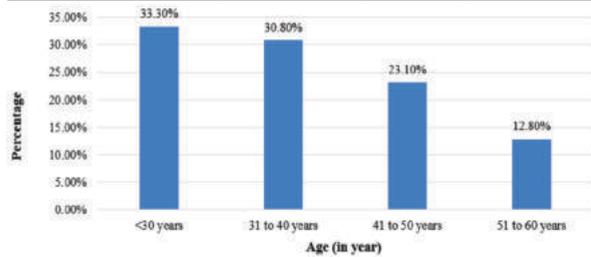


Figure 1: Bar Diagram Showing Age Distribution Of Subjects

In the study majority of 33.3% subjects were in the age group <30 years, followed by 30.8% were aged between 31 to 40 years, 23.1% were aged between 41 to 50 years and 12.8% were aged between 51 to 60 years.

Table 2: Gender Distribution Of Subjects

Gender	Count	%
Female	7	17.9%
Male	32	82.1%
Total	39	100.0%

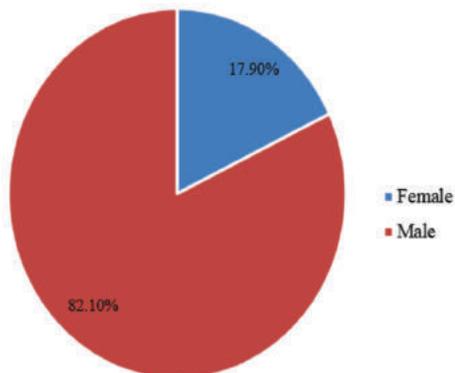


Figure 2: Pie Diagram Showing Gender Distribution Of Subjects

In the study 82.1% participants were males and 17.9% participants were females (Table 2).

Table 3: Mode Of Injury Distribution

Mode of Injury	Count	%
Assault	6	15.4%
Fall	2	5.1%
Punch	2	5.1%
RTA	29	74.4%
Total	39	100.0%

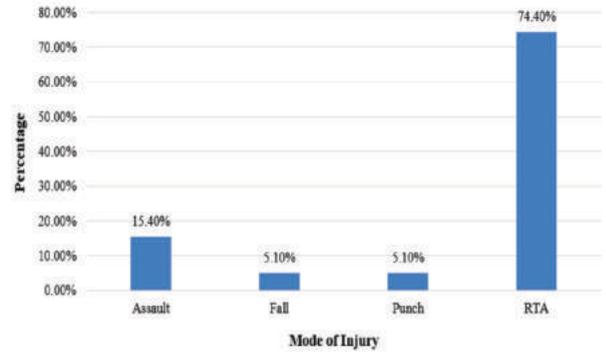


Figure 3: Bar Diagram Showing Mode Of Injury Distribution

In the study most common mode of injury was RTA in 74.4%, assault in 15.4%, fall and Punch in 5.1% (Table 3).

Table 4: Metacarpal Involved Distribution

Metacarpal involved	Count	%
1st	5	12.8%
2nd	5	12.8%
2nd, 3rd	2	5.1%
2nd, 3rd, 4th	2	5.1%
3rd	2	5.1%
3rd, 4th	3	7.7%
3rd, 4th, 5th	3	7.7%
4th	10	25.6%
4th, 5th	2	5.1%
5th	5	12.8%
Total	39	100.0%

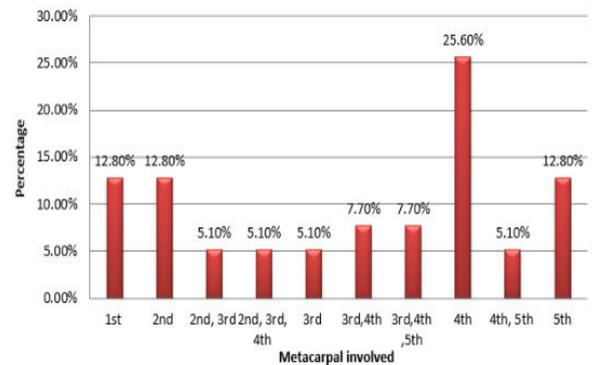


Figure 4: Bar Diagram Showing Metacarpal Involved Distribution

In the study most common metacarpal involved was 4th Metacarpal (25.6%), followed by 1st, 2nd and 5th metacarpal in 12.8% respectively (Table 4).

Table 5: Pain Assessment (vas Score) Distribution

Pain assessment (VAS Score)	Count	%
Mild Pain	21	53.8%
Moderate Pain	1	2.6%
No Pain	17	43.6%
Total	39	100.0%

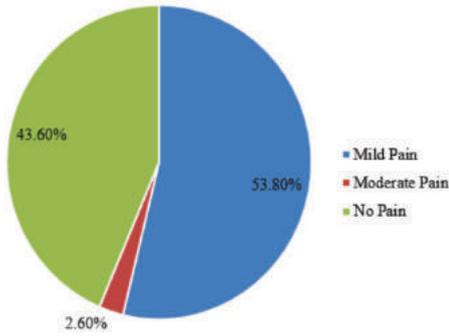


Figure 5: Pie Diagram Showing Pain Assessment (vas Score) Distribution

Out of 39 participants, 53.8% participants had mild pain, 2.6% participants had moderate pain and 43.6% participants had no pain (Table 5).

Table 6: Active Range Of Motion (tam) At Mcp Joint Distribution

Active range of motion (TAM) at MCP joint	Count	%
Excellent	17	43.6%
Good	18	46.2%
Fair	3	7.7%
Poor	1	2.6%

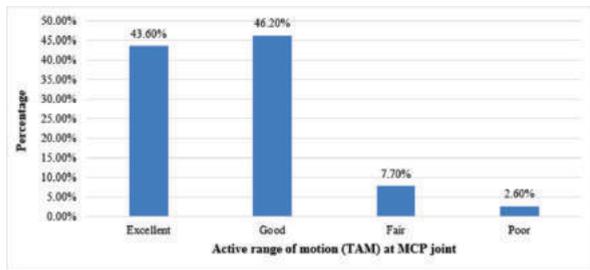


Figure 6: Bar Diagram Showing Active Range Of Motion (tam) At Mcp Joint Distribution

Among the study population, 43.6% had excellent, 46.2% had good, 7.7% had fair and 2.6% poor range of motion (Table 6).

Table 7: Functional Assessment (dash Score)

Functional Assessment (DASH SCORE)					
N	Mean	Std. Deviation	Median	Minimum	Maximum
39	15.03	4.869	15.00	10	30

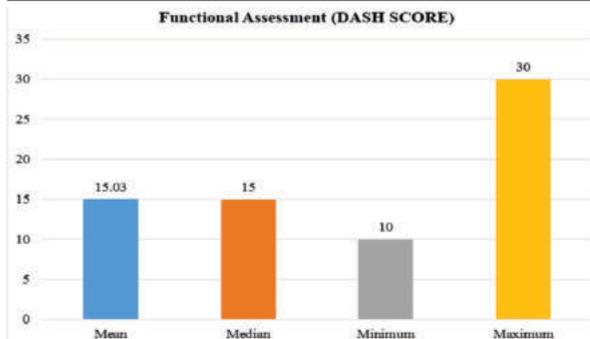


Figure 7: Bar Diagram Showing Functional Assessment (dash Score)

In the study mean DASH score was 15.03 ± 4.869. Minimum score was 10 and maximum score was 30 (Table 7).

Table 8: Complications Distribution

Complications	Count	%
Nil	35	89.7%
Pain with Stiffness	1	2.6%
Stiffness	1	2.6%

Complications	Count	%
Superficial Pin Tract Infection	2	5.1%
Total	39	100.0%

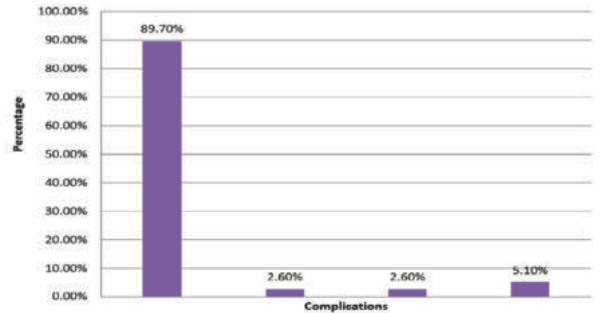


Figure 8: Bar Diagram Showing Complications Distribution

In the study 2.6% had pain with stiffness, stiffness respectively and 5.1% had Superficial Pin Tract Infection (Table 8).

Table 9: Procedure Distribution

Procedure	Count	%
Antegrade	7	17.9%
Criss Cross	3	7.7%
Retrograde	29	74.4%
Total	39	100.0%

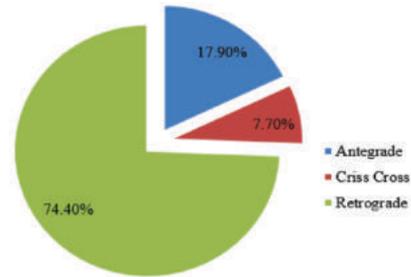


Figure 9: Pie Diagram Showing Procedure Distribution

The majority of 74.4% participants underwent retrograde procedure, 17.9% participants underwent antegrade procedure and 7.7% participants underwent Criss cross procedure (Table 9).

Table 10: Implant Removal (weeks) Distribution

Implant removal (Weeks)	Count	%
5	5	12.8%
6	27	69.2%
7	1	2.6%
8	6	15.4%
Total	39	100.0%

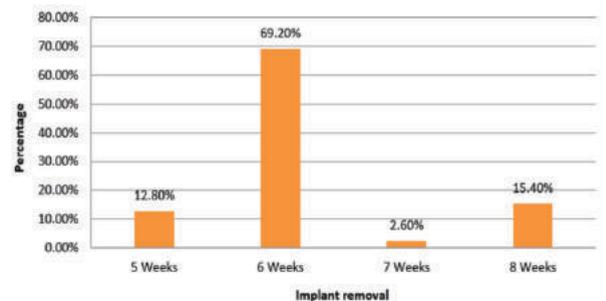


Figure 10: Bar Diagram Showing Implant Removal (weeks) Distribution

In the study the implant was removed at 5 weeks in 12.8%, at 6 weeks in 69.2%, at 7 weeks in 2.6% and at 8 weeks in 15.4% (Table 10).

DISCUSSION:

Metacarpals are one of the most commonly fractured bones because hand is used to provide protection from trauma due to fall. Among metacarpals the fifth metacarpal is frequently fractured carpal.

Management of metacarpal fractures must be done carefully because long term function of hand depends on angulation and rotation of fractures. Metacarpal fractures can be treated with Kirschner wire, screws or intraosseous wiring or hand plates.⁸ K-wire fixation method is considered to be least invasive technique for fixation after closed reduction and it is found to restore maximum long-term function.⁹

A total of 39 subjects were included in the final analysis. In the study majority of participants (33.3%) subjects were in the age group <30 years, followed by 30.8% in the age group of 31 to 40 years, 23.1% were aged between 41 to 50 years and 12.8% were aged between 51 to 60 years. This observation of majority of participants with metacarpal fractures being in the age group of less than 30 years was similar to that found in three similar studies. In one study on evaluation of surgical management of metacarpal fractures by Raghavendra, V., et al.¹⁰ 40% of participants were in the age group of 20 to 30 years, in another study by Fusetti, C., et al.¹¹ the median age was 33 years and in another study by Kelsch, G., et al.¹² the median age of 24 years. In the study 82.1% participants were males and 17.9% participants were females. This observation was also similar to that found in study by Raghavendra, V., et al.¹⁰ in which 80% of participants were males, in study by Fusetti, C., et al.¹¹ in which 79% of participants were males and in study by Kelsch, G., et al.¹² 82% of participants were males. 80% of participants were males, in study by Fusetti, C., et al.¹¹ in which 79% of participants were males and in study by Kelsch, G., et al.¹² 82% of participants were males.

In the study most common metacarpal involved was 4th Metacarpal (25.6%), followed by 1st, 2nd and 5th metacarpal in 12.8% respectively. This observation is slightly different than that reported in literature. The fifth metacarpal is the most commonly fractured among all the metacarpals¹¹

In the study mean DASH score was 15.03 ± 4.869. Minimum score was 10 and maximum score was 30. The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire is a 30-item questionnaire that looks at the ability of a patient to perform certain upper extremity activities. higher scores indicate a greater level of disability and severity, whereas, lower scores indicate a lower level of disability with a score range between 1 to 100¹⁶. The mean dash score of 15 observed in this study is slightly more than that observed in study by Van Bussel, E. M., et al.¹³ in which the mean DASH score was 5, in another study by Ozer et al.¹⁴ the mean DASH score was 0.5 and in another study by Schädel-Höpfner et al.¹⁵ for the fifth metacarpal neck fractures the mean DASH score was 0.8 (range 0–15) after 17 months. Nevertheless, considering the range of DASH score a score of 15 indicates good functional outcome.

Among the study population, 43.6% had excellent, 46.2% had good, 7.7% had fair and 2.6% had poor range of motion. Overall, around 90% of participants had good total active range of motion (TAM). This observation of majority of participants having good TAM on closed reduction and K-wire fixation is similar to that reported by Gupta R., et al.¹ in which 60% of participants reported excellent TAM and two other studies one by Belskey et al.¹⁶ and another by Green and Anderson¹⁷ also reported similar results. In a study by Raghavendra, V. et al.¹⁰ all the patients who underwent closed reduction and k-wire fixation of metacarpal fracture reported excellent range of motion. Studies by Pun et al.¹⁸, Page and stern¹⁹, and Tan., et al.²⁰ observed that open fractures had poor final TAM as compared to closed fractures

Out of 39 participants, 53.8% participants had mild pain, 2.6% participants had moderate pain and 43.6% participants had no pain. In the study 2.6% had pain with stiffness, stiffness respectively and 5.1% had Superficial Pin Tract Infection. stiffness of finger and pin tract infection are reported to be more with k-wire fixation by some studies.

Strengths and Limitations:

Because the data collected were recorded data, the reliability was verified thoroughly. The data collection and data entry were done by a single investigator which avoided bias in this study. In the present study no comparison group was included. Although this study employed universal sampling, more samples can yield better results. In this study mean time for union, Cost effectiveness were not studied.

CONCLUSION:

Metacarpal fractures are increasing with the increase in Road traffic accidents. These fractures need optimum treatment as most of them

involved the Productive men (20-40 years). Metacarpal fractures treated by CRIF with K wires give stable fixation following which the hand can be mobilized early, thereby preventing stiffness. Restoration of total normal function of the hand in treatment of hand fractures is extremely important and minimally invasive treatment procedures have been observed to aid in this than surgical interventions. It was noticed in the study that K-wire fixation which is a minimally invasive method for stabilizing metacarpal fractures is the best treatment option for metacarpal fractures as it provides excellent functional outcomes with fewer complications. In the study, around 90% of participants had a good total active range of motion after treatment. The mean DASH score in the study was 15 which reflects a good functional outcome. The technique does not affect the gliding properties of surrounding soft tissue which is required for the restoration of normal function of the hand. Fractures treated with CRIF with K Wire show faster recovery of daily activities and lesser stiffness. There will be fewer chances of infection and early bone union in the case of CRIF with K Wire fixation.

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