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Comparison of Joshi's external stabilization system and Kirschner wire fixation technique for extra-articular metacarpal fractures

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Abstract

Hand fractures, especially metacarpals and phalanges, account for 15% of emergency department admissions. Metacarpal fractures can be treated using various algorithms. Hand fractures have been treated with K wire fixation, micro plates, and external fixator application devices. A successful functional outcome requires surgical intervention with good fixation principles and a rigid system that allows early mobilization. JESS is a simple, lightweight fixation that can be used with splints or converted to dynamic mobilization units. In open fractures, JESS rigidly fixes bones. Compress, neutralize, or distract a fracture fragment to aggressively treat bone and soft tissue injuries. Moving the proximal and distal joints instantly reduces edema, capsular fibrosis, joint stiffness, and muscle atrophy. Kirschner wires are the easiest, cheapest, and most versatile hand injury treatment. They can be percutaneously introduced. It allows early movements without surgical stress. This study compares intramedullary Kirschner wires and Joshi's external fixator device for unstable extra-articular metacarpal fractures.

Keywords: Metacarpal fractures; Dynamic mobilization; Hand injury; JESS

1. Introduction

The hand is specialized and sensitive to functional dysfunction (1). Human hands are highly prehensile and capable of intricate manipulation. 15% of Emergency Department patients have hand injuries (2). Hand fractures are common for many reasons. Crush/compression injuries, blunt trauma, fall, road traffic accidents, mechanical injury, sports-related activities, explosions, and fire arm injuries are typical hand injury causes (3,4). Hand fractures, especially metacarpals and phalanges, account for 15% of emergency department admissions (5). Males at 10–40 year have the highest incidence (6). 18–44% of hand fractures are metacarpal. 88% of metacarpal fractures involve non-thumb metacarpals, most often the fifth finger. Metacarpal and phalanx fractures account for 46% of hand fractures, with the proximal phalanx and metacarpal neck being the most prevalent. Most metacarpal fractures are isolated, closed, and stable (7).

The hand fractures can cause significant impairment and long-term negative functional consequences, such as the inability to work and live at preinjury levels. Metacarpal fractures can be treated using various algorithms. Hand fractures have been treated with K wire fixation, micro plates, and external fixator application devices. A successful functional outcome requires surgical intervention with good fixation principles and a rigid system that allows early mobilization (8).

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Muscle power, joint range, and coordination are improved to cure hand abnormalities. Conservative therapy is preferred, although fixation is needed in unstable fractures, multiple fractures, intra-articular fractures, and open fractures to optimize bone healing and allow early movement (9). Unstable and complex injuries benefit from external stabilization. Joshi's external stabilizing system (JESS) uses thin smooth wires placed away from the injury site to create a stable skeletal environment for rapid soft tissue healing, microvascular circulation, and immediate active and passive mobilization of the uninjured adjacent joint (10).

JESS is a simple, lightweight fixation that can be used with splints or converted to dynamic mobilization units. In open fractures, JESS rigidly fixes bones. Compress, neutralize, or distract a fracture fragment to aggressively treat bone and soft tissue injuries. Moving the proximal and distal joints instantly reduces edema, capsular fibrosis, joint stiffness, and muscle atrophy (11). Kirschner wires are the easiest, cheapest, and most versatile hand injury treatment. They can be percutaneously introduced. It allows early movements without surgical stress (11). This study compares intramedullary Kirschner wires and Joshi's external fixator device for unstable extra-articular metacarpal fractures.

2. Material and methods

A hospital based prospective clinical study was undertaken in the Department of Orthopedics of Raja Rajeswari Medical College & Hospital, Bengaluru among the patients admitted for unstable extra-articular fractures of the metacarpals from June 2016 to June 2018. A total of 60 patients with metacarpal fractures constituted the study sample. Clearance from the institutional ethics committee was obtained before the study was started. A bilingual, written and informed consent was obtained from all the cases before they were included into the study. Inclusion criteria: Skeletally mature patients (20-60 years) with Closed and Open fractures of metacarpals (Type 1, 2 and 3A only), or Extra-articular fractures of metacarpals. Exclusion criteria: Patients with Intra-articular fractures, Crush injuries of the hand with multiple compound Grade 3 fracture, Associated co-morbidities, Infection at site of procedure.

A total of 60 subjects were considered for the study, with them being divided equally into two groups

- The percutaneous intramedullary Kirschner -wire fixation group (Group A).
- Joshi's external stabilization system fixation group (Group B).

The injuries were classified on the basis of fracture level and type. Assessment of patients was carried out according to the Mayo Wrist and DASH Scoring systems. Finally, Radiographic and clinical outcomes of both groups was assessed and compared.

A detailed history taken before the patients were subjected for the surgery. The patients were also subjected for the detailed physical examination. X ray with AP, oblique/lateral views were done, Routine investigations as per the institution protocol were sent. All the patients were subjected for Pre-anesthetic check-up and clearance. In case of open fractures, debridement of the wound and thorough irrigation was done with normal saline.

Closed/open reduction was achieved by traction and manipulation. To maintain reduction, percutaneous Kirschner wire or Joshi's external stabilization system were used. Image intensifier (C-arm) was used as a guide for the steps mentioned above. Post- Operatively, X rays were taken to evaluate the fixation. Patients were taught active mobilization of the unaffected fingers, elbow and shoulder from immediate post-op period. Pin tract dressings were done regularly. Patients were called for periodic evaluation at 2 weeks, 4 weeks, 6 weeks and 8 weeks on OPD basis to assess: Stability of fixation, Tenderness at fracture site, Pin tract infections and Residual stiffness.

Joshi's external stabilization system or Kirschner -wire removal was done at 3 to 6 weeks interval with immediate vigorous mobilization of the immobilized joint to avoid stiffness. Functional outcome was assessed based on the total active range of movement in degrees of each injured finger separately.



Figure 1 Pre and post-operative radiograph of an Extra-articular fracture of the neck of the 5th metacarpal

The data was obtained by using Predesigned and pretested proforma. The data was entered in Microsoft excel sheet and later transferred and analyzed using Statistical Package for Social Services (SPSS vs 20). The qualitative data was presented as frequencies and percentages and quantitative data was presented as mean and standard deviations. Chi square test was used as test of significance for the qualitative data.



Figure 2 Pre-& post-operative radiograph of an Extra-articular fracture of the base of the Thumb



Figure 3 Radiographic picture of patient treated with JESS at follow up at 10 weeks

3. Results

Most of the patients in Group A belonged to 41 – 50 years. In the group B, 33.3% of the patients belonged to 21- 30 years of age. This difference in age was not statistically significant between the two groups.

In Group A, 56.7% of the patients were found to be males in comparison to 43.3% of the patients being females. In Group B, an equal incidence of 50% on each side was documented. There was no statistically significant difference in sex between the two groups.

An equal incidence of 50% on each side was found in patients belonging to group A. The right hand was injured in 63.3% of the patients in Group B as compared to 36.7% of affection to the left hand. This difference in the side affected was not statistically significant.

First and second metacarpal was affected equally in 33.3% of the group A patients while 10% of patients had a third metacarpal injury. About 23.3% of the patients had first and third metacarpal injury in case of the group B, 20% in case of the second and fifth metacarpal and finally, 13.3% of the patients were found to have sustained injury to the fourth metacarpal. This difference in metacarpal involved was not statistically significant.

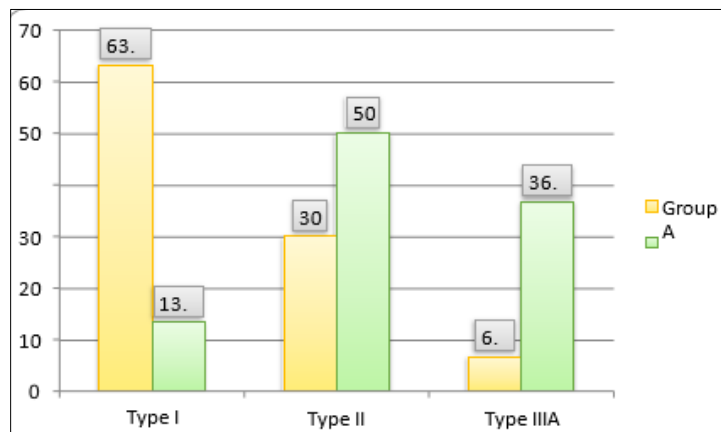


Figure 4 Distribution of the study groups according to type of fracture

About 63.3% of patients and 13.3% of patients of group A and group B respectively had Type I fractures. 30% of group A and 50% of the patients of group B had Type II fractures. 6.7% of group A and 36.7% patients of group B had Type IIIA fractures. This difference in type of the fractures was statistically significant between the two groups.

Table 1 Distribution of the study groups according to extension lag (in degrees)

Extension lag (indegrees)	Group A n (%)	Group B n (%)
0	4 (13.3)	15 (50.0)
5	1 (3.3)	5 (13.3)
10	6 (20.0)	4 (13.3)
20	7 (23.3)	4 (13.3)
30	3 (10.0)	3 (10.0)
40	4 (13.3)	0
50	2 (6.7)	0
60	3 (10.0)	0
Total	30 (100)	30 (100)

χ^2 value=18.387; df=7; p value=0.01, Sig

The pin tract infection was present in 46.7% of the group A patients as compared to 20% of the group B patients. This difference in pin tract infection was statistically significant between the two groups.

50% of the patients of group B were found to have complete extension at the MCP joint in comparison to 13.3% of the group A patients where complete extension was achieved. 3.3% of the patients of group A were found to have a 5° extension lag as compared to 13.3% in group B. The extension lag was found to be 10° for 20% of group A and 13.3% of group B patients. Most patients of group A were found to have an extension lag of 20° in group A as compared to 13.3% patients of group B. An equal incidence of 10% was found between the two groups for an extension lag of 30°. Further, 13.3%, 6.7% and 10% of extension lag of 40°, 50° and 60° respectively was found in patients of group A. This difference in extension lag was statistically significant between the two groups.

The mean flexion in Group A patients was 75 degrees and group B patients was 80 degrees. This difference in flexion was statistically significant between the two groups

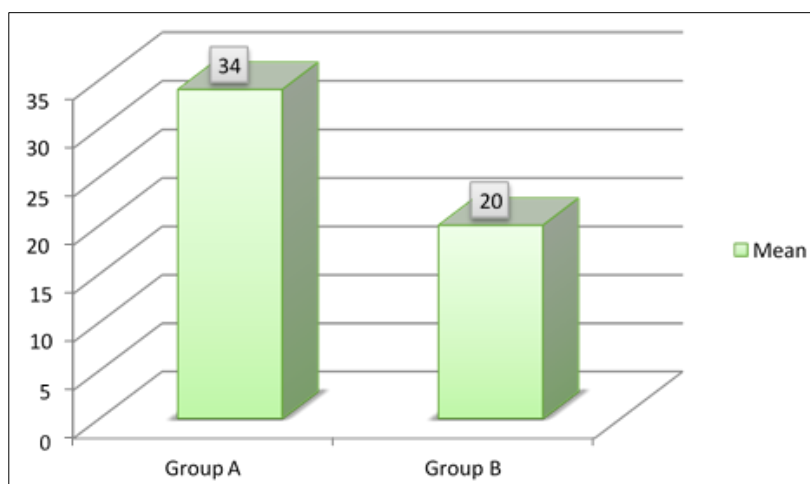


Figure 5 Distribution of the study groups according to DASH score

The mean Dash score in group A was 34 and group B was 20. This difference in DASH score was statistically significant between the two groups.

Table 2 Distribution of the study groups according to outcome

Outcome	Group A n (%)	Group B n (%)
Excellent	8 (26.7)	18 (60.0)
Good	7 (23.3)	6 (20.0)
Satisfactory	4 (13.3)	3 (10.0)
Poor	4 (13.3)	3 (10.0)
Total	30 (100)	30 (100)

χ^2 value=8.637; df=3; p value=0.035, Sig

Only 26.7% of the patients in group A as compared to 60% in group B had excellent results. The study revealed a poor outcome in 13.3% of the group A and 10% of the group B patients. This difference in outcome was statistically significant between the two groups.

4. Discussion

This study was mainly undertaken to compare and report the outcome of unstable extra-articular metacarpal fractures treated using intramedullary Kirschner wires and Joshi's external fixator system and to determine which of the two techniques provides better clinical and radiographic results.

Most of the patients in Group A were aged between 41 – 50 years and 21 – 30 years of age in groups B. In a study by Naidu et al, the incidence of fractures were more in the age group of 31 – 40 years in males and 21 – 30 years and more than 51 years in females.¹⁰ A study by Rajkumar et al had reported that, metacarpal fractures were most common in the age less than 30 years.¹¹ A study by Salunkhe et al had reported that the mean age was 30 years.¹¹ Gupta et al had observed that the age range was between 21 – 40 years in 80% of the cases. The average age of patients was 32.97 years.¹³

Male patients outnumbered female patients in this study. A study Naidu et al also observed similar findings.¹⁰ A study by Rajkumar et al had reported that males were commonly affected than females.¹¹ Salunkhe et al had also reported similar findings.¹²

Right hand was affected in 50% of the group A and 63.3% of the patients in Group B. A study by Rajkumar et al had reported that right side was affected more than the left side.¹¹ Salunkhe et al had reported no association between the right or left side.¹²

This study had shown that, about 63.3% of the patients had Type I fractures and 50% of the patients had Type II fractures. A study by Naidu et al had reported grade 3 injuries more than other type of injuries.¹⁰

The mean healing time in Group A was 7 weeks and in group B was 8.2 weeks which was significantly more in Group B. A study by Naidu et al had reported that non-union was common in 8% and delayed union was reported in 10% of the cases. Post-operative wounds healed within 4 weeks in 84% of the cases and in 26% of the cases it was observed to heal within 8 weeks.¹⁰ A study by Gupta et al had reported that the fracture healing time was between 8 – 12 weeks in more than half of the cases.¹²

About 66.7% of the patients in group A had stable fixation and 90% of the patients in group B had stable fixation which was statistically significant. Naidu et al had reported loosening of K wires in 16% of the cases.¹⁰

Tenderness was present in 56.7% of the group A patients and 26.7% of the group B patients which was statistically significant. A study by Naidu et al had reported swelling and tenderness as the most common post-operative complication in 32% of the cases.¹⁰

The pin tract infection was present in 46.7% of the group A patients and 20% of the group B patients significantly higher in Group A. A study by Naidu et al had reported pin tract infections in 14% of the cases.¹⁰ A study by Gupta et al had reported pin tract infection in 12 patients.¹³

About 26.7% of the patients in group A and 60% in group B had excellent results. This difference in outcome was statistically significant between the two groups. A study by Rajkumar et al reported that, excellent results were observed in 57.7% of the JESS method and 34.1% of the internal fixation method.¹¹ A study by Salunkhe et al had reported excellent outcome in 24 cases, 5 cases had good outcome and only 1 case had satisfactory outcome.⁵⁹ In a study of using UMEX by Gupta et al, good outcome was significantly associated with the younger age group in 37.77% of the cases. ¹³

5. Conclusion

This study was undertaken to assess the efficacy of JESS fixator over K wire in fixation of the extra articular metacarpal fractures. The study showed that JESS group had shown longer time of healing, more stable fixation, a smaller number of complications, less number of repeated surgeries, more range of mobility of the fracture site, higher Wrist and Mayo scores, Lower DASH and VAS scores, excellent to good outcome. The procedure is simple, easy to perform and requires less time and expertise. Hence, the study concludes that JESS fixation was superior than K wire fixation. But this study is with limitations like the sample size was not calculated in this study. The scanty literature preambles the need for more studies like this to bring out more facts about the use of JESS fixation in metacarpal injuries.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

Statement of ethical approval

Ethical committee clearance sought.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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