



Comparison between Outcome of Dual Intra-Medullary 1.5MM Flexible K-wire Fixation and Single 2.0MM K-wire Fixation in Metacarpal Fracture

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Authors' contributions

This work was carried out in collaboration among all authors. Author PSV designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ISG and RK managed the analyses of the study. Authors SS, GPS, A managed the literature searches. All authors read and approved the final manuscript.

Article Information

Editor(s):

(1) Dr. Parth Trivedi, C. M. Patel College of Physiotherapy, India.

Reviewers:

(1) Kavin Khatri, All India Institute of Medical Sciences Bathinda (AIIMS Bathinda), India.

(2) Falethu M. Sukati, University of Pretoria, South Africa.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/68024>

Original Research Article

Received 05 March 2021

Accepted 10 May 2021

Published 19 May 2021

ABSTRACT

Aim: To compare outcome of dual intra-medullary 1.5mm flexible k-wire fixation and single 2.0mm k-wire fixation in metacarpal fracture.

Study Design: A prospective study

Place of Study: Department of Orthopaedics, Govt. Medical College, Amritsar, India between November 2018 to December 2020.

Materials and Methods: The study included a total of 30 patients with a mean age of 35.7 years. The patients were divided into two groups (Group A - treated with Dual 1.5mm intramedullary k-wire) and Group B – treated with single 2mm Kirschner's wire) with 15 cases each at Government Medical College and Hospital, Amritsar.

Results: The average time for radiological union in Group A (Dual intramedullary k-wire) was 7.6 weeks, while it was 8.3 weeks in Group B (Single 2mm Kirschner's wire). There was no statistically significant difference in the radiological union time between the two groups ($p=0.274$) and (χ^2

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2.59). Stiffness was the most common associated complication in this study. It was more common in the group treated with Single 2mm Kirschner's wire (40%) compared to the group treated with Dual intramedullary k-wire (13.3%). Malunion was seen in 33.3% cases in group B while none in Group A. In Group A, 80.0% of cases had shown good to excellent results; while in Group B, 66.67% of the cases had similar result. There was no statistically significant difference ($P = 0.735$, chi-square = 1.28) in outcome in both groups.

Conclusion: Both Dual 1.5 mm intramedullary k-wire and Single 2 mm Kirschner's wire are good methods of internal fixation of fractures of metacarpal. Though patients who were treated with Dual 1.5 mm intramedullary k-wire had better functional results, but the difference was not statistically significant.

Keywords: Dual 1.5mm intramedullary k-wire; Single 2mm Kirschner's wire; metacarpal fracture.

1. INTRODUCTION

The hand is the most exquisite organ of direct interaction with the surrounding universe. It allows the ability to grasp and differentiated from other animals by an opposing thumb. The main functions include both fine and gross motor skills as well as being a key tool for sensing and understanding the immediate surroundings. The precision and stability of its small articulations, the fine balance between its intrinsic and extrinsic muscles, and the complex tendon mechanisms demand a stable and aligned supporting skeleton. The gliding tendons intimately enveloping the tubular skeleton of the phalanges prove in many cases to be the ultimate determinants of functional outcome after skeletal trauma. Swanson aptly stated "Hand fractures can be complicated by deformity from no treatment, stiffness from overtreatment, and both deformity and stiffness from poor treatment" [1]. Hand fractures are the most common fractures presenting at emergency and within orthopaedic clinics. Fractures of metacarpals and phalanges constitute between 14-28% of all visits to the emergency department [2].

Non-thumb metacarpals account for around 88 % of all metacarpal fractures, with the fifth finger most commonly involved [3]. Too often these metacarpal fractures are neglected or treated as minor injuries and results in major disability and deformity with permanent disability and handicap [4,5].

Fractures of the metacarpal are the most common of hand fractures accounting for up to 40% and are usually the injury described as 'a broken hand by the general public [6]. Fracture healing in the hand is not an isolated goal rather the functional result is of paramount importance [7].

2. MATERIALS AND METHODS

This was a prospective study of 30 cases of either sex above 18 years age with metacarpal fracture admitted in the department of orthopaedics at Government Medical College, Amritsar from November 2018 to December 2020. The cases were divided into two groups of 15 cases each by simple randomisation. The 30 selected cases were divided into two equal groups (group A and group B) of 15 cases each. Group A (15 cases) were treated with Dual intramedullary 1.5 mm flexible K-wire in metacarpal fracture. Group B (15 cases) were treated with single 2.0mm kirschner's wire in metacarpal fracture.

2.1 Inclusion Criteria

1. Patient with metacarpal fracture either single or multiple.
2. Patient more than 18 years of age.
3. Patient less than 60 years of age.

2.2 Exclusion Criteria

1. Patients with pathological fracture.
2. Patient with intraarticular fracture.
3. Patient with dislocation.
4. Patient with comminuted fracture.

Routine investigation were done in the form of blood tests. There after the injured hand was X-rayed to know the type and location of fracture. Medical fitness for surgery was ascertained. Patient were kept fasting for minimum of six hours before surgery. The operated limb was kept elevated for 48 hours. Broad spectrum I/V antibiotics, anti-inflammatory and analgesics were given. Radiological examination was done on next day of the operation to confirm the fixation of reduction. The first postoperative dressing was done on the fifth day.

3. RESULTS

The functional outcome after fracture treatment was assessed by calculating total active range of motion (TAM) as suggested by American Society for the Surgery of Hand (ASSH). Following results were obtained:-

- The youngest patients in the study had an age of 18 years and oldest had an age of 60 years. Mean age of patient was 35.7.
- Males outnumbered females in sustaining such fractures as they are more involved in outdoor road, industrial and assault activities.
- 76.6% people are right handed.
- 63.3% cases were due to road side accident and 33.7% cases were due to assault.
- All the cases in both the groups were extra articular diaphyseal non-comminuted fracture.
- 76.67% cases were closed and 23.33% cases were compound fracture.
- 13 patient (43.33%) had associated injuries like tendon injury, fracture both bone forearm, pelvic injury & abdomen injury.
- Single metacarpal involvement being the most common 70%.
- This study comprised of 30 cases majority of the patient was operated within one week of the surgery with 23 (76.67%) patient having been operated within 3 days of injury & 6 (20%) cases having been operated within 4-7 day of injury. One case (3.33%) was operated after one week due to associated abdominal injury.
- Average union time seen in group A was 7.6 weeks and average union time in group B was 8.3 weeks.
- In group A 10 patients had excellent result, 3 had good result and 2 had fair result. Whereas, in group B 6 patients had excellent, 5 had good result, 4 had fair result. (Table 1)

4. DISCUSSION

Open reduction / closed reduction and internal fixation with single K wire [8] is one of the treatment modalities in these unstable fractures but they provide less rigid fixation and are rotationally unstable with more incidence of stiffness, there is increased association of pin tract infection and problems due to protruding ends of K-wire are significant. To overcome these problems, dual k-wire fixation of metacarpal fracture has become quite popular. It provides more stability, early mobilization, less stiffness, with less incidence of infection. In the present study maximum patients were in the age group of 3rd and 4th decade. The youngest

patient in the study had an age of 18 years and the oldest had an age of 60 years with a mean age of 35.7 years. Similar trend was seen in a series of Tan V et al [9] in which mean age was 35 years and Page S Met al [10] observed an average age to 32 years. In our study of 30 cases, there were 23 males and 7 female patients with male to female ratio of approximately 3:1. Similar trend was observed in the series of Tan V et al [9] in which male to female ratio was 7:3. In The present study right upper limb was more commonly involved in the ratio of approximately 3:1. This is in concordance of the fact that approximately 90% of the people are right handed [11]. In our study the most common mode of injury was road side accident (63.3%) followed by assault (36.7%). This is in accordance with Soni A et al Roadside accidents with high-energy trauma were the mode of injury in most cases (11 cases). The second most common cause of these fractures was assault (seven cases) [12]. In our series associated injuries were found in 13 cases (43.33%). Associated injuries were tendon injuries 4 cases (13.33%), fracture both bone forearm 4 cases (13.33%), injury lower limb 2 cases (6.67%), pelvic injury 2 cases (6.67%), and abdominal injury 1 case (3.33%). Tendon injury was the most common associated injury due to superficial nature of the tendons and its close association with bone. In our study 23 (76.67%) patients were operated within three days of the injury and 6 (20%) cases were operated within 7 days of the injury. The delay in some cases was due to the time taken in preparing the medicolegal report and getting the medicolegal x rays done. In 1 case the delay was more than 8 days and it was due to associated abdominal injury. Khetri et al [8] reported the similar trend in which majority of the patients were operated within 1 week of the injury with 27 (67.5%) patients within 3 days of injury and 11 (32.5%) cases within 4-7 days of injury. 1 patient (6.67%) in group A and 1 patient (6.67%) in group B had fever, which is not statistically significant ($p=1.000$) the fever lasted for two days and subsided with tab. paracetamol. 3 patients (20%) in group A had discharge from wound in comparison to 4 patients (26.67%) in group B which is not statistically significant ($p=0.712$) the discharge was purulent due to pyogenic infection. The patient was given antibiotics after culture and sensitivity report for two weeks and daily antiseptic dressings were done. There was complete resolution of discharge following treatment. 2 patients (13.33%) in group A had shown postoperative stiffness in comparison to 6

patients (40%) in group B which is statistical not significant ($p=0.099$). Stiffness was the most common complaint in series reported by page SM et al [10] and Gupta et al [13] (15% cases). Stiffness was more common in group B as there was restriction of motion due to protruding kirschner's wire around the joint. 1 patient (6.67%) in group A had shown swelling in comparison to 2 patients (13.33%) in group B which is not statistically significant ($p=0.543$). No patient in group A and 1 patient (6.67%) in group B had shown delayed union, similar results were encountered by Page SM et al [10] (6.25%), and Gupta et al [13] (3.8%) 1 patient (6.67%) in group A had reported tendon rupture in comparison to none in group B. 5 patients (33.33%) in Group B shows malunion whereas none in Group A which

is statically significant ($p=0.014$). In our study, 100% rate of union was achieved. In our study 11 patients (73.33%) in group A had shown union in 6-8 weeks; 4 patients (26.67) in 9-12 weeks with average union time of 7.6 week in comparison to 10 patients (66.66%) in group B had shown union in 6-8 weeks; 4 patients (26.67%) in 9-12 and 1 patients (0.06%) in >12 weeks with average union time of 8.3 weeks. The average union time in group A was 7.6 weeks and average union time in group B was 8.3 weeks. There is no statistical significant difference in the radiological union time between two groups ($p=0.274$) and ($\chi^2 2.59$). Liew KH et al [14] noted 100% union with the use of kirschner's wire in treatment of fracture of hand in 5.7 weeks.

Table 1. Grading of results according to thestrickland's classification

Grade	Group			
	Group A		Group B	
	No.	%	No.	%
Excellent	9	60.0	6	40.0
Good	3	20.0	4	26.7
Fair	2	13.3	3	20.0
Poor	1	6.7	2	13.3
Total	15	100.0	15	100.0

Group A CASE



Fig. 1. PRE operative x-ray [15]



Fig. 2. POST operative x-ray [15]



Fig. 3. X-Ray showing union at 8 weeks [15]



(a)



(b)



(c)



(d)

Fig. 4. Range of motion (a) dorsiflexion at carpometacarpal joint (b) palmar flexion at carpometacarpal joint (c) extension at MCP joint, PIP joint and DIP joint (d) flexion at MCP, PIP and DIP joint [15]

Group B CASE



Fig. 5. Pre operative x-ray



Fig. 6. Post operative x-ray



Fig. 7. X-ray showing union at 9 weeks



(a)



(b)



(c)



(d)

Fig. 8. Range of motion (a) dorsiflexion at carpometacarpal joint (b) palmar flexion at carpometacarpal joint (c) extension at mcp joint, pip joint and dip joint (d) flexion at mcp, pip and dip joint

4.1 Functional Outcome at 8 Weeks

In our study, 11 patients (73.33%) in group A had flexion possible by greater than 59 degree at DIP; 3 patients (20%) had between 49 and 58 degree; 1 patient (6.67%) had less than 48 degree. This is in comparison to 9 patients (60%) in group B with flexion possible at DIP by more than 59 degree; 4 patients (26.67%) between 49 and 58 degree; 1 patient (6.67%) between 35 and 48 degree and 1 patient (6.67%) had less than 34 degree. 10 patients (66.67%) in group A had flexion by greater than 93 at PIP joint; 3 patients (20%) had flexion between 77 and 92 degree; 1 patient (6.67%) had flexion between 55 and 76 degree and 1 patient (6.67%) less than 54 degree in comparison to 8 patients (53.33%) in group B had shown flexion possible by greater than 93 degree at IP joint; 3 patients (20%) had flexion between 77 and 92 degree and 2 patient (13.33%) had flexion between 55 and 76 degree and 1 patient (6.67%) less than 54 degree. 10 patients (66.67) in group A had flexion possible at MCP joint by greater than 76 degree; 2 patients (13.33%) had flexion between 63 and 75 degree; 2 patients (13.33%) had flexion between 45 and 62 degree and 1 patient (6.67%) had flexion less than 45 degree in comparison to 7 patients (46.67%) in group B had shown flexion possible at MCP joint by greater than 76 degree; 2 patients (13.33%) had flexion between 63 and 75 degree and 3 patients (20%) had shown flexion between 45 and 62 degree and 3 patients (20%) had flexion less than 45 degree. Total active motion was calculated by adding flexion at MCP, PIP and DIP joints. Khatri K et al⁸ reported that ten patients in Group A had flexion possible at MCP joint by greater than 76°, eight patients

had flexion between 63 and 75°, one patient had flexion between 45 and 62°, and one patient had flexion less than 45°; in comparison to six patients in Group B who had shown flexion possible at MCP joint by greater than 76°, 10 patients had flexion between 63 and 75°, four patients had shown flexion between 45 and 62°, and none had flexion less than 45°. The results were tabulated as per Strickland's classification.

5. CONCLUSION

We, hereby conclude that fixation of metacarpal with dual intra-medullary 1.5 mm flexible K-wire is a good option for treating closed/open unstable metacarpal fractures, where other modalities of fixation are less effective due to the rigid stable fixation provided by dual intra-medullary 1.5 mm flexible K-wire which withstands load without failure and allowed early mobilization which achieved good functional results. Detailed clinical and radiological assessment of fracture, careful preoperative planning, meticulous dissection, precision in surgical technique and choosing the correct implant are critical in achieving good results and minimising the complication. Although Both dual intra-medullary 1.5 mm flexible K-wire and single 2.0mm k-wire were good methods of internal fixation in fractures of metacarpal; some important facts that came to light during study were:-

1. Stiffness was more prevalent with single k-wire as compare to dual k-wire because of joint involvement in wire.
2. Increase in infection in single wire because of protruding k-wire ends.
3. Earlier union was seen in dual wire.

4. Malunion was seen in single wire as compared to dual wire fixation.

Thus, we concluded that use of dual k-wire is a better option as compared to single k-wire in management of metacarpal fractures because of more rotational stability, early mobilization and hence less stiffness, less incidence complications like infection and malunion.

CONSENT AND ETHICAL APPROVAL

The study was undertaken after approval of Institutional Ethics Committee, Government Medical College, Amritsar. Operative informed consent and written informed consent of the patient was obtained before inclusion in the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

The peer review history for this paper can be accessed here:
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