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ORIGINAL RESEARCH

K Wire Versus Mini Plate Fixation For Metacarpal Fractures

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ABSTRACT

Introduction: The prevalent upper limb fractures caused by direct strikes, axial stress, and torsional loading are metacarpal fractures. The restoration of normal motion is the overarching goal of all fracture treatments, although the best stabilisation method is still up for debate. Kirschner wires (K wires) or miniplates can both be used for internal fixation, and each has its benefits. K wire use versus miniplate use in treating metacarpal fractures has not been compared in any prior research. The results of using K-wire and miniplates to treat metacarpal fractures were therefore evaluated in this randomised control trial.

Materials and methods: During June 2019-2022, this randomised controlled experiment was carried out in the orthopaedic surgery department of a hospital. In this study, 75 patients were enrolled, and they were divided into two groups at random. Both K-wire fixation and miniplate fixation were used to treat the two groups, respectively. Total active motion (TAM), range of motion (ROM), injury duration, and complication rate were all evaluated. IBM SPSS Statistics for Windows, Version 23.0, was used to analyse the data (Armonk, NY: IBM Corp). P values less than 0.05 were regarded as significant.

Results: Patients treated with K-wire had mean surgery times of 38.63 ±3.64 minutes, pain scores of 4.17 ±1.11, and time to union of 12.95 ±3.38 weeks, respectively. Table 2 shows that 38 fractures (95%) successfully united. Patients who underwent miniplate fixation had mean surgery times of 52.34 ±3.45 minutes, a mean pain score of 5.25 ±1.57, and a mean time to union of 11.80 ±2.38 weeks, respectively. 34 fractures successfully joined together (97.1%). Patients with miniplate fixation had better total active ROM than those with K-wire, although this difference was not statistically significant

Conclusion: When used to treat metacarpal fractures, K-wire fixation and miniplate fixation are both equally effective in terms of TAM, ROM, and complications.

Keywords: K-wire, miniplate, metacarpal fracture, range of motion.

INTRODUCTION

The most frequent upper limb fractures that result in a lifelong loss of upper extremity dexterity are metacarpal fractures[1]. The metacarpal bones are tubular in shape and have intrinsic longitudinal arches in addition to collective transverse arches [2]. These bones have concave surfaces on the palmer surface and are joined at the proximal and distal ends by

ligamentous attachments. Metacarpal shaft fractures are typically brought on by direct blows, axial loading, and torsional loading [3].

To restore the most normal function and anatomy possible, displacement and any neurological and vascular damage must be addressed with early mobilisation using open reduction and internal fixation [4]. Early mobilisation decreases edema, adhesion to free, normally gliding structures, and joint stiffness [5]. The ultimate goal in treating any type of fracture is to restore normal motion, although the best method for doing so is still up for debate [6]. The best stabilisation and fixing method would be inexpensive, maximise bony union, allow for appropriate rotation, length, and alignment, and restore normal hand functionality without concern for displacement [7]. Kirschner wires (K-wires) or miniplates can be used for internal fixation. K-wire utilisation has some benefits over the miniplate method, including advanced material, little dissection, technical simplicity, and material availability [8]. However, the miniplate features adjustments made specifically for hand surgery. We can accomplish increased stiffness and length maintenance by using these particularly developed plates [9,10].

There are no studies that contrast the effectiveness of miniplates with K-wires in treating metacarpal fractures. This randomised control experiment was done to assess how K-wire and miniplate therapy for metacarpal fractures performed.

MATERIALS AND METHODS

During June 2019-2022, this randomised controlled experiment was carried out at the department of orthopaedic, GMC, Jammu in India. All of the patients involved in the trial provided their informed consent, and our institutional ethics board approved the study as ethical. The study covered all displacement fractures of the metacarpal bones presenting to the emergency room that were malrotated, irreducible, subcapital open fractures, intra-articular fractures, multiple hand traumas, and segmental bone loss. Patients with firm cortical acquisition and osteoporosis were not included in the study. Consecutive non-probability sampling was utilised. Patients were randomly split into two equal groups. Both K-wire fixation and miniplate fixation were used to treat the two groups, respectively.

Patients were given light anaesthesia and a regional block to flex and stretch their fingers in order to evaluate their digit movement. The fracture site was revealed by a dorsal skin incision, and the periosteum was sufficiently incised longitudinally to clean and implant the required fixing. In order to decrease the fracture, the fixation pin was bored retrogradely from the fracture margin down the dorsoradial aspect of the metacarpal, then back down the shaft. Rotational alignment was preserved as the pin was introduced. The patient was instructed to extend and flex their fingers. If the alignment wasn't right, the pin was taken out and a new one was put in. Following surgery, a large dressing was used for five days, and the patient was instructed to actively move around. For six weeks following surgery, grasping and heavy lifting were prohibited.

On the borders of the radius and the first two metacarpals, as well as the ulna and the fifth metacarpal, the site was exposed for metacarpal fractures. To reveal the fracture location, a longitudinal incision was performed between the third and fourth metacarpals. In one attempt, the drill hole was positioned correctly. The periosteal layer was returned to its original location once fixation was completed and, if necessary, sutured. After the wound was closed, a soft dressing was put on it, and the surgeon-supervised active range of motion (ROM) exercise was started the next day.

An eight-week follow-up period was used. Every week, the surgical site was examined, and x-rays were collected to track bone repair and track reduction loss. Patients were released from the hospital once active ROM reached its maximum and the fracture had mostly healed. IBM SPSS Statistics for Windows, Version 23.0, was used to analyse the data (Armonk, NY:

IBM Corp). Using the visual analogue scale, we assessed pain, surgery time, union success, and complications. For numerical data, the mean and standard deviation were computed; for qualitative data, frequency (percentages) were determined. P-values under 0.05 were considered statistically significant.

RESULTS

In this study, 75 patients (42 males and 33 women) were included. K-wire fixation was used to treat 40 patients (21 men, 19 women), while miniplate fixation was used to treat 35 patients (21 men, 14 women). Patients who had K-wire treatment had an average age of 25.20 ±1.78 years and a mean injury time of 4.38 ±1.44 hours. In the K-wire group, there were 17 intraarticular fractures (42.5%) and 12 open fractures (30%). The mean age and duration of injury for the miniplate group were 25.51± 2.18 years and 4.88 ± 1.23 hours, respectively. In the miniplate group, there were 16 intraarticular fractures (45.7%) and nine open fractures (25.7%). Table 1 displays the distribution of fracture category distributions, which were not statistically significant.

Table 1: Demographic data

Variables	K-wire	Miniplate	P value
Gender Male Female	 21 (52.5%) 19 (47.5%)	 21 (60%) 14 (40%)	0.514
Age (years)	25.20±1.78	25.51±2.18	0.496
Time injury (hours)	4.38±1.44	4.88±1.23	0.106
Open fracture	12 (30%)	9 (25.7%)	0.680
Intraarticular	17 (42.5%)	16 (45.7%)	0.780

Patients treated with K-wire had mean surgery times of 38.63 ±3.64 minutes, pain scores of 4.17 ±1.11, and time to union of 12.95 ±3.38 weeks, respectively. Table 2 shows that 38 fractures (95%) successfully united. Patients who underwent miniplate fixation had mean surgery times of 52.34 ±3.45 minutes, a mean pain score of 5.25 ±1.57, and a mean time to union of 11.80 ±2.38 weeks, respectively. 34 fractures successfully joined together (97.1%). Patients with miniplate fixation had better total active ROM than those with K-wire, although this difference was not statistically significant (Table 2). Similar to total active motion (TAM), the difference in TAM between patients treated with K-wire and those fixed with miniplates was not statistically significant. Table 3 displays the distribution of both groups' various problems.

Table 2: Study outcome variables

Variables	K-wire	Miniplate	P value
Surgical time (minutes)	38.63±3.64	52.34±3.45	0.000
Pain scale	4.17±1.11	5.25±1.57	0.102
Time of union (weeks)	12.95±3.38	11.80±2.38	0.485
Success of union	38 (95%)	34 (97.1%)	0.637
Metacarpophalangeal joint (MP)	76.95±2.57	85.71±1.94	0.071
Proximal Interphalangeal Joint (PIP)	101.05±4.95	105.48±3.11	0.101
Distal Interphalangeal Joint (DIP)	62.25±1.99	64.31±2.60	0.324
Total Active Motion	246.63±3.22	254.37±3.44	0.142

Table 3: Complications

Complications	K-wire	Miniplate	P value
Infection	4 (10%)	1 (2.9%)	0.825
Implant loosening	2 (5%)	1 (2.9%)	
Loss of reduction	3 (7.5%)	2 (5.7%)	
Stiffness	4 (10%)	3 (8.6%)	
Malunion	2 (5%)	2 (5.7%)	
Total	15 (37.5%)	9 (25.8%)	

DISCUSSION

When an unstable fracture was treated with closed reduction, James et al. found that 77% of the fingers lost function [11]. Due to the loss of active ROM at the joint caused by K-wire fixation, these findings were disappointing; only 8% of patients recovered full functions. The outcomes of James et al. are comparable to what we discovered. According to Green et al., 69% of patients treated for proximal phalangeal fractures with closed reduction and percutaneous pin fixation have successful outcomes. They came to the conclusion that this method was exclusively effective for proximal phalanx oblique fractures [12].

According to one study, 32 patients who sustained hand fractures from low-velocity gunshot wounds were treated with antibiotics, wound cleaning, debridement, and splinting [13]. Although there was no infection, unstable fractures resulted in restricted motion at the corresponding joints, which is consistent with our findings. In patients with comminuted fractures, Barton et al. reported 57% good results, which is also consistent with our findings [13]. A study on the variables causing ROM decreases was undertaken by Huffaker et al. [14]. Without taking into account any particular treatment strategy, they reported satisfactory results in 67% of patients. In identical hands with unfractured metacarpal bones, they reported a 20% reduction in ROM. The outcomes were impacted by flexor and extensor tendon injuries. According to Strickland et al., TAM may be reduced by prolonged immobilisation of more than two weeks [15].

According to Lister et al., metacarpal shaft fractures treated with K-wire fixation and three weeks of immobilisation produced results that were nearly 157° TAM better. K-wire fixation was suggested as the preferred course of treatment by Lister et al., who attained a TAM of 199° [16]. Belsky et al. came to the conclusion that closed reduction with internal fixation is superior than open reduction. They saw outstanding outcomes in 69% of the instances, good results in 29% of the cases, and fair to bad results in 10% of the cases. The research by Belsky et al. is significant and advances the discussion on how to treat metacarpal fractures [17]. Fixation was shown to be poorer when K-wire was employed in a study by Fyfe et al. Fixation with a miniplate produced significantly superior outcomes, according to Fyfe et al. [18]. According to Massengill et al., miniplate fixation results in superior ROM, TAM outcomes, and equal stabilisation. They discovered that using miniplates made it easier to restore normal metacarpal function [19]. Miniplate offers substantial stability, allowing mobilisation and active ROM exercises to begin sooner. To enable the early start of activities, a soft dressing should be applied. K-wire and miniplate procedures are equally effective in treating metacarpal fractures, according to Wutphiriya-angkul et al. [13]. The findings from that study are identical to ours in that both approaches are time-saving and equally effective when employed in metacarpal fractures. Both techniques required the least amount of time for the operation.

CONCLUSION

When utilised to treat metacarpal fractures, the methods K-wire fixation and miniplate fixation are both equally successful in terms of TAM, ROM, and complications.

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