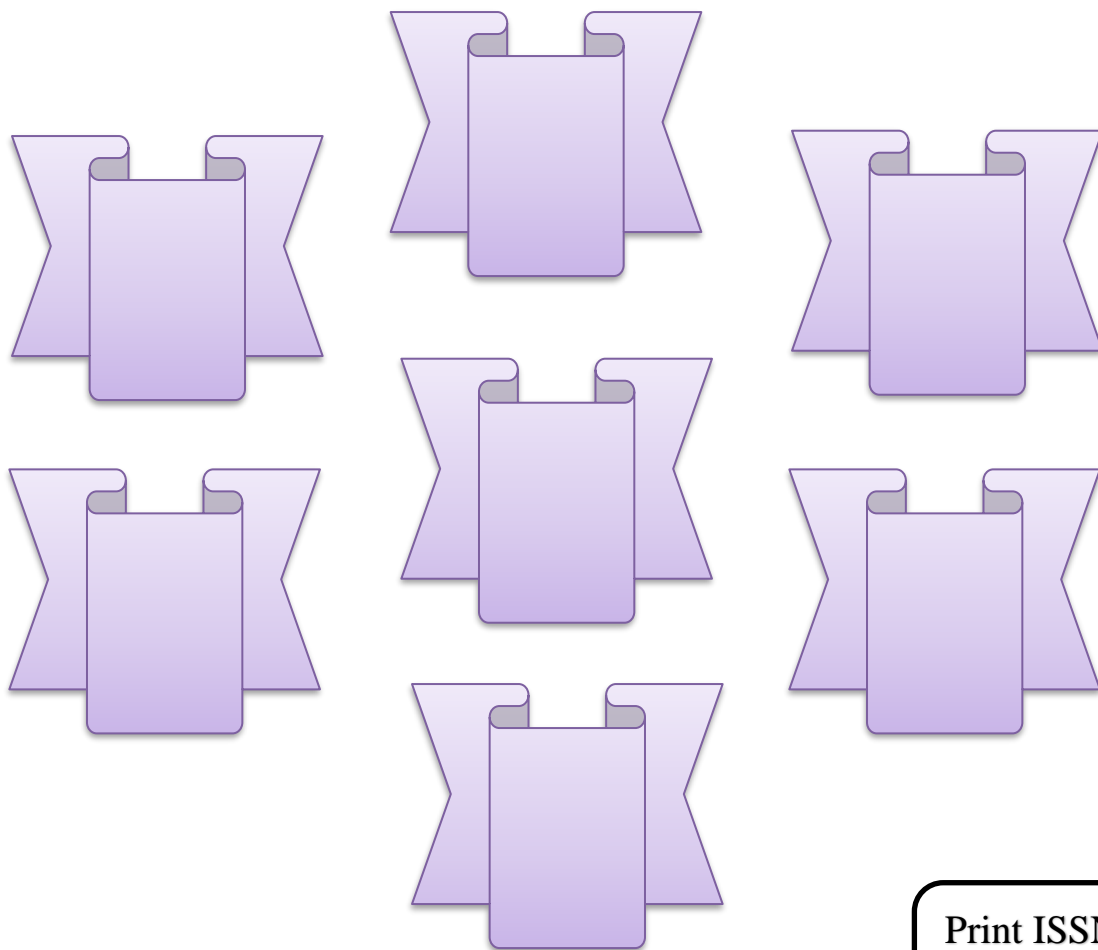


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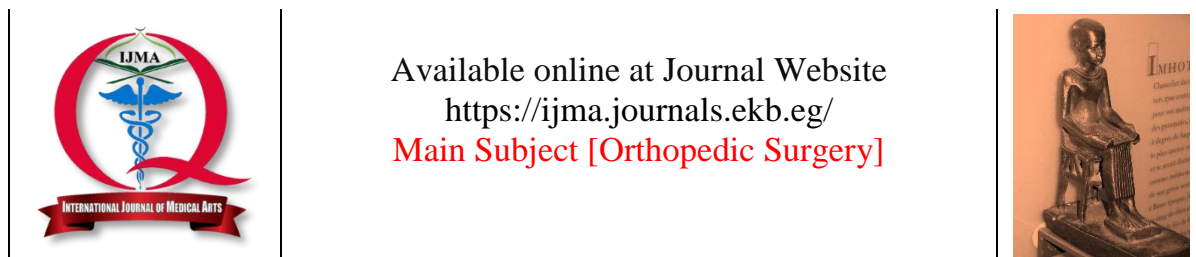
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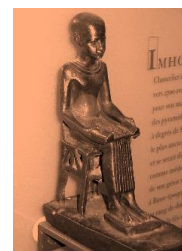


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Original Article

Comparative Study between Kirschner Wire versus Mini Plate in Management of Unstable Metacarpal Fractures

Ibrahim Ashraf Ibrahim Abdelbaky Elhomy *, Samir Ahmed El-Shoura, Ammar Fathy Abd-ELhamied

Department of Orthopedic Surgery, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt

ABSTRACT

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*Corresponding author

Email: ibrahimashraf1010@yahoo.com

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Background: Fractures of the metacarpals are often seen in the orthopedic emergency department. Complicated metacarpal fractures are more common than any other type of fracture. The general goal of treating all fractures is for the patient to achieve normal motion. However, the ideal stabilization technique is still debated. For internal fixation, Kirchner wires [Wires] or can be used, each offering several advantages. No previous study has compared the use of Kwire with miniplates in the treatment of unstable metacarpal fractures. Therefore, we conducted this prospective intervention study to evaluate the outcomes of using Kwire and miniplates in the treatment of unstable metacarpal fractures.

Aim of the work: To contrast the functional and radiological outcomes of MPIF and also KWIF for the treatment of unstable metacarpal fractures; and to determine which fixation method [Kirschner wire or mini plates] provides the best functional and radiological outcome in the treatment of metacarpal fractures.

Patients and Methods: This prospective interventional investigation was performed at the Al-Azhar university Hospital in Damietta, in the department of orthopedic surgery. This study was conducted on 40 patients with unstable metacarpal fractures.

Results: There were statistically significant variations among the two groups regarding operative time [minutes], blood loss [milliliters] & hospital stay [day]. The hand grip, DASH, and TAF scores did not differ significantly among the two groups. There was no statistically significant variation in result among the two groups. In regards to complications, there was not a significant distinction among both groups examined.

Conclusion: In the treatment of unstable metacarpal fractures, both the Kirschner wire and the Mini Plate proved to be reliable options. Kirschner Wire was related with much less operating time, shorter hospital stay, reduced blood loss, and quicker union time, despite the fact that both procedures had comparable functional outcomes and complication rates.

Keywords: MPIF; Kirschner wire; Internal fixation; Metacarpal Fractures.



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INTRODUCTION

Approximately 35.5% of daily emergency cases involve metacarpal fractures. Road traffic incidents [RTA], falls, and assaults are possible causes. It might cause structural deformities if left untreated or stiffness if treated too much [1-3]. It is responsible for around 18-44% of all hand fractures [4], fifth metacarpal fractures are the most prevalent form [5].

Fractures of the metacarpals can be categorized according to their location and fracture pattern. A metacarpal fracture may be located in the head, shaft, neck or base [1]. Open or closed, intra-articular or extra-articular, oblique, spiral, transverse, or comminuted, the fracture pattern is the same as that of any other long bone [6].

To reach maximal normal function and anatomy, dislocations and neurologic and vascular injuries must be treated with early mobilization by means of open reduction and internal fixation [7]. Joint stiffness, edema, and adhesion to normally free gliding components are all reduced through early mobilization [8]. The end aim of treating any fracture is to restore normal mobility, however there is some disagreement over the best method for stabilizing the fracture [9].

Minimal expense, maximum bone union, and full return of hand function without risk of displacement would characterize the ideal stabilization and fixation approach [10]. Miniplates or Kirschner wires [K-wires] can be employed for internal fixation. Where K wire fixation is a common technique that has the advantages of the subcutaneous nature of hand bones, small size, and their limited loading potential for the stress placed on hardware [11]. While mini-plates produce an anatomical reduction with good stabilization that is rigid enough to allow rapid mobilization, but rupture of extensor tendons, stripping of periosteum with affection of nutrition, difficult technique, loosening and distraction of the implant and infection are common problems with mini-plates [11].

The most important aspect of treatment is rehabilitation. Early movement following fixation of hand fractures is particularly important because tendon gliding and joint mobility are essential for proper hand function [12].

PATIENTS AND METHODS

Study design: A prospective interventional study was performed for comparative fixation of metacarpal fracture by k wire versus mini plate

Study setting: The research was performed in patient admitted in the Department of Orthopaedic surgery, Al-Azhar university Hospital in Damietta on [40] patients. All of the participants [n=40] with a metacarpal bone fracture were split into two categories: group A [n=20] had closed reduction and percutaneous fixation with antegrade intramedullary K wires, group B [n=20] performed open reduction, internal fixation with mini-plates and screws. During March 2022 to February 2023, we checked in on each individual for a full assessment. After surgery, all patients were followed up on for the duration of one year.

Inclusion criteria: Individuals [≥ 18 years] with recent closed fractures of any metacarpal bone [Transverse, oblique and spiral fractures] with an angulation above thirty degrees, a shortening greater than 2 mm, or a rotational deformity.

Exclusion criteria: Individuals with significant organ dysfunction; people who have past upper limb injuries; open fractures, pathological fractures and fractures needing bone grafting.

Methods

Preoperative assessment: Both general and local examinations that include inspection, palpation, movement, special tests and neurological examination [motor and sensory]. Plain X-rays or CT scan for confirming the fracture and its details.

Operative technique

1. For Mini Plate

The patients were positioned lying on their backs on the table. A straight incision was made along the back of the affected ray, and the layers of subcutaneous tissue were carefully dissected. The extensor tendon was then either pulled towards the ulnar or radial side, or if needed, a long incision was made along its length. The periosteum was incised lengthwise, and the bone was uncovered beneath it to observe the fracture. The fracture was subsequently aligned by pulling

the finger in a straight direction, and the alignment was maintained through the use of a clamp. A plate was then attached and screws were inserted, and the surgical incision was closed layer by layer. Sterile dressings and a flexible bandage were applied. A post-operative X-ray was performed to evaluate the alignment.

2. For k-wire

The affected limb is prepared and covered in a sterile manner and positioned on the image intensifier's cassette. Using an acutely flexed metacarpophalangeal joint, a Kirschner wire is inserted into the metacarpal head and drilled to the level of the fracture. Through manual pressure, manipulation of the wire, and guidance from the image intensifier, the fracture is realigned. The accuracy of the reduction is confirmed through radiographic examination, and if deemed successful, the wire near the skin is trimmed. Sterile dressings and an extended below elbow splint are applied in a functional position. A post-operative X-ray is taken to evaluate the realignment.

Postoperative Assessment: intraoperative blood loss, operative time, fracture healing time, joint function recovery, and postoperative complications were recorded and compared between the two groups. The postoperative palm function of the patients was evaluated using the TAFS score. Excellent results were defined as an active flexion degree of 2 to 5 metacarpophalangeal to interphalangeal joint >220 degrees, good results were defined as a flexion degree of 2 to 5 metacarpophalangeal to interphalangeal joint between 180 and 220 degrees, and poor results were defined as a flexion degree of metacarpophalangeal and phalangeal joints from 2 to 5 fingers to interphalangeal joints <180 degrees.

Ethical consideration: The details of the operation was explained to the participants and informed written consent was obtained, in addition, approval of the IRB committee, Damietta faculty of medicine, Al-Azhar University will be obtained before initiating this study, Privacy of participants has been approved by the hospital administration and was protected at all stages of the research. The information gathered was not shared or used for any other reason.

Statistical Analysis: All of the information was collected, tabulated, and examined statistically utilizing SPSS 22.0 for windows [SPSS Inc., Chicago, IL, USA]. To ensure that the data were normally distributed, the Shapiro-Wilk test was performed. The qualitative information was represented utilizing frequency and relative percentage. Chi-square [χ^2] & Fisher exact tests were employed for assessing significant variations amongst qualitative variables. We employed the mean and SD for parametric information and the median and range for nonparametric data. The Independent t test was utilized for contrasting parametric and non-parametric variables amongst the two groups quantitatively, while the Mann Whitney test was utilized to evaluate continuous variables. All statistical comparisons were two-tailed P-value < 0.05 is significant.

RESULTS

Table [1] demonstrates that there is not a significant distinction among both groups examined.

Table [2] demonstrates that there is no statistically significant variation among the 2 investigated groups in regards to involved side. Moreover, all the fractures were unilateral.

Table [3] indicates that there is not a significant variation in fracture morphology among both of the examined groups.

Table [4] demonstrates that there are statistically significant distinctions among the two investigated groups in terms of operative time [min], blood loss [ml] plus hospital stay [day].

Table [5] shows that union time is significantly lower in KWIF compared to MPIF. However, there is no significant among the groups regarding hand grip, DASH, and TAF score.

Table [6] illustrates that there is not a significant distinction among the outcomes of both studied groups.

Table [7] shows that there is no significant variance amongst the two studied groups according to complications.

Table [1]: Demographic data of the two studied groups

Variable		KWIF [n=20]	MPIF [n=20]	t / χ^2	P
Age [years], mean \pm SD		47.16 \pm 9.53	49.72 \pm 10.14	0.8227	0.42
Sex	Male	15 [75%]	17 [85%]	0.625	0.43
	Female	5 [25%]	3 [15%]		
BMI [kg/m ²], mean \pm SD		26.31 \pm 3.77	25.64 \pm 2.83	0.6356	0.52
Dominance hand	Right-handed	17 [85%]	19 [95%]	1.11	0.29
	Left-handed	3 [15%]	1 [5%]		
Fracture side	Right	13 [65%]	15 [75%]	0.476	0.490
	Left	7 [35%]	5 [25%]		

Table [2]: Fracture site distribution between the two examined groups

Side	KWIF [n=20]	MPIF [n=20]	χ^2	P
Index finger	8 [40%]	5 [25%]	2.403	.492
Middle finger	3 [15%]	7 [35%]		
Ring finger	4 [20%]	4 [20%]		
Little finger	5 [25%]	4 [20%]		

Table [3]: Fracture shape distribution amongst the two examined groups

	KWIF [n=20]		MPIF [n=20]		χ^2	P
	No.	%	No.	%		
Transverse	13	65	11	55	0.42	.8103
Oblique	4	20	5	25		
Spiral	3	15	4	20		

Table [4]: Operative data amongst the two examined groups

	KWIF [n=20]	MPIF [n=20]	t	p
Operative time [min], mean \pm SD	35.61 \pm 6.43	51.48 \pm 5.32	8.50	<0.001
Blood loss [ml], mean \pm SD	12.42 \pm 3.39	18.73 \pm 5.54	4.34	0.001
Hospital stay [day], mean \pm SD	5.31 \pm 1.85	6.97 \pm 2.26	2.54	0.01

Table [5]: Clinical characteristics amongst the two studied groups

	KWIF [n=20]	MPIF [n=20]	t	P
Union time [weeks], mean \pm SD	6.15 \pm 1.43	9.73 \pm 1.25	8.4295	< 0.001
Hand grip, mean \pm SD	91.8 \pm 2.54	92.3 \pm 2.37	0.6437	0.52
DASH, mean \pm SD	3.36 \pm 1.24	4.21 \pm 1.68	1.8205	0.07
TAF score, mean \pm SD	248.52 \pm 4.65	250.4 \pm 5.38	1.1823	0.24

Table [6]: Outcome distribution among the two groups

	KWIF [n=20]		MPIF [n=20]		χ^2	P
	No.	%	No.	%		
Excellent	15	75%	13	65%	1.14	0.766
Good	3	15%	3	15%		
Fair	1	5%	3	15%		
Poor	1	5%	1	5%		

Table [7]: Complications among the two studied groups

	KWIF [n=20]	MPIF [n=20]	χ^2	P
Infection	1 [5%]	3 [15%]	1.1	0.291
Sym. Hardware	1 [5%]	3 [15%]	1.1	0.291
Stiffness	1 [5%]	1 [5%]	--	1
Loosening	3 [15%]	1 [5%]	1.1	0.291

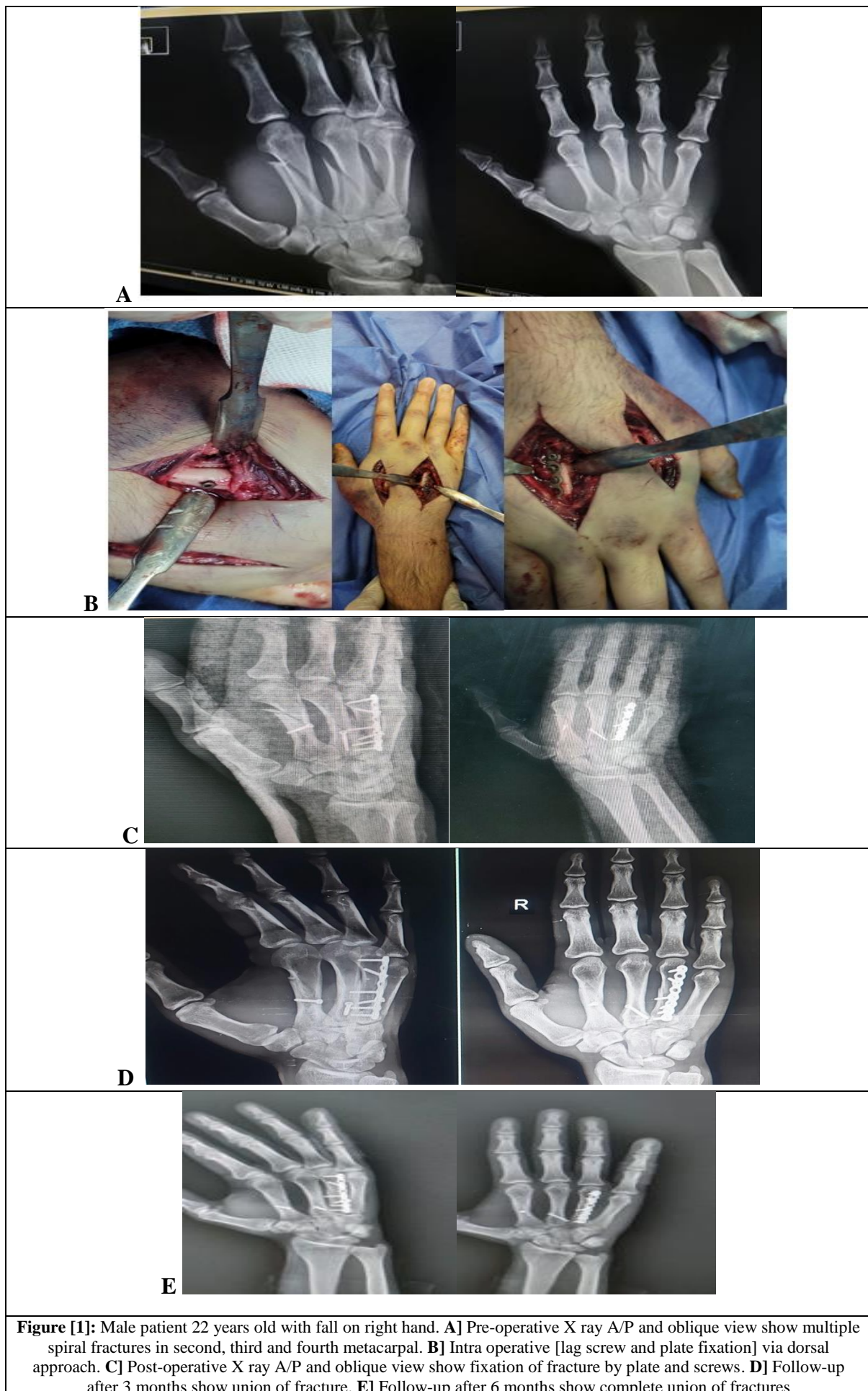


Figure [1]: Male patient 22 years old with fall on right hand. **A]** Pre-operative X ray A/P and oblique view show multiple spiral fractures in second, third and fourth metacarpal. **B]** Intra operative [lag screw and plate fixation] via dorsal approach. **C]** Post-operative X ray A/P and oblique view show fixation of fracture by plate and screws. **D]** Follow-up after 3 months show union of fracture. **E]** Follow-up after 6 months show complete union of fractures

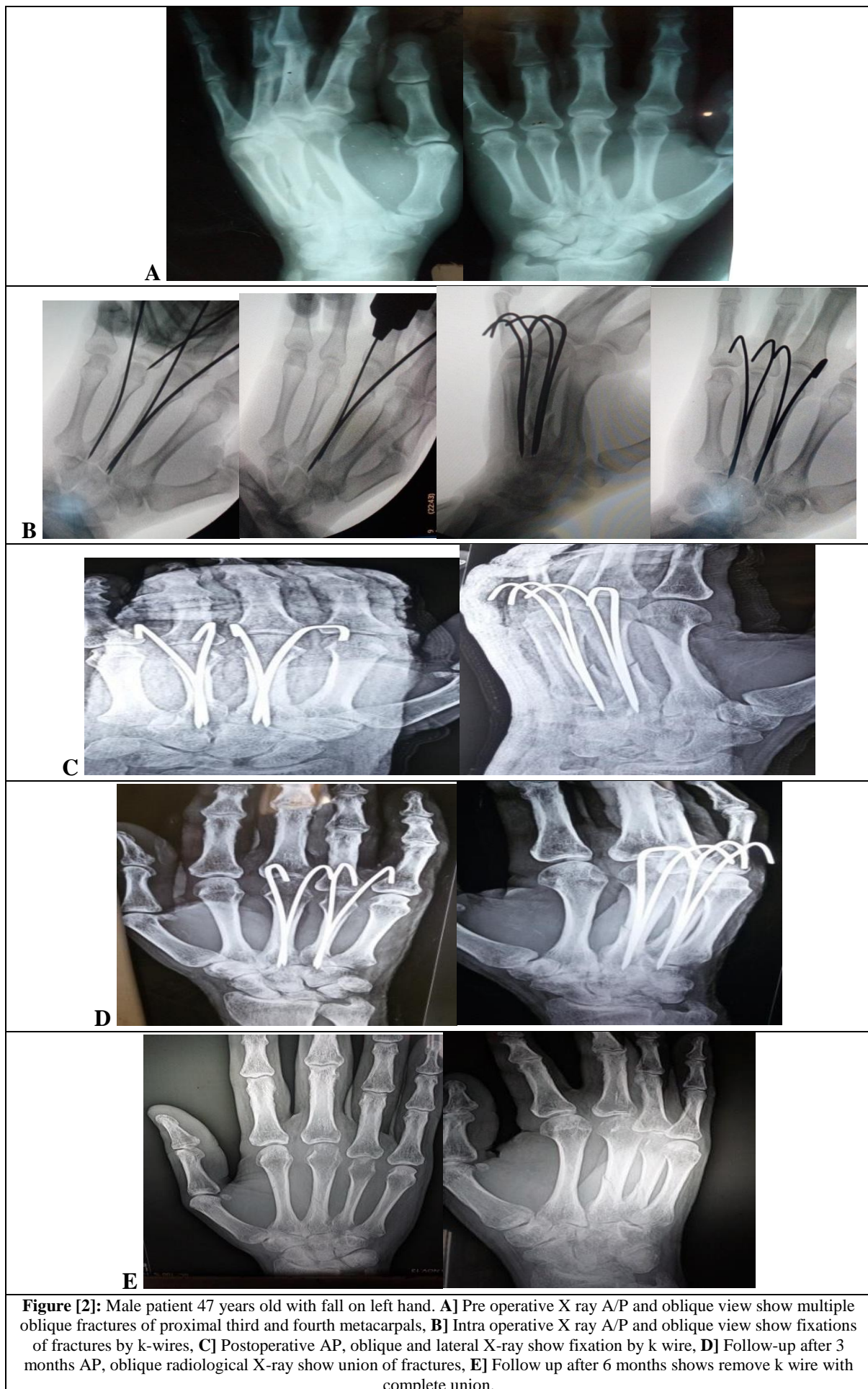


Figure [2]: Male patient 47 years old with fall on left hand. **A]** Pre operative X ray A/P and oblique view show multiple oblique fractures of proximal third and fourth metacarpals, **B]** Intra operative X ray A/P and oblique view show fixations of fractures by k-wires, **C]** Postoperative AP, oblique and lateral X-ray show fixation by k wire, **D]** Follow-up after 3 months AP, oblique radiological X-ray show union of fractures, **E]** Follow up after 6 months shows remove k wire with complete union.

DISCUSSION

The present research showed that the usage of Kirschner wire internal fixation was related to significantly shorter operative time, lower blood loss and shorter hospital stay. In accordance with the present investigation, **Gupta et al.** ^[14] contrasted the use of K-wires and miniplates in the treatment of metacarpal fractures. Seventy-five patients were enrolled and split into two groups to receive either a K wire [n=40] or a miniplate [n=35], both groups were well-matched in baseline data. Their study showed that the use of K wire internal fixation significantly reduced the surgical time compared to miniplate internal fixation.

Also, in concordance with the current study **Ahmed et al.** ^[15] enrolled 35 cases treated with mini plates and 40 participants treated with K-wire fixation. The studied groups were similar in baseline characteristics. The study showed that the surgical time in K-wire fixation group was significantly shorter than miniplate fixation group. In addition, **Abdel-hamid et al.** ^[16] compared the application of mini-plates [n=15] and K-wires [n=15] in the treatment of adults with unstable metacarpal shaft fractures. K-wire fixation is correlated with substantially shorter operative time and shorter hospital stay than miniplate fixation.

Regarding clinical characteristics, the current research revealed that union time in KWIF is substantially less than in MPIF. There is not a significant distinction among the groups in terms of hand grasp, DASH or TAF score. In harmony with the present research **Abdel-hamid et al.** ^[16] showed that union time is significantly lower in KWIF contrasted to MPIF. Nevertheless, there is no significant amongst the groups with regard to Quick DASH score, TAF, handgrip and total result. The research found that both methods are quite useful for fixing metacarpal shaft fractures. Both mini-plate and K-wire fixation facilitate speedy recovery of hand function while preserving mobility and soft tissue.

In accordance with the current research **Gupta et al.** ^[14] revealed that there no significant amongst the groups regarding functional outcome assessed by Total active motion [TAM], range of motion [ROM], pain scale and success of union, but in contrast to the current study they also reported that both procedures resulted in similar time of union [p=0.485].

Also, in harmony with or results **Shair et al.** ^[17] showed that There was not a statistically significant distinction among study groups in terms of radiological efficacy of the participants [p=0.6396] and pain score [p=0.0683]. In contrast to our results the study showed that there was no statistically significant variance among the studied groups as regard time of union. Furthermore, **Muhammad et al.** ^[18] concluded that Internal fixation using either a K-wire or a Miniplate is highly effective for healing metacarpal fractures. After four months of treatment, 96% of the K-wire group and 100% of the Miniplate group had successful union. As there was not a statistically significant distinction in union rates among the two methods, both were found to be equally successful for patients.

A research by **Luo et al.** ^[19] showed, however, that mini-plate fixation for complex metacarpal fracture had a better clinical impact than K wire. This means that mini-plate fixation may be employed as an efficient repair procedure for complicated metacarpal fracture. After 3 months of observation, statistical analysis demonstrated that there were significant variations [p<0.05] in the total action flexion score among the two groups. Also, **Khatri et al.** ^[20] discovered that 75 percent of cases with proximal phalangeal and metacarpal fractures benefited from K-wire internal fixation, while 85% benefited from miniplates. However, there was no statistical significance amongst the two study groups [p=0.737].

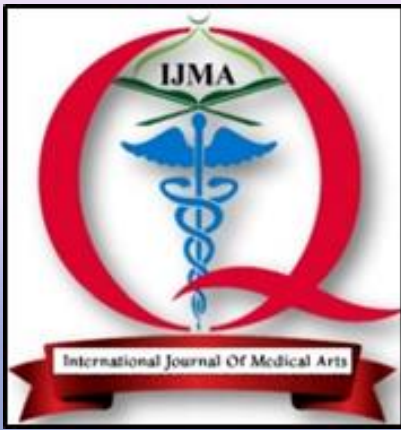
Regarding complications, the current study showed that there is no significant variance amongst the two studied groups regarding complications. In accordance with the current investigation **Gupta et al.** ^[14] in terms of complications, there was not a significant distinction among the categories. As well, consistent with the current study **Ahmed et al.** ^[15] revealed that no substantial difference among the groups in terms of complications including infection, implant loosening, loss of reduction, stiffness and malunion [p=0.825], the total complication rate was 15 [37.5%] and 9 [25.8%] in K-wire and miniplate respectively.

Conclusion: Both the K-wire and the Mini plate were shown to be a safe and effective option for treating unstable metacarpal fractures in the current study. Kirschner Wire was related with considerably less operating time, shorter hospital stay, reduced blood loss and quicker union time in comparison with the other procedure.

Conflict of Interest and Financial Disclosure: None.

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