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Evaluation of Outcome of Percutaneous Fixation in Management of Unstable Metacarpal

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ABSTRACT

Background: Injuries to the metacarpal bones are widespread and may severely limit a person's ability to go about their everyday lives. Unstable fractures usually need surgical intervention.

Objectives: This study aimed to investigate how well Kirschner wires percutaneous fixing improves the prognosis of patients with unstable metacarpal fractures.

Patients and methods: Fifteen patients with unstable metacarpal fractures were included in this study. They were treated by percutaneous fixation at Sharm El Sheikh Hospital through the period from 2017 to 2019. Nine patients in group 1 had antegrade intramedullary bouquet fixation and six in group 2 had transverse pinning. The results were evaluated using the total active movements (TAM) score after clinical and radiological follow-ups.

Results: The mean patient age was 33.26 years. There were no statistically significant differences between the groups when it came to the intervals of time before fixation (p=0.64) and time until union (p=0.44). Results showed that both group 1 (76.77%) and group 2 (66.66%) when evaluated using TAM scores (p=0.26), had very good results. There were also no statistically significant differences between both groups in terms of the duration of follow-up or surgical complications (p=0.39 and p=0.35 respectively).

Conclusion: There were no major variations in clinical or radiological outcomes between intramedullary and transverse pinning approaches when it comes to percutaneous fixation with Kirschner wires for unstable metacarpal fractures. Both methods provided equivalent results.

Keywords: Metacarpal fractures, Pinning, Metacarpal instability, Percutaneous fixation.

INTRODUCTION

Work and everyday activities become much more difficult after a metacarpal fracture. Particularly affecting males between the ages of 15 and 24. These injuries rank high among the most prevalent types of hand trauma making up 18% to 42% of all fractures of the hand and forearm. The pattern of the fracture is determined by the cause of damage, which might be falls, direct hits, or torsional forces [1, 2].

Immobilization and rehabilitation are the main conservative treatments for non-compound metacarpal fractures. There are cases when internal fixation is necessary, such as with unstable fractures or those that need early mobility [3, 4].

Metacarpal neck and comminuted head fractures are best treated with percutaneous pinning, whereas shaft and base fractures are treated with pinning or open reduction and internal fixation. Extensive soft-tissue injury or segmental bone loss are the only conditions that warrant external fixation [5]. Only in cases of severe angulation, segmental bone loss, soft tissue damage, open fractures, malrotation, and irreducible fractures surgical intervention should be considered [6].

Clinical examination is usually sufficient for identifying isolated metacarpal fractures; however, in cases of significant sagittal angular deformity, rotational deformity, or shortening, surgery may be necessary. Surgery is sometimes necessary for multiple metacarpal fractures, regardless of how little the displacement or angulation, since the surrounding ligaments reduce the bone's anatomical stability [7]. Therefore, the purpose of this research is to assess the efficacy of percutaneous Kirschner wire fixation in the treatment of unstable metacarpal fractures.

PATIENTS AND METHODS

Study design and participants: During the years 2017–2019, the Orthopedic Surgery Department at Sharm El Shikh Hospital operated on fifteen patients who had metacarpal fractures using percutaneous fixation as part of a clinical experiment.

Inclusion criteria: unstable metacarpal fractures, either open or closed, and had injuries at low or high velocities.

Exclusion criteria: Patients with pathological, non-united, or irreducible fractures.

Classifying patients: Nine patients were assigned to group 1 and had antegrade intramedullary bouquet fixation, whereas six patients were assigned to group 2 and given transverse pinning.

Approach: Each of the instances that were examined underwent the following procedures:

Name, gender, age, and employment were among the personal facts contained in the patient's history. After a thorough evaluation of the patient's medical history and any other possible injuries or conditions, the doctor examined the patient's afflicted hand in great detail, paying special attention to the wounds, sensory function, vascularity, and joint mobility. Lateral and PA X-rays were included of the radiographic examination,

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with extra views taken in case any metacarpals were suspected of having concealed fractures.

Operating room protocol: The patient was placed on a radiolucent table while they were supine for the surgery. Thirteen patients had general anesthesia and two had wrist blocks. We did not use a tourniquet. All patients were examined using intraoperative fluoroscopy. The Jahss technique was used to accomplish reduction in 10 instances, whereas axial traction was used in 5 cases. To safeguard the sensory nerves, K-wires were placed percutaneously, while imaging was underway. Clinical evaluation was used to confirm proper rotation and alignment after fixation using either single or double K-wire procedures.

Postoperative care: To alleviate swelling and discomfort, the hand was raised after surgery. Four days of first-generation cephalosporins, a kind of broad-spectrum antibiotics, and nonsteroidal anti-inflammatory drugs (NSAIDs) were given to patients to alleviate discomfort. For a duration of 7-10 days, with full extension of the interphalangeal joint, the metacarpophalangeal joint was flexed to avoid stiffness. Assuming alignment and fixation were adequate, immediate protected range of motion was permitted. Prior to the patient's release, X-rays were acquired.

After establishing that the fracture had healed by clinical examination and radiographic testing, which showed the presence of bridging callus, the Kirschner wires were removed in the outpatient clinic. Usually, a fracture would heal between four to eight weeks.

Clinicians will check the patient's pain levels, fracture stability, mobility, and for any problems as part of the follow-up plan. The radiologists took lateral and postero-anterior X-rays immediately after the procedure, then every two weeks for the first six weeks, and finally once a month until the radiographs showed radiographic union. Condition of the wire, deformities, callus development, and healing status of fractures were all evaluated during follow-up visits.

The findings were assessed at the 12th week postoperatively using the total active movements (TAM) score, which is determined by adding the flexion at the metacarpophalangeal, proximal, and distal interphalangeal joints, minus any extension deficiency. The following categories were used to classify the TAM score results: A flexion score of 220 or more was considered outstanding, a score of 200–219 was acceptable, a score of 180–199 was fair, and a score of 180 or below was bad [(8)].

Statistical analysis

IBM SPSS version 28 (Armonk, New York, USA) was used for both data management and statistical analysis. The percentages and frequencies of the categorical data were shown. For quantitative variables with normally distributed distributions, the independent t-test was used for group comparisons. When two samples were connected to differences between two populations, a paired sample t-test is used as a statistical tool. To show statistical significance, a two-tailed P value of 0.05 was used.

Ethical Approval: This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Al-Azhar University. Written informed consents were obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

RESULTS

Fifteen patients, with a mean age of 33.26 years, participated in the research. Nine patients (group 1) with an average age of 32.33 years had antegrade intramedullary bouquet fixing, whereas six patients (group 2) with an average age of 33 years underwent transverse pinning. The first group consisted of 8 men (88.88%) and 1 female (11.11%), while the second group consisted of 6 men (100%) exclusively. Group 2 consisted of 3 workers (50% of the total), 1 employee (16.66%), and 2 students (33.33% of the total), in contrast to group 1's 55.55% workforce, 22.22% of the total employees, and 22.22% of students. When looking at the two groups side by side, there was no statistically significant correlation between trauma type and treatment strategy ($p = 0.4777$). Similarly, neither the afflicted hand nor the particular metacarpal impacted by the injury were significantly associated with the treatment strategy ($p = 0.41$ and $p = 0.37$, respectively). Furthermore, the location of the fracture had no significant impact on the decision-making process for management ($p = 0.41$) (Table 1).

Table (1): Distribution of the patients investigated with respect to the kind of trauma, afflicted hand, fracture site, and fracture location

		Group 1 (n=9) (Intramedullary fixation)	Group 2 (n=6) (Transverse pinning)	Total (n=15)	U-value	P-value
Mode of trauma	Direct Trauma	2 (22.22%)	3 (50%)	5 (33.33%)	20.5	0.47
	Road traffic accident	3 (33.33%)	1 (16.66%)	4 (26.66%)		
	Fall on ground	4 (44.44%)	2 (33.33%)	6 (40%)		
Affected Hand	Right (%)	2 (22.22%)	3 (50%)	5 (33.33%)	19.5	0.412
	Left (%)	7 (77.77%)	3 (50%)	10 (66.66%)		
Metacarpal affected	First	3 (25%)	0 (0%)	3 (16.66%)	26	0.37
	Second	1 (8.33%)	1 (16.66%)	2 (11.11%)		
	Third	3 (25%)	1 (16.66%)	4 (22.22%)		
	Fourth	2 (16.66%)	2 (33.33%)	4 (22.22%)		
	Fifth	3 (25%)	2 (33.33%)	5 (27.77%)		
Fracture location	Shaft	7 (58.33%)	3 (50%)	10 (55.55%)	0.87831	0.41
	Neck	0 (0%)	1 (16.66%)	1 (5.55%)		
	Base	4 (33.33%)	2 (33.33%)	6 (33.33%)		
	CMC dislocation	1 (8.33%)	0 (0%)	1 (5.55%)		

Numbers and percentages were used to show the data, with * denoting statistical significance at a P value less than 0.05

Group 1 had a single case with ipsilateral hamate and capitate fractures, whereas group 2 included a single case with phalangeal fracture (Table 2).

Table (2): The associated ipsilateral fracture

		Group 1 (Intramedullary fixation)	Group 2 (Transverse pinning)	Total (n=15)
Associated injuries	No associated	8 (88.88%)	5 (83.33%)	13 (86.66%)
	Hamate and Capitate fractures	1 (11.11%)	0 (0%)	1 (6.66%)
	Phalangeal fracture	0 (0%)	1 (16.66%)	1 (6.66%)

Table (3) showed the number of days varied between one and ten. There was no statistically significant correlation between the two groups' management plans and the intervals before fixation (p = 0.64). Time for union was also not significantly related to management style (p = 0.44).

Table (3): Patients' distributions with respect to the intervals between fixation and union times

		Group1 (Intramedullary fixation)	Group 2 (Transverse pinning)	Total (n=15)	U-value	p- value
Time before fixation	1-5 days	6 (66.66%)	5 (83.33%)	11(73.33%)	22.5	0.64
	6-10 days	3 (33.33%)	1 (16.66%)	4 (26.66%)		
Time to Union (weeks)	Four	1 (11.11%)	1 (16.66%)	2 (13.33%)	0.15	0.44
	Six	5 (55.55%)	3 (50%)	8 (53.33%)		
	Eight	3 (33.33%)	2 (33.33%)	5 (33.33%)		

The TAM score was used to do the clinical examination. Excellent (flexion ≥220), good (flexion 200-219), fair (flexion 180-199), or bad (flexion <180) are the ways in which the TAM score categorizes the results. There was no statistically significant correlation (t p = 0.26), when comparing the two groups' TAM score evaluations of patients, between the TAM score findings and the care strategy (Table 4).

Table (4): Fracture follow-ups categorized by TAM score

		Group1 (Intramedullary fixation)	Group 2 (Transverse pinning)	Total (n=15)	t- value	P- value
TAM Score result	Excellent (Flexion ≥ 220)	7 (77.77%)	4 (66.66%)	11(73.33%)	-0.67	0.26
	Good (Flexion = 200-219)	1 (11.11%)	1 (16.66%)	2 (13.33%)		
	Fair (Flexion=180-199)	1 (11.11%)	0 (0%)	1 (6.66%)		
	Poor (Flexion <180)	0 (0%)	1 (16.66%)	1 (6.66%)		

There was no statistically significant correlation (p=0.39) between the two groups' follow-up periods and their treatment plans (Table 5).

Table (5): Cases that were followed up on

		Group1 (Intramedullary fixation)	Group 2 (Transverse pinning)	Total (n=15)	t- value	p- value
Follow up period (months)	2 months	1 (11.11%)	1 (16.66%)	2 (13.33%)	0.29	0.39
	3 months	8 (88.88%)	5 (83.33%)	13 (86.66%)		

A p-value of 0.35 indicated that there was no statistically significant relationship between post-operative problems and the treatment strategy when comparing the two groups as shown in table (6).

Table (6): Complications among studied patients

Post-operative Complications	Group1 (Intramedullary fixation)		Group 2 (Transverse pinning)		Total (n=15)	t- value	p- value
Superficial Infection	1	(11.11%)	1	(16.66%)	2 (13.33%)	-0.45	0.35
K wires loosening	1	(11.11%)	0	(0%)	1 (6.66%)		
Finger stiffness	0	(0%)	1	(16.66%)	1 (6.66%)		
Deformity	0	(0%)	0	(0%)	0 (0%)		
Non-union	0	(0%)	0	(0%)	0 (0%)		
Mal-union	0	(0%)	0	(0%)	0 (0%)		

DISCUSSION

The surgical treatment of fifteen instances with metacarpal fractures was the focus of this clinical investigation. Data from a wide range of sources were analyzed, including patient age, gender distribution, afflicted hand, trauma cause, fracture site, reduction and fixation method, and sequelae [8].

The median age of the subjects was 33.26 years, and their ages varied from 11 to 58. The median age was 24 years in one research and 33 years in another [9, 10].

In this research, 14 out of 20 participants were male (93.33%), which is higher than the male participation rates in the studies conducted by **Fusseti *et al.*** [9] (9%) and **Kelesh** and **Ulrich** [10], which were 92% and 92% respectively. Similar to the research conducted by **Fusseti *et al.*** [9] (9 instances), this study also found that left-handed people were more common than right-handed people, with 66.66% of the cases falling into the former category.

The majority of traumatic incidents involve a fall into an extended hand. Immediately after direct trauma, 6 instances (or 40%) The most prevalent method of injury was a fall on an extended hand in 5 instances (33.33%), which is lower than the 45% found in the research by **Kelesh and Ulrich** [10]. Ten instances (55.55%) had a fractured metacarpal shaft, lower than the sixty percent reported by **Gupta *et al.*** [11].

When compared to other studies on surgical treatment for metacarpal fractures, our results showed a similar functional outcome. Nine patients in group 1 had antegrade intramedullary bouquet fixing and six patients in group 2 had transverse pinning as part of the percutaneous K-wires fixation procedure for unstable metacarpal fractures. No statistically significant difference was found when comparing the two groups' patient evaluations using the TAM score. 18 patients who had antegrade bouquet pinning had a noticeably greater range of motion (ROM) in the 5th finger and 5th MCP joint compared to 18 patients who had transverse pinning three months following the procedure, according to the research by **Winter *et al.*** [12] and **Wong *et al.*** [13] who conducted a prospective, non-randomized trial in which 29 patients had transverse pinning and 30 patients underwent intramedullary pinning. The TAM score did not change much.

Research by **Fusseti C *et al.*** [9] demonstrates to avoid problems that can arise from open reduction and internal fixation, percutaneous transverse K-wire fixation or intramedullary K-wires are the main choices for treating metacarpal fractures. These potential issues include infection, post-operative stiffness from extensive soft tissue dissection, fibrosis, extensor tendon adhesion, plate loosening or fracture, and so on. Our research showed that both of these approaches, which were shown to be statistically equivalent, provided outstanding functional and radiological results. Quick and easy, these treatments don't need much tissue manipulation, so there's less chance of damaging the periosteal blood supply, which is why we think they're better. The bones are able to fuse more effectively because of this.

For this research, group 1 had one case of superficial pin tract infection (11.11% of the total) and one case of k wire loosening (11.11% of the total), while group 2 had one case of superficial pin tract infection (16.66%) and

one case of finger stiffness (16.66%) as post-operative complications, with no statistically significant difference between the two groups. Two significant issues emerge in the investigation conducted by **Botte *et al.*** [14] about percutaneous transverse K-wire fixation. The first is the possibility of sagittal band extensor mechanism tethering, which would include soft tissues. Pin tract infections are another potential issue. Intramural K-wires were shown to migrate and cause distal perforation of the metacarpal head as the primary problem in the research by **Foucher** [15].

CONCLUSION

There are no major variations in clinical or radiological outcomes between intramedullary and transverse pinning approaches when it comes to percutaneous fixation with Kirschner wires for unstable metacarpal fractures. Both methods provided equivalent results.

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- **Conflict of Interest:** Nil.

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