

A Comparison between Open Versus Closed Reduction in the Treatment of Fractures of the Base of the First Metacarpal Bone

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ABSTRACT

Background: Fracture of the thumb occurs most frequently. Thumb damage is expected to occur in 4% of hands fractures, while thumb impairment as a whole reduces 22% of body function. 20% of all fractures of the first metacarpal are caused by the Rolando fracture. Treatment of these fractures is still controversial. There are numerous different surgical therapy options.

Objective: To find an effective method for treating bone fractures in the first metacarpal base.

Patients and Techniques: This study included 40 patients presented with a fracture at the base of the first metacarpal bone at Plastic Surgery Department, Mansoura University and Al-Azhar Hospital. Patients were divided into closed-loop reduction fixed with K-wire (group A), open reduction and internal fixation with plate and screw (group B).

Results: Bennet fracture was the most frequent type. First week postoperative follow-up there were statistically significant higher rate of edema, pain, and movement limitation in the open group (group B). Range of movement in open group (group B) was significantly lower than closed group (group A).

Conclusion: K-wire Fixation is a beneficial treatment option for a comminuted fracture of the first metacarpal base. The optimum approach would be to combine closed anatomic reduction with effective K-wire fixation of the fracture fragments with early mobilization to prevent joint stiffness.

Key Words: First Metacarpal Bone – Bennett and Rolando's Fracture – K-Wire – Screw.

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Ethical Considerations: Our study was performed in accordance to Helsinki Declaration, after approval of The Local Ethical Committee of Faculty of Medicine, Mansoura University.

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INTRODUCTION

Fractures of the thumb, account for around 40% of impairment of hand function [1]. Thumb impairment causes a 22% reduction in body function, and thumb damage is considered to be responsible for 4% of hand fractures [2].

Many complications are associated with thumb metacarpal fracture. The initial metacarpal fracture can be divided into intra and extra articular components. Treatment for extra articular fractures and thumb dislocations frequently involves non-surgical methods. On the other hand, surgery is typically required to treat an intra-articular fracture [3].

Rolando and Bennett's fractures are the two types of intraarticular fractures. The distinction between Rolando and Bennet fractures, as well as the identification of comminuted fracture patterns, cannot be made only on the basis of clinical examination. Therefore, radiographic imaging is required for a thorough assessment of these injuries [4].

The inherent instability of Rolando fractures makes their treatment considerably more difficult than treating Bennett fracture types. The number of fragments and degree of displacement are the major factors that determine which treatment procedure is best [5].

There are numerous different surgical therapy options including closed reduction and k-wire to internal fixation and open reduction. However, there is no agreement on the best course of action more frequently adopted [6].

Every therapeutic approach has advantages and disadvantages. After the base of the first metacarpal was broken, it was vital to keep the thumb's full range of motion and avoid arthrodesis. The aim of our study is to evaluate a suitable a technique for

first metacarpal base fracture reduction bone, to compare between open and closed reduction, and to assess the rate of complication.

PATIENTS AND METHODS

This study included 40 patients presenting with a fracture at the base of the first metacarpal bone at Plastic Surgery Department, Mansoura University and Al-Azhar Hospital during the period from October 2021 to October 2022.

Patients with previous history of hand surgery, thumb trauma, and patient with infection were excluded from this study.

Patients were divided into:

- Group (A) included 20 patients who were managed with closed reduction fixation with K-wire.
- Group (B) included 20 patients who were managed by open reduction and internal fixation with plate and screw.

I- Preoperative assessment:

Every patient provides a thorough history that includes the clinical variable, age, gender, and occupation (which is broken down into heavy, manual, and office work). Complete general examination on chest, abdomen, head and neck, lower limb, upper limb and also a local examination to hematoma, infection, skin loss, range of motion and plain X-ray to the fracture (frontal oblique and lateral view) were performed to all patients.

The management plan was done according to the evidence base of each patient either small fragment was done in group (A), or severe unstable fracture was done in group (B).

II- Surgical management procedures:

All procedures were done under general anesthesia or supraclavicular block in supine position.

In group A: Patients were managed using closed reduction and fixation with 2 k-wire. Closed reduction was done in the anatomic position by good traction of the fracture, then the original K-wire inserted to fix it is fractured fragment in carpal bone, then second K-wire was put in place from the first metacarpal to the second metacarpal bone for good fixation. Thumb spica was placed in position of the thumb in abduction and extension (Fig. 1).

In group B: Patients were managed using internal fixation by a small plate with open reduction microplate and screw. Incision was done at the a side view of the first metacarpal to detect the fracture fragments then good reduction was done in the anatomical position of the carpo-metacarpal joint, then fixation of the fracture fragments was done by mini plate of 4 to 5 holes and screws, then sutured of the wound by mattress sutures, then thumb spica was placed in abduction and extension position of the thumb (Fig. 2).

Statistical analysis:

Data were analyzed using Statistical Package for Social Sciences (SPSS) software (version 23). The chi-square test and Student *t*-test were used. Quantitative measures provided as means \pm standard deviation (SD). As specified, regression analysis and correlation between various variables were carried out. The *p*-value ≤ 0.05 was considered statistically significant.



Fig. (1): Kirschner wire Fixation in Closed group: External attachment and closed reduction with 2 k-wire



Fig. (2): Internal fixation with a small plate and screws with open reduction group.

RESULTS

In the current study, the most frequent cause of fracture in group (group A) was fall to ground (FTG), while in (group B) it was blunt trauma. Bennet fracture was the most frequent type of fracture 75% and 70% in group A and B respectively. Edema was the most frequent association in both groups with higher rate of dislocation and hematoma in Group B (Table 1).

We compared the demographic data of the studied groups according to age, sex and occupation. According to the age, average age in (group A) was 33.48. While the patients' average age in (group B) was 32.61. According to sex, male to female ratios in both groups was 2:1. According to occupation, manual workers were the most common type of occupation in (group A) (Table 1).

Table (1): Comparison of demographic data between studied groups.

	Closed		Open		p-value
	Mean	SD	Mean	SD	
Age (years)	33.48	9.5	32.61	9.7	0.34
	N	%	N	%	
Sex:					
Male	13	65	15	75	0.62
Female	7	35	5	25	
Occupation:					
Housewife	4	20	4	20	0.75
Manual	8	40	7	35	
Heavy worker	6	30	7	35	
Office worker	2	10	2	10	

Operative time was statistically significant higher in open group (group B). It was 73.1±8.9 min than in closed group (group A) and 32.8±5.7min (p=0.001) (Fig. 3).

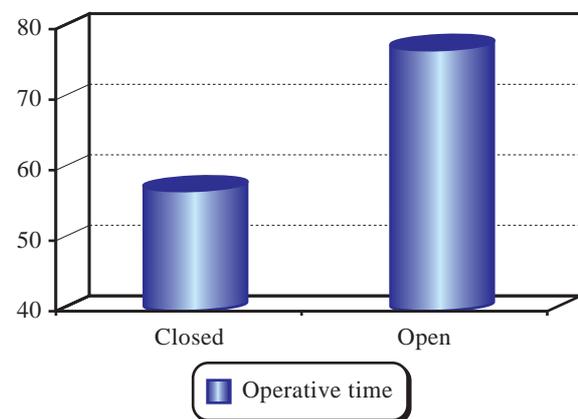


Fig. (3): Comparison of operative time between studied groups.

We compared the fracture properties between the studied groups according to the cause of the fracture and associations (edema, dislocation and hematoma). According to cause of the fracture, fall to ground was the most frequent reason for (group A) while blunt trauma was the most shared cause in open group (group B). According to type of the fracture, Bennett Fractures are the most prevalent kind of fractures in both groups. According to associations; edema, hematoma and dislocation were common in open group (group B) than closed group (group A) (Table 2).

Table (2): Comparison of Fracture properties between studied groups.

	Closed		Open		p-value
	N	%	N	%	
Cause of fracture:					
Blunt trauma	9	45	11	55	0.5
F.T.G	11	55	9	45	
Type:					
Rolando fracture	5	25	6	30	0.62
Bennet fracture	15	75	14	70	
Association:					
Edema	16	80	13	65	0.32
Dislocation	3	15	9	45	
Hematoma	2	10	5	5	

We compared the postoperative data between studied groups in the first week, first month and third month. In the first week; edema, pain and limitation of movement were common in open group (group B) than closed group (group A). In the first month; no discernible difference in movement involving the two teams. In the third month; full range of movement was good in closed group (group A) than open group (group B) (Table 3).

Table (3): Comparison of Postoperative data between studied groups.

	Closed		Open		p-value
	N	%	N	%	
<i>1st week:</i>					
Edema	4	20	6	30	0.04*
Pain	2	10	4	20	
Infection	2	10	3	15	
Limitation of movement	3	15	4	20	
<i>1st month:</i>					
Edema	10	50	11	55	0.9
Limitation of movement	10	50	10	50	
<i>3rd months:</i>					
Fair movement	9	45	14	70	0.043*
Good movement	4	20	2	10	
Full range of movement	7	35	4	20	

DISCUSSION

A Bennett fracture occurs on the ulnar side of the metacarpal base, whereas a Rolando fracture occurs at the base of the first metacarpal and is comminuted, multifragmented with fracture lines in a Y- or T-shaped pattern. The most common mechanism of damage is an axial stress to a partially extended metacarpal as a result of a fall or a punch [4].

The current study included 40 patients with base of 1st metacarpal fracture recruited and treated with two different modalities. Open reduction Using a small plate and internal fixation (ORIF) or micro-plate screw (group B) and closed reduction and external fixation (CREF) with K-wire (group A).

Overall closed reduction and external fixation (CREF) showed lower operative time, less post-operative complications, and excellent, earlier regaining of full range of movement. Sex distribution was 65% was male (group A) and 75% in (group B). Most frequent occupation was manual and heavy worker 40, 30% and 35, 35% in closed (group A) and open group (group B) respectively.

In study of Abdellah et al. [6] revealed about 60% of patients was injured with blunt trauma.

Salunkhe et al. [7] reported that the most of patients involved were in industrial trauma and road traffic accident.

In this study most frequent cause of fracture in closed fixation group (group A) was fall to ground (F.T.G.), while in open fixation (group B) was blunt trauma, and in both groups bennet fracture was most frequent type of fracture 75% and 70% in closed and open groups respectively. Edema was most frequent association in both groups with higher frequent rate of hematoma in open fixation group (group B).

All participants were undergoing fixation in the same day of trauma. Operative time was statistically significant higher in (group B) 73.1min and 32.8min in (group A).

Rolando fracture is responsible for about 20% of all fractures of the first metacarpal bone [4]. This agreed with the study of Zhang et al. [8] who reported that the mean intra operative time of closed reduction and external fixation (CREF) was 43.85 minutes.

Also, Abdellah et al. [6] found the mean operative time for closed reduction and external fixation (CREF) was 40.1±2min. Greeven et al. [9] found the average operation time was 27min. while Salunkhe et al. [7] revealed that the typical duration of operation was 45 min.

Abdellah et al. [6] showed that, 10% of cases had post-operative pain which continued whole period of follow-up, no secondary arthrosis, 10% had superficial pin tract infection and no valgus deformity.

In our study post-operative complications at 1st week postoperative follow-up were statistically significant, a higher rate of edema, pain, and infection in open group (group B). Also, range of motion of the thumb in open group (group B) performed worse than the closed group (group A).

In a study of by Greeven et al. [10] the reported complications following K-wire fixation were superficial infection, which could be managed conservatively, but issues following open reduction and internal fixation (ORIF) were more commonly related to functional impairment and more frequently required reoperation (17%).

Our results were supported by Diaz-Garcia and Waljee [11] who found that the average pain score

on the visual analogue scale was 1.5 (0.9) in closed reduction and external fixation (CREF) group (group A).

Zhang et al. [8] reported that age was a significant prognostic factor; patients were more likely to experience postoperative partial discomfort, reduced muscular strength, and joint degradation in advanced disease stages.

In our study External fixation and closed reduction (CREF) showed excellent and earlier regaining of movement than category known as open reduction and internal fixation (ORIF). Most of cases in open reduction and internal fixation (ORIF) group had poor movement after 3 months of follow-up.

Regarding to Greeven et al. [10] review both techniques had the magnitude of the functional impairment following open reduction and internal fixation, and favorable functional results (ORIF) requiring reoperation suggests ORIF, which stands for Open Reduction and Internal Fixation, favorable technique.

Lutz et al. [12] evaluated the installation of Kirschner wires close to the fracture line, which causes bone loss reduction, caused a significant incidence of adduction deformity of the first metacarpal bone with the percutaneous pinning approach, according to the study.

Early mobilization is a potential factor in favor of mini or micro plate fixation and screw since it should reduce edema and muscle weakness and hasten the recovery of hand function [13].

When combined with the lack of surgical dissection necessary for implant insertion, biomechanically imperfect designs may be enough for repairing these fractures and even lead to a postoperative gain in range of motion (ROM) [14].

Abdellah et al. [6] showed that there was a significant improvement of range of motion after closed reduction and external fixation (CREF). And there is significant difference between the normal and operated side as regard range of motion.

K-wire construction appears to be an effective treatment for a comminuted fracture of the base of the first metacarpal. Early mobilization to lessen joint stiffness, closed anatomic reduction, and stable fixation of the fracture fragments are all necessary components of the optimum treatment plan [15].

The majority of metacarpal fractures can first be treated with closed reduction in an effort to achieve anatomic reduction, while only irreducible fractures require open reduction and internal fixation in order to achieve anatomic reduction [16].

Not all metacarpal fracture dislocations respond well to closed approach for anatomic reduction. When the capsule and dorsal ligament complex have been severely wounded, closed reduction cannot achieve the anatomic reduction [17].

For irreducible fractures, internal fixation and open reduction should be used to obtain an anatomic reduction [17]. However, ORIF has a number of disadvantages including a high cost, a risk of implant infection, and exposure to radiation [16].

Conclusion:

A good treatment option for a comminuted fracture of the base of the first metacarpal is K-wire Fixation. It would be preferable to combine closed anatomic reduction with reliable K-wire fixation of the fracture parts before starting early mobilization to prevent joint stiffness.

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