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Fifth Metacarpal Neck Fractures Management by Antegrade Single Intramedullary Kirschner Wire

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Fractures of the metacarpals are very common fractures of the skeletal system and in approximately 50% of the cases comprise the neck of the fifth metacarpal bone. K wiring is a reliable method of fixation for these fractures.To study the results of fixation for boxer's fractures by single antegrade K wire as regard to outcome and complications with sparing fifth metacarpophalangeal joint and avoid osteoarthritis of the joint.This was a prospective cohort study where eighteen (18) cases with fracture of fifth metacarpal neck. They were treated by using blunt tipped pre bent single K wire with suitable diameter, in an antegrade manner through small 0.5 mm incision at dorso ulnar aspect at base of fifth metacarpal.At final follow up (mean follow up was 4 month), all fractures proceeded to bony union, the mean DASH score was 6.25±7.27, the mean value of grip strength in comparison to the other unaffected hand was 91.44±5.9%, the mean total active motion (TAM) score was 269.44±15.3°, the mean residual angulation at neck shaft angle of fifth metacarpal bone was 2.83±3.01°, the mean VAS score was 1±0.76 points, 2 cases with superficial pin track infection and 1 case with hypoesthesia of dorsum of little finger.Antegrade fixation of boxer fractures with pre bent single intramedullary K wire is a minimally invasive procedure that correct the palmar deformity, and provide satisfactory clinical and radiographic outcomes.

Keywords: Fifth Metacarpal Fracture, single intramedullary wire, surgery.

INTRODUCTION

Fractures of the metacarpals are very common fractures of the skeletal system and in approximately 50% of the cases comprise the neck of the fifth metacarpal bone. These fractures are commonly observed in active young men and usually occur in the dominant hand. These are typical injuries of aggression (Boxer's fracture) (Yammine and Harvey,2014).These fractures result from a longitudinal compression force acting on a flexed metacarpophalangeal joint (MP), regularly when a clenched fist strikes a hard object, the ensuing fracture is usually unstable with volar angulation due to comminution of the volar cortex and the action of the interosseus muscles (Duncan et al. 1993).Till the early part of the twenty century, these fractures were treated non operatively. The majority of metacarpal fractures are treated conservatively **(**Foucher, 1995). Those fractures that are non-displaced or slightly displaced are intrinsically stable and need only nonsurgical treatment, other fractures can be reduced in a closed way and held in a cast or splint. However more displaced fractures with rotational deformity regularly need operative intervention to diminish the volar flexion, rotation and shortening of the distal fragment (Cha et al. 2018). Fixation techniques include the use of K-wires, intramedullary nails, cerclage wires, mini plate and screws, lag screws, tension band wires,

and or external fixators (Sletten et al.,2015). Intramedullary nailing fixation is a common way of fixation for the metacarpal fractures. The intramedullary "bouquet" osteosynthesis for fractures of the metacarpal neck was first described by Foucher in 1976 and has since then grew fame in Europe (Başar et al. 2015). In 2006, Orbay and Touhami developed an intramedullary fixation method that improves rotational and longitudinal stability by locking proximal end of the metacarpal. However, for intramedullary K-wires, the chief complications are migration of the K-wires, perforation of the head of the metacarpal, and possibility of injury the sensory dorsal branch of the ulnar nerve (Curtis et al. 2015). Literature has numerous studies on boxer fracture management. However no specific method of management is recommended (Sadiq et al.2019). Hence, this study was planned to evaluate a simple and safe method to add evidence to the literature aiming to improve outcome of boxer fracture. In this study, it was aimed to assess the clinical outcome of using single antegrade K-wire for fixation of fifth metacarpal neck fractures.

MATERIALS AND METHODS

A cohort study was done on eighteen patients with fracture of 5th metacarpal neck. They were treated by antegrade single K-wire and followed up at Zigzag University Hospital, in the period between March 2019 and January 2020. The sample size was taken as a comprehensive sample due to rare attendance of patients with fifth metacarpal neck fractures. The research project was approved by ZU-IRB ethical committee with letter number #5408/24-7-2019.

Inclusion Criteria:

Patients with traumatic fractures of fifth metacarpal neck of both sexes, their age between 18-50 years old who surgically fit. Patients with unstable fractures with metacarpal shortening > 3mm or angulation > 30 degree.

Exclusion Criteria:

Patients with multiple metacarpal fractures or pathological fractures. Patients not indicated for surgery as in cases of stable fractures with metacarpal shortening < 3mm or angulation < 30^{o} degree.

The routine laboratory investigations were performed to assess the fitness of the patient for surgical interference as complete blood picture, blood grouping, blood sugar, bleeding profile, ECG, renal and liver function tests.

Surgical technique:

A blunt tip 1.5 mm K-wire was bent to about 15 degree at approximately five millimetres at its distal end. A small incision was taken on the dorso-ulnar surface of the fifth metacarpal base to avoid the injury of the dorsal sensory branch of the ulnar nerve. Under direct visualization with image intensifier the base of the fifth metacarpal bone was perforated with 2 mm drill bit or wire. Drill was first done perpendicular to the bone surface, so that the drill does not accidentally slip off the bone. While drilling, a great caution was taken not to cause any injury to sensory branch of the ulnar nerve or the extensor tendon. Then drill was tilted by approximately 60 degree to enter the intramedullary canal of the metacarpal. A great caution was taken not to drill through the opposite cortex then the drill hole was enlarged with 2.7 drill in the oblique direction. K-wire was introduced ante grade in the proximal fragment using T handle with or without a hammer. At the fracture site, the reduction was checked using image intensifier before advancing wire to the distal fragment, any rotation of fracture was carefully checked with passive flexion and extension motion of the finger. The K-wire was then inserted in the distal fragment, impacted in the head then rotated 180 degrees to keep the bent distal portion of the wire directed dorsally to maintain reduction and correct volar angulation. Final check of the fracture reduction and position of wire bend in anteroposterior and lateral views was done. The penetrated proximal part wire was bent and cut and left outside the skin for easy removal of the wire(Figure 1).

Post-operative measures and removal of wire:

The reduced metacarpal bones were kept in a posterior short arm splint in the functioning position of the hand that was removed three weeks after surgery, after that patients were permitted to perform day- to – day activities as tolerated.

The wire was removed after complete radiological union that was confirmed by visible callus bridging and the fracture continuity of bone trabeculae across fracture site.

Follow up:

The patients visited the outpatient clinic at two weeks, four weeks two months and three months after fixation. A follow up protocol with clinical evaluation for the intensity of the pain, stability of the fractures and the range of motion as well, to early identify and manage any complications.

Routine plain radiographs were taken immediately post- operative, at 2 weeks, 4 weeks,2 months and 3 months after the operation (Figure 2, 3) and were evaluated for deformity occurrence and to evaluate the soundness of the callus formation and the progression of the fracture union.

Figure 1: intra operative images , (A): Awl insertion and opening cortex, (B):K wire insertion at proximal fragment,(C): K wire inserted to distal fragment after fracture reeducation,(D): K wire is bent and cut and left outside skin.

Figure 2: follow up radiograph series for case no 1 , (A):intra operative x ray (B),(C): 2 weeks follow up x ray ,(D): 3 months follow up x ray .

Figure 3: follow up radiograph series for case no 2 , (A):intra operative x ray (B),(C): 2 weeks follow up x ray ,(D): 3 months follow up x ray .

Evaluation of the results:

The intensity of pain was assessed by VAS score and the hand function was assessed two months post operatively and when the patient finished physiotherapy by using grip strength (GS), range of motion (ROM), Quick DASH score and Total Active Motion (TAM)score that is

categorized according to Duncan et al (7)(Table 1).

Table 1: TAM scoring according to Duncan RW et al [7]

TAM/ degree Finger	TAM/degree Thumb	Result
220to260	119to140	Excellent
180to219	98to118	Good
130to179	70to97	Fair
<130	<70	Poor

All patients were followed up for a minimum period of twelve weeks- the maximum period of follow up was twenty-four weeks with a mean period of Sixteen weeks.

Statistical analysis:

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into SPSS version 20.0 software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD , the following tests were used to test differences for significance;. difference and association of qualitative variable by Chi square test (X^2) . Differences between quantitative independent groups by t test or Mann Whitney. P value was set at <0.05 for significant results &<0.001 for high significant result.

RESULTS

Eighteen patients were included in this study. Age of the patients ranged from 19 to 45 years with mean age of 29.55 years. All patients were males with 3 patients with dominant left-handed fracture side (16.7%) and 15 patients with right-handed fracture side (83.3%). Nine patients were manual workers (50%), 5 patients were not manual workers (27.8%) and 4 patients were students (22.2%).Fourteen patients turned up for follow up till 3 months, two patients for 2 months and two for 4 weeks. The mean time lag before management was 4.38±3.98 days, the mean operation time was 21.61±3.89 minutes while mean time before removal of wire was 39.61±3.93 days and mean time for radiological union was 39.33±4.14 days. At final follow up, the mean DASH score was 6.25±7.27 and the mean value of grip strength in comparison to the other unaffected hand was 91.44±5.9%. the mean of TAM score was 269.44±15.3 degrees with range of (217-290), 17 cases were with excellent results (94.4%) and 1 case was with good results (5.6 %) according to Duncan scoring of TAM score (7), the mean residual angulation at neck shaft angle of fifth metacarpal was 2.83°±3.01° degrees (Table 2). The mean of VAS score at final follow up was 1.0±0.76 points. Regarding complications 3 cases were complicated (16.7%), these complications arose at early follow up 2 weeks after operation (2 cases with superficial pin track infection subsided with antibiotics and 1 case with hyposethia on dorsum of little finger subsided 5 weeks later) DASH score and VAS score were higher among complicated Grip and TAM score were lower among complicated (Table 3).

Table 2: Grip, DASH score, TAM score and VAS score distribution among studied group at final follow up.

	Grip/%	DASH	TAM/degrees	VAS
Mean± SD	91.44±5.9	6.25±7.27	269.44±15.3	1.0±0.76
Median (Range)	93.0 (77-98)	2.5 (0-22)	272.0 (217-290)	0.0 (0-3)

Table 3: Relation of complication with other parameters (15 cases were non complicated and 3 cases were complicated).

			Not complicated	Complicated	t/ MannWhitney/X^2	P
Grip score			92.06±5.16	88.33±9.86	0.991	0.336
DASH score			4.43±6.18	15.33±5.77	-2.809	0.013*
TAM score			273.46±8.27	249.33±28.0	3.037	0.008*
VAS			0.33±0.15	2.0±0.71	-6.110	0.00**
TAM	**Excellent**	**N (%)**	15(100%)	2(66.7%)		
	Good	**N(%)**	0(0%)	1(33.3%)	5.29	0.02*
Total		**N**	15	3		
		%	100.0%	100.0%		

DISCUSSION

Boxers fractures (fracture of fifth metacarpal neck) are common injures seen in orthopaedics that occur mainly due to fist or punch and mainly occur in young men and management of these fractures could be done by many ways (Sola et al. 2016). It is widely known that the majority of fifth metacarpal neck fractures can be treated conservatively. However, there is no consensus about the degree of palmar angulation that is acceptable (Giddins,2015).

According to Ali et al.(1999) who reported that Acute angulations of less than thirty degrees were comparable with nearly normal mechanics, whereas any more displacement decreased the functional length of the muscle group.In a similar cadaveric study, Birndorf et al. (1997) who identified a decline in the ability of the flexor system when fracture displacement exceeded thirty degrees. Both suggested that thirty degrees is the upper limit of acceptable palmar angulation of such fractures. The mean operation time was 21.61±3.89 minutes with range (16-30) that was comparable with 24 minutes in the study by Sadiq et al. (2019) and 19.5 minutes (15-40) in the study by She and Xu (2017).

All cases were followed up for three months and K wire was removed after five weeks which is comparable with other studies as She and Xu (2017) where wire was removed after about five weeks and Sadiq et al.(2019) where fracture healing time mean was six weeks. Clinically, at final follow up in index study, mean total active motion (TAM) score was 269.44±15.3 degree with range of (217-290) with 17 cases (94.4%) with excellent results and 1 case (5.6%) with good results. These results were comparable with She and Xu (2017) with mean TAM score of 270±22(190-315) and Boussakri et al.(2014) with mean TAM score 270±21(190-310) and superior to Tank PM (14) with mean score of 263 and less than in Sadiq et al. (2019) with mean score of 277 and this may be explained that all patients included in their study were with hand dominant fracture side. Regarding grip strength analysis, Kim et al.(2015) found in their antegrade group at final follow up that the mean of grip strength in comparison to other unaffected hand was 93%(78-104). And the mean grip strength was 94±3.6%(88-100) in study of Cha et al.(2018) in their acute group and these results was comparable with our study with mean grip strength of 91.44±5.9% and range(77%-98%).

In this study mean DASH score was 6.25 ± 7.27 (0-22) and this is comparable with the study by Cha et al (2018) that found mean DASH of 4.7 ± 4 (0-14) and inferior to Kim et al (2015) [3 (0-12.5)] , Tank et al (2018) 2.7), Sadiq et al. (2019) (2.42) and She and Xu (2017) (2.1 ± 3.6). This may be contributed to the nature of the DASH score which is a subjective scale.

In the present study mean result was 1 ± 0.76 (0-3) which is comparable with other studies as Kim et al (2015) in Antegrade group 1 (0-2) and Cha et al (2018) in Acute group 0.2 ± 0.5 (0-1). Radiologically, the mean residual angle post-operatively was 2.38 ± 3.01 (0-12) degree in the index study. Sadiq M M et al (11) reported that the mean improvement of angle between pre and post x-ray was 32.82º while the correction angle in the study by She and Xu (2017) was 42º (40-45) with pre-operative angulation mean 50.2 ± 6.3 (47.3-68.5) and post-operative mean 7.4 ± 2.3 (6.5-10.2). On the other hand, Tank et al. (2018) who found that the pre-operative mean of angulation was 54.2º and post-operatively 9.4º

Post-operative complication in the present study were minor superficial pin track infection in 2 cases that improved on topical antibiotics and 1 case with hypoesthesia on dorsum of the little finger indicating affection of dorsal cutaneous branch of ulnar nerve that improved 2 months later after surgery, Boussakri et al.(2014) who reported only 1 case with reflex sympathetic dystrophy while She and Xu (2017) who reported 2 cases with skin irritation and 1 case of hypoesthesia on dorsum of the little finger.

Study limitations

larger sample size could give more significant relationships from the data also longer period of follow up could give more important results.

CONCLUSION

The authors recommend retrograde single intramedullary k wiring in all metacarpal neck fracture (boxers' fractures), especially when there is severe swelling of the hand, and with palmar angulation more than thirty degrees to get good functional results and low morbidity.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

All author contributed in all parts of the paper.

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