Original Research Article

Multiple Intramedullary Nailing Versus Low Profile Mini-Plating in Unstable Metacarpal Neck Fractures

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Abstract

Background: Neck fractures of the metacarpal bone can alter optimal hand function. Many surgical fixation techniques ~~were~~are described for this fracture with no robust evidence for the best treatment. Recently developed low profile plates may, however, challenge the preference for K-wires. Low profile plates were found to have lower complications than conventional plates in addition to early range of motion and early return to work. The aim of the present study was to determine the best outcome in patients with unstable fracture neck metacarpals using either multiple K wires or low profile mini-plating.

Methods: This prospective randomized controlled study ~~was~~ included 37 patients suffering from metacarpal neck fractures. patients were designated as group 1 (AIN group; 18 patients), and the other consecutive patients were designated as group 2 (LPP group; 19 patients). Both groups were treated within the first 48 hours of their injury and followed up for a minimum period of 40 weeks; the maximum period of follow up was 48 weeks.

Results: No significant differences were found for PVAS, Q-DASH, TAM, time to radiological union or residual deformities at last follow-up. Grip strength, however, was significantly better in the K-wire group. Operative time and time off work were significantly shorter in the k-wire group. Plate group showed prevalent complications both peri and post-operative hitting 63.2 % of the plate group vs 16.7% in K-wire group.

Conclusions: Low profile plates with immediate mobilization paradoxically prolonged operative time, technical demand and disturbing the fracture's biological environment along with the extra cost were thus not justified by results. Antegrade intramedullary K-wire nailing was superior for the management of unstable metacarpal neck fractures.

Keywords: Multiple Intramedullary Nailing, Low Profile Mini-Plating, Metacarpal Neck Fractures

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Introduction

Metacarpal fractures account for 13.6 per 100,000 person-years and >30% of all hand injuries. Males in the second and third decades of life sustain this injury most commonly in adults [1]. In most cases, favorable clinical outcomes can be obtained with conservative treatment.

However, treatment of markedly displaced, irreducible and rotational fractures can be challenging for surgeons and can lead to impaired function and restricted range of motion (ROM). Surgery is increasingly used to treat unstable metacarpal fractures, being especially indicated when there is shortening of the metacarpus by more than 3 mm or when severe apex dorsal angulation is present [2].

Intramedullary fixation has been a classical procedure for treating metacarpal and phalangeal fractures; various techniques and types of instrumentation have been proposed to improve postoperative functional recovery and ROM. These include various forms of Kirschner-wire (K-wire) pinning (antegrade intramedullary K-wire, retrograde intramedullary K-wire, transverse pinning with K-wire, retrograde cross pinning with K-wire) [3, 4], extramedullary fixation with plates and screws [5] and external fixation [6].

Anterograde intramedullary nail (AIN) fixation, the conventional treatment for metacarpal fractures, has been reported to have many advantages, including minimal soft tissue dissection, smaller skin incision and potentially less tendon irritation. However, these advantages may be outweighed by inferior stability and a greater incidence of complications. In recent years, fixation with low profile plate and screws (LPP) has been used to treat unstable metacarpal and has yielded favorable clinical outcomes in terms of shorter time to achieve union and return to normal daily life [7, 8] However, most reports describing these two techniques are non-comparative descriptive studies or case reports and thus provide insufficient evidence to identify the optimal type of fixation for this injury. The present prospective study was

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conducted to compare the outcomes of LPP and AIM in the treatment of unstable metacarpal neck fractures.

The aim of this study is to determine the best outcome in patients with unstable fracture neck metacarpals using either multiple K wires or low profile mini-plating.

Patients and Methods

This prospective randomized controlled study was included 37 patients suffering from metacarpal neck fractures who were admitted to Tanta University Emergency Hospital between late January 2020 and early March 2020. After approval from Ethical Committee and obtaining surgery related informed written consent, the patients were designated as group 1 (AIN group; 18 patients), and the other consecutive patients were designated as group 2 (LPP group; 19 patients).

Initially a metacarpal neck fracture was considered unstable and require operative treatment if it was irreducible, unacceptably angulated, shortening more than 3 mm or rotated [9]. An apex angulation > 60° (5th), 40° (4th), and 10° (2nd and 3rd metacarpal bone) on initial presentation before manual reduction on a lateral view three-dimensional computed tomography (3D-CT) scan was considered unstable [9].

Both groups were treated within the first 48 hours of their injury and followed up in Tanta university hospitals and outpatient clinics in the period between January 2020 and December 2020. All patients were followed up for a minimum period of 40 weeks; the maximum period of follow up was 48 weeks.

1) Inclusion criteria:

a. **Patient related criteria**

   1. Patients above the age of 18 years old.
   2. Patients fit for surgery.

b. **Fracture related criteria**

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1. Type of fracture: unstable metacarpal neck fractures
2. Time of trauma: less than 14 days.
3. Isolated fracture with no other upper limb fracture.

2) Exclusion criteria

a. **Patient related criteria**

- Patients under 18 years old.
- Patients unfit for surgery.

b. **Fracture related criteria**

1. Time of trauma: more than 14 days.
2. Fracture with other skeletal injuries in the upper limb.
3. Previous hand deformity
4. Pathological fractures other than osteoporosis.

Patients of both groups were subjected to complete medical history including a history of the trauma in the form of the mechanism of injury, the time passed since the trauma, medical history and previous regional surgeries. As well as clinical examination including inspection of the skin and soft tissue, palpation, neurovascular examination, laboratory investigations and radiological examination.

Methods of management:

Group 1: Antegrade Intramedullary Nailing (AIN)

Skin incision: A longitudinal 2-cm incision was made over dorsal aspect of the base of the involved metacarpal and dorso-ulnar in case of the fifth metacarpal. Both intended not to be directly over the extensor tendons.

Dissection to bone: Dissection was done to identify and protect the dorsal sensory branch of the ulnar nerve and recognize the insertion of the extensor carpi ulnaris tendon.

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For the other metacarpals, the sensory nerve branches and longitudinal veins were protected along with the extensor tendon on site (Figure 1). Then a uni-cortical hole was made through the dorso-ulnar cortex of the base of fifth or the dorsal cortex of the other metacarpals initially with a 2mm kirschner wire directed Perpendicular to open the cortex, avoiding perforation of the oppisite cortex. Then a 2.7 drill bit was used afterward in a distal direction to widen the hole and open up the medulla. A drill sleeve was used to protect the relevant sensory nerve branches, the extensor tendons and to avoid slippage and damage to the carpo-metacarpal joint or volar structures.

Two or three blunt ending K-wires of 0.8mm, or 1mm diameter were pre-bent length-wise to achieve the 3-point fixation principle. The distal tips were bent upward with pliers by about 20 degrees. About 2 cm further, the wires were bent in the same direction by not more than 10 degrees. The proximal end of the wires was bent by 90 degrees in the same plane to control the direction of introduction.

The prepared wires are then introduced through the medullary canal and stopped before the fracture zone.

Reduction of the fracture: primary reduction of the fracture was attempted by the "Jhass maneuver" [10] accomplished by flexing the metacarpophalangeal (MP) and proximal interphalangeal (PIP) joints to 90° degrees and applying an upward pressure on flexed proximal phalanx of the same digit and simultaneous downward pressure over the dorsal apex of the fracture.

The primarily achieved reduction is checked under fluoroscopy and manually held in place.

Definitive fixation: Wires were advanced manually into the head in a gentle manner to not perforate the thin cortex. Image intensifier was used to ensure the correct position. Wires were then rotated in divergent directions so that they separate in the metacarpal head as a "flower bouquet" [10] Meanwhile, malrotation was addressed and clinically rectified by carefully

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monitoring the parallelism of the planes of the fingernails in extension, whilst in flexion, all fingers were to be oriented pointing towards the scaphoid tubercle. Clinical testing for an adequate and stable fixation to the fractured neck metacarpal was established in all subjects.

Figure 2

The K-wires were then bent at the level of the entry portal and cut, leaving sufficient length to allow easy secondary removal. The skin incision was closed and a light dressing was wrapped around the hand and a plaster of paris splint in the intrinsic functional position was applied.

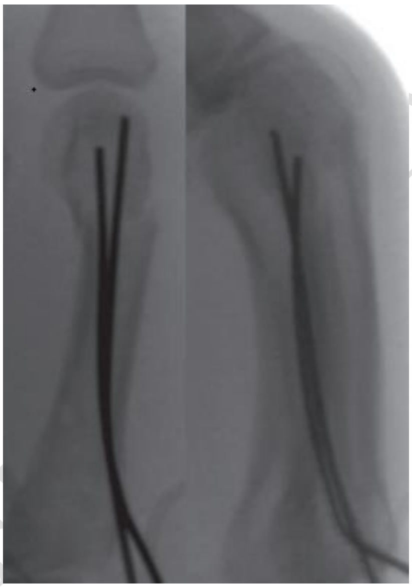

Figure 1: Final installment of k wires with their tips cut close to the bone buried followed by skin closure

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Group 2: Low Profile Plate (LPP):

Skin incision: a straight longitudinal dorsal skin incision was done in the interval between adjacent metacarpal bones with oblique distal extension. A dorso-ulnar incision in the same manner was done for the fifth metacarpal.

Dissection to bone: meticulous soft tissue dissection for preservation of the sensory nerve branches imbedded in the subcutaneous tissue, the longitudinal veins, the extensor tendons and intertendinous connections on site.

The extensor tendons were retracted together with the surrounding loose connective tissue by blunt retractors (Langenbeck) and the intertendinous connections were divided**.**

Partial detachment of the dorsal interosseous muscles from the fracture site and splitting the periosteum to clean fracture hematoma and interposed tissue. Hohmann levers were avoided to preserve volar structures.

*In case of the fifth metacarpal, the hypothenar muscles were elevated from the metacarpal and retracted palmarly in same manner.

Reduction of the fracture: the same way as group 1 using Jhass technique [10]. Reduction was maintained by introducing a disto-proximal retrograde non threaded 1.4 to 1.6 mm intramedullary Kirschner wire under fluoroscopy to keep the achieved alignment.

Definitive fixation: Fixation was achieved with plate and screws according to the standard AO technique with minimum of four cortices in each side of fracture using a 4–5-hole 1mm profiled Y or L shaped plate. The central hole in the five holed plate was to bridge a comminution. The plate was properly placed on the dorsal surface of the involved metacarpal except for the fifth where plates were placed medial. Postero-anterior and lateral views were checked with fluoroscopy to ensure that the plate was placed exactly on the dorsum of the bone and exactly medial in case of the fifth metacarpal. rotational alignment was also checked the same manner as in group one.

Then drilling using a 1.5 mm drill bit to the holes adjacent to the fracture line was done. Two 1.7 mm screws were inserted primarily of right length measured by depth gauge. Both are tightened making sure they engage with the far cortex and then the K-wire was removed and the rest of the screws were inserted.

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Figure 2: Intraoperative figures of pre and post reduction – an dorosomedial comminution was handeled by two interfragmentary mini screws

Wound closure: The implant was covered with the periosteum, as far as possible to minimize contact with the extensor tendons and the implant. If an intertendinous connection had been cut, it was repaired. No subcutaneous sutures were taken to avoid adhesions. Skin was closed primarily.

Postoperative management:

A short-arm splint (2nd/3rd finger fracture) or an ulnar gutter short-arm splint (4th/5th finger) was applied immediately after surgery in both groups. The splint was positioned with the wrist extended 20°, the MP joint at 90° degrees of flexion, and the interphalangeal (IP) joint at full extension in both groups.

In all cases the hand was elevated to promote maximal lymphatic and venous drainage to minimize the edema and thus diminishing the postoperative pain. Ice bags were intermittently applied in the first 48 hours.

A four-days course of a broad-spectrum oral antibiotic along with an analgesic was prescribed.

In patients of the first group (**AIN group**) the hand was immobilized for no longer than four weeks to achieve clinical healing –identified by lack of tenderness at fracture site- to avoid stiffness of the MCPJ. Patients were encouraged to move their fingers actively freely once they achieved clinical healing the end of the second week follow up and then against resistance by the end of the eighth week. K wires were removed under local anesthesia upon approval of achieving radiological healing and radiological healing by a callus bridging at least three cortices of the fracture fragments.

In patients of the second group (**LPP group**) the hand was immobilized in a plaster of paris splint for one week until pain and edema of the fingers subside. Then, patients were encouraged to move their fingers actively freely by the end of the first week and stitches were removed. Movement against resistance was allowed by the end of the fourth week.

Follow up:

All patients were followed up for one year in total. Clinical assessment was performed independently by senior orthopedic resident.

The variables assessed included total active ROM of the finger (TAM), grip strength using a sphygmomanometer, Michigan Hand Outcomes Questionnaire (MHQ), Quick DASH scores,

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Visual analogue scale and Patients' reaction to pain related scale and subjective patient's complaints and feedbacks.

Statistical Analysis

Statistical presentation and analysis of the present study was conducted using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**).** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation (SD), median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level. The used tests were chi-square test, Fisher's Exact or Monte Carlo correction, McNemar and marginal homogeneity test, Student t-test, paired t-test, Mann Whitney test and Wilcoxon Signed Rank test.

Commented [BWR1]: Shapiro Wilk is the better method for assessing data normality if the n is less than 50, which is the case here

Results

There was no significant difference regarding age, sex, occupation, affected hand dominance, special habits, mechanism of injury, fracture pattern and involved metacarpals between group 1 and group 2. **Table 1**

Table 1: Comparison between the two studied groups according to demographic data

	Group I (n = 18)		Group II (n = 19)		Test of Sig.	p
	No.	%	No.	%		
Sex						
Male	16	88.9	19	100.0	χ^2= 2.2	^{FE}p= 0.2
Female	2	11.1	0	0.0		
Age (years)						
Min. – Max.	18 – 61		18 – 59		t= 0.3	0.7
Average ± SD.	33.7±11.3		32.6±11.2			
Median (IQR)	32.5 (27 – 38)		31 (26 – 35.5)			
Occupation						
Non-worker	3	16.7	3	15.8	χ^2= 3.1	^{MC}p= 0.4
Student	1	5.6	2	10.5		
Manual worker	12	66.7	8	42.1		
Office worker	2	11.1	6	31.6		
Non dominant	6	33.3	5	26.3	χ^2= 0.2	0.6
Dominant	12	66.7	14	73.7		
Smoking						

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Non smoker	7	39	4	21	χ^2= 1.4	0.2
Smoker	11	61	15	79		
Drug abuse						
Non	5	27.8	7	36.8	χ^2= 0.3	0.5
Abuser	13	72.2	12	63.2		
Tramadol	6	46.2	4	33.3	χ^2= 0.4	^{FE}p=0.6
Hashish	11	84.6	12	100.0	χ^2= 2.0	^{FE}p=0.4
Alcohol	2	15.4	3	25.0	χ^2= 0.3	^{FE}p=0.6
Mechanism of injury						
Indirect	2	11	4	21	χ^2= 0.6	^{FE}p=0.6
Direct	16	89	15	79		
Fracture pattern						
Oblique	7	39	6	31.6	χ^2= 0.9	^{MC}p=0.7
Transverse	9	50	12	63.2		
Comminuted extra articular	2	11	1	5.3		
Involved metacarpals						
First	0	0.0	0	0.0	χ^2= 2.5	^{MC}p=0.6
Second	0	0.0	1	5.3		
Third	1	5.6	0	0.0		
Fourth	2	11.1	4	21.1		
Fifth	15	83.3	14	73.7		

χ^2: Chi square test **MC**: Monte Carlo **FE:** Fisher Exact
t: Student t-test **IQR**: Inter quartile range
p: p value for comparing between the studied groups

There was no significant difference regarding perioperative complications between group 1 and group 2. There was a significant increase in postoperative complications in group 2 compared to group 1. In group 2, there was a significant increase in postoperative complications compared to perioperative complications. Table 2~~Table 2~~

Table 2: Comparison between the two studied groups according to complications

Complications	**Group I (n = 18)**		**Group II (n = 19)**		**χ2**	**p**
	No.	**%**	**No.**	**%**		
Perioperative						
Null	18	100	17	89.5	2	^{FE}p=0.5
Yes	0	zero	2	10.5		
Post-operative						
Null	15	83.3	7	36.8	8.3^*	0.004^*
Yes	3	16.7	12	63.2		
^{MCN}**p**	0.250		0.002^*			

χ^2: Chi square test **FE:** Fisher Exact
^{McN}**p:** p value for McNemar test for comparing between **Peri** and **Post-operative complications**
p: p value for comparing between the studied groups

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*: Statistically significant at $p \le 0.05$

There was no significant difference regarding initial angulation between group 1 and group 2. There was a significant increase in immediate post-operative angulation in group 1 compared to group 2. In both groups, there were a significant increase in initial angulation compared to immediate post-operative angulation. Table 3

There was no significant difference regarding initial shortening and immediate post-operative shortening between group 1 and group 2. In both groups, there were a significant increase in initial shortening compared to immediate post-operative shortening. Table 4

Table 3: Comparison between the two studied groups according to angulation and shortening

Angulation	Group I (n = 18)	Group II (n = 19)	Test of Sig.	p
Initial angulation				
Min. – Max.	25.0 – 92.0	25.0 – 92.0		
Average ± SD.	74.7±17.5	74.7±14.8	t=0.003	0.9
Median (IQR)	80 (69 – 89)	80 (70 – 82.5)		
Immediate post-operative angulation				
Min. – Max.	14 – 17	12 – 15		
Average ± SD.	15.2± 0.9	13.7±1.2	t=4.2*	<0.001*
Median (IQR)	15 (15 – 16)	14 (13 – 15)		
^{t}p	<0.001*	<0.001*		
Initial shortening				
Min. – Max.	2 – 3.3	1.4 – 3.3		
Average ± SD.	2.9 ± 0.4	2.7 ± 0.5	U=153	0.6
Median (IQR)	3.1 (2.7 – 3.2)	2.9 (2.4 – 3.2)		
Immediate post-operative shortening				
Min. – Max.	0.0 – 0.2	0.0 – 0.2		
Average ± SD.	0.07 ± 0.08	0.05 ± 0.07	U=154.5	0.6
Median (IQR)	0.05 (0.0 – 0.1)	0.0 (0.0 – 0.1)		
^{Z}p	<0.001*	<0.001*		

t: Student t-test **IQR**: Inter quartile range **U:** Mann Whitney test
p: p value for comparing between the studied groups
^{t}p: p value for **Paired t-test** for comparing between **Initial** and **Immediate post op**
^{Z}p: p value for **Wilcoxon signed ranks test** for comparing between **Initial** and **Immediate post op**
*: Statistically significant at $p \le 0.05$

Group 2 (LPP group) time of operation was significantly longer than the group 1 (AIN group). Both groups had no significant variation till achieving radiographic union. Clinical union was

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significantly shorter in the group 1 compared to group 2. Group 2 was superior to the group 1 in both time off work and starting ROM. **Table 4**

There was no significant difference between both groups regarding final total active range of motion. Regarding grip power (recorded as percentile deficit off the contralateral hand), it was found significantly better in the antegrade IMN group. Both groups showed excellent Q-DASH scores with no significant variations. **Table 4**

Both groups ended up the one year follow up period with statistically significant no pain feedback unlike along the course of follow-up when pain varied between moderate and mild in group 1 group 2 respectively. **Table 4**

Table 4: Comparison between the two studied groups according to anesthesia and time of operation

	Group I (n = 18)		Group II (n = 19)		Test of Sig.	p
	No.	%	No.	%		
Anesthesia						
Regional	3	16.7	zero	zero	χ^2=3.4	^{FE}p=0.1
General	15	83.3	19	100		
Time of operation (Minutes)						
Min. – Max.	40 – 50		70 – 120		t=11.8*	<0.001*
Average ± SD.	43.3±4.2		87.4±15.7			
Median (IQR)	40 (40 – 45)		80 (75 – 97.5)			
Radiographic union (weeks)						
Min. – Max.	4 – 8		6 – 10		t=1.76	0.08
Average ± SD.	6.4±1.3		7.3±1.5			
Median (IQR)	6.0 (6.0 – 8.0)		6.0 (6.0 – 8.0)			
Clinical union (weeks)						
Min. – Max.	2.0 – 4.0		4.0 – 4.0		t=2.2*	0.042*
Average ± SD.	3.06± 0.86		4.0 ± 0.0			
Median (IQR)	4.0 (4.0 – 4.0)		4.0 (–)			
Start ROM (Days)						
Min. – Max.	14 – 28		2 – 14		U=4*	<0.001*
Average ± SD.	24.9 ± 5.9		3.3 ± 3.8			
Median (IQR)	28.0 (28.0 – 28.0)		2.0 (2.0 – 2.0)			
Time off work (Weeks)						
Min. – Max.	4 – 8		4 – 6		U=15*	<0.001*
Average ± SD.	6.7 ± 1.2		4.1 ± 0.5			
Median (IQR)	6 (6 – 8)		4 (4 – 4)			
TAM score						

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Min. – Max.	210 – 255		175 – 255		U=113	0.08
Average ± SD.	238.3 ± 14.04		243.4 ± 19.2			
Median (IQR)	242.5 (230 – 250)		250 (245 – 250)			
Grip strength						
Min. – Max.	5 – 28		24 – 29		U=85.5*	0.008*
Average ± SD.	24.4 ± 5.6		27.4 ± 1.7			
Median (IQR)	26 (24.5 – 27)		28 (27 – 29)			
Disability according to Q-DASH						
Fair	0	0.0	1	5.3	χ^2=1.6	^{MC}p= 0.56
Good	3	16.7	5	26.3		
Excellent	15	83.3	13	68.4		
Score according to Q-DASH						
Min. – Max.	3 – 20		3 – 25		U=140	0.36
Average ± SD.	8.2 ± 5.3		9.69 ± 5.9			
Median (IQR)	6.5 (4 – 10)		9 (4.5 – 12)			
3weeks Follow up according to PVAS						
No	0	0.0	0	0.0	χ^2=10.35*	^{MC}p= 0.003*
Mild	7	38.9	17	89.5		
Moderate	10	55.6	2	10.5		
Sever	1	5.6	0	0.0		
Final Follow up according to PVAS						
No	15	83.3	15	78.9	χ^2=1.87	^{MC}p= 0.6
Mild	3	16.7	2	10.5		
Moderate	0	0.0	2	10.5		
Sever	0	0.0	0	0.0		
p_0	<0.001*		<0.001*			

χ^2: Chi square test **FE:** Fisher Exact **t:** Student t-test **U:** Mann Whitney test
IQR: Inter quartile range **MC:** Monte Carlo
p: p value for comparing between the studied groups
p_0: p value for **Marginal Homogeneity Test** for comparing between **3weeks** and **Final follow up**
*****: Statistically significant at p ≤ 0.05

Discussion

The metacarpal neck fractures (commonly termed boxer's fractures) are the most common type of metacarpal fractures [11], reported as 9.7 % of all hand fractures, 25% of all metacarpal fractures. Of all fractures of the upper extremity, little finger metacarpal neck fractures constitute 5% of the overall total [12]. In our study, 78.3% of patients included had fracture of the fifth metacarpal neck.

The purpose of this study was to determine whether the intramedullary nail or low-profile plate allows for good clinical and radiological results for displaced unstable metacarpal neck fractures. We hypothesized that low profile plate fixation may have a better functional outcome

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due to satisfactory anatomical restoration for unstable metacarpal neck fractures and early postoperative range of motion.

Typical angulation deformity with dorsal apex because of frequent comminution of the volar cortex and the deforming muscle forces are pathognomic for metacarpal neck fractures [13]. Concomitant deformities as shortening, rotation and burst comminution is frequently happening [14]. The median degree of angulation and shortening in our study groups was 80° for both groups' angulation and 3mm and 2.9mm for shortening in both groups respectively.

This is typically caused by a direct trauma of a longitudinal compression force to the knuckles when the hand is in a clenched fist posture [15]. That was congruent to the epidemiological data collected in our study in which direct trauma occurred in 83.7% of total study subjects. Our demographic data matched the epidemiological studies and systematic reviews concerned with metacarpal neck fractures along past decade [11].

In spite of the virtually inherent instability of metacarpal neck fractures, it is usually recommended for conservative treatment [16] The conservative care of boxer's fractures (casting, with or without reduction), between 20°and 70°of dorsal angulation is acceptable according to many authors, however, the basic goal of fracture treatment is solid union in satisfactory alignment without loss of function [17, 18]. Considering the decreased grip strength and finger's range of motion caused by the degree of final angulation and subsequent shortening as described by Ali A., Matthew J. and their colleagues who studied the biomechanical effects of angulated and shortened metacarpal fractures [13, 19]. Multiple studies paid attention to define the parameters of predictable instability of metacarpal neck fractures at which conservative measures won't secure the accepted functional outcome [20, 21]. Irreducible, malrotated, shortening more than 3 mm and apex angulation > 60° (5th), 40° (4th), and 10° (2nd and 3rd metacarpal bone) on initial presentation were considered unstable [14, 22].

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Regarding unstable metacarpal neck fractures included in our study, 56.7% of were transverse fractures, 35% oblique and 8.3% comminuted extra articular. Prediction of fracture instability according to fracture pattern using the Monte Carlo randomization method found no significant correlation p=0.69. According to our knowledge no studies worked on figuring out significance of fracture pattern as a countable point in light of metacarpal neck fracture instability.

Hence 78.3% of patients, who meet the criteria of instability and other inclusion criteria in our study, had fracture of fifth metacarpal neck. We believe that fifth metacarpal is the most susceptible for instability yielding need for surgical fixation. The margin of acceptance in other metacarpal neck fractures is lower but yet their incidence is low too.

The operative management choice and metalwork products for the metacarpal neck fractures were increased as the surgical technology and internal fixation products developed.[4] Many studies compared different modalities of surgical treatment to weight out the best in the light of the improvement of materials and instruments, and better understanding of biomechanical principles of internal fixation [23, 24].

Several techniques available for obtaining stability include: Kirschner wire pinning with different techniques [12, 25], intraosseous wiring [26], external fixation [6], intramedullary devices [27], Plating and a combination of these methods [28]. Rigid internal fixation of unstable hand fractures allows immediate finger motion during the postoperative course [29]. However, many complications were reported after plating most commonly decreased range of motion [30] and more or less most of other operative measures yield complications themselves leading to undesirable functional outcomes [2, 3].

In recent clinical practice, low-profile plate systems have gained popularity for finger fractures because of the reduction of soft tissue irritation and complications [31].

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Perioperative complications incidence were analyzed in a comprehensive meta-analysis by Dong Wang and revealed incidence of other complications than what we found as increased blood loss in plate and pull out of the wires in antegrade medullary nailing [116].

Time of operation was significantly lower in the antegrade IMN group. Chen and Wang stated lower timing for both groups with similar significantly lower operative timing of the intramedullary wires group [29, 32].

Time to achieve clinical union was found to be significantly lower in antegrade IMN group (AIN). Multiple comparative studies stated no significant difference between two methods regarding time to union [29]. Fujitani, Baumgartner and their colleagues reported delayed radiological union in low profile plating in some patients with no interference with function and no need to re-operation [33].

Patients of the low-profile plating group had significantly lower period of time to return to their work. Chen [34] reported same results but Facca [29] found no significant difference between both groups regarding time off work.

Incidence of complications was significantly higher in the low-profile plate group. To our knowledge, all the comparative studies and systematic reviews weighting outcomes of antegrade nailing and plates agrees to our results with wider range of reported complications in both methods [29, 34]. Baumgartner [33] studied complications of low profile plate and in his retrospective study, low-profile plate fixation resulted in an 11% overall complication rate and a 1% re-operation rate. This is significantly less than reported in previous literature as Fusetti [30], whose retrospective study reported 35% complication rate for conventional plates.

After one year follow up, both groups had no significant difference regarding subjective feeling of pain. This agreed with Facca and colleagues results [29]. Fusetti reported 15% of the subjects of his retrospective analysis of 157 metacarpal fractures fixed by plate to have delayed union and pain [30]. Zhang and colleagues studied locked plate vs AIN and found VAS pain scores at

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3-month follow-up were significantly better in the plate than AIN group ($P < 0.05$). However, at 6-month follow-up, the differences were no longer significant.

No significant difference in final quick disability arm, shoulder and hand questionnaire between both groups of which majority of both groups patients reported excellent results. Facca, Chen and their colleagues recorded similar results in their comparative studies [29]. Cha and collegues found in a two years comparative prospective study better DASH score in antegrade IMN group ($p = 0.034$) [35].

Total active range of motion (TAM) at final follow up varied from good to excellent in average. Chen [34] agreed with our results, while, other comparative studies carried by Facca, Fujitani and their colleagues showed better final TAM in the antegrade Intramedullary nailing group rather than the plate group [29].

We measured the grip strength of both groups where the antegrade IMN group were significantly superior to the low-profile plate group. Facca, Chen and their colleagues [34] found no significant difference between the two groups regarding grip strength, while, Fujitani [2] reported better grip strength in the plate group. Variable methods are used to detect grip power with no standard technique may result in variable heterogeneous outcomes.

Conclusions

Low profile plates with immediate mobilization paradoxically resulted in longer period to return to work with high tendency of wide range of complications compared to antegrade intramedullary K-wire with 4 weeks' immobilization. The prolonged operative time, technical demand and disturbing the fracture's biological environment along with the extra cost of low-profile plates were thus not justified by results. Antegrade intramedullary K-wire nailing was superior for the management of unstable metacarpal neck fractures.

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