How to Cite:
Kumar, A., Kumar, R., Batra, A., Biswas, S., Pathak, A., & Ranjan, R. (2021). A comparative study between miniplate fixations versus K-wire fixation in closed metacarpal fractures. *International Journal of Health Sciences*, *5*(S2), 720–739. Retrieved from https://sciencescholar.us/journal/index.php/ijhs/article/view/13863

A comparative study between miniplate fixations versus K-wire fixation in closed metacarpal fractures

Kumar A.
Assistant Professor, Department of Orthopedics, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh, India

Kumar R.
Associate Professor, Department of Orthopedics, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh, India

Batra A.*
PG Resident, Department of Orthopedics, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh, India
*Corresponding author

Biswas S.
PG Resident, Department of Orthopedics, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh, India

Pathak A.
PG Resident, Department of Orthopedics, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh, India

Ranjan R.
Professor, Department of Orthopedics, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh, India

Abstract---Most finger and metacarpal fractures heal adequate in short time, without functional sequelae,[1] Although today's technology (anesthesia, antibiotics, technologically advanced implants) allows considerable freedom in treating these injuries, still a number of patients suffer a complicated course of events and experience stiffness, nonunion, malunion, and chronic pain following metacarpal fractures. In this paper we provide a comparative study between Miniplate fixations versus K-wire fixation in closed metacarpal fractures. Low profile mini titanium plating shows it can be successfully used regardless of fracture location and fracture pattern in metacarpal shaft fracture. Based on the clinical experience and

results in this series, it can be concluded that Low Profile Mini Titanium Plating technique is an ideal method for treatment of isolated closed medial metacarpal shafts fractures.

Keywords---metacarpal fractures, miniplate fixation, K-wire fixation, low profile, mini titanium, plating technique, closed metacarpal fractures.

Introduction

Fractures and dislocations of the hand are some of the most frequently encountered musculoskeletal injuries. Hand fractures occur frequently with the annual incidence of phalangeal fractures in the normal population is about 0.1-0.3%, of metacarpal fractures about being 0.1-0.2%[2.] Branco DF et.al [3] found that 22% of 1,500 hand fractures involved the metacarpals. Some of the common causes of phalanges and metacarpal fractures are like Crush injuries, Compression injuries, Blunt trauma, Road traffic accidents, Machinery injury, and Sports related activity. Functional restoration demands correct length, alignment and rotation of bone, and early mobilization.[4]Uncomplicated, undisplaced, and stable metacarpal fractures (at presentation or after reduction) can be managed conservatively by reposition, casting, splinting, or early motion; sometimes even follow-up is considered not strictly indicated, [5] Most metacarpal fractures can be successfully treated non-operatively with closed reduction and immobilization.

However, operative intervention is warranted for if fracture is considered in case of Irreducible fractures, if acceptable reduction cannot be maintained, or if motion at adjoining joints cannot be started without loss of reduction. Some form of fixation is often indicated in the following instances [5]. In surgical treatment, reduced bone fragments are fixed by an internal or external device, denominated 'osteosynthesis. There are many different osteosynthesis modalities, all of which have to meet the following requirements, it has to be stable enough to permit fracture healing preferably it should biologically inert or resorbable, it has to allow for some micro motion, permitting end osteal and periosteal callus formation, it has to minimize (further) damage to already impaired circulation of fracture fragments has to allow early mobilization.

Open reduction and internal fixation is indicated for: Unstable fractures, multiple closed fractures and, Fractures resulting in malrotation of the fingers. [6] Fixation with crossed Kirschner wires was the most stable method in soft tissue intact specimens. Fixation with plates was the most stable method in-Multiple fractures with soft tissue injury, markedly displaced shaft fracture (esp. border metacarpals). Technique and instrumentation for open reduction and internal fixation (ORIF) in the hand have improved considerably in recent years.[7]

Literature Survey

Bony anatomy

Picerno P et.al proposed Upper limb joint kinematics using wearable magnetic and inertial measurement units: an anatomical calibration procedure based on bony landmark identification.[8] Metacarpal bones are concave, short tubular bones within built longitudinal arch and a collective transverse arch. The metacarpal bases form the CMC joints with the carpal bones, cam-shaped head of the metacarpal bones makes the collateral ligaments relaxed in extension and stretched in flexion making it safer to immobilise the MP joints in Flexion (ideally 70-90°) than in extension. This flexed position of the MP joint is also the most stable position of the MP joint in power pinch and grip. Metacarpal bones are subcutaneous bones dorsally with a gentle volar concavity. Fracture of the shaft or the neck of the metacarpal caused either due to direct or axial loading injury will mostly result in dorsal apex angulation due to the deforming forces of interossei and other volarly placed muscles.

Extensor tendon anatomy

Desai MJ et.al proposed failed extensor tendon repairs: extensor tenolysis and reconstruction[9]. The extensor mechanism arises from multiple muscle bellies in the forearm. The EPL, EPB, extensor indicis proprius (EIP), and EDM have a comparatively independent origin and action. The proprius tendons at the MCP joint level usually are to the ulnar side of the communis tendons the wrist extensor retinaculum and the most common arrangement of the extensor tendons and juncturae. The wrist, thumb, and finger extensors gain entrance to the hand beneath the extensor retinaculum through a series of six tunnels, and at this level are covered with a synovial sheath. Small finger proprius tendon (EDM) over the metacarpal and wrist level usually is represented by two distinct tendinous structures.

Juncturae Tendinum

Hazlerigg A et.al proposed Metacarpophalangeal joint extensor tendon centralisation: a new technique using the juncturae tendinum with a proximal based partial extensor digitorum communis slip[10]. The extensor tendons are interconnected on the dorsum of the hand by intertendinous fascia and juncturae tendinum. The intertendinous fascia is present between all tendons of the fourth compartment and attaches to the paratenon of the extensors. In contrast, the juncturae tendinum are narrow connective tissue bands that extend between the EDC and EDM (and not the EIP) and attach to the tendons in a comprehensive study of the juncturae tendinum in 40 cadaver hands, von Schroeder et.al described three distinct morphologic types of juncture tendinum.

Proximal Interphalangeal Joint Fusion

Jung J et.al proposed proximal interphalangeal joint fusion: indications and techniques[11]. A unique arrangement is present at the dorsal aspect of the PIP joint, where the central slip of the extensor tendon invests a fibrocartilage plate

before its attachment to the dorsal base of the middle phalanx. The average thickness of the central slip at this level is 0.5 mm, but because of the presence of this fibrocartilage plate, the thickness is doubled over the PIP joint. Slattery named this structure the dorsal plate and described its structure in detail, noting that its function might relate to stability of the extensor tendon, stability of the PIP joint, an increase of the moment arm of the extensor tendon at the PIP joint, and prevention of attrition of the central slip at the PIP joint · The similarity of the dorsal plate and the patella is striking.

Sagittal Bands

Chinchalkar SJ et.al proposed Relationship between juncturae tendinum and sagittal bands. [12] The extensor tendon at the MCP joint level is held in place over the dorsum of the joint by the conjoined tendons of the intrinsic muscles and the transverse lamina or sagittal bands, which together tether and keep the extensor tendons centralized over the joint. The sagittal bands arise from the palmar plate and the intermetacarpal ligaments at the neck of the metacarpals, the fibers of the sagittal bands are perpendicular to the EDC in neutral position, angulated 25 degrees at 45 degrees of MCP flexion, and angulated 55 degrees at full MCP flexion. Pressure readings deep to the sagittal bands revealed that the greatest pressure occurred during complete MCP joint flexion and the least at 45 degrees of flexion.

Research Methodology

Source of data and duration of study

All isolated closed medial four metacarpal shaft fractures were seen at the Emergency and outdoor department (OPD) of the Orthopaedics department in Sharda Hospital between July, 2020 to December, 2021 were included in the study unless they had any of the exclusion criteria. Patients with fracture of isolated closed medial four metacarpals shaft fractures were prospectively randomized into two treatment groups either K-wire or low profile titanium miniplate. Patient who were treated with ORIF named as group 1 patients and patient who were treated with CRIF named as group 2 patients. An informed consent was taken. A total of 30 cases were managed by this method, all the 30 cases turned up for the final follow-up.

Inclusion criteria

- Age: age groups >18 years.
- Sex: both males and females.
- Location: metacarpal shaft fracture (spiral, oblique, transverse)
- Type: Closed , unstable, irreducible, malrotated , fracture of medial four metacarpal

Exclusion criteria

- Patients with any underlying medical history contraindication to surgery.

- Fractures with segmental bone loss or communication to the extent that accurate reconstruction with firm cortical apposition was impossible.
- Any type of Open fracture.
- Patients who do not willing for surgical procedure.

Study design

Single observer, hospital based, prospective comparative study.

Method of Sample size estimation

Being a hospital based study and based on the judgment of what constitutes a clinically significant difference on primary outcome and variability estimates from previous studies(Sedaghat AR (2019)[14] a sample size of total 30 patients was planned for duration of 24 months .The sample size calculation suggest that, to achieve 80% statistical power using a significance level of 5% ,the sample size providing outcome data needed to be atleast 15 per group.

Operative Technique

The patient under regional anesthesia was placed supine with affected extremity supported by the edge of the table. Metacarpal fractures were exposed through a direct dorsal incision over the involved metacarpal. Tendon and muscles are the fracture was reduced by using longitudinal traction on the finger, manually, using a finger trap, or with pointed reduction forceps. Additional pressure was exerted on the metacarpal head from the palmar aspect. Rotation was checked with the metacarpophalangeal (MCP) joints flexed to detect any overlapping of the fingers. Flexing the MCP joints whilst preventing overlap of the fingers reduced a rotational displacement

Plate Selection and Application

The plate was taken long enough to allow 2 screws in each main fragment. Usually, 2 mm plates were used for the fixation of the metacarpals. For comminuted fractures, 2.4 mm plates used. The plate was contoured to confirm with the normal shape of the metacarpal. The plate was applied dorsally onto the metacarpal in its long axis. Correct rotational alignment of the distal main fragment was achieved. It was ensured that at least 2 screw holes come to lie over each of the main fragments. Using a drill guide the first hole was drilled in the proximal or distal fragment close to the fracture zone. It was ensured that the screw does not enter the fracture site. First screw was inserted and it was ensured that it engaged the far cortex. Plate was correctly aligned in the longitudinal axis of the metacarpal. A second neutral screw was inserted into the distal main fragment in the same fashion as above. Correct axial alignment and length was confirmed using image intensification. Rotation was checked by flexing all fingers at the MCP joints. Remaining screws were drilled after measuring the screw length, and inserted in neutral position.

K-Wire operative technique

The treatment can be easily performed in Operation Theater as day care surgery. With the metacarpo phalangeal (MP) joint flexed, a 0.045- or 0.062-in. Kirschner wire was advanced proximally through the metacarpal head into the distal fragment. Closed reduction of fracture was done under fluroscopy that allowed the Kirschner wire to be advanced farther across the fracture. The metacarpal pin was placed retrograde through the flexed MCP joint. The pin engaged the distal metacarpal head and contained the fragment without going through the center of the dorsal extensor mechanism.

The pin was passed retrograde after the reduction had been achieved, so that the pin engaged the intramedullary space of the metacarpal bone proximal to the level of the fracture and was passed with a power drill, until the subchondral bone of the base of the metacarpal was encountered. Piercing through the substance of the cortex was avoided to allow the bone at the base of the metacarpal to retain the tip of the K-wire and to prevent proximal migration. The K-wire was left protruding percutaneously beyond the ski in general a single 0.045- or 0.062 - in. K-wire was used that was sufficient to prevent volar-dorsal and radial-ulnar displacement of the fracture. By placing the finger in a position of 70 to 90 degrees of MCP flexion, rotational control was readily achieved through immobilization. Alternatively, a second K-wire was used for prevention of rotational displacement. The second pin was parallel K-wire that was oriented obliquely to the axis of the first wire, thus creating a crossed K-wire pattern. The pin through the MCP joint was managed with a well-padded splint during immobilization, followed by aggressive rehabilitation after the pin was removed.

Low Profile Mini Titanium Plating

Low Profile Mini Titanium plating technique is an ideal method for treatment of isolated closed medial METACARPAL shafts fractures. It provides an early range of motion with rigid internal fixation, thereby, promoting patient for early resumption of activities. There is a pain free range of motion and no rotational deformity, instead of longer immobilization and stiffness, in K-wire technique, hence giving an early mental satisfaction to the patients. It has a lower complication rate and a good functional outcome when compared with other modalities of treatment.

Mini titanium plating is a simple, easy, reliable and effective method for management of isolated closed displaced metacarpal shafts fracture. It is mainly useful in long oblique and severe communited fractures, which otherwise have an unsatisfactory early functional outcome with other modalities of treatment, although it has an operative time that is longer than the K-wire technique. Another advantage of K-wire fixation if that the implant removal is easier. Though, the biggest disadvantage with K-wire technique is a longer immobilization period, thereby, leading to stiffness and psychological stress as well as functional restriction and Low profile mini titanium plating may be preferred treatment of choice as compared with closed reduction and K-wire fixation in displaced isolated closed metacarpal shaft fractures as the basic aim in these technique is to gain an early pain free range of motion with good cosmetic

results. It also preserves the gliding tissue and thus allows immediate active range of motion exercise. This modality of treatment is associated with excellent functional outcomes.

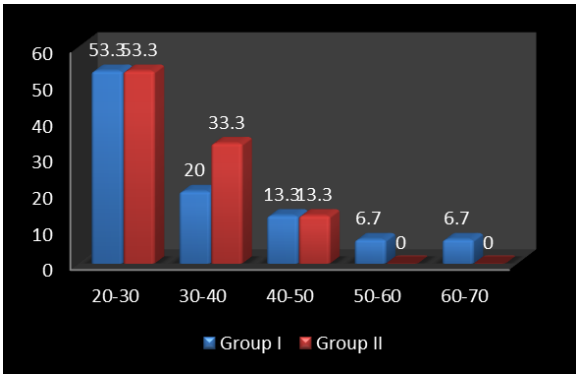
Experimental Results

ORIF– group I
CRIF– group II

Table 1
Age-wise distribution of study subjects

Age in year		group II			Total
		20-30	30-40	40-50	
group I	20-30	4 (50)	2 (40)	2 (100)	8 (53.3)
	30-40	2 (25)	1 (20)	0	3 (20)
	40-50	0	2 (40)	0	2 (13.3)
	50-60	1 (12.5)	0	0	1 (6.7)
	60-70	1 (12.5)	0	0	1 (6.7)
Total		8 (100)	5 (100)	2 (100)	15 (100)

Test applied: chi-square test. $X^2=7.2$ p>0.05 (NS)



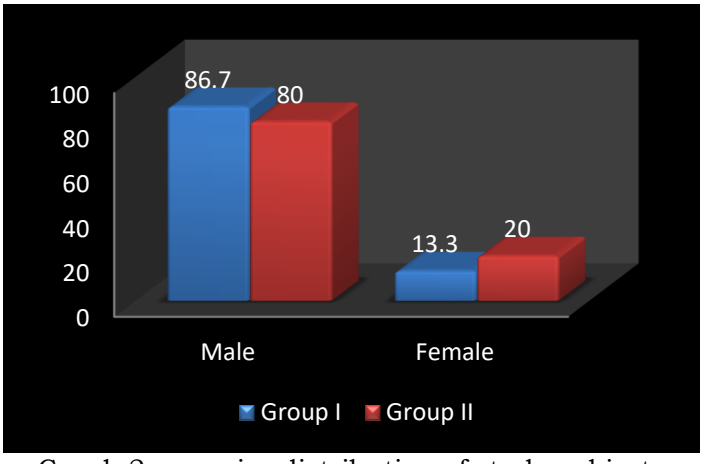
Graph 1. age-wise distribution of study subjects

In above graph, there is 16 (53.33%) patients were 20-30 years old and 8 (26.66. %) were 30 to 40 years old, 4(13.33%) were 40-50 years old, 1(3.33%) was 50-60 years old, and 1(3.33%) was 60-70 years old with mean age being 32.4 years

Table 2
Sex-wise distribution of study subjects

Sex		group II		Total
		M	F	
group I	M	10 (83.3)	3 (100)	13 (86.7)
	F	2 (16.7)	0	2 (13.3)
Total		12 (100)	3 (100)	15 (100)

Test applied: chi-square test. $X^2=0.57$ p>0.05 (NS)



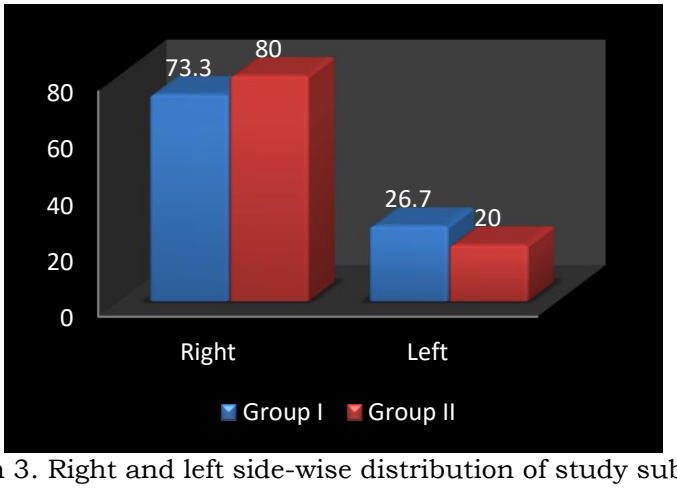
Graph 2. sex-wise distribution of study subjects

Above graph shows, 25(83.33%) patients were male and 5(16.66%) were female

Table 3
Right and left side-wise distribution of study subjects

Side		group II		Total
		R	L	
group I	R	9 (75)	2 (66.7)	11 (73.3)
	L	3 (25)	1 (33.3)	4 (26.7)
Total		12 (100)	3 (100)	15 (100)

Test applied: chi-square test. $X^2=0.08$ $p>0.05$ (NS)



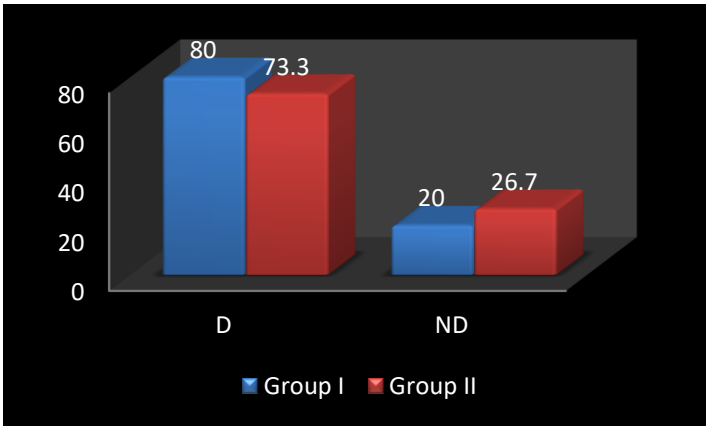
Graph 3. Right and left side-wise distribution of study subjects

Above graph shows, 20(76.66%) patients had right side metacarpal fracture while 7(23.33%) had left side metacarpal fracture

Table 4
Dominant/Non-Dominant side-wise distribution of study subjects

		Group II		Total
		D	ND	
Group I	D	8 (72.7)	4 (100)	12 (80)
	ND	3 (27.3)	0	3 (20)
Total		11 (100)	4 (100)	15 (100)

Test applied: chi-square test. $X^2=1.36$ p>0.05 (NS)



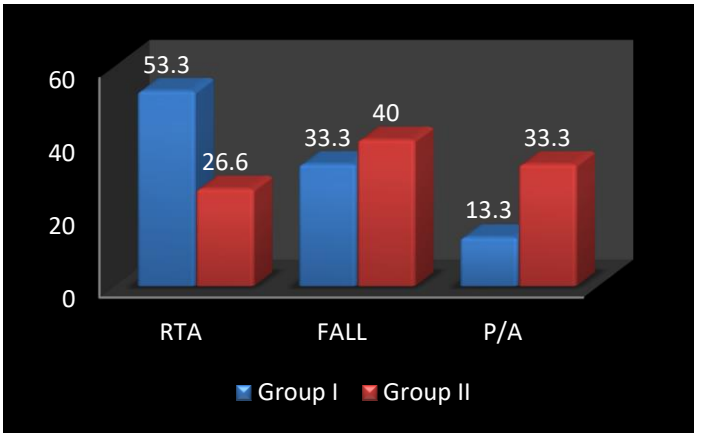
Graph 4. Dominant/Non Dominant side-wise distribution of study subjects

According to above graph there is total 23(76.66%) had dominant hand injury where 7(23.33%) had non dominant hand injury.

Table 5
Mechanism of injury-wise distribution of study subjects

		Group II			Total
		RTA	FALL	P/A	
Group I	RTA	2 (50)	4 (66.7)	2 (40)	8 (53.3)
	FALL	2 (50)	1 (16.7)	2 (40)	5 (33.3)
	P/A	0	1 (16.7)	1 (20)	2 (13.3)
Total		4 (100)	6 (100)	5 (100)	15 (100)

Test applied: chi-square test. $X^2=2.02$ p>0.05 (NS)



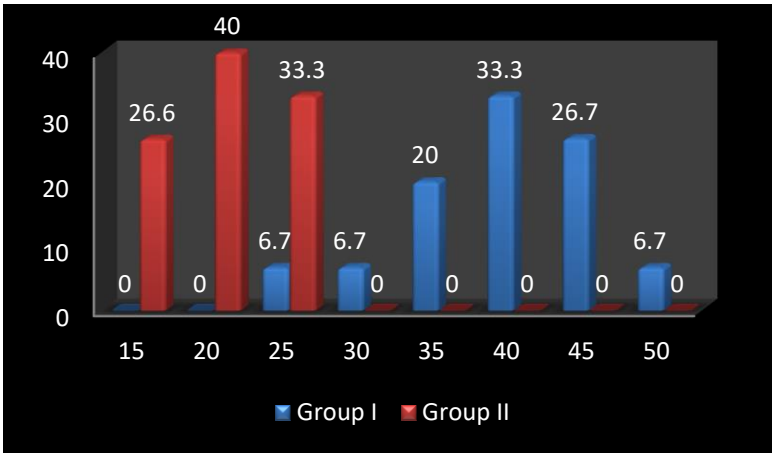
Graph 5. Mechanism of injury-wise distribution of study subjects

RTA was the most common mode of injury in above accounting for 12 (40%) cases and fall while different activity were 11 (36.66%) and 7(23.33%) were physical assault cases.

Table 6
Surgery time-wise distribution of study subjects

		Group II			Total
		15	20	25	
Group I	25	1 (25)	0	0	1 (6.7)
	30	1 (25)	0	0	1 (6.7)
	35	1 (25)	0	2 (40)	3 (20)
	40	1 (25)	3 (50)	1 (20)	5 (33.3)
	45	0	2 (33.3)	2 (40)	4 (26.7)
	50	0	1 (16.7)	0	1 (6.7)
Total		4 (100)	6 (100)	5 (100)	15 (100)

Test applied: chi-square test. $X^2=11$. $p>0.05$ (NS)



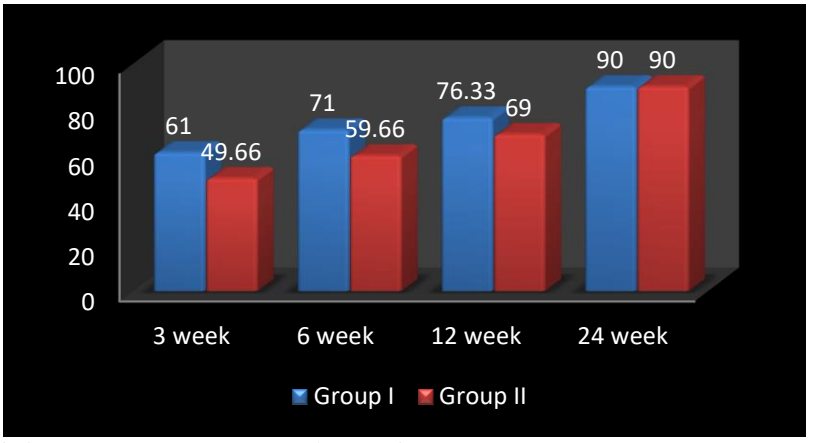
Graph 6. surgery time-wise distribution of study subjects

In above graph Mean duration surgery time in group 1 patient was 39.33 min and in group 2 patients was 20.33 min

Table 7
Inter-group comparison of affected metacarpophalangeal joint (range of motion)

	Group	N	Mean	Std. Deviation	Mean difference	p value
3rd week	Group I	15	61.00	4.705	11.33	<0.001 (S)
	Group II	15	49.66	6.67		
6th week	Group I	15	71.00	6.6008	11.33	<0.001 (S)
	Group II	15	59.66	6.39		
12th week	Group I	15	76.33	5.16	7.33	<0.001 (S)
	Group II	15	69.00	5.41		
24th week	Group I	15	90.00	0.00*	--	---
	Group II	15	90.00	0.00*		

*=can`tbe counted because both are same groups test applied: Unpaired t test



Graph 7. Inter-group comparison of RANGE OF MOTION OF INVOLVED metacarpo phalangeal joint

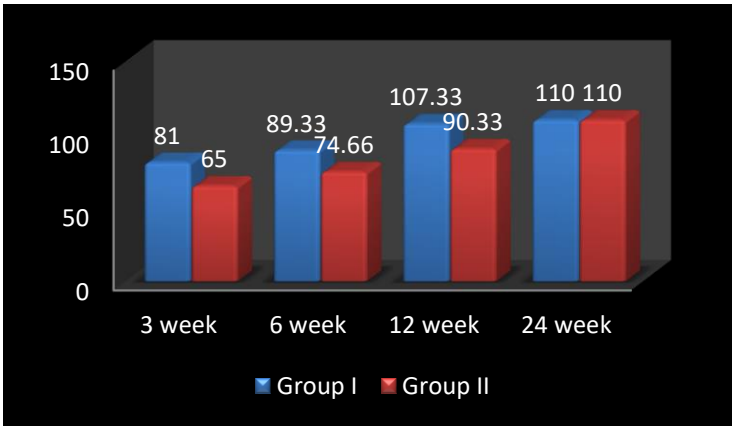
The mean ROM(MCP JOINT) of group 1 at 3rd week,6th week,12th week, and 24th week are 61,71,76.33,and 90 respectively which is superior to the group 2 patients who had MEAN ROM of 49.66,59.66,69,and 90 at 3rd weeks,6th week,12th week, and 24th week, respectively There is significant difference of p-value in group 1 and group 2 patients.

Table 8
Inter-group comparison of involed proximal interphalangeal joint (range of motion)

	Group	N	Mean	Std. Deviation	Mean difference	p value
3rd week	Group I	15	81.00	11.37	16	<0.001 (S)

	Group II	15	65.00	4.62		
6th week	Group I	15	89.33	9.79	14.66	<0.001 (S)
	Group II	15	74.66	7.43		
12th week	Group I	15	107.33	4.95	27	<0.001 (S)
	Group II	15	90.33	5.16		
24th week	Group I	15	110.00	0.00*	--	--
	Group II	15	110.00	0.00*		

*=can`tbe counted because both are same groups test applied: Unpaired t test



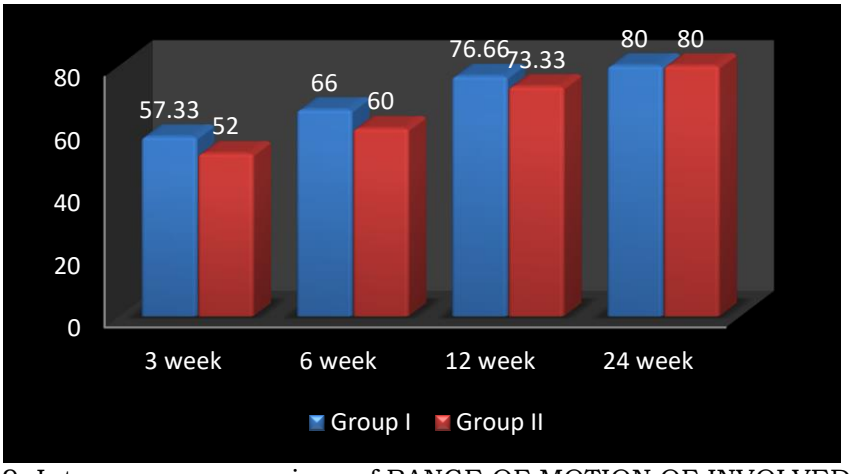
Graph 8. Inter-group comparison of RANGE OF MOTION OF INVOLVED proximal interphalangeal joint

The mean ROM(PIP JOINT) of group 1 at 3rd week,6th week,12th week, and 24th week are 81,89.33,107.33.and 110 respectively which is superior to the group 2 patients who had MEAN ROM of 65,74.66,90.33,and 90 at 3rd weeks,6th week,12th week, and 24th week, respectively There is significant difference of p-value in group 1 and group 2 patients.

Table 9
Inter-group comparison of involved distal interphalangeal joint (range of motion)

	Group	N	Mean	Std. Deviation	Mean difference	p value
3rd week	Group I	15	57.33	5.62	5.33	<0.01 (S)
	Group II	15	52.00	5.606		
6th week	Group I	15	66.00	5.73	6	<0.001 (S)
	Group II	15	60.00	4.22		
12th week	Group I	15	76.66	6.17	3.33	>0.05 (NS)
	Group II	15	73.33	6.17		
24th week	Group I	15	80.00	0.00a*	--	--
	Group II	15	80.00	0.00*		

*=can`tbe counted because both are same groups test applied: Unpaired t test



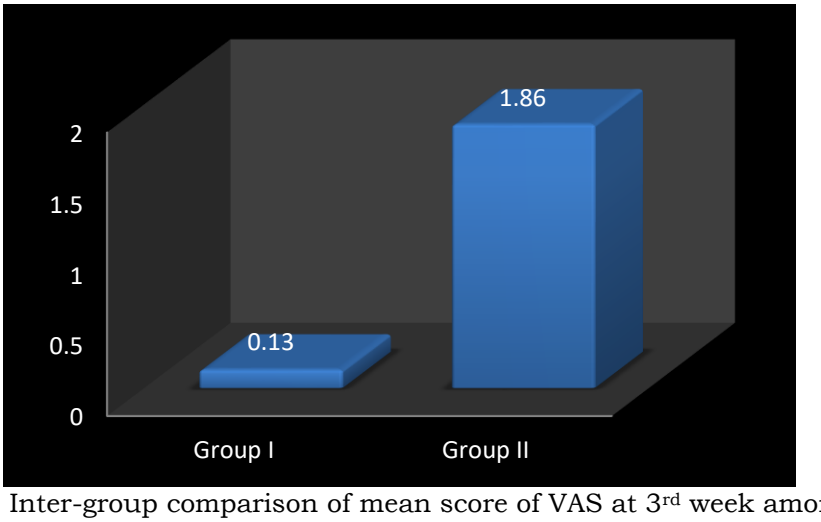
Graph 9. Inter-group comparison of RANGE OF MOTION OF INVOLVED distal interphalangeal joint

The mean ROM(DIP JOINT) of group 1 at 3rd week,6th week,12th week, and 24th week are 57.33,66,76.66,and 80 respectively which is superior to group 2 who had MEAN ROM of 52.60,73.33and 90 at 3rd week,6th week,12th week, and 24th week, respectively There is significant difference of p-value in group 1 and group 2 patients.

Table 10
Inter-group comparison of mean score of VAS at 3rd week among study subjects

	Group	N	Mean	Std. Deviation	Mean difference	p value
VAS	Group I	15	0.13	0.51	-1.73	<0.001 (S)
	Group II	15	1.86	1.35		

Test applied: Unpaired t test



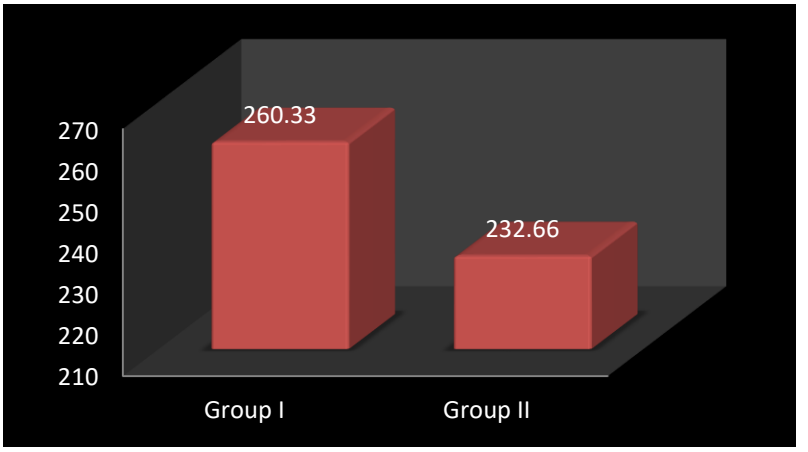
Graph 10. Inter-group comparison of mean score of VAS at 3rd week among study subjects

The mean VAS SCORE of group 1 at 3rd week is 0.13 and mean VAS SCORE of group 2 at 3rd week is 1.86.there is significant difference in group 1 and group 2 patients in VAS SCORE.

Table 11
Inter-group comparison of mean score of TAF at 12th week among study subjects

	Group	N	Mean	Std. Deviation	Mean difference	p value
TAF	Group I	15	260.33	14.57	27.66	<0.001 (S)
	Group II	15	232.66	10.99		

Test applied: Unpaired t test



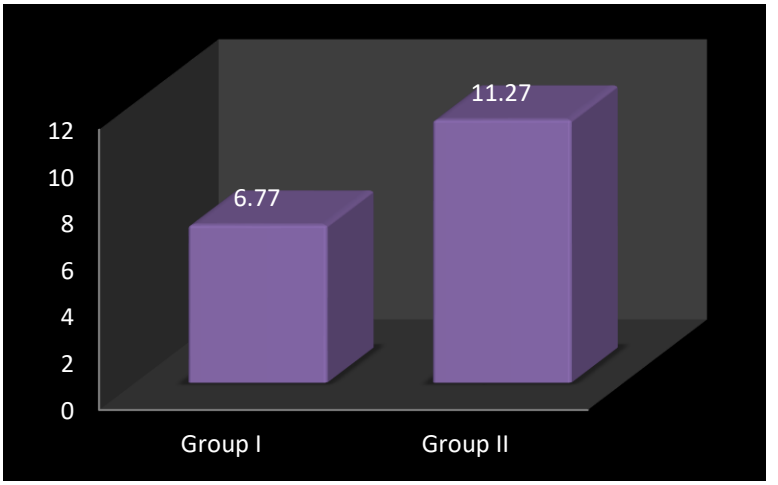
Graph 11. Inter-group comparison of mean score of TAF at 12th week among study subjects

TAF at 12 weeks in group 1 is 260.33 and TAF at 12 week in group 2 was 232.66 which are statistically significant.

Table 12
Inter-group comparison of mean score of DASH at 12th week among study subjects

	Group	N	Mean	Std. Deviation	Mean difference	p value
DASH	Group I	15	6.77	2.014	-4.5	<0.001 (S)
	Group II	15	11.27	2.17		

Test applied: Unpaired t test



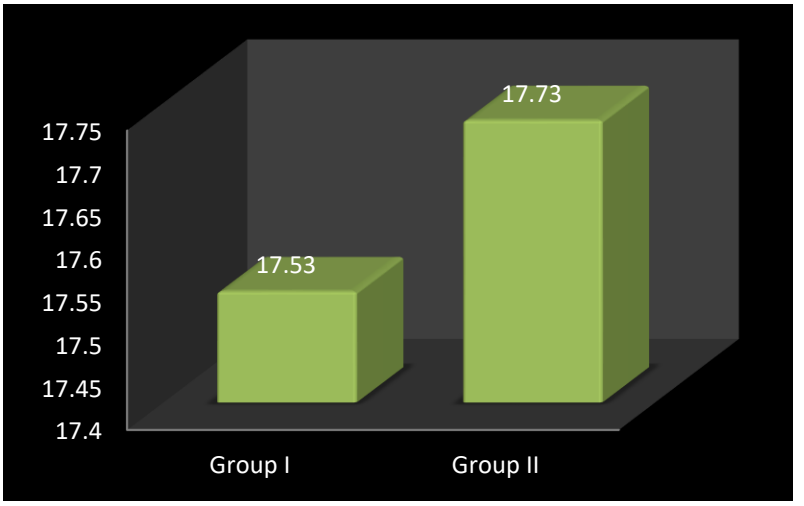
Graph 12. Inter-group comparison of mean score of DASH at 12th week among study subjects

DASH SCORE in group 1 is 6.77 and DASH SCORE in group 2 is 11.27.which is statistically significant.

Table 13
Inter-group comparison of mean score of complete union time on x-ray among study subjects

	Group	N	Mean	Std. Deviation	Mean difference	p value
complete union time	Group I	15	17.53	1.72	-0.2	>0.05 (NS)
	Group II	15	17.73	1.22		

Test applied: Unpaired t test



Graph 13. Inter-group comparison of mean score of complete union time on x-ray among study subjects

Complete mean union time in group 1 is 17.53 weeks and complete mean union time in group 2 is 17.73 which are statistically not significant.

Discussion

Hand injuries are common and usually result in metacarpal and phalangeal fractures. These injuries usually occur in adolescents and active young patients. Metacarpal and phalangeal fractures constitute 15-28% of all cases referring to the emergency department. Fractures of the metacarpal and phalanges constitute 10% of all fractures. Although these fractures are considered minor injuries, such injuries may cause major disabilities. There is no established treatment modality for metacarpal fractures. The optimal treatment modality is based on an individual patient fracture pattern. This suggests that it would be mandatory to select the optimal treatment modality for each case although many cases of metacarpal fractures can be treated by conservative management at present. In an actual clinical setting, there are some patients who achieve a recovery even when almost or completely left untreated. If over treated or incorrectly treated, however, patients will present with deformity or other severe complications than the deformity.

Age incidence

In this study, 16 (53.33%) patients were in age group of 20-30 years old and 8 (26.66.%) were in 30 to 40 years old age group,4(13.33%) were in 40-50 years old age group,1(3.33%) was 50-60 years old age group, and 1(3.33%) was in 60-70 years old with mean age being 32.4 years. These are similar to the studies done by Bergman, E., Lempesis (2021)[17] et al who found that men aged 10-29 to have the highest incidence rates for metacarpal fracture (2.5 per cent). E B H van Onselen et.al (2003) retrospectively found that patients with hand fractures were typically men aged between 15 and 35 years. Feehan LM &Sheps SB (2006) proposed that the most common age for a hand fracture was 14 years for males and 13 years for females. Males had a 2.08 greater relative risk for hand fracture and they maintained most of this increase in risk between the ages of 15 and 40. Venkatesh R, Kerakkanavar S et.al (2017)[13] also had similar findings who found that the mean age of the patient was 31.50±9.02 years (range 20-54 years). Fourteen (87.5%) patients out of 16 fell in age group of 20-40 years.

Sex incidence

In this study, 25(83.33%) patients were male and 5(16.66%) were female which is comparable to the studies done by Lempesis V, Rosengren BE (2019)[18] who found that males had a 2.08 greater relative risk for hand fracture and they maintained most of this increase in risk between the ages of 15 and 40 and Michael N. Nakashian(2012) who found metacarpal fractures to be more common in males (IR 23; 95 % CI, 22.9–23.1) than females (IR 4.5; 95 % CI, 4.5–4.5), with an incidence rate ratio of 5.08. Aksay E, Yesilaras M (2015)[15] in their study of 1475 hand fractures, found that 271 (18.4%) were located in the fifth metacarpal bone. In 130 of these cases (121 male, nine female), proving a significant male female distribution. A study by Spies CK, Langer M et.al (2019)[19] had majority of their patients as male (87.5%) with male female ratio of 7:1.

Mechanism of Injury

RTA and falls were most common mode of injury in this study accounting for around 12 (40%) cases amogs other causes different activities were 11(36.66%) and 7(23.33%) were physical assault cases. This is in corroboration with the studies done by Bergman, E., Lempesis (2021)[17]. Michael N. Nakashian (2012) found that the most common mechanisms of injury were contact with a wall or door, and falls. The most common setting was in the home, followed by recreational locations.

Distribution of hand injuries according to side

20(76.66%) patients had right side metacarpal fracture while 7(23.33) had left side metacarpal fracture.

Pattern of Facture

Most common fracture type was transverse fractures 12(40%). Communited fracture were 8(26.66), long oblique type were 6(20%), short oblique were 3(10%) and 1(3.33%) fracture was spiral oblique type. Spies CK, Langer M (2019)[19] et al found that oblique fracture was the most commonly observed fracture type in 8 (47.1%) patients followed by spiral in 6 (35.3%) and transverse in 3(17.6%).

Plate and K-wire size used:

Low profile titanium mini plate of 2 mm was used in this study for the fixation of the metacarpals fractures. For comminuted fractures, 2.4mm plates were used. The plate was contoured to the normal shape of the metacarpal. Kirschner wires of size 0.045- or 0.062-in. were used which was inserted retrogradely through metacarpal head.

Duration time for surgery

Duration of surgery was more in group I patients as it required opening up of the fracture site for fixation. This is comparable to the study done by Jiaming Xu (2014)[16] who also had a longer surgery time in patients undergoing miniplate fixation for metacarpal shaft fractures. Somboon Wutphiriya-angkul, MD (2009) described the mean total surgical time was 37 minutes (range, 25-60 minutes) for the K-wire group and 51 minutes (range, 35-70 minutes) for the miniplate group; this difference was significant ($P < 0.01$) which is similar to the findings of this study.

Range of motion at metacarpophangeal joint at follow-up

In this study at 3rd week group 1 patient mean ROM was 61.0 compare to 49.66 in group 2 patients, at 6th week mean ROM was 71.0 and 59.6 in group 2 patient, at the end of 12th week mean ROM in group 1 was 76.33 compare to 69.00 in group 2 patients. Mean ROM are same in both group patients at the end of 24 week. So early ROM is statistically significant Final range of motion of proximal interphalangeal joint at different time: In this study at 3rd week, group 1 patients

mean ROM was 81.00 compare to 65.00 in group 2 patient, at 6th week mean ROM was 89.33 and 74.66 in group 2 patient, at the end of 12th week mean ROM in group 1 was 107.33 compare to 90.33in group 2 patients. Mean ROM was same in both group patients at the end of 24 week so early ROM is statistically significant.

Range of motion of proximal interphalangeal joint at followup

In this study at 3rd week group 1 patient mean ROM was 81.00 compare to 65.00 in group 2 patient, at 6th week mean ROM was 89.33 in group 1 and 74.66 in group 2 patient, at the end of 12th week mean ROM in group 1 was 107.33 compare to 90.33 in group 2 patients. Mean ROM were same in both group patients at the end of 24 week so early ROM is statistically significant.

Range of motion of distal interphalangeal joint at follow-up

In this study at 3rd week group 1 patients mean ROM was 57.33 compare to 52.00 in group 2 patient, at 6th week mean ROM was 66.00 in group1 and 60.00 in group 2 patient, at the end of 12th week mean ROM in group 1 was 76.66 compared to 73.33 in group 2 patients. Mean ROM were same in both group patients at the end of 24 week so early ROM is statistically significant.

Final total active motion (TAM) at the end of 12 week

Total active motion (TAM) in this study in group 1 patients was 260.33 and in group 2 patients was 232.66, p value is <0.001 which is statistically significant which similar to Spies CK, Langer M (2019)[19] found that TAF improved in successive follow-up which was 240.59 ± 36.82 at 3 month and 261.76 ± 24.87 at the end of 6 months. At three months, mean TAF was significantly lower in comparison to the normal ray (p=0.002), although ASSG TAF was excellent (>220°). The mean TAF of operated ray improved to 261.76±24.87 at 6 month, which was not significantly different (p=0.06) from that of normal ray (272.94±4.69) which is similar to this study. Ahmed Z, Haider MI (2020)[20] studied that total active ROM in miniplate group was more than K-wire group in all fracture categories, but this difference did not reach significance Total active motion (TAM) in miniplate group was more than K-wire group in all fracture categories, but this difference did not reach significance.

Conclusion

This study provides new evidence that expands the inclusion criteria for the treatment with Low profile mini titanium plating and shows that it can be successfully used regardless of fracture location and fracture pattern in metacarpal shaft fracture. Thus it proves to be a practically feasible, economically viable and an effective treatment method for treatment of isolated closed displaced metacarpal shaft fracture as compared with closed reduction and K-wire fixation. Metacarpal fractures are common hand and upper extremity injuries encountered in the emergency department. The ideal treatment modality of closed isolated metacarpal shaft fractures is still inconclusive and the optimum treatment modality is based on the extent and mechanism of injury, patient's age,

concurrent injuries and surgeon's technical expertise, thereby, emphasizing on an individual patient fracture pattern based treatment. It is therefore mandatory to select an optimum treatment modality for each case. If over treated or incorrectly treated, however, patients will present with deformity or other severe complications than the deformity. Based on the clinical experience and results in this series, it can be concluded that LOW PROFILE MINI TITANIUM PLATING technique is an ideal method for treatment of isolated closed medial METACARPAL shafts fractures.

References

1. Ahmed Z, Haider MI, Buzdar MI, Chugtai BB, Rashid M, Hussain N, Ali F. Comparison of Miniplate and K-wire in the Treatment of Metacarpal and Phalangeal Fractures. Cureus. 2020 Feb 19;12(2).
2. Aksay E, Yesilaras M, Kılıc TY, Tur FC, Sever M, Kaya A. Sensitivity and specificity of bedside ultrasonography in the diagnosis of fractures of the fifth metacarpal. Emergency Medicine Journal. 2015 Mar 1;32(3):221-5.
3. Amin TK, Patel I, Patel MJ, Kazi MM, Kachhad K, Modi DR. Evaluation of results of open reduction and internal fixation (ORIF) of fracture of distal end of femur with intra-articular extension. Malaysian Orthopaedic Journal. 2021 Nov;15(3):78.
4. Bergman, E., Lempesis, V., Jehpsson, L. *et al.* Time trends in pediatric hand fracture incidence in Malmö, Sweden, 1950–2016. *J Orthop Surg Res* 16, 245 (2021). https://doi.org/10.1186/s13018-021-02380-y.
5. Branco DF, Bouvet C, Hamard M, Beaulieu JY, Poletti PA, Boudabbous S. Reliability of radio-ulnar and carpal alignment measurements in the wrist between radiographs and 3D imaging. European Journal of Radiology. 2022 Sep 1; 154:110417.
6. Chinchalkar SJ, Barker CA, Owsley B. Relationship between juncturae tendinum and sagittal bands. Journal of Hand and Microsurgery. 2015 Jun; 7(01):96-101.
7. Desai MJ, Wanner JP, Lee DH, Gauger EM. Failed extensor tendon repairs: extensor tenolysis and reconstruction. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2019 Aug 1;27(15):563-74.
8. Goyal N, Bohl DD, Ong KL, Lau E, Nicholson GP, Wysocki RW. Reoperation risk after total elbow arthroplasty versus open reduction internal fixation for distal humerus fractures in elderly patients. Journal of Orthopaedic Trauma. 2020 Sep 1; 34(9):503-9.
9. Gracy JA. The Hand and Wrist. InOrthopedics for Physician Assistant and Nurse Practitioner Students 2022 (pp. 27-52). Springer, Cham.
10. Hazlerigg A, Riley N, McNab I. Metacarpophalangeal joint extensor tendon centralisation: a new technique using the juncturae tendinum with a proximal based partial extensor digitorum communis slip. Annals of the Royal College of Surgeons of England. 2020 May 1;102(5):391.
11. Henry TW, Tulipan JE, Kwan SA, Beredjiklian PK, Lutsky KF, Matzon JL. Outcomes after surgically managed oblique extra-articular proximal phalanx fractures: a comparison of closed-reduction percutaneous pinning and open-reduction internal fixation with lag screws. Hand. 2021 Apr 9:15589447211003185.

12. Jiaming Xu and Changqing Zhang Mini-plate versus Kirschner wire internal fixation for treatment of metacarpal and phalangeal fractures in Chinese Han population: a meta-analysis Journal of Orthopaedic Surgery and Research 2014, 9:24 doi: 10.1186/1749-799X-9-24.
13. Jung J, Haghverdian B, Gupta R. Proximal interphalangeal joint fusion: indications and techniques. Hand Clinics. 2018 May 1; 34(2):177-84.
14. Lempesis V, Rosengren BE, Landin L, Tiderius CJ, Karlsson MK. Hand fracture epidemiology and etiology in children-time trends in Malmö, Sweden, during six decades. J Orthop Surg Res. 2019 Jul 12;14(1):213. doi: 10.1186/s13018-019-1248-0. PMID: 31299998; PMCID: PMC6626361.
15. Passias PG, Poorman GW, Segreto FA, Jalai CM, Horn SR, Bortz CA, Vasquez-Montes D, Diebo BG, Vira S, Bono OJ, De La Garza-Ramos R. Traumatic fractures of the cervical spine: analysis of changes in incidence, cause, concurrent injuries, and complications among 488,262 patients from 2005 to 2013. World neurosurgery. 2018 Feb 1; 110:e427-37.
16. Picerno P, Caliandro P, Iacovelli C, Simbolotti C, Crabolu M, Pani D, Vannozzi G, Reale G, Rossini PM, Padua L, Cereatti A. Upper limb joint kinematics using wearable magnetic and inertial measurement units: an anatomical calibration procedure based on bony landmark identification. Scientific reports. 2019 Oct 8; 9(1):1-0.
17. Sedaghat AR. Understanding the minimal clinically important difference (MCID) of patient-reported outcome measures. Otolaryngology–Head and Neck Surgery. 2019 Oct; 161(4):551-60.
18. Spies CK, Langer M, Hohendorff B, Mueller LP, Oppermann J, Unglaub F. Open reduction and screw/plate osteosynthesis of metacarpal fractures. Operative Orthopadie und Traumatologie. 2019 Sep 5;31(5):422-32.
19. Venkatesh R, Kerakkanavar S. Functional outcome of closed metacarpal shaft fractures managed by low-profile miniplate osteosynthesis: A prospective clinical study. Journal of Orthopaedics and Spine. 2017 Jul 1; 5(2).
20. Yang K, Deng J, Pan Y, Yuan Y, Duan G, Zhu J. Secondary Thumb Reconstruction via Ectopic Banking of Bony Phalanges from a Nonreplantable Amputated Thumb: A Follow-Up Study. The Journal of Hand Surgery. 2022 Aug 26.