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Management of Fractures of Metacarpals and Phalanges of Hand with Mini External Fixator

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Abstract

Introduction: Metacarpal and phalangeal fractures are more common injuries in hand, either closed or open. These injuries are encountered every day. Most of the fractures are treated conservatively, but for unstable fractures, open fractures, comminuted fractures operative treatment is indicated. This study was undertaken to evaluate the functional outcome of closed or open metacarpal and phalangeal fractures treated with a mini-external fixator.

Materials and Methods: From July 2016 to June 2019, a total of 40 cases of metacarpal and phalangeal fractures of the hand were treated with a mini-external fixator. All patients were screened using inclusion and exclusion criteria. Follow up was done till 12 months to evaluate the fracture union and range of movements by DASH score.

Results: The mean soft tissue healing was 2.56 weeks. The mean fracture healing was 14.45 weeks. The results were found excellent in 55%, good in 22.5% cases, fair in 15% cases, whereas poor results were seen in 7.5% of fractures.

Conclusion: External fixation is an adequate alternative treatment for unstable phalangeal and metacarpal fractures which are open or accompanied by severe soft-tissue injuries.

Keywords: Mini-External Fixator; Metacarpal; Phalanx; DASH Score

Introduction

The hand is the most vulnerable part of the body prone to injuries especially in road traffic accidents, fall, blunt trauma, industrial, agricultural and sports injuries resulting in fractures of phalanges and metacarpal which may be open or closed fractures. Fractures of metacarpals and phalanges are the most common among upper limb bony injuries and contribute to about 10% of total fractures among them [1-3]. Fractures of the metacarpal and phalanges are more common in males and the peak incidence is at the age of 10 - 40 years [4,5]. Fractures of the proximal phalanx (PP) are more frequently encountered than the middle or distal phalanx [6]. The displacement with considerable deformity is typical when the proximal phalanx is fractured.

Citation: Madhan Jeyaraman., et al. "Management of Fractures of Metacarpals and Phalanges of Hand with Mini External Fixator". Acta Scientific Orthopaedics 4.9 (2021): 34-39. Fractures of the hand are common problems in hand surgery. Bone fragments are comparatively small and comminuted hence reduction is hard to be conducted. A few of the factors which affect the treatment include injury to the tendons, ligaments and articular capsule. The principle in treating this type of fracture include anatomical reduction, stable fixation and early mobilisation [7,8].

Fractures of the hand can be managed by non-operative and operative management. Non-operative treatments like splinting, buddy strapping and slab application [9]. Operatively by k-wire, plates and screws etc leads to further damage to the soft tissues, stiffness of the joints, delay in rehabilitation [10].

External fixation for fractures of the hand allows fracture reduction and maintain normal bony length and provides rigid external support [11]. External fixation allows mobilisation of joints proximal and distal to the fracture. External apparatus is used as an alternative to internal fixation. Advantages like it simplify surgery being both quick and easy to apply, maintains alignment, avoids internal dissection, minimal soft tissue damage allowing early mobilisation [12].

We aimed to assess the functional outcome of closed and open fractures of metacarpals and phalanges using a mini-external fixator.

Materials and Methods

After obtaining institute ethical clearance, a prospective study was carried out from July 2016 to June 2019 with a total of 40 patients with metacarpal and phalangeal fractures.

Patients 18-65 years of age, patients with unstable fractures of the hand, intraarticular and extra-articular fractures, open fractures, and multiple fractures were included in the study. Patients with severely crushed hand injuries with extensive soft tissue damage, pathological fractures, associated vascular and tendon injuries, and delayed presentation for management were excluded from the study.

All the patients were treated by mini external fixator as shown in figure 1 to 4 and followed up at the immediate post-op period and at the end of 1, 2, and 6 months and evaluated for functional outcome using DASH score as shown in figure 5 to 8.



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Figure 2: K-wire drilled at an angle of 45 degrees.

Figure 3: Distractor frame connected to k-wires.

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Figure 5: Radiograph of fracture of shaft of 4th and 5th proximal phalanx of the right hand.

Figure 6: Post-op X-ray showing proximal phalanx fracture fixed with the mini-external fixator.

Figure 8: Range of movements.

The descriptive statistics were reported as mean (SD) for continuous variables, frequencies (percentage) for categorical variables. Data were statistically evaluated with IBM SPSS Statistics for Windows, Version 25.0, IBM Corp, Chicago, IL. The functional outcome was measured by a repeated-measures ANOVA test with a Greenhouse-Geisser correction. The p-value of less than 0.05 was considered significant.

Results

The most common age group presenting was < 30 years (45%). The mean age of the study participants were 33.85 ± 10.15 . Males (65%) outnumbered females (35%) in our series. A total of 72.5%

Citation: Madhan Jeyaraman., et al. "Management of Fractures of Metacarpals and Phalanges of Hand with Mini External Fixator". Acta Scientific Orthopaedics 4.9 (2021): 34-39. of the patients had RTA and 27.5% had an occupational mode of injury and assault.

Out of 40 cases, 9 cases (according to Swanson., *et al.* classification, 6 cases were type 1 and 3 cases were type 2) reported with open fractures. Three cases were reported with the distal end of radius fracture in 2 cases and shaft of radius fracture in 1 case. The fractures united for 8 cases (20.0%) in 8 - 12 weeks, 26 cases (65.0%) in 13 - 16 weeks and 6 cases (15%) in 17 - 20 weeks. The duration of JESS in situ for 16 cases (40.0%) in 3 - 4 weeks, 18 cases (45.0%) in 5 - 6 weeks and 6 cases (15%) in 7 - 8 weeks. The time taken for different parameters related to surgical outcome were tabulated in table 1.

Variable	Mean	SD
Surgery Time (in days)	2.50	4.40
Healing time soft tissue (in weeks)	2.56	0.88
Healing time fracture (in weeks)	14.45	2.68
Ex-fix <i>in situ</i> (in weeks)	5.15	1.13

Table 1: Time taken	for different	parameters
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The results were found excellent in 55%, good in 22.5% cases, fair in 15% cases, whereas poor results were seen in 7.5% of fractures. A total of 14 cases (35%) have partial stiffness, 8 cases (20%) had malunion, 3 cases (7.5%) had pinloosening, and 2 cases (5%) had pin tract infection. A repeated-measures ANOVA with a Greenhouse-Geisser correction determined that the mean DASH score differed statistically significantly between time points [F (1.726,32.78) = 159.804, p < 0.001] as shown in table 2.

Timeline	Mean	SD	(95% CI) Lower bound	(95% CI) Upper bound	P-value
1 st month	86.400	3.011	80.098	92.702	< 0.001
3 rd month	64.250	2.971	58.032	70.468	< 0.001
6 th month	52.300	3.096	45.820	58.780	< 0.001

Table 2: DASH score.

Discussion

Fractures of metacarpals and phalanges are probably the most common fractures in the skeletal system and are often neglected as minor injuries [10,13]. Most of the fractures are treated conservatively, but fixation is often indicated in unstable fractures, intra-articular fractures, open fractures and multiple fractures. Mini-external fixator acts by the principle of ligamentotaxis to achieve closed reduction without requiring immobilization of the adjacent joint [14].

Various studies by Jenkin., *et al.* [15] [external fixation apparatus], Parson., *et al.* [16] [Shearer micro-external fixator], Mullett., *et al.* [17] ["S" Quattro dynamic external fixator], Kontakis., *et al.* [18] [mini-Hoffman external fixation], Fricker., *et al.* [19] [AO mini-external fixator], Inanami., *et al.* [20] small dynamic external finger fixator], Johnson., *et al.* [21] [dynamic external spring fixator], Li., *et al.* [22] [mini external fixator + limited internal fixation], El-Shaer., *et al.* [23] [mini external fixator], and Yaseen., *et al.* [24] [mini external fixator] reported excellent to good functional outcome in metacarapal and phalangeal fractures of hand with the follow-up duration of 3 to 9 months.

Gupta., *et al.* reported at the end of 3 months follow up, an excellent total active range of motion was observed with plate and screw/screw fixation technique (100%) and closed reduction and percutaneous Kirschner wire fixation (60%) for metacarpal and phalangeal fractures of the hand with finger stiffness as the most common reported complication in this series [25]. Out of 30 patients with 37 fractures of metacarpal and phalanges, Bakki., *et al.* reported excellent in 35.13%, good in 40.55% cases, in 18.92% whereas poor results in 5.40% with JESS fixation [5]. With UMEX (universal mini external fixator), Gupta., *et al.* managed 45 patients with metacarpal and phalanges fracture of the hand. The results were found excellent in 35.55, good in 37.77, fair in 13.33, whereas poor results were seen in 13.33% of fractures [14].

Kapur., *et al.* reported a study on intra-articular fractures of the proximal interphalangeal (PIP) joint treated with dynamic external fixation. All fracture cases are united with good joint congruency. All patients achieved a good range of motion of the PIP joint but with some restriction of full flexion (mean, 20 degrees). No complications were reported during the follow-up [26]. Drenth., *et al.* used an external fixator for phalangeal and metacarpal fractures and reported that the functional outcome was excellent in middle phalangeal fractures than proximal phalangeal fractures [27].

Shehadi., *et al.* employed external fixation with methylmethacetylate rods in 26 hand fracture cases (19 metacarpal

Citation: Madhan Jeyaraman., et al. "Management of Fractures of Metacarpals and Phalanges of Hand with Mini External Fixator". Acta Scientific Orthopaedics 4.9 (2021): 34-39. and 11 phalangeal) and reported the percentage return of total range of motion in phalangeal fractures varied from 66% to 98% (mean 84%), and in metacarpal fractures, it varied from 77% to 100% (mean 96%) [12]. Various parameters have been studies among published literature were tabulated in table 3.

Parameters		Bakki., <i>et al</i> . [5]	Gupta., <i>et al</i> . [14]	Our study
No. of patients		30	45	40
	Proximal phalanx	21	15	17
Fractures distribution	Middle phalanx	04	14	13
	Distal phalanx	-	-	02
	Metacarpal	13	16	08
Fixator used		UMEX	UMEX	JESS distractor
Fixator <i>in situ</i>		4.42 weeks	5.21 weeks	5.15 weeks
Mean soft tissue healing		2.61 weeks	2.32 weeks	2.56 weeks
Mean fracture healing		12.77 weeks	12 weeks	14.45 weeks
Complications	Pin tract infection	5	12	03
	Pin loosening	3	12	02
	Joint stiffness	10	15	14
	Malunion	2	06	08
	Non union	0	0	0
	Osteomyelitis	0	0	0
Results	Excellent/ Good	28	33	22/9
	Fair/poor	09	12	6/3

Table 3: Comparison of various surgical parameters in thepublished literature.

In our series of 40 cases, the results were found excellent in 22 (55%) cases, good in 9 (22.5%) cases, fair in 6 (15%) cases, whereas poor results were seen in 3 (7.5%) cases. A repeated-measures ANOVA with a Greenhouse-Geisser correction determined that the mean DASH score differed statistically significantly between time points [F (1.726,32.78) = 159.804, p < 0.001].

Conclusion

External fixation is an adequate alternative treatment for unstable phalangeal and metacarpal fractures which are open or accompanied by severe soft-tissue injuries. It is a minimally invasive procedure, reduces surgical trauma to soft tissue and protects vascular integrity. Understanding the biomechanical principles and correct applicationmethodology is essential.

Conflicts of Interest

Nil.

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