Outcomes of metacarpal and phalangeal fracture management with plate and screw fixation at Viet Duc University Hospital

Nguyen Van Hoc, Nguyen Manh Khanh, Cao Dinh Bang, Le Hoang Gia Khoa, Nguyen Van Su

Viet Duc University Hospital

Corresponding author:
Cao Dinh Bang
Viet Duc University Hospital
40 Trang Thi, Hoan Kiem, Ha Noi
Mobile: 0968 738 919
Email: caodinhbang93@gmail.com

Received date: 14/8/2024
Accepted date: 25/9/2024
Published date: 30/9/2024

Abstract

Introduction: The hand holds an essential role in our lives, it is the tool for labor and daily activities. There are numerous methods to treat metacarpal and phalangeal fractures and plate fixation, which have many benefits. This technique has been routinely applied at Viet Duc University Hospital for a significant duration, showing promising therapeutic outcomes. This study aimed to evaluate the consequences of operative fixation with microplates in treating metacarpal and phalangeal fractures in adults.

Patients and methods: This cross-sectional descriptive retrospective study was conducted on 60 patients diagnosed with metacarpal and phalangeal fractures and underwent plate fixation surgery at Viet Duc University Hospital from 01/2020 to 06/2021.

Results: The anatomical corrections of the fractures archived positive results, with good alignment and no patients experiencing significant displacement of the fracture over 10o or fracture area greater than 3mm. The success rate for bone fusion appeared in 97.3% of cases, with only one patient experiencing delayed fusion after 3 months. Evaluating postoperative hand functions based on TAM score showed good and excellent results, accounting for 94.6%

Conclusions: The application of plate and screw fixation for treating metacarpal and phalangeal fractures results in improved functional outcomes of the hand when compared to other therapeutic approaches.

Keywords: metacarpal and phalangeal fractures, plate fixations, hand functions.

Introduction

The hand plays a crucial role in daily functioning, serving as a primary instrument for labor and routine activities. With the rapid economic development, urbanization, and the rise in vehicular use, there has been a significant increase in the incidence of injuries, particularly hand trauma, associated with occupational and traffic accidents. Fractures of the metacarpals and phalanges are relatively common, accounting for approximately 10% of

all bone fractures[1]. Hand fractures can be treated conservatively due to their expeditious healing capability. However, delayed mobility might result in stiffness. The alignment of fractured bones rarely achieves precise anatomy, leading to the suppression of the hand function. Surgical treatment for these fractures currently involves several methods, such as intramedullary nail fixation and plate and screw fixation. Plate and screw fixation is regarded as the most advantageous among these methods. In Chiu's study[2], the stability of double screw fixation is inferior to bone plate fixation; however, this technique still achieves a stiffness similar to that of bone plate fixation.

In contrast, Neumeister's study[3] concludes that surgical intervention can lead to scarring and potentially greater stiffness compared to a conservative approach. Furthermore, a malaligned fracture does not necessarily result in a malaligned digit.

Orthopedic surgeons in Viet Duc University Hospital have performed many operations for fractures of metacarpals and phalanges using plate and screw fixation with satisfactory results, so this study was conducted to evaluate the surgical outcomes of this technique.

Patients and Methods

60 patients were diagnosed with traumatic metacarpal or phalangeal fractures and treated surgically with plate and screw fixation at Viet Duc University Hospital from January 2020 to June 2021.

Selection criteria:

Patients aged ≥18 years old

Diagnosed with metacarpal or phalangeal fractures

Complete medical records.

Patients attend all scheduled follow-ups.

Exclusion criteria:

Pathological fractures.

Incomplete medical records.

Research Method

Study Design: Retrospective descriptive study.

Data Collection: Review medical records, follow up for at least 3 months, and re-evaluate at 3 months, 6 months, 9 months, 12 months, and annually in subsequent years.

Sample Size: Convenience sampling. All patients who met the selection criteria during the study period from January 2020 to June 2021 were included.

Data Analysis: Using SPSS 20.0 software.

Treatment Outcome Evaluation: ASSH and CHEN criteria4.

Figure 1. Hand operative instruments.

Results

General characteristics:

The mean age of patients included in the study was 32.2 years, with an age range from 18 to 65 years. The male-to-female ratio was 2.7:1. Traffic accidents emerged as the leading cause of injuries, representing 41.6% of cases, followed by domestic accidents at 31.7%. The remaining injuries were attributed to various other causes.

Diagnostic characteristics:

Clinical characteristics:

In total, 74 metacarpal and phalangeal fractures, closed fractures comprised 64 cases (86.5%), whereas open fractures were only 10 cases (13.5%).

All 60 patients (100%) experienced pain at the fracture site and restricted movement. Local swelling, bruising, and subcutaneous hematoma were observed in 48 patients (80%). Skin lacerations at the fracture site were found in 10 patients (16.7%), including 3 patients with extensor tendon tear (5%) and 1 patient with a flexor tendon rupture (1.6%).

Radiological characteristics:

Metacarpal fractures represented 34 cases (46%), whereas phalangeal fractures made up 40 cases (54%). The fifth digit had the highest incidence of metacarpal fractures, accounting for 11 out of the 34 cases. 50 patients had a single fracture (83.3%), 6 had two fractures (10%), and 4 had fractures of three sites (6.7%).

Table 1: Metacarpal and phalangeal fracture location (n=74).

Fracture / Location	Metacarpal	Phalangeal	n	%
Head	3	2	5	6,8%
Neck	2	6	8	10,8%
Shaft	18	27	45	60,8%
Base	11	5	16	21,6%
Total	34	40	74	100

The most frequent fracture location is in the shaft of the metacarpal bones, with 45 out of 74 fractures occurring there. (18 fractures in the metacarpal bones and 27 fractures in the phalanges). Subsequently, fractures at the base of the bones account for 16 out of 74 fractures (21.6%). Neck fractures account for 10.8% of the cases, whereas head fractures are the least common, comprising only 5 out of 74 fractures (6.4%) (Table 1).

Transverse fractures are the most prevalent, representing 56.8% of cases, followed by oblique fractures at 36.4%. Comminuted fractures have the lowest incidences, occurring in 5 out of 74 cases (6.8%).

Short-term result:

The plate and screw fixation surgeries conducted by our team were without any intraoperative complications. None of the patients developed early postoperative infections, seromas, or hematomas. The mean hospital stay was 4.4 ± 2.5 days, with the shortest being 2 days and the longest 14 days. All patients exhibited complete wound healing, and sutures were removed within 7 to 10 days postoperatively.

Table 2: Postoperative angulation(n =74).

Angulation	Metacarpal	Phalangeal	N	Percentage
< 5^0	29	31	60	81,1%
5 - 10^0	5	9	14	18,9%
> 10^0	0	0	0	0
n	34	40	74	100%

There is a significant reduction in the angulation of fractured bones postoperatively, with all cases of angulation displacement measuring less than 10^o (Table 2).

Table 3: Postoperative fracture site displacement (n =74).

Displacement	Metacarpal	Phalangeal	N	Percentage
< 1mm	25	27	52	70,3%
1-3mm	9	13	22	29,7%
> 3mm	0	0	0	0
n	34	40	74	100%

No patients experienced displacement of the fracture site greater than 3 mm on radiological images postoperatively (Table 3).

Long-term results:

The study demonstrated that patients achieved good fracture healing within the expected time frame, with optimal callus formation occurring on average after 3 months. Only 2 patients experienced delayed healing.

There were 4 patients (6.6%) who exhibited signs of muscle atrophy, while 56 had no symptoms. Of the 74 fracture sites, 66 (89.2%) had no pain experienced during motion. Mild pain was reported in 5 cases (6.8%), and significant pain was noted in 3 cases (4%).

This study utilizes the classification system established by the American Society for Surgery of the Hand (ASSH) to assess functional movement outcomes. The Total Active Motion (TAM) assessment is categorized into four levels: excellent, good, fair, and poor, based on the percentage of the patient's range of motion relative to the normal expected active range (TAM%).

Table 4: Postoperative evaluation of patient's motion.

Result	Metacarpal fracture	Phalangeal fracture	Total	Percentage
Excellent	14	15	29	39,2%
Good	18	23	41	55,4%
Satisfactory	2	2	4	5,4%
Poor	0	0	0	0
Total	34	40	74	100%

The majority of patients (86.7%) were able to resume their prior occupations without problems. However, 8 out of 60 patients faced some work limitations, and finger function was preserved in all instances. Evaluation of joint mobility in the metacarpophalangeal and interphalangeal joints indicated that 39.2% of cases achieved excellent results, 55.4% (41 out of 74 fractures) had good results, and 5.4% (4 fractures) showed moderate outcomes.

Table 5: Postoperative evaluation according to ASSH (n=74).

Result	Metacarpal fracture	Phalangeal fracture	Total	Percentage
Excellent	14	15	29	39,2%
Good	18	20	38	51,4%
Satisfactory	2	4	6	8,1%
Poor	0	1	1	1,3%
Total	34	40	74	100%

Based on the ASSH criteria, 90.6% of cases demonstrated either excellent (39.2%) or good (51.4%) outcomes, while 8.1% (6 out of 74 fractures) had average results, and 1.3% (1 case) showed poor results (Table 5).

Example case images:

Figure 2. 21-year-old male patients with proximal phalangeal fracture of IV digit.

Figure 3. Postoperative Xray.

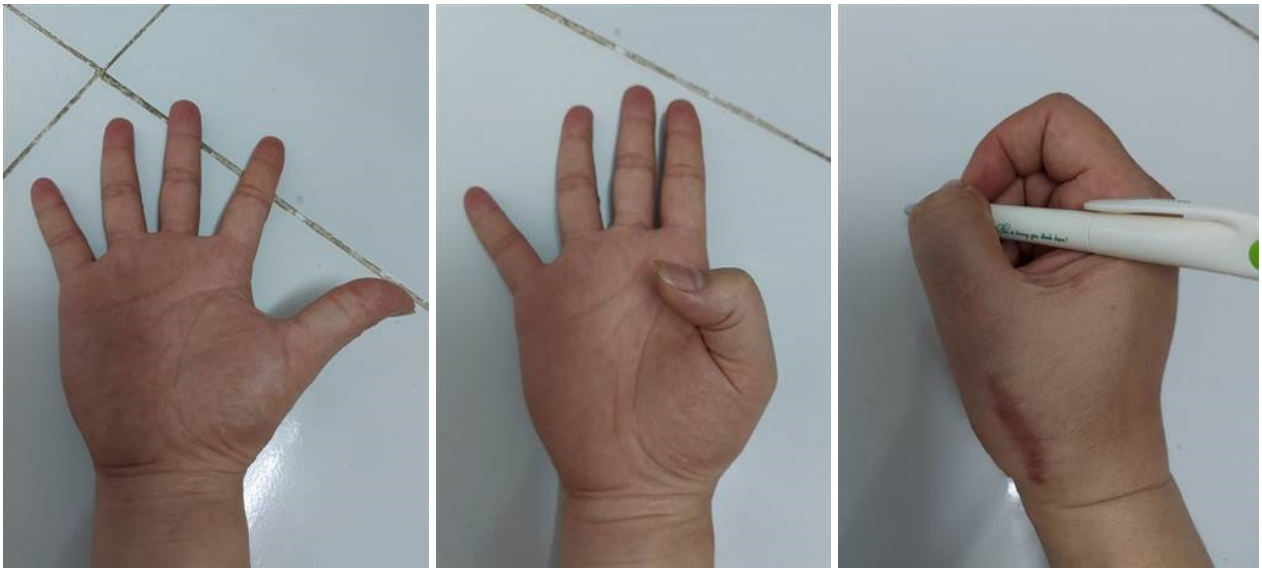

Figure 4. Six-Month Follow-Up Motion. Results: No pain during movement, return to normal daily activities and occupation, and full range of motion achieved.

Discussion

General characteristics:

In our study, the predominant age group was 18-40 years, comprising 49 cases or 81.7% of the sample, followed by the 41-60 year age group, which accounted for 13.3%. The average age of participants was 32.2 years. These findings are consistent with those reported by other researchers,

including Tran Trung Dung[5], Rashed Eman Rashed[6], and Fahad A. Alhumaid[7].

The male/female ratio was 2.7, aligning our findings with both domestic and international studies. Notably, the 2019 study conducted by Rashed Eman[6] in India indicated a more balanced gender distribution; however, this observation was based on a small cohort of 20 patients.

The primary cause of fractures was traffic accidents, comprising 41.6% of cases, followed by domestic accidents at 31.7%. Several studies reported occupational accidents as the leading cause, our study findings indicate that trauma from traffic accidents is the most common cause. This is reflective of the current economic and traffic conditions in Vietnam.

Diagnostic characteristics:

In this study of 60 patients with 74 fracture sites, our results concerning the X-ray characteristics such as the number of fracture sites, their locations, and morphologies, were consistent with the findings of authors Tran Trung Dung[5], Phan Ba Hai[8], and Fahad A. Alhumaid[7]. However, while they differ from the results reported by Vu Viet Son[8], a consistent observation is that the majority of phalangeal fractures occurred in the proximal phalanx (56 out of 66 phalangeal fractures).

Treatment results:

Our study found that, after 3 months, 97.3% of patients achieved good bone healing as verified by X-ray standards. Only two patients exhibited delayed healing at the 3-month follow-up, related to severe bone and soft tissue injuries. These patients received additional medical treatment and subsequently achieved bone union within 6 months. Vu Viet Son[9] reported a bone healing rate of 98%, with only one case of impaired healing and a nonunion. Page's study indicated a 4.5% delayed union rate and a 1.5% nonunion rate among 66 metacarpal fractures treated with plate and screw fixation[10]. According to Jupiter JB, Koniuch MP, and Smith RJ[11], clinical bone healing (defined as a stable and painless fracture site) typically occurs within 4-5 weeks for metacarpals and 3-4 weeks for phalanges, which are confirmed by X-ray, with a nonunion rate of approximately 1%[11]. Therefore, our findings are consistent with both domestic and international studies, demonstrating that plate and screw fixation produces high bone healing rates.

The postoperative range of motion result based on ASSH criteria was categorized as excellent in 29 fractures (39.2%), good in 41 fractures (55.4%), and average in 3 fractures (5.4%). The mean Total Active Motion (TAM) at 3 months after surgery in our study was $230.5^o \pm 22.5^o$. This finding is comparable to the results reported by Tran Trung Dung[5], who observed a 3-month postoperative TAM of $246^o \pm 15.6^o$, with excellent and good range of motion outcomes accounting for 93.5%. In contrast, our range of motion results differ from those reported by Basar[12] ($212.3^o \pm 30.3^o$) and Brei-Thoma[13] (213^o). Variations in the 3-month postoperative range of motion across studies can be the result of differences in soft tissue injuries. Many other studies included a higher proportion of patients with open fractures, whereas only 10 out of 60 patients in our study had open fractures. Additionally, TAM measurements are influenced by the number of fractures involving the first metacarpal, where the normal TAM for the first finger is a maximum of 160^o, compared to 260^o for other fingers. We used ASSH's range of motion evaluation based on TAM to compare our results with other studies.

The study's overall results showed that 60 patients and 74 fractures met the evaluation criteria, as follows: excellent and good results account for 90.6%, achieving excellent and good results. Tran Trung Dung's study reported excellent and good outcomes in 93.5% of cases, with 2 patients achieving average results. Similarly, Vũ Viết Sơn's study indicated excellent and good results in 96.8% of cases, with only 1 patient experiencing poor outcomes[5]. Phan Ba Hai's study demonstrated excellent and good results in 90% of cases, with 2 patients attaining average results and 1 patient experiencing poor results[8].

Our evaluation criteria are relatively consistent with those used in other studies, and our results are comparable to those of other authors. The proportion of good and excellent outcomes in our study aligns with the results reported by Phan Ba Hai[8], which is slightly lower than those reported by Tran Trung Dung[5] and Vu Viet Son[9]. Nonetheless, with the rate of good and excellent outcomes exceeding 90%, the findings underscore the reliability of the internal fixation method for metacarpal and phalangeal fractures and highlight the advantages of plate and screw fixation.

Conclusion

In this study of 60 patients with 74 fracture sites, we evaluated fracture healing, postoperative function, and mobility which revealed that plate and screw fixation for hand fractures provides notable advantages and merits further development.

References

1. Karl JW, Olson PR, Rosenwasser MP. The Epidemiology of Upper Extremity Fractures in the United States, 2009. J Orthop Trauma 2015; 29(8): e242-4.
2. Chiu Y-C, Ho T-Y, Hsu C-E, Ting Y-N, Tsai M-T, Hsu J-T. Comparison of the fixation ability between lag screw and bone plate for oblique metacarpal shaft fracture. Journal of Orthopaedic Surgery and Research 2022; 17(1): 72.
3. Neumeister MW, Winters JN, Maduakolum E. Phalangeal and Metacarpal Fractures of the Hand: Preventing Stiffness. Plast Reconstr Surg Glob Open 2021; 9(10): e3871.
4. Wei FC, Al Deek NF, Lin YT, Hsu CC, Lin CH. Metacarpal-Like Hand: Classification and Treatment Guidelines for Microsurgical Reconstruction with Toe Transplantation. Plast Reconstr Surg 2018; 141(1): 128-35.
5. Dung. TT. Evaluation of the treatment outcomes for metacarpal and phalangeal fractures using plate and screw fixation at Hanoi Medical University Hospital. Vietnam Journal of Practical Medicine. 2013;884(10):8-9.
6. Rashed RE, Hegazy GM, Abusamada HSAA. Results of Treatment of Oblique and Spiral Phalangeal Fractures of the Hand by Mini Lag Screws. The Egyptian Journal of Hospital Medicine 2019; 76(4): 3882-90.
7. Alhumaid FA, Alturki ST, Alshareef SH, et al. Epidemiology of hand fractures at a tertiary care setting in Saudi Arabia. Saudi Med J 2019; 40(7): 732-6.
8. Hai PB. Evaluation of surgical outcomes for metacarpal and phalangeal fractures in adults at Viet Duc University Hospital. Residency thesis, Hanoi Medical University. 2011.
9. Son VV. Evaluation of treatment outcomes for metacarpal and phalangeal fractures using plate and screw fixation. Master's degree thesis in Medicine, Hanoi Medical University. 2010. 2010.
10. Page SM, Stern PJ. Complications and range of motion following plate fixation of metacarpal and phalangeal fractures. J Hand Surg Am 1998; 23(5): 827-32.
11. Jupiter JB, Koniuch MP, Smith RJ. The management of delayed union and nonunion of the metacarpals and phalanges. The Journal of Hand Surgery 1985; 10(4): 457-66.
12. Başar H, Başar B, Başçı O, Topkar OM, Erol B, Tetik C. Comparison of treatment of oblique and spiral metacarpal and phalangeal fractures with mini plate plus screw or screw only. Arch Orthop Trauma Surg 2015; 135(4): 499-504.
13. Brei-Thoma P, Vưgelin E, Franz T. Plate fixation of extra-articular fractures of the proximal phalanx: do new implants cause less problems? Arch Orthop Trauma Surg 2015; 135(3): 439-45.