Journal of Hand Surgery Global Online 6 (2024) 27–30

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Original Research

Metacarpal Fracture Repair: Early Reoperation Rates and Characteristics

Benjamin Miltenberg, MD, * Daniel Nemirov, MD, * Hassan Siddiqui, BS, * Alexis Kasper, BS, * Asif M. Ilyas, MD, MBA *

* Rothman Orthopaedic Institute at Thomas Jefferson University, Philadelphia, PA USA

ARTICLE INFO

Article history:
Received for publication August 4, 2023
Accepted in revised form August 7, 2023
Available online September 9, 2023

Key words:
Hardware removal
Metacarpal fracture
Metacarpal repair
Reoperation

Purpose: Metacarpal fractures are common injuries of the hand that often require operative repair. However, there is a paucity of data regarding the rate of reoperation and circumstances following metacarpal repair.

Methods: A retrospective review of all metacarpal fracture cases performed at a single academic institution between 2017 and 2021 was performed. All patients with isolated, acute metacarpal fractures were included for review. Data on patient demographics, fracture morphology, surgical technique, rate of early reoperation, and reason for reoperation were collected.

Results: A total of 499 patients were identified to have undergone operative treatment for an isolated metacarpal fracture with an average follow-up of 4.2 months. The rate of unplanned early reoperation was 8.0% (n = 40), with seven patients requiring revision fracture surgery and 33 patients undergoing removal of symptomatic hardware. Mean and median time to reoperation was 2.1 and 1.5 months, respectively. The rate of reoperation for fractures of the metacarpal shaft was significantly lower than that of other fracture locations. Among the 40 revision cases, one case was following percutaneous fixation while 39 cases were following open reduction and internal fixation. Other demographic factures and fracture characteristics failed to show significant correlations to the rate of reoperation.

Conclusions: An unplanned early reoperation rate of 8.0% after operative fixation of acute metacarpal fractures was observed with the majority involving cases of removal of symptomatic hardware and an average time to reoperation of approximately 2.1 months. This information can be used to counsel patients and set expectations about the potential for metacarpal fracture surgeries.

Type of Study/Level of Evidence: Prognosis 2b.

Metacarpal fractures are among the most common fractures treated by orthopedists and hand surgeons, representing approximately 40% of all upper-extremity fractures.[1-3] These injuries can be treated nonoperatively or operatively depending on fracture characteristics. Surgical treatment is typically indicated for fractures with malrotation, angulation, longitudinal shortening, and associated soft tissue injuries or bone loss.[1,4] Despite its utility, operative intervention is not devoid of complication.[5-7] It is valuable to understand the complications and reoperation rates associated with operative treatment of metacarpal fracture for both surgical decision making and appropriate patient counseling and expectation setting.

Although several studies have looked at complications associated with both operative and nonsurgical treatment of metacarpal fractures, there is a paucity of data regarding the rate of reoperation after these procedures.[5,7-10] Only a handful of studies have assessed reoperation rates as part of studies broadly addressing postoperative complications.[5,8,11] Moreover, these studies include relatively small numbers of patients and involve limited assessment of associated risk factors, highlighting the need for additional data on reoperation after surgically treated metacarpal fractures.[5,8,11]

The goal of this study is to better understand the rate and causes of reoperation after surgically treated metacarpal fractures. This

Declaration of interests: No benefits in any form have been received or will be received related directly to this article.

Corresponding author: Asif M. Ilyas, MD, MBA, Rothman Orthopaedic Institute, 925 Chestnut St, Philadelphia, PA 19107.
E-mail address: asif.ilyas@rothmanortho.com (A.M. Ilyas).

https://doi.org/10.1016/j.jhsg.2023.08.003

Table 1
Demographic and Fracture Morphologic Data

	Patients, n	Age (y), mean	Female (%)	BMI (kg/m^2), mean	Smoking (%)	Diabetes (%)	Metacarpal (%)	Location (%)
Open Reduction and Internal Fixation	342	39.6	23.4%	28.3	18.1%	3.2%	1st - 12.0% 2nd - 6.4% 3rd - 9.6% 4th - 24.6% 5th - 47.1%	Neck - 26.0% Shaft - 52.5% Base - 21.8%
Percutaneous Pinning	157	38	23.6%	25.4	17.2%	3.2%	1st - 35.0% 2nd - 5.1% 3rd - 0.6% 4th - 8.9% 5th - 49.7%	Neck - 24.2% Shaft - 21.0% Base - 54.8%
All Patients	499	39	23.4%	26.6	17.8%	3.2%	1st - 19.2% 2nd - 6.0% 3rd - 6.4% 4th - 19.6% 5th - 48.3%	Neck - 25.5% Shaft - 43.9% Base - 30.7%

BMI, body mass index.

information may assist surgeons in better counseling and educating their patients before surgery.

Materials and Methods

A retrospective review of all metacarpal fractures from a single, large, academic institution over a 5-year period between January 2017 and December 2021 was performed. Institutional review board approval was obtained prior to study commencement. Patients with operatively treated metacarpal fractures were identified via Current Procedural Terminology (CPT) codes. The following CPT codes were used: 26600, 26608, 26650, 26615, 26685, 26665, 26746, 26740, 26605, 26720, 26525, 26676, 26410, 26546, 26562, 26442, 26686, 26715, 26550, 26607, 29130, 26356, 26476, 26445, 26520, 26727, 26770, 26645, 26565, 26591, 26750, 26480, 26735, 26776, and 26568. The charts of identified patients were then manually reviewed. Patients with isolated and acute metacarpal fractures were eligible for inclusion. An acute fracture was defined as any fracture presenting within 4 weeks of injury. Exclusion criteria included patients with multiple metacarpal fractures, less than 6 weeks follow-up after surgery, additional other bony injuries to the hand or upper extremity, and patients who presented following previously failed management of subacute and chronic metacarpal fractures. Procedures were performed by one of 14 hand surgery fellowship-trained board-certified hand surgeons, each with a Certificate of Added Qualification in Hand Surgery.

For patients meeting inclusion criteria, baseline demographic data, patient specific risk-factors, and fracture morphological data was retrospectively collected. Baseline demographic data included age, race, sex, body mass index, smoking status, and history of diabetes. Diabetic and smoking history was self-reported by patients. Fracture morphological data collected included location, laterality, displacement, and description. Displacement was recorded in a binary fashion with any degree of displacement being considered as a displaced fracture. Metacarpal involvement was delineated one through five. Fracture location was recorded as base, shaft, or neck as determined by the operative surgeon's classification.

To determine the rate of reoperation, a query was performed, which extracted all operations performed within 1 year following the index metacarpal fracture surgery. Surgical procedures were manually reviewed. Reoperation was classified as any surgical procedure on the same digit and/or metacarpal as treated in the index operation. Hardware removal was only recorded as a reoperation for patients who underwent open reduction and internal fixation (ORIF) with subsequent hardware removal or for patients who underwent percutaneous fixation with documentation expressing unplanned return to the operating room (as many instanced of hardware removal after percutaneous fixation are planed).

Demographic variables and fracture morphologic data were compared between patients undergoing reoperation and those who did not require reoperation. Student's T-test was used to determine differences in means. Categorical variables were compared by Chi-squared test. The threshold for statistical significance was set at $P = .05$.

Results

In total, 4380 patient with metacarpal fractures were treated at our institution between January 2017 and December 2021. Specifically, 3648 patients underwent nonsurgical treatment of their fractures, and 732 patients underwent operative treatment. A total of 499 patients were identified to have undergone operative treatment for an isolated metacarpal fracture with at least 6 weeks of postoperative follow-up, with 342 patients undergoing ORIF and 157 undergoing closed reduction and percutaneous fixation. Demographic and fracture morphologic data can be seen in Table 1. Mean follow-up time for the entire group was 4.2 months (range 1.5–62.3 months). Mean follow-up for patients undergoing reoperation was 9.4 months (range 1.5–62.3 months).

The rate of unplanned reoperation was found to be 8.0% (n = 40) across all patients undergoing operative fixation of their metacarpal fracture, with one case being among patients undergoing percutaneous fixation and 39 cases among patients undergoing ORIF. Overall, only seven cases (1.4% of total patients) required revision fracture surgery. In addition, 33 cases (6.6% of total patients) underwent unplanned removal of deep symptomatic hardware; all cases of unplanned hardware removal were in patients undergoing ORIF. The average time to reoperation (including both revision surgery and hardware removal) was 2.1 months, and the median time to reoperation was 1.5 months (range 0.5–11.9 months).

Table 2 presents demographic and fracture morphologic data broken down by patients requiring reoperation and patients not requiring reoperation. No significant demographic differences were found between patients requiring

Table 2
Demographic and Fracture Morphologic Data Based on Reoperation or Non-Reoperation

	Patients, n	Age (y), mean	Female (%)	BMI (kg/m^2), mean	Smoking (%)	Diabetes (%)	Metacarpal (%)	Location (%)
Reoperation	40	34.3	27.5%	25.6	20.0%	3.5%	1st - 22.5% 2nd - 5.0% 3rd - 5.0% 4th - 15.0% 5th - 52.5%	Neck - 32.5% Shaft - 27.5% Base - 40.0%
No Reoperation	459	39.7	22.9%	26.7	17.6%	3.1%	1st - 19.0% 2nd - 6.1% 3rd - 7.0% 4th - 19.6% 5th - 47.5%	Neck - 25.4% Shaft - 44.3% Base - 30.3%

BMI, body mass index.

reoperation and those not requiring reoperation. Regarding fracture morphologic data, the rate of reoperation for fractures of the metacarpal shaft was significantly lower (rate: 4.8% - $X^2[1, N = 499] = 5.6$, $P = .2$). Other fracture morphologic features failed to show any significant difference in the rate of reoperation.

Among the seven cases requiring revision fracture surgery, the causes included loss of fracture fixation (n = 3), a new fracture around the previously repaired fracture (n = 2), and failure of the hardware (n = 2). Additional details regarding revision cases can be seen in Table 3.

Discussion

This study identified an unplanned early reoperation rate of 8.0%, with seven cases requiring revision surgery and 33 cases requiring removal of symptomatic hardware. No significant correlation was identified between patient demographics and rate of reoperation. Fracture morphologic characteristics did, however, show a correlation with the reoperation rate with fracture of the metacarpal shaft being associated with a significantly lower rate of reoperation compared to other fracture locations. These data can help surgeons when counseling patients and setting expectations.

In a systematic review comparing ORIF to percutaneous fixation for metacarpal shaft fractures, Greeven et al[9] report that 17% of patients undergoing ORIF required reoperation, whereas 0% of patients undergoing percutaneous fixation required reoperation. Given these results, the authors concluded that the higher rate of reoperation after ORIF suggests ORIF to be a less favorable technique than percutaneous fixation. However, that assessment must be balanced against the fact that percutaneous fixation is relative fixation requiring longer immobilization, which can lead to higher rates of postoperative stiffness and greater delays to return to function.[12,13]

Bannasch et al[8] noted a 14% rate of reoperation after ORIF in 365 patients, but the data set included both phalanx and metacarpal fractures. Ozer et al[10] identified an overall reoperation rate of 40% and revision rate of 9.6% in 52 metacarpals treated with ORIF. They also noted that hardware removal and loss of fixation were more common for ORIF with intermedullary fixation than with plate and screw constructs, which is anecdotally (though not statistically) corroborated by the current study's data.[10] The reason for this is not well understood and is likely multi-factorial. Biomechanical studies have shown intramedullary fixation to confer lower levels of stability than plate fixation. Given this, failure in intermedullary fixation is more commonly seen at the hardware bone interface.[14] This could certainly lead to the propagation of perihardware fracture. Additionally, it is possible that the intermedullary constructs create greater stress risers, which would explain the higher rate of perihardware fracture.

The rate of reoperation for fractures of the metacarpal shaft was significantly lower when compared to the cohort at large. Supporting this, prior studies have shown significantly higher complication rates for periarticular metacarpal fractures when compared to metacarpal shaft fractures.[15] It is possible that this is related to numerous tendinous attachments at the metacarpal base, making hardware prominence more bothersome and/or problematic which could, in turn, lead to higher rates of unplanned hardware removal when compared to fractures of the metacarpal shaft. It is also possible that surgeons have a higher tolerance for angulation of the shaft leading to a higher threshold of acceptance (and thus lower rate) for reoperation.

Limitations

This study has several limitations. First, the choice to look at early reoperation within 1 year of the index procedure certainly does limit the reporting of all reoperations. Moreover, the average follow-up time was relatively low at approximately 4.2 months. Although this is a relatively short follow-up period, it was deemed long enough to capture the majority of cases of reoperation. Longer follow-up may capture some additional cases of reoperation but the rate of additional complications warranting reoperation would be expected to be low as clinical fracture union is typically achieved by 6–8 weeks. In support of this, the median time to reoperation in this cohort was quite early (1.5 months), indicating that the majority of patients in need of reoperation tend to present early in their postoperative course. However, long-term studies on survivorship are currently lacking and could help shed further light on this matter. Another limitation of this study is surgeon variability. There were 14 surgeons included in this study, and surgical decision making, technique, and postoperative management were not standardized. Additionally, not every surgeon has the same threshold for returning to the operation room. Thus, by using data accrued from numerous surgeons there is the possibility of decreased internal validity of the reported rate of reoperation. However, using data from multiple surgeons also increases the external validity and generalizability of the study findings. Assessing the reoperation rates from a combine cohort of 14 surgeons makes our findings more generalizable across the heterogeneous landscape of hand surgery; this relatively large cohort offers a better assessment of the 'typical'

Table 3
Demographic, Fracture Morphologic, and Surgery Specific Data for Patients Requiring Revision Surgery

Age (y)	Sex	BMI (kg/m^2)	Diabetes	Smoking	Laterality	Metacarpal	Location	Reason for Revision	Index Procedure	Revision Procedure	Time to Revision
73	M	37.74	Yes	Yes	Left	Second	Shaft	Hardware failure - screw back out	ORIF with miniplate	ORIF with miniplate	4.1 mo
43	M	24.27	No	No	Left	Fourth	Shaft	Nonunion	ORIF with modular locking plate	ORIF with modular locking plate and bone grafting	7.3 mo
16	M	22.5	No	Yes	Right	Fifth	Neck	Refractured around hardware	3-0 headless intermedullary compression screw	ORIF with Synthes modular locking plate	6.5 mo
65	F	20.8	No	No	Right	Fifth	Neck	Bone collapsed around screw due to overwork	3-0 headless intermedullary compression screw	Open reduction and hardware advancement	2 mo
19	M	29.8	No	No	Right	Fifth	Shaft	Refractured around hardware	2-0 headless compression screw	3-0 headless intermedullary compression screw	16.6 mo
47	M	28.9	No	No	Right	Fourth	Shaft	Hardware failure - plate bent	ORIF with miniplate	Revision ORIF with 90-90 degree plating with hardware correction and addition of lateral plate	0.5 mo
28	M	22.6	No	Yes	Right	Fifth	Neck	Refractured around hardware	3-0 headless intermedullary compression screw	ORIF with Synthes modular locking plate	6.4 mo

hand surgeon and thus makes its findings likely more representative of the true rate of reoperation than studies assessing the outcomes of individual or small groups of surgeons. Another possible limitation is that patients may have sought follow-up treatment and reoperation at another institution which could underestimate the reported reoperation rate.

Patient satisfaction is a multifaceted concept which has been linked to preoperative patient expectations.[1] In light of this, providing patients with an accurate estimate of reoperation rates is important. Ultimately, the information presented in the article should not change who undergoes operative treatment of their metacarpal fractures as the criteria for this are well established.[1,4] Nonetheless, this information remains important for surgeons when educating patients before surgery both for the sake of informed consent and expectation setting. Based on the results of this study, surgeons should counsel patients that roughly 1 in 10 patients will require an additional surgical procedure within 1 year of undergoing operative treatment for their isolated metacarpal fracture. It should also be emphasized that the majority of additional surgical procedures are performed to remove painful or symptomatic hardware. It is our belief that this will help establish realistic patient expectations which remains an important part of preoperative counseling.

In short, in a review of nearly 500 cases of operatively repaired isolated metacarpal fractures, an unplanned early reoperation rate of 8.0% was identified, with the majority involving cases with internal fixation that was symptomatic and a mean and median time to reoperation of approximately 2.1 and 1.5 months, respectively. This information can be used to counsel patients and set expectations about the potential for metacarpal fracture surgeries.

References

1. Diao E. Metacarpal fixation. *Hand Clin*. 1997;13(4):557–571.
2. Rhee PC, Becker HA, Rizzo M. Update on the treatment of metacarpal fractures. *Curr Orthop Pract*. 2012;23(4):289–295.
3. Sahu A, Gujral SS, Batra S, et al. The current practice of the management of little finger metacarpal fractures—a review of the literature and results of a survey conducted among upper limb surgeons in the United Kingdom. *Hand Surg*. 2012;17(1):55–63.
4. Kozin SH, Thoder JJ, Lieberman G. Operative treatment of metacarpal and phalangeal shaft fractures. *J Am Acad Orthop Surg*. 2000;8(2):111–121.
5. Kollitz KM, Hammert WC, Vedder NB, Huang JI. Metacarpal fractures: treatment and complications. *Hand (N Y)*. 2014;9(1):16–23.
6. Neumeister MW, Winters JN, Maduakolum E. Phalangeal and metacarpal fractures of the hand: preventing stiffness. *Plast Reconstr Surg Glob Open*. 2021;9(10):e3871.
7. Page SM, Stern PJ. Complications and range of motion following plate fixation of metacarpal and phalangeal fractures. *J Hand Surg*. 1998;23(5):827–832.
8. Bannasch H, Heermann AK, Iblher N, et al. Ten years stable internal fixation of metacarpal and phalangeal hand fractures-risk factor and outcome analysis show no increase of complications in the treatment of open compared with closed fractures. *J Trauma*. 2010;68(3):624–628.
9. Greeven APA, Bezstarosti S, Krijnen P, et al. Open reduction and internal fixation versus percutaneous transverse Kirschner wire fixation for single, closed second to fifth metacarpal shaft fractures: a systematic review. *Eur J Trauma Emerg Surg*. 2016;42(2):169–175.
10. Ozer K, Gillani S, Williams A, et al. Comparison of intramedullary nailing versus plate-screw fixation of extra-articular metacarpal fractures. *J Hand Surg Am*. 2008;33(10):1724–1731.
11. Stern PJ, Wieser MJ, Reilly DG. Complications of plate fixation in the hand skeleton. *Clin Orthop Relat Res*. 1987;214(214):59–65.
12. Chin SH, Vedder NB. MOC-PSSM CME article: metacarpal fractures. *Plast Reconstr Surg*. 2008;121(1 suppl):1–13.
13. Vasilakis V, Sinnott CJ, Hamade M, et al. Extra-articular metacarpal fractures: closed reduction and percutaneous pinning versus open reduction and internal fixation. *Plast Reconstr Surg Glob Open*. 2019;7(5):e2261.
14. Melamed E, Hinds RM, Gottschalk MB, et al. Comparison of dorsal plate fixation versus intramedullary headless screw fixation of unstable metacarpal shaft fractures: A biomechanical study. *Hand (N Y)*. 2016;11(4):421–426.
15. Ouellette EA, Freeland AE. Use of the minicondylar plate in metacarpal and phalangeal fractures. *Clin Orthop Relat Res*. 1996;327:38–46.