RESEARCH ARTICLE

Metacarpal Fracture Trends in Treatment: A Matched Cohort Analysis of 1022 Patients

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Abstract

Objectives: The goals of this study were twofold: first, to assess epidemiologic characteristics of metacarpal fractures including patient and fracture characteristics; second, to investigate the most common treatment strategies employed.

Methods: Patients presenting to a single large academic practice with an isolated acute metacarpal fracture were retrospectively reviewed. Baseline demographics and fracture-specific data were collected. Two investigative arms of the study were then delineated. In the first arm, patient groups were matched based on metacarpal involvement between operative and nonoperative cohorts and CPT-stratified data was independently assessed and grouped based on frequency. In the second arm, a non-matched analysis was performed to assess management strategies and relative frequency of varying techniques.

Results: After matching, 1022 patients were included in the first investigational arm. Fractures of the fifth metacarpal were most common. Most operative fractures were located at the metacarpal shaft (43.2%), whereas those managed nonoperatively were most found at the metacarpal neck (38.2%). In the second investigational arm, the four most common CPT codes were 26600 (closed management without manipulation), 26615 (open reduction and internal fixation), 26608 (closed reduction and percutaneous pinning), and 26605 (closed management with manipulation) in descending order. 97.2% of patients undergoing ORIF underwent plate and screw fixation.

Conclusion: Most metacarpal fractures were found to have been managed nonoperatively. When treated operatively, metacarpal fractures were more often treated with open reduction and internal fixation rather than closed reduction and pinning. Most patients were treated with a plate and screw construct in favor of an intramedullary screw.

Level of evidence: III

Keywords: Fracture fixation, Metacarpal, Metacarpal repair, Treatment trends

Introduction

Fractures of the hand are common presenting complaints in emergency departments, often resulting from either direct trauma or a fall onto an outstretched hand. Fractures of the metacarpal comprise 18-44% of all hand fractures, with fractures of the non-thumb metacarpals occurring with more relative frequency than those of the thumb.[1–6] The appropriate management of metacarpal fractures is multifaceted and requires a comprehensive understanding of anatomy, pathophysiology, and biomechanics.

Broadly, metacarpal fractures can be treated nonoperatively or operatively. Both fracture- and patient-specific factors need to be considered when determining best treatment. The number of metacarpals involved, fracture pattern, degree of comminution, angulation, rotational deformity, articular involvement, degree of soft-tissue compromise, and whether the fracture itself is open are all factors that need to be considered in the decision tree.[1,7–10] Additionally, patient functional demands and comorbidities need to also be taken into consideration.

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The goals of this study were twofold: First, to assess epidemiologic characteristics of metacarpal fractures including patient and fracture characteristics; second, to investigate the most common treatment strategies employed.

Materials and Methods

Institutional review board approval was secured. Patients having presented to a single large academic practice between January 2017 and through December 2021 with single acute metacarpal fractures were included for retrospective review. Exclusion criteria included patients with multiple metacarpal fractures, concurrent bony injuries to the hand or upper extremity, and patients who presented following previously failed management of subacute and chronic metacarpal fractures. Baseline demographic data collected included age, race, sex, BMI, smoking status, and history of diabetes. Diabetic and smoking history was self-reported by patients.

Fracture specific data included specific metacarpal involved and location (base, neck, shaft), fracture laterality, and presence of displacement. Displacement was recorded in a binary fashion, with any degree of displacement being considered as a displaced fracture. Treatment was characterized as nonoperative versus operative, with the latter being further sub-characterized by surgical strategy employed. Complications were compiled and selected for during the initial coding query and confirmed utilizing manual chart review. Complications included infection, nonunion, and need for revision surgery.

The patient groups were subsequently matched. First, the data was evaluated in totality and broken down into nonoperative and operative patients (4045 in total, 3470 non-operative, 575 operative). Next, preoperative demographics (including age, sex, BMI, race, and history of diabetes) were matched. Finally, based on this matched data, a second round of matching was conducted, based upon which metacarpal was involved (one through five) between operative and nonoperative cohorts. This process was conducted with the aim of achieving increased statistical strength while limiting potential bias. Following matching, 1022 patients were included for the study in the first arm of the investigation.

Patient data was compiled using CPT and ICD codes. Initially, ICD codes were utilized to compile all patients who carried a diagnosis of metacarpal fracture. Next, the specific CPT codes associated with each patient encounter were documented and compiled. The CPT codes initially included were as follows: 26546, 26565, 26600, 26605, 26607, 26608, 26615, 26645, 26650, 26665, 26676, 26685, 26686, 26715, 26740, 26746. Subsequently, CPT stratified data was independently assessed and grouped based on frequency. For the second arm of the study, a non-matched analysis was performed to assess management strategies and the relative frequency of varying techniques.

Finally, specific operative modalities within the CPT code of ORIF (26615) (400 patients) were evaluated. Operative reports for each patient with CPT 26615 were manually reviewed. Subsequently, patients were further characterized as ORIF using plate and screws versus an intramedullary screw.

Statistics

Mann-Whitney U tests were used to compare continuous data and Chi-Square tests were used to compare categorical data. Demographic and fracture morphologic data were analyzed as a whole, with subsequent comparative analysis conducted comparing operative and nonoperative cohorts. $P < 0.05$ was defined as statistically significant. All statistical analyses were done using R Studio (Version 4.1.2, Vienna, Austria).

Results

Following the matching process, 1022 patients with isolated metacarpal fractures were included in the first investigational aim, with the matched cohort consisting of 511 patients managed operatively and 511 treated nonoperatively. Matched cohorts were found to be similar with regards to patient age, sex, BMI, and pre-existing history of diabetes [Table 1]. However, there were significantly more active smokers in the cohort of patients who ultimately underwent operative management (26.2% vs. 18.6%; p=0.013).

Table 1. Demographic data matched by metacarpal involvement between patients undergoing operative versus nonoperative metacarpal fracture management Continuous data is presented as mean (standard deviation) and categorical data is presented as cell count (%)

	Total Data (N=1022)	Non-Operative (N=511)	Operative (N=511)	P Value
Age	37.2 (18.3)	37.5 (19.9)	37.0 (16.6)	0.632
Race:				
White	773 (75.6%)	393 (76.9%)	380 (74.4%)	0.584
Black	128 (12.5%)	59 (11.5%)	69 (13.5%)	
Other	121 (11.8%)	59 (11.5%)	62 (12.1%)	
Sex:				
Female	216 (21.1%)	100 (19.6%)	116 (22.7%)	0.250
Male	806 (78.9%)	411 (80.4%)	395 (77.3%)	
BMI	26.5 (5.62)	26.4 (5.69)	26.6 (5.55)	0.592

Table 1. Continued				
Diabetes:				
No	978 (95.7%)	488 (95.5%)	490 (95.9%)	0.878
Yes	44 (4.31%)	23 (4.50%)	21 (4.11%)	
Smoking Status:				
No	677 (66.2%)	353 (69.1%)	324 (63.4%)	0.013
Current	229 (22.4%)	95 (18.6%)	134 (26.2%)	
Former	116 (11.4%)	63 (12.3%)	53 (10.4%)	

Metacarpal involvement was controlled between operative and non-operative cohorts, with equal numbers of first through fifth metacarpal fractures included in each group under study (p=1.000) [Table 2]. There were no significant differences regarding fracture laterality between operative and non-operative groups (p=0.280), with most fractures being right sided overall (68.8%). A significantly higher percentage of fractures in the operative group were displaced compared to the nonoperative cohort (98.0% vs. 43.6%; p<0.001). There was also a significant difference between operative and non-operative groups regarding fracture site location (p=0.014). Most fractures that ultimately went on to be operatively managed were located at the metacarpal shaft (43.2%), whereas those managed nonoperatively were most often found at the metacarpal neck (38.2%). There were no statistically significant differences in complications between groups (p=0.249) with a total incidence of 0.29% and occurring in three out of 511 operative patients.

Table 2. Fracture-specific and outcome data matched by metacarpal involvement between patients undergoing operative versus nonoperative metacarpal fracture management Continuous data is presented as mean (standard deviation) and categorical data is presented as cell count (%)

	Total Data (N=1022)	Non-Operative (N=511)	Operative (N=511)	P Value
Laterality:				
Left	319 (31.2%)	168 (32.9%)	151 (29.5%)	0.280
Right	703 (68.8%)	343 (67.1%)	360 (70.5%)	
Displaced:				
No	298 (29.2%)	288 (56.4%)	10 (1.96%)	<0.001
Yes	724 (70.8%)	223 (43.6%)	501 (98.0%)	
Metacarpal:				
1	156 (15.3%)	78 (15.3%)	78 (15.3%)	1.000
2	48 (4.70%)	24 (4.70%)	24 (4.70%)	
3	74 (7.24%)	37 (7.24%)	37 (7.24%)	
4	184 (18.0%)	92 (18.0%)	92 (18.0%)	
5	560 (54.8%)	280 (54.8%)	280 (54.8%)	
Location:				
Base	270 (26.4%)	134 (26.2%)	136 (26.6%)	0.014
Shaft	403 (39.4%)	182 (35.6%)	221 (43.2%)	
Neck	349 (34.1%)	195 (38.2%)	154 (30.1%)	
Complication:				
No	1019 (99.7%)	511 (100%)	508 (99.4%)	0.249
Yes	3 (0.29%)	0 (0.00%)	3 (0.59%)	

For the second arm of the study, regarding the CPT-specific, non-matched data, sixteen distinct codes were associated with the initial management of metacarpal fractures in the present study. The four most common CPT codes associated with the initial management of metacarpal fractures in this study were 26600, 26615, 26608, and 26605 in descending order [Table 3]. In brief, 26600 represents closed management without manipulation (CMwoM), 26605 is closed management with manipulation (CMwM), 26608 is closed reduction and percutaneous pinning (CRPP), and 26615 represents open reduction and internal fixation using Orthopaedic hardware (ORIF). These four CPT codes made up 92.7% of all management interventions (4045/4362).

Table 3. Demographic data of patients in the four largest management cohorts. Continuous data is presented as mean (standard deviation) and categorical data is presented as cell count (%). Statically significant P values (<0.05) are bolded

	Total Data	26600 (CMwoM*)	26605 (CMwM**)	26608 (CRPP***)	26615 (ORIF****)	P Value
	N = 4045	*N = 3397*	*N = 73*	*N = 175*	*N = 400*	
Age	44.1 (21.9)	45.3 (22.6)	33.6 (15.9)	37.6 (18.7)	38.6 (16.4)	<0.001
Race:						
White	2788 (79.4%)	2378 (80.4%)	39 (67.2%)	115 (74.7%)	256 (74.4%)	0.005
Black	378 (10.8%)	308 (10.4%)	7 (12.1%)	18 (11.7%)	45 (13.1%)	
Other	346 (9.85%)	270 (9.13%)	12 (20.7%)	21 (13.6%)	43 (12.5%)	
Ethnicity:						
Not Hispanic	3169 (96.8%)	2651 (97.4%)	53 (94.6%)	151 (98.1%)	314 (92.1%)	<0.001
Hispanic	105 (3.21%)	72 (2.64%)	3 (5.36%)	3 (1.95%)	27 (7.92%)	
Sex:						
Female	1482 (36.7%)	1337 (39.4%)	12 (16.4%)	32 (18.3%)	101 (25.2%)	<0.001
Male	2559 (63.3%)	2056 (60.6%)	61 (83.6%)	143 (81.7%)	299 (74.8%)	
BMI	26.4 (5.73)	26.4 (5.80)	25.9 (5.06)	25.4 (4.51)	26.8 (5.69)	0.120
Diabetes:						
No	3185 (93.6%)	2640 (92.9%)	56 (96.6%)	153 (97.5%)	336 (96.6%)	0.006
Yes	219 (6.43%)	201 (7.07%)	2 (3.45%)	4 (2.55%)	12 (3.45%)	
Smoking Status:						
No	1898 (64.8%)	1582 (64.9%)	34 (70.8%)	89 (64.0%)	193 (62.9%)	0. 018
Current	643 (21.9%)	512 (21.0%)	13 (27.1%)	34 (24.5%)	84 (27.4%)	
Former	389 (13.3%)	342 (14.0%)	1 (2.08%)	16 (11.5%)	30 (9.77%)	

*CMwoM: Closed managed without manipulation
**CMwM: Closed managed with manipulation
***CRPP: Closed Reduction and Percutaneous Pinning
****ORIF: Open Reduction Internal Fixation

When metacarpal fractures were treated operatively, 69.6% of the time the treatment was ORIF while 30.4% of the time was CRPP. In contrast, when metacarpal fractures were treated nonoperatively, CMwM was only performed 2.1% of the time while CMwoM was performed 97.9% of the time [Figure 1]. Of those patients who underwent ORIF, operative data was collected on 396 of 400 patients (99.0%). Of those patients, 387 (97.7%) underwent ORIF with plate and screw fixation whereas 9 (2.27%) underwent fixation with an intramedullary screw [Figure 1].

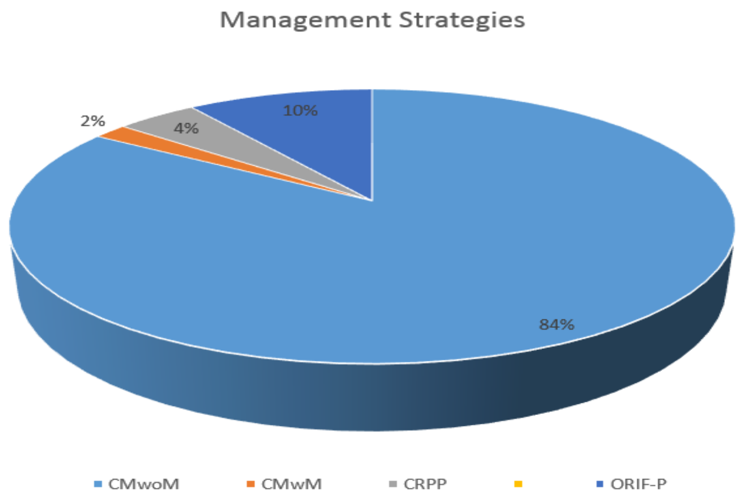

Figure 1. Breakdown of frequency of each major management strategy under investigation
CMwoM: Closed managed without manipulation/ CMwM: Closed managed with manipulation/ CRPP: Closed Reduction and Percutaneous Pinning/ ORIF-P: Open Reduction Internal Fixation with plate and screws/ ORIF-IMN: Open Reduction Internal Fixation with intramedullary nail

There were statistically significant differences in age, race, ethnicity, sex, diabetes, and smoking status when comparing these four interventions [Table 3]. Furthermore, displacement significantly differed across groups (only 43.4% of fractures in the CMwoM group were displaced compared to 98.7% of ORIF, 96.5% of CRPP, and 97.2% of CMwM patients; p<0.001) [Table 4]. Metacarpal involvement differed significantly across all four groups, although fractures of the fifth metacarpal were most frequently seen across all four groups (p<0.001) [Table 4, Figure 2]. Fractures of the fifth metacarpal made up 59.9% of all fractures. In descending frequency, 17.9% of fractures were in the fourth metacarpal, 8.8% in the third metacarpal, 7.32% in the first metacarpal, and 6.13% in the second metacarpal.

Fracture location also differed across all four groups (p<0.001), with metacarpal shaft fractures most common in the CMwoM and ORIF groups (35.9% & 6.9% respectively), with fractures at the metacarpal neck most common in the CRPP and CMwM subgroups (37.2% & 61.1% respectively) [Figure 3].

Discussion

The management of metacarpal fractures is an ever-evolving field of investigation with a clear lack of consensus or evidence to support any one modality of intervention. In the present study, the hypotheses of the authors were confirmed as it was shown that both fracture- and patient-specific factors dictate provider decision-making and that specific patient presentations lend themselves to specific interventional techniques. Overall, this study serves to provide both breadth and depth to the conversation surrounding metacarpal management, while also offering several key takeaways.

First, from an epidemiological standpoint, fractures of the fifth metacarpal were most common across both operative and nonoperative groups in the matched-data investigational arm as well as the unmatched, CPT-specific data. This finding corroborates data previously demonstrated in the literature.[3,7,11] Across numerous studies, the success of nonoperative management of fifth metacarpal fractures has repeatedly been shown, which supports the present finding of CMwoM being the interventional strategy most employed here.[7,9–15] As expected, the presence of displacement is a key fracture-specific factor dictating management. When assessing the matched patient cohorts, 98% of all fractures that went on to operative management were displaced at the time of initial presentation. Despite the general lack of consensus surrounding metacarpal fracture management, fracture displacement can reliably be used as a consequential factor guiding management.[1,7,9,10,16] However, as outlined by Bloom et al., among others, there is a wide array of fracture-specific data that needs to be incorporated into any clinician's treatment algorithm to appropriately manage patients with these types of injuries.[10] Additionally, physical examination, patient functional demands, and ability to comply with post-management restrictions and rehabilitative protocols need to be part of the decision-making equation.

Table 4. Fracture specific and outcome data of patients in the four largest management cohorts. Statically significant P values (<0.05) are bolded

	Total Data	26600 (CMwoM*)	26605 (CMwM**)	26608 (CRPP***)	26615 (ORIF****)	P Value
	N = 4045	*N = 3397*	*N = 73*	*N = 175*	*N = 400*	
Laterality:						
Left	1435 (36.1%)	1251 (37.6%)	16 (21.9%)	51 (29.7%)	117 (29.3%)	<0.001
Right	2540 (63.9%)	2080 (62.4%)	57 (78.1%)	121 (70.3%)	282 (70.7%)	
Displaced:						
No	1914 (47.9%)	1901 (56.6%)	2 (2.78%)	6 (3.49%)	5 (1.27%)	<0. 001
Yes	2081 (52.1%)	1457 (43.4%)	70 (97.2%)	166 (96.5%)	388 (98.7%)	
Complication:						
No	4039 (99.9%)	3397 (100%)	73 (100%)	174 (99.4%)	395 (98.8%)	<0.001
Yes	6 (0.15%)	0 (0.00%)	0 (0.00%)	1 (0.57%)	5 (1.25%)	
Thumb:						
No	3736 (92.6%)	3151 (93.0%)	71 (97.3%)	137 (78.7%)	377 (94.5%)	<0.001
Yes	298 (7.39%)	237 (7.00%)	2 (2.74%)	37 (21.3%)	22 (5.51%)	
Metacarpal:						
First	295 (7.32%)	235 (6.94%)	2 (2.74%)	36 (20.8%)	22 (5.51%)	
Second	247 (6.13%)	214 (6.32%)	4 (5.48%)	5 (2.89%)	24 (6.02%)	
Third	353 (8.76%)	309 (9.13%)	1 (1.37%)	1 (0.58%)	42 (10.5%)	<0.001
Fourth	720 (17.9%)	600 (17.7%)	5 (6.85%)	16 (9.25%)	99 (24.8%)	
Fifth	2416 (59.9%)	2028 (59.9%)	61 (83.6%)	115 (66.5%)	212 (53.1%)	

Table 4. Continued						
Location:						
Base	1033 (25.9%)	940 (28.0%)	3 (4.17%)	67 (39.0%)	23 (5.85%)	<0.001
Neck	1436 (35.9%)	1213 (36.1%)	44 (61.1%)	64 (37.2%)	115 (29.3%)	
Shaft	1526 (38.2%)	1205 (35.9%)	25 (34.7%)	41 (23.8%)	255 (64.9%)	

*CMwoM: Closed managed without manipulation
**CMwM: Closed managed with manipulation
***CRPP: Closed Reduction and Percutaneous Pinning
****ORIF: Open Reduction Internal Fixation

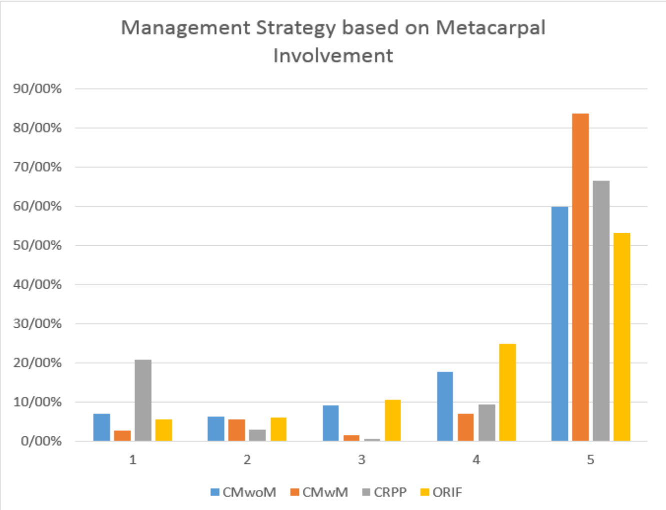

Figure 2. Management strategy broken down by metacarpal involvement

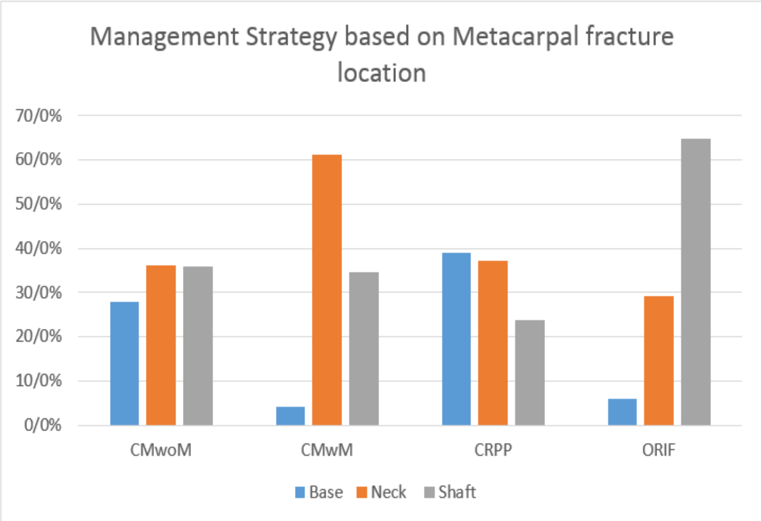

Figure 3. Management strategy based on metacarpal location across four major CPT cohorts

In the present study, ORIF was more commonly utilized compared to CRPP when it came to operative management strategies (397/4565 versus 178/4565). Fractures of the metacarpal shaft were most common in patients undergoing ORIF (64%) versus those of the metacarpal base, which made up the highest proportion of patients undergoing CRPP (37.6%). There is an ongoing discussion in the literature surrounding the management of metacarpal shaft fractures, with a recent systematic review conducted by Taha et al. investigating this very question.[1,8,17] Additionally, However, what continues to be demonstrated is the need for large, randomized controlled trials to guide practice and management.[17]

Vasilakis et al. directly compared CRPP vs. ORIF in the management of extra-articular metacarpal fractures.[18] In their retrospective review of 70 patients, they were able to demonstrate that ORIF may allow for earlier mobilization without compromising stability, clinical, or functional short-term outcomes.[18] However, the findings that can be garnered from their investigation are limited by small sample size, limited patient-reported outcome measure survey response rate, and short-term follow-up data.[18] Plate and screw constructs have been demonstrated to be biomechanically superior to CRPP, which may have also contributed to surgeon decision making in the present study.[19] However, other investigations have demonstrated similar functional and subjective outcomes between both modalities, which, when considering the added soft tissue and invasive risks of ORIF, lead certain researchers to favor the prospective use of CRPP in unstable metacarpal fractures.[20]

Most patients who underwent ORIF were treated with a plate and screw construct versus intramedullary nail (97.2% versus 1.78%, respectively). There is an increasing amount of evidence comparing biomechanical fixation strengths of metacarpal fracture fixation using Kirschner wires, plate and screw constructs, and intramedullary nail devices.[21-23] A recent biomechanical study by Wallace et al, demonstrated that intramedullary threaded nails were biomechanically superior in the treatment of transverse metacarpal neck fractures compared to locking plate constructs.[21] However, it is unclear how these results translate to fractures at other metacarpal locations or fracture patterns of increasing complexity or comminution.[21]As the technology surrounding metacarpal intramedullary nails (IMN) continues to develop, the discrepancy between fractures treated with plates and screws versus IMN may narrow.

The present study is not without limitations. One major limitation of the present study is the absence of fracture specific data on shortening, angulation, rotation, and intra-articular involvement. As these factors have all been proven to dictate not only treatment modalities but also outcomes, further investigation is warranted. Additionally, in a similar vein, data surrounding physical examination and patient functional and occupational demands was not recorded, which also undoubtedly factors into the decision-making process when addressing these injuries.

Another limitation is the lack of specifics within each treatment modality. For example, Poolman et al. highlighted the heterogeneity of non-operative management strategies and immobilization periods, which contributed to their inability to recommend one modality as superior over others.[24] This degree of diversity within each specific treatment modality also applies to CRPP, CMwM, and ORIF which only further muddies this conversation. This was a retrospective study, lacking randomization and blinding, thereby increasing the chance of underlying bias. Finally, all data was recorded from a single institution, which could limit translatability of outcomes.

Conclusion

Moreover, this study demonstrated that both patient- and fracture-specific factors dictate operative versus nonoperative management of metacarpal fractures. Additionally, this study found most metacarpal fractures to be managed conservatively, without an operation. In the setting of fractures necessitating operation, ORIF was more common than CRPP, with metacarpal involvement and specific metacarpal location significantly differing among treatment groups. ORIF with plates and screws was more common than intramedullary nails in this study.

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