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Original Research Article

COMPREHENSIVE STUDY OF METACARPAL FRACTURES

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ABSTRACT

Background: Metacarpal fractures are among the most common hand injuries, accounting for a significant proportion of trauma cases. These fractures present unique challenges in terms of functional recovery and management due to the intricate anatomy and biomechanics of the hand. Early diagnosis and appropriate treatment are crucial to restoring optimal function. **Objective:** To analyze the patterns, clinical presentations, and outcomes of metacarpal fractures among 55 patients managed at a tertiary care center, and to evaluate the effectiveness of current management strategies.

Materials and Methods: This prospective observational study included 55 patients diagnosed with metacarpal fractures over 12 months. Patients were assessed clinically and radiographically to determine fracture patterns, mechanisms of injury, and associated factors. Treatment modalities included conservative management, closed reduction, and surgical fixation based on fracture severity. Outcomes were measured using the QuickDASH (Disabilities of the Arm, Shoulder, and Hand) score at follow-up intervals.

Results: The majority of fractures involved the fifth metacarpal (47.3%), with direct trauma being the most common mechanism of injury (60%). Conservative management was successful in 67% of cases, while surgical intervention was required in 33%. Functional outcomes were favorable, with 85% of patients achieving excellent or good QuickDASH scores. Factors such as delayed presentation and associated injuries influenced recovery.

Conclusion: Metacarpal fractures, predominantly involving the fifth metacarpal, can be effectively managed with conservative or surgical approaches, depending on the severity. Early intervention and individualized treatment planning are essential to achieve optimal functional outcomes.

Keywords: Metacarpal fractures; Fifth metacarpal; Conservative management; Surgical fixation; Functional outcomes; QuickDASH score.

INTRODUCTION

Metacarpal fractures are among the most prevalent hand injuries, accounting for a significant proportion of upper extremity fractures.[1] These injuries are particularly common in young, active individuals and are often associated with high-energy trauma or occupational hazards.[2] The metacarpal bones play a critical role in hand function, contributing to grip strength, fine motor skills, and overall dexterity. Consequently, fractures of these bones can result in substantial morbidity, including stiffness, deformity, and compromised hand function, if not managed appropriately.[3]

The complex anatomy and biomechanics of the hand pose unique challenges in the management of metacarpal fractures. Factors such as fracture location, displacement, angulation, and associated soft tissue injuries influence the choice of treatment.[4] While conservative management remains the cornerstone for many stable, non-displaced fractures, surgical intervention is often required for unstable or significantly displaced fractures to restore alignment and function.[5,6]

Despite advancements in imaging techniques and surgical approaches, there is considerable variability in the outcomes of metacarpal fractures. Factors such as delayed presentation, associated injuries, and patient compliance can affect recovery.[7,8] Moreover, functional outcomes are often difficult to standardize due to the individualized nature of hand injuries and the subjective perception of recovery among patients.[9]

This study aims to address the gaps in understanding the clinical and functional outcomes of metacarpal fractures by conducting a comprehensive evaluation of 55 patients treated at a tertiary care center. By analyzing fracture patterns, mechanisms of injury, treatment modalities, and outcomes, this study seeks to provide evidence-based insights into optimizing the management of these injuries.

Objectives

1. To determine the distribution of metacarpal fractures based on demographic factors and fracture characteristics.
2. To evaluate the effectiveness of conservative and surgical management strategies.
3. To analyze functional outcomes using the QuickDASH (Disabilities of the Arm, Shoulder, and Hand) score.
4. To identify factors influencing recovery and complications associated with metacarpal fractures.

This study contributes to the growing body of literature on metacarpal fractures, offering insights into clinical decision-making and individualized patient care for optimal recovery and functionality.

MATERIALS AND METHODS

Study Design: This was a prospective observational study conducted over a period of 12 months to evaluate the patterns, management, and outcomes of metacarpal fractures. The study included clinical and radiological assessment, treatment interventions, and follow-up evaluations of functional outcomes.

Study Setting and Participants

- **Study Setting**: The study was carried out at the Department of Orthopedics, a tertiary care center.
- **Sample Size**: A total of **55 patients** diagnosed with metacarpal fractures were included in the study.

Inclusion Criteria

- Patients aged 18 years and older.
- Radiologically confirmed metacarpal fractures.
- Patients presenting within 2 weeks of injury.
- Willingness to participate with informed consent.

Exclusion Criteria

- Open fractures with significant contamination.
- Pathological fractures.
- Patients with associated severe neurovascular injuries.

Ethical Clearance

Approval was obtained from the Institutional Ethics Committee before commencing the study. Written informed consent was obtained from all participants after explaining the purpose and procedures of the study.

Data Collection

1. **Baseline Assessment**:
   - Detailed demographic data, including age, sex, occupation, and hand dominance, were recorded.
   - Mechanism of injury was documented (e.g., direct trauma, fall, occupational hazard).
2. **Clinical and Radiological Evaluation**:
   - Fracture location, type (e.g., oblique, transverse, comminuted), displacement, angulation, and associated soft tissue injuries were assessed.
   - Radiographs of the hand in anteroposterior, lateral, and oblique views were taken to classify fracture patterns.

Interventions

- **Conservative Management**:
  - Stable fractures were treated with immobilization using splints or casts for 3–6 weeks, depending on the fracture type.
- **Surgical Management**:
  - Indicated for unstable or significantly displaced fractures.
  - Procedures included closed reduction with internal fixation (CRIF) or open reduction with internal fixation (ORIF) using K-wires or plates and screws.

Outcome Measures

1. **Functional Outcomes**:
   - Functional recovery was evaluated using the **QuickDASH (Disabilities of the Arm, Shoulder, and Hand) score** at 6-week, 3-month, and 6-month follow-ups.
   - The score measures physical function and symptoms, with lower scores indicating better outcomes.
2. **Complications**:
   - Delayed union, malunion, stiffness, and infection were monitored during follow-ups.

Data Analysis

- Quantitative data were summarized as means and percentages.
- Statistical analysis was performed using appropriate tests (e.g., paired t-test for pre- and post-treatment scores, chi-square test for categorical data).
- A p-value < 0.05 was considered statistically significant.

This detailed methodology ensures a robust framework for evaluating the clinical and functional outcomes of metacarpal fractures, providing insights into the effectiveness of different management strategies.

RESULTS

Demographic and Clinical Characteristics: The study included **55 patients**, with the following demographic and clinical features:

- **Age**: The mean age was 34.5 years, ranging from 18 to 65 years.
- **Gender**: Male predominance was noted, with 76% of patients being male and 24% female.
- **Hand Dominance**: 82% of patients reported right-hand dominance.
- **Mechanism of Injury**: Direct trauma was the most common cause (60%), followed by falls (25%) and occupational hazards (15%).

Fracture Characteristics

- **Fracture Distribution**: The majority of fractures involved the fifth metacarpal (47.3%), followed by the fourth (21.8%), third (18.2%), and second (12.7%).
- **Fracture Type**:
  - Oblique fractures: 40%
  - Transverse fractures: 36%
  - Comminuted fractures: 24%
- **Displacement**: 35% of fractures were significantly displaced, requiring surgical intervention.

Management

- **Conservative Management**:
  - 37 patients (67%) were treated conservatively with immobilization.
  - Mean immobilization period: 4.5 weeks.
- **Surgical Management**:
  - 18 patients (33%) underwent surgical intervention.
  - Most common procedure: Closed reduction with internal fixation (CRIF) using K-wires (78% of surgical cases).

Functional Outcomes

- The **QuickDASH score** was used to assess functional recovery:
  - **Excellent** (QuickDASH <15): 50% of patients
  - **Good** (QuickDASH 15–30): 35% of patients
  - **Fair** (QuickDASH 31–50): 10% of patients
  - **Poor** (QuickDASH >50): 5% of patients
- Patients managed surgically demonstrated slightly better functional recovery (mean QuickDASH score: 14.2) compared to those treated conservatively (mean QuickDASH score: 18.6).

Complications

- **Delayed Union**: Observed in 7 patients (12.7%), predominantly in conservatively managed cases.
- **Malunion**: Reported in 3 patients (5.5%).
- **Infection**: Occurred in 2 surgical cases (3.6%), managed successfully with antibiotics.
- **Stiffness**: Mild stiffness was noted in 8 patients (14.5%), resolved with physiotherapy.

Key Statistical Results

1. **QuickDASH Score Comparison**:
   - The mean QuickDASH scores improved significantly over time in both groups ($p < 0.05$).
   - Surgical intervention showed statistically better outcomes compared to conservative management ($p = 0.038$).
2. **Fracture Type and Outcomes**:
   - Oblique fractures had the best functional recovery compared to comminuted fractures ($p < 0.01$).
3. **Time to Presentation**:
   - Patients presenting within 5 days of injury had significantly better outcomes ($p = 0.022$).

Table 1: The results in Table 1 highlight the demographic distribution and injury mechanisms among 55 patients. The data show a male predominance (76%) and right-hand dominance in most cases (82%). Direct trauma was the leading cause of injury (60%).

Table 2: Table 2 shows the distribution of metacarpal fractures, with the fifth metacarpal being the most commonly involved (47.3%).

Table 3: The results in Table 3 indicate that 50% of patients achieved excellent functional outcomes (QuickDASH <15), while only 5% had poor outcomes.

Table 4: Table 4 summarizes the treatment modalities, showing that conservative management was utilized in 67% of cases, while 33% required surgical intervention.

Table 5: Table 5 presents the complications observed during the study, with delayed union (12.7%) being the most common.

Table 6: Table 6 demonstrates the relationship between the mechanism of injury and fracture type. Direct trauma was the leading cause of oblique fractures, while falls accounted for most transverse fractures.

Table 7: Table 7 highlights the influence of time to presentation on functional outcomes. Patients presenting within 5 days had significantly better QuickDASH scores compared to those presenting later.

Table 8: Table 8 shows that surgical interventions, particularly CRIF with K-wires, resulted in better QuickDASH scores compared to ORIF with plates and screws.

Table 9: Table 9 correlates fracture type with functional outcomes. Oblique fractures had the best outcomes, while comminuted fractures were associated with poorer recovery.

Table 10: Table 10 examines the relationship between follow-up duration and recovery. Patients who adhered to the full follow-up schedule showed better outcomes.

Table 1: Demographics and Injury Characteristics. This table presents the demographic characteristics and injury mechanisms observed in the study population.

Characteristic	Frequency (n)	Percentage (%)
Male	42	76
Female	13	24
Right-Hand Dominance	45	82
Left-Hand Dominance	10	18
Direct Trauma	33	60
Falls	14	25
Occupational Hazards	8	15

Table 2: Fracture Distribution. This table categorizes fractures based on the affected metacarpal bone.

Metacarpal Bone	Frequency (n)	Percentage (%)
Fifth	26	47.3
Fourth	12	21.8
Third	10	18.2
Second	7	12.7

Table 3: Functional Outcomes (QuickDASH Score). This table summarizes functional outcomes based on QuickDASH score categories.

Outcome	Frequency (n)	Percentage (%)
Excellent (<15)	28	50
Good (15–30)	19	35
Fair (31–50)	5	10
Poor (>50)	3	5

Table 4: Management Modalities. This table categorizes the treatment approaches employed for metacarpal fractures.

Management Approach	Frequency (n)	Percentage (%)
Conservative	37	67
Surgical	18	33

Table 5: Complications. This table highlights the complications encountered during follow-up.

Complication	Frequency (n)	Percentage (%)
Delayed Union	7	12.7
Malunion	3	5.5
Infection	2	3.6
Stiffness	8	14.5

Table 6: Mechanism of Injury and Fracture Type. This table categorizes fracture types based on the mechanism of injury.

Mechanism of Injury	Oblique Fractures (%)	Transverse Fractures (%)	Comminuted Fractures (%)
Direct Trauma	50	30	20
Falls	20	50	30
Occupational Hazards	30	20	50

Table 7: Time to Presentation and Outcomes. This table illustrates the effect of presentation delay on functional outcomes.

Time to Presentation	Excellent Outcomes (%)	Good Outcomes (%)	Fair/Poor Outcomes (%)
≤ 5 Days	65	25	10
> 5 Days	30	50	20

Table 8: Surgical Interventions and Outcomes. This table compares outcomes based on the type of surgical procedure.

Surgical Procedure	Number of Patients (n)	Mean QuickDASH Score	Excellent/Good Outcomes (%)
CRIF with K-wires	14	12.5	85
ORIF with Plates/Screws	4	18.0	50

Table 9: Fracture Type and QuickDASH Scores. This table presents functional outcomes by fracture type.

Fracture Type	Mean QuickDASH Score	Excellent Outcomes (%)	Good Outcomes (%)	Fair/Poor Outcomes (%)
Oblique	13.2	70	25	5
Transverse	16.5	50	40	10
Comminuted	22.0	30	40	30

Table 10: Follow-Up Duration and Recovery. This table illustrates the impact of follow-up compliance on functional recovery.

Follow-Up Duration	Mean QuickDASH Score	Excellent Outcomes (%)	Good Outcomes (%)	Fair/Poor Outcomes (%)
Full (6 months)	12.8	75	20	5
Partial (<6 months)	18.7	40	45	15

DISCUSSION

The present study evaluated the clinical and functional outcomes of metacarpal fractures in 55 patients treated at a tertiary care center. The findings provide valuable insights into the epidemiology, management, and recovery patterns associated with these common hand injuries.

Key Findings

1. **Demographic and Injury Characteristics**:
   - A male predominance (76%) and right-hand dominance (82%) were observed, consistent with previous studies indicating a higher incidence of metacarpal fractures in active, working-age males due to occupational hazards and physical activities.[10,11]
   - Direct trauma emerged as the leading cause (60%), highlighting the need for preventive measures in high-risk environments.[12]
2. **Fracture Patterns**
   - The fifth metacarpal was the most commonly affected (47.3%), which aligns with the literature on "boxer's fractures" commonly resulting from direct trauma to the clenched fist.[13]
   - Oblique fractures showed the best functional outcomes due to easier anatomical reduction and stability during healing, while comminuted fractures were associated with poorer recovery due to complexity.[14]
3. **Management Approaches**
   - Conservative management was successful in the majority (67%) of cases, demonstrating its effectiveness for stable fractures.[15,16]
   - Surgical interventions, required in 33% of cases, showed superior outcomes in displaced fractures, with CRIF using K-wires achieving better functional scores than ORIF with plates and screws.[17,18]
4. **Functional Outcomes**:
   - Overall, 85% of patients achieved excellent or good outcomes based on QuickDASH scores, reflecting the effectiveness of individualized treatment planning.[19]
   - Early intervention significantly influenced recovery, with patients presenting within 5 days showing better outcomes ($p = 0.022$).[20]
5. **Complications**
   - Delayed union and stiffness were the most common complications, particularly in conservatively managed cases, emphasizing the importance of close monitoring and physiotherapy.[21]

Comparison with Existing Literature

The findings corroborate prior research indicating the predominance of fifth metacarpal fractures and the effectiveness of conservative management for stable fractures. Studies by Gupta et al. (2019) and Brown et al. (2020) similarly highlight the role of CRIF in improving outcomes for unstable fractures. However, this study also sheds light on the specific impact of fracture type and early presentation on recovery, adding nuanced insights to existing knowledge.

Strengths

1. **Comprehensive Data**
   - The study evaluated a broad range of variables, including fracture characteristics, management modalities, and functional outcomes, providing a holistic view of metacarpal fracture management.
2. **Use of Standardized Outcome Measures**
   - The QuickDASH score ensured an objective assessment of functional recovery, allowing for standardized comparisons.

Limitations

1. **Sample Size**
   - Although sufficient for initial insights, a larger sample size would enhance the generalizability of findings.
2. **Follow-Up Duration**
   - A 6-month follow-up, while adequate for most cases, may not capture long-term complications or outcomes.

Implications for Clinical Practice

1. **Individualized Treatment**
   - Tailoring treatment based on fracture type, displacement, and patient factors can optimize outcomes.
2. **Early Intervention**
   - Prompt presentation and treatment are critical to achieving favorable functional recovery.
3. **Focus on Rehabilitation**
   - Physiotherapy should be an integral part of management, particularly for preventing stiffness and ensuring full recovery.

Future Directions

1. **Longitudinal Studies**
   - Extended follow-ups to evaluate long-term outcomes and complications.
2. **Biomechanical Analysis**:

Assessing the biomechanical implications of different fracture patterns and fixation methods.

CONCLUSION

This study provides a comprehensive evaluation of the clinical and functional outcomes of metacarpal

fractures among 55 patients treated at a tertiary care center. The findings emphasize the effectiveness of both conservative and surgical management approaches, with the choice of treatment largely dictated by fracture type, displacement, and patient-specific factors. Key conclusions include:

1. **Prevalence and Patterns**:
   - The fifth metacarpal was the most commonly affected bone, and direct trauma emerged as the leading mechanism of injury. This underscores the importance of preventive strategies, particularly in high-risk occupational settings.
2. **Management Outcomes**:
   - Conservative management proved effective for stable, non-displaced fractures, while surgical intervention demonstrated superior outcomes for displaced fractures. Closed reduction with internal fixation (CRIF) using K-wires was particularly successful in restoring functional outcomes.
3. **Functional Recovery**:
   - Overall, 85% of patients achieved excellent or good outcomes, as measured by the QuickDASH score. Early intervention and adherence to follow-up schedules were critical factors influencing recovery.
4. **Complications**:
   - Delayed union and stiffness were the most common complications, highlighting the need for early mobilization and physiotherapy to optimize recovery.

The study underscores the importance of individualized treatment planning and early intervention in achieving favorable outcomes for metacarpal fractures. By combining conservative and surgical approaches based on fracture characteristics, healthcare providers can optimize functional recovery while minimizing complications. Future research with larger sample sizes and longer follow-up durations is warranted to further refine management strategies and explore long-term outcomes.

REFERENCES

1. Holst-nielsen F. Subcapital fractures of the four ulnar metacarpal bones. Hand. 1976; 8:290–3. doi: 10.1016/0072-968X(76)90017-6.
2. Hunter JM, Cowen NJ. Fifth metacarpal fractures in a compensation clinic population. A report on one hundred and thirty-three cases. J Bone Joint Surg Am. 1970; 52:1159–65
3. McNemar TB, Howell JW, Chang E. Management of metacarpal fractures. J Hand Ther. 2003; 16:143–51. doi: 10.1016/S0894-1130(03)80009-1.
4. Strub B, Schindele S, Sonderegger J, et al. Intramedullary splinting or conservative treatment for displaced fractures of the little finger metacarpal neck? A prospective study. J Hand Surg Eur Vol. 2010; 35:725–9. doi: 10.1177/1753193410377845.
5. Westbrook AP, Davis TR, Armstrong D, et al. The clinical significance of malunion of fractures of the neck and shaft of the little finger metacarpal. J Hand Surg Eur Vol. 2008; 33:732–9. doi: 10.1177/175319340809249
6. Al-Qattan MM. Outcome of conservative management of spiral/long oblique fractures of the metacarpal shaft of the fingers using a palmar wrist splint and immediate mobilisation of the fingers. J Hand Surg Eur. 2008; 33:723–7. doi: 10.1177/1753193408093559
7. Lane CS. Detecting occult fractures of the metacarpal head: the Brewerton view. J Hand Surg [Am] 1977; 2:131–3. doi: 10.1016/S0363-5023(77)80098-1
8. Harris AR, Beckenbaugh RD, Nettrour JF, et al. Metacarpal neck fractures: results of treatment with traction reduction and cast immobilization. Hand. 2009; 4:161–4. doi: 10.1007/s11552-008-9150-51
9. Strub B, Schindele S, Sonderegger J, et al. Intramedullary splinting or conservative treatment for displaced fractures of the little finger metacarpal neck? A prospective study. J Hand Surg Eur Vol. 2010; 35:725–9. doi: 10.1177/1753193410377845
10. Hofmeister EP, Kim J, Shin AY. Comparison of 2 methods of immobilization of fifth metacarpal neck fractures: a prospective randomized study. J Hand Surg [Am] 2008; 33:1362–8. doi: 10.1016/j.jhsa.2008.04.010.
11. Stern PJ. Management of fractures of the hand over the last 25 years. J Hand Surg [Am] 2000; 25:817–23. doi: 10.1053/jhsu.2000.4214.
12. Winter M, Balaguer T, Bessiere C, et al. Surgical treatment of the boxer's fracture: transverse pinning versus intramedullary pinning. J Hand Surg Eur Vol. 2007; 32:709–13. doi: 10.1016/j.jhse.2007.07.011.
13. Schadel-Hopfner M, Wild M, Windolf J, et al. Antegrade intramedullary splinting or percutaneous retrograde crossed pinning for displaced neck fractures of the fifth metacarpal? Arch Orthop Trauma Surg. 2007; 127:435–40. doi: 10.1007/s00402-006-0254-y.
14. 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; 33:1724–31. doi: 10.1016/j.jhsa.2008.07.011. [PubMed] [Cross Ref]
15. Facca S, Ramdhian R, Pelissier A, et al. Fifth metacarpal neck fracture fixation: Locking plate versus K-wire? Orthop Traumatol Surg Res. 2010; 96:506–12. doi: 10.1016/j.otsr.2010.02.009.
16. Agarwal AK, Pickford MA. Experience with a new ultralow-profile osteosynthesis system for fractures of the metacarpals and phalanges. Ann Plast Surg. 2006; 57:206–12. doi: 10.1097/01.sap.0000215925. 58902.bc.
17. Dumont C, Fuchs M, Burchhardt H, et al. Clinical results of absorbable plates for displaced metacarpal fractures. J Hand Surg [Am] 2007; 32:491–6. doi: 10.1016/j.jhsa.2007.02.005.
18. Omokawa S, Fujitani R, Dohi Y, et al. Prospective outcomes of comminuted periarticular metacarpal and phalangeal fractures treated using a titanium plate system. J Hand Surg [Am] 2008; 33:857–63. doi: 10.1016/j.jhsa.2008.01.040.
19. Sakai A, Oshige T, Zenke Y, et al. Mechanical comparison of novel bioabsorbable plates with titanium plates and small-series clinical comparisons for metacarpal fractures. J Bone Joint Surg Am. 2012; 94:1597–604. doi: 10.2106/JBJS.J.01673.
20. Braakman M, Oderwald EE, Haentjens MH. Functional taping of fractures of the 5th metacarpal results in a quicker recovery. Injury 1998; 29:5–9
21. Ford DJ, Ali MS, Steel WM. Fractures of the fifth metacarpal neck: is reduction or immobilisation necessary? J Hand Surg 1989;14B:165–7.