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A STUDY OF MANAGEMENT OF METATARSAL FRACTURES

Orthopaedics

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ABSTRACT

Introduction: Metatarsal fractures are common foot injuries that can significantly impair function and mobility if not treated properly. Management of these fractures varies from conservative approaches to surgical interventions, depending on the displacement and complexity of the fracture. This study aims to evaluate the functional outcomes of different treatment methods, including conservative management, Kirschner wire (K-wire) fixation, intramedullary (IM) nailing, and open reduction and internal fixation (ORIF), for metatarsal fractures. **Methods:** This prospective study was conducted at Al-Ameen Medical College & Hospital, Vijayapura, from May 2022 to May 2024. Forty patients with metatarsal fractures were enrolled and divided into groups based on the treatment method. Conservative treatment involved closed reduction and plaster of Paris (POP) casting, while surgical treatments included K-wire fixation, IM nailing, and ORIF. Patients were followed up at intervals of 6 weeks, 3 months, and 6 months. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, and radiological healing was monitored through X-rays. Complications such as delayed union and deep vein thrombosis (DVT) were also recorded. **Results:** At the 6-week follow-up, 95% of patients demonstrated callus formation, and by 3 months, 95% showed normal radiological findings. By the 6-month follow-up, 90% of patients had complete radiological healing. Functional outcomes, as measured by the AOFAS score, improved significantly over time, with mean scores of 87.88 at 6 weeks, 97.20 at 3 months, and 95.75 at 6 months ($p < 0.001$). Patients treated with K-wire fixation showed the best functional outcomes (mean AOFAS score of 98.62), followed by ORIF (95.83), conservative treatment (92.33), and IM nailing (84.89). Complications were minimal, with delayed union observed in 10% of patients and DVT in 5%, both of which resolved with treatment. **Discussion and Conclusion:** The study found that surgical intervention, particularly K-wire fixation, produced better functional outcomes compared to conservative treatment, especially for displaced fractures. Radiological healing was observed in the majority of patients by the 6-month follow-up. Complications were infrequent and manageable. These findings suggest that individualized treatment based on fracture severity is essential for optimizing functional recovery in patients with metatarsal fractures.

KEYWORDS

Metatarsal fractures, Kirschner wire fixation, Intramedullary nailing, Open reduction internal fixation, AOFAS score, Conservative management, Functional outcomes, Radiological healing.

INTRODUCTION

Metatarsal fractures are common foot injuries, accounting for 5-6% of all fractures and up to 35% of foot fractures. They typically occur in physically active individuals and are often caused by direct trauma, such as road traffic accidents or sports injuries. Treatment of metatarsal fractures varies based on the type and severity of the fracture, ranging from conservative management with immobilization for non-displaced fractures to surgical interventions for displaced fractures. Surgical techniques include K-wire fixation, intramedullary (IM) nailing, and open reduction with internal fixation (ORIF), each chosen based on patient and fracture-specific factors.[1,2]

Despite advancements in treatment, the optimal management of metatarsal fractures remains debated, with outcomes affected by factors like patient comorbidities and fracture characteristics. Functional recovery is often assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, which evaluates pain, function, and alignment.[3,4]

This study aims to evaluate the functional outcomes of patients with metatarsal fractures managed by conservative and surgical methods, comparing the effectiveness of each treatment. Specifically, the study assesses radiological healing, incidence of complications, and functional outcomes using the AOFAS score at follow-up intervals of 6 weeks, 3 months, and 6 months. The findings will provide insights into the most effective treatment strategies for metatarsal fractures and guide clinical decision-making for optimal patient recovery.

This study involved 40 patients with metatarsal fractures, including a 22-year-old male who presented with a compound fracture of the right second metatarsal following a road traffic accident (RTA). The study aimed to compare the outcomes of conservative and surgical treatments, including K-wire fixation, intramedullary (IM) nailing, and open reduction with internal fixation (ORIF). Demographic characteristics, clinical outcomes, radiological healing, and functional recovery were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score over six months.[5–7]

MATERIALS AND METHODOLOGY

This prospective study was conducted in the Department of Orthopaedics at Al-Ameen Medical College and Hospital, Vijayapura, from May 2022 to May 2024, enrolling 40 patients with metatarsal fractures. Patients aged 14 years and above with either displaced or undisplaced fractures were included in the study, while those with pathological fractures or under 14 years were excluded to maintain a homogenous sample.

Data collection included a detailed history, clinical examination, radiological assessments (X-rays in anteroposterior and oblique views), and routine blood tests (RBS, CBC, blood urea, serum creatinine, HIV, HCV, and HbsAg). Treatment methods were selected based on the fracture type and severity. Patients with non-displaced fractures were managed conservatively using closed reduction and immobilization with a below-knee plaster of Paris (POP) cast for four weeks. Surgical interventions were used for displaced or unstable fractures, including closed reduction with internal fixation (CRIF) using K-wires, intramedullary (IM) nailing, and open reduction with internal fixation (ORIF) using plates or pins.

Follow-up assessments were conducted at 6 weeks, 3 months, and 6 months to monitor clinical and radiological outcomes. Clinical evaluations included assessments of pain, tenderness, swelling, abnormal mobility, crepitus, and ankle movement using a goniometer. Radiological examinations were performed to monitor fracture healing, alignment, and complications like malunion or delayed union. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, recorded at each follow-up visit to evaluate improvements in pain relief, function, and weight-bearing capacity.

Data analysis was conducted using SPSS version 20.0, applying descriptive statistics to present demographic characteristics and inferential statistics for outcome analysis. Continuous variables were compared using Analysis of Variance (ANOVA), and categorical variables were compared using the Chi-square test, with statistical significance set at $p \leq 0.05$. Graphs, tables, and diagrams were used to illustrate the findings, providing a comparison between different treatment approaches and their respective outcomes. Ethical approval

was obtained from the Institutional Ethics Committee, and informed consent was taken from all participants. All patient information was kept confidential and used solely for research purposes.

RESULTS AND ANALYSIS

This study involved 40 patients with metatarsal fractures to compare the outcomes of conservative and surgical treatments, including K-wire fixation, intramedullary (IM) nailing, and open reduction with internal fixation (ORIF). Demographic characteristics, clinical outcomes, radiological healing, and functional recovery were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score over six months.

Demographic Characteristics

The patients' ages ranged from 14 to 70 years, with the majority falling in the 21-30 (30%) and 31-40 (27.5%) age groups, consistent with the higher risk of fractures in younger, active individuals. Males made up 75% of the study group, likely due to higher participation in physically demanding activities.

Clinical Presentation and Treatment Modalities

Presenting complaints included pain (37.5%) and stiffness (12.5%), while 50% reported no major issues. Conservative treatment with closed reduction and casting was used for 42.5% of patients, primarily for non-displaced fractures. The remaining 57.5% underwent surgical interventions: K-wire fixation (32.5%), IM nailing (15%), and ORIF (10%).

Clinical Follow-up and Healing Progress

At 6 weeks, tenderness was present in 32.5% of patients, which decreased to 5% by 6 months, showing statistically significant improvement ($p = 0.005$). Abnormal mobility was observed in 17.5% at 6 weeks, decreasing to 10% by 6 months, though the change was not statistically significant. Crepitus, present in 17.5% at 6 weeks, resolved completely by 3 months ($p = 0.001$). Ankle movement improved significantly, with 82.5% achieving normal movement at 6 weeks, increasing to 100% by 6 months ($p = 0.01$). Neurovascular status was normal in all patients by 3 months, with no significant changes.

Radiological Healing and Complications

Radiological healing was evident, with 95% showing callus formation at 6 weeks and 90% having normal radiographs at 6 months ($p < 0.001$). Complications included deep vein thrombosis in 10% of patients at 6 weeks and delayed union in 10% by 6 months, primarily in those treated with IM nailing.

Functional Outcomes (AOFAS Scores)

The mean AOFAS score improved significantly from 87.88 at 6 weeks to 97.20 at 3 months and 95.75 at 6 months ($p = 0.001$). K-wire fixation provided the highest functional outcomes (mean AOFAS score 98.62), followed by ORIF, conservative treatment, and IM nailing. Differences in AOFAS scores across treatment groups were statistically significant, highlighting the effectiveness of K-wire fixation in treating displaced fractures.

Metatarsal fractures can be effectively managed with both conservative and surgical approaches, with surgical interventions—especially K-wire fixation—showing better functional outcomes, faster healing, and fewer complications. Radiological healing was achieved in most patients by 3 months, and functional recovery continued to improve through 6 months. Individualized treatment, based on fracture type and patient factors, was crucial in achieving optimal recovery and minimizing long-term complications.

Table 1: Distribution of Age

Age Group	Frequency	Percent
11-20 Years	4	10.0%
21-30 Years	12	30.0%
31-40 Years	11	27.5%
41-50 Years	4	10.0%
51-60 Years	7	17.5%
61-70 Years	2	5.0%
Total	40	100.0%

Inference: The majority of patients were between 21-30 years (30%) and 31-40 years (27.5%), with a smaller percentage in other age groups.

Table 2: Distribution of Gender

Gender	Frequency	Percent
Male	30	75.0%
Female	10	25.0%
Total	40	100.0%

Inference: The majority of the patients were male (75%).

Table 3: Distribution of Complaints

Complaint	Frequency	Percent
Stiffness	5	12.5%
Pain	15	37.5%
None	20	50.0%
Total	40	100.0%

Inference: 50% of the patients reported no complaints, while 37.5% had pain and 12.5% had stiffness.

Table 4: Distribution of Procedures

Procedure	Frequency	Percent
Conservative	17	42.5%
K-wiring	13	32.5%
IM Nailing	6	15.0%
Plating	4	10.0%
Total	40	100.0%

Inference: 42.5% of the patients were treated conservatively, 32.5% with K-wiring, 15% with IM nailing, and 10% with plating.

Table 5: Distribution of Tenderness at Different Time Intervals

Tenderness	6 Weeks	3 Months	6 Months	Total	Chi-value	p-value
Present	13 (32.5%)	6 (15.0%)	2 (5.0%)	21 (17.5%)	10.736	0.005
Absent	27 (67.5%)	34 (85.0%)	38 (95.0%)	99 (82.5%)		

Inference: Tenderness decreased significantly over time ($p = 0.005$), indicating improvement in patient recovery.

Table 6: Distribution of Abnormal Mobility at Different Time Intervals

Mobility	6 Weeks	3 Months	6 Months	Total	Chi-value	p-value
Present	7 (17.5%)	6 (15.0%)	4 (10.0%)	17 (14.2%)	0.959	0.61
Absent	33 (82.5%)	34 (85.0%)	36 (90.0%)	103 (85.8%)		

Inference: Abnormal mobility decreased over time but was not statistically significant.

Table 7: Distribution of Crepitus at Different Time Intervals

Crepitus	6 Weeks	3 Months	6 Months	Total	Chi-value	p-value
Present	7 (17.5%)	0 (0.0%)	0 (0.0%)	7 (5.8%)	14.861	0.001
Absent	33 (82.5%)	40 (100.0%)	40 (100.0%)	113 (94.2%)		

Inference: Crepitus resolved completely by the 3rd and 6th months ($p = 0.001$), indicating significant improvement.

Table 8: Distribution of Ankle Movement at Different Time Intervals

Ankle Movement	6 Weeks	3 Months	6 Months	Total	Chi-value	p-value
Normal	33 (82.5%)	38 (95.0%)	40 (100.0%)	111 (92.5%)	12.703	0.01
Terminally Painful	5 (12.5%)	0 (0.0%)	0 (0.0%)	5 (4.2%)		
Painful	2 (5.0%)	2 (5.0%)	0 (0.0%)	4 (3.3%)		

Inference: Ankle movement significantly improved over time ($p = 0.01$), with normal movement achieved in all patients by 6 months.

Table 9: Distribution of NV Status at Different Time Intervals

NV Status	6 Weeks	3 Months	6 Months	Total	Chivalue	p-value
Normal	38 (95.0%)	40 (100.0%)	40 (100.0%)	118 (98.3%)	4.068	0.13
Abnormal	2 (5.0%)	0 (0.0%)	0 (0.0%)	2 (1.7%)		

Inference: NV status was normal in nearly all patients by the 3rd and 6th months.

Table 10: Distribution of Radiological Findings at Different Time Intervals

Radiological Finding	6 Weeks	3 Months	6 Months	Total	Chi-value	p-value
Callus Formation	38 (95.0%)	0 (0.0%)	0 (0.0%)	38 (31.7%)	117.081	<0.001
Non-Callus Formation	2 (5.0%)	2 (5.0%)	2 (5.0%)	6 (5.0%)		
Normal Finding	0 (0.0%)	38 (95.0%)	36 (90.0%)	74 (61.7%)		
Displaced Bony Healing	0 (0.0%)	0 (0.0%)	2 (5.0%)	2 (1.7%)		

Inference: Radiological findings showed significant improvement, with most patients having normal findings by the 3rd and 6th months.

Table 11: Distribution of Complications at Different Time Intervals

Complication	6 Weeks	3 Months	6 Months	Total	Chi-value	p-value
Deep Vein Thrombosis	2 (5.0%)	0 (0.0%)	0 (0.0%)	2 (1.7%)	16.268	0.03
Ankle Stiffness	1 (2.5%)	0 (0.0%)	0 (0.0%)	1 (0.8%)		
Skin Irritation	1 (2.5%)	0 (0.0%)	0 (0.0%)	1 (0.8%)		
None	36 (90.0%)	40 (100.0%)	36 (90.0%)	112 (93.3%)		
Delayed Union	0 (0.0%)	0 (0.0%)	4 (10.0%)	4 (3.3%)		

Inference: The incidence of complications significantly decreased over time, with minimal complications by the 3rd and 6th months.

Table 12: Distribution of AOFAS Score at Different Time Intervals

Time Interval	Mean	Std. Dev	F-value	p-value
6 Weeks	87.88	13.794	6.985	0.001
3 Months	97.20	8.656		
6 Months	95.75	12.937		

Inference: The AOFAS score significantly improved over time, peaking at 3 months ($p = 0.001$).

Table 13: Comparison of Procedure with Outcome (AOFAS Score)

Procedure	Mean	Std. Deviation	F-value	p-value
Conservative	92.33	13.605	5.869	0.001
K-wiring	98.62	6.051		
IM Nailing	84.89	16.641		
Plating	95.83	9.731		

Inference: K-wiring showed the best outcomes with a mean AOFAS score of 98.62, followed by plating, conservative treatment, and IM nailing ($p = 0.001$).

DISCUSSION

Metatarsal fractures are a common type of foot injury, particularly affecting middle-aged individuals. These fractures, which occur between the toes and the tarsal bones of the foot, can be caused by direct or indirect trauma, with road traffic accidents (RTAs) being the most frequent cause of high-velocity injuries. These fractures, if left untreated, can lead to persistent pain and significant limitations in daily activities. In some cases, metatarsal injuries may also involve the Lisfranc joint, which plays a crucial role in foot stability and function. Anatomically, metatarsal fractures can be classified into four types: proximal metaphyseal, diaphyseal, cervical, and cephalic.

Management of metatarsal fractures depends largely on the extent of displacement and the type of fracture. Non-displaced fractures are typically managed conservatively, while displaced fractures, especially those involving joint dislocation, often require surgical intervention. In this study, patients with metatarsal fractures were treated using both conservative and surgical approaches. Conservative treatment involved closed reduction and the application of a plaster of Paris (POP) cast, while surgical methods included closed reduction and internal fixation (CRIF) with Kirschner wires (K-wires), intramedullary (IM) nailing, and open reduction with internal fixation (ORIF) using plates.

The present study, conducted at Al-Ameen Medical College & Hospital, Vijayapura, involved 40 patients with metatarsal fractures. Data was collected through clinical examinations, radiological assessments, and blood tests. In terms of demographics, the majority of patients (30%) were between the ages of 21 and 30, followed by 27.5% in the 31-40 age group. Most patients were male (75%), which can likely be attributed to their greater involvement in physically demanding activities, such as sports or heavy labor, which increase the risk of traumatic injuries like RTAs.

Upon clinical examination, 12.5% of patients reported stiffness, 37.5% complained of pain, and 50% had no significant complaints, likely reflecting the varying severity of the fractures. The distribution of treatment modalities showed that 42.5% of the patients were treated conservatively, while the remaining 57.5% required surgical intervention. Among the surgical patients, 32.5% underwent K-wire fixation, 15% were treated with IM nailing, and 10% received ORIF with plates.

In evaluating the clinical outcomes, tenderness was a key indicator of recovery. At six weeks, 32.5% of patients experienced tenderness at the fracture site, which reduced to 15% at three months and further to just 5% at six months. This reduction in tenderness was statistically significant, indicating that both conservative and surgical treatments promoted effective healing over time. Similarly, abnormal mobility was noted in 17.5% of patients at six weeks, but this gradually decreased to 10% by six months. While this improvement in mobility was not statistically significant, it still points to a trend of functional recovery as the fractures healed.

Crepitus, a sensation of grinding or crackling, was present in 17.5% of patients at six weeks but was completely resolved by the three-month follow-up. This improvement was statistically significant and reflects the stabilization of fractures over time. Ankle movement, another critical marker of functional recovery, showed a significant improvement as well. At six weeks, 82.5% of patients had regained normal ankle movement, with this number rising to 100% by the six-month follow-up. These results suggest that proper fracture management helped restore full mobility and function in the majority of patients.

The neurovascular (NV) status of patients was largely unaffected by the fractures or treatments. By three months, 100% of the patients had normal NV status, demonstrating that the surgical interventions did not result in nerve damage or compromised blood supply to the foot.

Radiological assessments played a crucial role in monitoring the healing process. Callus formation, which indicates the early stages of bone healing, was seen in 95% of patients at six weeks. By the three-month follow-up, 95% of patients had normal radiological findings, indicating complete fracture healing, and 90% of patients continued to show normal findings at six months. These results were statistically significant, confirming the effectiveness of both conservative and surgical treatments in promoting bone healing.

Although complications were minimal in this study, some issues did arise. Deep vein thrombosis (DVT) was observed in 10% of patients at six weeks, likely due to the reduced mobility associated with surgical recovery. However, all cases were successfully managed with anticoagulant therapy, and no further complications were noted at later follow-ups. Delayed union, where the fracture took longer to heal than expected, occurred in 10% of patients by six months, primarily among those treated with IM nailing. This underscores the importance of continued monitoring and individualized treatment, particularly for more complex fractures.

Functional outcomes were measured using the American Orthopaedic Foot and Ankle Society (AOFAS) score, which evaluates pain, function, and alignment. The mean AOFAS score improved significantly over time. At six weeks, the mean score was 87.88, indicating that patients were still in the early stages of recovery. By three months, the mean score had risen to 97.20, and by six months, it was 95.75, reflecting sustained functional improvement. When comparing the different treatment methods, patients treated with K-wiring had the highest mean AOFAS score (98.62), followed by those treated with ORIF (95.83), conservative treatment (92.33), and IM nailing (84.89). These results suggest that K-wiring, a minimally invasive technique, provides superior functional outcomes,

particularly for displaced fractures.

The results of this study align with those of previous research. Wu et al. found that surgical intervention leads to better short-term outcomes compared to conservative treatment for displaced metatarsal fractures, a finding that is consistent with the outcomes observed in this study. Similarly, KC KM et al. demonstrated significant improvements in AOFAS scores for surgically treated patients, particularly those undergoing K-wire fixation, as observed in the present study. Other studies, such as those by Kim et al. and Zarei et al., have also reported high rates of bony union and functional recovery following K-wire or IM nailing, further validating the findings of this research.

One of the strengths of this study is the comprehensive follow-up period, which allowed for a thorough assessment of both short-term and long-term outcomes. The use of standardized scoring systems, such as the AOFAS, ensured that functional outcomes were measured objectively. However, the study also has some limitations. The inclusion of patients who used NSAIDs during recovery may have affected pain scores and the rate of bone healing. Additionally, the relatively small sample size may have limited the ability to detect significant differences in secondary outcomes, potentially leading to type II errors.

In conclusion, this study provides valuable insights into the management of metatarsal fractures. While conservative treatment is effective for non-displaced fractures, displaced fractures require surgical intervention for optimal recovery. K-wire fixation, in particular, was associated with the highest functional outcomes and the fewest complications. These findings contribute to the growing body of literature on the management of metatarsal fractures and offer evidence-based recommendations for improving patient care and outcomes.

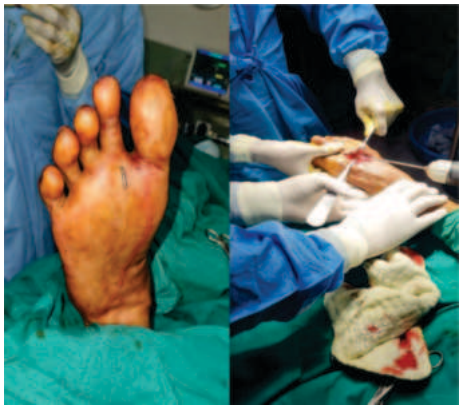
Summary

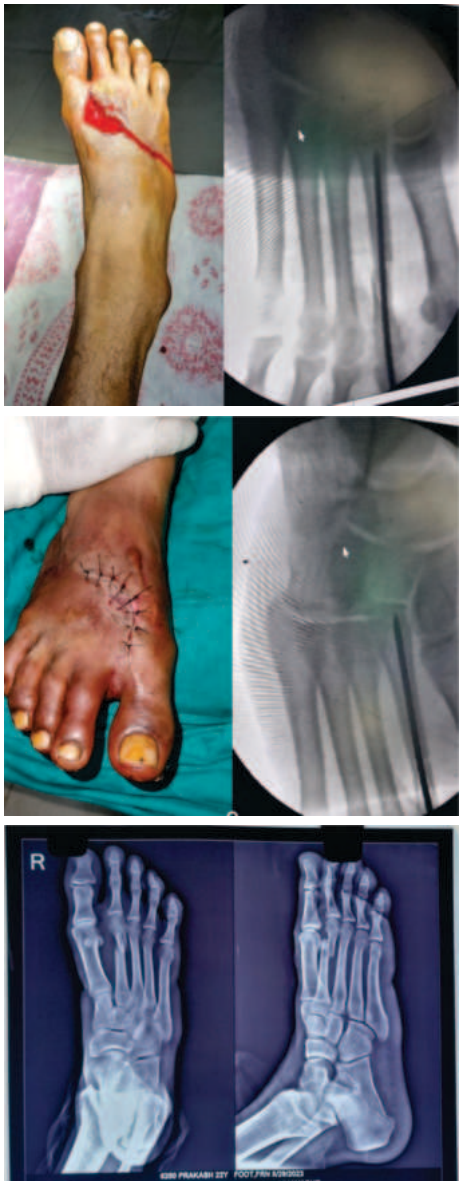
Metatarsal fractures are common injuries that account for approximately 5-6% of fractures treated in primary care settings. This study aimed to evaluate the functional outcomes of patients with metatarsal fractures treated through various management methods, including both conservative and surgical approaches. Conducted at Al-Ameen Medical College & Hospital, Vijayapura, the study involved 40 patients. Data were collected through clinical examinations, radiological assessments, and blood tests, with follow-up periods of 6 weeks, 3 months, and 6 months.

The results indicated that 95% of patients showed callus formation at 6 weeks, with 90% demonstrating normal radiological findings at 6 months. Complications were minimal, with 90% of patients experiencing no complications at 6 weeks and 100% complication-free by 3 months. Functional recovery, as measured by the AOFAS score, improved significantly over time, with K-wire fixation yielding the best outcomes. The study concludes that while conservative treatment is effective for non-displaced fractures, displaced fractures benefit most from surgical intervention, particularly with K-wire fixation.

These findings offer valuable insights into the management of metatarsal fractures, providing evidence-based guidance for clinicians to improve patient outcomes and ensure optimal recovery.

Image Gallary





22yr Old Male H/O RTA Presented With Rt Sided 2nd Metatarsal Compound Fracture

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