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CLINICAL OUTCOMES IN THE TREATMENT OF FOOT FRACTURE BY USING MINI RAIL EXTERNAL FIXATOR

Sunisht Kumar[1*], Shashank Mishra[2], Manvi Sharma[3]

[1]Regulatory Department, 2Clinical Research Department, Auxein Medical Private Limited, Sonipat, Haryana, India

Corresponding Author:
**Email: qa7@auxeinmedical.com*

Abstract

Background: Foot fractures, particularly those involving the metatarsals and phalanges, are prevalent injuries that can significantly impact a patient's mobility and quality of life. The Mini Rail System (Auxein Medical) has emerged as a promising tool in the management of these fractures, offering advantages in terms of stability, minimal invasiveness, and the ability to preserve joint motion. This article reviews the clinical outcomes associated with the use of the MiniRail system in treating foot fractures, focusing on its efficacy, complications, and functional outcomes.

Method: We conducted an observational study involving 46 patients who met the inclusion and exclusion criteria, with a study duration of six months. The participants were aged between 20 and 60 years. For the treatment, we used mini external fixators with minirail lengthener T-clamps, threaded wires, clamp cover with screw. Patients were monitored throughout the study period, with periodic follow-up visits and necessary radiographs to assess fracture union.

Results: Of the 46 patients, the majority were aged between 20 and 40 years, with a higher proportion of males. Open fractures were more common than closed fractures. The functional outcomes, as assessed by the American Orthopedic Foot and Ankle Society (AOFAS) scale, were predominantly excellent, good and average. Radiological union was achieved in most cases, with 2.17% of patients experiencing delayed union.

Conclusion: Surgical approach reduces the risk of complications, while an intensive rehabilitation program optimizes the final result. Overall, the minirail external fixator is an effective treatment for fracture management, offering the best functional outcomes.

Keywords: Foot fracture, foot fixation, Minirail External Fixator, Management, Treatment.

INTRODUCTION

Foot fractures, particularly those involving the metatarsals and phalanges being most susceptible to fractures due to trauma, industrial accidents, and sports injuries. These fractures can occur due to various mechanisms, such as direct trauma, overuse, or pathological conditions, and are frequently seen in both athletes and the general population. Metatarsal fractures are commonly associated with activities involving high-impact forces, such as running, jumping, or accidents.[1] Traditionally, these fractures have been treated with methods like closed reduction and casting or internal fixation, which may not always yield optimal results, particularly in cases with complex fractures or soft tissue damage.

The metatarsals, consisting of five long bones in the midfoot, are essential for weight-bearing and providing stability during walking and running.[2] Fractures of these bones can disrupt the normal biomechanical function of the foot and may require surgical intervention, depending on the location, displacement, and severity.[3] Similarly, fractures of the phalanges, which serve as the toes, can severely impact a person's ability to perform basic tasks such as walking, standing, and balancing.[4] These fractures are often categorized as either non-displaced or displaced, with non-displaced fractures generally managed conservatively, while displaced fractures may necessitate surgical intervention for optimal healing.[5]

In recent years, external fixation has gained popularity as a reliable method for managing such fractures, offering advantages such as better control of alignment and less invasive surgical approaches. The use of a mini rail external fixator, in particular, has demonstrated promising outcomes due to its ability to provide precise, adjustable stabilization while allowing for minimal disruption to the soft tissues. This technique involves the application of a lightweight, custom-fitted external frame that provides continuous, controlled mechanical support during the healing process. As a less invasive alternative to traditional internal fixation, mini rail external fixators have shown positive results in terms of fracture healing, reduced risk of complications, and quicker recovery times.[6,7]

This study aims to evaluate the effectiveness and outcomes of mini rail external fixators in the treatment of metatarsal and phalangeal fractures of the foot. By examining clinical outcomes such as fracture healing times, complication rates, and functional recovery, this research seeks to contribute to the growing body of evidence supporting the use of mini rail external fixation as an effective management option for these challenging fractures.

METHOD

The retrospective data was collected from the Private Hospital De San Del Vieja, Guatemala, over a period of six months from September 2023 to March 2024. A total of 46 patients were enrolled based on strict inclusion and exclusion criteria to ensure consistency and reliability of outcomes.

Inclusion Criteria:

- Patients who have completed 12 Months follow up.
- Patients aged between 18 and 65 years, irrespective of gender
- Open fractures
- Fractures involving the metatarsals and phalanges.

Exclusion Criteria:

- Patients below 18 years or above 65 years of age
- Fractures associated with:
  - Vascular injury
  - Tendon injury
  - Crush injury
  - Pathological fractures
- Patients with a history of previous injuries to the foot.

All patients included in the study underwent surgical treatment for foot fractures using the Mini Rail External Fixator. Preoperative evaluation included clinical assessment, radiographic imaging (anteroposterior, lateral, and oblique views), and routine blood investigations. Informed consent was obtained from each patient. The procedures were performed under either spinal, regional (ankle block), or general anesthesia based on the fracture complexity and patient-specific factors.[8,9]

Patients were positioned supine on the operating table with the affected foot placed over a radiolucent foot platform. A tourniquet was applied when required for better operative field visibility. Standard aseptic preparation and draping were done. Closed or limited open reduction was attempted under fluoroscopic (C-arm) guidance. If satisfactory alignment was not achievable through closed manipulation, a minimal open approach was used. Under real-time fluoroscopic guidance, the fracture site was identified and aligned in all planes. A threaded K-wire was inserted transversely into the proximal bone fragment. A second threaded K-wire was placed into the distal fragment to stabilize the opposing segment. Once alignment was confirmed, rotation, angulation, and length were checked in both anteroposterior and lateral planes. The K-wires were connected using the Mini Rail External Fixator clamps, which allowed for precise adjustments and compression or distraction across the fracture site as needed. Final fluoroscopic images were taken to ensure stable fixation and satisfactory alignment. Pin sites were cleaned and dressed appropriately.[10,11]

Early postoperative mobilization was encouraged beginning on the first postoperative day. Although weight-bearing was restricted initially, patients were advised to begin active ankle and toe range-of-motion exercises to prevent stiffness and preserve joint mobility. Immediate postoperative radiographs were obtained on Day 1 to confirm the position of the fracture and external fixator alignment. Patients were reviewed every 72 hours for wound inspection and pin site care. Sutures were removed between the 13th and 16th postoperative day, based on individual wound healing progress.[12] Radiographic follow-up was performed at the end of the fifth postoperative week to evaluate the progression of fracture healing. Provided that adequate callus formation and stability were observed, the Mini Rail External Fixator was removed at this time. Functional recovery was assessed using a validated scoring system appropriate for foot injuries, such as the American Orthopaedic Foot and Ankle Society (AOFAS) score, at 4 weeks, 8 weeks, and 12 weeks postoperatively. These scores evaluated parameters including pain, function, gait, and alignment.[13,14,15]

Results

Patients were evaluated based on several clinical and demographic parameters. This included age, sex, affected side (right or left foot), type and mechanism of injury (e.g., road traffic accident, industrial trauma, agricultural injury, or crush injury), number and location of metatarsals involved, and the presence of associated soft tissue or neurovascular injuries. Detailed assessment was conducted through clinical examination and radiographic imaging to guide appropriate management strategies.

The study included a total of 46 patients, comprising 39 males (84.5%) and 7 females (15.4%), with ages ranging from 20 to 40 years (mean age: 30.3 years). The study population experienced a range of injury mechanisms. Road traffic accidents were the most common cause, accounting for 23 cases (50%). This was followed by industrial and occupational injuries in 11 cases (23.9%), agricultural accidents in 8 cases (17.39%), and crush injuries in 4 cases (8.69%) (Table 1). Among the 46 cases included in the study, 30 patients (65.21%) sustained isolated metatarsal fractures, 10 patients (21.73%) presented with isolated phalangeal fractures, and 6 patients (13.04%) had combined fractures involving both the metatarsals and phalanges (Table 2). The results of the AOFAS questionnaire are presented in Table 3. In our study, which focused on promoting the percutaneous application of mini-rail external fixation, the average AOFAS score was 83.7. The AOFAS scoring system consists of three categories, the first of which is pain. In this category, participants achieved an average score of 34.7 out of a possible 40 (SD = 5.05). The second category, function, includes seven subcategories and had an average score of 39.4, with a possible maximum score of 50. The scores in this category ranged from 13 to 50 (SD = 8.35). The final category, alignment, had an average score of 9.6 out of 10 (SD = 1.4). Overall, the total score range was from 53 to 100, with a standard deviation of 15.2. Among the study population, radiological union was achieved in 45 cases (97.82%). Delayed union was observed in 1 case (2.17%), attributed to non-compliance with postoperative activity restrictions. The average duration for achieving radiological union ranged between 4 to 6 weeks.

Table 1: Cause of Injury

Cause of Injury	Number of Patients	Percentage (%)
Road Traffic Accidents (RTAs)	23	50
Industrial and Occupational Injuries	11	23.9
Agricultural Injuries	8	17.39
Crush Injuries	4	8.69

Table 2: Clinical Profile

Types of Injury	Number of Patients	Percentage (%)
Metatarsal (Left/Right Foot)	16 (Left Foot) & 14 (Right Foot)	65.21
Phalanges (Left/Right Foot)	7 (Left Foot) & 3 (Right Foot)	21.73
Both	6	13.04

Table 3: AOFAS Hindfoot-Ankle Score. Determined by questionnaire filled out by patient and a physical examination component.

Subcategories (Maximum)	Mean	Range	SD
Pain (40)	34.7	30-40	5.05
Function (50)	39.4	13-50	8.35
Alignment (10)	9.6	5-10	1.5
Total (100)	83.7	53-100	15.2

Table 4: Radiological Union

Parameters	Number of Patients	Percentage
Union	45	97.82
Delayed Union	1	2.17
Mal-Union	0	
Non-Union	0	

DISCUSSION

The MiniRail system provides several advantages in the treatment of foot fractures. Its modular design allows for precise adjustments, accommodating complex fracture patterns and anatomical variations. The ability to perform gradual lengthening is particularly beneficial in cases of congenital deformities. Furthermore, the external fixation preserves joint motion and reduces the risk of soft tissue complications associated with internal fixation methods. However, the success of the MiniRail system is contingent upon proper patient selection, surgical technique, and postoperative care. Patients with poor bone quality or significant comorbidities may not achieve optimal outcomes. These findings are consistent with previously published studies advocating the use of mini external fixators in foot trauma.

CONCLUSION

The mini rail external fixator is an effective treatment option open foot fractures, offering Satisfactory union rates, high functional recovery and preservation of soft tissue integrity. This method should be considered a viable alternative to internal fixation, especially in cases where soft tissue condition is compromised or anatomical complexity limits internal fixation. An external fixator facilitates uncomplicated post-operative care, aids in the healing of soft tissues, and promotes bone healing with good range of motion and functional results. The best functional outcomes with steady fixation are provided by a small external fixator that preserves foot motions.

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