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Original Research Article

Evaluation of Functional Outcomes Following Plate Fixation of Intra-Articular Calcaneal Fractures: A Prospective Study

Ravi Shekhar[1], Abnish Nandan[2], Rakesh Kumar[3]

[1]Senior Resident, Department of Orthopaedics, Sri Krishna Medical College, Muzaffarpur, Bihar, India
[2]Senior Resident, Department of Orthopaedics, Sri Krishna Medical College, Muzaffarpur, Bihar, India
[3]Associate Professor & Head of Department, Department of Orthopaedics, Sri Krishna Medical College, Muzaffarpur, Bihar, India

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Corresponding Author: Dr. Abnish Nandan
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Abstract:

Background: Intra-articular fractures of the calcaneus are among the most complex and disabling injuries of the foot. Restoration of anatomical alignment and joint congruity is essential for optimal functional recovery. Surgical management using plate fixation has shown promise in improving outcomes, but controversy remains regarding its efficacy in different settings.

Objective: To assess the functional outcome of patients with intra-articular calcaneal fractures managed surgically with plate fixation.

Methods: A prospective observational study was conducted over a period of one year at the Department of Orthopaedics, Sri Krishna Medical College, Muzaffarpur, Bihar, India. A total of 40 patients with displaced intra-articular calcaneal fractures who underwent open reduction and internal fixation (ORIF) using locking plates were included. Patients were evaluated clinically and radiologically at regular intervals, and functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score at the 6-month follow-up.

Results: At 6 months postoperatively, 70% of patients had good to excellent functional outcomes based on the AOFAS score, while 20% had fair and 10% had poor outcomes. Restoration of Böhler's angle correlated strongly with higher functional scores. Common complications included wound dehiscence (10%) and transient sural nerve irritation (5%).

Conclusion: Surgical management of intra-articular calcaneal fractures with plate fixation provides favorable functional outcomes when anatomical reduction and proper fixation are achieved. Early mobilization and rehabilitation further contribute to recovery. With careful patient selection and adherence to surgical principles, plate fixation remains a reliable option in managing these complex fractures.

Keywords: Calcaneal fracture, intra-articular fracture, open reduction internal fixation, plate fixation, AOFAS score, Böhler's angle, functional outcome.

Introduction

Calcaneal fractures are the most common tarsal bone fractures and constitute approximately 2% of all fractures, with intra-articular variants accounting for more than 70% of cases. These fractures often result from high-energy trauma such as falls from height or motor vehicle accidents and can lead to significant disability if not managed appropriately. Intra-articular involvement poses a considerable challenge due to the complex anatomy of the calcaneus and the difficulty in restoring joint congruity and heel morphology [1,2].

Historically, conservative treatment was the mainstay for many calcaneal fractures, especially in cases where surgical techniques were not well developed. However, non-operative management of displaced intra-articular fractures has often resulted in malunion, chronic pain, subtalar arthritis, and impaired function [3]. With advances in imaging and surgical instrumentation, operative treatment using open reduction and internal fixation (ORIF) has become more widely accepted, particularly in carefully selected patients.

Surgical fixation aims to restore the alignment of the posterior facet of the subtalar joint, Böhler's angle, and the overall shape of the heel, thus enabling better load transmission and functional outcomes [4]. Locking plate fixation has shown promising results by providing stable fixation that allows for early mobilization. However, the decision to operate remains controversial in certain settings due to the

potential for complications such as wound breakdown, infection, and neurovascular injury, especially in regions with limited resources [5].

There is limited literature from Eastern India, particularly from Bihar, evaluating the outcomes of surgical treatment of intra-articular calcaneal fractures. Given the socioeconomic and healthcare delivery challenges in this region, it is essential to understand the effectiveness of surgical management in local clinical practice [6].

This study was undertaken to evaluate the functional outcomes of intra-articular calcaneal fractures treated surgically with plate fixation at a tertiary care teaching hospital in Bihar. The results are intended to inform surgical decision-making and contribute to improved standards of care in the region.

Methods

This prospective observational study was conducted over a duration of one year at the Department of Orthopaedics, Sri Krishna Medical College, Muzaffarpur, Bihar, India. The study included patients presenting with displaced intra-articular calcaneal fractures who were treated surgically with open reduction and internal fixation using locking calcaneal plates.

A total of 40 patients aged between 20 and 60 years were enrolled after obtaining informed consent. Patients with open fractures, bilateral calcaneal fractures, pathological fractures, associated lower limb injuries preventing weight-bearing, and those medically unfit for surgery were excluded from the study.

Preoperative assessment included clinical examination, lateral and axial radiographs of the calcaneus, and computed tomography (CT) scans to evaluate fracture classification and plan surgical intervention. The Sanders classification system was used to categorize fracture types.

Surgical procedures were performed under spinal or general anesthesia through an extended lateral approach. Fracture reduction was achieved using direct visualization and temporary K-wire fixation, followed by definitive fixation using pre-contoured locking plates. Postoperative protocols included limb elevation, wound care, and non-weight-bearing mobilization for 6–8 weeks followed by gradual weight-bearing as tolerated.

Patients were followed up at 6 weeks, 3 months, and 6 months postoperatively. Clinical and radiological assessments were carried out at each visit. The American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score was used at the 6-month follow-up to evaluate functional outcomes, considering pain, walking ability, and range of motion.

Descriptive statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as means with standard deviations, and categorical variables as percentages. Correlation between functional outcomes and radiological restoration of Böhler's angle was assessed.

Results

A total of 40 patients with displaced intra-articular calcaneal fractures underwent open reduction and internal fixation using locking plates. The mean age of patients was 37.8 years, with a male predominance. At the 6-month follow-up, 70% of patients showed good to excellent outcomes based on the AOFAS hindfoot score. Restoration of Böhler's angle showed a strong association with better functional scores. Common complications included wound-related issues in a minority of patients.

Table 1: Age-wise distribution of patients (N = 40)

Age Group (Years)	Number of Patients	Percentage (%)
21–30	8	20.0
31–40	18	45.0
41–50	9	22.5
51–60	5	12.5

Table 2: Gender distribution

Gender	Number of Patients	Percentage (%)
Male	32	80.0
Female	8	20.0

Table 3: Mode of injury

Mode of Injury	Number of Patients	Percentage (%)
Fall from height	29	72.5
Road traffic accident	9	22.5
Others	2	5.0

Table 4: Fracture classification based on Sanders type

Sanders Type	Number of Patients	Percentage (%)
Type II	21	52.5
Type III	13	32.5
Type IV	6	15.0

Table 5: Preoperative Böhler's angle

Böhler's Angle (°)	Number of Patients	Percentage (%)
<0	8	20.0
0–10	22	55.0
11–20	10	25.0

Table 6: Postoperative Böhler's angle

Böhler's Angle (°)	Number of Patients	Percentage (%)
11–19	20	50.0
≥20	20	50.0

Table 7: AOFAS hindfoot score at 6 months

Outcome Grade	AOFAS Score Range	Number of Patients	Percentage (%)
Excellent	90–100	10	25.0
Good	80–89	18	45.0
Fair	70–79	8	20.0
Poor	<70	4	10.0

Table 8: Correlation between Böhler's angle and functional outcome

Postop Böhler's Angle	Mean AOFAS Score	Patients with Good–Excellent Outcome (%)
<20°	77.4	50.0
≥20°	88.6	90.0

Table 9: Time to full weight-bearing

Time Post-Surgery	Number of Patients	Percentage (%)
≤10 weeks	11	27.5
11–12 weeks	22	55.0
>12 weeks	7	17.5

Table 10: Postoperative complications

Complication Type	Number of Patients	Percentage (%)
Wound dehiscence	4	10.0
Sural nerve irritation	2	5.0
Deep infection	0	0.0
No complications	34	85.o

Discussion

This study aimed to evaluate the functional outcomes of patients with intra-articular calcaneal fractures managed surgically using locking plate fixation. At six months postoperatively, 70 percent of patients achieved good to excellent results based on the AOFAS hindfoot score, demonstrating that anatomical reconstruction of the subtalar joint and calcaneal morphology can result in favourable clinical recovery.

The study population predominantly consisted of adult males in the 31–40 age group, with the most common mechanism of injury being fall from height. This demographic profile is in line with global and regional trends, where younger, working-age males are more frequently involved in high-energy trauma[7,8].

The Sanders classification system identified type II fractures as the most common, followed by type III. These findings are consistent with earlier studies, which report that less complex fracture patterns (type II) are more amenable to surgical reconstruction and yield better functional outcomes. In this study, patients with Sanders type II fractures had a higher likelihood of achieving excellent AOFAS scores compared to those with type III or IV fractures [9,10]

Restoration of Böhler's angle was significantly associated with improved functional outcomes. Patients with a postoperative Böhler's angle of 20 degrees or more had a notably higher mean AOFAS

score and a greater proportion of good-to-excellent outcomes. This finding reinforces the role of Böhler's angle as a key radiographic predictor of clinical success, as it reflects restoration of heel height and calcaneal architecture [11,12].

The surgical approach used in this study was the extended lateral approach, which offers adequate visualization for reduction and fixation. While this method is associated with soft tissue complications, the overall complication rate in this study was low. Only four patients developed wound dehiscence, and two experienced sural nerve irritation, both of which were managed conservatively. No deep infections or cases of implant failure were observed, indicating that careful surgical technique and appropriate postoperative care can minimize complications [13,14].

Time to full weight-bearing varied among patients, with most achieving it by 12 weeks. Early mobilization, guided by radiographic healing and pain tolerance, likely contributed to better joint motion and functional results [15,16].

This study's findings are consistent with other regional and international studies advocating for operative treatment of displaced intra-articular calcaneal fractures. While conservative management may be considered in select cases, surgical fixation with locking plates offers superior anatomical and functional restoration in appropriately selected patients [17,18].

Limitations of this study include a relatively small sample size and a short follow-up period of six months. Longer-term evaluation may reveal additional insights into the development of subtalar arthritis or chronic pain. Additionally, patient-reported outcome measures beyond AOFAS scoring could offer a more comprehensive assessment of post-injury quality of life.

In summary, surgical management of intra-articular calcaneal fractures using locking plate fixation is associated with favourable functional outcomes, especially when anatomical reduction is achieved and Böhler's angle is restored. Structured rehabilitation and patient compliance further enhance recovery.

Conclusion

The results of this study demonstrate that open reduction and internal fixation using locking plates for displaced intra-articular calcaneal fractures leads to good functional outcomes in the majority of cases. Restoration of anatomical parameters, particularly Böhler's angle, was associated with better recovery and improved AOFAS hindfoot scores.

Surgical management was effective in facilitating early mobilization and return to functional activities, with a low incidence of complications. These findings support the role of operative treatment as a reliable and beneficial approach in appropriately selected patients with displaced intra-articular calcaneal fractures.

To optimize outcomes, emphasis should be placed on early diagnosis, accurate fracture classification, careful surgical technique, and structured rehabilitation. Further studies with larger sample sizes and long-term follow-up are needed to assess sustained functional results and the development of post-traumatic arthritis.

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