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ORIGINAL RESEARCH ARTICLE

Functional Outcome of Surgically Managed Calcaneal Fractures – A Follow-Up Study

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ABSTRACT

INTRODUCTION
Calcaneal fractures are the most prevalent type of tarsal fractures, and the management of displaced intra-articular fractures remains a debated topic. Historically, many calcaneal fractures were treated conservatively with plaster casts. However, advances in surgical techniques have led some surgeons to opt for surgical intervention. This study aims to assess the functional outcomes of surgically treated calcaneal fractures.

MATERIALS AND METHODS
The study included 40 patients aged 18-60 years. A comprehensive patient history and detailed clinical examination were conducted. The fractures in this study were primarily joint depression type, with 13 patients classified as Sanders type II and 27 as Sanders type III. Surgical intervention involved open reduction and internal fixation using 3.5mm contoured recon or calcaneal plates. Follow-up assessments were performed clinically and radiologically at 12 weeks, 6 months, and 1 year. SPSS software was used for statistical analysis.

RESULTS
A total of 40 patients underwent surgery at a tertiary care hospital, Mangalore. All patients had sustained fractures from a fall from height, and all had joint depression type fractures. Among the study population, 37 patients were males and 3 were females. Out of these, 26 patients had good outcomes with a mean AOFAS score of 82.9, 11 had fair outcomes with a mean score of 72.77, and 3 had poor outcomes with a mean score of 51.36.

CONCLUSION
The study suggests that open reduction and rigid fixation provide favorable postoperative results, facilitating early mobility with minimal complications.

KEYWORDS
Calcaneal, Intra-Articular, Surgical Intervention, Radiological Assessment.

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INTRODUCTION

Fractures of the calcaneus are the most frequently occurring among all tarsal fractures, accounting for 60% of such injuries and approximately 2% of all fractures in adults.[1] The management of displaced calcaneal fractures presents a significant challenge for surgeons. Due to dissatisfaction with the outcomes of conservative treatment and advancements in surgical techniques that have led to reduced complication rates, many surgeons now prefer operative intervention. Long-term effects of calcaneal fractures often include pain and functional impairment. Studies have consistently shown that surgical treatment of calcaneal fractures yields better outcomes compared to non-surgical approaches.[2] Palmer (1948) and Letournel (1984) advocated for the lateral approach to the calcaneus, which was later refined by Benirschke and Sangeorzan in 1993. This approach has since become the most widely adopted technique[3].

A classification system based on CT imaging introduced by Sanders proved valuable in determining treatment approaches and predicting prognosis following surgical fixation. Initially, the classification was specific to joint-depression fractures. A true extra-articular tongue fracture is typically classified as Type IIC, where the entire posterior facet is displaced but remains intact. When the tongue fracture involves the joint, it is categorized as Type IIB. Moreover, mixed fractures with both tongue-type and joint-depression components can be effectively assessed using the CT-based classification. Type I represents non-displaced fractures, while Type II is subdivided into IIA, IIB, and IIC based on the primary fracture line's location. Type III fractures consist of three parts with central depression, and Type IV includes comminuted fractures. The present study aimed to evaluate the functional outcomes of surgically managed calcaneal fractures.[3]

MATERIALS AND METHODS

Study Design and Setting

This prospective study was conducted at Father Muller Medical College, Mangalore, from February 2021 to August 2023. Ethical approval was obtained from the institutional ethics committee prior to the commencement of the study. All participants were informed about the study and provided written informed consent.

Inclusion and Exclusion Criteria

The study included patients aged 18–60 years, classified under ASA grade I and II, who underwent surgical management with open reduction and internal fixation and were available for follow-up. Patients with the following conditions were excluded:

- Paraplegia/paraparesis.
- Long bone fractures in the ipsilateral limb.
- Open fractures.
- Subtalar or ankle arthritis.
- Any coexisting disabilities.

Sample Size

A sample size of 40 patients was determined using the formula:

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$$N = Z^2 p(1-p)/d^2$$

Where Z (standard) =1.96, *p* represents the prevalence (2.5% - obtained from medical records maintained in the hospital) and *d* represents the allowable error. An allowable error of 5% was used to calculate the sample size.

Procedure

Comprehensive patient history was obtained, followed by a detailed clinical examination. The condition of the heel, including swelling and skin integrity, was assessed. Radiological investigations, including lateral and axial views and CT scans of the calcaneum, were performed at admission. Fractures were classified using the Essex-Lopresti and Sander's classification systems.

- In this study, the majority of fractures were joint depression types, with 12 patients having Sander's type II fractures and 18 having Sander's type III fractures.
- Surgical intervention involved open reduction and internal fixation using six-holed 3.5mm contoured recon plates or calcaneal plates. The lateral extensile approach was utilized for all patients.
- Post-surgical care included the application of a short leg splint for 3–5 days, with early active range-of-motion (ROM) exercises initiated after wound healing. Ankle and subtalar ROM exercises began during the second postoperative week, and weight-bearing activities were introduced after 12 weeks.

Follow-Up and Evaluation

Follow-up assessments were conducted clinically and radiologically at 12 weeks, 6 months, and 1 year. Evaluations focused on the following parameters:

- Height and width of the calcaneum.
- Range of motion (ROM) at the subtalar joint.
- Tubero-talar angles.
- During each follow-up visit, pain, swelling, tenderness, and clinical union were assessed.
- The functional outcome was evaluated at 12 months using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot scoring system. This system measures pain (40 points), function (50 points), and alignment (10 points) on a 100-point scale.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS), version 18.0 (SPSS Inc., Chicago, IL). Descriptive statistics summarized sociodemographic and clinical characteristics. Parametric tests (Chi-square test, Student's t-test) and non-parametric tests (Mann-Whitney U) were employed for group comparisons. A significance level (α) of < 0.05 (two-tailed) was considered statistically significant.

RESULTS

A total of 40 patients were operated on for calcaneal fractures at Father Muller Medical College, Mangalore, between February 2021 and August 2023. The mode of injury for all patients was a fall from a height, and all had joint depression-type fractures. Among the 40 patients, 27 (67.5%) had Sander's type III fractures, while 13 (32.5%) had Sander's type II fractures. The cohort

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comprised 37 (92.5%) males and 3 (7.5%) females, all aged between 18 and 60 years, with a mean age of 37.2 years. Among the 40 cases, 25 (62.5%) had left-sided fractures, and 15 (37.5%) had right-sided fractures.

The functional outcomes of these patients were assessed using the AOFAS scoring system. Of the 40 patients, 26 (65%) demonstrated good results, with a mean AOFAS score of 82.9. Eleven patients (27.5%) had fair results, with a mean score of 72.77, and three patients (7.5%) showed poor results, with a mean score of 51.36. Among the patients with good outcomes, two (7.69%) underwent implant removal after fracture union, approximately one and a half years post-surgery. These patients reported no complaints postoperatively.

The mean range of motion (ROM) of the subtalar and ankle joints was evaluated based on functional outcomes. For patients with good results, the mean inversion and eversion were 21.37 and 18.58 degrees, respectively, while mean dorsiflexion and plantarflexion of the ankle were 30.23 and 25.28 degrees, respectively. For those with fair results, the mean inversion and eversion were 16.58 and 12.63 degrees, and the mean dorsiflexion and plantarflexion were 20.26 and 15.12 degrees, respectively. Patients with poor outcomes had a mean inversion and eversion of 10.24 and 7.7 degrees, with mean dorsiflexion and plantarflexion of 15.27 degrees each.

Sl. No.	Baseline Characteristics	No. of Patients (%)
	Age	
1	26 – 30 Years	8 (20%)
2	31 – 35 Years	11 (27.5%)
3	36 – 40 Years	6 (15%)
4	41 – 45 Years	12(30%)
5	46 – 50 Years	3 (7.5%)
	Gender	
1	Male	37 (92.5%)
2	Female	3 (7.5%)
	Laterality of Fracture	
1	Left side	25 (62.5%)
2	Right side	15 (37.5%)
	Type of Fracture	
1	Sander's Type II fracture	13 (32.5%)
2	Sander's Type III fracture	27 (67.5%)

Table 1: Baseline characteristics of the study population

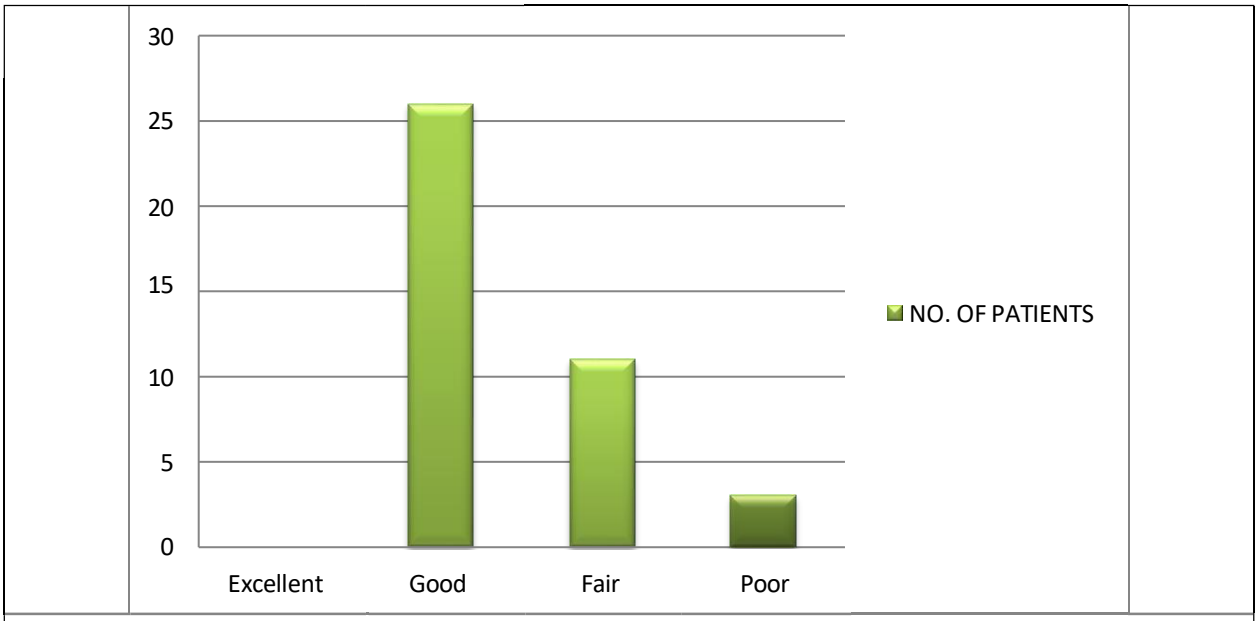

Figure 1: Results as Per AOFAS Scores

DISCUSSION

The calcaneum is the most frequently fractured tarsal bone. In terms of prognosis, extra-articular fractures generally have better outcomes, whereas intra-articular fractures show variable results. The management of intra-articular fractures remains a subject of considerable debate. Despite the availability of numerous treatment protocols, there is no consensus on the most effective approach. Stapleton JJ et al. highlighted that calcaneal fractures are challenging to manage surgically and often yield inconsistent outcomes. They observed that conservative treatment for displaced intra-articular calcaneal fractures frequently leads to significant deformities and post- traumatic arthrosis. An open surgical approach is often necessary to achieve anatomical reduction and long-term success.[4]

In 2014, Cao L et al. reported that Sanders type II and III fractures of the calcaneus treated with a minimally invasive method, combining percutaneous reduction and locking plate fixation, produced satisfactory clinical outcomes with fewer complications.[4] Similarly, Chen XD et al. in 2015 concluded that using titanium plates for internal fixation was an effective treatment strategy for calcaneal fractures, providing reliable fixation, adequate reduction, and facilitating early rehabilitation.[6] Conversely, Griffin D et al., in a 2014 study, found no significant symptomatic or functional advantages between operative and non-operative management for displaced intra-articular calcaneal fractures, noting a higher risk of complications associated with surgical intervention.[7]

Stapleton JJ et al. also reported that intra-articular calcaneal fractures are typically caused by high-energy trauma. Their findings emphasized that surgical treatment should prioritize anatomical reduction while minimizing complications. The lateral approach to these fractures has been shown to achieve these goals without compromising the healing process.[8] Although some studies with sample sizes exceeding 100 cases have demonstrated favorable outcomes following open reduction and internal fixation for intra-articular calcaneal fractures,[9,10,11] the optimal

treatment remains uncertain. Prospective randomized trials have not consistently shown superior outcomes with surgery, although Buckley et al. identified better results within specific subgroups of patients after surgical intervention.[12,13,14]

In the present study, 67.5% of patients had Sanders type III fractures, while 32.5% had Sanders type II fractures. The sample included 92.5% males and 7.5% females, all aged between 18 and 60 years, with a mean age of 37.2 years. In a study by Melcher et al., long-term outcomes assessed ten years post-surgery were found to be superior to those observed after three years.[15] In the current analysis, 26 patients (65%) achieved good results, with a mean AOFAS score of 82.9, while 11 patients (27.5%) had fair results, scoring an average of 72.77. Three patients (7.5%) had poor outcomes, with a mean score of 51.36. Among those with good results, two patients underwent implant removal approximately 18 months post-surgery, and none reported postoperative complaints.

Sander's findings indicated that excellent or good outcomes were achieved in 73% of type II fractures, 70% of type III fractures, and only 27% of type IV fractures.[16] Similarly, Johny Joshi et al. in 2015 found that functional outcomes were excellent in 26.4% of cases and good in 61.64%, with no cases reporting poor outcomes.[17] Another study by Tashfeen Ahmad et al. noted significant improvement in anatomical parameters following surgery.[18] Carlo Biz et al. also demonstrated marked functional improvement after open reduction procedures.[19]

In this study, 65% of patients had good results, while 35% had fair or poor outcomes, despite successful restoration of calcaneal anatomy, as measured by Bohler and Gissane angles. The use of plate and screw fixation significantly enhanced functional outcomes post-surgery. However, limitations of this study included a small sample size and the lack of consideration for specific fracture patterns.

CONCLUSION

The study suggests that open reduction and rigid fixation provide favorable postoperative results, facilitating early mobility with minimal complications.

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