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Comparative analysis of surgical approaches for calcaneal fractures: Cannulated cancellous screw vs. open reduction and internal fixation

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Abstract

Aims: To investigate, evaluate, and compare the functional and radiographic outcomes of two prominent treatment approaches for calcaneal fractures: Open Reduction and Internal Fixation with Plating and Percutaneous Cannulated Cancellous Screw fixation.

Methods and Material: The study was conducted at medical colleges of Ahmedabad and Nadiad focusing on patients admitted to Orthopedic OPD and Casualty. The sample size comprised 30 patients, and it was a randomized comparative retrospective study from data collected from patients operated from May 2021 to May 2023.

Results: Among 30 patients with unilateral calcaneus fractures, right-side involvement was observed in 46.6%, and left-side involvement in 53.3%. Two fixation methods were employed: Group P (n=11) Open Reduction and Internal Fixation with Plating (37% of patients) and Group C (n=19) Cannulated Cancellous Screw fixation (63% of patient). In Group C, 10 patients had excellent results, while in Group P, 5 patients achieved an excellent outcome.

Conclusions: In our comparative study, patients treated with Cannulated Cancellous Screw for calcaneal fractures demonstrated superior radiographic and functional outcomes compared to those undergoing Open Reduction and Internal Fixation with Plating.

Keywords: CC screw v/s ORIF plating, calcaneum fractures different approaches

Introduction

Fractures of the calcaneum represent the most common type of tarsal bone fracture, comprising 60 percent of all tarsal fractures in adults, with a higher prevalence among young males. Accounting for approximately 2% of all fractures, displaced intra-articular fractures make up 60% to 75% of these calcaneal injuries. The calcaneum, a crucial weight-bearing bone forming the subtalar joint essential for foot movements, is susceptible to subtalar arthritis following intra-articular fractures, resulting in significant pain when walking on uneven surfaces.

Comminuted calcaneal fractures, in particular, pose a substantial threat to long-term mobility, raising serious socio-economic concerns for patients and their families. The complexity of treating calcaneal fractures arises from the irregular bony anatomy, intricate relationships between tarsal bones, and the challenges posed by soft tissue injuries. Despite extensive research, no universally accepted ideal management for calcaneal fractures has been identified in the literature.

In recent years, Open Reduction and Internal Fixation (ORIF) through the extended lateral approach has emerged as a leading surgical procedure for treating displaced intra-articular calcaneal fractures. This technique allows for precise reduction of the subtalar joint and provides an optimal anatomical alignment, supported by rigid fixation in the lateral area. However, the advantages of ORIF are accompanied by a higher risk of complications, including wound-related infections such as dehiscence and skin necrosis, necessitating additional surgeries for plate removal, debridement, and free flap coverage. These complications extend hospitalization, delaying rehabilitation. In response to the challenges posed by ORIF, some surgeons explore alternative approaches, including conservative

management, closed reduction, external fixation, and percutaneous techniques, aiming to reduce complications and shorten hospitalization times.

Percutaneous techniques, particularly those employing Cannulated Cancellous Screws or Steinman pins, are gaining popularity due to their potential to improve radiographic parameters and achieve superior functional outcomes with less postoperative pain, enhanced range of movement, and fewer complications compared to traditional ORIF. It is noteworthy that swelling is not a contraindication for percutaneous techniques, making them suitable for elderly patients and those with systemic co-morbidities, as these techniques minimize blood loss and soft tissue dissection. The primary objective of this study is to investigate, evaluate, and compare the functional and radiographic outcomes of two prominent treatment approaches for calcaneal fractures: Open Reduction and Internal Fixation with Plating and Percutaneous Cannulated Cancellous Screw fixation.

Methodology

The study was conducted at medical colleges of Ahmedabad and Nadiad, focusing on patients admitted to Orthopedic OPD and Casualty. The sample size comprised 30 patients, and it was a randomized comparative retrospective study from data collected from patients operated from May 2021 to May 2023.

Inclusion criteria involved patients aged 20-50 years with closed displaced calcaneal fractures. Exclusion criteria included open fractures, pre-existing arthritis of the subtalar joint, fractures older than 4 weeks, pediatric calcaneus fractures, and patients unwilling to participate.

The pre-operative protocol included assessing vitals and associated injuries on admission, conducting radiological assessments (lateral and axial views of calcaneum, spine, and pelvis), and utilizing a CT scan for preoperative planning. Strict limb elevation on Bohler-brown splint, measurement of Bohler's angle and Crucial angle of Gissane, and classification of fractures using Essex Lopresti classification were performed. Injectable antibiotics were administered preoperatively, and further management was determined by fracture geometry.

Conservative treatment criteria included patients unfit for surgery due to medical comorbidities and those unwilling for surgery. Operative management indications encompassed impaction and/or lateral shift of the tuberosity fragment, intra-articular displacement >2mm, and extraarticular fractures compromising soft tissues.

The aims of surgery were the restoration of subtalar joint congruency, calcaneus height (Bohler angle), reduction of calcaneus width, and realignment of tuberosity into a valgus position. The timing of surgery involved assessing swelling daily, with surgery scheduled after the appearance of the 'Wrinkle Sign'.

Operative management included Closed Reduction and Percutaneous Screw Fixation methods. Using 4.5mm Steinmann pin is inserted from the medial side through a stab incision in calcaneal tuberosity, followed by distraction of pins to restore primarily length and height of the calcaneus. Traction is applied manually through a traction bow in the long axis of the calcaneum, with alternating varus and Valgus stress on the heel and the forefoot to disimpact the fracture and gain space for further reduction of the articular fragments. The varus position of the tuberosity fragment is corrected and reduced onto the

sustentaculum one. Reduction of the articular surface seen under image-intensifier and compress the heel in order to impact the lateral wall. A Steinmann pin used for the initial leverage of the articular fragment. Reduction secured by multiple k-wires. Last, appropriate size (6.5mm diam.) screw inserted percutaneously. Post-operatively proper dressing applied and give limb elevation and short leg non-weight-bearing cast for 4-6 weeks with rehabilitation protocol followed.

Operative management with open reduction and internal fixation with plating using The lateral approach, was performed with "L" incision used to reach the fracture in all patients. The subtalar joint was reduced under direct visualization after transecting the calcaneofibular ligament, then reduced the sustentaculum calcanei, anterior process, tuberosity, and then the posterior facet. Furthermore, Kirschner wires were also used to reduce and tentatively fix the calcaneal length and inclination. Once the correction was achieved and confirmed with C-Arm, the internal fixation was performed using a plate and fixed using three or four leg screws. Furthermore, we performed below knee slab immobilization treatment for eight weeks.

Post-operative protocol included strict limb elevation with a below knee cast/splint and administering three doses of injectable antibiotics and intravenous painkillers. Follow-up at 6 weeks involved patient interaction about pain/stiffness, cast removal, range of movements, and radiological and clinical union assessment. At 6 months, assessments included radiological and clinical union, functional ability evaluation, and assessment of functional outcomes using the AOFAS Score. Complications mainly related to malunion, stiffness, and soft tissue injury, with rare occurrences of nonunion of calcaneus. Pain sources included the subtalar joint, midtarsal joint, ankle, malleoli, and heel pad soft tissues. Weakness of plantar flexion, stiffness of forefoot and toes, infection, and malunion were also considered.

Results and Observations

In our study of thirty patients with calcaneus fractures, two main surgical techniques were employed: Cannulated Cancellous Screw fixation and Open Reduction and Internal Fixation with calcaneus anatomical plate. The patients were followed up for a minimum of six months, and key observations include Calcaneus fractures being more prevalent in the younger age group (24 to 49 years) and more common in males, attributed to increased involvement in outdoor activities. Among 30 patients with unilateral calcaneus fractures, right-side involvement was observed in 46.6%, and left-side involvement in 53.3%. The mechanism of injury varied, with Road Traffic Accidents being predominant in Group C and a mix of Road Traffic Accidents and Falls from Height in Group P. Utilizing the Essex-Lopresti classification, Group P predominantly exhibited joint depression type fractures, while Group C had more tongue type fractures. Two fixation methods were employed: Group P (n=11) Open Reduction and Internal Fixation with Plating (37% of patients) and Group C (n=19) Cannulated Cancellous Screw fixation (63% of patient). Assessment using the American Orthopedic Foot & Ankle Society's AOFAS Score revealed varying outcomes. The AOFAS scores were divided as excellent (>90), good (80-90), fair (70-80), and poor (<70). In Group C, 10 patients had excellent results, while in Group P, 5 patients achieved an excellent outcome. Complications such as pain, infection, wound dehiscence, and malunion occurred, with

varying incidence in both groups. Radiological union occurred between 6 to 12 weeks, with Group C showing slightly earlier union compared to Group P. The majority of patients (19) were operated within a week of injury, with 14 in Group C and 5 in Group P. Full weight bearing started earlier in Group C compared to Group P. Group P had a longer mean duration of hospitalization, potentially due to swelling management. Seventeen patients returned to their original occupation, with varying degrees of work modification. Group C generally had more patients returning to their original occupation.

Discussion and summary

This prospective comparative study, conducted between May 2019 and May 2021 at Sheth L.G. Hospital, Ahmedabad, aimed to evaluate the outcomes of calcaneal fractures treated with Open Reduction and Internal Fixation with Plating (Group P) and Cannulated Cancellous Screw (Group C). The study included 30 patients, randomly divided into the two operative groups. The age distribution revealed a majority of patients in the 31-40 age group, emphasizing the impact of trauma in the working-age population. The study reaffirmed the higher incidence of calcaneus fractures in males engaged in outdoor activities, consistent with existing literature. The mode of injury predominantly involved Road Traffic Accidents (RTA), aligning with the working group's susceptibility to such incidents. Unilateral fractures were observed in all cases, with an equal distribution between right and left sides. Operative timing varied

between the groups, with Group C primarily operated within the first week and Group P within 1-2 weeks. Group C exhibited faster union, and the days of hospitalization were fewer compared to Group P. Both groups initiated weight-bearing around 10-12 weeks, emphasizing the importance of a cautious postoperative rehabilitation timeline. Open Reduction and Internal Fixation emerged as the mainstay treatment modality, aiming for anatomical restoration and early subtalar joint mobilization. The study utilized the Essex-Lopresti classification, revealing an equal distribution of tongue and joint depression types. Postoperatively, Bohler's angle, indicative of calcaneal height and arch angle, showed better correction in Group P, aligning with the favorable outcomes observed in that group. Gissane's angle, another crucial parameter, exhibited postoperative values within the normal range for both groups. The AOFAS Score, a measure of functional outcomes, favored Group C, indicating superior results with Cannulated Cancellous Screw fixation. Complications included pain, malunion, infection, and wound dehiscence, with variations between groups. Group C experienced less pain, while Group P had more cases of infection and wound-related complications. Comparisons with other studies, such as Carlo Biz *et al.*, underscored the importance of a nuanced interpretation due to the study's small sample size and relatively short follow-up. Despite these limitations, the study provides valuable insights into the comparative effectiveness of the two fixation methods.

Table 1: Demographic and Clinical Characteristics

Characteristic	Group C (n=19)	Group P (n=11)
Age Distribution (years)	31-40 (Majority)	31-40 (Majority)
Gender Distribution	Male (100%)	Female (0%)
Mode of Injury	RTA: 22	FFH: 8
Side of Fracture	Right: 14	Left: 16
Timing of Surgery	Mostly within 1 week	Rarely upto 2 weeks

Table 2: Radiological and Functional Outcomes

Outcome Measure	Group C	Group P
Bohler's Angle (Postoperative Mean)	28.9 degrees	33.18 degrees
Gissane's Angle (Postoperative Mean)	122.63 degrees	124.81 degrees
AOFAS Score (Excellent/Good/Fair/Poor)	10/6/2/1	5/2/1/3
Complications (Pain/Infection/Malunion/Wound)	4/0/1/0	2/2/1/2

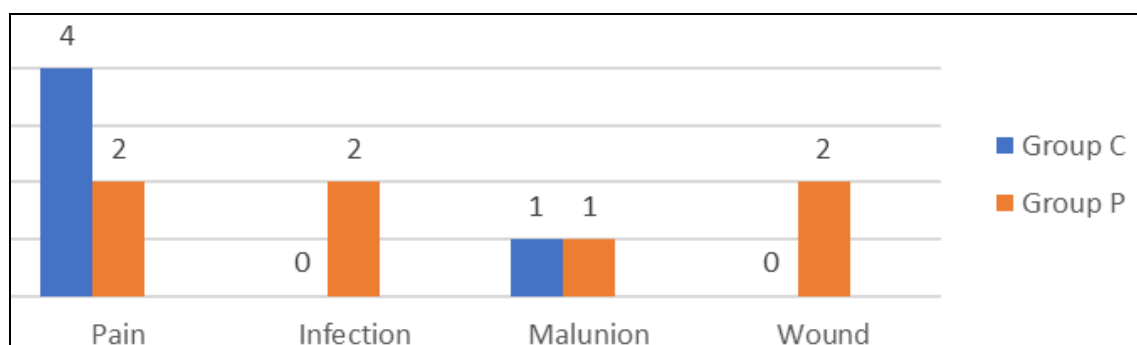


Fig 1: Complication

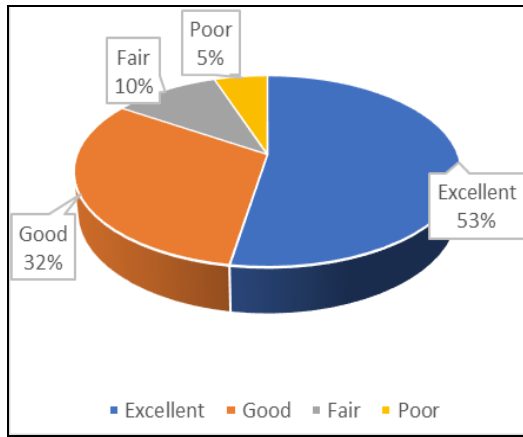


Fig 2: AOFAS score: CC screw

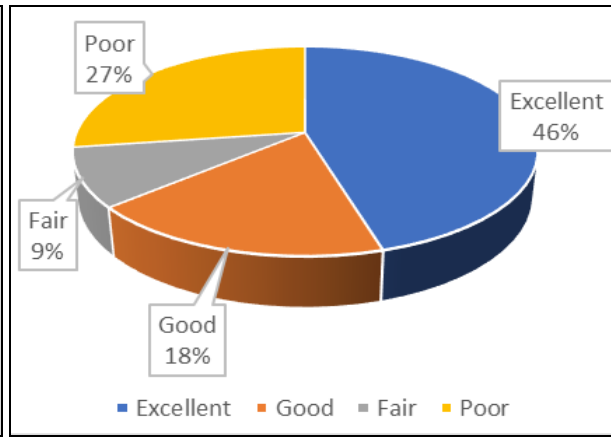


Fig 3: AOFAS score: ORIF plating

These findings underscore the complexity of calcaneal fractures, with treatment outcomes influenced by various factors, including the chosen fixation method. While this study offers valuable insights, further research with larger sample sizes and longer follow-up periods is necessary for comprehensive conclusions.

Conclusion

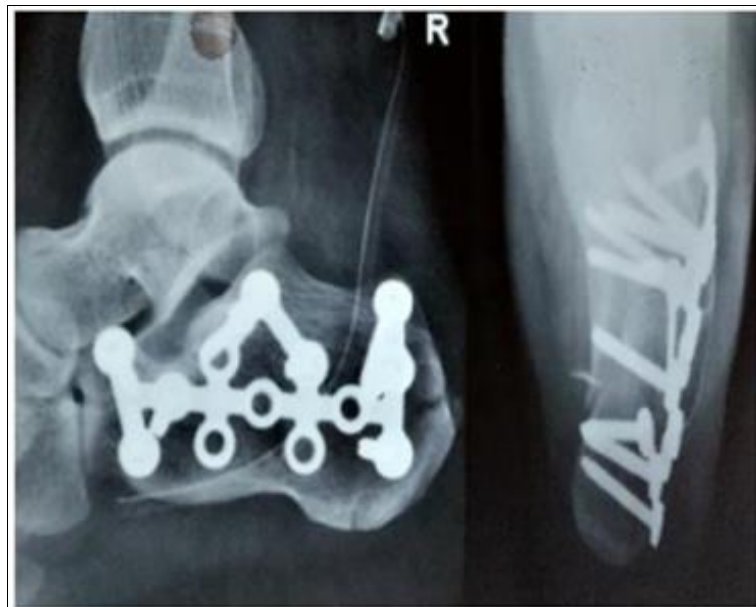
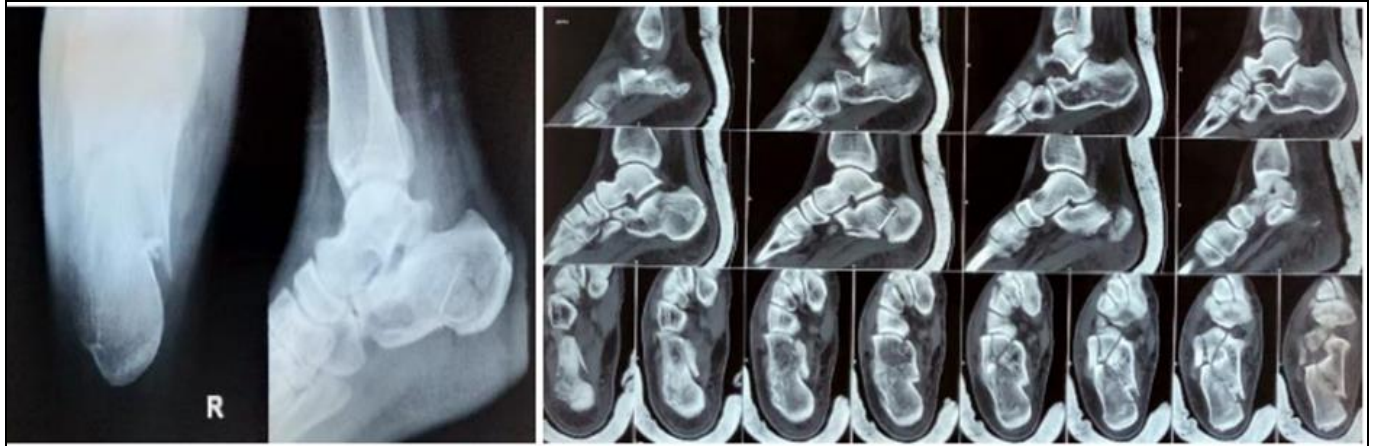
In our comparative study, patients treated with Cannulated Cancellous Screw for calcaneal fractures demonstrated superior radiographic and functional outcomes compared to those

undergoing Open Reduction and Internal Fixation with Plating. The latter was associated with higher complication rates, emphasizing the need for careful planning and consideration of patient-specific factors. The analysis suggests that Cannulated Cancellous Screw, offering shorter operative times and fewer complications, may be a preferred option, especially for individuals with age-related concerns or comorbidities. Additionally, our findings indicate a correlation between anatomical correction (Bohler's angle) and improved clinical outcomes, emphasizing its potential prognostic value in predicting functional results post-operatively.





Case 1: Preop images, post op images, final clinical outcome



Case 2: Pre-op images, post op images, final clinical outcome

Conflict of Interest

Not available

Financial Support

Not available

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