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Estimation of radiological and functional outcome of closed calcaneus fractures treated by open reduction internal fixation with calcaneal plate and screws: A prospective study

Pranjal Sarkar[1], Indrajit Saha[2], Surojit Mondal[3], Susanta Rakshit[4], Ranadeb Bandyopadhyay[5], Debasish Saha[6]

[1,3,4]Assistant Professor, [2]Postgraduate Resident, [5]Professor, Department of Orthopaedics, [6]Professor, Department of Anaesthesiology, Bankura Sammilani Medical College, Bankura, West Bengal, India

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ABSTRACT

Background: Calcaneus fracture comprising only about 2% of all fractures is the most common tarsal bone fracture, constituting about 60% of all tarsal bone fractures. Most of calcaneus fractures are intra-articular making them difficult to treat conservatively with unpredictable outcome. With surgical fixation, there is apprehension of soft-tissue complication. Hence, we decided to conduct this study to estimate radiological and functional outcome of closed calcaneus fractures treated by open reduction internal fixation (ORIF) with calcaneal plate and screws. **Aims and Objectives:** Study was conducted to estimate radiological and functional outcomes of closed calcaneus fractures treated by ORIF with calcaneal plate and screws. **Materials and Methods:** This prospective study included patients with calcaneus fractures operated by extended lateral approach and fixed by ORIF with standard calcaneal low-profile locking plates and screws at Bankura Sammilani Medical College, Department of Orthopaedics and reviewed at out or inpatient department between January 2021 and August 2022. 15 patients with total 19 calcaneus fractures, with 4 patients needing bilateral calcaneus fixation, were enrolled for the study. The data were then recorded as for duration to fracture union, satisfactory radiological reduction as for Bohler's angle, and functional outcome using the American Orthopaedic Foot and Ankle Society score. Data were then processed and analyzed with the help of Microsoft Excel spreadsheet and SPSS (version 27.0) using descriptive statistics in terms percentage and frequency, range, and standard deviation. **Results:** Comparing pre-operative and post-operative Bohler's angle, 17 (89.47%) had adequate reduction and for 2 (10.53%) cases, adequate reduction could not be achieved. In our study, overall 7 out of 19 limbs (36.84%) had excellent functional outcome, 10 (52.63%) had good result, and 2 (10.53%) had fair result. **Conclusion:** ORIF of displaced intra-articular calcaneal fractures through extended lateral approach with low-profile locking calcaneal plates gives good subtalar joint reduction in most cases with satisfactory functional outcome with few complications.

Key words: Calcaneus fracture; Locking calcaneal plate; ORIF

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INTRODUCTION

Calcaneal fracture is the most common tarsal bone fracture, constituting about 60% of all tarsal bone fractures.[1] However, it is uncommon in comparison to other fractures comprising only about 2% of all fractures.[1-3] Common mode of injury is either fall from height or road traffic accident[1,2,4,5] where a biker tries to stop his bike with his

Address for Correspondence:
Dr. Pranjal Sarkar, Assistant Professor, Department of Orthopaedics, Bankura Sammilani Medical College, Bankura, West Bengal, India.
Mobile: +91-967405756. **E-mail:** pranjal.sarkar@hotmail.com

feet constituting high-velocity axial trauma to the bone. Most of calcaneal fractures are intra-articular making them difficult to treat conservatively with unpredictable outcome[1] often patients have debilitating pain in the subtalar region. On the other hand with surgical fixation, there is always apprehension of soft-tissue complications due to acute swelling after injury, precarious soft tissue, and chances of wound infection and wound dehiscence, making it difficult to decide between conservative treatment or operative fixation.[2]

Bankura is a peripheral district of West Bengal with largely rural population and relatively high number of road traffic accident, and we often come across calcaneal fractures with intra-articular comminution. With inadequate data, we often face dilemma regarding whether to treat patients conservatively or by operative means. Hence, we decided to conduct this study to estimate radiological and functional outcome of closed calcaneal fractures treated by open reduction internal fixation (ORIF) with calcaneal plate and screws.

Aims and objectives

Study was conducted to estimate radiological and functional outcome of closed calcaneum fractures fixed by locking calcaneal plate.

MATERIALS AND METHODS

This prospective study was conducted at the Department of Orthopaedics, Bankura Sammilani Medical College, Bankura, from January 2021 to August 2022.

Inclusion criteria

The study included patients aged 18 years and above presenting with calcaneal fractures operated by extended lateral approach and fixed by ORIF with standard calcaneal low-profile plates (Figure 1) and locking screws and followed up for at least 6 months at outpatient or inpatient department.

Exclusion criteria

Undisplaced calcaneal fractures, compound calcaneal fractures, and patients with neurological deficits or grossly uncontrolled diabetes were excluded from the study.

The study is approved by institutional ethics committee memo no BSMC/IEC/3314 dated September 28, 2022. Written informed consents were taken from all participants, after proper explanation regarding the process. Bedhead tickets, operation details, discharge, and follow-up record were retrieved from hospital record department and patients themselves for enrolment in the study.

Evaluation of patients included pre-operative radiograph of anteroposterior (AP) view of ankle and lateral (LAT) and axial view of calcaneal (Figure 2). Pre-operative computed tomography scan of heel was used for the classification of calcaneal fractures as per Sander's classification.[6] Post-operative evaluation included ankle AP and LAT and axial view radiograph of calcaneal. Radiological bone union was defined as the absence of radiolucent fracture line and the presence of bridging callus formation. Bohler's angle and Gissane's angle were measured on lateral view radiograph of calcaneal with 25 to 40° of Bohler's angle which is considered normal.[7] In case of displaced calcaneal fractures, Bohler's angle is reduced below 25°. Patients were followed up every month till 6 months after surgery then every 3 months.

Fractures are classified as per age, gender, laterality, mechanism of injury, type of fracture as per Sander's classification, time interval between injury and surgery, and post-operative wound complications.

Functional outcome was recorded using the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot questionnaires (scores).[8] The AOFAS hindfoot score system includes intensity of pain and functional disability and alignment. Pain is scored with 40 points, alignment has 10 points whereas functional disability has 50 points. Functional disability includes maximum walking distance, walking surface, gait abnormality, sagittal motion (flexion plus extension), hindfoot motion (inversion and eversion), and ankle hindfoot stability (AP, varus-valgus). The score has maximum 100 points as best possible outcome. The result is excellent when score is between 90 and 100, good when it is between 80 and 89, fair when between 70 and 79, and poor when below 70.

At the end of study, there were 15 patients with total 19 calcaneus fractures, who meet inclusion criteria. 4 patients had bilateral calcaneus fractures with all 4 needing bilateral ORIF with calcaneal plates and screws.

The data were then recorded, processed, and analyzed with the help of Microsoft Office Excel spreadsheet and SPSS (version 27.0) using descriptive statistics in terms of percentage and frequency, range, and standard deviation.

Observations

There were 15 patients with 19 calcaneal fractures, 11 (73.33%) patients had unilateral calcaneus fractures, 4 (26.66%) had bilateral calcaneus fractures. Among the participants included in the study, 12 (80%) were male and 3 (20%) were female giving male: female ratio of 4:1. Age distribution was maximum 40 and minimum 20 years of age with average age of 29.27 years and standard deviation (SD) of 6.55 years. There were 8 (42.11%) right-sided calcaneus fractures whereas 11 (57.89%) left calcaneus

fractures. 10 (66.66%) patients had a road traffic accident whereas 5 (33.33%) had fall from height.

CT scan based on Sander`s classification showed 17 (89.47%) type III calcaneus fractures and 2 (10.53%) type II calcaneus fractures. Average duration between injury and surgery was 11.26 days with range of 6–21 days and standard deviation of 4.81 days.

Functional outcome as per AOFAS score shows mean value of 85.94 with a range of 70–92 and standard deviation of 5.92. Excellent, good, fair, and poor functional outcome with Sander's classification of calcaneus fracture is as below (Table 2).

All 19 fractures united within 12 weeks with average duration to achieve radiological union were 9.52 weeks with a range of 8–12 weeks and standard deviation of 1.50 weeks (Figures 3 and 4).

Out of 19 calcaneus fractures treated by ORIF with calcaneal plates and screw, most of them had no complications, only 1 (5.26%) had hardware prominence needing early implant removal, and 1 (5.26%) had superficial skin infection needing dressing and antibiotics to heel the wound.

DISCUSSION

Dilemma regarding open reduction and fixation of calcaneus fracture is about chances of wound infection and wound dehiscence. But with careful handling of soft tissue and advent of low-profile locking calcaneus plates, chances can be minimized.

All calcaneus fractures included in this study achieved radiological union within 12 weeks from fracture fixation.

Table 1: Pre-operative and post-operative mean Gissane's angle and Bohler's angle

Calcaneal radiological angles	Pre-operative	Post-operative
Gissane's angle	137.63 (SD 6.97)	122.39 (SD 3.61)
Bohler's angle	17 (SD 3.58)	34.56 (SD 6.26)

SD: Standard deviation

Comparing pre-operative and post-operative Bohler's angle, 17 (89.47%) had adequate reduction and for 2 (10.53%) cases, adequate reduction could not be achieved (Tables 1 and 3). In our study, overall 7 out of 19 limbs (36.84%) had excellent functional outcome, 10 (52.63%) had good result, and 2 (10.53%) had fair result (Table 2). Both fair result can be attributed to failure to adequately restore Bohler's angle. We had no poor result. We did not have any Type IV calcaneus fracture, which is often associated with poor functional outcome in other studies can be the reason of absence of poor result.

Santosha et al.[9] studied 24 patients with ORIF of displaced calcaneus fractures with locking calcaneal plate for 24 months and had 43.3% excellent 33.3% good, 10% fair, and 13.3% poor result. They concluded that ORIF of intra-articular calcaneus fractures with locking plate gives good result and maintenance of calcaneal height and Bohler's angle avoids subtalar arthritis.

Palange et al.,[10] on their study of functional outcome of displaced intra-articular fractures of the calcaneus, treated with open reduction plate fixation and bone grafting observed 20 out of 30 had good AOFAS score, 7 had fair result, and 3 had poor result. They concluded that open reduction rigid internal fixation allows anatomical fracture reduction and joint surface restoration and prevents subtalar arthritis.

Rak et al.,[11] on their comparative study between locking and non-locking calcaneal plate fixation, had good or excellent result for 30/34 (85%) cases treated with locking calcaneal plate and 23/42 (55%) cases with non-locking calcaneal plate with no late complication for locking plate group. They concluded open reduction and internal fixation as standard procedure for intra-articular calcaneal fracture and locking compression plates to be better due fewer complication and better functional result in comparison to non-locking plates.

Dwivedi et al.[12] had studied 15 cases of calcaneus fractures treated by ORIF with plate and screws and had 5 (33.33%) excellent, seven (46.66%), two fair (13.33%), and one (6.66%) poor results. They opined that ORIF with plates and screws for displaced intra-articular calcaneus fractures

Table 2: Functional outcome as per Sander's classification

Sander's classification	Functional outcome as per AOFAS score (n, %)			
	Excellent (100–90)	Good (89–80)	Fair (79–70)	Poor (below 70)
II	1 (33.33%)	2 (66.66%)	0	0
III	6 (37.5%)	8 (50%)	2 (12.5%)	0
IV	0	0	0	0

AOFAS: American Orthopaedic Foot and Ankle Society

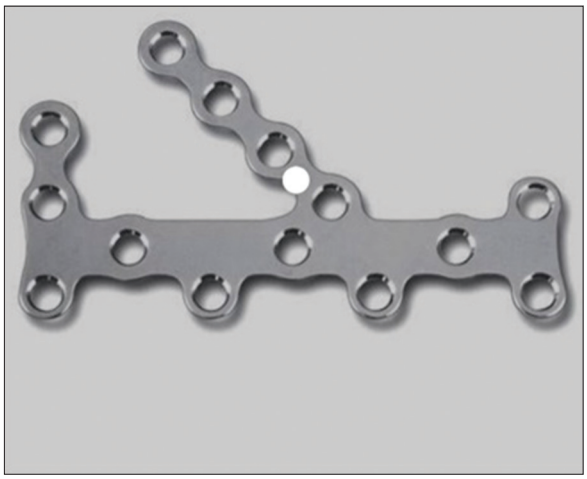

Figure 1: Calcaneal locking plate 3.5 mm

Figure 2: Pre-operative X-ray

Figure 3: Immediate post-operative X-ray

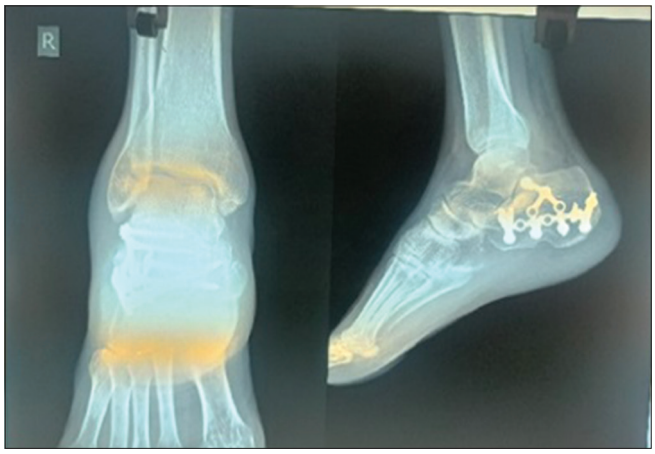

Figure 4: X-ray on 8 week

Table 3: Functional outcome depending upon restoration of Bohler's angle

Bohler's angle	Functional outcome as per AOFAS score (n, %)		
	Excellent	Good	Fair
<25°	0	0	2 (100%)
25–40°	7 (41.18%)	10 (58.82%)	

AOFAS: American Orthopaedic Foot and Ankle Society

is a better option due to its good number of satisfactory outcomes and very few unsatisfactory results.

Buzzi et al.[13] on their study of displaced intra-articular fractures of the calcaneus with ORIF through an extended lateral approach showed average AOFAS score of 80.5 with excellent outcome in 40.9% cases, good in 31.8% of cases fair in 22.7% cases, and poor in 4.6% cases. They concluded osteosynthesis through extended lateral approach restored bone morphology with a reasonable complication rate. Clinical results are good but a normal function and complete subtalar motion were rarely achieved.

Kulkarni et al.[14] on their study showed relatively better functional outcome in displaced and comminuted calcaneus fracture plating provided Bohler's angle is restored so post-treatment Bohler's angle restoration has prognostic significance.

Makki et al.[15] on their retrospective review of 47 intra-articular calcaneus fractures treated with ORIF had 18 (38.3%) excellent result, 17 (36.2%) good, 3 (6.3%), and 9 (19.2%) poor result. They concluded that restoration of Bohler's angle was associated with better outcome. Moreover, prompt osteosynthesis should be considered for intra-articular calcaneus fractures to restore hindfoot shape and Bohler's angle.

Some of the studies also have view contrary to our findings such as, Buckley et al.,[16] concluded that functional results after non-operative care of displaced intra-articular calcaneal fracture were equivalent to those after operative care. However, they also showed on unmasking data by removal of the patients receiving workers; compensation outcomes are significantly better in group treated surgically.

Griffin et al.[17] concluded that operative treatment compared to non-operative treatment showed no symptomatic or functional advantage with typical intra-articular calcaneus fracture and the risk of complications was higher after surgery.

Wei et al.[18] on their meta-analysis of operative versus non-operative treatment of displaced intra-articular calcaneal fracture concluded higher incidence of complications but better anatomical recovery in operative treatment.

Zeman et al.[19] on their comparison between augmented versus non-augmented fixation of calcaneal fractures with locking plates concluded both type of fixation brings good result and there is no significant difference in the results of osteosynthesis by locking plate alone and combined with augmentation of diaphyseal defect of calcaneus.

Limitations of the study

This study is a single center study with relatively small number of cases and no comparative case group and short follow up.

A multicenter study with larger number of cases and comparative study between multiple modalities of treatment with long follow up would have provided better understanding.

CONCLUSION

Open reduction and internal fixation of displaced intra-articular calcaneal fractures through extended lateral approach with low-profile locking calcaneal plates give good subtalar joint reduction in most cases, with satisfactory functional outcome and few complications. Hence, it can be considered a good treatment for displaced intra-articular calcaneal fractures.

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Authors Contribution:
PS- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, and submission of article; **IS**- Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **SM**- Design of study, statistical analysis, and interpretation; **SR**- Review manuscript; **RB**- Review manuscript; **DS**- Review manuscript.

Work attributed to:
Department of Orthopaedics, Bankura Sammilani Medical College, Bankura, West Bengal, India.

Orcid ID:
Pranjal Sarkar - https://orcid.org/0009-0009-2428-614X
Indrajit Saha - https://orcid.org/0009-0005-7681-8348
Surojit Mondal - https://orcid.org/0009-0008-7452-281X
Susanta Rakshit - https://orcid.org/0009-0008-9556-3303
Ranadeb Bandyopadhyay - https://orcid.org/0009-0001-1281-5122
Debasish Saha - https://orcid.org/0009-0009-1891-3717

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