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Original Article

# Outcome Analysis of Closed Displaced Intraarticular Fracture of Calcaneum Treated with Calcaneum Locking Plate

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## Abstract

**Introduction:** Around 75% of calcaneal fractures are intra-articular and have previously been linked with poor functional outcomes. The operative treatment has become more popular, as fracture care has improved. However reviews on this subject, have failed to demonstrate indisputable superior results of a single line of treatment for displaced intra-articular calcaneal fractures. The comparison of studies is difficult because of different outcome variables used for evaluation.

**Aims and Objective:** To evaluate the functional outcome of patients treated with open reduction and internal fixation with plate/screw fixation for intra-articular fracture calcaneum of Sander's CT Type II, III, IV using Maryland Foot Score (MFS).

**Methods:** A prospective study, including 16 patients with an intra-articular calcaneal fracture who met the inclusion criteria, was conducted in tertiary care hospital of central India between March 2021 to October 2022. The patients were managed surgically with open reduction and internal fixation. Radiological outcome and functional outcome using Maryland Foot Score was evaluated at 6 months.

**Results:** Mean age of the patients was 35.5 years. The mean duration from the time of injury to the time for surgery was 6.8 days. Out of 16 patients, functional outcome among 62.5% cases was good (75-89) and 31.25% cases was moderate (54-74) while 6.25% had poor score. The mean score (MFS) among the study participants was found to be 76.81 ± 8.109.

**Conclusion:** We conclude that with good pre-operative planning, surgery timing, intra-operative expertise of the surgeon, and post-operative care, surgical treatment of intra-articular fracture utilizing a locking plate results in a better outcome with few complications.

**Key words:** Calcaneal fractures, Intra-articular, High energy fractures, Soft tissue, Operative technique

## INTRODUCTION

Calcaneal fracture is comparatively the most common fracture of tarsal bone representing 60% of all tarsal fractures in adults, with a reported occurrence of 2% of all fractures. 75% of calcaneal fractures are intra-articular. These fractures occur mostly among young age male patients due to vertical fall from height when lateral process of talus hits like a hammer on the Gissane's angle and then breaks through the posterior articular facet.[1,2] The annual incidence of calcaneal fractures is 11.5 per 100,000 people, with a male to female ratio of 2.4:1, according to a retrospective study of 752 cases during a 10-year period. Falls are the cause of 72% of these fractures. About 10% cases are associated with spine fractures and 26% associated with other trauma.[3]

In 5–10% of cases of fracture calcaneum, both heels are injured at the same time. Although crush injuries recover biologically, they are likely to result in long-term disability.

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A perception formed at the start of the 20th century, at least from the perspective of industry, was that "the man who breaks his heel-bone is finished." Following this, efforts were made to alter the outcome by open reduction and internal fixation of these fractures over the latter half of that century.[4]

Controversy remains with respect to whether displaced intra-articular calcaneal fracture be treated operatively or non-operatively.[2] Historically, displaced intra-articular calcaneal fractures were treated conservatively, as predictable outcome of operative reduction and fixation was not achieved. Operative treatment became more popular, as fracture care improved. Reviews on this subject, however, have failed to demonstrate indisputable superior results of a single line of treatment for displaced intra-articular calcaneal fracture.

### Aim and objective

1. To evaluate the functional outcome of patients treated with open reduction and internal fixation with plate/screw fixation for intra-articular fracture of calcaneum for Sander's CT Type II, III, IV calcaneal fractures.
2. To assess the incidence of infection and complications following open reduction and internal fixation of calcaneal fractures.

## MATERIALS AND METHODS

**Study Design:** The prospective study was conducted at Pt. JNM medical college and associated Dr Bhimrao Ambedkar Memorial Hospital, Raipur (C.G) in central India between March 2021 to October 2022.

**Sample Size**: A total of 16 patients with intra articular fracture of calcaneum meeting the inclusion and exclusion criteria were included in the study.

### Inclusion Criteria

1. Patients with closed intra articular, displaced calcaneal fractures
2. Patients aged between 18 to 60 years.

### Exclusion Criteria

1. Local site infections
2. Coexisting spinal injury with paraplegia
3. Significant coexisting diseases (bleeding disorder etc.) comorbidities with contradiction to any anesthesia.
4. Patients with extra articular fracture, open fracture or Sander's CT type 1 fracture.

### Methodology and procedure

The patients with displaced intra articular fractures of calcaneum were selected by CT Sander's grading (grade II, III and IV) and treated with open reduction and internal fixation with locking compression Plate/CC screw. The patients satisfying the inclusion and exclusion criteria were included in the study after taking the informed consent. The patients' details were collected, and preoperative radiological imaging was performed and pre-operative planning was done.

All the patients being taken for open reduction and internal fixation were primarily treated by limb elevation, ice application and crepe bandage to reduce the edema. Pre-operative x-rays-lateral and axial view of the calcaneum and CT scan of calcaneum were obtained and pre-operative planning was done. Pre-Operative Bohler's and Gissane's angles were measured using radiographs and fractures were classified using Sander's classification with the help of a CT-scan. After obtaining informed consent from the patients and ethical committee clearance, the patients were taken up for surgery once the swelling was reduced and the wrinkle sign was positive. Patients subjected to surgery for calcaneum fracture were followed up at regular intervals with clinical and radiological evaluation. The surgery was performed to restore the height and length of the calcaneum, realign posterior facet of the subtalar joint, and restore mechanical axis of the hindfoot.After the appearance of wrinkle sign surgery was done by standard lateral approach. (Benirschke and Sangeorzan).[5]

The patient was made to lie in lateral position on a radiolucent table after the patient was anaesthetized. The lateral skin incision (L shape EXTENDED LATERAL APPROCH) extending from the calcaneal tuberosity to the calcaneo-cuboid joint was made extending upwards between posterior border of distal fibula and the lateral aspect of the Achilles tendon. It is preferable to raise a thick skin flap to avoid skin necrosis and in all cases k-wires were placed at the proximal end of the wound, bent at an angle of 90 degrees to avoid repeated handling of the skin flap. Care was to taken to preserve the neuro vascular structures (Sural nerve and the short saphenous vein).

Fracture visualization was achieved by using k wires (Three K Wires- one in fibula, one in cuboid, one in neck of talus) and the depressed articular facet fragments were elevated as needed after hinging down the lateral wall subperiosteally for access. Appropriate size plate was fixed over fracture fragment which was reduced and proper size and length of screws used. Complete procedure was done under c-arm(image intensifier) guidance. When there was any deficit then it was filled with cancellous bone graft (autograft).

This plate in all of the procedures was kept under peronei tendons to avoid future impingement. After this procedure

we sutured the back the flap which was kept elevated by k wires and moistened intermittently and skin suturing was done without tension, using Allgower stitch (atraumatic skin closure technique), and suture removal after 3 weeks was recommended. Surgical site was now dressed with sterile gauze and dressing material and the patient given below knee POP slab for immobilization of affected limb.

First sterile dressing was done on the third post-operative day and non-weight bearing mobilization and ankle pumps advised. Then reapplication of below knee POP slab was done for at least 03 - 04 weeks. The surgical site was examined properly for any wound dehiscence in all subsequent dressings. Complete weight bearing was recommended only after ensuring fracture union on x-ray.

During the follow up period the patient operated was assessed radiologically for Bohler's angle and Gissane's angle and height and width of calcaneum immediately after surgery and at 6 weeks of surgery and Maryland food score was taken and evaluated at 6 weeks,3 months and 6 months post operatively. The patient was also assessed for fracture healing at each visit.

## STATISTICAL ANALYSIS

The data was collected and entered into a Microsoft Excel spreadsheet and analyzed using SPSS version 21. The results were averaged (mean + standard deviation) for each parameter for continuous data and numbers and percentages for categorical data presented in Tables and Figures.

## RESULTS

The study included 16 patients. The variables like age, gender, mode of injury, type of fractures, comorbidity, duration of fractures and day of injury to the operative day, complications related to fracture and wound healing, functional outcome at 06 months were analyzed.

In our study, patients were between the age group 20 to 53 years with a mean age of 35.5 ± 8.556 years and majority (62.5%) belonged to the age between 20-40 years of age. The majority of the patients in the study were males, with 87.5 % of the study population being males.

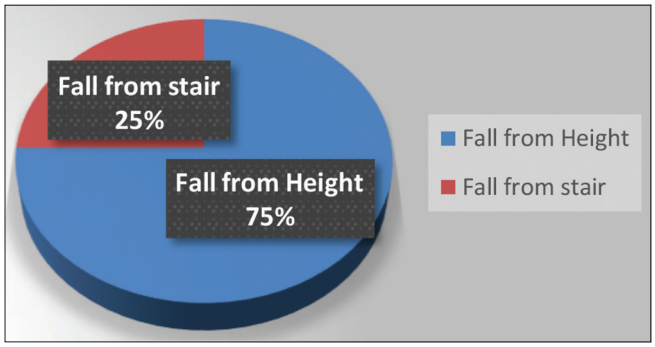


**Figure 1: Mode of injury among study subjects**

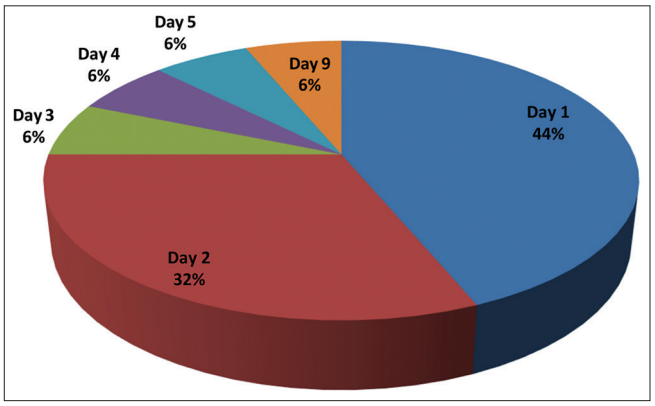


**Figure 2: Presenting day among study subjects**

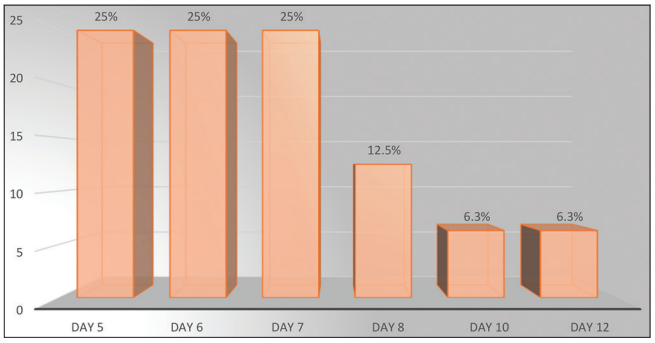


**Figure 3: Operated day among study subjects**

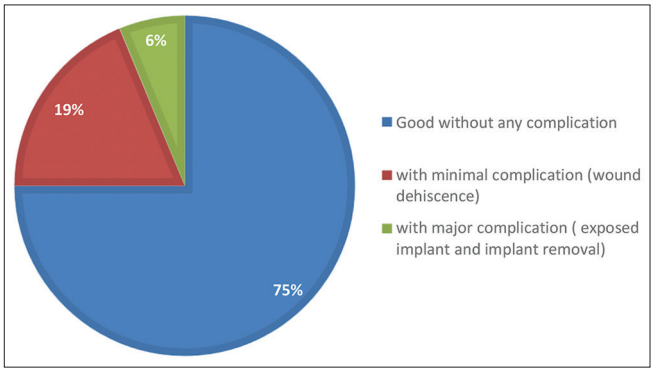


**Figure 4: wound healing at 6 week among study Subejcts**

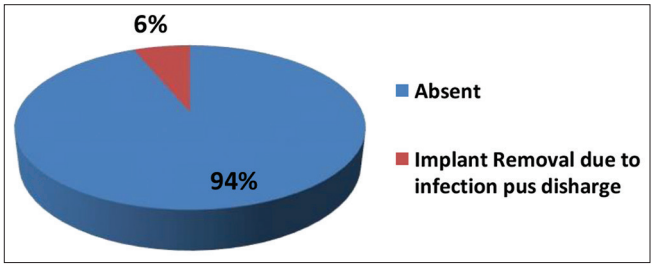


**Figure 5: Major complication needing removal of plate among study subjects**

**Table 1: Age and gender distribution among study participants**

| Variables | Frequency (n=16) | Percent (%) |
|---|---|---|
| Age | | |
| 20-40 years | 10 | 62.5 |
| 41-60 years | 6 | 37.5 |
| Mean±SD | 35.5±8.556 | |
| Gender | | |
| Female | 2 | 12.5 |
| Male | 14 | 87.5 |

**Table 2: Sander's type among study subjects**

| Sander's type | Freq. | Percent |
|---|---|---|
| Type II | 4 | 25 |
| Type III | 9 | 56.25 |
| Type IV | 3 | 18.75 |
| Total | 16 | 100 |

**Table 3: Wound healing at six week among study subjects**

| Wound healing at 6 week | Frequency | Percent |
|---|---|---|
| Good without any complication | 12 | 75.0 |
| With minimal complications (wound dehiscence) | 3 | 18.5 |
| With major complication (exposed implant and implant removal) | 1 | 6.5 |
| Total | 16 | 100.0 |

**Table 4: Maryland foot score among study subjects**

| Maryland foot score | Frequency | Percent |
|---|---|---|
| Good (75-89) | 10 | 62.5 |
| Moderate (54-74) | 5 | 31.25 |
| Poor (<54) | 1 | 6.25 |
| Mean±SD | 76.81±8.109 | |

The mode of injury among study subjects shows that 75% had injury due to fall from height and 25% had injury due to fall from stairs.

The distribution of Sander's type among study subjects shows that among 16 cases 4 (25%) had Sander's type II, 9 cases (56.25%) had Sander's type III and 3 cases (18.8%) had Sander's type-IV calcaneal fractures.

Presenting day among study subjects shows that majority 7 (43.8%) cases presented at day-1 and 5 cases (31.3%) presented on day 2 rest one case each presented on day-3,4,5 and 9.

Operated day among study subjects shows that 4 patients each (25%) were operated on day-5, 6 and 7, 2 (12.5%) operated on day 8 and 6.3% each operated on day 10 and

**Table 5: Wound Dehiscence among study subjects**

| Minor complication | Frequency | Percent |
|---|---|---|
| Absent | 12 | 75.0 |
| Wound Dehiscence | 4 | 25.0 |
| Total | 16 | 100.0 |

**Table 6: Major complication needing removal of plate among study subjects**

| Major complication | Frequency | Percent |
|---|---|---|
| Absent | 15 | 93.8 |
| Implant Removal due to infection pus discharge | 1 | 6.3 |
| Total | 16 | 100.0 |

day 12. The mean duration of time for the surgery to be done was 6.8 days.

Wound healing at 6 weeks in study subjects shows that in 75% patients it was without any complications, in 18.5 % cases there were minimal complications and in 1 case (6.5%) there was a major complication needing implant removal.

Maryland foot score among study subjects shows that among 62.5% cases it was good (75-89) and in 31.25% cases it was moderate (54-74) and 6.25% had poor score. The mean score among the study participants was found to be 76.81 ± 8.109.

Among 75% cases wound dehiscence was absent while it was seen in 25% cases.

Major complication needing removal of plate among study subjects shows that it was absent in 93.8% cases and in one case only Implant Removal was done due to infection and pus discharge [Figures 1-5 and Tables 1-6].

## DISCUSSION

The hospital based prospective analytical study was conducted at Department of Orthopedics at a tertiary care hospital in India to assess the outcome of patients treated with ORIF and plating for intra-articular fracture calcaneum for Sander's grade 2,3,4 calcaneal fractures. The study included 16 patients of intra-articular fracture of calcaneum who were evaluated with X-ray of the calcaneum —axial, lateral and AP views and CT scan for classification of fracture calcaneum. All of them underwent open reduction and internal fixation and functional outcome was accessed using Maryland Foot Score at 6 weeks, 3 months and finally at 6 months.

In the present study majority (62.5%) of patients belonged to the age group of 20 to 40 years and 37.5% between 41 to

60 years and males comprised of 87.5% of study participants while only 12.5% were females. It was comparable to previous studies by Mitchell MJ *et al.,* and O'Farrell DA *et al.*, that revealed that fractures were more prevalent in younger age groups and that the majority of patients were male.[3,6]

In our study, the mode of injury among most of the study participants was fall from height (75%) while 25% had injury due to fall from stairs which was similar to the study conducted by Mitchell MJ *et al.,* (fall from height 71.5%) and Chandrashekhar HS *et al.,* (fall from height 80%).[3,7]

In our study 11 patients had fracture in left calcaneum while 5 had fracture in right calcaneum. The majority of patients had Sander's type 3 fracture (9patients, 56.25%), while 4 patients (25%) had Sander's type 2 fracture and 3 patients (18.75%) had Sander's type 4 fracture in either left or right calcaneum.

In order to reduce wound complications, our study delayed surgical intervention until the wrinkle sign was positive. The surgery was performed within the first two weeks of injury, as open reduction and internal fixation is not recommended with more than three weeks of delay.[8] The mean duration between time of surgery and injury in our study was 6.8 days.

Pendse *et al.*, concluded that in intra-articular calcaneus fractures open reduction and internal fixation with a plate for restoring the anatomical articular congruency, early mobilization, and the primary option for subtalar arthrodesis if necessary are the most effective treatments. [9] Schepers *et al.*, also reported that ORIF is the mainstay among all the treatment modality.[10]

Although calcaneal fracture surgery can be performed using medial, lateral, or mixed approach.[11-14] In our study, the lateral extensile exposure popularized by Benirschke and Sangeorzan was used.[5]

In our study, the wound healing at six weeks showed that 75% of patients had wound healing without any complications, 18.75% (3) cases had minimal complications and 6.25% had major complication. Minor complications among study subjects shows that in 75% cases it was absent and Wound Dehiscence was seen in 25% cases. Major complications needing removal of plate was absent in 93.8% cases and in one case only Implant Removal was done due to infection pus discharge. This is similar to the study conducted by Chandrashekhar HS *et al.,*[7] where out of 25 patients, 24 % had minor complications which included 2 with ankle and foot stiffness, 2 with implant prominence and 2 with superficial wound infection. The major complication of deep wound infection was reported in one patient in the study which is similar to our current study. In the study by Biz C *et al.,* the wound dehiscence was observed in 5 cases out of 19 (26.31 %) cases in which open reduction and internal fixation was used for calcaneal fracture management.[15]

Maryland foot score among study subjects showed that 62.5% of patients had good (75-89) score and 31.25% had moderate score (54-74) and 6.25% had poor score (<54). In our study Maryland foot score ranged from 53 to 88 among the patients with mean score of 76.81 with the standard deviation of 8.109. However in the study conducted by Dhillon *et al.,* the group receiving open reduction and internal fixation of calcaneal fracture had a MFS of 84.4 and an AOFAS score of 86.1 at one year which was comparatively higher than the current study.[16] Similarly in the study conducted by Biz C *et al.*, among the 19 patients who underwent open reduction and internal fixation for calcaneal fracture authors reported MFS in the range of 76 to 99 with the mean of 87 and AOFAS score of 82 with the range of 66 to 97.[15]

Many studies used AOFAS score to assess the functional outcome after the treatment. Biz *et al.,* examined the functional outcomes with the AOFAS score, and they reported excellent results in 11 (12.6%) patients, good results in 46 (52.9%) patients, fair results in 26 (29.9%) patients, while 4 (4.6%) patients were graded as failures.[15] Similarly Voclav *et al.,* reported outstanding results in 24 (32%) patients, good results in 28 (37%) patients, acceptable results in 14 (18%) patients, and bad results in 10 (13%) patients.[17]

The present study has few limitations. Due to short duration of study and limited number of study subjects only limited data was collected. However, it derives few important findings, the fracture is more common in age group of 20-40 years compared to 41 to 60 years and most of the cases result from fall from height.

Younger age group had less comminuted fracture (Sanders type II and III) while 41-60 years had more comminuted fractures (Sanders type III and IV). The Maryland foot score of patients improved for all study participants with the mean of 76.81 ± 8.11.

Surgical incision (Extended Lateral Approach).

Skin flap raised by 3 k' wires

Reduction & lateral locking plate fixation

1st post op dressing

Follow up at 6 weeks
(wound completely healed)

Another patient at 3 months follow up

**Case 1**

Pre-operative X rays and CT scan showing comminuted calcaneal fracture

Post-Operative X rays
with restoration of anatomy

**Case 2**

Pre op and Post op X rays of another comminuted calcaneal fracture operated with calcaneal plating

**Case 3**

Pre-operative picture of another calcaneal fracture

Post-operative picture of the same patient

**Case 4**

Severely comminuted calcaneum fracture

Post-operative x rays of the patient with good restoration of anatomy

## CONCLUSION

Open reduction internal fixation of fracture calcaneum is a good tool for achieving good results in displaced intra-articular calcaneum fracture. Precise timing of surgery, operative expertise of the surgeon, good post-operative care, and surgical treatment of intra-articular fracture utilizing a locking plate results in a better outcome with few complications.

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