

## Original Research Article

# Comparison of open reduction internal fixation by lateral extensile approach versus conservative management in sanders type 2 and 3 calcaneum fractures: a prospective, two-arm, parallel group study

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## ABSTRACT

**Background:** Calcaneum bone is the most common tarsal bone to get fractured. It accounts for 50-60% of all fractured tarsal bones. Calcaneum fractures are always debilitating and are challenging and cumbersome to treat. There is a paucity of Indian studies to assess the comparative treatment outcomes of calcaneal fractures treated by non-operative conservative procedure and open reduction internal fixation by lateral extensile approach.

**Methods:** Adult patients with closed intra-articular calcaneum fractures of Sanders type 2 and 3 were enrolled. Patients managed by cast application (non-operative) or open reduction internal fixation (operative) were separated into two groups. The VAS score for pain, range of motion, radiological angles (Bohler's and Crucial angle of Gissane) and parameters, functional scores American orthopedic foot and ankle society and Maryland foot score were evaluated sixth month and 1-year post-intervention and compared between the study groups. Descriptive statistics were used for statistical analysis.

**Results:** 29 patients managed with open reduction internal fixation (N=15) or cast application (N=14) were enrolled. The mean age of patients was  $39.54 \pm 7.81$  years, 22 being males and 7 females. Mean VAS score was significantly lower in the plating group at sixth month ( $4.31 \pm 0.69$  vs.  $5.01 \pm 0.66$ ,  $p < 0.05$ ) but not significant at 1 year ( $1.25 \pm 1.09$  vs.  $1.86 \pm 0.77$ ,  $p < 0.05$ ). Range of movements at the ankle and subtalar joints were higher in the operative group. Mean Bohler's angle was significantly higher and Gissane's angle lower in the operative group ( $p < 0.05$ ). Significantly higher AOFAS and Maryland scores were noted in the operative group ( $p < 0.05$ ). Subtalar arthritis with malunion was more common in the non-operative group.

**Conclusions:** Operative open reduction and internal fixation methods were found to be significantly better than the conservative management of calcaneus fracture based on clinical, radiological and functional outcomes. Results are most favourable if wound complications are minimized.

**Keywords:** Calcaneum fracture, Lateral extensile, Conservative management

## INTRODUCTION

Calcaneal fractures usually occur as a result of a fall from height when one lands on their feet. These fractures represent approximately 2% of all fractures and 60% of tarsal bone fractures.<sup>1</sup> According to the published

literature, calcaneal fractures are more common in males with 90% occurring between 21 to 45 years of age, with the majority being in industrial workers; thus, having dire economic implications.<sup>2</sup> Most commonly, the etiological cause for calcaneal fractures are motor vehicle accidents or fall from height. Several authors have reported long

term partial to complete impairment thus causing economic burden to the patients and their families. The main goal of treatment for calcaneal fractures is painless, plantigrade and mobile foot. Although modern surgical techniques have improved the outcome; controversies exist concerning various management protocols for calcaneal fractures ranging from non-operative to minimally invasive to open reduction and internal fixation by lateral extensile approach; which has been made complex due to complex bony anatomy and joint mechanics and delicate soft tissue cover.<sup>3</sup> In the past, the fractures were more commonly treated by non-operative procedures due to the high risk of complications like skin necrosis, infections associated with open reduction and internal fixation. However, even non-operative procedures have their share of complication risks which include, inability to maintain reduction of articular surface and shape of foot.<sup>4</sup> Very few studies have been published which have prospectively tried to assess the outcomes of calcaneal fractures, taking into account the VAS pain scores, extent of movements at the ankle and subtalar joints, calcaneal angles and functional scores at follow-up. Hence, it was decided to evaluate the calcaneal fracture sander's type 2 and 3 patients admitted and managed at this tertiary care centre by either conservative or open reduction internal fixation with lateral extensile approach.

**Aims and objectives**

This study aimed to compare the operative and non-operative treatment in calcaneum sanders type 2 and 3 and study the complications associated with each intervention.

**METHODS**

This was a comparative study with a prospective longitudinal study design conducted at a tertiary care hospital from August 2018 to august 2020 in government medical college and hospital, Nagpur. Ethics committee permission was taken before initiating the study and informed consent was taken before the patient was enrolled in this study. The inclusion criteria included: age above 18 years, closed calcaneum fracture of Sanders type 2 and 3. Exclusion criteria included patients with open injuries, comorbidities like uncontrolled diabetes or peripheral vascular disease, patients with associated ankle or foot injuries or extra-articular fractures of the calcaneus. Sample size calculation for each group was done using the formula mentioned below;

$$n = (Z_{\alpha/2} + Z_{\beta})^2 * 2 * \sigma^2 / d^2$$

Selection was done for each intervention by simple randomisation. Patients were evaluated clinically and radiographically by X-rays and CT scans. Radiographs of affected limb were taken which included: ankle anteroposterior and lateral views, calcaneal harris axial view and foot anteroposterior and oblique views. The

affected limb was applied below knee slab and advised limb elevation and ice application for swelling to subside and wrinkling signs to appear. Patients were operated after waiting period of 7-10 days. An extensive lateral approach was used. The approach starts by taking a L-shaped incision starting lateral to the achilles tendon and 2 cm proximal to the tip of lateral fibula curving dorsally to end in a calcaneocuboid joint distally. Full thickness flaps are raised containing sural nerve and peroneal tendons and retracted by k wires in fibula and talus. The tuberosity fragments are brought out of varus alignment with the schanz pin directed medially.

Central depressed fragment is reduced to sustentacular fragment and stabilized with k wires. To maintain articular reduction 3.5 mm screws were used. Calcaneocuboid articular reduction obtained when required. After acceptable reduction fixation was done with low profile lateral calcaneal plates, without bone grafts.<sup>5</sup> Case illustrated treated by open reduction internal fixation in sanders type 2 and 3 calcaneum fractures (Table 1-2, Figure 1-2). For the conservative group, a below knee slab was applied and advised limb elevation, ice application until wrinkle appears. This was followed by manual reduction under spinal or short general anesthesia and the reduction involves the patient in prone position knee flexed 90 degrees and grasping heel with clasped hand and longitudinal traction to restore calcaneum height and reducing lateral wall blowout which in turn minimizes fibular impingement and heel widening.<sup>6</sup> A below knee cast was applied in slight equinus. Cast was removed after 2 months with movements started at subtalar and ankle joints, and PWB started after the 3rd month with gradual weight bearing as tolerated by the patient in both the study groups. Case illustrated treated by conservative management in sander type 3 calcaneum fractures (Table 3).

**Table 1: Open reduction internal fixation in sanders type 2 and 3 calcaneum fractures.**

Parameters	Mean VAS score at 6 months	Mean VAS score at 1 year
Treated with plating	4.31±0.69	1.25±1.09
Treated with casting	5.01±0.66	1.86±0.77

Radiological evaluation was done by calculating Bohler's angle and Gissane's angle pre and post-intervention at sixth month and 1 year.<sup>7</sup> Clinical results were compared at various time-points based on the pain intensity using the VAS (Visual Analogue Scale) Score. The VAS score for pain was evaluated at 6th month and 1-year post-intervention when the patient started weight-bearing. A visual analogue scale with a 10 cm vertical score ranged from "no pain" to "worst possible pain" was used to assess the pain when the patient bears weight. The range of motion at the ankle joint and subtalar joint was evaluated post-intervention at sixth month and 1 year.

**Table 2: Open reduction internal fixation in sanders type 2 and 3 calcaneum fractures.**

Parameters		At 6 months	At 1 year
Treated with plating	Mean inversion angles	23.05±2.51	33.88±2.13
	Mean plantar flexion angles	27.5±2.57	48.88±2.13
	Mean eversion angles	18.61±2.31	23.89±2.13
	Mean dorsiflexion angles	17.78±2.55	23.88±2.13
Treated with casting	Mean inversion angles	16.91±2.4	29.63±2.22
	Mean plantar flexion angles	23.63±2.22	44.63±2.23
	Mean eversion angles	13.63±2.22	23.63±2.22
	Mean dorsiflexion angles	13.63±2.22	23.63±2.22

**Table 3: Radiographic parameter in both the groups.**

Radiographic parameter	Time point of assessment	Angle (mean degrees)	
		Open reduction internal fixation (N=15)	Cast (N=14)
Bohler's Angle	Preoperative	10.83±3.92	18.54±3.19
	6 <sup>th</sup> Month	32.77±2.55	17.08±2.4
	1 year	32.77±2.55	16.91±2.2
Critical angle of Gissane	Preoperative	147.5±2.57	140.45±2.92
	6 <sup>th</sup> Month	127.22±2.55	142.23±1.78
	1 year	127.22±2.55	143.1±1.33

**Table 4: Functional score in both the groups.**

Radiographic parameter	Time point of assessment	Mean scores	
		Open reduction internal fixation (N=15)	Cast (N=14)
	6 <sup>th</sup> Month	63.11±1.71	50.90±1.78
	1 year	99.33±1.28	91.36±2.67
	6 <sup>th</sup> Month	56.55±0.85	50.90±1.78
	1 year	94.11±1.71	88.36±2.67

**Table 5: Early and late complications of calcaneum fracture patients (n=29).**

Open reduction internal fixation group (N=15)	Cast group (N=14)
Wound necrosis=3, infection=1, subtalar arthritis with malunion=3	Subtalar arthritis with malunion=6 which includes 1 plantar exostosis 2 lateral fibular impingement

**Functional outcome for the calcaneal fractures**

Assessment of functional outcome by the American orthopedic foot and ankle society (AOFAS) score as well as the Maryland foot score. Both these scoring systems are standardized, and well-known functional grading systems used extensively by orthopaedic surgeons globally.<sup>8,9</sup> The mean scores of these functional outcomes were compared in both the study groups at sixth month and 1 year of follow-up. The post interventional complications were grouped into early and late and were noted down and expressed descriptively in the final analysis.

**Statistical analysis**

After data collection, data entry was done in Excel. Data analysis was done with the help of statistical software

GraphpadInStat version 3.1. Quantitative data was presented with the help of Mean and Standard deviation. Clinical, radiological and functional outcomes were compared between the study groups by unpaired t-test and between the timeintervals by paired t-test, p value of less than 0.05 was statistically significant.

**RESULTS**

During the study period, 29 patients were treated in the study center with either open reduction internal fixation method (N=15) or conservatively with the help of a cast (N=14). Out of these, 22 were males and 7 were females. The mean age of the patients was found to be 39.54±7.81 years. The maximum age of the patients was 53 years while minimum age noted was 29 years. The most common cause of fracture was found to be a road traffic accident (RTA), seen in 16 (55.17%) cases followed by

fall seen in 13 (44.83%) cases. On intragroup analysis, there was a significant decrease in the mean VAS scores at 1 year compared the mean values at 6 months post-intervention ( $p < 0.05$ ). On intergroup analysis, the VAS score was lower in the open reduction internal fixation group at 1 year but not statistically significant ( $p < 0.05$ ). We found inversion and plantar flexion angles were significantly higher in the open reduction internal fixation group at 6 months ( $p < 0.05$ ) and 1 year ( $p < 0.05$ ) respectively. Similarly, dorsiflexion and eversion angles were also higher in the open reduction internal fixation group as compared to cast groups but not statistically significant at 1 year ( $p < 0.05$ ).



**Figure 1: A) Pre-operative plain radiographs of 34 years old male with left calcaneum sanders type 2a with plating done, B) Follow up plain radiographs at 1 year.**

On intergroup analysis, the mean Bohler's angle in the open reduction internal fixation group at follow-up was found to be significantly higher ( $p < 0.05$ ), while the mean Critical angle of Gissane was found to be significantly lower than that in the cast group ( $p < 0.05$ ) (Table 3). On comparing the mean functional scores (AOFAS score and Maryland scores) in management groups, a significant difference was found at both sixth month and 1 year ( $p < 0.05$ ), with higher values witnessed in the open reduction internal fixation group (Table 4). On assessing the complications of the patients in the two study groups, 4 patients in the open reduction internal fixation group developed wound complications, while none in the conservative group developed any kind of infection. 3 of

these 4 patients had superficial infection (skin necrosis) treated with regular dressings while 1 patient suffered from deep infection leading to osteomyelitis and needed implant removal. 6 patients in the cast group and 3 patients in the open reduction internal fixation group developed radiological subtalar arthritis with malunion respectively (Table 5).



**Figure 2: A) Pre-operative plain radiographs of 36 years old male with-right calcaneum sanders type 3ac managed with plating, B) Follow up plain radiographs at 1 year.**

## DISCUSSION

Calcaneal fractures frequently result in long-term disability with a potentially severe economic impact on the patient. Open reduction and internal fixation are found to be associated with 5-20% infection rates leading to chronic osteomyelitis and permanent disability.<sup>10</sup> However, the nonoperative treatment also has many complications; it includes the inability to maintain reduction leading to broadening of the heel, muscle imbalance, loss of motion, peroneal impingement, impaired gait, intractable pain, and early development of subtalar arthritis, and permanent disability. In this study, the mean age of the patients was found to be 39.54 years, with a range of 29 years to 53 years. The males were more commonly affected than females (76% vs 24%). These findings were similar to other Indian studies by Kawalkar et al (mean age: 34 years, males: 78.57%, females: 21.43%); Gadhavi et al (Commonest age group: 31- 40 years, males: 81%, females: 19%); and Reddy et al (mean age: 38 years, males: 66%, females: 33%).<sup>4,11,12</sup> Majority of the patients suffered calcaneal fractures due to road traffic accidents (16 patients, 55.17%) while the remaining

patients suffered secondary to a fall (13 patients, 44.83%). This finding was different in comparison to other similar studies, where fall was a commoner cause compared to RTA. In a British study by Griffin et al 151 calcaneum fracture patients were treated by plating method (N=73) or non-operative method (N=78). The authors mentioned that there were no differences in patient-reported general health, quality of life, or the ability to return to work. Ranges of motion of the injured hindfoot were comparable between treatment groups. However, the complication rates were much higher in the operatively treated group, with a 19% infection rate and an 11% requirement for secondary surgery. These are serious and expensive complications, which can be avoided by choosing non-operative care Gadhavi et al studied the outcomes of calcaneum fractures treated by conservative and surgical treatment.<sup>11,13</sup> AOFAS Score in the category of excellent as well as good was found to be 31% for the conservative group and 40% for the operative group, while in the category of fair and poor it was found to be 69% for the conservative group and 60% for the operative group. This indicates a comparatively better outcome for the operative group. The Bohler angle at final follow-up was found to reduce more in the conservatively treated group compared to the operatively treated group, which suggests that internal fixation prevents further depression of the articular fragment. The authors found both the study groups comparable on complication parameters. In another study by Chandramurthy et al of the 25 patients operated upon by plating, 16 had good results with mean AOFAS score of 83.6, 7 had fair results with a mean score of 73.28 and 2 had poor results with a mean score of 54.<sup>14</sup> Subtalar arthritis which developed may be due to articular cartilage damage at the time of trauma or due to improper reduction of the joint, irrespective of conservative or plating management. Subtalar arthritis with malunion can be relatively easy to fuse in near normal shape calcaneum rather than one with distorted shape calcaneum. Pain in malunited calcaneal fractures treated by casting is multifactorial ranging from subtalar arthritis, heel widening, peroneal tendon subluxation, fibular impingement due to loss of calcaneal height, calcaneocuboid arthritis, plantar exostosis. However pain in calcaneal fractures treated by open reduction internal fixation group are usually due to subtalar arthritis, calcaneocuboid arthritis and implant related problems, fat pad injury. Disabling pain resulting from cartilage injury ultimately will require arthrodesis.<sup>15</sup> The study had few important merits. After an extensive literature search, we found that this is probably the first study which takes a holistic view on the outcome of calcaneum fractures, considering the clinical, functional and radiological outcomes as well as the complications. Also, the two management strategies of open reduction internal fixation with lateral extensile approach and conservative approach were compared with each other, which was again a strength of this study. However, the study also had a few limitations. The sample size was limited (29 patients) and the study was conducted at only

one centre. Future studies with higher sample size and conducted at multiple centres can help in creating robust Indian evidence pertaining to outcomes of calcaneum fracture management by various management strategies.

## CONCLUSION

The open reduction internal fixation method was found to be significantly better than the conservative management of calcaneus fracture in terms of pain, restoration of articular surface and shape, and functional scores. The visual analog scores can decrease upto 1 year in calcaneal fractures managed by open reduction internal fixation with increase in ankle and subtalar movements. All efforts to reduce wound complications should be taken to improve results including delay of surgery for soft tissue to settle, minimal manipulation no touch technique, minimum tourniquet time and low-profile implant. Supervised conservative management with rehabilitation can be used for the management of calcaneal fractures with obvious complications of arthritis in the long run but without wound and hardware-related complications. Future studies comparing the two management approaches can add further to the evidence to substantiate the findings.

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