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## Comparative study of conservative versus operative management of closed displaced intraarticular fracture of calcaneum

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### Abstract

Intraarticular fractures of calcaneum are frequently complex injuries, requiring experience in the diagnosis and management, for favourable results. The historical aspects of calcaneal fracture treatment are difficult to appraise, secondary to varied forms of treatments, classifications, numerous retrospective studies and mixture of diagnoses and results. Significant controversy remains over the results of non-operative treatment. Due to the lack of standardization, accurate comparisons cannot be made between reported surgical and conservative treatment modalities to precisely determine the long term and short-term functional results between each method. Here is a cohort prospective study to compare patients of closed displaced intra-articular fracture of calcaneum. 30 patients were taken for this study out of which fifteen patients were treated operatively and fifteen patients were treated non-operatively. Patients were followed up to an average of 1 year. The functional outcome was measured by AOFAS hind foot score. It was observed that under the operative group 73.3% of the patients had excellent results, 13.3% had good result and 6.7% each had fair and poor results. Similarly, under the conservative group 53.3% of the patients had fair results, 26.7% had good result, 20% had poor result and none of the patients had excellent results. Further, it was observed that there was a significant difference in results between the two groups (p value <0.001). We through our study and reviewing the literature conclude that the operative management by Locking Calcaneal Plate being a low profile, mouldable, multiplanar with locking screw shows satisfactory results with improved functional outcome and less complications as compared to conservatively managed displaced intra articular calcaneal fracture by below knee cast.

**Keywords:** Calcaneum, displaced intraarticular fracture, comparative study

### Introduction

The calcaneum (os calcis) is the largest tarsal bone. It is the major weight bearing osseous structure of the foot and is one of the components of the tri-tarsal articulation and has important functional tasks with regard to normal ambulation. With a bone so vital to the normal mechanics of locomotion, it is easy to see why a fracture of calcaneum is attended by considerable morbidity. Calcaneum is the most commonly fractured tarsal bone. Calcaneal fractures account for 2% of all fractures, with displaced intra-articular fractures comprising 60% to 75% of these injuries. These fractures are uniformly caused by an axial load mechanism; a fall from height or a motor vehicle accident and may be associated with other axial load injuries, such as lumbar, pelvic and tibial plateau fractures<sup>[1]</sup>. Calcaneus has 4 articular facet allowing it to articulate with talus superiorly and cuboid anteriorly. The 3 subtalar facet (anterior, middle, and posterior) must function as unit, and any interruption in their alignment is by definition is intraarticular. Posterior facet is major weight bearing surface although anterior and middle bear more weight per unit area. The body of the calcaneus is composed primarily of cancellous bone, having a comparatively thin cortex. There are, however, several important areas of increased bony density. Cotton as early as 1908 wrote, "Ordinarily speaking the man who breaks his heel bone is 'done', so far as his industrial future is concerned"<sup>[2]</sup>. Bankart, 35 years later, wrote, "The results of treatment of crush fractures are rotten". The best result that can be expected from a fracture of the sub-tarsal joint is a completely stiff but painless foot of a good shape with free movement of the entitled joint<sup>[3]</sup>. Earliest attempts at management of these fractures have been essentially conservative.

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Although, there is a wide disparity of results after conservative management, generally the literature gives the opinion that the outcome after non operative management has universally been poor. The major cause of poor results has been ineffectiveness of these methods in restoring congruity of the displaced posterior fragment. Other problems associated with conservative treatment are due to difficulty in maintaining reduction and loss of position, which may result in broadening of the hind foot, decreased motion in subtalar joint, muscle imbalance, impingement of peroneal tendons or a secondary osteoarthritis. Hence, these methods fail to produce a painless and functional foot after the fractures have healed [4, 5, 6]. The goal of surgical treatment initially was only to restore the shape of calcaneum. Restoration of overall shape of the calcaneus appeared critical for subtalar and midtarsal articular functions and by the end of 1960's, it had developed into a treatment protocol that required two conditions: (a) perfect reconstruction of calcaneal joint surfaces reduced and maintained with lag-screws and (b) restoration of the whole morphology of the bone, by the position of articular surface, relative to the overall status of the anterior process and the tuberosity. Benirishke & Sangeorzan in 1990, introduced the lateral extensile incision technique [7]. This was later endorsed by Sanders *et al.* in 1993. This approach has become very popular over the past decade. Advantages include, a wide exposure to the subtalar joint, allowing more accurate reduction of the facet fragment, ability to decompress the lateral wall, exposure of the calcaneocuboid joint and sufficient area available laterally for plate fixation. Inability to directly assess the reduction of the medial wall and thus inability to accurately restore the height and length of the calcaneus, is a great disadvantage with this approach. Incidence of wound complications is less with this approach as compared to other lateral approaches and can be further reduced with meticulous exposure and flap elevation [8].

Now, it is believed that displaced intra articular fractures of the calcaneum, shall be treated on the same principle as the other injuries of weight bearing joints, i.e., by anatomical reduction of the joint surface and rigid internal fixation, followed by early movements and delayed weight bearing [9]. These fractures require a perfect anatomic reduction with stable internal fixation to maximize the chances of good joint function. Perfect restoration of the joint congruency has come to be regarded as one of the most important prognostic indicators of the outcome of these fractures, as shown repeatedly in several studies [10, 11, 12].

The purpose of our study is to compare the results of conservative versus operative management (plate and screw fixation) of intraarticular calcaneal fracture.

### Aims and objectives

To compare study of conservative management and operative management (Plate fixation) of closed displaced intra-articular fracture of calcaneum in terms of

1. Time for union of fracture.
2. Functional outcome.
3. Complications.

### Material and Methods

Source of data: The study was conducted at Department of Orthopaedics, north DMC medical college and Hindu Rao Hospital Delhi, between April 2016 to April 2018. Closed displaced Intra-articular fractures of calcaneum admitted through emergency department and outpatient department

were included in the study.

Study design: This is a cohort prospective study to compare patients of closed displaced intra-articular fracture of calcaneum. 30 patients were taken for this study out of which fifteen patients were treated operatively and fifteen patients were treated non-operatively. Patients were followed up to an average of 1 year. Patients were randomly selected in Ratio of 1:1 using random number table.

### Inclusion criteria

1. All patients above 18 years of age and less than 55, with intra-articular calcaneum fractures.
2. Fresh fractures-less than 2 weeks old.
3. Patients should be walking prior to the fracture.
4. Displaced intra-articular fracture involving posterior facet
5. Fractures of Sander's type II and type III were included in the study.

### Exclusion criteria

1. Open fractures.
2. Pathological fractures.
3. Calcaneal fractures with other associated fractures around ankle.
4. Fracture in children-less than 18 years old.
5. Fractures in adults more than 55 years.
6. Fractures of Sander's type I and type IV were excluded from the study.

**Statistical analysis:** Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0. Continuous variables are presented as mean  $\pm$  SD, and categorical variables are presented as absolute numbers and percentage. The comparison of normally distributed continuous variables between the groups was performed using Student's t test otherwise mann whitney U test was used (For VAS scores). Nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate.  $P < 0.05$  was considered statistically significant. Microsoft excel was used to draw tables, bar and pie diagrams and for the statistical analysis.

**Operative management:** Primary goal was restoration of the congruence of the sub talar joint and secondary goal was to restore height, width, alignment of calcaneum. The endpoints of treatment are pain free ambulation and ability to return to work. After clinical examinations radiological workup done which include calcaneal radiographs in four views. Radiographs of the foot Antero-posterior, lateral, axial and Broden's views were taken. Bohler's angle and Gissange angle were measured from lateral projection of the radiograph using goniometer [13, 14]. CT Scan of Calcaneum: CT scan with 3-D reconstruction were taken in patients in whom x-rays were not suggestive of clear anatomy with intra-articular fracture calcaneum and axial, coronal and sagittal sections were obtained and coronal section of CT was used to classify intra-articular fracture using Sander's classification [8].

In all patients antibiotic prophylaxis was given starting half an hour before surgery and was continued post-operatively for one week. Parenteral analgesics were given initially and then converted to oral analgesics. Drain removal was done at 48 hrs on first wound inspection. Post-operative radiographs were taken in all patients. All the patients irrespective of fracture pattern were immobilized in below knee posterior splint. Suture removal was done between 18-20 days. Immediate surgical wound complications were noted in some

patients. Posterior splint was continued for 6 weeks. Range of motion exercises started at 2 weeks. Partial weight bearing started around 8-10 weeks depending on radiological progress of union and gradually increased to full weight bearing.

**Conservative management:** It included early mobilisation and delayed weight bearing. The foot was elevated in a well-padded below knee posterior plaster slab for 2 to 3 weeks. Once the pain and swelling subsided the slab was removed and ankle and foot mobilisation was begun. The leg elevation was continued and a compression bandage was applied for a period of 4 to 6 weeks in order to avoid gravitational edema. Weight bearing was not be permitted for a period of 12 weeks. Patients was followed up in orthopaedics OPD at 6 weeks, 12 weeks and then monthly thereafter till 6 months. Each patient was evaluated on each visit clinically and radiologically. Clinically patients were assessed for evaluation of union by observing clinical signs of absence of tenderness on putting stress at the fracture site. Radiological union was assessed by observing haziness of fracture site and callus formation in and around the fracture site. Any postoperative complication was noted and appropriate intervention was done when required.

The functional outcome was measured by AOFAS hind foot score. The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Scale is a clinical rating system developed by Kitaoka *et al.* It combines subjective scores of pain and function provided by the patient with objective scores based on the surgeon's physical examination of the patient.<sup>28</sup> It consists of nine items: pain, limitations, walking pattern, walking distance, walking surface, and physical exam (range of motion of the ankle and hindfoot joint, stability and alignment). To use the AOFAS Ankle-Hindfoot Scale, the patient rated his or her pain and function levels by verbal history with the surgeon<sup>[15]</sup>.

In addition to subjective questions, the AOFAS hindfoot score also included a physical exam in which the range of motion (ROM) of the ankle and subtalar joint were measured using a Goniometer. The maximum score is 100 points, and score between 90-100 is excellent, score between 80-89 is good, score between 70-79 is fair and score below 70 is poor.

AOFAS hind foot score consist of 100 points which includes pain (40 points), function (50 points) and alignment (10 points).

## Results

The mean age of the patients was 34.27 years in operative group and 34.87 years in non-operative group. In operative group 7 patients had type II fracture (46.7%) and 8 patients had type III fracture (53.3%). In non-operative group 8 patients had type II fracture (53.3%) and 7 patients had type III fracture (46.7%). In operative group 14 patients suffered from fall from height and 1 patient suffered from road side accident (RSA). In non-operative group 12 patients suffered

from fall from height and 3 patients suffered from road side accident (RSA). In both group fall from height was the common mode of injury. Out of total 15 patients, only one patients had surgical wound infection (6.7%). Rest of the patients i.e. 14 patients (93.3%) had healthy surgical incision site. Out of total 15 patients, none of the patient had complication of skin necrosis at and around surgical incision site. All 15 patients had healthy skin condition after lateral extensile incision was used. Comparison of pain at end of 1 yr. by VAS between the two groups was noted. Out of 15 patients in operative group only 2 patients had pain (13.3%) but in conservatively managed patients out of 15, 9 patients had pain (60%) which is statistically significant. ( $p < .001$ ). It was observed that under the operative group 86.7% of the patients were under the 0-45 flexion angle while 6.7% were under in each 0-25 and 0-30 angle. Similarly, under the conservative group 53.3% of the patients were under 0-40 angle while 26.7% were under 0-45 angle, 13% under 0-25 and 6.7% under 0-20 respectively. It was observed that there was significant difference in comparison of Stiffness at ankle and subtalar joint at 1 yr. (planter-flexion) when compared between the two groups. Comparison of Postoperative Bohler's angle (Degree) between the two groups. It was observed that under the operative group 86.7% of the patients were under the 21-40 angle while 13.3% were under  $\leq 20$  angle. Similarly, under the conservative group 73.3% of the patients were under 21-40 angle while 26.7% were under  $\leq 20$  angle. Further it was observed that mean post-operative Bohler's angle in operative group was  $28.20 \pm 6.89$  and for the conservative group mean angle was  $27.73 \pm 7.96$ . It was also observed that there was no significant difference in comparison of Postoperative Bohler's angle when compared between the two groups.

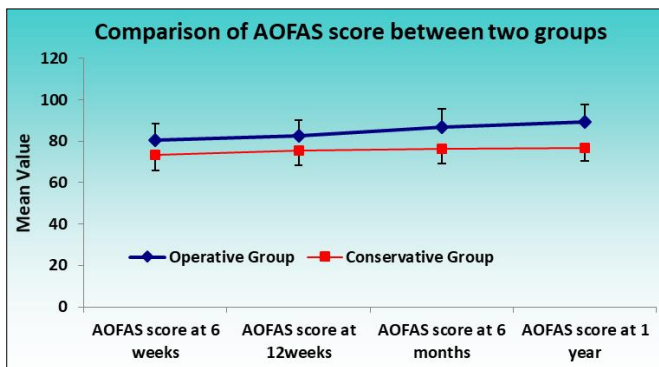
The mean AOFAS score showed increasing trend in both the groups from 6 weeks to 1 year time intervals. It was observed that under the operative group mean AOFAS score at 6 weeks was  $80.40 \pm 8.16$ , at 12 weeks it was  $82.73 \pm 7.42$ , at 6 months it was  $86.87 \pm 8.63$  and at 1 year mean AOFAS score was  $89.27 \pm 8.49$ . Similarly, under the conservative group mean AOFAS score at 6 weeks was  $75.53 \pm 7.54$ , at 12 weeks it was  $75.40 \pm 7.06$ , at 6 months it was  $76.13 \pm 6.95$  and at 1 year mean AOFAS score was  $76.87 \pm 6.60$ . Further, it was observed that there was a significant difference in mean AOFAS score at various time intervals when compared between the two groups (Table 1, Graph 1)

It was observed that under the operative group 73.3% of the patients had excellent results, 13.3% had good result and 6.7% each had fair and poor results. Similarly, under the conservative group 53.3% of the patients had fair results, 26.7% had good result, 20% had poor results and none of the patients had excellent results. (Table 2, Graph 2) Further, it was observed that there was a significant difference in results between the two groups ( $p$  value  $< 0.001$ ).

**Table 1:** AOFAS at 6 Weeks, 12 Weeks, 6 Month and 1 Yr Follow-up

	Operative group (n=15)		Conservative group (n=15)		P value
	Mean $\pm$ SD	Min-Max	Mean $\pm$ SD	Min - Max	
AOFAS score at 6 weeks	$80.40 \pm 8.16$	59 - 89	$73.53 \pm 7.54$	60 - 84	0.024
AOFAS score at 12weeks	$82.73 \pm 7.42$	65 - 94	$75.40 \pm 7.06$	62 - 86	0.010
AOFAS score at 6 months	$86.87 \pm 8.63$	65 - 94	$76.13 \pm 6.95$	64 - 86	0.001
AOFAS score at 1 year	$89.27 \pm 8.49$	66 - 96	$76.87 \pm 6.60$	66 - 86	$< 0.001$

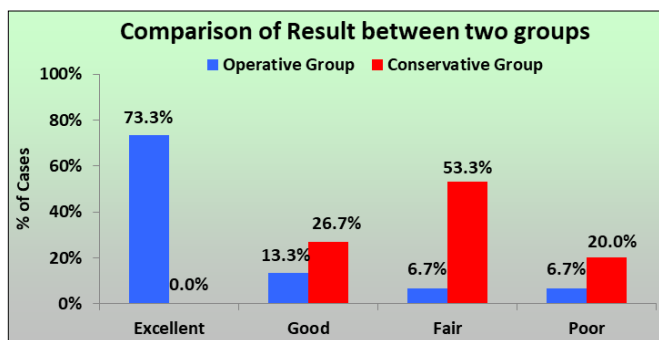




Graph 1: AOFAS at 6 Weeks, 12 Weeks, 6 Month and 1 Yr Follow Up

Table 2: Comparison of results of operative vs conservative management

Result	Operative group		Conservative group		P Value
	Frequency	%	Frequency	%	
Excellent	11	73.3%	0	0.0%	<0.001
Good	2	13.3%	4	26.7%	
Fair	1	6.7%	8	53.3%	
Poor	1	6.7%	3	20.0%	
Total	15	100%	15	100%	



Graph 2: Comparison of results of operative vs conservative management

Case 1



Fig 1: pre-operative X-ray

Fig 2: pre-operative CT scan



Fig 3: Pre-operative CT scan

Fig 4: Post-operative lateral view

Follow up at 1 Year



Fig 5: Lateral view calcaneum

Fig 6: Axial view

Follow up clinical picture



Fig 7: lateral view of ankle

Fig 8: posterior view of ankle

Discussion

Treatment of calcaneal fracture remains a topic of debate since many years. But over the last 25 years, however, due to advances in anaesthesia, prophylactic antibiotics, computed tomography (CT) scanning, and fluoroscopy have allowed surgeons to improve outcomes when operating on closed displaced intra articular fractures of calcaneum when compared with conservative management of the same fracture type. The present study consisted of 30 patients with fracture intra articular calcaneum (15 patients operative and 15 patients conservative). In our study all the patients had depression type of fracture. Nobody among the patients had tongue type of fracture. Reason for this could be that in our study in most of the patients mechanism of injury was fall from height. In other studies 20% were tongue type and 80% were depression type [16, 17]. The mean duration of surgery in study was 83.6 minutes. Which is comparable to other studies [17]. All patients were followed up at 6 weeks, 12 weeks, 6months, and one year and were evaluated radiologically with x-rays, and functionally using AOFAS Hind Foot Score. AOFAS Score of operatively managed patients is progressive from range of Good towards Excellent result whereas patients who were conservatively managed had AOFAS score FAIR result as compared to operatively managed patients. Reason for this could be restriction of movements at ankle and sub talar joints and persistence of pain more in conservatively managed patients (statistically significant). Most of the patients shows improvement in functional outcome as assessed by AOFAS HIND FOOT Score gradually with the time. Out of total 30 patients, 15 patients who were operatively managed had 73.3% of the patients had excellent results, 13.3% had good result and 6.7% each had fair and poor results whereas 15 patients who were conservatively managed, 53.3% of the patients had fair results, 26.7% had good result, 20% had poor results and none of the patients had

excellent results. (Statistically significant p value <.05). So the overall conclusion of the study was that the patients who were operatively managed by open reduction and internal fixation had better results in terms of functional outcome as compared to the patients of same fracture type who were conservatively managed. These results of our study are comparable to other series also. In our study only 1 (6.7%) patient had surgical wound infection as a complication. None of the patients had skin necrosis but some patients who were conservatively managed had pain at 1 year follow up as a main complication (60%) most probably due to arthritis of ankle and sub talar joint. In other studies which has reported a complication rate of as much high as 25% [18, 19, 20].

We through our study and reviewing the literature conclude that the operative management by Locking Calcaneal Plate being a low profile, mouldable, multiplanar with locking screw shows satisfactory results with improved functional outcome and less complications as compared to conservatively managed displaced intra articular calcaneal fracture by below knee cast.

### Conclusion

Treatment of fracture calcaneum remains controversial since last many decades. Calcaneus being a cancellous bone, the implant hold is poor leading to screw backout and soft tissue cover is less leading to wound healing problems. The other implant had increased rate of complications e.g. wound healing problems, segmental collapse during weight bearing, Screw backout, Implant failure. Because of locking screw principle, chances of implant failure & screw back-out are less. The need for bone grafting is reduced and secondary segmental collapse is avoided. Locking calcaneal plate is modular, low profile, multiplanar, & multidirectional implant. It gives good results with less complications. It is a good alternative to other implants-so should be routinely used for displaced intra-articular calcaneal fractures. If intra articular calcaneal fracture managed conservatively leads to more pain and stiffness at subtalar and ankle joint probably due to arthritis.

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