

## Operative Versus Non-Operative Treatment for Closed Displaced intra-articular Fractures of the Calcaneum

### Abstract

**Background:** Despite years of study, there is no consensus on the best method for treatment of intraarticular calcaneum fracture. This study aims to compare the outcome of operative versus nonoperative modality of management in intraarticular displaced calcaneum fractures over one year.

**Method:** This is a prospective study carried out at a tertiary care hospital over a period of 2 years: 2017 to 2018 in Surat, Gujarat, India. In this period, out of 49 fractures 25, were treated non-operatively and 24 by operative method (11 Open Reduction Internal Fixation ORIF plating, 13 Minimally Invasive Surgery – (MIS). The outcome was recorded using American Orthopaedic Foot & Ankle Society (AOFAS) score and radiographs up to 1-year post injury. The assessment was made using Analysis of Variance (ANOVA) method.

**Result:** Operative method of management of intraarticular calcaneal fractures had a significantly better (95% confidence) functional outcome at 3 month compared to non-operative management. However, at 6 and 12 months follow ups the difference between them become insignificant. Non-operative management, however, had more complications as compared to operative management.

**Conclusion:** Operative modality even in experienced hands has better outcome in terms of AOFAS score and radiographically compared to non-operative method in treatment of intraarticular displaced calcaneal fractures only in first few months. At 6 and 12 months follow up, the functional outcomes become similar.

**Key words:** Intraarticular calcaneal fractures, ST pin calcaneum, ORIF plating calcaneum, Non-Operative calcaneum.

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### Introduction

The management protocol modality of calcaneal fracture has under gone a drastic change over the years. Since the 1900's when Cotton and Wilson proposed the importance of reduction of lateral wall through closed dis-impaction, the calcaneal fracture still remains the most challenging fracture for the orthopaedic surgeon to manage effectively<sup>(1)</sup>.

Displaced intraarticular fractures represent 60% to 75% of all calcaneal fractures<sup>(2)</sup>. This study compares two modalities of management of intraarticular calcaneal fractures. Non-Operative management consisting of slab, elevation and casting; and operative management consisting of Minimally Invasive Surgery (MIS) or Open Reduction Internal Fixation (ORIF) Plating. In the recent years there has been an increased trend for operative management of Calcaneal fractures with even recent studies proclaiming similar benefits. Even in the operative methods, the debate exists on the outcome of closed method versus open<sup>(2, 3)</sup>. However, very few studies exist comparing the functional outcome of all three managements for intraarticular calcaneal fractures. This study aims to come to a decision on whether operative methods are superior in terms of functional outcome at 1 year.

## Method

This prospective study was carried out over a period of two years from 2017 to 2018 at a tertiary care hospital in Surat, Gujarat, India. Appropriate ethical committee approval was obtained from the institutional ethical committee before carrying out the study. A total of 47 patients with 49 (two bilateral) intraarticular displaced calcaneal fractures were studied, the sample size for which was calculated based on a pilot study carried out at the institute. On admission, lateral and axial radiographs were taken, and a computer tomography scan was carried out. Routine preoperative blood investigation was done. The modality of treatment (ORIF Plating, MIS, Non-Operative) selected for each patient was different surgeons' preference. Operative procedures were carried out under Spinal or General anaesthesia selected on case by case basis.

Inclusion criteria were: Intraarticular closed displaced calcaneal fracture (Sanders type 2, 3); with no neurological or vascular deficit; patients giving informed written consent.

Exclusion criteria were pure extraarticular calcaneal fractures; any pathological fracture; Open fracture; Patient with other ipsilateral limb fracture affecting outcome; Patient with any form of neurological involvement or distal vascular deficit; and in those patient not giving the consent.

### NON-OPERATIVE MANAGEMENT

25 of these fractures were managed non-operatively, where an initial below knee slab was given and on sufficient reduction of swelling, a below knee cast was applied. Patients were kept non-weight bearing for 10-12 weeks until radiological union was confirmed. Partial and complete weight bearing was started at 12 and 16 weeks respectively.

### OPERATIVE MANAGEMENT

24 of the fractures were treated with operative modality. In operative, 13 were managed with percutaneous operative leverage reduction with Steinman pin (ST) and cannulated cancellous screw (CC) fixation and 11 were managed with ORIF (open reduction and internal fixation) plating using the extended lateral approach.

### MINIMALLY INVESIVE SURGERY (MIS)

Essex-Lopresti method was used with ST pin<sup>(4)</sup>. CC screw were used as and when deemed necessary for achieving compression. The patients were

started on ankle mobilization immediately post surgery within slab and kept non weight bearing for 6 weeks. Partial and complete weight bearing was started at 6-8 and 12 weeks respectively.

### ORIF AND PLATING METHOD

The extensile lateral approach was used, with the incision starting just anterior to the Tendo-Achilles and running distally towards the edge of the heel, where it curves 90° to continue to the base of the fifth metatarsal<sup>(5)</sup>. Patients were operated upon only after the wrinkle sign became positive. Calcaneal plate was used. The patients were started on ankle mobilization immediately post surgery within plaster slab and kept non weight bearing for 6 weeks. Partial and complete weight bearing was started at 6-8 and 12 weeks respectively.

### FOLLOW UP

A follow up of the patients was done at 3 months, 6 months and 12 months and the functional outcome evaluated using the AOFAS score which was filled in by the doctor at follow up by asking the patient, and radiologically using calcaneum lateral and axial radiographs to assess union or malunion. They were reported by expert radiologists. In Minimally Invasive Surgery method an outcome comparison with Bohler's angle was also made, using the lateral radiograph where Bohler's angle was measured using the line drawn tangent to anterior and posterior aspects of superior calcaneus in immediate postoperative and at final follow-up. A note was made for all the complications which developed during the study. The mean of AOFAS score was used and ANOVA test applied to assess the difference of the AOFAS score between different modalities for its statistical significance.

## Results

In our study there was male predominance with 41 (87%) patients being male and 6 (13%) female out of total 47 patients. The age distribution in the 47 patients regard from 17 years to 58 years. In the Operative method the age range varied from 17 to 48 years in non-operative group 26 to 58 years. Mean age being 31 years.

The most common mode of injury was fall from height which was the cause in 36 patient (74%). 8 (16%) patients had road traffic accident as their mode of injury and 5 (10%) had a history of slipping as their mode of injury. Fall from height was:

associated with other injuries, lumbar compression fractures. 6 patients had associated compression fractures of the Lumbar spine, 4 of them L1, one L2 and one L4 compression fracture, and all of them had normal neurologic examination.

**Operative Management :** Operative modalities, which included MIS method as well as Open reduction internal fixation plating had significantly better outcomes at 3 month and 6 months follow up on AO A S scores when compared to non-operative management.

**(i) Plate Osteosynthesis**

Excellent or good results were obtained in 6 cases (54%), fair in 1 case (9%) and poor in 4 (37%) (Fig 1). The mean score at 3 month, 6 months and 12 months follow up of operative (Open reduction internal fixation Plating) methods were 62.6, 70.2 and 78.7 respectively.

Table 1: Post injury delay to

The average operative delay was to days. Most of the cases were operated upon within first 12 days of injury. (Table 1)

Table 1		
Time after which Operated	No. Of patients	%
<5 Days	0	0
5-8 Days	3	27
9-12 days	5	45
>12 days	3	27

Table 2: Outcome in Open Reduction Internal Fixation (ORIF) Plating	
OUTCOMES	NO.
Duration of incapability	
3 MONTHS	8
4 MONTHS	1
5 MONTHS	1
>6 MONTHS	1
Loss of reduction	
YES	1
NO	10
Pain	
YES	2
NO	9
Infection	
YES	3 (2 superficial)
NO	8



**Fig 1: Preoperative and Post operative radiographs of ORIF plating in calcaneal fracture**

Complications [Table 2]: One (9%) of the patient developed deep infection necessitating plate removal later on and loss of reduction was seen in only one (9%) of cases. There were 2 (18%) patients who even at 12 month follow up had complaint of some form of pain. Superficial stitch line necrosis in open reduction internal fixation plating was very common. To avoid this, the rule for surgery was to wait till wrinkle sign was positive. Despite this 2 (18%) patients developed superficial stitch line necrosis

**(ii) Minimally Invasive Surgery**

Excellent or good results were seen in 9 cases (i.e.69%) and fair in 1 (8%) poor in 3 (23%) . The mean score at 3 month, 6 months and 12 months follow up of operative (Minimally Invasive Surgery) method were 55.5, 72 and 77.15 respectively. [Fig 2]



**Fig 2: CRPS case in Minimally invasive operated case**

Table 3: Time lag for operation		
Time after which Operated	No. Of patients	%
1 day	2	15
2 day	4	31
3 day	6	46
4 day	1	8

12 (92%) of the cases were operated within the first three days of admission. [Table 3]

Complications [Table 4]: There were 2 cases where pain remained even at 12 months follow up. One of in which was Complex regional pain syndrome (Sudeck's osteodystrophy) [Fig 3] and the other case with persistent complain of pain was the one where pin tract infection occurred leading to pin loosening followed by loss of reduction.

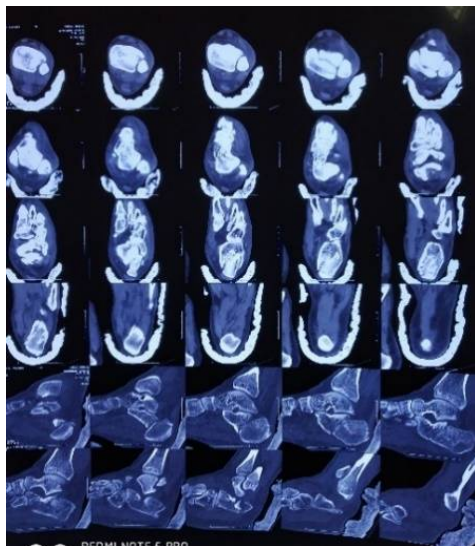


Fig 3: Pre-operative and Post operative radiographs of Minimally invasive operation in calcaneal fracture

Table 4: Outcome in MIS	
OUTCOMES	NO.
Duration of Incapability	
3 MONTHS	7
4 MONTHS	3
5 MONTHS	2
>6 MONTHS	1
LOSS OF REDUCTION	
YES	1
NO	11
Pain	
YES	2
NO	11
INFECTION	
YES	1
NO	12

Bohler's angle was within normal limits (10-40) in all cases where American Orthopaedic Foot and Ankle Society score was achieved as Excellent, Good or fair. Out of the three cases with poor results, normal (10-40) Bohler angle was not achieved post operatively in two cases. [Fig 4]

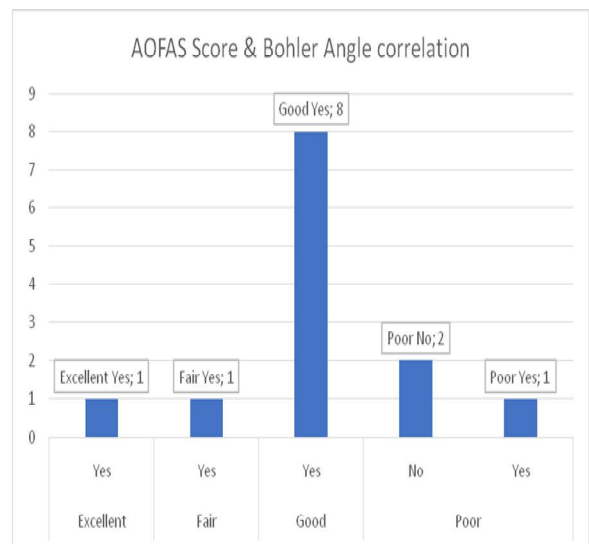


Fig 4: Chart Comparing Bohler's angle recreation and AOFAS outcome in minimally invasive surgery operated cases

**Non-operative management**

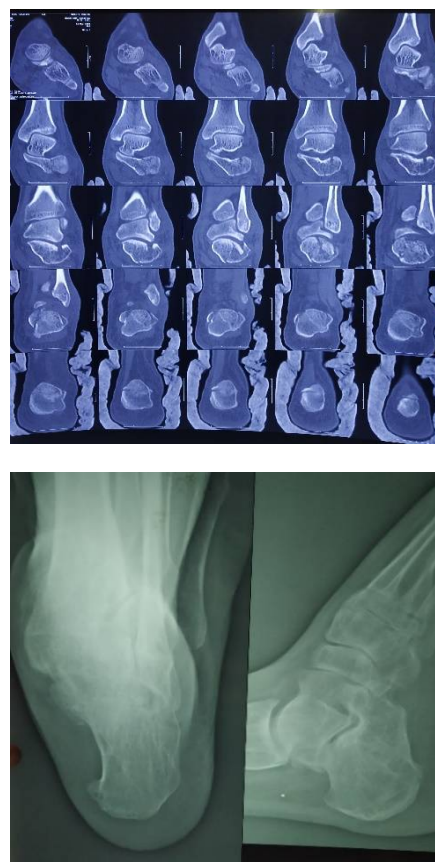
Results were excellent in 2 cases, Good in 11 cases, making it a total of 13 (52%) out of 25. Results were fair in 4 (16%) and poor in 8 (32%) [Fig 5]. The mean score at 3 month, 6 months and 12 months follow up of non-operative methods were 52.4, 66.8 and 76.4 respectively.

Table 5: Outcome in Nonoperative management cases	
OUTCOMES	NO.
DURATION OF INCAPABILITY	
3 MONTHS	15
4 MONTHS	3
5 MONTHS	3
>6 MONTHS	4
LOSS OF HEIGHT	
YES	7
NO	18
PAIN	
YES	9
NO	18
INFECTION	
YES	0
NO	25

Complications [Table 5]: There was loss of height in 7 (28%) of cases out of 25 cases, Because of the longer term of immobilization, the risk of Complex Regional Pain Syndrome (Sudeck’s osteodystrophy) exists, which was seen in 2 cases. Heel widening (3 cases = 12%), Varus deformity at heel (4 case = 16%) and subtalar arthritis (9 cases = 36%) are some of the common complications developing in non-operatively treated patients.

Application of ANOVA table to the means of AOFAS score of all three treatment groups gave the p values as: At 3 month, p=0.0049, at 6 months, p=0.2063, at 12 months p=0.8586. Thus, with 95% confidence we can say that the mean of AOFAS score obtained in operative method is better at 3 month- follow up compared to non-operative method. But, in the longer run, at 6 months and 12

months follow ups the difference in those means is insignificant.



**Fig 5: Initial and Follow up radiographs of Non-Operatively managed calcaneal fracture**

**Discussion**

Our attempt behind this study was to, evaluate, document and compare the results of intraarticular displaced calcaneal fractures managed either operatively or Non-Operatively.

In the current study the age range was from 17 to 58 years. In the operative method the age range was from 17 years to 48 years and Non operative from 26 years to 58 years, which is comparable. The mean age of a patient with calcaneal fracture was 31 years. Parmar et al <sup>(6)</sup> had a mean age of 48; Thordarson et al <sup>(7)</sup> had a mean age of 35. There was a male preponderance for this fracture in our study with male to female ratio being 7:1. Parmar et al <sup>(6)</sup> had a ratio of 6:1, Buckley et al <sup>(8)</sup>, 2002 had a ratio of 381:43, Ibrahim et al <sup>(9)</sup>, 2007 21:5. 39 (79.5%) patients presenting to the hospital with displaced intraarticular calcaneum fractures had a

history of fall from height, making it the most common mode of injury

Walde et al had 85% of the cases having mode of injury as fall from height. In our study, 6 patients (12.2%) had associated vertebral compression fractures with normal neurology. Walters reported associated spine fractures in 7.21%, which is comparable<sup>(10, 11)</sup>.

Open reduction internal fixation plating with early mobilization has significantly better outcome on the basis of American Orthopaedic Foot and Ankle Society score compared to nonoperative modality of management only at 3 month follow up but, it has the inherent risk of infection, especially the risk of skin necrosis. Excellent or good result is obtained in 6 cases (54%) Fair in 1 case (9%) and Poor in 4 cases (37%). The mean score at 3 month, 6 months and 12 months follow up of operative (Open reduction internal fixation Plating) methods is 62.6, 70.2 and 78.7 respectively. Table 6 shows

comparison of results of our study with similar study for outcome of ORIF plating.

**Minimally invasive Surgery** has a significant better outcome on the basis of American Orthopaedic Foot and Ankle Society score at 3 month follow up compared to non operative management. This method is cost effective and has less incidences of infection

There is a risk of pin tract infection, but it occurred in only one case. There is a risk of developing reflex dystrophy (Regional pain syndrome) but can be avoided by monitored early mobilization.

The reconstruction of Bohler's angle is significant, with closer to normal the values of Bohler angle post operative the better the AOFAS.

The mean score at 3, 6 and 12 months follow up of operative (Minimally Invasive Surgery) methods is 55.5, 72 and 77.15 respectively. This shows a gradual improvement of score with the mean score being fair at 12 months follow up.

**Table 6: Comparison of ORIF plating with similar studiein literature**

Study	Year	Cases	Average operation delay after injury	Outcome	Infection Superficial; Deep
Kumar et al <sup>(12)</sup>	2015	30	11 days	MFS* Excellent or good: 26	1; 3
Rak et al <sup>(13)</sup>	2009	76 total, 34 LCP 42 SP	8 days	AOFAS; Excellent or good in: 30/34 with LCP 23/42 with Non LCP	8; 8
Gusic et al <sup>(14)</sup>	2015	103 total, 67 SP; 16 LCP 20 SP+ABG	7 days	MFS Excellent/ Good in in: 86 cases	2; 2
<b>Our Study</b>	<b>2018</b>	<b>11</b>	<b>10 days</b>	<b>AOFAS Excellent or good in 6 cases</b>	<b>2,1</b>

\*MFS: Maryland Foot Score

**Table 7: Comparison of Minimally invase operation with similar studies**

Study	Fractures	Follow up	Technique	Functional Outcome	Infection rate: Superficial; Deep
Rammelt et al, 2010 <sup>(15)</sup>	33	29 months	PACO	AOFAS 92.1	0;0
Schepers et al, 2009 <sup>(16)</sup>	61	35 months	Minimally Invasive Surgery, Reduction screws	AOFAS 83	14;4
Abelgaid, 2012 <sup>(17)</sup>	60	29 months	Minimally Invasive Surgery, Wires	AOFAS 89.2	0;0
<b>Our Study</b>	<b>13</b>	<b>12 months</b>	<b>Minimally Invasive Surgery, wires, screws</b>	<b>AOFAS 77.2</b>	<b>2;1</b>

There is Excellent or good result in 9 cases (i.e.69%) and fair in 1 (8%) poor in 3 (23%). This is comparable to other studies. Sherif Mohamed in his 2012 study had 79.3 % with either excellent or good result. Table 7 shows comparison of results of our study with similar study for outcome of MIS.

**Non-Operative method** Non-operative method Requires lesser resources. It has a comparable AOFAS at 6 months and 12 month follow up to that of operative methods. It is technically less demanding and cost effective.- It can be used with limited number of resources. There are no chance of infection. However, complications like heel widening, subtalar arthritis and Varus deformity are a cause of lingering pain. It has a comparative lesser mean AFSSO at 3 month and 6 month follow up compared to operative methods.

A total of 25 cases treated in the form of Non-Operative management have been studied.

American Orthopaedic Foot and Ankle Society score is Excellent in 2 cases. Good in 11 cases, making it a total of 52%. Result is fair and 16% and poor in 32%. Table 9 shows comparison of outcome of non-operative management with similar studies.

**Table 8: Comparison of Non-Operative management with similar studies**

Study	Year	Cases	Outcome
Ibrahim et al <sup>(9)</sup>	2007	11	78..5 Average AOFAS
Pozo et al <sup>(18)</sup>	1984	176	81% had good or excellent subjective outcome
<b>Our study</b>	<b>2018</b>	<b>25</b>	<b>Excellent or Good outcome in 52% cases</b>

Limitation: Our study was carried out on a small scale with just 49 of total fractures. Such a study needs to be carried out on a larger scale to come to a definite conclusion about the better mode of management. Also because of the relatively short term of follow up comment cannot be made on subtalar arthritis developing and the need for subtalar arthrodesis in these patients

### Conclusion

In our hands, operative management has a superior functional outcome in comparison with non-operatively managed patients only in the initial follow up of 3 month. In that, ORIF plating has better results compared to Minimally Invasive Surgery fixation method. At 6 and 12 months the functional outcome based on the statistics applied on the AOFAS scores becomes similar. Though the quantity of complications remain higher with non-operative management, still the functional outcome remains similar.

However, as our study has been carried out on a smaller scale such a study needs to be carried out on a larger scale and with longer term follow up to better compare the results.

**Table 9: Various similar comparative studies carried out over the years deviated in the following way in results of management of intraarticular calcaneum fractures.**

Year	Study Author	Total/ Operative/ Nonoperative	Outcome assessment	Follow Up	Conclusion
2013	Agren et al <sup>(19)</sup>	82/42/40	VAS SF-36 form AOFAS scale OM scale	1 year (n=76), 8 to 12 years (n=58)	Outcome similar at 1 year. At 8-12 year results of operative treatment better
2011	Nouraei et al <sup>(20)</sup>	61/31/32	Functional and pain scoring	1 year	ORIF has better outcome
2007	Ibrahim et al <sup>(9)</sup>	26/15/11	AOFAS, FFI, CFS, Calcaneal height, Bohler's angle, OA grade		Similar outcome, No correlation of Bohler's angle.
2003	Howard et al <sup>(21)</sup>	424/206/218	SF-36, VAS	2-8 years	Operative better but not significantly, More complications in operative
2004	Buckley et al <sup>(8)</sup>	424/206/219	SF-36, VAS	2-8 years	Female patients, patients without compensation had better outcomes
2018	Our study	49/24/25	AOFAS Score	1 year	Operative has significantly better outcome

**Legends:**

- ORIF: Open Reduction Internal Fixation
- MIS: Minimally invasive surgery
- ST: Steinmann

CC: Cannulated Cancellous

AOFAS: American Orthopaedic Foot and Ankle Score

MFS: Maryland Foot Score

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