

# Outcome following open reduction and internal fixation of intra artucular calcaneum fractures in terms of complications: A prospective study

<sup>1</sup>Dr. Shekar M, <sup>2</sup>Dr. Vivekananda BR, <sup>3</sup>Dr. Gaurav Sen, <sup>4</sup>Dr. Syed Farhan Bukhari

<sup>1,2,3</sup>Assistant Professor, Department of Orthopedics, Sanjay Gandhi Institute of Trauma and Orthopedics, Bangalore, Karnataka, India

<sup>4</sup>Junior Resident, Department of Orthopedics, Sanjay Gandhi Institute of Trauma and Orthopedics, Bangalore, Karnataka, India

**Corresponding Author:**

Dr. Syed Farhan Bukhari

## Abstract

**Background:** Intraarticular fractures account for approximately 75% of calcaneal fractures and historically have been associated with poor functional outcome. The management of intra articular calcaneal fractures remains a controversy with strong arguments supporting both conservative & operative managements. Significant controversy remains over the results of nonoperative versus operative treatment. Lack of standardization of results has made it difficult to compare studies that have evaluated outcomes <sup>(1)</sup>.

**Aims and Objective:** To evaluate the functional and radiological outcome of intra-articular calcaneal fractures managed surgically with a plate in terms of Bohler's and Gissane's angle, rate of radiological union and AOFAS score.

**Methods:** A prospective study including 25 patients with intra-articular calcaneal fracture who met the inclusion criteria was conducted in SGITO, Bangalore, between November 2019 and November 2020. Patients were managed surgically with plate fixation and were followed up regularly at 6 weeks, 12 weeks, 24 weeks and 1 year. Radiological outcome and functional outcome evaluated using AOFAS score.

**Results:** Mean age of the patients was 33.6 years. Mean time duration between injury and surgery was 7.8 days. The mean time for fracture union was 13.64±2.56 weeks. The difference between pre and post-operative mean Bohler's and Gissane's angle was statistically significant with p value <0.01. Out of 25 patients 4 patients (16%) had excellent, 16 patients (64%) had good, 4 patients (16%) had fair and 1 patient (4%) had poor outcome.

**Conclusion:** We conclude that with proper pre-operative planning, timing of surgery, intra-operative expertise of the surgeon and post-operative care, surgical management of intra-articular fracture using locking plate, gives a better outcome and minimal complications.

**Keywords:** Calcaneal fractures, intra-articular, high energy fractures, soft tissue, operative techniques

## Introduction

Calcaneal fractures account for up to 75% of all foot fractures and 1-2% of all fractures <sup>[1]</sup>, being more common in males and those who work in an industrial profession. Intraarticular fractures account for approximately 75% of calcaneal fractures and historically have been

associated with poor functional outcome. These fractures are uniformly caused by an axial load mechanism, such as 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 [2].

The management of intra articular calcaneal fractures remains a controversy with strong arguments supporting both conservative & operative managements. Recent studies are of varied opinion; some siting no difference between the two & others suggesting operative to be a better option. Significant controversy remains over the results of non-operative versus operative treatment. Lack of standardization of results has made it difficult to compare studies that have evaluated outcomes [2].

Historically, there have been dramatic changes in management protocols as our understanding of the fracture has evolved. The historical statement by Cotton that “the man who breaks his calcaneus is done” [3] perhaps does not hold good in the twenty-first century.

Over the past 25 years, however, marked advances in anesthesia, prophylactic antibiotics, CT scanning, and fluoroscopy have allowed surgeons to improve outcomes when operating on fractures, and these techniques have been applied to calcaneal fractures as well. Overall, operative treatment of acute fractures has become the standard of care for many authors who, critically evaluating their results, have concluded that good outcomes are possible.

### **Aims and Objectives of the study**

1. To evaluate the functional and clinical outcome of intra-articular calcaneal fractures managed by open reduction and internal fixation with a plate.
2. To analyse the radiological outcome of intra articular calcaneal fractures following open reduction and internal fixation with a plate in terms of bohler’s and gissane’s angle and rate of radiological union.

### **Materials and Methods**

**Sampling area:** Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore.

**Study duration:** Between November 2019 and November 2020

**Study design:** Prospective study.

**Sample size:** A total of 25 patients with intra-articular calcaneal fractures meeting the inclusion and exclusion criteria were chosen for the study.

### **Inclusion criteria**

1. Patients age between 18-60yrs.
2. Intra-articular fracture of calcaneum (Sanders classification).
3. Ability to understand the content of the subject information/informed consent form and to be willing to participate in the clinical investigation.
4. Written informed consent.

### **Exclusion criteria**

1. Patients with extra-articular fracture.
2. Open fracture (Gustillo-Anderson type 2 and 3).
3. Patients medically not fit for surgery.
4. Paraplegia/paraparesis as they interfere with the assessment of functional outcome of the surgery.
5. Old ankle fractures.
6. Fracture in osteoporotic bone.

7. Fracture of long bone in the ipsilateral limb.
8. Chronic local infection.
9. Sanders type I calcaneal fracture.

### **Sampling method**

The patients who sustained intra-articular calcaneal fracture and presented to Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore, between November 2019 and November 2020, who met the inclusion and exclusion criteria were included in the study.

### **Methodology and Procedure**

After admitting the patients with intra-articular calcaneal fractures satisfying the inclusion criteria, relevant investigations were done and fitness for surgery taken. Appropriate measures to reduce the swelling like, below knee slab with cotton padding, limb elevation, ice pack application, were taken. Pre-operative x-rays-lateral and axial view of the calcaneus and CT scan of calcaneum was 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 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 wrinkle sign was positive.

After the patient is anaesthetised, the patient is placed in the lateral decubitus position over a radiolucent table with the operative side up. The lower extremities are positioned in a scissor like configuration. Protective padding is placed beneath the contralateral limb to protect the peroneal nerve and a pillow is placed between the legs. A pneumatic thigh tourniquet is used, and the limb is exsanguinated with an Esmarch bandage to provide a dry operative field. The limb is painted and draped till mid-calf region and the fracture is approached with a lateral extensile incision starting 2cm above the tip of the lateral malleolus and just lateral to the Achilles tendon and taking it upto base of 5<sup>th</sup> metatarsal in a L shaped fashion. The knife is taken "straight to bone" at this level, with care taken not to bevel the skin. Once the initial incision is made, the corner of the flap is now raised as a subperiosteal, full-thickness flap. One K-wire (1.5mm) is passed in fibula, talar neck and cuboid each to retract the flap using "no-touch" technique.

Fracture reduction and correction of calcaneus varus, height and width was done under direct vision and with the help of fluoroscopy. K wires were used for temporary stabilization of fracture fragments. Application of locking compression calcaneal plate and locking screws is done. Intra operative radiographic evaluation with image intensifier with lateral, axial and Antero-posterior view. Wound wash given with normal saline. Wound closed with non-absorbable suture (Ethilon) using Allgower-Donati technique. Bulky cotton dressing done. Patients were given below- knee slab and limb elevation in post-op period, till wound healing and suture removal which was usually done on 14<sup>th</sup> day. Ankle range of movements were started at 2<sup>nd</sup> post-op week. Patients were followed up regularly in OPD at 6wk, 12wk, 24wk and 1yr and clinical and radiological assessment were done. Weight bearing was allowed after 3 months depending upon the fracture union.

Radiological assessment was done by measuring bohler's and gissane's angles, union rate. Functional outcome was measured using American Orthopaedics Foot and Ankle Society (AOFAS) score. A score of 90-100 is taken as an excellent outcome, 75-89 as good, 55-74 as fair and a score less than 50 is considered a poor outcome.

### **Results**

A prospective study of 25 patients with intra-articular calcaneal fractures (Sander's type II,III

and IV) treated by calcaneal locking compression plate and screws was undertaken. Results were analysed in terms of functional outcome of postoperative range of movement after union, time for fracture union, early and late post-operative complications.

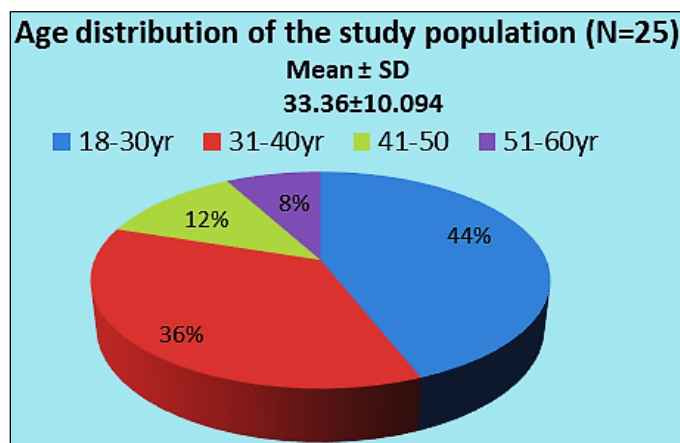
### Method of statistical analysis

The data collected was entered into Microsoft Excel spreadsheet and analysed using STATA 14 (Stata Corp. 2015. Stata Statistical Software: Release 14. College Station, TX: Stata Corp LP).

The results were averaged (mean  $\pm$  standard deviation) for each parameter for continuous data and numbers and percentage for categorical data presented in Table and Figure.

**Table 1:** Distribution of age of patients

Age (years)	Frequency	Percentage (%)
18-30	11	44
31-40	9	36
41-50	3	12
51-60	2	8
Total	25	100

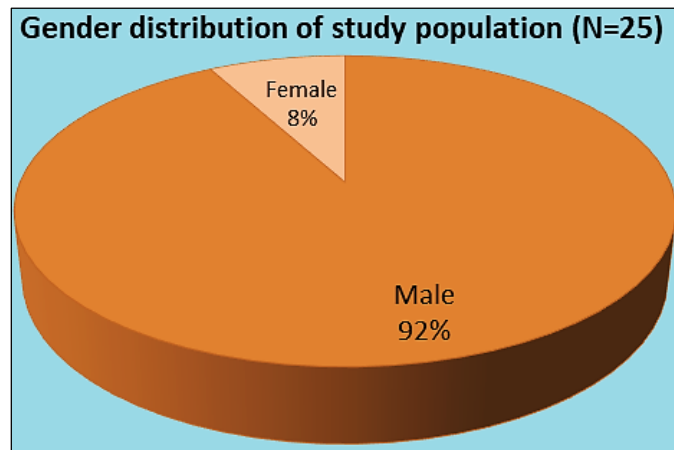


**Graph 1:** Age distribution of the study population

In our study, patients between age group 18yr and 60yr with mean age of 33.36yr were included.

**Table 2:** Gender distribution in the study population

Gender	Frequency	Percentage (%)
Male	23	92
Female	2	8

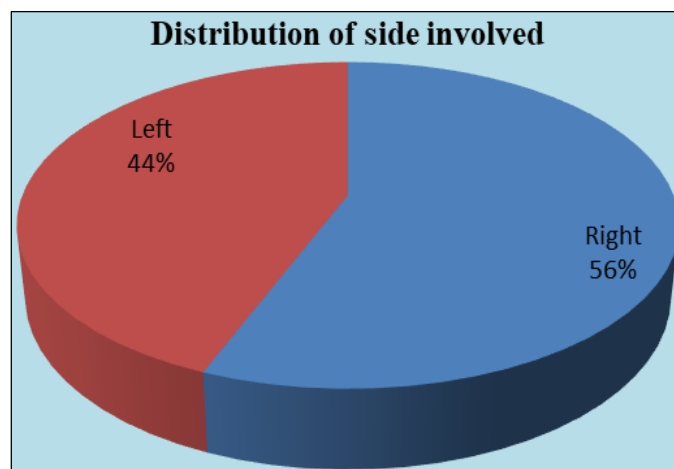


**Graph 2:** Gender distribution of study population

Majority of the patients in the study were males with 92% of the study population.

**Table 3:** Distribution of side involved in patients studied

Side	No. of Patients	Percentage (%)
Right	14	56
Left	11	44
Total	25	100

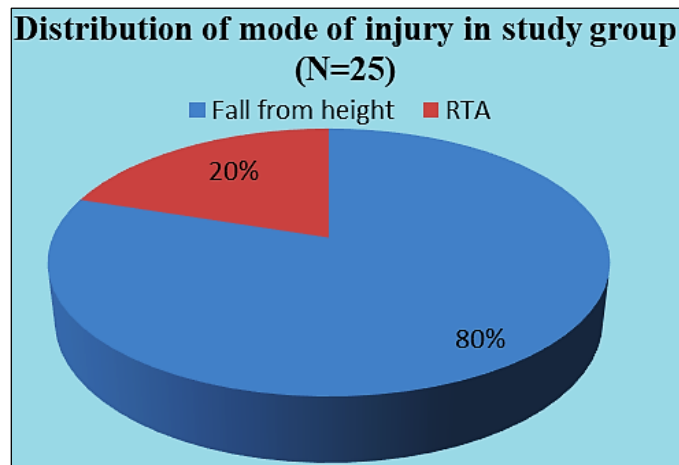


**Graph 3:** Distribution of side involved in patients studied

In this study, 56% of the patients had right side involvement and 44% of the patients had left side involvement.

**Table 4:** Distribution of mode of injury in study group

Mode of injury	No. of Patients	Percentage (%)
Fall from height	20	80
RTA	5	20

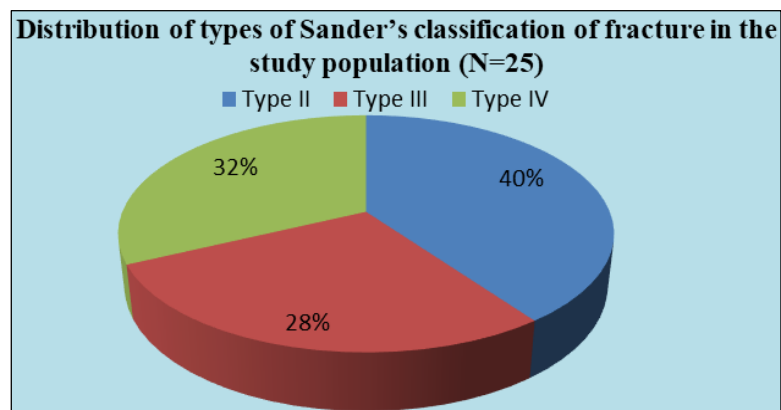


**Graph 4:** Distribution of mode of injury in the study group in percentage

Most common mode of injury in the study group was fall from height followed by RTA.

**Table 5:** Distribution types of Sander's classification of fracture in the study population

Sander's type	No. of Patients	Percentage (%)
Type II	10	40
Type III	7	28
Type IV	8	32
Total	25	100

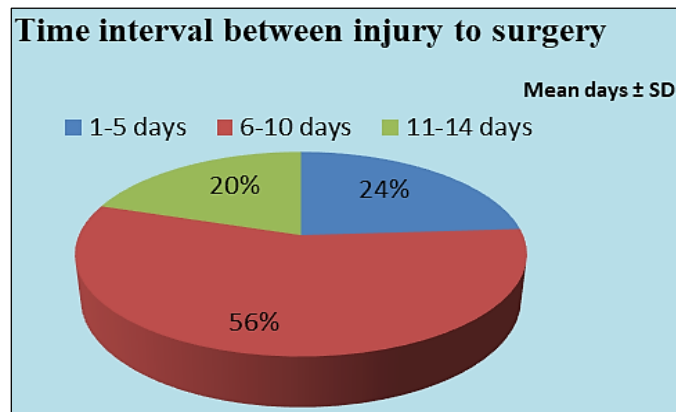


**Graph 5:** Distribution of types of Sander's classification of fracture in the study population

In our study the most common type of fracture was Sander's type II, followed by type IV. Type III was the least common.

**Table 6:** Time interval between injury to surgery

Time interval	Frequency	Percentage (%)
1-5 days	6	24
6-10 days	14	56
11-14 days	5	20

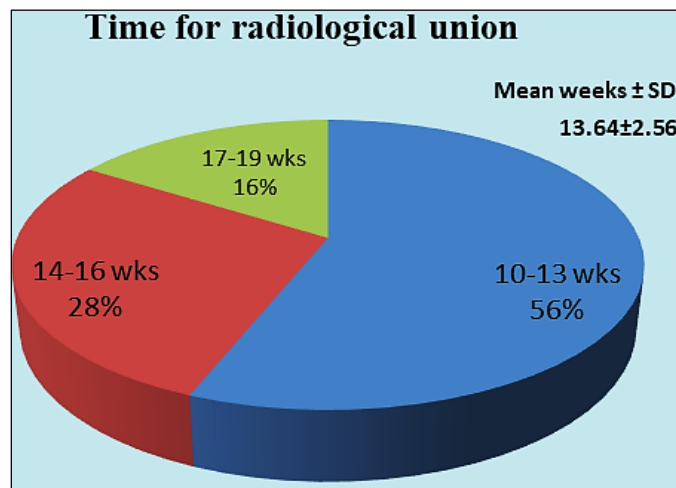


**Graph 6:** Time interval between injury to surgery

In all the patients included in the study, surgery was delayed until the appearance of wrinkles on skin to avoid the complication of wound dehiscence and for appropriate wound closure. The number of days from the injury to surgery varied from 4 to 14 days with average of 7.8 days.

**Table 7:** Distribution of Time period in weeks for complete radiologic union in patients studied

Time in weeks	No. of Patients	Percentage (%)
10-13 wks	14	56
14-16 wks	7	28
17-19 wks	4	16
Total	25	100



**Graph 7:** Distribution of Time period in weeks for complete radiologic union in patients studied in percentage

Average time period for radiological union was 13.64 weeks in the study population.

**Table 8:** Distribution of pre and post-operative Bohler’s angle in the study population

Bohler’s angle	Pre-operative (%)	Post-operative (%)
<10°	7 (28%)	00
10°-20°	18 (72%)	00
20°-30°	00	12(48%)
30°-40°	00	13(52%)
Mean	11.75°	29.67°
Total	25 (100%)	25(100%)

About 72% patients had bohler’s angle between 10°-20° and in 28% patients it was <10° in the pre-operative period, with mean bohler’s angle of 11.75°. Where as in the post-operative period, 48% of patients had bohler’s angle between 20°-30° and 52% had it between 30°-40°, with mean post-operative bohler’s angle of 29.67°.

**Table 9:** Comparison between mean pre-operative and post-operative bohler’s angle

Parameter	Pre-op (mean ± SD)	Post-op (mean ± SD)	P-value
Bohler’s angle	11.75 <sup>0</sup> ± 2.59	29.67 <sup>0</sup> ±4.57	p<0.01

The difference between pre-operative and post-operative mean bohler’s angle was statistically significant with p value <0.01. (paired t test)

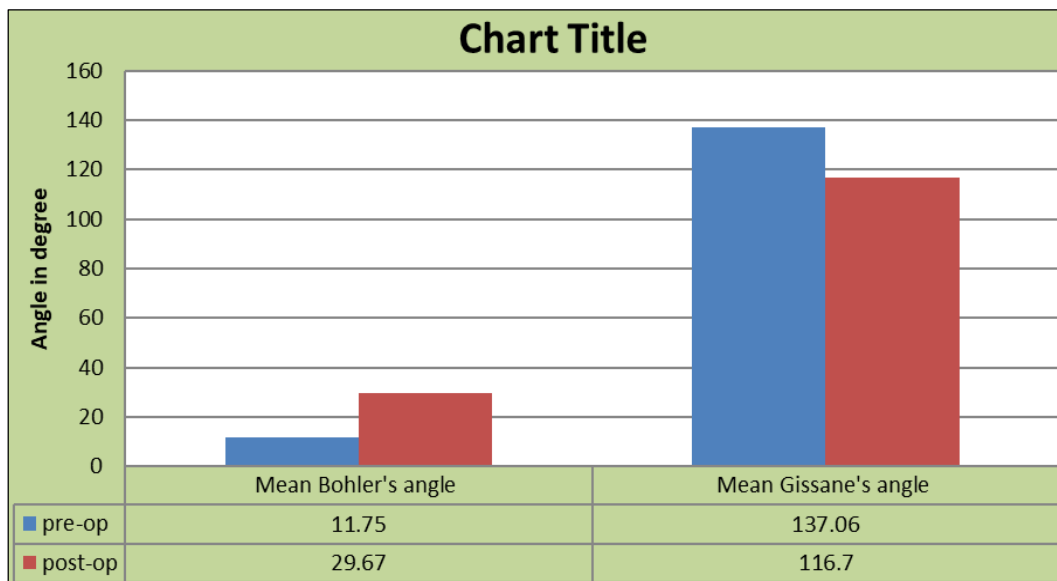
**Table 10:** Distribution of pre and post-operative Gissane’s angle in the study population

Gissane’s angle	Pre-operative (%)	Post-operative (%)
110°-120°	00 (28%)	18(52%)
120°-130°	4(16%)	7(28%)
130°-145°	18(52%)	00
>145°	3(12%)	00
Mean	137.06 <sup>0</sup>	116.7 <sup>0</sup>
Total	25 (100%)	25(100%)

**Table 11:** Comparison between mean pre-operative and post-operative gissane’s angle

Parameter	Pre-op (mean ± SD)	Post-op (mean ± SD)	P-value
Gissane’s angle	137.06 <sup>0</sup> ± 6.08	116.7 <sup>0</sup> ±4.75	p<0.01

The difference between pre-operative and post-operative mean Gissane’s angle was statistically significant with p value <0.01. (paired t test)



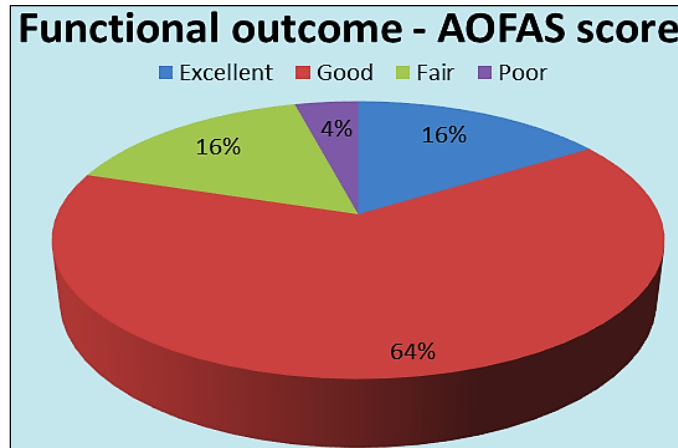
**Graph 8:** Comparison of pre and post -op mean Bohler's and Gissane's angle

**Table 12:** Functional outcome using AOFAS score

Result	Frequency	Percentage (%)
Excellent	4	16
Good	16	64



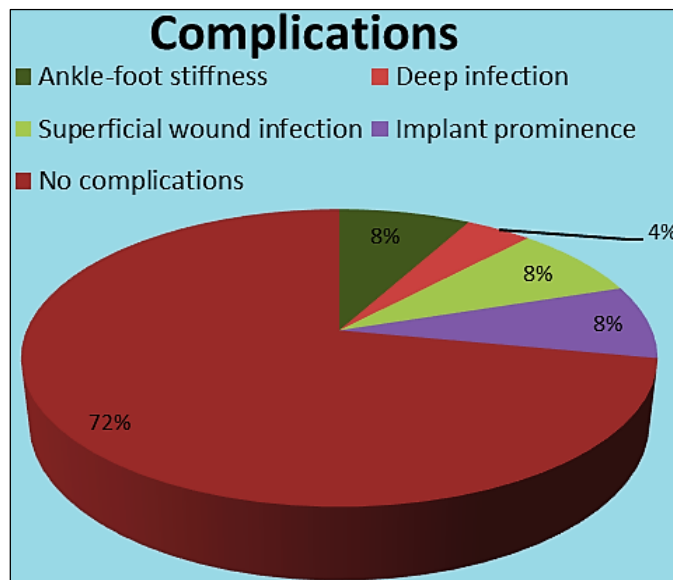
Fair	4	16
Poor	1	4
Total	25	100



**Graph 9:** Distribution of functional outcome using AOFAS score in study population

**Table 13:** Distribution of complications in the study population

Complication	Frequency	Percentage (%)
Ankle and foot stiffness	2	8
Deep infection	1	4
Superficial wound infection	2	8
Implant prominence	2	8
No complications	18	72
Total	25	100



**Graph 10:** Distribution of complications in the study population

**Discussion**

Our study consists of 25 cases of displaced intra-articular calcaneal fractures operated at Sanjay Gandhi institute of trauma and Orthopaedics from November 2019 to November 2020. Functional outcome was assessed using AOFAS scoring system and radiological outcome was assessed through Bohler’s and Gissane’s angles and rate of fracture union.

Out of 25 cases there were 23 males (92%) and 2 females (8%). Mean age of the patients was 33.6 years with age ranging from 18 years to 60 years. In our study the mean age of the patients was 33.6 years which was comparable to previous studies done by M.J. Mitchell *et al.* [4] and Farell *et al.* [5] who also demonstrated that the fracture was more in younger age group and majority of the patients were male.

The mode of injury was fall from height in 20 cases and 5 cases had history of RTA. In our study most common mode of injury was fall from height (80%) followed by RTA (20%). This result was comparable with results of study done by M.J. Mitchell *et al.* [4] (fall from height 71.5%).

In our study, to prevent wound complications, the operative management was delayed until wrinkle sign was positive. We operated within the first 2 weeks of injury, as open reduction internal fixation with more than 3 weeks delay is not recommended [6]. Mean time duration between injury and surgery in our study was 7.8 days.

The treatment of choice for intra articular calcaneum fractures remains controversial. In the past, surgical treatment was associated with significant incidence of wound complications, particularly sepsis [7]. However, conservative treatment also has its share of complications such as subtalar joint pain, heel varus and peroneal tendon impingement [8]. Sanders *et al.* confirmed that the learning curve for operative treatment of this fracture is steep. Sanders observed that the clinical results are a surgeon-dependent learning curve and requires 35 to 50 cases or about 2 years' experience [9, 10].

Pendse *et al.* [11] concluded that open reduction and internal fixation with plate in intra-articular calcaneus fractures to restore anatomical articular congruency, early mobilization and primary option for subtalar arthrodesis if needed. Schepers *et al.* [12] observed that ORIF was the mainstay among all modalities of treatments.

A medial, lateral or combined approach can be used to perform calcaneal fracture surgery [13-16]. In our study, a lateral extensile exposure popularized by Benirschke and Sangeorzan was used in all the cases [17]. Important points for success with this approach include careful flap elevation and "no-touch" technique using K-wires, mobilization and anatomic restoration of the posterior facet; adequate mobilization and reduction of the tuberosity fragment through the primary fracture line and stabilization with plate and screws. Plates allowing locking of the screws to the plate have become popular for this fracture. We used locking calcaneal plates in all our cases. The "blow out" of the lateral wall, when present, could be well reduced and held in place with this plate. The contoured plate was fixed extending from anterior process into the most posterior aspect of the tuberosity.

If a large defect remains after the procedure, which often is the case, most surgeons recommend the use of autogenous iliac crest bone graft; however, if internal fixation is secure and the fracture is stable, the defect may be accepted. A.K. Singh *et al.* in his study concluded that Bohler's angle showed improved restoration and the patients returned to full weight-bearing earlier when bone grafting was used in the treatment of intra-articular calcaneal fracture [18]. However, studies by Rammelt *et al.*, [19] and Zhongguo *et al.*, [20] suggested that it is not necessary to implant a bone graft for DIACFs.

Surgical treatment of displaced intra-articular calcaneal fractures enables anatomical reduction and restores shape, height and alignment. It also aims to reduce the subtalar and calcaneocuboid joints in order to achieve a reduced lateral wall and peroneal tendons [21]. Paley D *et al.* stated that Bohler's angle is an indirect measurement of both calcaneal height and the arch angle [22]. The Bohler's angle [23], is considered as normal within measurements ranging from 20° to 40°. In this study, the post-operative mean Bohler angle was 29.67 degree.

In our study, the time for fracture union showed that the mean time for union among patients was 13.64±2.56 weeks. Biz [24] *et al.* reported radiological consolidation of calcaneal fractures in an average± period of around 3 months (12 weeks) which was in agreement to the findings

of our study. In a study on functional outcomes of different modalities of fixation in intra-articular calcaneus fractures by Rajesh V Chawda <sup>[25]</sup> *et al.*, it was observed that the radiological union appear between 2-3 months. This finding was comparable to the present study.

In this study, outcomes were measured with AOFAS Score. Out of 25 patients 4 patients (16%) had excellent (90-100 points), 16 patients (64%) had good (75-89 points), 4 patients (16%) had fair (50-74 points) and 1 patient (4%) had poor outcome (<50points). Biz *et al.* <sup>[24]</sup> who also measured outcomes with AOFAS score and he found 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. We also compared our outcomes of AOFAS Score with Voclav *et al.* <sup>[26]</sup> who found excellent results in 24(32%) patients, good in 28(37%) patients, fair in 14(18%) patients and poor results in 10(13%) patients. We also compared our outcomes with other series of Gusic *et al.* <sup>[27]</sup> and Mohammed *et al.* <sup>[28]</sup>.

The main drawback of ORIF of calcaneal fractures is the complications usually associated with it's surgical treatment. In this study, out of 25 patients two patients had ankle and foot stiffness, two patients had implant prominence and 2 patients had superficial wound infection and 1 patient had deep wound infection.

The patients developed ankle and foot stiffness as a result of non-compliance for physiotherapy. Deep wound infection was treated with implant removal, wound debridement and antibiotic cover as per culture and sensitivity. Superficial wound infection was treated with regular dressings and appropriate antibiotics. Patients with implant prominence were treated with implant removal after the fracture was united at the final follow up.

## Conclusion

A prospective study of functional outcome of intra-articular calcaneal fractures managed surgically with plating, including 25 patients, conducted in Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore, during the period between November 2019 and November 2020 with the follow up period of 1 year, had excellent (16%) and good (64%) results. Hence, we conclude that:

Good quality radiographs like lateral and axial view and pre-operative CT scan is necessary in understanding the displacement of major fragments and helps to classify the fracture pattern according to Sander's classification which is vital in pre-operative planning and assessment of prognosis of fracture.

The timing of the surgery is a crucial determinant for the treatment outcome and to be done once the wrinkle sign is positive. If for other reasons operation is done after three weeks, it causes not only soft tissue healing problems and high infection rate but also intra-operative difficulty in fracture reduction, as the fracture would have started consolidating.

Surgeon's expertise in soft tissue handling, anatomical alignment of fracture fragments, maintaining the height of the calcaneum, Bohler's and Gissane's angle, Judicious use of bone graft in large void spaces before placing the plate and proper intra-operative planning and post-operative care are the main factors which can lead to a successful outcome and minimize the postoperative complications.

This study has some limitations, which include a smaller number of study population and short duration of follow up. However, this study throw some lights on future long term and randomized study.

## Case illustrations

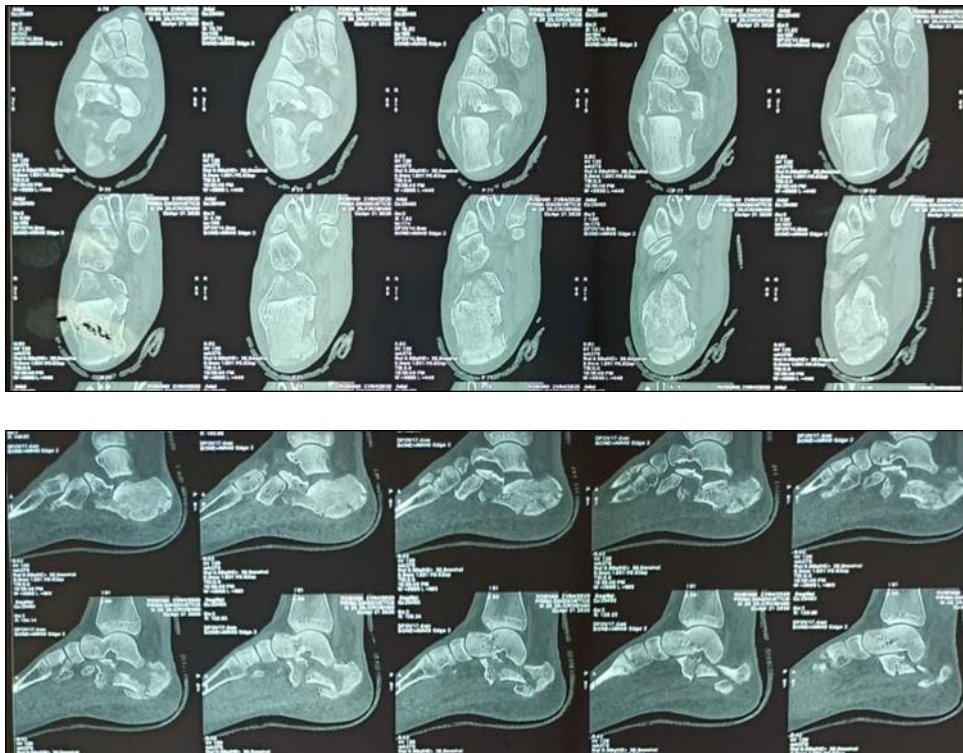
**Case 1:** A 25y male with history of fall from height sustained right intra articular calcaneal fracture sander's type III.



**Fig 30a:** Pre-op skin condition- wrinkle sign present



**Fig 30b:** Pre-op x-ray lateral and axial view

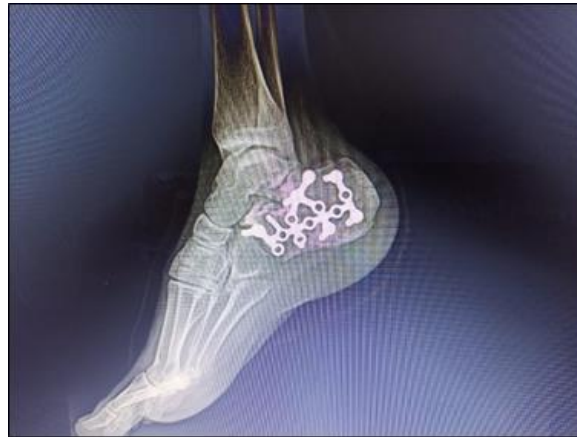


**Fig 30c:** Pre-operative CT calcaneus





**Fig 30d:** Immediate post-operative x-ray axial and lateral view



**Fig 30e:** 12 weeks post op x-ray

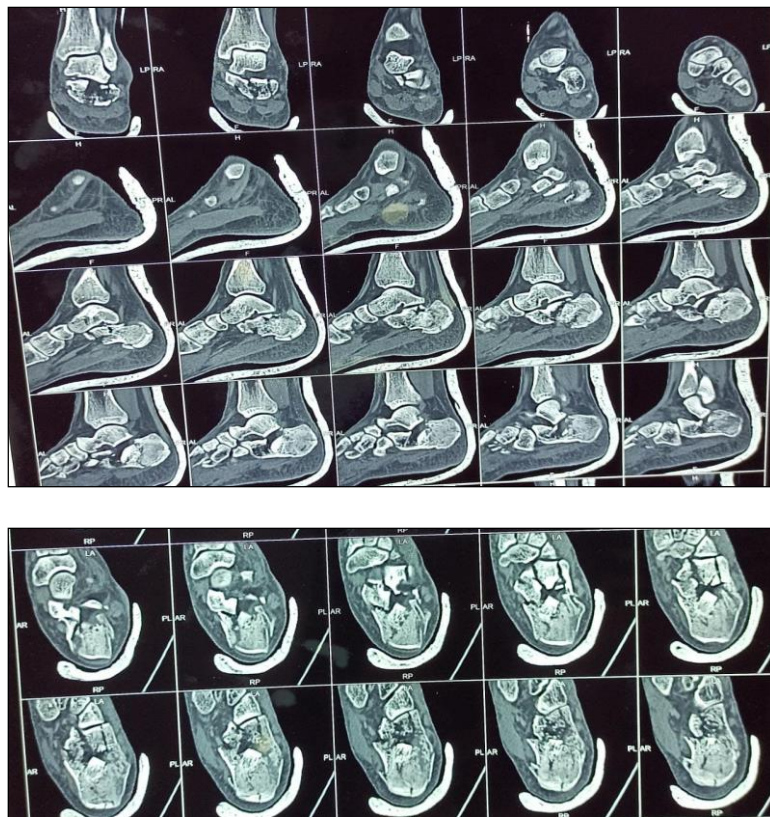


**Fig 30f:** Clinical picture-functional outcome

**Case 2:** A 28y male with history of RTA sustained left intra-articular calcaneal fracture Sander's type III.



**Fig 31a:** Pre-op x-ray



**Fig 31b:** Pre-op CT calcaneum



**Fig 31c:** Immediate post op x-ray





**Fig 31d:** 24 weeks post-op x-ray



**Fig 31e:** Post-op x-ray on final follow up

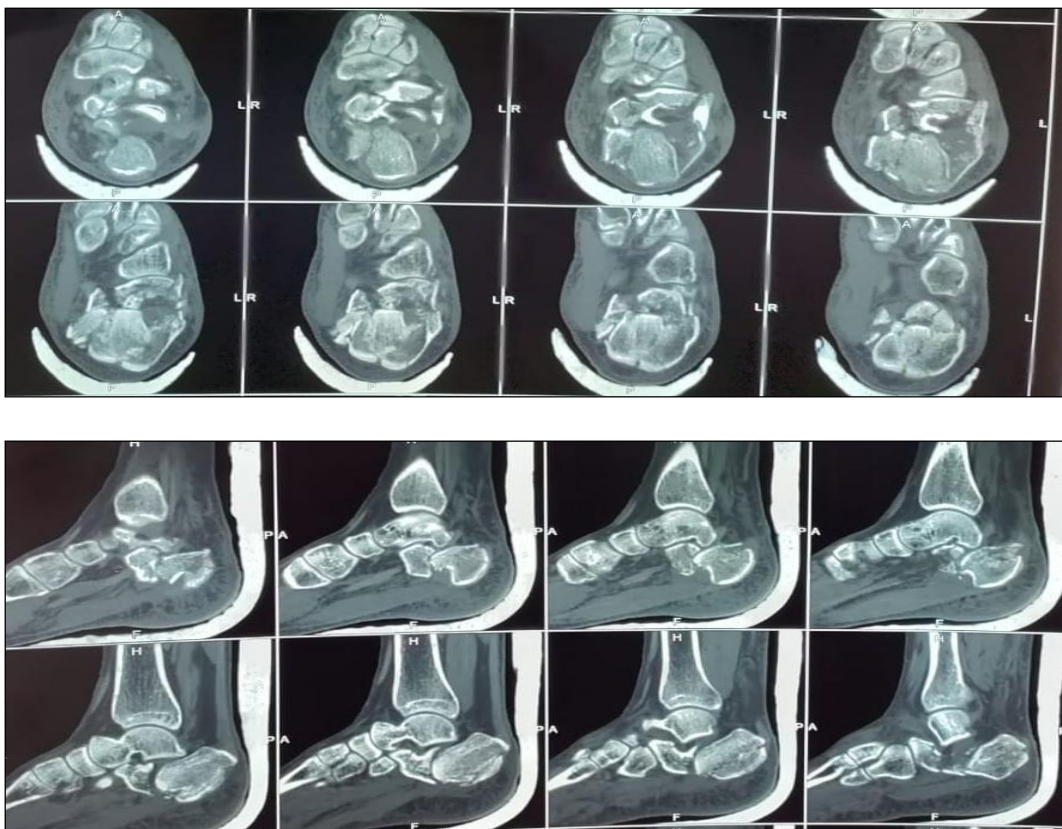


**Fig 31f:** Clinical picture-functional outcome

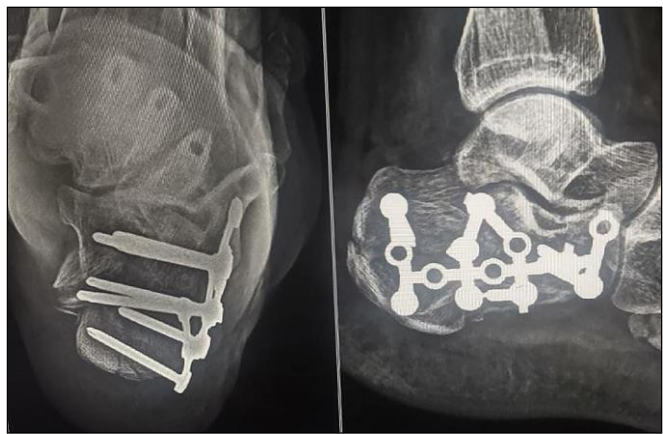
**Case 3.** A 28y male patient with history of fall from height sustained left intra-articular calcaneal fracture.



**Fig 32a:** Pre-op x-ray



**Fig 32b:** Pre-op CT calcaneum



**Fig 32c:** Immediate post-op x-ray



**Fig 32d:** 12 weeks post op x-ray





**Fig 32e:** Clinical picture-functional outcome

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