

3

Original article

Doi [10.5281/zenodo.13199220](https://doi.org/10.5281/zenodo.13199220)**EVALUATION OF PATIENTS OF INTRAARTICULAR CALCANEUS FRACTURES TREATED WITH OPEN REDUCTION AND INTERNAL FIXATION OR CLOSED REDUCTION AND PERCUTANEOUS FIXATION.****Dr. Takshay Gandhi¹, Dr. Chirag Amin^{2*}, Dr. Shreyansh Panchal³, Dr. Yash Patel⁴, Dr. Kamal Prajapati⁵**¹Department of Orthopaedics, Asst. Professor, [Shardaben General Hospital, Ahmedabad, India](#)²Department of Orthopaedics, Resident Doctor, [Shardaben General Hospital, Ahmedabad, India](#)³Department of Orthopaedics, Sr. Resident Doctor, [GMERS Medical College, Dharpur, Patan, India](#)⁴Department of Orthopaedics, Resident Doctor, [Shardaben General Hospital, Ahmedabad, India](#)⁵Department of Orthopaedics, Resident Doctor, [Shardaben General Hospital, Ahmedabad, India](#)

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Abstract:

Background: Calcaneus fractures account for approximately 60% of tarsal injuries and most occur in males varying between 20–50 years of age, leading to severe impairment of day-to-day activities and complications. Patients presenting with isolated calcaneal fractures, and those sustained during high-energy injuries were commonly associated with other injuries. Within this group, Pilon-type fractures, femoral fractures, and talus dislocations were most seen. Spinal injuries are a well-documented complication of falls from height. **Methodology:** After radiological evaluation, preoperatively Bohler’s angle and crucial angle of Gissane were measured retrospectively. Calcaneum fractures were classified according to Essex-Lopresti and Sanders. Patients were treated surgically according to fracture geometry. Functional outcomes of fixation on intra and extra-articular calcaneum fractures were evaluated using the AOFAS Scoring system. **Results:** The difference between pre- and post-mean Bohler angle showed a correlation with the quality of the outcome. In all patients, the post-operative Gissane angle was less than the pre-operative, which suggested a good outcome. Subtalar joint movements (inversion & eversion) are greatly affected in displaced intra-articular calcaneal fractures. **Conclusion:** With good anatomical articular reduction with suitable surgical intervention along with strict post-operative rehabilitation protocol, we can achieve good to excellent outcomes. **Keywords:** Calcaneus Fracture, Bohler’s Angle, Angle of Gissane, CRPF (Closed Reduction and percutaneous Fixation), ORIF (Open Reduction and Internal Fixation)

1. Background

Among all tarsal bones, the calcaneum is the most common bone to get fractured. The annual incidence of calcaneus fracture is approximately 11.5 per 1,00,000 population. Calcaneum fracture accounts for around 2% of all fractures. These fractures can affect an individual's life in the short term as well as long term as they can cause complications which affect daily life, they can cause chronic pain and disability so their management becomes crucial. The goal of calcaneal fracture treatment as per the American Foot and Ankle Society [AOFAS] is to restore the normal Alignment and contour of calcaneus. This is measured by one parameter called "Bohler's-Angle". [1,2]

Indications for operative management of calcaneal fractures [3]

- Displaced Intra-articular posterior facet fracture or Anterior process fracture with more than 25% of calcaneus cuboid joint involvement.
- Open fractures
- Fractures of calcaneal tuberosity

Via This study, we try to add literature on the operative management of calcaneal fracture by ORIF (open reduction internal fixation) and CRPF (Closed reduction and percutaneous fixation) and post-operative complications.

Anatomy: Among all tarsal bones calcaneum is the largest tarsal bone which has four surfaces. The posterior surface, middle surface, anterior facet which articulates with the Talus and articular surface for the cuboid are found distally. Sustentaculum tali support the middle facet medially and provide a groove for the flexor hallucis longus tendon from the inferior side. The anterior process of the calcaneus is located on the most distal aspect of the calcaneus bone, which gives origin to bifurcate ligament. This ligament is inserted on both the cuboid and Navicular. Calcaneal tuberosity is found on the postero-superior surface of the calcaneus and on the lateral surface there is a peroneal tubercle. [4]

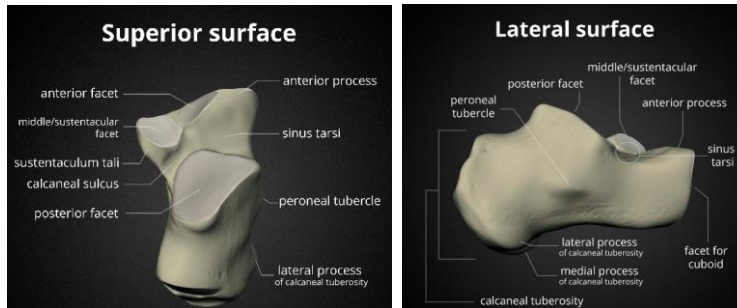


Figure 1(a,b). Superior and Lateral surface anatomy of Calcaneus.

Radiology

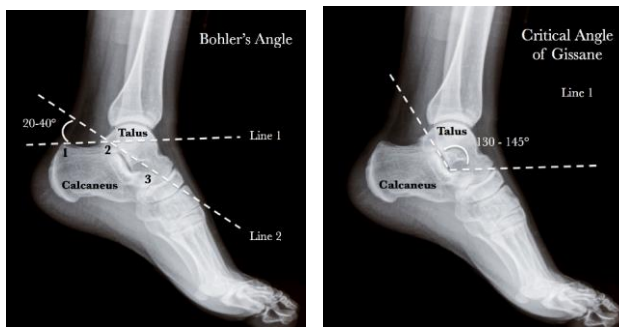


Figure 2(a,b): Bohler's Angle & Crucial Angle of Gissane

X-rays are used to diagnose calcaneal fractures preferably lateral and axial views. In this era of high-velocity injury, where fracture morphology is very difficult to understand in x-ray. CT scans proved to be very useful for understanding such fractures and for better pre-operative planning and thus good outcomes for such fractures can be achieved. In a lateral radiograph, 2 angles are clinically important. Which is used to decide the position of the Posterior facet. [4,5]

(1) Bohler's Angle (Tuber Angle): It is formed by two intersecting lines.

1. Line joining the posterior tuberosity (I) and the Appx of the posterior facet (II)

2. Line connecting the Apex of the posterior facet (II) and the Apex of the Anterior process (III)

It is usually depressed in calcaneal fractures.

Normal value: - 20 to 40⁰

- (2) Gissane angle (Crucial angle of Gissane): It is formed by two strong cortical struts that extend laterally and form an obtuse angle directly inferior to the lateral process of the talus. The first strut extends along the lateral border of the posterior facet and the second strut extends Anterior to the beak of the calcaneum.

Normal value: - 120 to 145⁰

Bohler's Angle and the crucial angle of Gissane may get altered in intra-articular calcaneal fractures depending on the direction of force and position of the foot and Ankle at the time of injury. In diagnosis-making, the reliability and utility of Bohler's angle are much more than the crucial angle of Gissane. A crucial angle of Gissane has found a lack of sensitivity and specificity. Other than lateral radiograph axial view a.k.a Harris projection view is also useful. It is an axial heel radiograph that helps to assess the axial alignment of the calcaneus and identify the medial or lateral shift of the fractured fragments. Lateral and axial views are helpful in the emergency department to diagnose calcaneal fractures while a CT scan is useful for operative planning. [4,5]

2. Materials and Methods

We conducted a retrospective review of intra-articular calcaneal fractures, treated in our hospital in the last 3 years (December 2020 to December 2023). Patients were identified with the help of hospital record books. All procedures were performed by multiple surgeons who are postgraduates in orthopaedic and trauma management with vast experience in utilising both techniques an extensile lateral approach used in the ORIF and a combination of screws

and/or Kirschner wire (K-wire) used for the CRPF. The Decision to proceed either with CRPF or ORIF was made by the following protocols: [3]

CRPF

- Simple 2-part Facet Pattern fractures

ORIF

- Fracture patterns involving more than 2 pieces of the posterior facet
- Fractures older than 2-3 weeks

Postoperative rehabilitation protocols:

Post-operative strict non-weight bearing and immobilization with below knee cast up to 8-12 weeks.

In this study patients above the age of 15 years are included with intra-articular calcaneal fractures. They are either treated with CRPF or ORIF. In ORIF, an Extensive lateral approach is taken. The minimally invasive CRPF technique was done with closed reduction manoeuvre only without any open exposure to the subtalar joint. In this study group, all patients have at least 6 months of follow-up.

Patients who developed immediate post-operative complications like post-operative infection are also included. It helps to minimize the



Figure 3: Sander's Classification

positive bias. Demographic data include Age, gender, mechanism of injury, mean time between

trauma and surgery. Pre-operative CT scan was done in all patients and fractures were classified according to Sander's classification. [6]

Clinical Outcome & Complications Included in This Study

(1) Development of post-operative infection

a. Superficial infection (involving skin & subcutaneous tissue)

b. Deep infection (involving musculoskeletal tissue)

(2) Development of post-traumatic subtalar arthritis.

(3) Post-operative calcaneal fracture reduction as determined by restoration of Bohler's angle on lateral radiographs

Bohler's angle was measured at 3 points in time

- I. Pre-operative
- II. Immediate post-operative
- III. At 6 months follow up.

3. Results

Table 1. Demographics & Mechanism of injury of the study population. Either treated with CRPF or ORIF

Demographic	Study Population	CRPF	ORIF
Number of Total Patients (n)	25	15	10
Age means +/- SD, Years	38	36	39
SEX (Number [%])			
Males	23(92%)	7	16
Females	2(8%)	1	1
Mechanism of Injury			

Fall from Height	19(76%)	5(26%)	14(74%)
Road Traffic Accident	6(24%)	4(66%)	2(33%)

Table 2. Pre-operative classification of calcaneus fracture in ORIF & CRPF group according to Sanders and Essex Lopresti classification.

Essex - Lopresti Classification			
Variable	Study Population	CRPF	ORIF
Depression	18	2	16
Tongue Type	7	4	3

Table 3. Mean time of surgery

On the day of trauma (1 st day)	04
Within a week of trauma (3-7 days)	17
After a week	04

Table 4. Complications after surgical management of calcaneal intra-articular fracture.

Variable	Study Population
Superficial infection (involving skin & subcutaneous tissue)	1
Deep Infection (involving musculoskeletal tissue)	0
Post-operative Arthritis of Sub-Talar Joint	2
Screw-impingement	3
Heel pain	5

4. Discussion

In our study, 17 patients were younger age group between 21 to 50 years of age (68%) and the remaining 8 patients were 51 to 80 years of age (32%) group. Essex Lopresti [7] mentioned that 90 % of intra-articular calcaneus fractures occur in the younger age group between 21-45 years. This suggested calcaneus fractures are more common in younger age groups.

Calcaneus fractures most occurred in males (85%) [8], in our study 23 patients were males and 2 patients were female which showed 92% of patients were males and 8% of patients were females. This shows the high magnitude of outdoor activities, sports as well as driving among the male population. Mitchell et al [9] observed that calcaneal fractures most occurred due to falls from height (70%) followed by a motorcycle accident. In our study, 19 patients had a history of falls from height (76 %) and the other 6 patients had having history of road traffic accidents. Most injuries in males occurred due to falls from height and bilateral fractures were associated with high-energy injuries. In females, the injury was more likely to occur from simple falls and other low-energy injuries representing an osteoporotic fracture in this group. [10]

In our study, 14 patients had left side (56%) and 10 patients had right side (40%) calcaneal fractures. We found that one patient (4%) had a bilateral intraarticular calcaneal fracture. Many articles observed that 16.6% of patients have bilateral calcaneal fractures. We found 18 patients were having joint depression type (72%) and 7 patients were having tongue type (28%) calcaneal fracture. According to Essex Lopresti, [7] joint depression variety was more common in intraarticular calcaneal fracture.

In this study, the time interval between trauma and surgery for all intraarticular calcaneus fractures was 1 to 10 days. In literature, also mentioned that the average time of all surgeries in all intra-articular calcaneus fractures was between 3 to 14 days after trauma.

Out of 25 patients 17 patients are treated with open reduction and internal fixation with plate (68%) and 8 patients are treated with percutaneous screw fixation (32%). Scheper et al [11] concluded that ORIF was the mainstay of all five modalities of treatments while the utility of the percutaneous technique was also helpful.

We found a preoperative mean Bohler angle of 20.37°. The Bohler angle is considered as normal within measurement ranging from 20° to 40°. We found a postoperative mean Bohler angle of 26.43°. The difference between pre-and post-mean Bohler angle showed a correlation with the quality of the outcome. The Bohler's angle can be used to guide the fracture reduction intraoperatively. Restoring the Bohler's angle to the normal range of 25–40 degrees is one of the surgical goals in clinical practice. We compared pre- and post-operative Gissane angles in all patients and we found postoperative Gissane angles were less than pre-operative which suggested a good outcome. Subtalar joint movements (inversion & eversion) are greatly affected in displaced intra-articular calcaneal fractures. We observed that after 1 year of follow-up, the mean of inversion and eversion of the affected side were near to normal range and no major difference was seen compared to the normal side.

In our study, no major complication was observed during early follow-up except for 1 patient was having a post-operative infection, 2 patients were having post-operative arthritis of the Sub-Talar Joint, 5 patients had heel pain and 3 patients had screw impingement which is treated with removal of screws. The patient did well and the pain subsided.

Outcome is measured with AOFAS score and we found excellent results in 13 patients (52%), good in 11 patients (44%) and fair in 1 patient (4%). No patient was having a poor outcome. We compared this with the series of Voclav et al[12] who also found excellent

results in 24(32%) patients, Good in 28(37%) patients, Fair in 14(18%) patients and Poor results in 10(13%) patients and Biz et al[13] who also measured outcomes with AOFAS score and he found excellent results (90–100 points) in 11 (12.6 %) patients, good results (75–89 points) in 46 (52.9 %) patients, fair results (50–74 points) in 26 (29.9%) patients, while 4 (4.6%) patients were graded as failures (<50 points).

5. Conclusion

In this study, we analysed 25 cases of intraarticular calcaneal fractures. Proper radiological evaluations like lateral and axial view of fracture are a must for understanding the fracture pattern. CT scan is helpful for assessment of minor fragments and comminution which helps in better preoperative planning. Factors like the age of the patient, personal history, mode of injury, general medical status, osteoporosis, and local factors like blisters, hemodynamic instability, and insufficiency of surgeons may result in poor outcomes. Essex Lopresti classification and CT-based Sander's classification are useful in better preoperative planning and management. The goal of the treatment of the intraarticular calcaneal fracture is to restore the subtalar joint articulation, height, and width of the calcaneum. For less severe intraarticular fracture, the modified Essex Lopresti method of closed reduction and percutaneous screw fixation is a good option to minimise the complications of open fixation. Open reduction and internal fixation are good options for joint depression and tongue-type comminuted intra-articular calcaneal fractures. The lateral extensile approach is better for visualisation of the subtalar as well as the calcaneocuboid joint. Joint destruction and severe intra-articular comminution with soft tissue compromise led to fair to poor outcomes. With good anatomical articular reduction with suitable surgical intervention along with strict post-operative rehabilitation protocol, we can achieve good to excellent outcomes.

6. References

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