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## Clinical radiological & functional outcome of calcaneal fractures undergoing fixation with contoured locking plate

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### Abstract

**Objectives:** With the advancement in surgical technique and newer fixation devices the treatment outcome of calcaneal fractures have improved. Therefore it is paramount to identify the appropriate treatment techniques for better functional outcomes in terms of better stability and early weight bearing without pain. Hence this study was carried out to study the functional outcomes of displaced Intra-articular Calcaneal fractures, treated with operative management using contoured locking plate.

**Material and Methods:** This study was carried out as a prospective study. Fifty (50 fractures) patients with acute, displaced Intra-Articular fractures of calcaneum aged above 18 years, were enrolled in the study. Open fractures and fractures older than two weeks were excluded. The functional outcome was measured by the "American Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot scoring system" at twelve months.

**Results:** Of the 50 patients, all were males. Five patients had bilateral fractures. 35 patients had left sided fractures, while 15 had right sided fractures and mode of injury for all the patients was fall from height. Post operatively all 50 patients had swelling, 20 patients had persisting pain, 5 had superficial infections and 2 had deep infection. Superficial infections healed with antibiotics and dressings, while the patient with deep infection had persistent pain and difficulty in walking with discharge from surgical wound site. Both of them underwent implant removal and debridement after a year. Of the 50, 32 had good results, 14 had fair results and 4 had poor results. Hence we conclude from the above findings that contoured plate fixation helps in improving the functional outcome of the patients in view of their physical and radiological findings.

**Conclusion:** A relatively better functional outcome was observed in displaced and comminuted fractures in plating, provided that the Bohler's angle was restored. The technique of contoured plate fixation with a lateral approach is good with regards to fracture union and functional outcome.

**Keywords:** Intra articular calcaneal fracture, bohler's angle, crucial angle of gissane, heel varus angle, calcaneal locking plating

### Introduction

Calcaneal fractures account for approximately 2% of all fractures. Displaced Intra-Articular fractures comprising 60% to 75% of these injuries are the fractures of serious concern. With the advancement in surgical technique and newer fixation devices the treatment outcome has improved. Therefore it is paramount to identify the appropriate treatment techniques for better functional outcomes in terms of better stability and early weight bearing without pain.

Understanding the geometry of the calcaneal fractures is not easy as any other bone. Because of its subcutaneous anatomy, surgical treatment was associated with complications till recently. Computerized Tomography imaging has helped in better understanding of the fracture pattern. Treatment of Intra- Articular Calcaneal fractures is still a controversy with strong arguments supporting both conservative & operative managements. Lack of standardization of results has made it difficult to compare studies that have evaluated outcomes. Last two decades has seen marked advances in anesthesia, prophylactic antibiotics, CT scanning, and intra-operative fluoroscopy resulting better outcomes in calcaneal fixation. Acute calcaneal fractures undergoing fixation has shown better outcomes in recent studies. Various fixation methods have been advocated. Open Reduction Internal Fixation with contoured locking plate of the Intra-Articular fractures along with bone grafting is the

treatment of choice. Complications like poor wound healing and infection is always a concern.

## Methodology

### Study design

It is a prospective study, patients presenting to casualty and outpatient clinic of Department of Orthopedics, Government TD Medical College, Alappuzha with calcaneum fracture between August 2017 and November 2018 were included. All patients above the age of 18 years undergoing surgery were included. Patients with open fracture having neurovascular and tendon injuries, pathological fractures, ankle injuries, multiple fractures or other associated fractures were excluded from the study. Patients were explained the purpose of the study and a separate informed written consent for being included in the study was obtained from them. The study was approved by the Institutional Ethics Committee.

### Pre-Operative Evaluation

The swelling of the heel and status of the skin was recorded. X-ray imaging of calcaneum included lateral and axial views. CT imaging was done. The patient was temporarily put on a below knee slab with adequate limb elevation until the swelling subsided and until wrinkle sign positive.

The fractures were classified based on the Essex-Lopresti Classification System.

After pre-anaesthetic evaluation patient was then posted for open reduction internal fixation with Calcaneal Locking plates. The lateral extensile approach was used for all the patients.

### Operative Technique

Lateral approach was used for all, the incision was started approximately 2 cm above the tip of the lateral malleolus, just lateral to the Achilles tendon curving along the junction of the lateral foot and the heel pad till calcaneo-cuboid joint. A full thickness subperiosteal flap was elevated to maintain the vascularity especially at the apex of the incision. Retraction done with no touch technique with 3 k-wires.

Lateral wall exposed by varus force applied by a transverse K-wire drilled in tuberosity. Reduction of articular surface was done, along with reduction of the Sustentacular fragment. Hydroxyapatite crystals were filled to fill the void where there was substantial loss of cancellous bone to support the articular fragments. The lateral border was then reduced along with the varus by the k wire, by giving a valgus force. Restoration of angle of Gissane was confirmed, which is the best intra-operative indicator of good restoration of articular surface anatomy.

The reduction is confirmed by lateral and axial views under image intensifier. The appropriately sized plate was placed on the lateral surface of calcaneum. Skin closed with Allgower-Donati sutures.

### Post Operative

#### Immediate

- NPO for 6 hours postoperatively.
- I.V antibiotics and I.M analgesics
- Limb elevation over pillows
- Active toe movements
- Check X-ray of the calcaneum and ankle joints in both Axial and lateral views.

#### Later

- IV antibiotics for 3 days and change of dressing with

wound inspection on postoperative day 3.

- Switch over to oral antibiotics if the wound is clean with no discharge.
- If discharge is present culture sensitivity sent and antibiotics started as per the sensitivity report.
- On post op day 10 suture removal done after wound inspection.

### Follow up and criteria for evaluation

The patients were followed up clinically and radiologically at 6weeks, 12weeks, 6 months, and 1year, with respect to height of calcaneum, width of the calcaneum, range of movements at subtalar joint, tubero-talar angles.

At every follow up clinical examination was done to assess status of the surgical wound, pain, tenderness, range of motion of subtalar joint, stability of the fracture and clinical union. Roentgenograms were taken in Lateral and axial views to look for signs of radiological union. In our study we concluded clinical union when the fracture site had become stable and pain free.

The union is confirmed radiologically when plain X-ray showed bone trabeculae or cortical bone crossing fracture site on at least three surfaces on orthogonal radiograms. The time taken for clinical and radiological union was noted. If there are no clinical and radiological signs of union by 16 weeks, the fracture was categorised as delayed union and if absence of fracture union after 24 weeks after injury was categorized as non union. We had 5 cases of delayed union following fixation.

The functional outcome was measured by the “American Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot scoring system” at twelve months. The AOFAS scoring system is a very useful tool to measure function of the foot developed by the American Academy of Orthopaedic Surgeons (AAOS) and has been validated by various studies. The AOFAS score is a 100 point scoring system mainly assessing the pain, function and alignment of the foot. The functional outcome decreases as the score decreases.

The result was then graded as Excellent, Good, Fair and Poor as follows:

Excellent – 89 to 100 Points.

Good – 79 to 89 points.

Fair – 69 to 79 points.

Poor – Less than 60 points.

### Results

There were 50 adult patients who presented with calcaneal fractures to our hospital during the course of the study. Of the 50 patients, all were males. Five patients had bilateral fractures. Of the 50 patients, 35 (70%) had left sided fractures, while 15 (30%) had right sided fractures. The mode of injury for all the patients was fall from height. All the operated patients had a joint depression type of fracture. Of the 50, 35 (70%) had Essex Lopresti Classification type III fracture and 15 (30%) had a Essex Lopresti Classification type II fracture. Of the 50, all patients had gross swelling of the foot following the fall, only 10 (20%) had blisters associated with it.

The number of days from the fall to surgery varied from 1- 18 days (mean 7.3days). Days of hospital stay varied from 12- 25 days (Mean- 14.04 days).

All patients were treated with a lateral extensile approach and fixed with contoured locking plates. Post operatively all 50 had swelling, 20 patients had persisting pain, 5 had superficial infections and 2 had deep infection. All the patients with

superficial infections were treated with injectable antibiotics for a week, and oral antibiotics for another week. Suture removal was delayed till the wound infection subsided and patients were discharged. Further follow up showed no signs of any infection. The one patient with deep infection was treated repeatedly with a course of injectable and oral antibiotics. Patient had persistent pain and difficulty in walking with discharge from surgical wound site at every follow up. X rays showed delayed union. Patient developed calcaneal osteomyelitis and underwent implant removal and debridement after a year.

All the operated patients had an increase in the Bohler's angle and decrease in the Gissane's angle with a statistically significant p value. The mean pre op Bohler's angle was 11.52° and Gissane's angle was 126.8°. The mean Post op Bohler's angle was 26.16° and Gissane's angle was 119.76°. The p value for the increase in Bohler's angle is 3.13 x 10-18. The pvalue for the decrease in Gissane's angle was 1.10 x 10-12.

Post operatively all patients had an increase in heel height and decrease in heel width with a statistically significant p value. The mean pre op heel height was 5.75 and heel width was 6.85. The mean Post op heel height was 6.45 and heel width was 6.15. The p value for increase in heel height value was 7.5 x 10-18. The p value for decrease in heel width was 1.2 x 10-11.

At 12 weeks of follow up, X rays of 45 patients showed radiological signs of union. Mean duration of radiological union was 12 weeks with SD of 1.79. Five patients had delayed union radiologically. Two patient had deep infection and underwent implant removal at end of 1 year.

Of the 50, 32 had good results with mean AOFAS score of 83.6, 14 had fair results with mean score of 73.28 and 4 had poor results with mean score of 54. Of the patients with good results, no patients underwent implant removal. Post operatively patients had no complaints.

The mean ROM of subtalar and ankle joints of patients with good results are as follows. Inversion and eversion were in the normal range, and the mean dorsiflexion and plantarflexion of ankle are 30 and 25 degrees respectively.

The mean ROM of subtalar and ankle joints of patients with fair results are as follows. Inversion and eversion are 16.50 and 12.80 degrees respectively, and the mean dorsiflexion and plantarflexion of ankle are 20 and 15 degrees respectively. The mean ROM of subtalar and ankle joints of patients with poor results are as follows. Inversion and eversion are 10 and 7.5degrees respectively, and the mean dorsiflexion and plantar flexion of ankle are 15 degrees each.

## Discussion

Intra-Articular Calcaneum treatment is considered to be difficult. The management of every aspect of Intra-Articular calcaneal fractures is controversial. Although some studies with more than 100 cases have demonstrated good results after open reduction and internal fixation of Intra-Articular calcaneal fractures [2, 3, 4], the best choice of treatment remains controversial because prospective randomized studies have not shown convincingly better results after surgery [5, 6]. However, in the largest prospective randomized trial described to date, Buckley *et al.* found better results in some subgroups of patients after surgery [7].

Essex-Lopressti, Rowe and Sanders are the commonly used classification systems for calcaneal fractures. Although, classifications show positive correlation with outcome, there is no correlation with choice of treatment [8, 9, 10]. In our study we have used the Essex-lopressti classification systems.

It is difficult to compare outcome between studies since different measures of outcome are often used and there is no consensus among surgeons as to which is the most scientific and practical system.

Historic cohort studies [11, 12, 13] have concluded no difference in functional outcome with operative and conservative treatment of displaced Intra-Articular calcaneal fractures. Many of the recent studies [14, 15, 7] have also shown no advantage of operative treatment, many other studies [5, 16, 17, 18, 19, 20] have shown superior results with operative treatment.

Surgical treatment is definitely associated with significant incidence of wound complications, particularly sepsis [21]. On the other hand, conservative treatment is also associated with subtalar joint pain, heel varus and peroneal tendon impingement [22].

We staunchly believe that displaced Intra-Articular fractures of the calcaneum should be treated on the same principles as any other injury of the weight bearing joints; that is by anatomical reduction and stable internal fixation, to allow early movement for a better functional outcome [23].

Application of these principles to Intra-Articular calcaneal fractures have been slow because of complex bony and fracture anatomy, tenous soft tissue envelope and difficulty of achieving anatomic reduction and stable fixation [24]. With Improved surgical techniques and novel implants especially locking plates, limited complication rates have made many surgeons more confident in operative treatment for these fractures.

Calcaneal fracture surgery can be performed using medial, lateral or combined approaches [25, 26, 27, 28, 29]. The lateral approach is the most popular approach. A lateral extensile exposure popularised by Benirschke and Sangeorzan was used in all our cases. Various fixation devices like pelvic reconstruction plates, calcaneal plates [30, 23] K-wires or a combination [31] of k-wires and screws [32] can be used for fixing these fractures. We used a contoured locking plate to the lateral wall of the calcaneum and screws to fix these fractures. Hydroxyapatite was stuffed to fill the void. Deficiency of the lateral wall, when present, could be well reduced and held in place with this plate.

In our analysis, we confirmed correlation between the Böhler's angle size and patient satisfaction in terms of their functional outcome. This fact, proved and verified by a lot of other authors, confirms the role of Böhler's angle and Gissane's angle size as a predictive factor for subsequent late complications [33, 34].

Outcome measurements can be expressed by various scoring systems [35] or its modifications based on the author's experience of important symptoms and functional abilities. AOFAS clinical rating system the Ankle Hindfoot Scale for calcaneal area is a standard scoring system for foot function evaluation [1]. Using this standard scoring system that takes into account subjective and objective assessments enables to achieve relevant results and comparisons of different patients' studies. Finally, one has to mention optimistic findings of Melcher who followed up patients operated by ORIF 3 and 10 years after the surgery. In his study, subjective and objective results assessed after ten years were better than those achieved in a 3-year follow-up [36].

Complications occur regardless of the management strategy chosen for displaced Intra-Articular fractures and despite management by experienced surgeons. Complications are a cause of significant morbidity for patients [37]. The rate of wound complications (superficial and deep infections) in this study was 32%, which is similar to that in many studies in the literature [38, 39].



A prospective, randomised, CT-based study comparing operative versus non-operative treatments for type-II and -III fractures, revealed that the former type of treatment followed by early mobilisation produced superior results<sup>5</sup>, as was seen in our study. In a meta-analysis published in 2000, Randle *et al.* stated that “there is a trend for surgically treated patients to have better outcomes; however, the strength of evidence for recommending operative treatment is weak.” They concluded that, before a strong recommendation could be made for operative treatment, a randomized trial with controls and validated outcomes was needed<sup>[40]</sup>.

There were certain limitations to our study. Only 50 patients with calcaneal fractures were operated and their functional outcome score was measured at a mean follow-up of 12 months. A study involving more patients followed up for a longer period of time can more accurately define the functional outcome of displaced Intra-Articular calcaneal fractures treated by this method. All measurements were performed by the same author, all values were captured manually. This author was not involved in patient surgery or care, thus keeping observer bias to the minimum. Therefore this discussion is essentially a preliminary assessment.

### Conclusion

Calcaneal fractures are one of the common fractures following a fall from height and the treatment modality has to be decided according to the fracture pattern for the better functional outcome.

We conclude that all Intra-Articular calcaneal fractures should be treated with open reduction & internal fixation. Anatomical reduction and stable internal fixation allows early mobilization and weight bearing. The technique of contoured locking plate fixation is good with regards to stable fixation and fracture union resulting in better functional outcome. Bohler's and Gissane's angle are detrimental of good anatomical reduction.

**Table 1:** Distribution of patients according to their demographic and clinical characteristics

Age	15-24	25-34	35-44	>45
	2	20	16	12

**Table 2:** Age Distribution

Variables	N (%)
Injured side	
Left	35 (70%)
Right	15 (30%)
Essex Lopresti Classification	
II	15 (15%)
III	35 (70%)

**Table 3:** Post operative complications

Post operative complications	Number of patients
Persistent pain	20
Swelling	50
Superficial infection	5
Deep infection	2

**Table 4:** Results as per AOFAS scoring at 12 months

Results	Excellent	Good	Fair	Poor
Percentage	0	16 (64%)	7(28%)	2 (8%)
Mean	0	83.5	73.28	54
SD	0	2.03	1.25	8.48

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