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## Comparative analysis of functional outcome between operative and conservative treatment for closed, displaced, intra- articular fractures of the Calcaneum, A randomized study

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### Abstract

**Background:** Calcaneum fracture is one of the more common fractures causing significant morbidity to the patients, so debate continues for choice of management of calcaneal fractures, between operative and conservative management. The aim of this study was to compare the outcomes of operative management and conservative management in closed, displaced, intra- articular fractures of the calcaneum.

**Materials and Methods:** Thirty patients with thirty-two displaced intra-articular calcaneal fractures were selected during July 2019 to June 2020 with taking inclusive and exclusive criteria into consideration and randomly divided into surgical and non-surgical groups. First group of patients was managed with operative technique. Patients in other group were treated with closed reduction and cast immobilization using the Omoto technique. The observations in both the groups were compared and analysed.

**Results:** The difference between the outcomes of surgical treatment and nonsurgical methods that were significant were noted. The fracture union occurred between 12 -16 weeks and no case of non-union has been reported. Some of the patients had reported with wound related complications and were managed with higher antibiotics and regular antiseptic dressings. The functional assessment of patients during follow ups has indicated that 87.6% patients of the operated group has good to excellent outcomes while 87.55% of conservatively managed patients have good to fair outcome.

**Conclusion:** Operative management for closed displaced, intra- articular calcaneal fractures in absence of high grade osteoporosis, fracture comminution, and associated morbidity may be the preferred method of treatment.

**Keywords:** Calcaneum fracture, internal fixation, open reduction, close reduction, omoto technique

### Introduction

Malgaigne described calcaneal fractures in 1843. It is most commonly fractured tarsal bone (60% of all tarsal bones) and in 7-10% cases bilateral calcaneum are fractured. It accounts for approximately 2% of all fractures and 10% patients of calcaneum fracture has open wound. Almost 10% of calcaneal fractures are associated with spinal, pelvic injuries. It is more common in male population specially in industrial workers and age group of 21-45 years, the mechanism of injury commonly being fall from height.

### Material and Methods

A prospective randomized study was carried out on 30 patients with 32 displaced intra-articular calcaneum fractures attending the Emergency Trauma center and OPD of Orthopedic Department at B.J Medical College and Civil Hospital, Ahmedabad, Gujarat from 1<sup>st</sup> July 2019 to 30<sup>th</sup> June 2020. Patients were divided into two groups operative (15 cases) and non-operative (15 cases) according to randomization sequence. Patients in Group A were treated with Operative methods while those in Group B were managed with closed reduction by the 'Omoto technique' and below knee plaster of paris cast application. Immediate post-op or post-cast check x-rays were taken in both lateral and axial views. The deformity correction

was checked and any displacements, if present were noted. Information on age, gender, mode of injury, side, classification of fracture with associated injuries, etc. was recorded for these patients.

**Table 1:** Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> <li>• Age &gt; 18 years</li> <li>• Fracture with displacement &gt;2mm</li> <li>• Less than 3 week old fracture</li> <li>• Sander's type II, III &amp; IV fracture classification</li> <li>• Patients who gave consent for study</li> </ul>	<ul style="list-style-type: none"> <li>• Patients with previous calcaneum pathology (tumor; infection; fracture)</li> <li>• Open calcaneum fracture</li> <li>• History of alcohol or drug abuse</li> <li>• Patient not likely to cooperate or attend all schedule visits</li> <li>• Sander's Type I calcaneum fractures</li> <li>• Associated neurovascular injury</li> <li>• Extra-articular calcaneum fractures</li> <li>• Patients who did not give consent for study</li> </ul>

**Surgical Procedure:** Lateral extended approach which is standard to the calcaneum was used. Fracture was reduced, congruity of the joint was confirmed using C-arm imaging followed by fixation was done with calcaneal plate and locking cancellous screws. Wound was closed in layers and drain was applied. In some patients percutaneous cannulated-cancellous screws were also done.

**Post-operative care:** Immobilization of limb was done in below knee splint with the advice for active toes mobilization and limb elevation. Analgesics were given the patient as and when required. Antibiotics (oral/intravenous) were administered every 12 hourly till stitch removal was done. Every alternate day antiseptic wound dressing was done. Early Range of Movement exercise was encouraged.

**Closed reduction Technique (Omoto technique)** [5]: Under sedation patient was placed under a prone position. Surgeon stands on the foot end of the patient and applied medial and lateral pressure to the heel while one assistant supported the thigh. Longitudinal traction given by the surgeon in the line of leg. Heel valgus or varus deformity was corrected and tuberosity was manipulated. Finally below the knee Plaster of Paris cast was applied in which the angle between the foot and tibia was 90° in standard neutral position.

**Rehabilitation:** Post-cast pain and swelling were treated using anti-inflammatory analgesics and limb elevation along with advice to perform active toe mobilization from first day. Physiotherapy was started post cast removal after 2 months. In conservative cases partial weight bearing was started after 10 weeks and full weight bearing was started after 14-16 weeks. Partial weight bearing was started after 8-10 weeks and full weight bearing was allowed only after union and subsidence of pain at about 12 weeks in all operatively treated cases.

**Follow-ups:** Patients were followed up at 2, 4, 8, 12 week time and then every 3 months.

**Parameters for evaluation:** When clinically there was no tenderness and subjective complaints (if any) which were noted at every follow-up then the fracture was considered united.

• **Radiographic Assessment:** this was done to assess consolidation or post reduction collapse and any displacement was noted. The fracture was considered united when the fracture line was not visible and establishment of trabecular continuity was achieved between the two fragments on axial and lateral x-rays. All radiological parameters (Bohler's angle, Gissane/crucial angle, height, width etc.) were checked at every follow up [8].

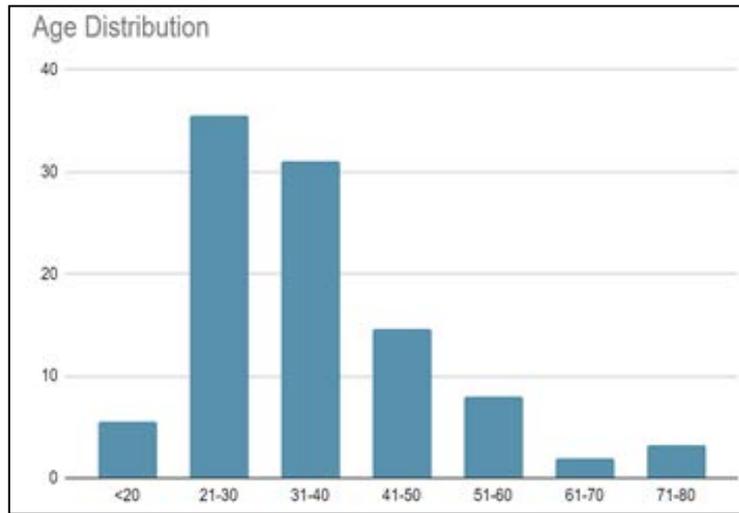
• **Functional Assessment:** The results were assessed using the guidelines of American Orthopaedic Foot Ankle Society (AOFAS) Ankle-Hindfoot Score [5]. This takes the following factors into consideration: pain intensity; function, including activities that are restrained and the need for support with an orthosis; maximum walking distance possible for the patient which is measured by blocks; gait abnormality; mobility in sagittal plane (flexion and extension); mobility of hindfoot (inversion and eversion); the valgus-varus and antero-posterior stability of the ankle joint and hindfoot and the alignment of the foot and ankle joint. The scores for each item were added together, providing a total between 0 and 100.

### Statistical Analysis

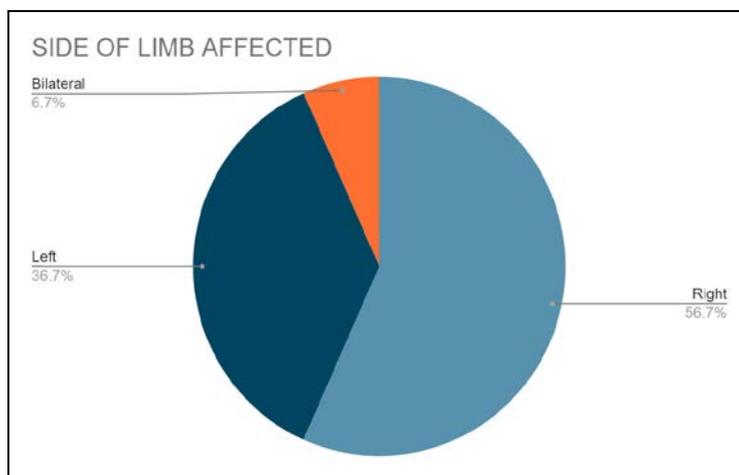
Statistical testing of data was done with the statistical package of social science system version 22.0. Mean±SD was used to present the continuous variables. Absolute numbers and percentage were used to present the categorical variables. For comparison of preoperative v/s post-operative and pre casting v/s post casting measurements, paired t-test was used while for post-operative v/s post-manipulation measurements, unpaired t-test was used. *P-values* were calculated and if the p-value was less than 0.05 then differences between the two groups were considered significant. For determining the correlation between radiological and functional outcome, Pearson correlation coefficient was calculated

### Results

All 30 patients were followed up regularly during the study period. Of these 24 patients were male and 6 patients were female (M:F= 4:1). The youngest patient was 18 years of age and the oldest was 76 years of age. The mean age at presentation was 30.5 ± 11.40 years. The maximum numbers of cases were between 21 to 30 years of age (35.5%). 2 patients had fracture on bilateral sides. The most common mode of trauma was fall from height in 85% cases, followed by RTA accounting for 15% of patients. There were total of 10 fractures of Sander's Type II (31.2%), 18 (50%) fractures of Sander's Type III and 6 (18.8%) of Sander's Type IV fracture. There were 2 (6.67%) cases with associated spinal injury one at L2 vertebra and D12 vertebra in other. There was one case (3.33%) of fracture right superior and inferior pubic rami of pelvis. One of the cases of spinal injury was associated with neurological deficit and was managed operatively by posterior fixation and calcaneum fracture was managed with POP cast while the other case of spinal injury was not associated with any neurological deficit and was managed conservatively. The average time interval between trauma and surgery was 5 ± 1.68 days (range 2 to 14 days), while between trauma and cast application was 3 ± 1.60 days (range 9 to 14 days). We had either operated or applied cast to all the cases after achieving a positive wrinkle sign.



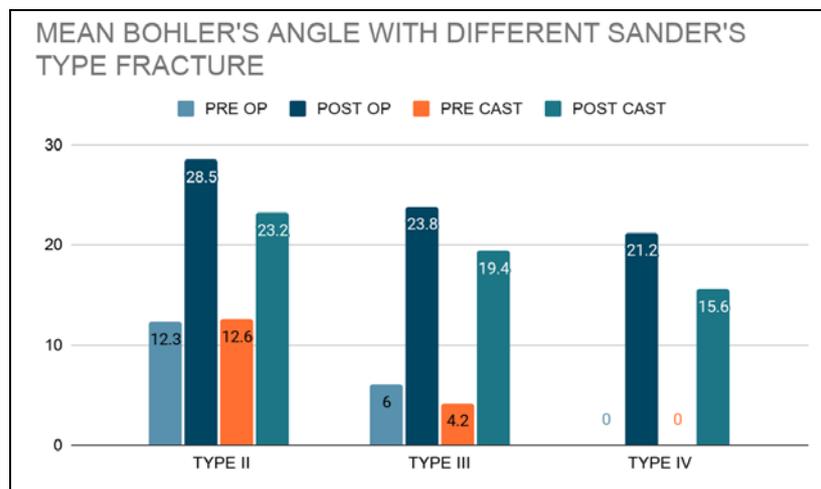
**Fig 1:** Age Distribution of Patients



**Fig 2:** Side of limb affected

**Table 2:** Duration of surgeries with their types as per Sander's Classification

Type Of Fracture (Sander's Classification)	Duration Of Surgery (In Minutes)
Type II	79.50±7.25
Type III	88.35±6.47
Type IV	100.57± 5.57



**Fig 3:** Mean Bohler's Angle (In Degree) different Sander's Type Fracture

Post intervention we had achieved an increase in Bohler's angle in both the groups. The Bohler's angle improved from  $6.1^0 \pm 4.61^0$  to  $24.5^0 \pm 4.43^0$  in operative group and from

$5.0^6 \pm 4.43^0$  to  $19.4^0 \pm 2.8^0$  in manipulation group. The increase was significantly more after plate osteosynthesis than post-manipulation ( $p < 0.05$ ).

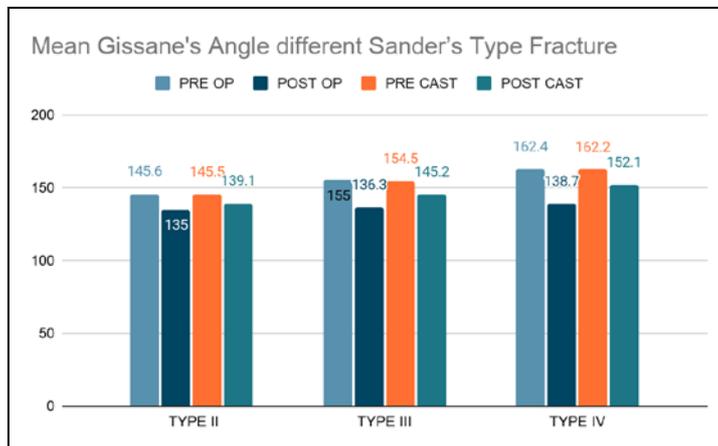


Fig 4: Mean Gissane's Angle (In Degree) with different Sander's Type Fracture

A reduction in Gissane's angle is achieved in both the groups. The Gissane's angle changed from  $154.33^0 \pm 5.50^0$  to  $136.66^0 \pm 3.64^0$  in operative group and from  $154.06^0 \pm 6.74^0$  to  $145.46^0 \pm 4.74^0$  in manipulation group post intervention. The Gissane's angle was decreased significantly after operative management than after manipulation ( $p < 0.05$ ).

The total calcaneal height in operative group improved from preoperative value of  $3.64 \pm 0.22$  cm to postoperative value of  $4.29 \pm 0.18$  cm. The total calcaneal height improved from  $3.55 \pm 0.25$  cm to  $4.0 \pm 0.15$  cm in conservatively managed. The calcaneal height was increased significantly after operatively managed than after manipulation ( $p < 0.05$ ).

The calcaneal width improved from its preoperative value of  $4.46 \pm 0.2$  cm to postoperative value of  $3.72 \pm 0.09$  cm in the surgically managed group. The calcaneal width changed from

$4.25 \pm 0.18$  cm to  $3.69 \pm 0.10$  cm in conservative group. The decrease in calcaneal width was significantly more after operation than after manipulation ( $p < 0.05$ ).

The average time of union in operated cases was  $13.45 \pm 1.34$  weeks (range = 12 to 16 weeks) while in conservatively managed cases was  $13.13 \pm 1.13$  weeks (range = 12 to 16 weeks). Maximum number of fractures united between 12 to 14 weeks (93.75%) in both the groups. No case of nonunion was encountered in either group. The result was not statistically significant.

**Functional Evaluation by American Orthopaedic Foot Ankle Society (Aofas) Ankle-Hindfoot Score<sup>[6]</sup>**

The functional outcome was assessed using AOFAS score at last follow up or minimum after 3 months.

Table 3: Functional outcome using AOFAS Ankle-Hindfoot Score

Outcome	Aofas Score
Excellent	90 to 100
Good	80 to 89
Fair	70 to 79
Bad	below 69

Table 4: AOFAS Ankle-Hindfoot Score in different Sander's Type in both groups

Aofas Score	Type II	Type III	Type IV
Operative Group	$96 \pm 1$	$89.67 \pm 2.46$	$75.33 \pm 5.56$
Conservative Group	$86.5 \pm 1.55$	$76.11 \pm 4.96$	$70.0 \pm 5.33$

As per our analysis of post-operative and post-conservative AOFAS score, the result obtained was statistically significant ( $p < 0.05$ ).

The AOFAS score increased significantly after operative management than after conservative management.

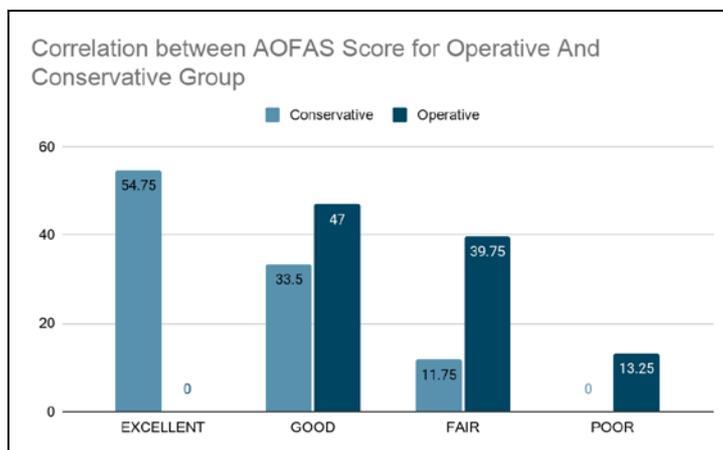


Fig 7: Correlation between AOFAS Score for Operative and Conservative Group

**Complication**

Superficial wound defect at the skin incision site was observed in 3 cases of Sander's Type III fracture and 1 case of Sander's Type IV fracture, which was managed with higher antibiotics and antiseptic dressings. Only 1 case with Sander's Type III fracture presented with severe defect of the soft tissue. There was wound edge slough formation, gaping and necrosis. Debridement of devitalized tissue and secondary suturing was done to manage the infection. The wound healed with higher intravenous antibiotics and regular sterile dressing. No patient reported severe soft tissue complication that required plate removal. Only one case presented with varus malunion but in long term functional outcome was not

affected. There was no case of postoperative screw loosening or implant failure. Among conservatively managed group 2 cases (12.5%) had reported with superficial skin erosion which was managed by cast removal, below knee slab with oral antibiotics and regular dressings. Below knee cast was re-applied after wound healing. three case presented with varus malunion of the calcaneum and at last follow up, two of them presented with good functional outcome but one had poor functional outcome. None presented with other complications like compartment syndrome, blisters, peroneal tendinitis, sural nerve hypoesthesia, tarsal tunnel syndrome, tendon rupture and sympathetic dystrophy in any group.

**Operative Patient (29 year female with Sander's Type III fracture)**



Pre-op X-ray



Immediate post-op x-ray



3 Weeks follow up



3 months follow up



9 month follow up

**Operative Patient (39 year male with Sander's Type III fracture)**



Pre OP X Ray



Intra OP C-arm Image



Post OP X Ray

Conservative Patient (77 years male with Sander's Type III fracture)



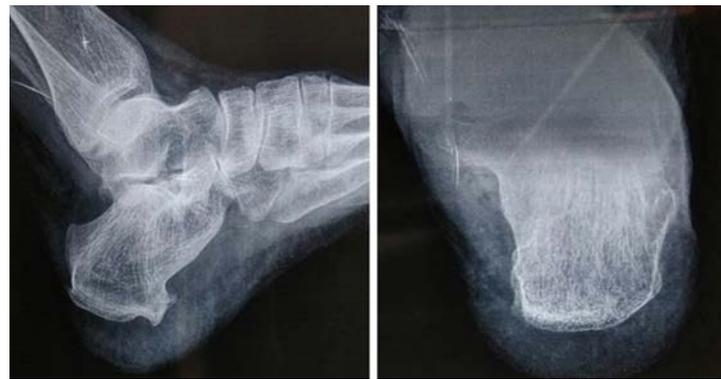
Pre-manipulation x-ray



Immediate Post Manipulation X Ray



3 months follow up



6 months follow

## Discussion

Calcaneal fractures are serious injuries which commonly affect young individuals, and are often associated with long term complications, chronic disability, reduced life quality, and high socio-economic costs. The majority of published literature on operative treatment of calcaneal fractures have mentioned an operative approach through which reduction of the calcaneal body and restoration of calcaneal height, length, and width was reproducible, irrespective of the fracture type.<sup>[7-29]</sup> In the last decade, open reduction and internal fixation of displaced intra-articular calcaneal fractures has become a standard surgical method with low complication rate and better quality of life post surgery. By implanting locking compression plates, the osteosynthesis becomes more stable, enabling earlier weight bearing<sup>[26]</sup>.

Many studies have been done to evaluate the effectiveness of operative management of calcaneum fracture and compare its effectiveness with conservative management. O'Farrell *et al.*<sup>[25]</sup> has shown that patients managed operatively had a significantly more stable calcaneal height and width than the patients managed conservatively. Cheng Long *et al.*<sup>[35]</sup> had found in their study that the average time for calcaneum fracture to unite was 3.2 months which is comparable to the result of our study. Vaclav Rak *et al.*<sup>[36]</sup> confirmed correlation between the Böhler's angle size and patient. O'Farrell *et al.*<sup>[25]</sup> shows that conservatively managed patients had a significantly higher mean Gissane's angle than those operatively managed.

Buckley *et al.*<sup>[28]</sup> and a lot of other authors, has confirmed the role of Böhler's angle value as a predictive factor for long term complications. The studies done by O'Farrell *et al.*<sup>[25]</sup>, Buckley *et al.*<sup>[28]</sup>, Ibrahim *et al.*<sup>[29]</sup> and Thordarson *et al.*<sup>[9]</sup> shows that soft tissue complications are more in operated

cases and other complications like varus mal-union, subtalar joint stiffness are more in conservatively managed cases.

All the above observations are comparable with our study.

## Conclusion

Operative management in calcaneal fractures gives a better functional outcome, even without bone grafts, manifested by achieving anatomical reconstruction of height, width, Bohler's and Gissane's angles of the calcaneum, and enabling early mobilization as compared to conservative management. However larger study with a longer time period is needed for proper evaluation.

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