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Operative versus non operative treatment for displaced intra articular fracture of calcaneus: A prospective study 58 patients

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Abstract
Background: Calcaneus fractures are the most common tarsal bone fractures, and displaced intra articular fractures account for 60% to &75% of all calcaneal fractures. Fractures of the calcaneus remain among the most challenging for the orthopedic surgeon to manage effectively as these injuries are more destructing and devastating. The management dilemma is still going on regarding conservative or operative treatment for such fractures as there is no clear evidence to delineate the gold standard treatment method, which is superior in every aspect.
Material and Method: We have done a prospective study of 58 patients (2 had bilateral fracture) with displaced intra-articular calcaneus fracture after applying strict inclusion and exclusion criteria. We have randomly allocated patients into operative (A, n-30) and non-operative groups (B, n-30). We compared the clinical, functional and radiological outcomes of both groups.
Results: The mean age in the operative group is 34.7 years and in the non-operative group is 36.03 years. The average follow-up is 12.4 months and the average time of union was 10.1 weeks in the operative group, while in a non-operative group it is 11.03 month and 10.6 weeks, respectively. The mean AOFAS score at the final follow up of the operative group is 84.2 and in the other group it is 79.4. Total of 8(39%) patients undergoing operative management have an excellent result, 15(50%) have good results,3(10%) have fair and 4(1%) have poor results as compared to the other group 4 (13%), 9 (30%), 8(27%), 9(30%) respectively.
Conclusion: Operative management has a better radiological, clinical and functional score in comparison with conservatively managed patients of displaced intra articular calcaneal fracture. However, operative management is also associated with an increased number of surgery-related complications like long hospital stay, cost effectiveness, local wound healing problems, superficial and deep infection, implant related problems as compared to another group.

Keywords: Displaced intra articular calcaneus fracture, plate osteosynthesis, conservative method, AOFAS score

Introduction
Calcaneus fractures are the most common of tarsal bone fractures and account for approximately 2% of all fractures [1]. Displaced intra-articular fractures represent 60% to 75% of all calcaneus fractures [2]. The Industrial Revolution and the advent of the High Velocity Transportation lead to an increase number of incidences of falls from height and motor vehicle accidents and it remains the most common causes of calcaneus fractures at present. Even though an isolated fracture of the calcaneus is not a life-threatening injury, the associated functional disability is significant and people have often been even crippled due to severely deformed heels. Several studies have shown that patients may be totally incapacitated for up to 3 years and at least partially impaired for up to 5 years after injury [3]. It has been said "the man who breaks his heel bone is done, so far as his industrial future is concerned" [4].
Fractures of the calcaneus remain among the most challenging for the orthopedic surgeon to manage effectively. Böhler, who provided an analysis of the patho-anatomic features of calcaneus fractures that is still relevant today, changed his treatment regimen no less than 12 times over a course of 30 years [5, 6]. Conn in 1935, described calcaneus fractures as "Serious and disabling injuries in which the end Results are incredibly bad," [7] Calcaneus bone is a largest cancellous foot bone and its structure is like an egg outer thin shell covering inner soft bone.

These injuries are more destructing and devastating usually occurs as a result of high energy trauma causing major displacement, depression, deformity, the collapse of its fracture fragments and also articular surfaces involving subtalar joint mainly. Restoration of normal anatomy of bone mainly articular congruity, calcaneus height, width and alignment is a mammoth task for an orthopedic surgeon to accomplish.

In early days, the surgeon used to treat these fractures conservatively due a to lack of understanding of fracture geometry and also the absence of effective fracture techniques and implants. Conservative care includes rest, elevation, cold compression and below knee calcaneus splints. It causes a union of fracture fragment in a same displaced position leading to decreased fracture pain and early mobilization, but In the long term, the fractured calcaneus remains displaced, joints mainly the subtalar joint in particular may be severely disrupted and the overall heel remained deformed leading to early subtalar arthritis which is a main cause of residual persistent pain and poor functional outcome. Most patients had a painful, stiff, deformed foot and unable to wear a normal shoe causing painful walking and may need an assistance [8]. The development of various radiological diagnostic modalities like CT scan, 3-Dimension CT imaging helped surgeon to understand fracture geometry to do better pre-operative planning. Also the advent of various surgical techniques and fixation implants improved better restoration of anatomical parameters of fractured calcaneus like calcaneus height, width, Bohler's angle, Gissane angle and alignment [9]. Various approaches like conventional lateral approach, minimally invasive subtalar approach, medial approach and combination of multiple approaches had been developed to access fracture fragment and put proper implant for fracture fixation. Various anatomical plates and screws have been designed to maintain anatomical reduction and provide rigid fixation of fracture fragments. But still operative treatment can increase risk of complications like skin necrosis, problems in wound healing, infection, hardware Prominence which compromise overall clinical outcome.

The current situation is one of uncertainty. Many systematic reviews and randomized control trials have been done to draw a final conclusion regarding the best treatment method to provide optimum results [10, 11, 12]. All these studies have shown that operative treatment provide better anatomical restoration of articular fragments and hence leading to better functional as well as a clinical outcome, but these operative techniques are associated with an increased number of complications as compared to conservative management. The management dilemma is still going on as there is no clear evidence to delineate the gold standard treatment method, which is superior in every aspect. The surgeon has to evaluate Risk- Benefit Ratio before applying any treatment strategy to these patients at present. We performed a prospective study of 60 patients having displaced intra-articular calcaneus fracture in which 30 were treated conservatively and 30 were treated operatively by various techniques and we compared radiological, clinical and functional outcome using the AOFAS (American orthopedic foot and ankle society) score.

Materials and methods

We have done a prospective study of 58 patients of displaced intra-articular calcaneus fracture at Gujarat Adani Medical Institute of Medical Sciences, Bhuj, Gujarat from October 2018 to April 2020. Institutional Ethical Committee approval was taken prior to commencement of study. Informed and written consent have been taken of all patients to be included in the study. Total 58 patients (2 had bilateral fracture); 60 calcaneus fractures were included in the study. We have randomly allocated patients in the operative (A, n-30) and non-operative group (B, n-30). All the patients were selected after strict application of inclusion and exclusion criteria.

Inclusion criteria

- Skeletally mature patients.
- All closed displaced intra-articular calcaneal fractures, with >2 mm intra-articular step.
- Sander's type II, III and IV fractures.

Exclusion criteria

- Patients with congenital deformities.
- Pathological fractures.
- Open fractures or severe soft tissue compromise includes massive blistering, severe oedema, large local abrasions, previous dermatological local lesions.
- Re-fracture or previous hind foot surgeries or associated other Tarsal bone fractures.

All injuries were attended to immediately. Proper general and systematic examination was done and patients were stabilized hemodynamically. Patients were investigated for routine blood investigations like CBC, Renal and Liver Function Tests, Electrolytes and Viral Markers. Lateral and Axial radiographs of the calcaneus and also routine trauma series of X-rays were taken if indicated. Calcaneus fracture is immobilized with below knee slab and kept on Bohler frame. After Confirmation of intra-articular calcaneus fracture, a CT scan with 3-Dimension Image reconstruction were done of all calcaneus fracture. All the patients were then randomly allocated to the operative (A) and non-operative (B) group. Patients undergoing non operative management were initially treated with a RICE (Rest, Ice, `Compression, Elevation) regime followed by a supportive splint in form of below knee slab. After the swelling subsided, a below knee calcaneus cast was a applied after doing some reduction maneuver in form of traction, medio-lateral compression and manual heel deformity correction. Ankle was locked in neutral flexion to avoid equinus contracture. Cast was removed after 6 weeks and signs of radiological union were assessed. Early subtalar, ankle and toes range of motion exercises were initiated after removal of cast. Non weight bearing restrictions were maintained for approximately 10-12 weeks, until radiographic union was confirmed. Partial and full weight bearing was commenced at an average 12^{th} and 16^{th} weeks respectively. Patients were advised to wear soft soled light weight footwear that covers the whole foot like sports shoe and also advised to avoid walking bare foot and over uneven surfaces initially.

Patients undergoing operative management were initially treated with RICE (Rest, Ice, Compression, Elevation) regime same as previous group followed by a supportive splint in form of below knee slab. We usually wait till significant decrease in swelling and appearance of wrinkle sign over local part before going surgery. Depending upon fracture geometry patients were operated by Open Reduction and Internal Fixation by plating osteosynthesis using standard lateral approach or minimal invasive technique through subtalar approach according to fracture geometry. Patients were kept immobilized for 6 weeks postoperatively with below knee splint and non-weight bearing for around 10-12 weeks till fracture unites. All patients were followed up regularly on 1, 2, 3, 6 and 12 months for radiological, clinical

and functional assessment. American orthopedic foot and ankle society (AOFAS) score was used for functional and clinical assessment which includes pain, function and alignment. This score includes pain, function and alignment evaluation and allows a maximum of total 100 points, with higher scores indicating better outcomes.

Results

We did comparison of outcome of 60 calcaneus fractures treated by various methods.in which 30 were treated Operatively (Group A) by conventional open reduction and internal fixation by calcaneus plate (18 patients) or minimally invasive method(12 patients) and 30 by non-operative management(Group B).The age distribution range in the 58 patients is from 17 years to 58 years. The mean age in operative group is 34.7 years and in non-operative group is 36.03 year. There are 50 (87%) male patients and only 8 (13%) female patients in our study. Fall from height in 44(74%) cases and road traffic accidents in 9(16%) cases remain common mode of injury in our study also.

Patients are randomly distributed in our study in both group irrespective fracture geometry. Displaced intra-articular calcaneus fracture is classified according to Sander's Classification (CT based). Operative group have total 10(33%) patients of Sanders´ type 2, 15(50%) patients of Sanders' type 3 and 5 (17%) patients of Sanders' type 4, While Non-Operative group have total 10(33%) patients of Sanders´ type 2, 5(17%) patients of Sanders' type 3 and 15 (33%) patients of Sanders' type 4. The average injury-surgery interval is 4.1 day in our study. Mean operative time in plate fixation was 122.3 min while in minimally invasive sub-talar approach with screw fixation was 69.1 min. Average follow-up is 12.4 months and average time of union was 10.1 weeks in operative group. At final follow-up, average Bohler's angle is 21.06° and average Gissane angle is 134.96° in operative group. In AOFAS Score, three component including pain, function and alignment are to be assessed. Total 4 patients undergoing plate osteosynthesis have excellent results, 4 have good results (25%), 2 have fair (12.5%) and 2 have poor results (12.5%) while total 4 patients undergoing surgery by minimally invasive method have excellent result (27%),11 have good results (61%),1 have fair (5.5%) and 2 have poor results(11%). The mean AOFAS score at final follow up of operative methods is 84.2. In our study, Total 12 patients are operated by plate osteosynthesis out of which 2 patients had superficial infection (16.66%) and wound healing problem which was treated by regular dressing and antibiotics, one had deep infection (8.3%) which required debridement and implant removal. Total 3 patients have persistent pain (25%) and reduced ankle and subtalar motion at the end of final follow up. On the other end, total 18 are treated by minimally invasive procedure in which one patient presented with implant loosening and 3 patients had persistent pain (16.6%) at final follow up.

A total of 30 cases treated in the form of conservative management has been studied. Average follow-up time is 11.03 month and mea time of union is 10.6 weeks in non-operative group. Excellent results were seen in 4 patients (13%), good results in 9 patients (30%), fair results in 8 patients (27%) and poor results in 9 patients (30%). The mean AOFAS score at final follow up is 79.4.Total 12 out of 30 patients treated conservatively had persistent pain at the end of final follow up out of which 4 patients had developed early sub talar arthritic changes in x-ray at final follow up. Heel widening and progressive varus deformity at heel was seen in 5 patients.

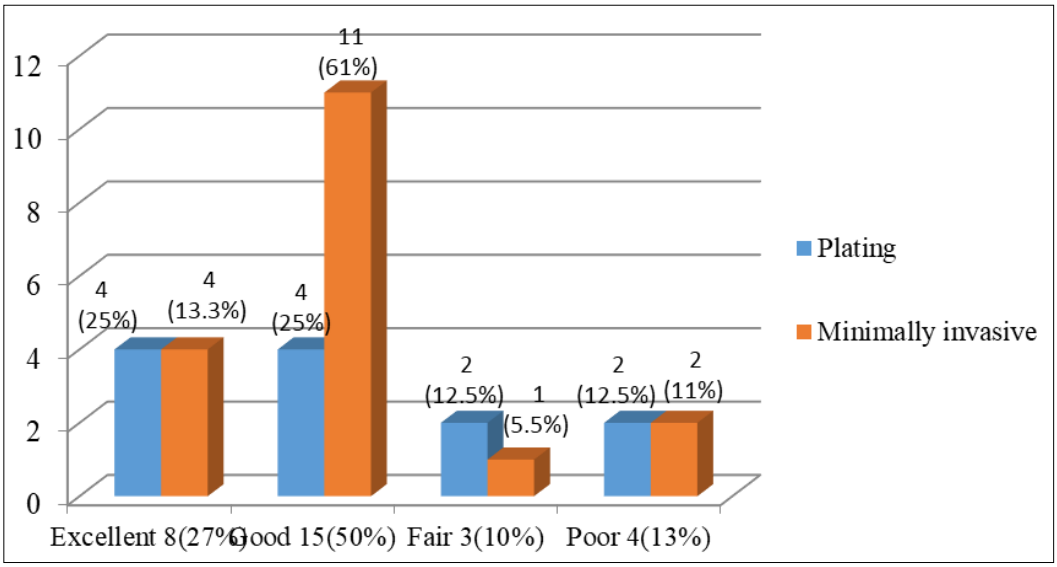

Chart 1: Functional Outcome of Operative Methods

Discussion

In our study, we have compared clinical, functional and radiological outcomes between operative(n=30) and non-operative group(n=30).Mean Bohler's angle for operative group was 21.06° with standard deviation of 3.1 and for non-operative group 17.5° with standard deviation of 3.002. P value for Bohler's angle is 0.0012 which is significant. Mean Gissane angle for operative group was 134.96 with standard deviation of 7.08 and for non-operative group 140.2 with standard deviation of 6.64.P value for Gissane angle was 0.0015 which was significant. Our study has shown that operative technique is superior in terms of restoration of radiological parameters as compared to non-operative technique. Restoration of articular surfaces is important for prevention of early subtalar arthritis and persistent post injury pain as shown in our result, only 6 patients was having persistent pain in operative group as compared to 12 patients in conservative group at the end of final follow up.

Mean radiological union for operative management was 10.1 weeks with standard deviation of 2.13 and for non-operative

group was 10.6 weeks with standard deviation of 2.38.P value for radiological union was 0.33. The P value is >0.05 which showed that lower value for radiological union obtained in operative method compared to conservative is not significant. Any of these treatment methods having no impact on bony union timing. Non union was not seen in any patients of both groups. Mean AOFAS score for operative management was 84.2 with standard deviation of 7.75 and for non-operative group was 79.4 with standard deviation of 9.04. P value for AOFAS score was 0.0162 which is significant. At the end of final follow up, Operative management had shown decreased incidence of postoperative prolonged heel pain. Patients undergoing operative management with any of methods had less incidence of limitation of activity, gait abnormality, walking problems on uneven surfaces. Ankle, hind foot motions and ankle-hindfoot stability were more preserved in operative group. Good plantigrade alignment of foot was achieved in operative group that leads to less incidence of peroneal tendon impingement and shoe wear related problems. Thus, operative management has shown overall better clinical as well as functional outcome as compared to non-operative management.

Early subtalar arthritis and persistent pain were the most common complications associated with non-operative group. Also many patients had progressive heel widening, varus deformity, peroneal tendon impingement, shoe wearing problems and gait abnormality. However, in operative group, surgery related complications are more like superficial and deep infection, local wound healing problems and implant loosening as compared to arthritis and persistent pain.

Table 1: Comparison of radiological and clinical parameters of both groups

Parameters	n-Number	Mean	Standard deviation	P value	Significance
1. Radiological parameter					
a) Bohler's angle					
Operative	30	21.06°	3.10°	0.0012	Significant
Nonoperative	30	17.5°	3.002°		
b) Gissane angle					
Operative	30	134.9°	7.08°	0.0015	Significant
Non operative	30	140.2°	6.64°		
c)Radiological union (weeks)					
Operative	30	10.1	2.13	0.33	Non significant
Nonoperative	30	10.6	2.38		
2. Clinical parameter					
a) AOFAS score					
Operative	30	84.2	7.75	0.016	Significant
Non operative	30	79.4	9.04		

We have compared our study with various similar studies of comparing outcome of operative vs non operative management of calcaneus fracture. Ibrahim *et al*. [11], conducted randomized controlled study involving total 26 displaced intra-articular Calcaneal fractures of which, 15 were managed operatively and 11 were managed non-operatively. Both groups were evaluated and compared after 15 year of follow-up using FFI(foot function index), Calcaneal height, Bohler's angle, OA grade and AOFAS score They concluded that both-operative and non-operative groups shows similar outcome and there is no correlation of Bohler's angle with functional outcome. But our study has shown that operative management is better in term of restoring radiological parameters and hence having better clinical outcomes compared to other group at the end of 1 year follow up. In 2013, Agren *et al*. [13], conducted prospective, randomized trial involving total 82 displaced intra-articular calcaneal fractures of which,42 were managed operatively and 40 were managed non operatively. Both groups were evaluated and compared after 1 year and 8-12 year of follow-up using VAS,SF-36, OM scale and AOFAS score They concluded that both-operative and non-operative groups shows similar outcome at 1 year follow-up but operative group showed better outcome than non- operative group at 8-12 years follow-up same as in our study. However operative treatment was associated with higher risk of surgical complication but reduced the prevalence of persistent pain as compared to non-operative group.

Our study has many limitations like small sample size, selection bias of patient, short duration of follow up. Long term follow up and large sample size are required to draw better conclusion for revealing differences in consequences between management methods. There was no difference in severity of intra-articular calcaneal fracture between conservative and operative patients according to Sanders' Classification. Also ours being a general institute, different surgeons with different level of skill and experience have operated these patients which would again affect final outcome.

Conclusion

Operative management has a better clinical and functional score in comparison with conservatively managed patients of displaced intra articular calcaneal fracture. Though there is no significant difference in radiological union time between both groups, operative method is better in term of restoration and maintenance of normal radiological parameters causing less incidence of subtalar arthritis and persistent post injury pain. However, operative management is also associated with increased number of surgery related complications like long hospital stay, cost effectiveness, local wound healing problems, superficial and deep infection, implant related problems as compared to other group. Hence, Operative group has overall superior outcome compared to conservative group in short term.

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