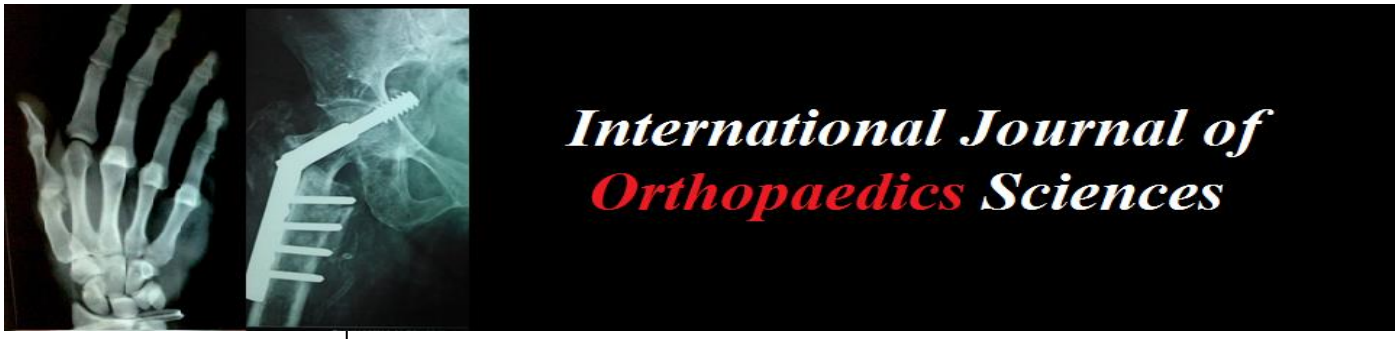

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Outcome of conservative and surgical management of displaced intra-articular calcaneal fractures: Original article

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Abstract
Introduction: A calcaneal fracture is a break of the calcaneus. Symptoms may include pain, bruising, trouble walking, and deformity of the heel. It may be associated with breaks of the hip or back. It usually occurs when a person lands on their feet following a fall from a height or during a motor vehicle collision. Diagnosis is suspected based on symptoms and confirmed by X-rays or CT scan. If the bones remain normally aligned treatment may be by casting without weight bearing for around eight weeks. If the bones are not properly aligned surgery is generally required.
Materials and Methods: This is a prospective study of 20 cases of displaced intra-articular calcaneal fractures managed both surgically and conservatively. Patients were selected according to inclusion and exclusion criteria mentioned below.10 patients were treated surgically and 10 patients who were not willing for surgery were treated conservatively after taking proper consent.
Results: The mean age was 26.5 years (10-49), 40% of the cases were in the age group of 20-29 in conservative whereas surgical cases constitutes of 43% (20-29) with the mean age of 26.88. Mode of injury was fall from height in 100% of cases in conservative whereas in surgical 90% cases are in fall from height and rest 10% can be seen in road traffic accident. In conservative 20% of results were excellent, 70% were good and 10% of the cases were fair. Whereas in surgical 60% of the cases were excellent and 40% were good. Occupational rehabilitation to the patient's pre injury state was achieved in 60% of cases in conservative and 90% of cases in surgical.
Conclusion: Intra articular calcaneal fractures are better managed surgically compared to conservative management by understanding the fracture anatomy and restoration of Bohler's angle and angle of Gissane. Delayed surgical intervention had better results than early intervention for surgery.

Keywords: Calcaneus, intra-articular fracture, bohler's angle, angle of gissane, k-wire

Introduction
Fractures of the calcaneus make up about 2% of all fractures and are the commonest fracture of the tarsal bones. Serious injury usually occurs after a fall from a height, often from scaffolding or a ladder, or as a result of a road traffic incident. The incidence is even higher in developing countries [1]. Intra articular fractures account for approximately 75% of calcaneal fractures and historically have been associated with poor functional outcome [2]. Despite many authors' attempts to define an algorithm for the management of displaced, intra-articular calcaneal fractures, it remains a controversy with strong arguments supporting both conservative & operative managements [3, 4]. Recent studies are of varied opinion; some evidences citing no difference between the two & others suggesting operative management to be a better option [5]. 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. 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 [6]. 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 [7]. Despite these improvements, it is recognized that operative

treatment still requires an experienced surgeon and that complications may be inevitable. There are only a few studies on this topic making it hard to choose one over the other. We expect this study to be of some use in outlining the outcomes of both conservative and surgical management of intra articular fractures of the calcaneum. This study would also be of use to test whether; the recent advances in fracture management, better understanding of fracture patterns, better perioperative antibiotic use, rigid fixation and early mobilization has any positive effect on the operative outcomes of calcaneal fractures.

Aim of the study

To study the outcome of conservative and surgical management of displaced intra-articular calcaneal fractures.

Materials and Methods

This is a prospective study of 20 cases of displaced intra-articular calcaneal fractures managed both surgically and conservatively between June 2015 and January 2018 in department of Orthopaedics at Nizam's Institute of Medical Sciences. Patients were selected according to inclusion and exclusion criteria mentioned below.10 patients were treated surgically and 10 patients who were not willing for surgery were treated conservatively after taking proper consent from them by explaining the complications involved. Antero-posterior, lateral and Harris view radiographs of foot and in addition X- rays of spine and pelvis were also done to rule out associated injuries. CT scan of foot with 3D reconstruction was done for all cases. Bohler's angle and angle of Gissane were measured on lateral radiograph. Fracture classification was done based on lateral ankle radiograph and CT scan. Anthropometric data, co-morbidities, type of fracture, neuro-vascular status, associated injuries, surgical approach, fixation method used, complications, hospital stay and outcome were recorded. Post-operative examination after two weeks, one month, three months, six months and one year were recorded. The questionnaire was completed just after 6 months of injury. Functional outcome isnmeasured by American Orthopedic Foot and Ankle Society Score (AOFAS) [8, 9] and Maryland foot score [10].

Inclusion criteria-Patients with closed displaced intra-articular calcaneal fractures of Sanders type 2, 3, 4 and Age group >18 years.

Exclusion criteria-Open fractures, Pathological fractures, fracture in children, fracture in adults > 55 years, calcaneal fractures with other associated fractures in the lower limb, grossly comminuted fractures, severely osteoporotic bones, patients who did not give consent for participation in this study, patients with uncontrolled hypertension and diabetes, preganacy and patients with chronic and local infections.

On admission, vitals of the all patients were assessed and examination was done for any associated injury. All patients were evaluated radiologically with Antero-posterior (AP), lateral and axial views of the involved calcaneum and in addition radiographs of spine and pelvis were also done to rule out associated injuries. CT scan was done in patients with suspected intra articular fractures. Patients were given strict limb elevation and below knee slab to reduce edema. Pre-operatively Bohler's and Gissane angle were measured in all patients. All the fractures of calcaneum were classified according to Essex-Lopresti a n d Sanders classification. Pre-operatively all patients were administered with broad spectrum antibiotics six hour before surgery. Surgical approach used for open reduction was a modified Kocher, extensile lateral approach to calcaneum, described by Fernandez. Various types of locking and non-locking calcaneum plates in the form of simple reconstruction plate, Y' reconstruction plate and anatomical calcaneal plates were used for fixation with iliac crest bone grafting. Intra operative assessment of reduction of the sub-talar joint was done under vision and using fluoroscopy.

Post operatively all patients were given strict limb elevation. Intravenous antibiotics were given for five days. Suture removal was done after 12 to 15 days. All patients were allowed and encouraged ankle mobilization after edema subsided.

Regular follow ups were done at 4weeks, 8weeks, 12 weeks, 16 weeks, 6 months and 1year post operatively. Patients were discharged from follow up in cases with satisfactory outcomes, the rest were followed up further at an interval of 3 months. Detailed surgical site examination, subjective feeling, physical findings, radiological evaluation, functional scoring was done at each follow up. Radiological evaluation for restoration of Bohler's and angle of Gissane was done. All patients were allowed partial weight bearing at 12 weeks after of surgery. Progression to full weight bearing was allowed as and when tolerated by the patient. Functional outcome was assessed with American Orthopedic Foot and Ankle Society Score (AOFAS) and Maryland foot score [8, 9, 10].

Results

The mean age was 26.5 years (10-49), 40% of the cases were in the age group of 20-29 in conservative whereas surgical cases constitutes of 43% (20-29) with the mean age of 26.88. 40% of the cases were between the age group 20-29 years in conservative and 43% of cases were between 20- 29 years in surgical. Mode of injury was fall from height in 100% of cases in conservative whereas in surgical 90% cases are in fall from height and rest 10% can be seen in road traffic accident.

The side of affection in conservative was quite high in right foot being affected in 80% and the left foot in 20% whereas in surgical the right and left foot being affected by 40% and 60% each respectively. Nine (9) cases 90% were of joint depression type based on Essex Lopresti classification in conservative group, where as in surgical 7 (70%) of the cases were joint depression type and 3 (30%) were tongue type.

The average pre-operative Bohler's angle was recorded to be 6.5^0, Whereas that measured post operatively averaged at 30^0 in surgical, and in conservative the angle was recorded at 9.5^0. The crucial angle of Gissane also was seen to be corrected from an average of 134.3^0 pre operatively to 126.3^0 post operatively and in conservative group it was recorded at an average of 135.9^0. Based on Sanders classification in conservative group 40% of cases belonged to type 2, two part displaced fracture of the posterior facet and 50% were of type 3, three part displaced fracture of the posterior facet whereas in surgical 30% of cases belonged to type 2, 50% were belonged to type 3 and 20% were of type 4.

The average delay in surgery from the day of injury was 10.5 days. In conservative 20% of results were excellent, 70% were good and 10% of the cases were fair. Whereas in surgical 60% of the cases were excellent and 40% were good. Occupational rehabilitation to the patient's pre injury state was achieved in 60% of cases in conservative and 90% of cases in surgical.

Our complications and their rates corresponded to previously performed studies, with the incidence of wound necrosis and dehiscence seen in 2 (20%) cases, deep infection in 1 (10%) case and persistent subtalar pain in 1 (10%) of the cases in

surgically managed cases and persistent subtalar pain in 6(60%) of the cases in conservatively managed cases.

Table 1: Age group percentages

S. No	Age group (Years)	Conservative		Surgical	
		Number of Cases	Percentage	Number of Cases	Percentage
1	10-19	3	30 %	5	24 %
2	20-29	4	40 %	9	43 %
3	30-39	1	10 %	4	19 %
4	40-49	2	20 %	3	14 %

Table 2: Sex indices

S. No	Sex	Conservative		Surgical	
		Number of Cases	Percentage	Number of Cases	Percentage
1	Men	9	90 %	10	100 %
2	Women	1	10%	00	00 %

Table 3: Mode of injury

S. No	Type of Injury	Conservative		Surgical	
		Number of Cases	Percentage	Number of Cases	Percentage
1	Road Traffic Accident (RTA)	00	00 %	1	10 %
2	Fall From Height	10	100%	9	90 %

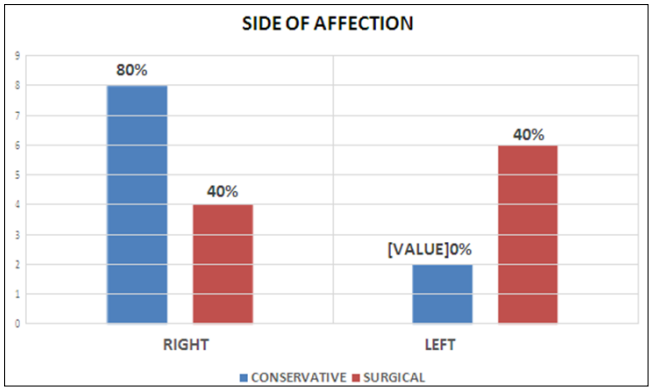

Chart 1: Side of affection chart

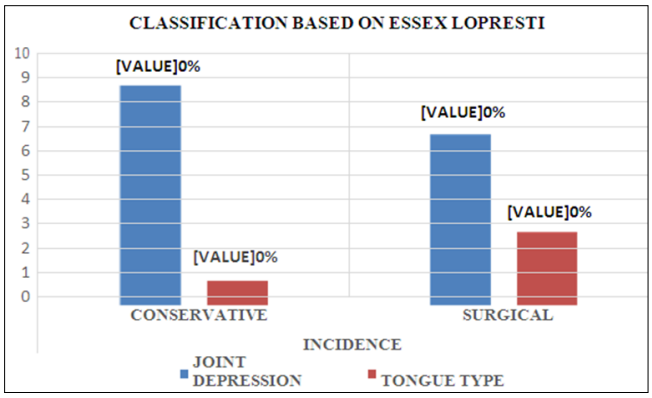

Chart 2: Essex lopresti chart of conservative and surgical

Table 4: Bohler's Angle

S. No	Type of Angle	Surgical pre-OP post-OP		Conservative
1	<0	2	0	0
2	0-9	5	0	5
3	10-19	3	0	5
4	20-40	0	10	0

Table 5: Critical Angle of Grissane

S. No	Type of Angle	Surgical pre-OP post-OP		Conservative
1	<130	5	7	4
2	130-145	2	3	3
3	>145	3	0	3

Table 6: Sanders Classification

S. No	Sanders Classification	Conservative		Surgical	
		Number of Cases	Percentage	Number of Cases	Percentage
1	2A	2	20 %	1	10 %
2	2B	1	10 %	1	10 %
3	2C	1	10 %	1	10 %
4	3AB	2	20 %	2	20 %
5	3AC	1	10 %	2	20 %
6	3BC	2	20 %	1	10 %
7	TYPE IV	1	10 %	2	20 %

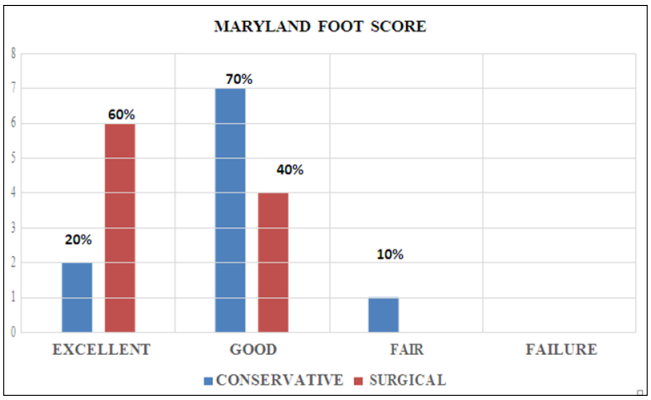

Chart 3: Maryland foot score chart of conservative and surgical chart 4: A of as chart of conservative and surgical

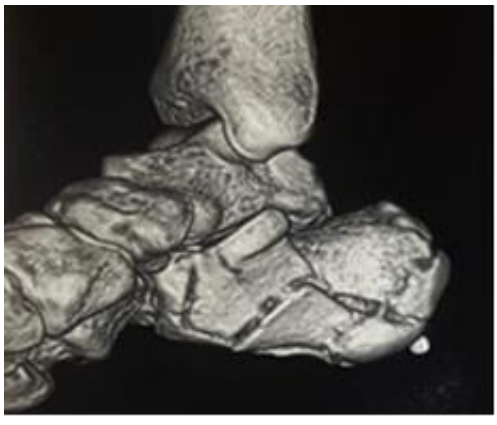

Fig 1: CT Image showing tongue type fracture of calcaneum.

Fig 2: Radiograph showing fixation of calcaneum fracture with plates; reduced Bohler angle and angle of Gissane

Fig 3: CT Images showing depressed fracture of calcaneum

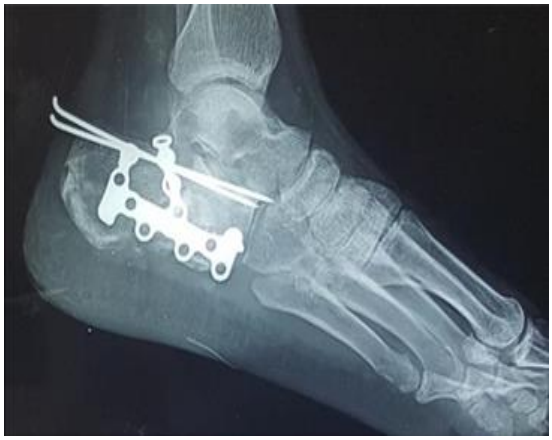

Fig 4: Radiograph showing fixation of the fracture with plates and K-Wire.

Fig 5: Clinical image showing wound dehiscence

Fig 6: Post-operative clinical image demonstrating dorsifexion.

Fig 7: Post-operative clinical image demonstrating plantarflexion.

Fig 8: Post-operative clinical image demonstrating Inversion.

Discussion

Among the tarsal bones, calcaneum is the most commonly fractured bone. It accounts for 2% of all fractures and 60-75 % of these fractures are displaced, intra-articular. Calcaneal fractures result in loss of height, varus deformity, and heel widening and subtalar joint incongruity. The results for an extra articular fracture are good with a good prognosis while that for intra articular fractures are varied. There is controversy with every aspect of management of intra-articular fractures. Though there are different classifications for intra articular calcaneal fractures, there is no consensus as which is the most practical one among them. Although some studies with more than 100 cases have demonstrated good results after open reduction and internal fixation of intra-articular calcaneal fractures, the best choice of treatment

remains controversial because prospective randomized studies have notshown convincingly better results after surgery [7, 11]. However, in the largest prospective randomized trail done till date, Buckley *et al.* found better results in some subgroups of patients after surgery [12]. Also it is difficult to compare between different studies as, different measures of outcome are used in different studies and there is no consensus as to which is the most reliable outcome measure. Essex- Lopresti and Sanders are commonly used classification system and these show a positive correlation with outcomes but there is no correlation with the choice of treatment [13, 14, 15].

In the present study, Essex Lopresti classification based on radiographs and Sanders classification based on CT scans have been used. Cohort studies done previously, have shown similar results with operative and non-operative treatment of displaced intra articular calcaneal fractures [12, 16, 17]. While some of the more recent studies show no advantage of operative management, others have shown superior results with operative treatment [3, 7, 11, 18, 19, 20, 21, 22, 23]. Earlier operative treatment was considered to be associated with wound complications and sepsis, however, non-operative treatment is not devoid of complications like subtalar joint pain, heel varus and personal tendon impingement.

We believe that like the principles followed for any other weight bearing joints, intra-articular calcaneal fractures should also be treated on the same lines, that is, anatomical reduction and rigid internal fixation to allow early movement and get a better functional outcome [24]. Application of these principles to intra articular calcaneal fractures have been slow because of complex bony and fracture anatomy, tenuous soft tissue envelope and difficulty of achieving anatomic reduction and rigid fixation [25]. Improvements that have occurred in surgical techniques, better understanding of the fracture anatomy, better radiographic assistance and improvement in antibiotics have encouraged surgeons to operate more on these fractures without the fear of complications associated with surgical management.

Calcaneal fractures can be approached medially, laterally or by using a combined approach. The lateral approach is the most popular approach as it provides a good exposure of the fracture and the subtalar and calcaneocuboid joints. It is also devoid of the major neurovascular bundles of the foot. It allows stabilizing the fracture with internal fixation and allowing early mobilization. A lateral extensile approach was used in all cases in this study. Various implants like the pelvic reconstruction plates, calcaneal plates, K wires and a combination of K wires and screws can be used for fixation [24, 25, 26, 27]. In our study, anatomical locking and non-locking calcaneal plates were used and fixed with corresponding screws; ipsilateral iliac crest bone graft was used in all cases to prevent collapse and to maintain the height of calcaneum.

In this study, restoration of Bohler‘s and crucial angle of Gissane was associated with a satisfactory functional outcome in surgically managed cases where in restoration of angles were not seen in conservatively managed cases. This fact, proved and verified by a lot of other authors, confirms the role of Bohler‘s angle and Gissane‘s angle as predictive factor for development of late complications.

As said earlier, there are various scoring systems for assessment of functional outcomes. As proven by studies, MFS and AOFAS were used in this study and are considered to be standard and reliable scoring system for foot function evaluation.

Table 7: Comparitive Study of Maryland Foot Score Results

Study	Maryland foot score results			
	Excellent	Good	Fair	Poor
Fouad *et al.* [28]	57.1%	35.7%	-	-
B Magnan *et al.* [29]	48.1%	42.6%	3.7%	-
Our study (Surgical)	60%	40%	-	-
Our study(Conservative)	20%	70%	10 %	-

As it is known, 90% of calcaneal fractures occur in men between the age group 21 and 45 most of whom are industrial workers thus causing substantial economic implications [22]. This study is in correlation with the studies done bu Fouad *et al.* and B magnan *et al.* [28, 29]. The commonest mode of injury in this study was fall from height (90% in surgical and 100 % in conservative) which is in correlation with the studies done by fouad *et al.* (84%) and Zeman *et al.* (93 %) [28, 30]. In this study, the complications such as wound dehiscence, deep infections and subtalar pain was little more when compared to the other studies done by Buckley *et al.* and Zeman *et al.* [12, 30]. It has been stated that surgery should be delayed until the skin wrinkles on the lateral aspect of the heel reappear on dorsiflexion and eversion, indicating subsidence of edema. The average time delay from injury to surgery in our study was 10.5 days.

It is a proven fact that poorest outcomes are consistently seen in patients who were treated operatively without restoration of Bohler‘s angle. The pre and post operative measures of Bohler‘s angles in our study were restored and are in close correlation with the other studies done by B Magnan *et al.* and V Cherry *et al.* [29, 31].

Conclusion

Intra articular calcaneal fractures are better managed surgically compared to conservative management by understanding the fracture anatomy and restoration of Bohler‘s angle and angle of Gissane. Delayed surgical intervention had better results than early intervention for surgery.

Limitations of the Study

Limitations of our study are less number of patients in both surgical group and conservative group with short term follow-up. More studies can be done involving large sample size and for longer duration.

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