



Clinical, Radiological And Functional Outcomes Of Surgically Treated Calcaneal Fractures: A Prospective Observational Study

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Abstract

Introduction:

The most frequently fractured bone of the foot is the calcaneum. Calcaneal fractures most common in young active male and industrial workers. The controversy between the operative and nonoperative interventions remains ongoing subsequent analysis and other related Publications has pushed the pendulum towards the surgical option. In our study we have tried to assess the clinical, functional and radiological outcome treated either with locking compression plate or non-locking compression plate in intraarticular calcaneal fractures

Materials and methods:

This were a prospective observational study conducted in the department of orthopaedics, Sri Ramachandra Medical College& hospital. The study was conducted from July 2022 to Jan 2023 and 35 patients with displaced intra-articular calcaneal fractures were included based on the inclusion and the exclusion criteria.

Results and conclusion:

Our study concluded that Open reduction Internal fixation remains the gold standard treatment for displaced fractures of the calcaneum, since it restores the congruity of the subtalar joint and restores the normal anatomy of the bone.

Keywords: Calcaneum, Open reduction Internal fixation

Introduction

The calcaneum or Os Calcis is a unique bone, with a unique mechanism of fracture. The most frequently fractured bone of the foot is the calcaneum. Calcaneal fractures most common in young active male and industrial workers. Most of these persons unfortunately are the sole earning members of the family. Hence this results in more financial burden apart for the significant morbidity for the patient. The burden to the society is significant with the socioeconomic impact being substantial in the terms of days away from work and recreation.

The advent of advanced imaging modalities that kindled desire of restoring the distorted anatomy of this bone. The operative treatment of calcaneal fractures includes Percutaneous k-wire, Percutaneous screw, Nonlocking compression plate and Locking compression plate. The controversy between the operative and nonoperative interventions remains ongoing subsequent analysis and other related Publications has pushed the pendulum towards the surgical option.

In our study we have tried to assess the clinical, functional and radiological outcome treated either with locking compression plate and non-locking compression plate in the treatment of intra-articular calcaneal fractures admitted during the period from July 2022 to Jan 2023 at Sri Ramachandra Medical College & hospital, Chennai

Materials and Methods

In our institution 35 patients with displaced intra-articular calcaneal fractures were selected for my prospective study. The study period is from July 2022 to Jan 2023. Out of these patients 25 fractures occurred in men and 10 fractures occurred in women.

15 patients were treated with Locking Compression Plate and 10 patients were treated with Percutaneous Cancellous Screw Fixation based on fracture patterns.

Mode Of Injury:

Fall from height : 20
Road traffic accidents : 15

Associated Injuries:

Out of 35 patients 2 patients had associated spine injuries without neurological deficit.

The locking compression plate group had 1 case associated with D12 anterior wedge compression fracture without neurological deficit.

Percutaneous Cancellous Screw Fixation group had 1 associated spine injury. (L1 Anterior Wedge Compression fracture) without neurological deficit.

All Intra-articular and Extra-articular calcaneal fractures between the age groups 20 and 60 years presenting within 3 weeks of injury were included in the study.

Undisplaced calcaneal fractures including tuberosity, open fractures, Malunited Fractures Existing subtalar Arthritis, Associated neuropathic foot and Pathological fractures were excluded.

PRE-OPERATIVE assessment was done where in patients were evaluated using the Computerised Tomography (CT) method and classified using SANDERS classification. X-RAYS:

Standard ANTEROPOSTERIOR AND LATERAL VIEWS AXIAL VIEW {HARRIS VIEW} was taken and CT: Axial and coronal views were take

Fig:1.



Fig:2



Antioedema measures were strictly followed to avoid patient's discomfort.

1. Calcaneal Locking compression Plate with locking compression screw (4mm cancellous locking compression screw)
2. Calcaneal nonlocking compression plate with 3.5mm cancellous screw.

3. 4.5mm cannulated cancellous screws
4. Bone grafts like G bone were used in the surgery

All patients were operated within three weeks of injury, ranging from 10-19 days from the time of fracture, if the soft tissue condition was satisfactory. The mean duration was 14 days

Surgery was done in standard radiolucent table with patient in supine position. Spinal anaesthesia was used in all patients

Surgical Techniques included using an extensile lateral approach was used in most of the patients. The land marks are lateral malleolus, calcaneocuboid joint and base of fifth metatarsal. Incision made in a

right angled fashion with the vertical limb started 4 cm above the lateral malleolus between fibula and tendoachilles and extended downwards till the skin colour between the lateral ankle and sole changed. The angle of incision should be obtuse to prevent skin necrosis. The horizontal limb is extended distally up to the calcaneo cuboid joint.

Fig:3



The sural nerve lies approximately 1.5cm anterior to the insertion of Achilles tendon is cautiously retracted and raised along with the flap.

It crosses the line of incision at its proximal and distal part. Retractors should be avoided as it tears the skin from subcutaneous layer, which leads to postoperative skin necrosis.

The flap is retracted by means of two or three k wires placed either over talus, lateral malleolus and cuboid until the subtalar joint and calcaneocuboid is visualized. The peroneal tendons are dissected from the peroneal tubercle and subluxated over the lateral malleolus and held with k wire over lateral malleolus

Reduction was done where in the lateral wall of the calcaneum is elevated with a curved osteotome. The depressed posterior facet lies within the neutral triangle. The articular fragment is elevated by a small periosteal elevator or by an osteotome.

At this stage reduction of the tuberosity is done if in varus angulation. A schanz screw or a 3 mm k wire is passed from the posteroinferior corner of the calcaneal tuberosity. Reduction can be aided by a periosteal elevators or osteotome placed through the void beneath the articular surface and the tuberosity

is pulled plantarward and distracted medially. This corrects the varus angulation and provisionally fixed with axially directed 2.5mm k wires

The posterior facet reduction is done under direct vision. In cases with severe crush injuries the articular surface may be rotated to 90-180 degrees and lies within the void in the neutral triangle, we elevated the fragment using cervical spine inter-body spreader gently and held in position by means of k wires. Intra-operative radiographic assessment of Bohler's and Gissane's angle is done. The reduction of posterior facet results is a large void which is filled with bone graft or bone graft substitutes and impacted. Graft impaction prevents postoperative collapse of the posterior facet. The lateral wall remnant is then placed and the low profile calcaneal plate is placed in position. The plate is secured by 4mm cancellous screws over the anterior process, posterior tuberosity and the thalamic portion which lies beneath the facet. Bending of the plate is not done as the plate is low profile; it contours with placement of screws. We used suction drain in all cases passing through the tip of the vertical limb. The flap is sutured using '0' vicryl from the apex to proximal and distal ends and temporarily clamped and tied in uniform tension. The skin is sutured with

'3'o silk. A compression bandage is applied and tourniquet released. The limb is immobilized in a posterior plaster splint in 90 degrees.

Postoperatively All patients were immobilized with below knee posterior plaster splint and limb elevated. First EOT done on 3 or 4th day under sterile conditions. We maintained operated foot in below knee slab until suture removal which is done at 18th to 21st postoperative days. For patients with serous discharges or signs of delayed wound healing vac dressing (vacuum assisted closure of wound) were

applied which improves faster wound healing. Range of motion exercise were started in patients with satisfactory wound, after suture removal.

Followup was done All patients were regularly followed up once a month for three months, after that three month interval follow-up was maintained. At discharge, end of 3 months,6 month and after one year following x-rays were taken; standard anteroposterior, lateral, and axial views. In all the patients following radiological parameters like the Bohler's angle and Gissane angle were assessed.

Fig:4, One year follow up xray



Results

Our study is a prospective study which includes 35 patients admitted with displaced intra-articular calcaneal fractures. The study period is from July 2022 to Jan 2023. Out of these patients 25 fractures occurred in men and 10 fractures occurred in women. The mean age group of all patients was 38.87years (21-50). The age group above 40 dominates the series accounting for 40% of Cases.

Left calcaneum constitutes 60% and right calcaneum constitutes 40% in the remaining patients. Calcaneal fractures caused by fall from height includes 8 fractures (55%) and by Road Traffic Accident includes 7 fractures (45%) overall. By X-Ray classification 7 patients had joint depression type fracture and 8 patients had tongue type fracture.

Among the fractures, further classified with CT scan according to Sander's classification. Of which

Sanders type 2 was 7 fractures (46.7%), Sander's type 3 was 6 fractures (40%) and Sander's type IV was 2 fractures (13.3%).

The average time from injury to surgery was 14 (range 10-19) days. All patients were either Locking compression plate with Extensile lateral approach or Percutaneous screw fixation.

The mean preoperative Bohler's angle is 15.3 (8-16 degrees) whereas the mean postoperative Bohler's angle at the time of discharge 26.53 degree ,mean Bohler's angle at one month follow up was 26.67 and one year follow up is 26.87(24-32 degrees). Preoperative Gissane's angle averages 146.93 (140-165 degrees) and postoperative Gissane's angle at the time of discharge 136.73 degrees, mean Gissane's angle at one month follow up was 136.27 and one year follow up averages 136.33 degrees (130 -142 degrees). When compared to the preoperative

Bohler's angle and Gissane's angle the postoperative Bohler's angle and Gissane's angle was **maintained** and remains the same on consecutive followup.

The ankle hindfoot score (AOFAS) score at the end of 1 month is **Fair** (56.67), 3 months is **Fair** (72.6), 6 months is **good** (83.73) and 1 year followup is **good** (85.73). All the patients AOFAS score has been **Fair**

on 1 and 3 months followup and its been **Good** and 6 and 12 months followup for all the patients.

In our series the radiological parameters which includes the Bohler's angle, Gissane's angle was paired at varies interval is **statistically significant** P<0.001

Table:1 Baseline Demographics

Baseline Demographics	Study Participants=35	Percentage
Sex		
Male	25	71.4
Female	10	28.6
Age Group		
20 - 30 Years	10	28.5
31 - 40 Years	11	31.4
> 40 Years	14	40.0
Leg Involved		
Right foot	14	40.0
Left foot	21	60.0

Table :2 Pre and Post op surgical evaluation during the study period

Bohler's Angle	Mean	SD
Bohler's angle - Pre op	16.53	7.736
Bohler's angle - Post op	26.53	2.167
1 month Post op	26.67	2.127
3 Months post op	26.60	2.098
6 months post op	26.73	2.251
12 months post op	26.87	2.200
P value#	<0.0001	

Gissane's Angle	Mean	SD
Gissane's angle - Pre op	146.93	7.573
Gissane's angle - Post op	136.73	2.219
1 month post op	136.27	3.305
3 months post op	136.33	3.200
6 months post op	136.07	3.127
12 months post op	136.33	2.820
P value#	<0.0001	
AOFAS Score	Mean	SD
AOFAS SCORE - 1month	56.67	3.519
AOFAS SCORE - 3 months	72.60	4.703
AOFAS SCORE - 6 months	83.73	6.724
AOFAS SCORE - 12 months	85.73	6.584
P value#	<0.0001	

#mANOVA

There is statistical significant difference between preop and postop Bohler's angle with a p value =0.0001 but no significant difference between immediate postop, one month, 3rd month, 6 & 12th month postop Bohler's angle at P >0.05

There is statistically significant difference between pre op and immediate post op gissane's angle with a p value of <0.0001 with no significant difference between Immediate post op, 1 month, 3rd month, 6th and 12th month post op gissane's angle P value >0.05

There is statistical significant difference between one month AOFA score with 3 months, 6 months and 12 months AOFAS score at P < 0.0001

Out of 15 postoperative patients 5 patients encountered delayed wound healing that was treated by VAC (Vacuum Assisted Wound Closure) dressing which was beneficial for early wound healing

Discussion

Management of displaced intraarticular calcaneal fractures (DIACF) remains controversial. Non-operative management may be indicated in patients with contraindications to operative treatment and in patients with minimal intraarticular displacement. In the last decade open reduction and internal plate fixation of intraarticular calcaneal fractures has become a standard surgical method with low complication rate and better quality of life after the surgery²⁵.

Our study group were treated with locking compression plate with locking compression screw and percutaneous cancellous screw fixation. Most of the patients were treated with bone graft substitute, 'G' bone does not carry any infection and disease, prevent the long-term tuberosity collapse and maintain calcaneal height and width. Excellent results in Extensile Lateral approach with plate osteosynthesis it was supported by many studies^{19,10}.

Skin related complication was very less in this approach.

We have evaluated the radiological parameters at the end of one year, Bohler's angle, Gissane's angle which has statistically significant. Restoration of Bohler's angle and Gissane's angle is associated with excellent results in operated patients in our study. This fact, proved and verified by a lot of authors, confirmed the role of Bohler's angle size as a predictive factor for subsequent late complications.

Mario Baptista, Rui Pinto *et al* studied a total of 44 patients for the outcome of surgically treated calcaneus fractures in the year 2015. Average age for their study was 48 years (range 17 to 73) among which 86% were male, Right foot involving in 52.3% and left foot in 36.4%. In our study with 35 patients the mean age group for all patients was 38.87 years (21-50) with 25 male patients. Left calcaneum constitutes 60% and right calcaneum 40%, hence male involvement and right foot predominance is similar in both the studies.

Carlo Biz, Elia Barison *et al* studied a total of 87 fractures for the radiographic and functional outcomes after displaced intra-articular calcaneus fractures. They classified the fractures with Essex Lopresti among them 58 were joint depression type and 26 were tongue type fractures. Based on CT Sander's classification they had 37 patients with type 2 and 31 with type 3 and 19 with type 4 fractures. In our study we had 53.3% with Tongue type fracture and 46.7% with Joint depression type fracture, based on CT we had 47% of Type 2, 40% of Type 3 and 13% of Type 4 fractures, Hence type 2 Sander's are the common type of fractures which is similar in both the studies.(1)

Zeman *et al* ⁴⁶ studied a total of 49 patients with 62 calcaneal fractures. The most common mode of injury was fall from height and the average time taken for the surgical procedure is 11.7 days. In our study the most common mode of injury is fall from height and the average time take for the surgical procedure is 14 days. Hence the most common mode of injury are fall from height is similar in both the studies. (3)

Rak V *et al* ¹⁹ studied 76 intra-articular calcaneal fractures in 67 patients from February 2004 to October 2007. In his study the mean pre operative

Bohler's angle was 8.7 degrees and the post operative mean Bohler's angle was 31.2 degrees. In our study the mean pre operative Bohler's angle was 16.53 degrees and the post operative Bohler's angle was 26.53 degrees. Hence the post operative Bohler's angle is maintained which is similar in both the studies.(4)

Tashfeen Ahmad *et al* in the year 2015 studied 54 cases for radiological outcome in calcaneal fractures. In his study the mean preoperative Gissane's angle was 115 ± 27 degrees and the postoperative mean Gissane's angle was 121 ± 7 degrees. In our study the mean preoperative Gissane's angle was 146.93 degrees and the postoperative Gissane's angle was 136.73 degrees, hence the postoperative Gissane's angle was maintained which is similar in both the studies(5).

Saurabh Jain *et al* ⁴⁷ in the year 2013 studied 28 patients for the outcome of open reduction and internal fixation of intraarticular calcaneal fracture. In his study the mean American Orthopaedic Foot and Ankle Society Score (AOFAS) score at the end of 1 year followup was 86.3 which was good. Among 28 patients he had 3 patients with associated spinal injuries. In our study the 1 year follow up of AOFAS score was 85.73 which was good, we had 2 patients with associated spinal injuries without any neurological deficit. Hence the mean 1 year postoperative AOFAS score was good and spinal injuries are the most commonly associated injuries is similar in both the studies(7).

Manouk Backes *et al*, Tim Schepers *et al* in their study for postoperative complications following calcaneal fracture fixation with 191 patients, encountered few complications such as wound dehiscence or signs of infections which were treated with intravenous antibiotics, wound debridement or vacuum assisted closure (VAC) dressing. In our study we encountered 2 patients with wound healing it was treated with vacuum assisted wound closure (VAC) dressing which is similar in both the studies. (6)

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