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Functional outcomes of different modalities of fixation in intra-articular calcaneus fractures

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Abstract

Background: Closed manipulation and percutaneous screw fixation, minimal sinus tarsi approach reduction and screw fixation, open reduction and plate fixation these all useful in management of intraarticular calcaneus fracture management. In this study we used all these three different methods and evaluate outcome on postoperative follow up with different modalities of treatment.

Material and Methods: A series Twenty-Five patients with intraarticular calcaneus fractures were included in this analysis. Essex-Lopresti classification was used to evaluate the injuries and their prognostic correlation tested. Bohler's angle and Gissane's angle was measured pre- and postoperatively and evaluated as radiological outcome. Clinical outcomes were evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS).

Results: A total of 25 patients with intraarticular fractures out these 24 patients having unilateral calcaneus fracture and 1 patient having bilateral calcaneus fracture. All were male patients with a mean postoperative follow-up of 24 months. Overall mean age of patient was 48 years old. The most frequent cause of trauma was a fall from a height. According to Essex-Lopresti, there were 21 joint depression type fractures, and 4 tongue type. Clinical outcome on follow up measured with AOFAS score and we found out of 25 patients 13 patients with excellent AOFAS score, 10 patients with good AOFAS score and 2 patients with fair AOFAS score. The restoration of the Bohler's angle and Gissane's angle achieved most frequently.

Conclusion: Internal fixation either in the form of percutaneous screw fixation or plate fixation effective and useful in management of intraarticular calcaneus fracture.

Keywords: Calcaneus fractures, percutaneous screw, ORIF, Bohler's angle, Gissane's angle

Introduction

Calcaneus fractures account for approximately 2 % of all, with displaced intraarticular fractures comprising 60 to 75 percent of these injuries. Ten percent associated spine injury and 26 percent associated with other extremity injury. Male more frequently affected with peak age group varies from 20-45 years [1]. These type of injuries leads to serious nature of disabilities as they constitute a serious socio-economic problem. Surgical management of calcaneus fractures require to restore three-dimensional anatomical articulation and the subtalar joint as subtalar joint is major load bearing joint of foot as formed between calcaneus and talus. Sometimes calcaneo-cuboid joint requires lesser importance due to limited weight-bearing of joint [2, 3].

Different modalities have certain steps in common including disimpaction of the fragments, reduction of the displaced fragments either manually or percutaneously and protection of reduction with plaster and pins, external fixation and open reduction and internal fixation. The assessment of these type of fractures are done depending upon types of fractures, types of treatment given, residual symptoms, duration of immobilization and occupation before and after trauma. We treated these patients with different modalities either with closed manipulation or open reduction depending upon functional outcomes and socio-economical demands. In closed procedure we treated these types of fracture with percutaneous screw and with open reduction we used two methods including minimal sinus tarsi approach and standard extensile lateral approach. In limited sinus tarsi approach, fixation done using percutaneous screw and while using standard extensile lateral approach open reduction and internal fixation done with anatomical plate.

The primary aim of this study to get idea for selection of patients, selecting right technique and treatment method to get maximum outcomes.

Material and methods

This study includes twenty patients with calcaneus fracture treated with different modalities in our institute. It is a prospective, observational study. This study carries out between July 2016 to August 2018.

Inclusion Criteria

- Closed intra-articular calcaneus fractures with or without comminution i.e. joint depression type and tongue type fracture.

Exclusion Criteria

- open fracture
- with pre-existing arthritis of subtalar joint
- fracture >4 weeks old
- pediatric calcaneus fractures
- extra-articular calcaneus fractures
- Patients with peripheral vascular disease and insulin dependent diabetes mellitus and Non-compliance for surgery.

Techniques

Indication

- Impaction and/or lateral shift of the tuberosity fragment at the medial wall fracture site,
- Intraarticular displacement >2mm,
- Extraarticular fractures compromising the soft tissues and/or with unacceptable, positioning, shortening and broadening of the calcaneus (>10 valgus/>5 varus)

On admission vitals of the all cases were assessed and examination was done for any associated injury. The entire cases evaluated radiologically with lateral and axial view of calcaneum, in addition X rays of spine and pelvis were also done to rule out associated injuries. CT scan was done wherever patient feasible. Primarily below knee plaster given and swelling over operative site was assessed daily and strict limb elevation maintained and when swelling subsided, and appearance of 'Wrinkle Sign', patient was posted for surgery on very next day. Treatment of choice among two surgical techniques depending upon experience of surgeons involved in operation and basis of soft tissue condition and patient's demands. Pre-operatively prophylactic antibiotics given and continued post-operatively for 24-48 hours. All procedures were done in well-equipped orthopedics operation theatre. Surgeries were performed under general or spinal anesthesia. Patient was kept on simple table in lateral position with a tourniquet applied properly. Painting and draping done.

A) Closed reduction and percutaneous screw fixation

First, 4.5mm Steinmann pin is inserted from the medial side through a stab incision in calcaneal tuberosity, followed by distraction of pins to restore primarily length and height of the calcaneus. Traction is applied manually through a traction bow in the long axis of the calcaneum, with alternating varus and Valgus stress on the heel and the forefoot to disimpact the fracture and gain space for further reduction of the articular fragments. The varus position of the tuberosity fragment is corrected and reduced onto the sustentaculum one. Reduction of the articular surface seen under image-intensifier and compress the heel in order to impact the lateral wall. A Steinmann pin used for the initial leverage of the articular fragment. Reduction secured by multiple k-wires. Last, appropriate size (6.5mm diam.) screw inserted percutaneously. Post-operatively proper

dressing applied and give limb elevation with rehabilitation protocol followed.

B. Open Reduction and Fixation

1. Small lateral approach (Limited sinus tarsi approach)

This approach is now a days widely used for minimal invasive surgery. In Semi lateral position, incision is 5-6 cm long, beginning from the anterolateral corner of the calcaneocuboid joint and extends posteriorly in straight line to ankle up to 1-2 cm anterior to the Tendo Achilles. To achieve reduction, under image intensifier control, one or two 2-mm K-wires were inserted from the calcaneal tuberosity toward the subtalar joint. Then, during closed reduction, one or two Steinman pins were introduced forward across the fracture line for repeated percutaneous leverage to reduce the articular surface and the height of calcaneus which can be helpful to restore Bohler's angle to normal range. Fluoroscopic images in lateral and axial radiographic views allowed the evaluation of the anatomical reduction. Final stabilization was obtained with 2-mm K-wires or with cannulated screws (6.5 mm diam.), inserted in the same posterior-anterior direction. Sometimes, for better thalamic support, a latero-medial screw was introduced through the incision used for the talar joint reduction. Screw fixation was performed being careful to avoid the protrusion of the screw head. Proper compression dressing was applied on the operated side for 48 hours after surgery. Patients were kept non-weight-bearing for 4 weeks during which passive and active ankle ROM exercises were allowed after screw fixation.

2. Extensile lateral approach

This approach is most commonly used for open reduction and internal fixation described by Gould^[4] and popularised by Benirschke and Sangeorzan^[5] in lateral decubitus position with affected limb up. A full thickness "L" shaped incision starts approximately 2 cm above the tip of the lateral malleolus, just lateral to the Achilles tendon. In extensile lateral approach to calcaneus, place K-wire retractors in cuboid, talar neck, and fibula, mobilize lateral wall and superolateral articular fragments, mobilize tuberosity through primary medial fracture line Place Schanz pin in tuberosity and reduce superolateral articular fragment to sustentaculum fragment and stabilize with K-wires, reduce anterior process and anterolateral fragment to articular fragments to restore crucial angle of Gissane and primarily stabilize with K-wires, reduce tuberosity to body of calcaneus and provisionally stabilize with K-wires, Replace lateral wall fragment if needed add bone void filler and apply anatomic calcaneal plate. Place cortical or cancellous screws through perimeter holes in plate in box configuration, place cortical lag screws to stabilize articular fragment, one screw through plate; one screw outside plate. Assess stability of superior peroneal retinaculum. Flap closure done with drainage tube and sutures tied sequentially from ends to apex with skin closure in identical sequence.

Results

This study included Twenty-five patients with displaced intra-articular calcaneus fracture treated with different modalities, with minimum post-operative follow-up of Three months and maximum follow-up of Two years. This study includes Twenty-five patients with minimum age 23 years and maximum age 65 years. It shows that calcaneus fracture more commonly occurs in younger age group.

In this study, we observed intra-articular calcaneus fracture more commonly occurred in male. In this study, we observed one

patient having bilateral Calcaneus fracture and remaining Twenty-four patients with unilateral intra-articular calcaneus fracture 24 patients with unilateral calcaneus fracture we observed with right sided 13 patients (52%) and left sided 11(44%). Depending upon mode of injury, out of 25 patients, 18 (72%) patients having history of fall from height, 5(20%) patients having Slipped and remaining 2(8%) patients having Road-Traffic accidents.

In this study, intra-articular calcaneus fracture classified according Essex-Lopresti [16] classification having Twenty-one (84%) patients with joint depression type of variety and Four patients (16%) having tongue type of variety. In this study, we observed two type of fixation method one is percutaneous screw fixation and other is anatomical plate fixation. We observed that Eleven (44%) patients having fixation with plating, thirteen (52%) patients with percutaneous screw and one (4%) patients having bilateral intra-articular calcaneus fracture with right sided percutaneous screw fixation and left sided plate fixation.

In this study, functional outcomes of treatment of intra-articular calcaneus fracture measured using AOFAS Score in which Thirteen (52%) Patients having excellent results, ten (40%) patients having good, two (8%) patients having fair results and

none having poor outcomes. In this study, complications like Pain more frequently seen rather than wound dehiscence, heel widening or peroneal tenosynovitis this study shows that radiological union appear between 2-3 months. Among 25 patients, mean of bohler's and gissane's angle measured pre and post-operatively. Bohler angle and the angle of Gissane were measured on postoperative lateral radiographs using a goniometer where hard copies of the radiographs were available.

Table 1: Operative fixation according to fracture pattern

Operative procedure	No. of patients	Percentage
ORIF with locked Plates	11	44
Percutaneous screw	13	52
Both	1	4

Table 2: Results and outcomes according to AOFAS Score

Results	No. of patients	Percentage
Excellent	13	52
Good	10	40
Fair	2	8
Poor	0	0

Table 3: Mean of Bohler's and Gissane's angle [6,7] measurement pre and post- operatively

No. of Patients	Mean of Bohler's angle				Mean of Gissane's angle			
	Pre-op		Post-op		Pre-op		Post-op	
	Right	Left	Right	Left	Right	Left	Right	Left
25	29.32	36.8	31.52	37.4	123.76	111.9	123.5	114.08

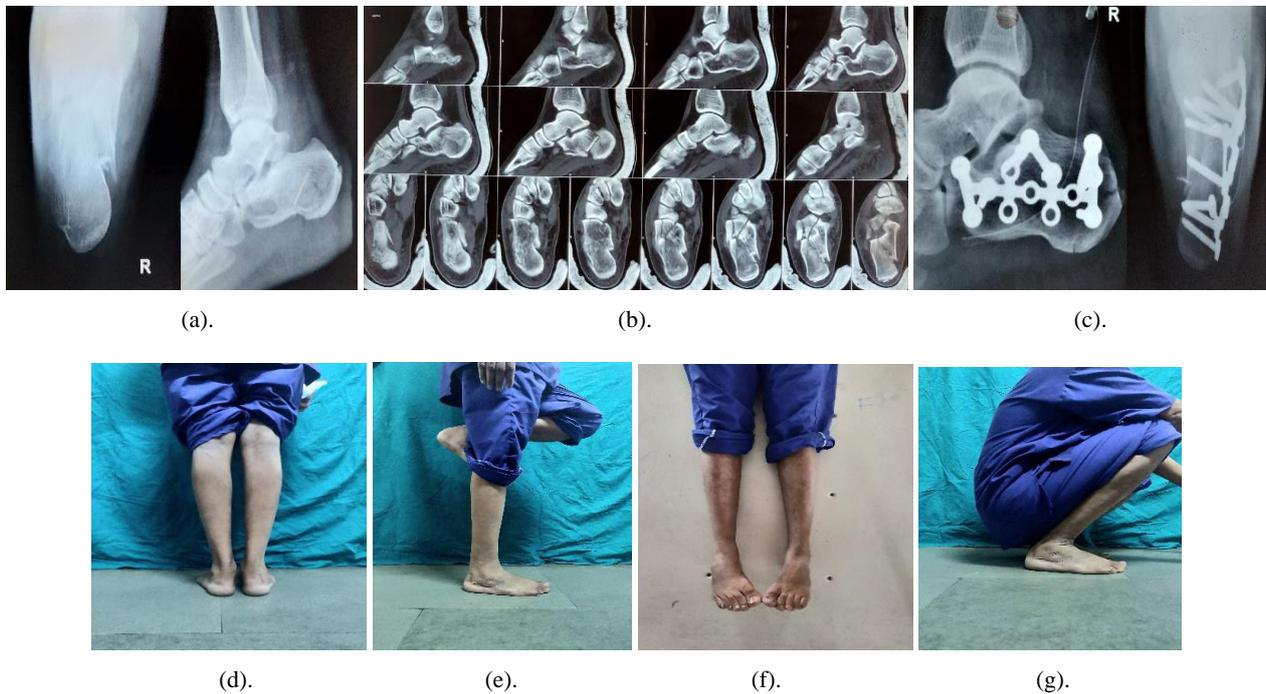


Fig 1: a). Pre-op x-ray b). Pre-operative CT scan c). Post-op x-ray d-g). Final outcomes as shown in above picture





Fig 2: a) Pre-operative x-ray b) Post-operative x-ray c-f) Final outcomes as shown above.

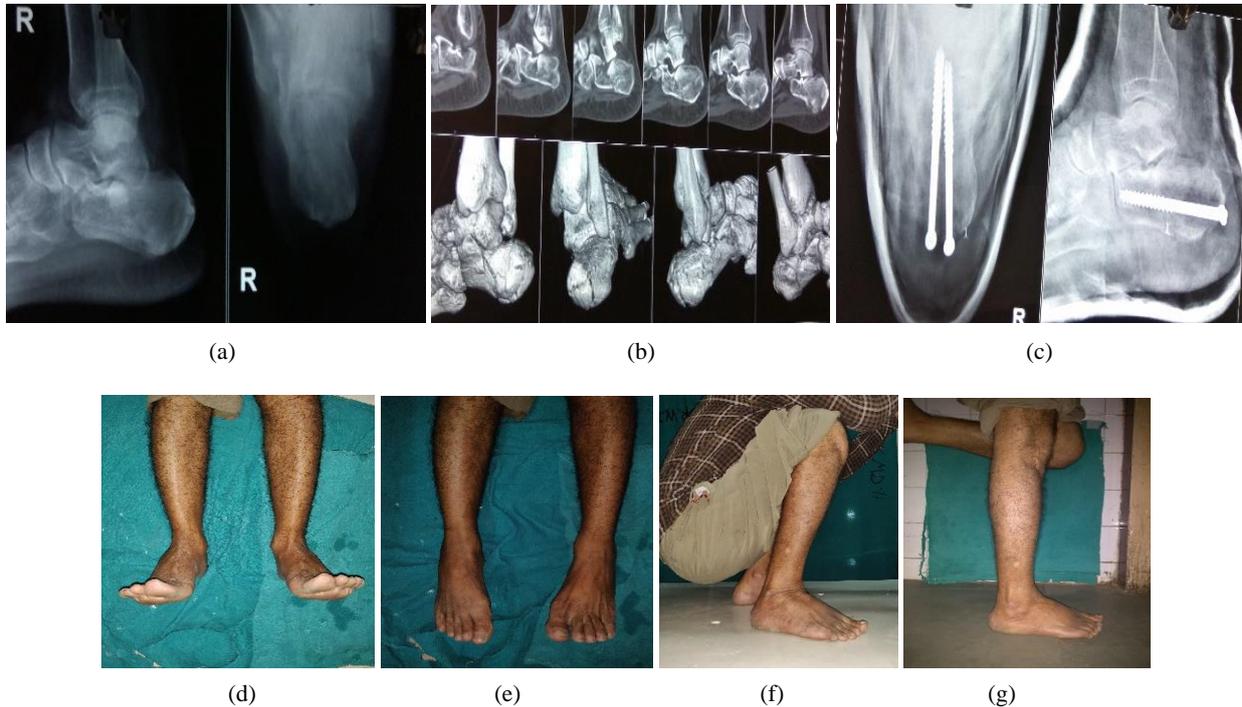


Fig 3: a) Pre-operative x-ray b) Pre-operative CT scan c) Post-operative x-ray d-g) Final outcomes shown above.

Discussion

Agreement to treat intra articular calcaneus fractures remain a controversial problem among orthopaedic surgeons to achieve optimum use of radiology, local soft tissue condition and choice of appropriate implant with stable osteosynthesis provides early range of motion and desired functional outcomes.

Based upon comprehensive statistical analysis of data obtained from 25 patients, we reviewed that different modalities of fixation used for intra-articular calcaneus fractures to restore morphology and anatomical articular congruity, Bohler’s and gissane’s angle and final follow-up functional outcomes by using American Orthopaedic Foot & Ankle Society Score.

In this study, eighty eight percent patients were younger age group between 23-49 years and remaining Twelve percent were 50-65 years of age group where mean age was 35.52 years. This shown that intra-articular calcaneus fracture occurs in younger active age group. In this present study, all intra-articular calcaneus fractures occur in male. This shown that high magnitude of outdoor activities, sports as well as driving among male population.

In this study, seventy two percent patients developed this injury due to fall from height, Twenty percent due to slipped at working site and remaining Eight percent due to Road traffic accidents. Coughlin [8] in his series also noted that intra-articular calcaneus fractures occur more commonly among working

group due to highly socio-economical demand. Tornetta [9] also observed that Seventy Three percent with intra-articular calcaneus fractures occur due to fall from height and Twenty seven percent of patients having history of road traffic accidents. We found that Four percent patient having bilateral intra-articular calcaneus fracture. Jain *et al.* [10] observed that 16.6% patients having bilateral calcaneus fracture.

In this study, Ninety Six percent intra-articular calcaneus fractures occur as unilateral with almost equal on both sides. Mohammed *et al.* [11] observed that 66% patients had calcaneus fracture on right sided and 33% had left sided. In our study, two (8%) patients having associated injuries including one had distal tibia fibula fracture and one had patella fracture. In this study, we found Eighty Four percent of patients with joint depression-type and Sixteen percent patients with tongue-type. According to Essex-Lopresti’s [12] classification, joint depression variety more common in intra-articular calcaneus fractures [13]. Ehrendorfer *et al.* [14] studied that 55.5% of patients had tongue type and 44.5% of patients had joint depression type of intra-articular fracture.

In this study, the time interval between trauma and surgery for all intra-articular calcaneus fractures were 1 to 10 days depending upon swelling and local soft tissue condition. In literature also mentioned that average time for surgery in all intra-articular calcaneus fracture were between 3 to 7 days after trauma.

In our study, out of 25 patients Eleven patients having Extensile lateral approach and plate fixation, thirteen patients having percutaneous screw fixation in which out of Thirteen, four patients having closed reduction and percutaneous screw fixation and remaining Nine patients having limited sinus tarsi approach with percutaneous screw fixation. Remaining one patient out of Twenty-Five who had bilateral intra-articular calcaneus fracture percutaneous screw fixation done with closed reduction on one side and other side treated with open reduction and plate fixation. Treatment of choice depend upon age of patient, occupational status, local soft tissue condition and functional outcomes. Schepers *et al.* [15], they observed that ORIF was the mainstay of all five modality of treatments and also importance of percutaneous technique mentioned. Tornetta *et al.* [9] observed 88% of Sanders type IIC tongue type fracture treated with modified Essex Lopresti technique while remaining 12% treated with open reduction and plate fixation. Pendse *et al.* [16] concluded that open reduction and internal fixation with plate in intra-articular calcaneus fractures to restore anatomical articular congruency, early mobilization and primary option for subtalar arthrodesis if needed.

The Bohler's angle [6], considered as normal within measurements ranging from 20° to 40°. In this study, we found post-operative mean bohler angle of 34.74 degree. The value of this angle showed correlation with the quality of outcome and in literature also mentioned that bohler's angle is highly prognostic indicator. Paley and Hall [17]. Stated that Bohler's angle is an indirect measurement of both calcaneal height and the arch angle, a small Bohler's angle is associated with poor result. This implies that preservation of calcaneal height and arch angle is important.

In this study, we measured Gissane's angle [7] post-operatively in all patients measured between 120 – 145° and compared it with the normal side radiograph except one patient who had a bilateral intra-articular calcaneus fracture. In this study, radiological union mostly seen between 2-3 months. No major complications were observed during early follow-up except two patients having superficial infection with wound dehiscence which managed with regular dressing. In long follow up, one patient having peroneal tenosynovitis, two patients having heel widening. To avoid complication rates, some surgeons prefer minimal invasive procedure over open reduction and internal fixation as outcomes among these procedures equal.

In this study, outcomes measured with AOFAS Score and we found Excellent results in 13(52%)patients, Good in 10 (40%) patients, Fair in 2 (8%) patients with none having poor outcomes and we compared this with series of Biz *et al.* [1] who also measured outcomes with AOFAS score and he found excellent results (90–100 points) in 11 (12.6 %) patients, good results (75–89 points) in 46 (52.9 %) patients, fair results (50–74 points) in 26 (29.9 %)patients, while 4 (4.6 %) patients were graded as failures (<50points).We also compared our outcomes of AOFAS Score with Voclav *et al.* [18] who also found excellent results in 24(32%)patients, Good in 28(37%)patients, Fair in 14(18%) patients and Poor results in 10(13%)patients. We also compared our outcomes with other series of Gusic *et al.* [19] and Mohammed *et al.* [11]

This study has some limitations due to prospective nature of study design. We have studied limited patient sample size and follow up period not so prolonged so we can not stamp for one modality of treatment in all intra-articular calcaneus fractures.

Conclusions

Results of 25 cases of intra-articular calcaneus fracture analyzed

from our statistical data. With good anatomical articular reduction and proper post-operative rehabilitation protocol, good to excellent outcomes achieved. Severe intra-articular comminution with joint destruction and soft tissue compromise leads fair to poor outcomes. Essex-Lopresti's classification useful in better pre-operative planning and management. Proper quality radiographs like lateral, axial view must in understanding the displacement of major fragments.

CT scan helps in assessment of intra-articular displacements and comminution. The goal of treatment of all intra-articular calcaneus fracture is to restore height and width, better articular reduction of subtalar joint. Lateral extensile approach better for visualization of subtalar as well as calcaneocuboid joint. Open reduction and internal fixation with anatomical plate good option for treatment of joint depression and tongue type comminuted intra-articular calcaneus fractures.

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