

Original research article

Prospective open label observational study to determine the outcome of displaced intraarticular fractures of calcaneum treated using locking plate fixation.

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Abstract

Background: The calcaneus is the frequently injured tarsal bone. 75% of calcaneal fractures are intraarticular. Treating calcaneal fractures is a challenge for orthopaedic surgeon due to complex fracture pathology.

Aim: The aim of the present study determines the Functional and anatomical outcome of displaced intraarticular fractures of calcaneum treated using locking plate fixation.

Material and methods: This Prospective open label observational study was done the Department of Orthopaedics, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, from January 2016 to December 2017, A total of 60 patients aged $n \geq 18$ years, displaced intra articular fractures of calcaneum were included in this study. Post-operative management involved, immobilization using a below the knee slab for a duration of 2-3 weeks to ensure wound healing. Subsequently on the second post operative day non weight bearing mobilization was advised followed by ankle movements on removal of the slab. Complete weight bearing was recommended only after ensuring fracture union on x-ray. Follow up- Patients were followed up at an interval of 6 weeks, 3 months and 6 months post surgery and imaging via x-ray, at each visit was done to assess the fracture healing.

Results: In our study we included 60 patients, amongst them 8 were female and the rest 52 were male. The mechanism of injury was noted to be road traffic accident in 13 patients and fracture sustained as a result of fall from a height in the rest. According to this scale, 39 patients (65%) had good outcome, 17 patients had fair outcome (28.33%) while 4 patient (6.67%) had poor outcome. 4 out of the 60 patients, was noted to have wound dehiscence where suture removal was delayed until 3 weeks and the wound healing was ensured at the end of 8 weeks.

Conclusion: we concluded that the anatomic locking plate can be used effectively in the treatment of displaced intraarticular calcaneal fractures using simple reduction techniques with a potentially shortened operating time.

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

Introduction

The calcaneum is the most commonly fractured tarsal bone. Calcaneal fractures comprise 1-2% in adults.^{1,2} Most of the calcaneal fractures are intraarticular and almost all occur due to an axial load such as a fall from height. Intraarticular calcaneal fractures have significant importance as poor outcomes of treatment are associated with poor health status. Calcaneal fractures are mostly work related, as they result from a fall from height especially in males aged 35-45 years. These fractures frequently result in long term disability with potentially severe economic impact on the patient. Fractures of the calcaneus are typically the result of high-energy trauma, such as a fall from a height or a motor vehicle accident. The pattern of fracture lines and extent of comminution are determined by the position of the foot, the amount of force, and the porosity of the bone at the time of impact. 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.³ Calcaneum fractures are classified into intra-articular and extra-articular fractures based on the involvement of the subtalar joint. The intra-articular fractures, based on plain radiograph, are further classified by Essex-Lopresti (1952) into joint depression- and tongue-type fractures. On plain radiograph, when the fracture line exits behind the posterior facet and anterior to attachment of Achilles tendon, it is called joint depression-type fracture. Tongue-type fracture is one in which there is a secondary fracture line which exits distal to Achilles tendon attachment, and the articular fragment remains attached to the tuberosity fragment.^{4,5} A further detailed descriptive classification was given by Sanders^{6,7} based on axial view computed tomography (CT) scan. According to this classification, undisplaced fractures are classified as Type I. Type II is further classified into IIA, IIB, and IIC based on the location of the primary fracture line. Type III is classified into IIIAB, IIIBC, and IIIAC. Comminuted fractures are classified as Type IV. Most of the calcaneal fractures are intraarticular and almost all occur due to an axial load such as a fall from height. Intraarticular calcaneal fractures have significant importance as poor outcomes of treatment are associated with poor health status. Calcaneal fractures are mostly work related, as they result from a fall from height especially in males aged 35-45 years. These fractures frequently result in long term disability with potentially severe economic impact on the patient. Fractures of the calcaneus are typically the result of high-energy trauma, such as a fall from a height or a motor vehicle accident. The pattern of fracture lines and extent of comminution are determined by the position of the foot, the amount of force, and the porosity of the bone at the time of impact. Treating calcaneal fractures is a challenge for orthopaedic surgeon. A wide range of treatment options varying from non-operative to operative methods are available. Studies conducted by Batra, Makki et al, Wu et al all had results favouring open reduction and internal fixation with plate and screws.⁸⁻¹⁰ the aim of the present study determine the Functional and anatomical outcome of displaced intraarticular fractures of calcaneum treated using locking plate fixation.

Material and methods

This Prospective open label observational study was done the Department of Orthopaedics, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pardesh, India from January 2016 to December 2017, after taking the approval of the protocol review committee and institutional ethics committee. After taking informed consent detailed history was taken from the patient or relatives. A total of 60 patients aged $n \geq 18$ years were included in the study.

Inclusion criteria

All displaced intra articular fractures of calcaneum

Exclusion criteria

- All open fractures.
- Heel crush injury.
- Pre-existing vascular injury or compromise.
- Patients with diabetic neuropathy and Charcot's joint.

Methodology

Patients subjected to surgery were followed up at regular intervals with clinical and radiological evaluation. Assessment was done based on a performa that enlisted the following information-

- Personal details: age, sex, address and occupation.
- Classification; sanders classification.
- Range of movements achieved postoperatively.
- Intra-operative and post-operative complication(s), if any.

Surgical procedure- Patient is made to lie in the lateral position on a radioluscent table. A lateral skin incision extending from the calcaneal tuberosity to the calcaneocuboid joint is made. It is preferable toraisea thick skin flap to avoid skinnecros is and insomecasesk-wireswere placed at the proximal end of the wound, bent at an angle of 90 degrees to avoid repeated handling of the skin flap. Care was taken to preserve the sural nerve and the short saphenous vein. Fracture reduction was achieved by using k wires and the depressed fragments were elevated as needed after cleaning the lateral wall subperiosteally for access and any deficit was filled with an allograft. The fracture reduction was then confirmed with the aid ofc-arm and subsequently secure dusinga locking plate on the lateral aspect of the calcaneum. The plate was in most cases placed below the peroneal tendons, which were retained. Post-operative management involved, immobilization using a below the knee slab for a duration of 2-3 weeks to ensure wound healing. Subsequently on the second post operative day non weight bearing mobilization was advised followed by ankle movements on removal of the slab. Complete weight bearing was recommended only after ensuring fracture union onx-ray. Follow up- Patients were followed-up at an interval of 6 weeks, 3 months and 6 months post surgery and imaging via x-ray,at each visit was done to assess the fracture healing. Patients were followed up using American Orthopaedic foot and ankle hind foot score (AOFAS). Radiological assessment was done in terms of maintaining the Bohler's and Gissane angles, calcaneal height and anatomical articular reconstruction.

Results

In our study we included 60 patients, amongst them 8were female and the rest 52 were male. The mechanism of injury was noted to be road traffic accident in 13 patients and fracture sustained as a result of fall from a height in therest.The age distribution is mentioned in (Table 1).

Table 1: Age distribution of patients

Age in years	No.of patients	%
Below 30	26	43.33
30-40	11	18.33
40-50	15	25
50-60	8	13.33
Total	60	100
Mean \pm SD: 36.12 \pm 11.74		

The fractures were classified according to sanders classification after the required CT scans were done (Table2)

Table 2: Sander Type distribution of patients

Sander Type	No. of patients	%
1	0	0
2	20	33.33
3	38	63.34
4	2	3.33
Total	60	100

The surgery was not performed immediately for all patients, though most presented on the day of the injury and it was delayed until the swelling decreased and wrinkle sign appeared (Table 3).

These patients were followed up at 6 months and the functional outcome was assessed in all patients using Ankle- Hind foot scale which includes assessment of pain, function, maximum walking distance, gait abnormality, graded difficulty in walking on different surfaces, motion, stability of ankle and alignment of ankle and foot.

Table 3: Operated Day distribution of patients

Operated Day	No. of patients	%
<10	30	50
10-15	23	38.33
>15	7	11.67
Total	60	100
Mean \pm SD: 10.85 \pm 3.69		

According to this scale, 39 patients (65%) had good outcome, 17 patients had fair outcome (28.33%) while 4 patients (6.67%) had poor outcome (Table 6).

Table 4: AOFAS score distribution of patients

AOFAS Score	No. of patients	%
<70	13	21.67
70-80	20	33.33
>80	27	45
Total	60	100
Mean \pm SD: 80.05 \pm 13.01		

Amongst the 60 patients, alignment of the foot and ankle was restored in all cases and so was the ankle hind foot stability. There was no varus or valgus angulation identified. Only 12 patients had visibly altered gait. The motion in the sagittal plane was restored to >30 degrees in 48 patients but the hind foot motion (inversion-eversion) was restored to >75% in only 6 of the patients. Bony union occurred in all patients. The pre operative Bohlers angle (calcaneal height) and Gissane angle was compared with the post operative parameters at 6 months and it was noted that in comparison with the contralateral limb there was a statistically significant alteration between the two. Clinically it was noted that in most patients the post operative parameters at 6 month follow up were within the acceptable range (Table5).

The complications we encountered were –

4 out of the 60 patients, was noted to have wound dehiscence where suture removal was delayed until 3 weeks and the wound healing was ensured at the end of 8 weeks. Regular dressings were done and the wound healed with secondary intention without any further intervention. For this patient regular cultures were taken and the antibiotics were changed accordingly. 4 patient developed superficial wound infection, for which regular dressings were done and antibiotics changed according to culture reports. The wound subsequently healed well by the end of 6 weeks. Further, 4 patients showed delayed healing wherein the wound healed by 3-4 weeks and regular dressings were ensured during that period (Table 6). 2 patient developed sural nerve hypoesthesia.

Table 5: Gissane and Bohler angle

Gissane angle	Min-Max	Mean \pm SD	Difference	t value	P value
Normal	99.14-130	114.06 \pm 8.75			
Operate	103.23-58.13	120.95 \pm 9.83	9.26	4.73	<0.001**
Bohler Angle					
Normal	25.12-43	33.11 \pm 4.59	-	-	
Operate	19.04-35.11	28.11 \pm 5.79	5.69	5.69	<0.001**

Table 6: Result six-week wound healing distribution of patients

Result Six-week wound healing	No. of patients	%
Poor	4	6.67
Fair	17	28.33
Good	39	65
Total	60	100

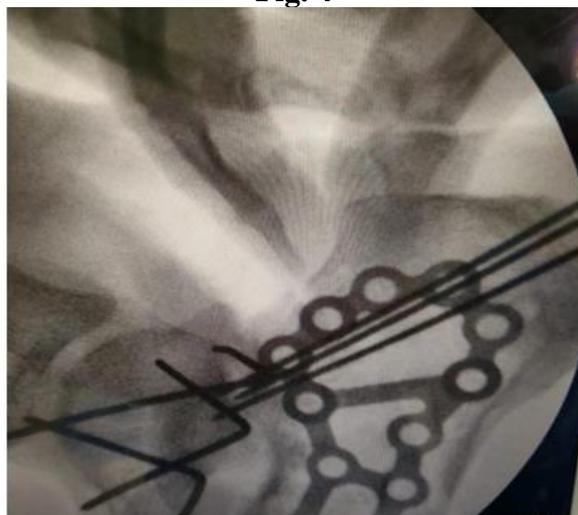
None of the patients developed heel pad problems, compartment syndrome or peroneal tendinitis. None were noted to develop subtalar arthrodesis in the observation period



Fig. 1:



Fig. 2

**Fig. 3****Fig. 4****Fig. 5**

Discussion

Calcaneum intraarticular fractures are common as compared to extra articular fractures, hence the importance of anatomical reduction to decrease the possibility of joint incongruity and subtalar arthritis. Open reduction and internal fixation is now more aggressively advocated for management of intraarticular fractures of calcaneum. The incidence of calcaneus fracture depends upon factors such as gender, age and mechanism of injury. In our study we included 60 patients, amongst them 8 were female and the rest 52 were male. Most of the patients below 30 years (43.33%) followed by 30-40 years (18.33%). The mechanism of injury being fall from height(78.33%)and road traffic accidents/vehicular accidents (21.67%).¹¹Calcaneal fracture can affect health for many years after the trauma. This observation is confirmed as prepare- set questionnaire (AOFOS), wherein majority of patients (about 65%) obtained good

results and 6.67% obtained poor results. The long-term results of calcaneal fractures usually include persistence of pain for many years after trauma, but not enough to significantly affect the activity of daily living. Calcaneus fracture is difficult to manage due to its complex bony anatomy, tenuous soft tissue envelope and difficulty of acquiring anatomic reduction and rigid fixation. The other factors that might play a role include the intensity of trauma, as calcaneal fractures often result from high energy trauma, associated with open and contaminated fractures; also the limited vascularity owing to the thin layer of skin overlying the calcaneus may play a role. There is some controversy regarding whether to manage calcaneal fractures conservatively or via surgical options. The risk of major complications after surgery is high but development of subtler arthritis is significantly greater after conservative treatment.¹² However, in the largest prospective randomized trial described till date, Buckley et al. found better results in patients after surgery.¹³

The incidence of superficial wound infections after fracture management is high (6.67%) as compared to lower extremity fractures. Sural nerve injury (3.33%) was also noted in our study group, which is similar to that in many studies in literature.¹⁴

According to previous studies, for displaced calcaneal fractures the best functional and radiological outcomes were obtained with ORIF through an extended lateral approach, but the technique is criticised for its complications, most frequently affecting the soft tissues. Screws and plates can be used for fixation of the fragments and when the patient experiences persistent pain because of screws or plates, the hardware can be (partially) removed.¹⁵

In developing countries like ours, less complicated fractures like Sander's type II are usually treated conservatively in secondary care center and are not referred to tertiary centers.

Melcher, in his study followed up patients who underwent ORIF, after a period of 3 years and 10 years following the surgery. He observed that the subjective and objective results assessed after 10 years were better than those achieved after the three-year follow-up.¹⁶

In Sander's study, excellent or good results were seen in 73% of type-II, 70% of type-III, and 27% of type-IV fractures (Sander's classification).¹⁷ A similar study conducted in our sub-continent where the sample size was twenty had 65% good and 35% fair or poor results at the end of a 6 months follow up period.¹⁸ The average number of Sander's type III fractures in our study 39 patients (65%) had good outcome, 17 patients had fair outcome (28.33%) while 4 patient (6.67%) had poor outcome which is not comparable to previous studies conducted by Biz C1, Barison E2 and Ruggieri P2.¹ The mean number of days between the history of fall and surgery in our study was 10.85 ± 3.69 days, which is comparable to studies by Weber M1,¹⁴ Lehmann O, Sagesser D.

Conclusion:

We conducted that the anatomic locking plate can be used effectively in the treatment of displaced intraarticular calcaneal fractures using simple reduction techniques with a potentially shortened operating time.

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