



Original Research Article

Functional and anatomical outcome of displaced intraarticular fractures of calcaneum treated using locking plate fixation

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ABSTRACT

Most calcaneal fractures are intraarticular fractures involving the posterior facet of the subtalar joint. Treating displaced intraarticular calcaneal fractures is challenging due to the paucity in optimal treatment options. Internal fixation typically involves screw-and-plate implants, which can be unfavourable owing to the lack of an anatomic design and the intraoperative bending required for the plate to contour to the irregular surface of the calcaneus. In our study we included fifteen patients, two were female and the rest thirteen were male.

The mechanism of injury involved road traffic accident in two cases and fracture as a result of fall from height in the remaining patients.

These patients were followed up for 6 months at the end of which functional outcome was assessed in all patients using the Ankle-Hind foot scale, that included 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. Based on this scale 10 patients (66.6%) had good outcome, 4 patients had fair outcome (26.6%) while 1 patient (6.66%) had poor outcome. The results were promising, revealing 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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1. Introduction

Calcaneum is the most commonly fractured tarsal bone and it accounts for 2% of the total fractures.¹ Majority of the patients are young males. The main mechanism of injury in calcaneum fractures is sudden axial load frequently as a result of fall from height and is common in construction workers at work site. Nearly 60 -75% of these calcaneal fractures are intraarticular and invariably displaced.² The lateral view is useful for measuring Bohler and Gissane angle; to assess the loss of calcaneal inclination and in evaluating the involvement of the subtalar joint.³ Furthermore most intraarticular fractures involve the posterior articular facet of the subtalar joint, which is the major weight bearing portion of the human heel.

The functional outcome of these calcaneal fractures is invariably dependent on the proper reduction of fracture fragments and the maintenance of the congruity of the articular surfaces. Surgical management of calcaneal fractures includes various modalities like use of Steinman pin or cannulated-cancellous screws, but fixation with locking plates has recently gained popularity. This method of calcaneal fracture fixation permits early fracture union mobilization and rehabilitation. Inadequate reduction of the intra articular fractures especially with posterior facet involvement can lead to sub-talar joint arthritis causing persistent disability for several years which will eventually lead to arthrodesis.¹

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2. Materials and Methods

This study was conducted on patients with intra articular calcaneal fractures in the department of Orthopaedics, Kempegowda institute of medical science and research centre, VV puram, Bangalore, Karnataka. The study period was from March 2016 to December 2018. A total of 15 patients aged $n \geq 18$ years were included in the study.

2.1. Study design

Prospective open label observational study.

2.2. Study location

Kempegowda institute of medical science and research Centre, VV puram, Bangalore, Karnataka.

2.3. Study duration

November 2016 to November 2018.

2.4. Sample size

15 patients.

2.5. Procedure methodology

Written informed consent was obtained from all the patients. Individuals presenting to the outpatient and emergency department, who fulfilled the study criteria were recruited.

2.6. Inclusion criteria

All displaced intra articular fractures of calcaneum

2.7. Exclusion criteria

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

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-

1. Personal details: age, sex, address and occupation.
2. Classification; sanders classification.
3. Range of movements achieved post operatively.
4. 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 to raise a thick skin flap to avoid skin necrosis and in some cases k-wires

were 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 of c-arm and subsequently secured using a locking plate on the lateral aspect of the calcaneum. The plate was in most cases placed below the peroneal tendons, which were retained.(figure 1 and 2)



Fig. 1: Approach and plate placement



Fig. 2: Intraoperative C-Arm image

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. Patients were followed up using American Orthopaedic foot and ankle hindfoot score (AOFAS). Radiological assessment was done in terms of maintaining the Bohler's and Gissane angles, calcaneal height and anatomical articular reconstruction.

3. Results

In our study we included 15 patients, amongst them 2 were female and the rest 13 were male.

The mechanism of injury was noted to be road traffic accident in two patients and fracture sustained as a result of fall from a height in the rest.

The age distribution is mentioned in (Table 1).

Table 1: Age distribution of patients studied

Age in years	No. of patients	%
21-30	6	40.0
31-40	3	20.0
41-50	4	26.7
51-60	2	13.3
Total	15	100.0

Mean \pm SD: 36.13 \pm 11.82

The fractures were classified according to sanders classification after the required CT scans were done (Table 2)

Table 2: Sander Type distribution of patients studied

Sander Type	No. of patients	%
1	0	0.0
2	5	33.3
3	9	60.0
4	1	6.7
Total	15	100.0

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-Hindfoot scale which includes assessment of pain, function, maximum walking distance, gait abnormality, graded difficulty in walking on different surfaces, motion, stability

Table 3: Operated Day distribution of patients studied

Operated Day	No. of patients	%
<10	7	46.7
10-15	6	40.0
>15	2	13.3
Total	15	100.0

Mean \pm SD: 10.43 \pm 3.55

of ankle and alignment of ankle and foot. According to this scale, 10 patients (66.6%) had good outcome, 4 patients had fair outcome (26.6%) while 1 patient (6.66%) had poor outcome (Table 4).

Table 4: AOFAS score distribution of patients studied

AOFAS Score	No. of patients	%
<70	3	20.0
70-80	5	33.3
>80	7	46.7
Total	15	100.0

Mean \pm SD: 77.40 \pm 11.80

Amongst the 15 patients, alignment of the foot and ankle was restored in all cases and so was the ankle hindfoot stability. There was no varus or valgus angulation identified. Only 3 patients had visibly altered gait. The motion in the sagittal plane was restored to >30 degrees in 12 patients but the hindfoot motion (inversion-eversion) was restored to >75% in only 2 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 (Table 5).

The complications we encountered were –

1. One out of the fifteen 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.
2. One 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, three patients showed delayed healing wherein the wound healed by 3-4 weeks and regular dressings were ensured during that period (Table 6).
3. One patient developed sural nerve hypoaesthesia.

Table 5: Gissane and Bohler angle

	Min-Max	Mean \pm SD	Difference	t value	P value
Gissane angle					
Normal	99.30-130.00	111.41 \pm 8.48	-	-	-
Operate	103.10-137.90	121.03 \pm 9.25	-9.620	-4.524	<0.001**
Bohler Angle					
Normal	23.40-40.00	31.49 \pm 4.44	-	-	-
Operate	17.40-33.70	26.08 \pm 5.08	5.407	5.912	<0.001**

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

Result Six-week wound healing	No. of patients	%
Poor	1	6.7
Fair	4	26.7
Good	10	66.7
Total	15	100.0

**Fig. 3:** Delayed wound healing

None of the patients developed heel pad problems, compartment syndrome or peroneal tendinitis.

None were noted to develop subtalar arthrodesis in the observation period.

4. Discussion

The incidence of calcaneus fracture depends upon factors such as gender, age and mechanism of injury. In our study majority were young adults and male patients in the age group between 21 to 60 years of age with a surge among mid-twenties. The mechanism of injury being fall from height (90%) and road traffic accidents/ vehicular accidents

(10%).⁴ Calcaneal fracture can affect health for many years after the trauma. This observation is confirmed as per a pre-set questionnaire (AOFOS), wherein majority of patients (about 66%) obtained good results and 6% obtained poor results. The long-term results of calcaneal fractures usually includes 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 subtalar arthritis is significantly greater after conservative treatment.⁵ However, in the largest prospective randomized trial described till date, Buckley et al. found better results in patients after surgery.⁶

The incidence of superficial wound infections after fracture management is high (10%) as compared to lower extremity fractures. Sural nerve injury (5%) was also noted in our study group, which is similar to that in many studies in literature.⁷

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.⁸

In developing countries like ours, less complicated fractures like Sander's type II are usually treated

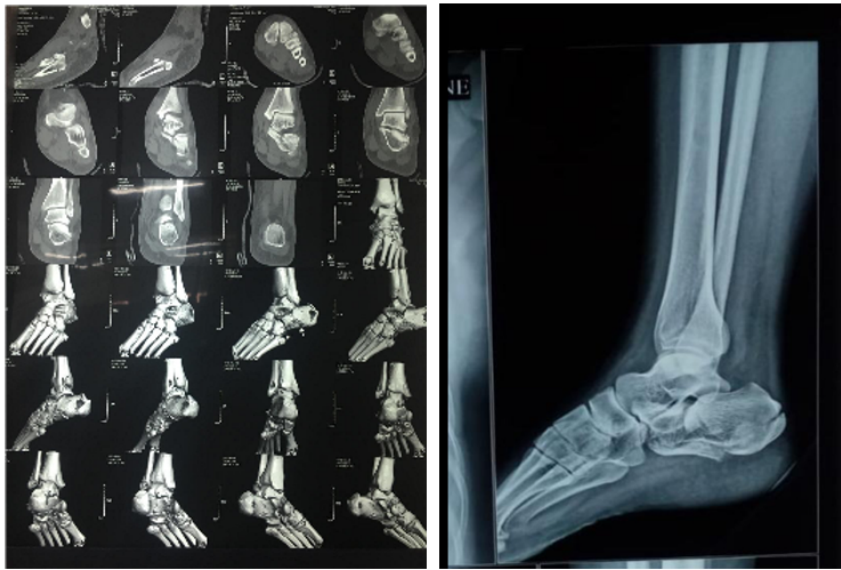


Fig. 4: Case 1

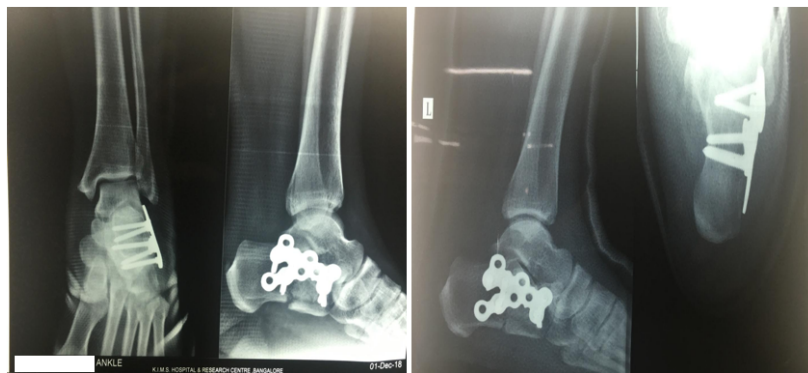


Fig. 5: Case 1

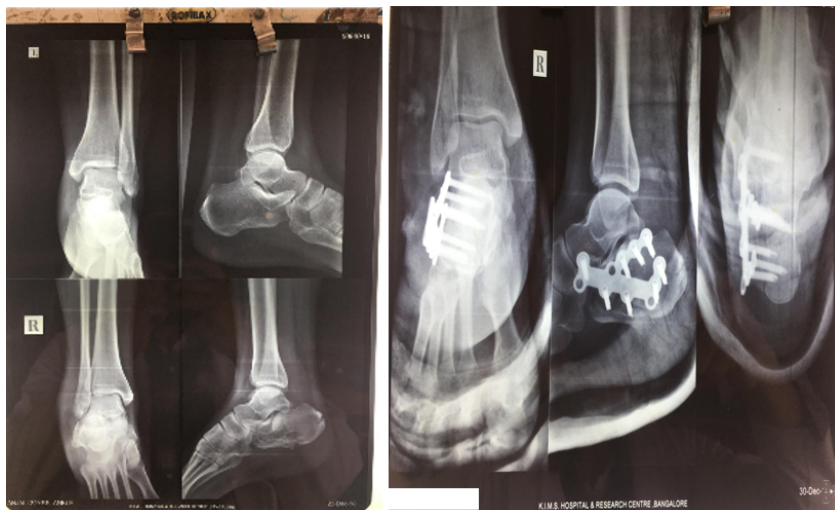


Fig. 6: Case 2

conservatively in secondary care centers 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.⁹

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 (sanders classification).¹⁰ 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.¹¹

The average number of Sander's type III fractures in our study was 69% which is not comparable to previous studies conducted by Biz C1, Barison E2 and Ruggieri P2.¹²

The mean number of days between the history of fall and surgery in our study was 10.8 days, which is comparable to studies by Weber M1, 14 Lehmann O, Sägesser D.

There were certain limitations in our study. Only 15 patients with calcaneal fractures were operated and their functional outcome was measured at a mean follow-up of only 6 months. A study involving a comparatively large number of patients and followed up for a longer period of time can more accurately assess the functional outcome of displaced intra-articular fractures of the calcaneum treated by this method.

5. Conclusion

Advancement in surgical techniques and implants have improved functional outcome in cases of calcaneus fracture, yet the surgical intervention is technically challenging and not devoid of the risk of complications.

Displaced intra-articular fracture of more than 2 mm with altered Bohler's angle reveal better long term functional outcome if treated optimally with surgical intervention but have a worse outcome if joint congruity and Bohler's angle are not restored. Initial displacement of Bohler's angle signifies the outcome of treatment and it is concluded in literature that patients with severely comminuted intra-articular fracture and severely depressed Bohler's angle are more prone to develop early subtalar arthritis and have poor outcome regardless of the type of treatment that they were offered. Primary subtalar arthrodesis is recommended in Sander's type 4 intra-articular fractures to achieve better functional outcome and to avoid secondary operative intervention and its complications.

6. Source of Funding

None.

7. Conflict of Interest

None.

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