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Dr. Johney Juneja
Assistant Professor, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Dr. Nitin Andrews
Junior 3rd Year Professor, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Dr. Gaurav Garg
Junior 3rd Year, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Dr. Rahul Gorakh
Junior 3rd Year, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Dr. Piyush
Junior 3rd Year, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Dr. AK Mehra
Senior, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Dr. Ramesh Sen
Senior Professor, Max Superspeciality Hospital Mohali, Punjab, India

Corresponding Author:
Dr. Johney Juneja
Assistant Professor, Department of Orthopaedic, RNT Medical College Hospital Udaipur, Rajasthan, India

Functional outcome of open reduction and internal fixation of calcaneal fractures with plates using extensile lateral approach

Dr. Johney Juneja, Dr. Nitin Andrews, Dr. Gaurav Garg, Dr. Rahul Gorakh, Dr. Piyush, Dr. AK Mehra and Dr. Ramesh Sen

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Abstract
Objective: To evaluate the functional outcome and to study the advantages and disadvantages of open reduction and internal fixation of calcaneal fractures with plates using extensile lateral approach using Ankle Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score.
Methods: Our prospective study was conducted in Department of Orthopaedics, Ravindra Nath Tagore Medical College and Maharana Bhupal Hospital, Udaipur, Rajasthan between December 2021 to November 2022. Patients who attended Orthopaedics casualty and outpatient department with fracture of calcaneo were admitted and selected for the study based on inclusion and exclusion criteria. 30 patients were selected, informed written consent taken, evaluated preoperatively and operated and were followed up to 9 months. The functional outcome was assessed using AOFAS score.
Results: AOFAS Ankle-Hindfoot score was assessed at 3 months and 9 months follow up of all patients. At 3 months follow up, 20% of Sanders type II , 15% of Sanders type III, 14% of Sanders type IV showed a good score, 70% of Sanders type II, about 77% of Sanders type III and about 57% of Sanders type IV of cases showed a fair score. 10% in Sanders type II, 7% of Sanders type III, and about 28% in Sanders type IV showed a poor score.
At 9 months follow up of all patients, around 30% of Sanders type II, 15% of Sanders type III cases and 14% of Sanders type IV cases showed an excellent AOFAS score. 50% of Sanders type II, 62% of Sanders type III and 28% of Sanders type IV showed good AOFAS score. A total of 20% of Sanders type II, 15% of Sanders type III and 43% of Sanders type IV showed fair AOFAS score. Only 7 % of Sanders type III and 14 % of Sanders type IV showed poor AOFAS score.
Conclusion: The functional outcome after surgical management of calcaneal fractures were done at 3 months and 9 months using AOFAS Ankle-Hindfoot score and identified that majority of patients got good score. AOFAS Ankle Hindfoot scoring system was found to be effective in assessing the functional status of patients and the same was in accordance with previous studies. The advantages of extensile lateral approach for calcaneal fracture management include wide exposure of the calcaneus, allowing easier access to facet fragments, ability to decompress the lateral wall, exposure of the calcaneo-cuboid joint and sufficient area laterally for plate fixation. Disadvantages include injury to the blood supply of the lateral flap, difficulty with assessment of reduction of the medial wall and a higher incidence of wound problems occur with this approach.

Keywords: Calcaneal fractures, extensile lateral approach, AOFAS-Ankle Hindfoot score

Introduction

Calcaneal fractures accounts for about 2% of fractures of lower limb. Most (70**%**) of these are intra-articular. 10% are associated with spine fractures. Mostly they are due to high energy axial trauma, mainly due to fall from height [1]. The management of these fractures can be done either by closed reduction methods or by aggressive surgical methods. But among these methods, which has the better functional outcome is still unsettled. However, a recent trend in management of displaced, intra-articular calcaneal fractures is open reduction and internal fixation with plate and screws [2]. The various deformities occurring as a result of calcaneal fractures, like loss of calcaneal height, heel widening, subtalar joint incongruency can be addressed by open reduction and internal fixation. The surgical procedure often results in restoration of calcaneal morphology and thereby the biomechanics and functions of hindfoot [3]. Restoring the width of heel will result in prevention of chronic

Peroneal tendinitis which can occur secondary to impingement from lateral wall blowout fractures of calcaneus, restoring the length and alignment of Achilles tendon maintains plantar flexion strength [4].

The calcaneus has two main functions: to transmit body weight and to act as a lever for the force generated by the calf muscles. Painless motion at its articulations with the talus and cuboid are essential for normal gait [5]. Two important angles reflect the anatomy as seen on lateral radiographs. The first is Böhler's angle which is subtended by a line drawn from the superior aspect of the anterior process to the superior aspect of the posterior facet and a second line drawn from the superior aspect of the posterior facet tangential to the superior edge of the tuberosity. A normal Böhler's angle is approximately 25 to 40 degrees. Normal subtalar motion is integral for the foot to adapt on uneven surfaces with inversion and eversion [7].

Plate osteosynthesis of the intra-articular fractures is a standard treatment method, but it has potential complications such as poor wound healing and infection [8]. Calcaneal shape restoration by means of open reduction and internal fixation (ORIF) or primary subtalar arthrodesis, if needed is mandatory for prevention of late complications such as malposition, flattening of the longitudinal arch, anterior ankle impingement syndrome, lateral impingement syndrome, and axial malalignment of the hind foot [9].

Aims and Objectives

1. To evaluate the functional outcome of open reduction and internal fixation of calcaneal fractures with plates using extensile lateral approach using Ankle Orthopedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score.
2. To study the advantages and disadvantages of open reduction and internal fixation of calcaneal fractures with locking plates using extensile lateral approach.

Materials and Methods

This prospective study of thirty patients was conducted in Department of Orthopaedics, Ravindra Nath Tagore Medical College and Maharana Bhupal Hospital, Udaipur, Rajasthan between December 2021 to November 2022. Patients who attended Orthopaedics casualty and outpatient department with fracture of calcaneum were admitted and selected for the study based on inclusion and exclusion criteria and were followed up to 9 months. Ethical Committee clearance was obtained prior to the study.

Inclusion criteria

1. Patients willing to give consent and willing for follow-up.
2. Age criteria: 20 to 60 years
3. Sanders type II, III and IV
4. Fractures < 4 weeks
5. Closed fracture calcaneum

Exclusion criteria

1. Fractures > 4 weeks
2. Sanders type I calcaneal fracture
3. Avulsion and compound fracture
4. Patients not willing for surgery
5. Lost to follow up and death

Surgical procedures

Anaesthesia

The procedure was performed under anaesthesia.

The lower limb was thoroughly scrubbed followed by painting with betadine and surgical spirit and then draping were done.

Position of patient

Patient is placed in lateral decubitus position. C-Arm is placed (As shown in figure 18) in order to take fluoroscopy images of both lateral and Harris axial views without changing its position.

Implant choice: The calcaneus locking plate system was selected for open reduction plate fixation. A4.5-mm-diameter cannulated screw and a 6.5-mm-diameter cannulated screw were selected for closed reduction percutaneous fixation

Operative Procedure: Extensile Lateral approach

1. A 'L' shaped incision was made with the horizontal limb in line with the fifth metatarsal and the vertical limb is in between the Achilles tendon and fibula.
2. The incision was made down to the bone to create a flap
3. The flap developed was then retracted anteriorly (held with K wires) to expose the posterior subtalar joint.
4. The subtalar joint was opened and the fractures of the lateral calcaneal wall was dissected.
5. Reduction was maintained temporarily by 1.5mm K-wires.
6. Plate with appropriate number of holes was selected and fixed to the lateral wall of calcaneum with K wires. The sleeves were then screwed into the hole.
7. The holes for fixation of screws were drilled using a drill bit. Screws were inserted until the base of their head is blocked against the plate.
8. Wound was closed in layers.

Fig 1 a): Extensile lateral approach with exposed lateral wall of calcaneum with fracture

Fig 1 b): Fracture reduced with k wire and calcaneal plate along with sleeve is inserted

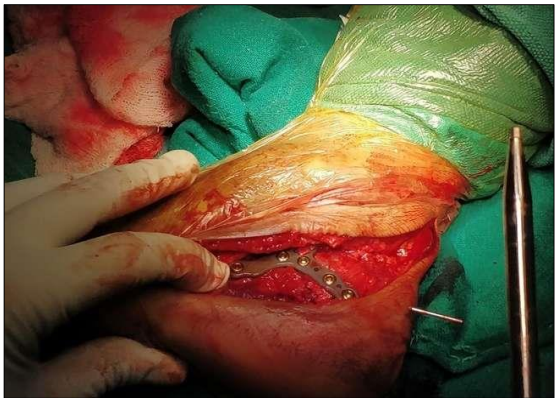


Fig 1 c): Calcaneal plate fixed with screws

Post operative care

Compression bandage and limb elevation were done in immediate postoperative period to reduce edema. Suture removal was done on the 14th postoperative day. Ankle joint and subtalar joint mobilization was started after 2 weeks.

Post-operative protocol

Non-weight-bearing ambulation was begun from the 2nd day until 6 weeks. After 6 weeks, lateral and axial view X-rays were obtained. Weight-bearing from a tolerated to full weight-bearing was permitted at 6–8 weeks after surgery. After 8 weeks, the patients were allowed to return to light work (after 10 weeks for medium work and 12 weeks for heavy work).

Table 1: American orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score

Parameters	Points
Pain (40 points)	
None	40
Mild	30
Moderate	20
Severe	0
Function (50 points) Activity limitations	
None	10
Limitations on recreational activities	7
Some limitations on daily and recreational activities	4
Severe limitations on daily and recreational activities	0
Maximum continuous walking distance	
600m or more	5
400m to less than 600m	4
100m to less than 400m	2
Less than 100m	0
Walking surfaces	
No difficulty on any surface	5
Some difficulty on uneven terrain, stairs, inclines	3
Severe difficulty or inability to walk on uneven terrain, stairs, inclines	0
Gait abnormality	
None or slight	8
Obvious (walking possible but gait abnormality obvious)	4
Marked(walking difficult and gait abnormality obvious)	0
Sagittal motion (flexion plus extension)	
Normal or mild restriction (300 or more)	8
Moderate restriction (150 to 290)	4
Severe restriction (less than 150)	0
Hindfoot motion (inversion plus eversion)	
Normal or mild restriction (75% - 100%normal)	6
Moderate restriction (25%-74%normal)	3
Severe restriction (less than 25%normal)	0
Ankle-hindfoot stability (Anterior drawer, varus-valgus stress)	
Stable	8
Unstable	0
Alignment (10 points)	
Good, plantigrade foot, well aligned	10
Fair, plantigrade foot, mild to moderate degree of malalignment	5
Poor, non-plantigrade foot, severe malalignment	0

Functional Assessment

Clinical outcome pictures of the operated left calcaneum at 9 months follow up are shown below

Dorsiflexion of left ankle joint

Plantarflexion of left ankle joint

Fig 2: Image showing clinical outcome of operated left calcaneum at 9 months

Observations

Table 2: Age and Gender wise distribution of patients

Age group (years)	Female		Male	
	No.	%	No.	%
21-30	2	66.67	10	37.03
31-40	1	33.33	8	29.62
41-50	0	0	7	25.92
51-60	0	0	2	7.4
Total	3	100	27	100

Table 3: Side of injured foot and gender wise distribution of patients

Side of injured foot	Female		Male	
	No.	%	No.	%
Left	2	66.67	14	51.86
Right	1	33.33	10	37.03
Bilateral	0	0	3	11.11
Total	3	100	27	100

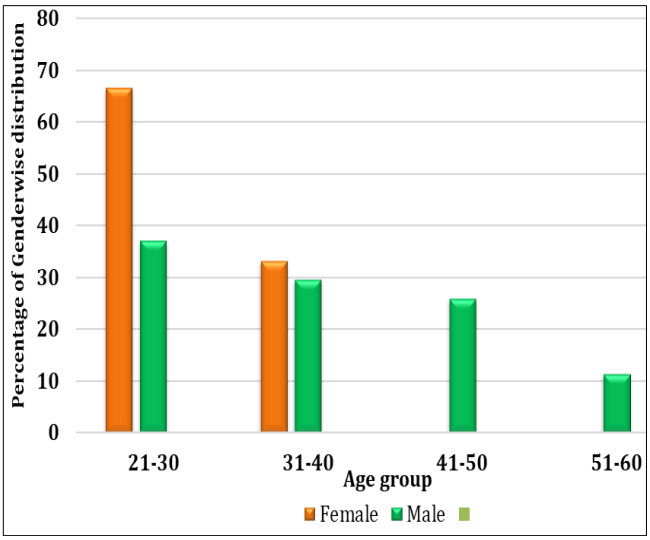


Fig 3: Age and percentage of Gender wise distribution of patients

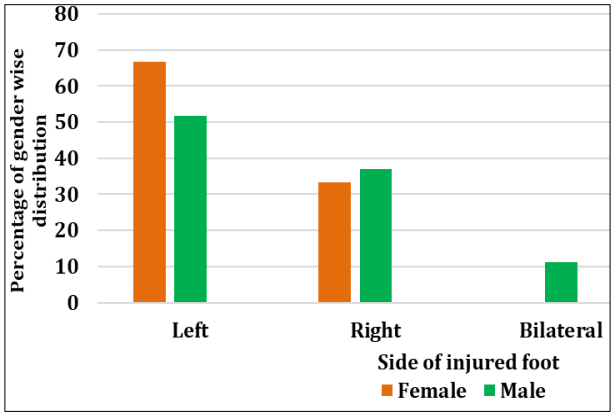


Fig 3: Side of injured foot and percentage of Gender wise distribution of patients

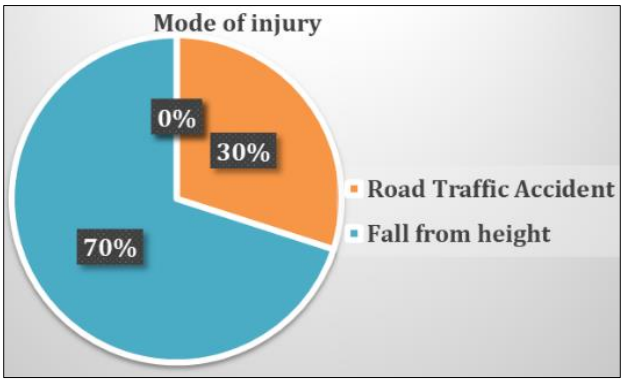


Fig 4: Mode of injury showing percentage distribution of patients

In this present study, there were 5 patients with associated injuries. These include-

1. Fracture both bone leg right, fracture medial malleolus right.
2. Grade 2 compound fracture both bone leg left.
3. Fracture distal radius left.
4. Undisplaced fracture right superior and inferior pubic rami, L1 anterior wedge compression fracture.
5. Fracture D12, L1 vertebrae

Table 4: Number of patients in each category of Sanders classification

Type II	10
Type III	13
Type IV	7

Table 5: Duration of operation from date of injury

Duration (days)	No. of cases	Percentage
1-10	12	40
11-20	18	60

Table 6: Number of cases with complications and associated comorbidities and risk factor

	Smoking	Diabetes mellitus	Systemic hypertension	Nil
Wound dehiscence	1	1	0	1
Stiffness	0	1	1	0
Delayed union	1	1	0	0

Table 7: Duration of fracture union

Time of union	Number of cases	Percentage
2-3 months	24	80
3-4 months	4	13.34
More than 4 months	2	6.66

Table 8: Radiological analysis Preoperative and postoperative Bohler's angle in Sanders types II, III and IV.

		Type II	Type III	Type IV
Preoperative	10°-20°	8	9	4
	Less than 10°	2	4	3
Postoperative	20°-30°	9	11	5
	15°-20°	1	2	2

Table 9: Functional outcome at 9 months-pain

Character	Number of cases	Percentage (%)
No pain	26	86.67
Mild	3	10
Moderate	1	3.33
Severe	0	0
Total	30	100

Table 10: Sanders classification and AOFAS scoring at 3 months follow up

Sanders type	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
II	-	-	2	20	7	70	1	10
III	-	-	2	15.38	10	76.92	1	7.69
IV	-	-	1	14.28	4	57.14	2	28.57

Table 11: Sanders classification and AOFAS scoring at 9 months follow up

Sanders type	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
II	3	30	5	50	2	20	0	0
III	2	15.38	8	61.53	2	15.38	1	7.69
IV	1	14.28	2	28.57	3	42.85	1	14.28

Table 12: Outcome assessed with AOFAS Score at 9 months follow up

S. No.	Name	Pain (40)	Function (50)							Alignment (10)	Total (100)
			L (10)	WD (5)	WS (5)	G (8)	SM (8)	HFM (6)	AHS (8)		
1	Ratan	20	4	2	3	4	4	3	0	5	45
2	Mahender	40	7	4	3	4	8	3	8	5	80
3	Mohit	30	7	4	3	8	4	3	8	5	72
4	Sarita	40	10	4	5	8	8	6	8	10	99
5	Saruprita	30	7	4	3	8	4	3	8	5	72
6	Kunal	30	7	5	3	8	4	3	8	10	78
7	Mukesh	40	7	4	3	4	4	3	8	5	78
8	Dinesh	40	7	4	3	4	4	3	8	5	78
9	Daksh	30	7	4	3	4	4	3	8	5	68
10	Kalu	30	4	4	3	8	4	3	8	5	69
11	Sunil	20	4	4	3	4	4	3	0	5	47
12	Ravi	40	4	4	3	4	4	6	8	5	78
13	Govind	30	4	4	3	4	4	3	8	5	65
14	Mahesh	40	7	4	3	4	4	6	8	10	86
15	Raghav	40	10	4	3	8	4	6	8	10	93
16	Prakash	40	7	4	3	4	8	6	8	10	90
17	Pankaj	30	7	4	3	8	4	3	8	5	72
18	Bhagwan	40	7	5	3	8	8	6	8	10	95
19	Anand	40	10	4	5	8	8	3	8	10	96
20	Akash	40	7	4	3	4	4	6	8	5	81
21	Soumyajit	40	10	4	3	4	8	6	8	10	93
22	Himanshu	40	4	4	3	4	4	6	8	5	78
23	Pooja	40	10	4	3	8	4	6	8	10	93
24	Suresh	40	10	4	3	8	8	6	8	10	97
25	Bhanwar	30	4	4	3	4	8	3	8	5	69
26	Mohan	30	7	4	3	8	8	3	8	5	76
27	Mani lal	40	10	5	3	8	8	3	8	10	95
28	Durgesh	30	7	5	3	4	8	3	8	10	78
29	Upendra	40	7	4	3	4	8	6	8	10	90
30	Kailash	40	10	5	3	8	8	3	8	10	95

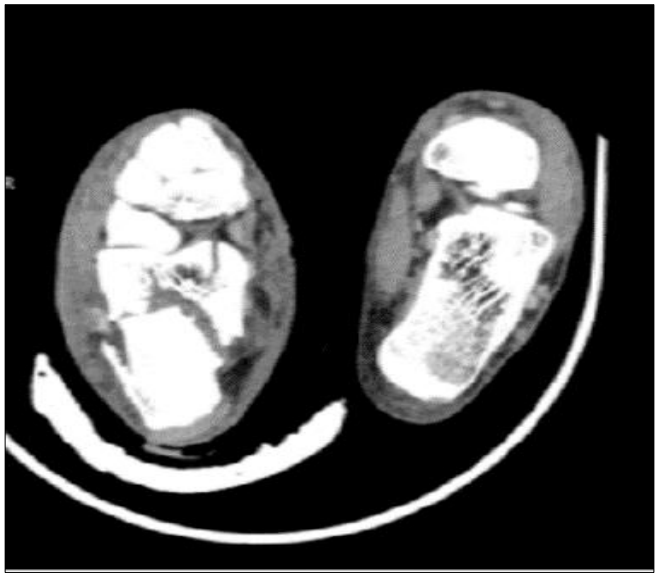
L-Limitation, WD-Walking Distance, WS-Walking Surface, G-Gait, SM-Sagittal Motion, HFM-Hind Foot Motion, AHS-Ankle Hindfoot Stability.

Case illustrations

Case 1

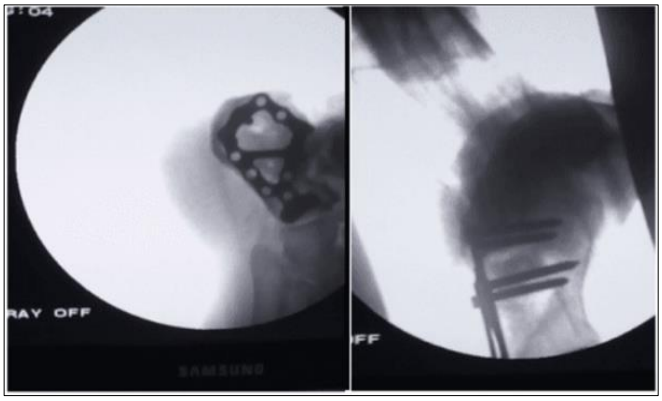
Pre operative skin condition

Preoperative X-ray



CT scan showing Sanders type III

Intra operative image showing gentle retraction of entire flap in one layer with plate and screws



Intra operative C-arm image showing lateral and axial views

Functional outcome at 9 months follow up.

Case 2

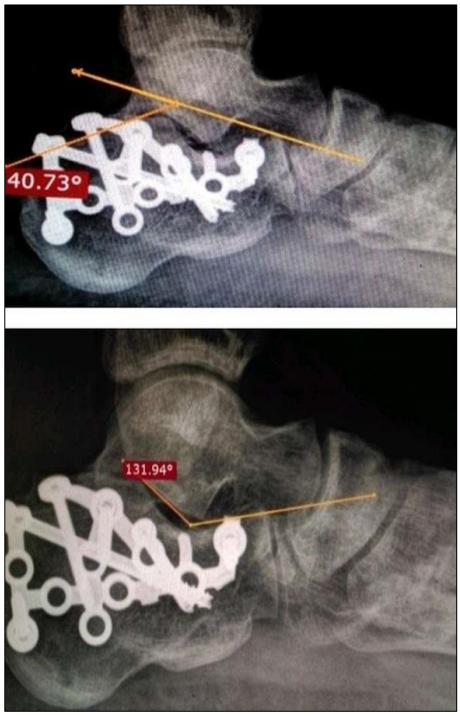
Preoperative X-ray

CT scan showing Sanders type II

Postoperative X-ray

Postoperative wound showing good healing

Functional outcome

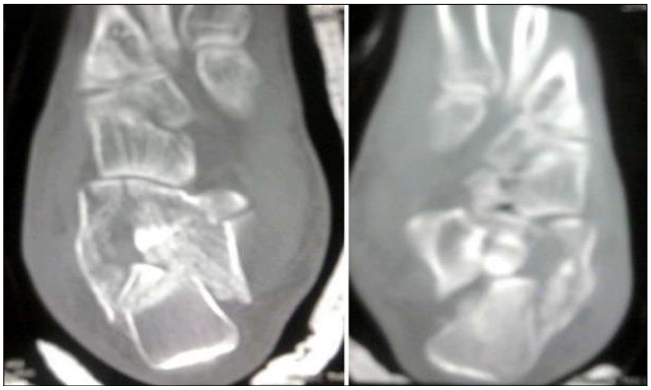


Radiological results showing restoration of Bohler's and Gissane's angles

Case 3

Preoperative clinical photograph

Radiological images showing fractures of right and left calcaneum



CT scans showing Sanders type III of left side and right side calcaneum respectively

Postoperative radiograph showing left and right calcaneum respectively

Postoperative 9 months follow up clinical examination showing inversion

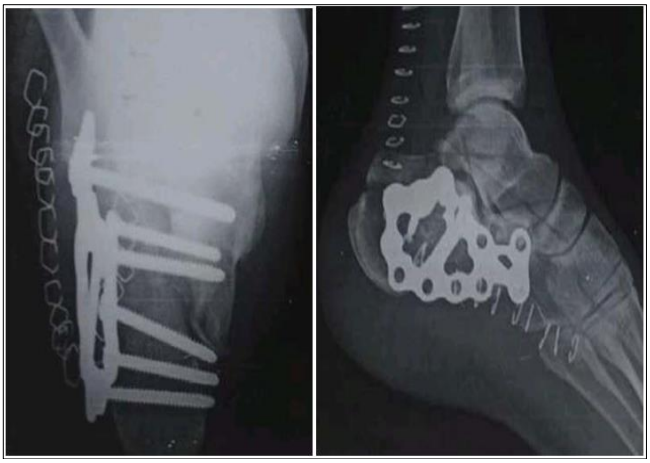
Postoperative 9 months follow up clinical examination showing longitudinal arch of foot

Case 4

Preoperative X-ray

Postoperative X-ray at 9 months showing both lateral and axial views

Functional outcome at 9 months follow up-plantar flexion and dorsiflexion respectively



Immediate postoperative X-ray

Functional outcome at 9 months follow up

Postoperative X-ray at 9 months follow up

Case 5

Preoperative X-ray

Functional outcome at 9 months follow up- plantar flexion and dorsiflexion respectively

Functional outcome at 9 months follow up

Discussion

The present study was done to assess the functional outcome of open reduction and internal fixation of calcaneal fractures with plates using extensile lateral approach. The study included 30 patients with closed calcaneal fractures.

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Not available

Author's Contribution
Not available

Conflict of Interest
Not available

Financial Support
Not available

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