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Research Article

Functional Outcome Assessment after Surgical Treatment of Calcaneal Fractures with Plates Using an Extensile Lateral Approach

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Abstract

Objective: *The aim of this study was to assess the functional outcome of open reduction and internal fixation of calcaneal fractures using plates and an extensile lateral approach. Additionally, we aimed to evaluate the advantages and disadvantages of this surgical technique using the Ankle Orthopedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score.*

Methods*: In this prospective study, conducted between December 2021 and November 2022, patients with calcaneal fractures who attended the Orthopedics casualty and outpatient department at Ravindra Nath Tagore Medical College and Maharana Bhupal Hospital in Udaipur, Rajasthan were admitted and selected based on specific inclusion and exclusion criteria. A total of 30 patients were chosen, provided informed written consent, and underwent preoperative evaluation. They were then operated on and followed up for 9 months. The functional outcome was assessed using the AOFAS score.*

Results: *The AOFAS Ankle-Hindfoot score was evaluated at 3 months and 9 months follow-up for all patients. At the 3-month follow-up, 20% of patients with Sanders type II fractures, 15% with Sanders type III fractures, and 14% with Sanders type IV fractures achieved a good score. Fair scores were observed in 70% of Sanders type II cases, approximately 77% of Sanders type III cases, and around 57% of Sanders type IV cases. Poor scores were seen in 10% of Sanders type II cases, 7% of Sanders type III cases, and approximately 28% of Sanders type IV cases. At the 9-month follow-up, approximately 30% of Sanders type II cases, 15% of Sanders type III cases, and 14% of Sanders type IV cases achieved an excellent AOFAS score. Good scores were observed in 50% of Sanders type II cases, 62% of Sanders type III cases, and 28% of Sanders type IV cases. Fair scores were seen in 20% of Sanders type II cases, 15% of Sanders type III cases, and 43% of Sanders type IV cases. Poor scores were observed in only 7% of Sanders type III cases and 14% of Sanders type IV cases.*

Conclusion

This study demonstrates that the functional outcome of surgical management for calcaneal fractures, assessed using the AOFAS Ankle-Hindfoot score at 3 months and 9 months, showed a majority of patients achieving a good score. The AOFAS Ankle Hindfoot scoring system proved effective in assessing the functional status of patients, consistent with previous studies. The advantages of the extensile lateral approach for managing calcaneal fractures include enhanced exposure of the calcaneus, facilitating easier access to facet fragments, the ability to decompress the lateral wall, exposure of the calcaneo-cuboid joint, and adequate lateral area for plate fixation. However, disadvantages include potential injury to the blood supply of the lateral flap, challenges in assessing reduction of the medial wall, and a higher incidence of wound problems associated with this approach.

Key words:

Calcaneal fractures, Extensile lateral approach, AOFAS-Ankle Hindfoot score.

Introduction

Fractures of the calcaneus are the most commonly occurring fractures in the tarsal bones, accounting for 60% of all tarsal fractures. Among these fractures, 75% are displaced intra-articular fractures. The management of these fractures proves to be challenging and often controversial. Traditionally, open reduction and internal fixation with a conventional plate, using an extensible lateral L-shaped approach, has been considered the standard treatment for displaced intra-articular calcaneal fractures. This approach provides excellent exposure of the fracture and allows for direct reduction of the depressed posterior facet fragment. However, various studies have reported a high rate of postoperative wound complications associated with this technique, including wound edge necrosis, dehiscence, hematoma, or deep infection. To minimize these complications, several minimally invasive procedures have been introduced, such as percutaneous reduction internal fixation, arthroscopically assisted fixation, and minimal incision techniques via different approaches. These techniques aim to reduce soft tissue trauma, thereby lowering the risk of operative complications, while still achieving good fracture reduction.

Our team has developed a new minimally invasive percutaneous insert plate based on the anatomical structure of the calcaneus and the sinus tarsi approach for treating displaced intra-articular calcaneal fractures. This approach has shown favorable outcomes in our clinical series. The purpose of this study is to compare the therapeutic effects and complications between open reduction and internal fixation with a conventional plate via an L-shaped lateral approach and internal fixation with our percutaneous plate using a sinus tarsi approach for the treatment of calcaneal fractures.

Aims and Objectives

1. To assess the functional outcome of open reduction and internal fixation of calcaneal fractures using plates and an extensible lateral approach, using the Ankle Orthopedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score
2. To analyze the advantages and disadvantages of open reduction and internal fixation of calcaneal fractures using locking plates and an extensible lateral approach.

Material & Methods

This study was conducted at the Department of Orthopaedics, Ravindra Nath Tagore Medical College and Maharana Bhupal Hospital in Udaipur, Rajasthan, between December 2021 and November 2022. A total of thirty patients with calcaneum fractures who visited the Orthopedics casualty and outpatient department were admitted and selected for the study based on specific criteria. These patients were followed up for a period of 9 months. Prior to the study, ethical clearance was obtained from the Ethical Committee.

The inclusion criteria for patient selection were as follows:

1. Patients who were willing to give consent and participate in the follow-up
2. Age range of 20 to 60 years
3. Patients with Sanders type II, III, and IV fractures
4. Fractures that occurred within the past 4 weeks
5. Closed fractures of the calcaneum.

On the other hand, the following criteria were used for exclusion:

1. Fractures that occurred more than 4 weeks prior
2. Sanders type I calcaneal fractures
3. Avulsion and compound fractures
4. Patients who were not willing to undergo surgery.
5. Patients who were lost to follow-up or deceased.

The surgical procedure was performed by the senior author, usually within 5 to 12 days (average of 7.4 days) after the injury. Upon admission, all patients had their affected extremities elevated and ice applied to reduce swelling and prevent blisters. Spinal subarachnoid block analgesia or epidural anesthesia was administered, and the patients were positioned either in a lateral decubitus position with the affected foot's lateral malleolus uppermost for unilateral fractures or in a supine position for bilateral fractures.(fig1)

In the routine treatment group, the standard extended lateral approach with an L-shaped incision was employed. The vertical part of the incision was placed between the fibula and Achilles tendon, while the horizontal part aligned with the base of the fifth metatarsal. A full-thickness flap was created by making an incision directly to the bone at the corner. Three 2.0-mm Kirschner wires were used to hold the flap in place once the lateral wall of the calcaneus and subtalar joints were exposed. Distraction with a 3.5 mm Steinmann pin was used for fracture reduction, and fixation was achieved using a Y-plate or H-plate specifically designed for the calcaneus. Rigid fixation was confirmed under C-arm fluoroscopy, and rubber drains were inserted into the anterior and posterior incisions. The incision was then closed in layers, followed by compression bandaging.

Post Operative Care

In the immediate period following the operation, a compression bandage and limb elevation were utilized to effectively reduce swelling. On the 14th day after the operation, the sutures were removed. Two weeks thereafter, mobilization of the ankle joint and subtalar joint was initiated.Few examples showed different cases & followup .(fig 1,2,3)

Post Operative Protocol

Following the operation, intravenous antibiotics were administered for a duration of 5 days, while oral antibiotics were continued for 7 days. A below knee slab was applied to all patients postoperatively. Regular follow-ups were scheduled on a monthly basis for the first three months, followed by visits every three months. These follow-up appointments consisted of subjective evaluations (assessing patient satisfaction) and clinical assessments. The clinical assessments included evaluating pain levels, gait, activity limitations, maximum continuous walking distance, ankle hindfoot stability, plantar flexion and dorsiflexion at the ankle, as well as inversion and eversion at the subtalar joint. These assessments were based on the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle Hindfoot Score. The purpose of using this score during the follow-up period was to gauge the patient's functional improvement. Additionally, radiographs were taken of all patients to assess radiological union, using anteroposterior, lateral view, and Harris axial view.(fig 2).

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

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

Results	**Scores**
Excellent	95-100
Good	75-94
Fair	51-74
Poor	0-50

Case 1

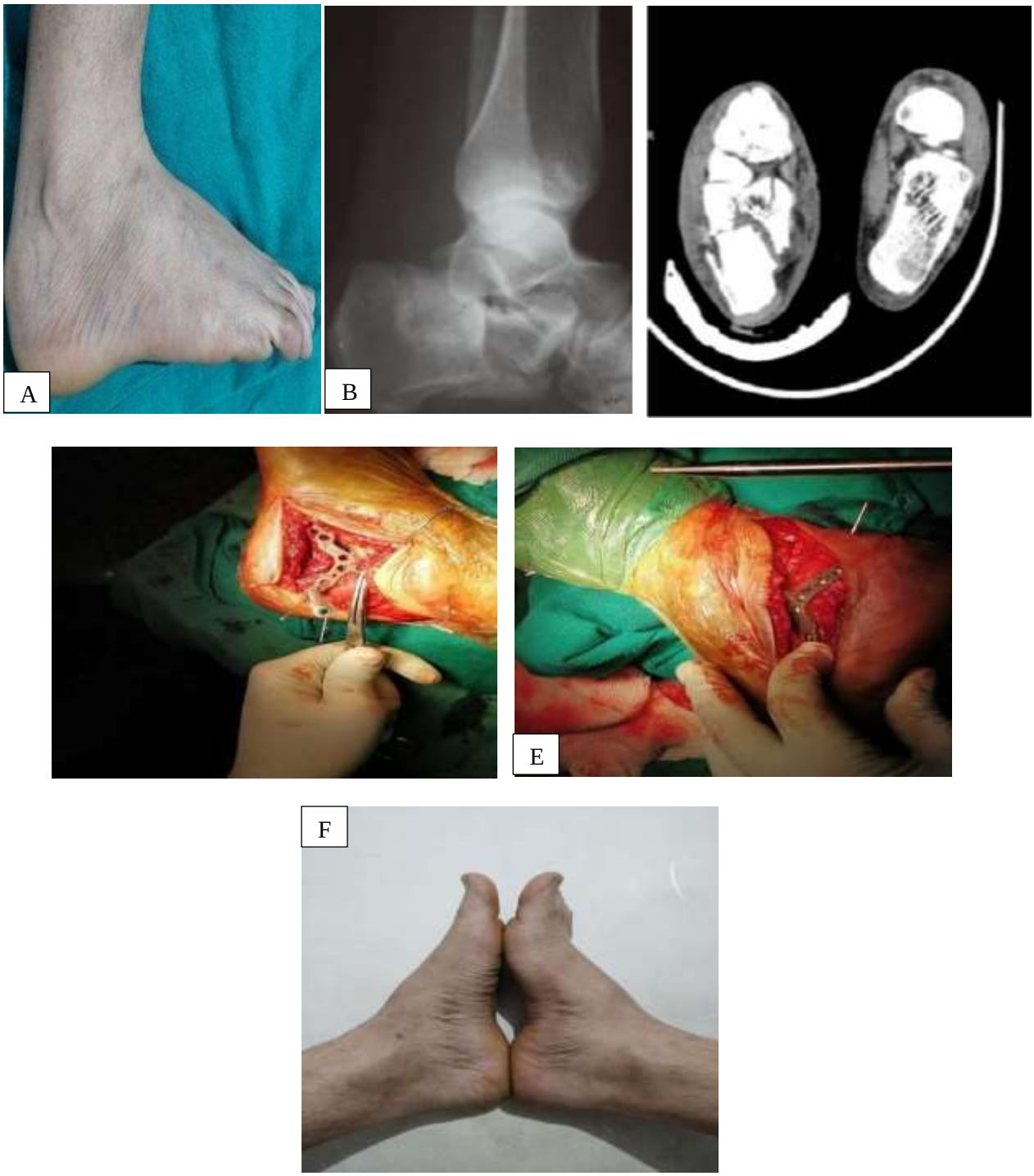
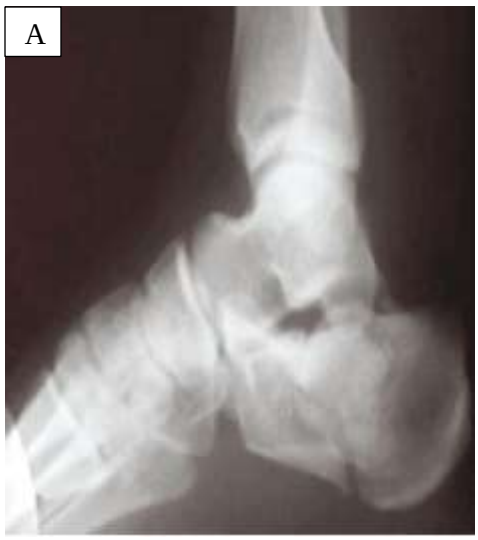
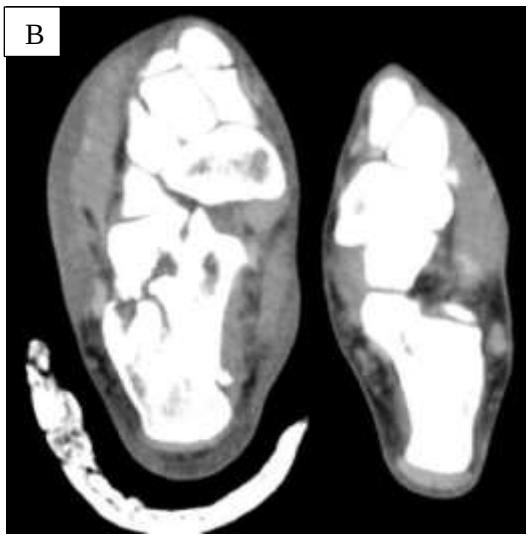


Figure 1 a,b,c,d ,e,f shows the wrinkle sign, preop sanders type 3 , CT scan showing Sanders type III lateral calcaneal approach with application of lateral anatomical plate, fracture reduction process with the use of K-wires, Functional outcome at 9 months follow up.

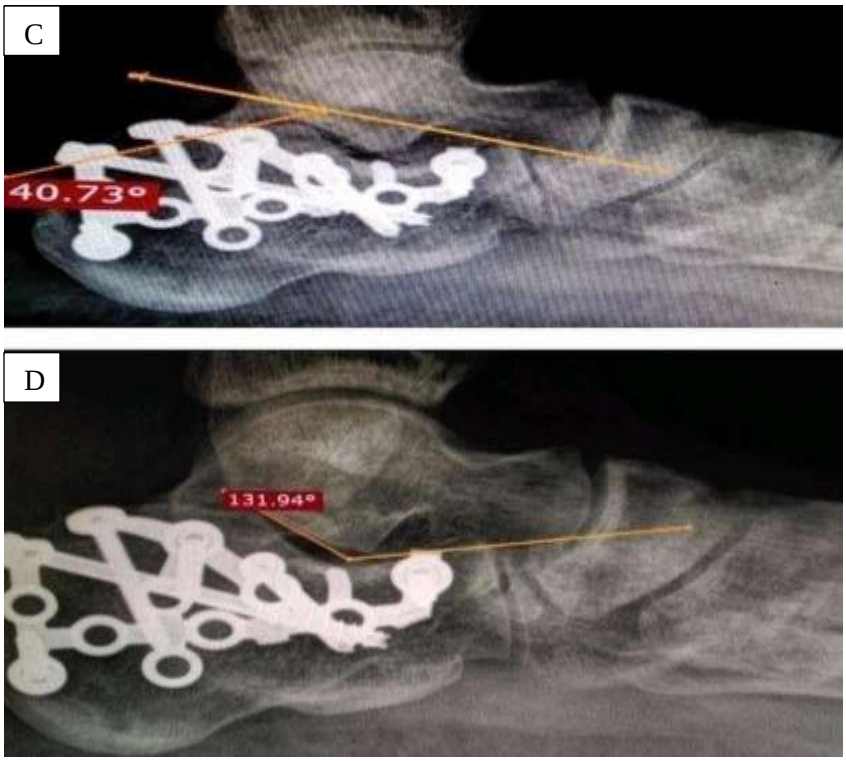
Case 2



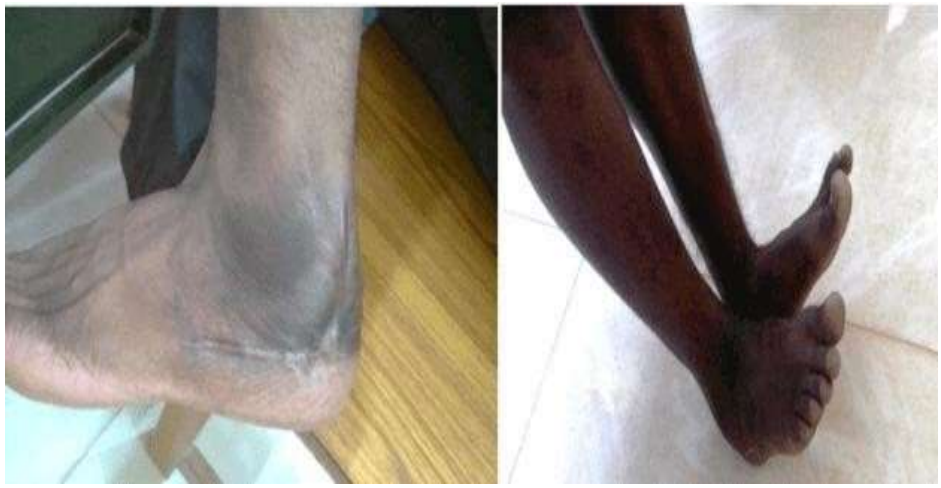
Preoperative X-ray



CT scan showing Sanders type II



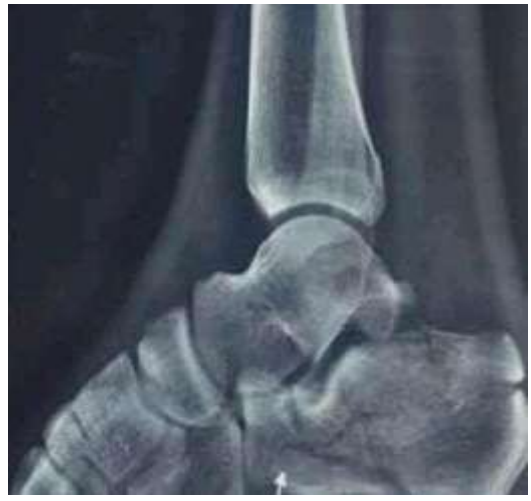
Radiological results showing restoration of Bohler's and Gissane's angles.



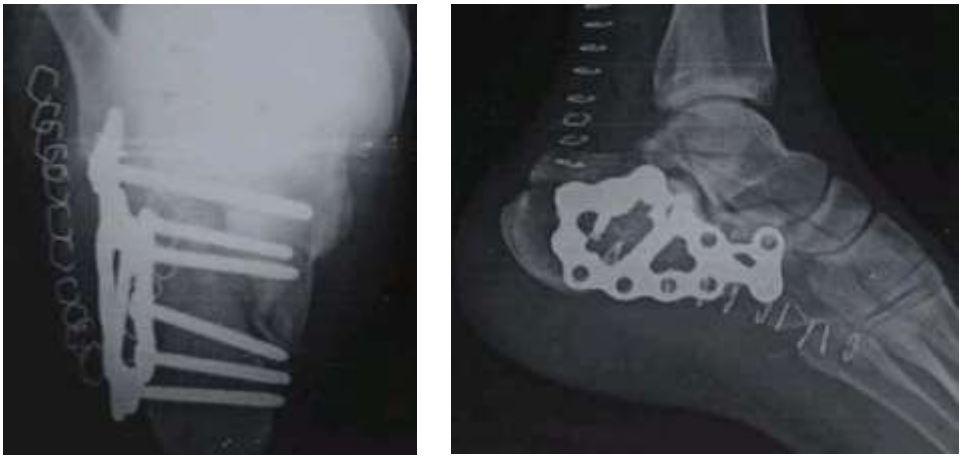
Functional outcome

fig 2 a, b, c, d Before the surgery, an X-ray CT scan was conducted, which revealed a Sanders type II fracture. The radiological results indicated the restoration of both Bohler's and Gissane's angles. The functional outcome after the surgery was positive.

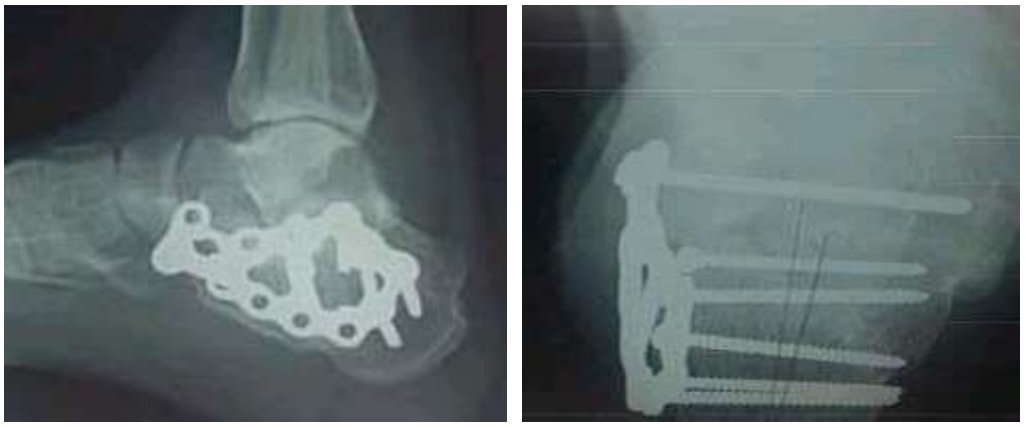
Case 3



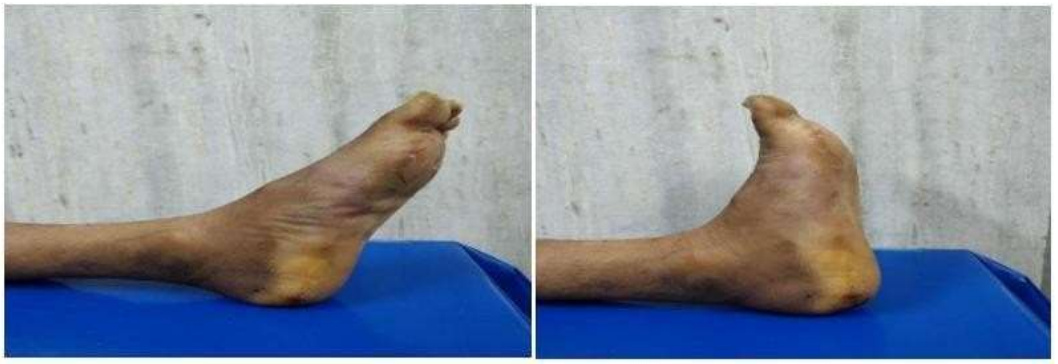
Preoperative X-ray



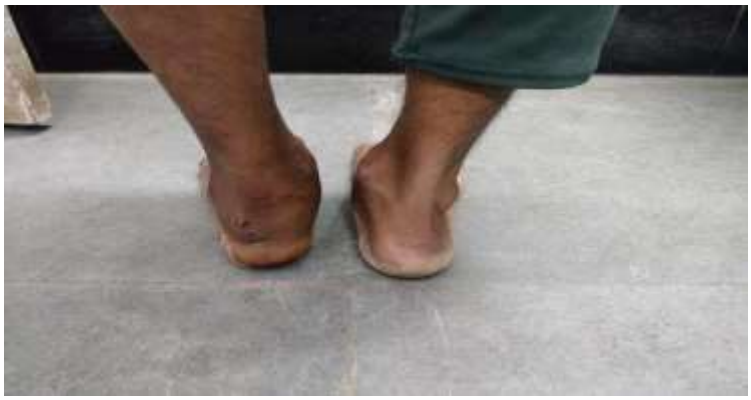
Immediate postoperative X-ray



Postoperative X-ray at 9 months follow up



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



Functional outcome at 9 months follow up

Fig 3 a, b, c, d: Before the surgery, a clinical photograph was taken, which showed fractures in the right and left calcaneum. CT scans were also performed, revealing Sanders type III fractures in both the left and right calcaneum, respectively. Postoperative radiographs showed the condition of the left and right calcaneum after the surgery. A follow-up examination conducted 9 months after the surgery showed inversion and the preservation of the longitudinal arch of the foot.

CASE 4 Before the surgery, an X-ray was taken. Postoperative X-rays, including both lateral and axial views, were taken at the 9-month mark. The functional outcome at the 9-month follow-up showed positive results for plantar flexion and dorsiflexion, respectively.

Result & Observations

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 2: Age and Gender wise distribution of patients

Type II	10
Type III	13
Type IV	7

Table 3: Number of patients in each category of Sanders classification

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

Table 4: Number of cases with complications and associated comorbidities and risk factor

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 5: Duration of fracture union

		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 6: Radiological analysis

Preoperative and postoperative Bohler's angle in Sanders types II, III and IV

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

Table 7: Functional outcome at 9 months-pain

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 8: Sanders classification and AOFAS scoring at 3 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 9: Sanders classification and AOFAS scoring at 9 months follow up

S. No.	Name	Pain (40)	Function (50)							Alignment	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

Table 10: Outcome assessed with AOFAS Score at 9 months follow up

Discussion

Although there is ongoing debate about the best way to manage displaced intra-articular calcaneal fractures, the most commonly used approach has been an L-shaped, extensile lateral approach.

This method allows for a good view of the fractured lateral wall of the calcaneus and subtalar joints, as well as the reduction of the subtalar and calcaneocuboid articulations using Steinmann pins. (fig3) Additionally, the fracture is stabilized using internal fixation plates, which have been shown to result in positive functional outcomes. In our study, we observed significant improvements in calcaneal height, width, length, Böhler's angle, and Gissane's angle using this extensile lateral L-shaped approach, with a success rate of 86.8%. Recently, there has been increased focus on the delicate management of soft tissues using the extensile lateral L-shaped approach, including the creation of full-thickness flaps and a "no touch" technique.

However, postoperative wound complications still occur. Previous research has identified risk factors for such complications, including diabetes, smoking, and open fractures. In our own research, we excluded patients with these risk factors and employed full-thickness flaps and a "no touch" technique.

The treatment of displaced calcaneal fractures has also been successfully achieved using percutaneous screws fixation. However, this approach may not fully expose the lateral wall of the calcaneus and limit the use of common calcaneal plates. In our team's approach, we utilized a calcaneus plate with a protruding screw hole for support of fractured fragments below the posterior articular surface.

This creates a solid triangle support through front, central, and rear screw fixation. Our plate has a simple structure, small size, and perfect fit with the lateral calcaneus, providing adequate strength to support the fractured calcaneus while reducing tension on the skin and soft tissues. Additionally, the plate allows for easy insertion and extraction through the channel between the peroneal tendon and the lateral wall of the calcaneus due to its minimal space occupation.

Conclusion

In summary, when it comes to treating displaced fractures in the calcaneum joint, employing an extended lateral approach with calcaneum locking plates and screws for open reduction and internal fixation can yield a considerable number of favorable outcomes, with only a minimal occurrence of unsatisfactory results. Therefore, this treatment approach stands as a superior choice for managing displaced fractures in the calcaneum joint.

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