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Original Research Article

A Comparative Study between Conservative and Surgical Management of Displaced Calcaneal Intraarticular Fracture

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Abstract

Background: Fractures of the calcaneus, or heel bone, constitute the majority of tarsal fractures, representing about 2% of all fractures and 60% of tarsal fractures. They tend to occur more frequently in men than in women, typically peaking in incidence during the fourth and fifth decades of life. The primary cause of these fractures is often a high-energy fall from a height, responsible for approximately 70% to 80% of cases. Other contributing factors include motor vehicle accidents, crush injuries, and sports-related trauma.

Methods: Upon hospital admission, the patient underwent airway, breathing, and circulation assessment, followed by a comprehensive neurological examination to exclude other significant injuries. Radiographs of the calcaneus, ankle mortise, spine, and other pertinent areas were obtained. History-taking encompassed age, sex, occupation, injury details, and medical history. Fracture diagnosis was confirmed via radiographs.

Results: Surgical Group: 60% of patients achieved an "excellent" outcome. 20% achieved a "good" outcome. 13.33% had a "fair" outcome. 6.67% had a "poor" outcome.

Conservative group: No patients achieved an "excellent" outcome. 40% achieved a "good" outcome. 40% achieved a "fair" outcome. 20% had a "poor" outcome. This table shows that surgical intervention may be associated with better outcomes compared to conservative management for intra-articular calcaneal fractures. A higher proportion of surgically treated patients achieved "excellent" and "good" outcomes, while the conservative group had no patients with "excellent" outcomes and a higher percentage with "fair" and "poor" outcomes.

Conclusion: In our study, open calcaneal fractures had good outcomes when surgery was performed, and functional results were better when restoration of Bohler's angle was performed. The restoration of subtalar congruency is necessary for optimal outcomes. tensile L-shaped lateral approach is associated with minimal postoperative wound complications, better visualization of the subtalar joint, and a wide space for lateral plate fixation. Conservative management resulted in no change in the restoration of Bohler's angle, and few cases had poor outcomes.

Keywords: Calcaneal Fractures, Conservative Management, Surgical Management.

Introduction

The calcaneus, or os calcis, serves as the largest and most commonly fractured tarsal bone, playing a pivotal role in weight-bearing and normal ambulation due to its contribution to the foot's structural integrity. Despite advancements in mechanized industry and transportation, calcaneal fractures have remained prevalent throughout human history, causing significant morbidity given their importance in locomotion. Calcaneal fractures are the most common tarsal fracture, accounting for approximately 2% of all fractures and 60% of tarsal fractures. [1, 2] They are more common in men than in women, with a peak incidence in the fourth and fifth decades of life. The most common mechanism of injury is a high-energy fall from a height, accounting for 70% to 80% of cases. [3] Other mechanisms of injury include motor vehicle accidents, crush injuries, and sports injuries. Being the most frequent type of tarsal bone fracture, approximately 75% of calcaneal fractures are intra-articular. Treatment outcomes for displaced intra-articular calcaneal fractures (DIACF) are often suboptimal, with no definitive consensus on the superiority of surgical versus conservative approaches. [4] While some retrospective studies advocate for surgical intervention, citing improved functional outcomes and reduced pain compared to conservative management, concerns persist among orthopedic surgeons regarding potential wound complications associated with surgery. Cotton F et

al. [5] remarked that individuals sustaining heel bone fractures often faced grim prospects for their future employability. Bankart et al. [6] echoed this sentiment 35 years later, highlighting the poor treatment outcomes for crush fractures. Conn et al. [7] described calcaneal fractures as severe and disabling injuries with incurable outcomes. Bohler et al. [8] advocated for open reduction of calcaneal fractures in 1931, though closed reduction remained standard due to technical challenges associated with surgery. Subtalar fusion emerged as a common treatment during the 1950s due to its simplicity. However, advancements in anesthesia, antibiotics, imaging modalities like computed tomography (CT), and surgical techniques have since revolutionized fracture management, leading to improved outcomes. Despite these strides, operative treatment remains challenging. This study aims to evaluate the functional outcomes, benefits, and complications associated with various management approaches for displaced intra-articular calcaneal fractures in patients aged 20 years and above.

Material and Methods

This is a prospective study done in Mahatma Gandhi Memorial Hospital, Warangal from August 2020 to December 2022 after due approval of the ethical committee of medical college. The present study was done to evaluate the outcome of Calcaneal fractures by various methods. The outcome of the study was evaluated based on the Creighton Nebraska scoring system, radiological criteria (Bohler's and Gissane's angle), and heel width.

Inclusion Criteria

1. Age above 18 years of age.
2. Simple/ closed fractures
3. Compound fractures

Exclusion Criteria

1. Age below 20 years.
2. Associated with infection.
3. Patients having associated lower end of tibia and fibula fracture involving ankle mortise.

As soon as the patient was brought to the hospital, the patient's airway, breathing, and circulation were assessed. A complete survey was then conducted to rule out other significant neurological injuries. Plain radiographs of the anteroposterior, lateral, and Harris axial calcaneus were obtained. Plain radiographs of the lower end of the tibia and fibula (ankle mortise), dorsolumbar, lumbosacral spine, anteroposterior, and lateral views were obtained to rule out fractures and wedge compression. A complete neurological examination was performed. On admission to the ward, a thorough history was obtained relating to Age, Sex, Occupation, Mode of injury, and any significant past/personal history (especially diabetes and smoking). Patients were examined giving special importance to determine whether the fracture was open or closed, the presence of gross swelling, fracture blisters, features of compartment syndrome, and the presence of other associated injuries. The diagnosis was confirmed using anteroposterior (dorsoplantar), lateral, and axial radiographs.

Routine investigations were performed for all patients. Preoperative Bohler's and Gissane's angles were measured. Open fractures were classified according to the Gustilo Anderson Classification. The majority of the patients were treated as patients and a few as outpatients. Conservative or operative treatment was decided based on the type of fracture, patient age, condition of the surrounding soft tissues, associated injuries, comorbidities, patients' occupation, and surgeons' decisions. 44 Calcaneal fractures in 20 patients were evaluated for calcaneal fractures. Among the fractures, 15 were surgically managed and 5 were conservatively managed. Conservative management was initially in the form of a below-knee plaster cast if there was no gross swelling. If swelling was present, it was first reduced by limb elevation, local ice packs, and anti-inflammatory drugs, and once the swelling was reduced, the cast was placed.

All patients were advised to walk without weight bearing. The cast was removed–6-8 weeks after application. Patients were radiologically assessed for fracture union. Once the fracture had united, partial weight-bearing was advised, which was gradually increased to full weight-bearing. Main indications for treating calcaneal fractures with incongruous joints and low Bohler angles. Surgery targeted these fractures using plates, screws, or a combination of both, depending on the break. Nonsurgical treatment involves casts and weight-bearing progression based on X-rays. Both approaches aim at joint alignment and good patient outcomes. Fifteen of the 20 fractures underwent surgery, while five were treated conservatively. All the patients were monitored for healing and function.

Preoperative Preparation of Patients: Patients fasted overnight before surgery. An adequate amount of compatible blood was kept ready for any eventuality, and a systemic antibiotic, usually a 3rd generation cephalosporin, was administered 1 h before surgery. The surgical implants used included K-wires, CC screws with washers, and Recon and Calcaneal plates. After surgical fixation, a below-knee cast is used. Closed reduction and internal fixation with CC screws with or without washers were performed in 3 intra-articular calcaneal fractures. Under the C arm, the K-wire was initially passed from the posterior towards the anterior fragment. Another K-wire was fixed to the sustentaculum tali over the CC screws with or without washers.

Clinical assessment by Creighton Nebraska scores All parameters were assessed in the follow-up of the patients, and the scores were graded as excellent,

good, fair, or poor. Radiological assessment in the form of pre-and postoperative Bohler's angle, improvement in angle, and outcome was assessed. Harris axial and lateral views were also taken to determine the congruity of the subtalar joint and the width of the heel.

Statistical Analysis: Descriptive statistics, such as numbers, percentages, averages, and standard deviations, were used. Data are presented as tables and graphs wherever necessary. Inferential statistical tests, such as Chi-square and Fisher's exact probability tests, were applied to determine the association between the incidence of complications and clinical variables.

Results

Figure 1: Closed intraarticular fracture right calcaneum displaced managed conservatively, Bohler's angle restored.

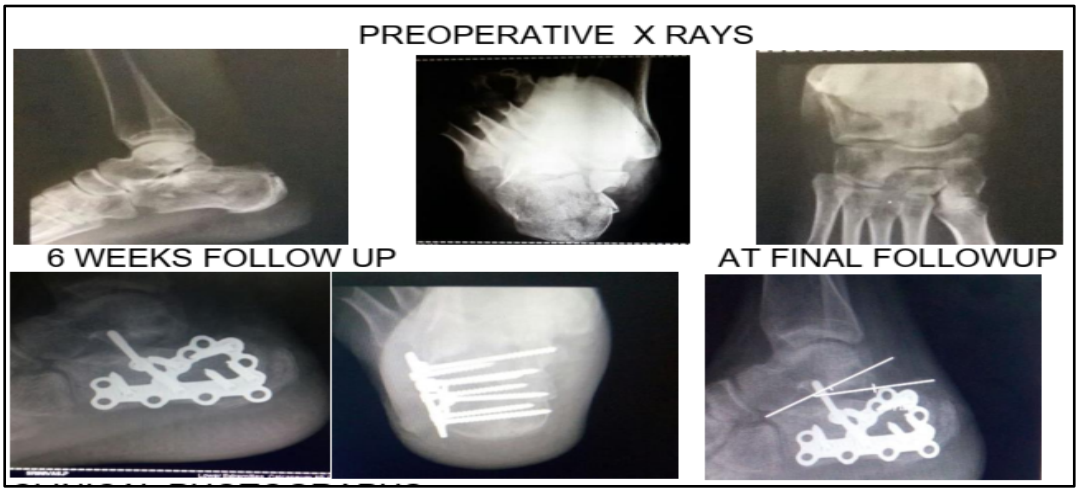

Figure 2: Closed intraarticular fracture displaced left, managed by calcaneal plate, Bohler's angle restored from 16 to 22degrees

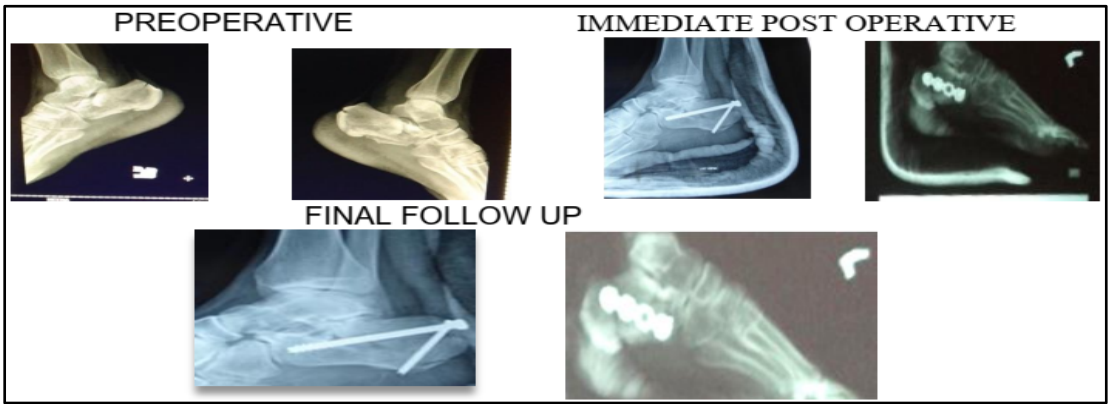

Figure 3: Closed intraarticular fracture displaced right and left tongue type, managed by right-cc screws, left-recon plate, Bohler's angle restored from right 10 degrees to 22 degrees, left 15 degrees-21 degrees.

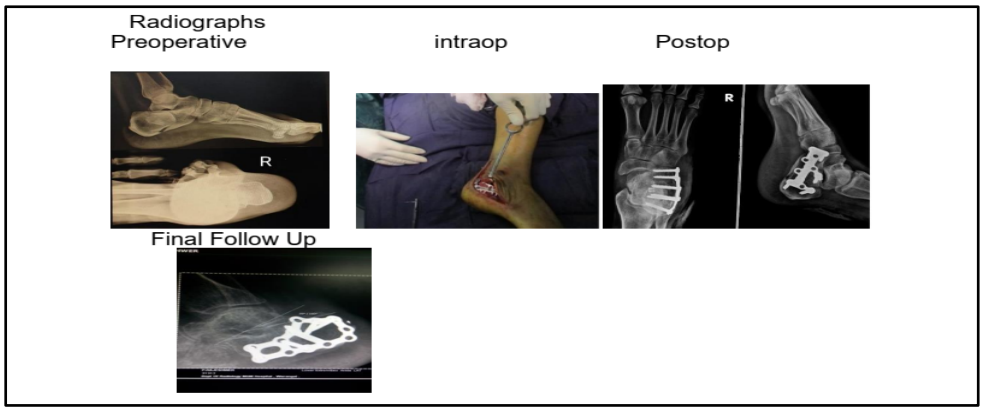

Figure 4: Closed intraarticular fracture displaced Right joint depression, managed by reconstruction plate, Bohler's angle restored from 12 to 21 degrees.

Out of n= 20 cases of calcaneal fractures n=15(75%) were males and n=5(25%) were females. The male-to-female ratio was 3:1. Table 1 shows the age distribution of 20 patients with displaced calcaneal intra-articular fractures. The patients' ages range from 20 to 70 years old. The mean age of the cohort was 31.7 ± 5.5 years. The highest percentage (35%) of fractures occurred in the 31- 40 age group. The 20-30 and 41-50 age groups each had 25% of the fractures. The 51-70 age group had the lowest percentage (10%) of fractures. This distribution suggests that displaced calcaneal intra-articular fractures are more common in middle-aged adults, particularly between 31 and 40 years old. The relatively lower incidence in younger and older age groups might be due to differences in activity levels, bone strength, or fall types associated with different age groups.

Table 1: Age Distribution of Displaced Calcaneal Fractures

Age in years	No. of patients	Percentage %
20-30	6	30
31-40	7	35
41-50	5	25
51-70	2	10
Total	20	100

Table 2 shows the mechanism of injury, laterality, and type of fractures in 20 patients with displaced calcaneal fractures. *Mode of Injury:* The vast majority (85%) of fractures resulted from falls from height. Road traffic accidents were a less common cause (15%). *Laterality:* Most fractures were unilateral (80%), while a minority were bilateral (20%). *Fracture Type:* The majority of fractures were closed (90%), meaning there was no open wound communicating with the fracture. Only 10% were compound fractures with an associated open wound. Falls from height appear to be the predominant cause of displaced calcaneal fractures in this sample, possibly due to high-impact forces. The presence of both unilateral and bilateral fractures suggests diverse mechanisms of injury. The high prevalence of closed fractures indicates that skin integrity is often maintained despite the displacement.

Table 2: Mode of Injury in Displaced Calcaneal Fractures

	Frequency	Percentage
Mode of Injury		
Fall from height	17	85
Road traffic accident	3	15
Total	20	100
Laterality		
Unilateral	16	80
Bilateral	4	20
Total	20	100
Types of fractures		
Closed	18	90
Compound	2	10
Total	20	100

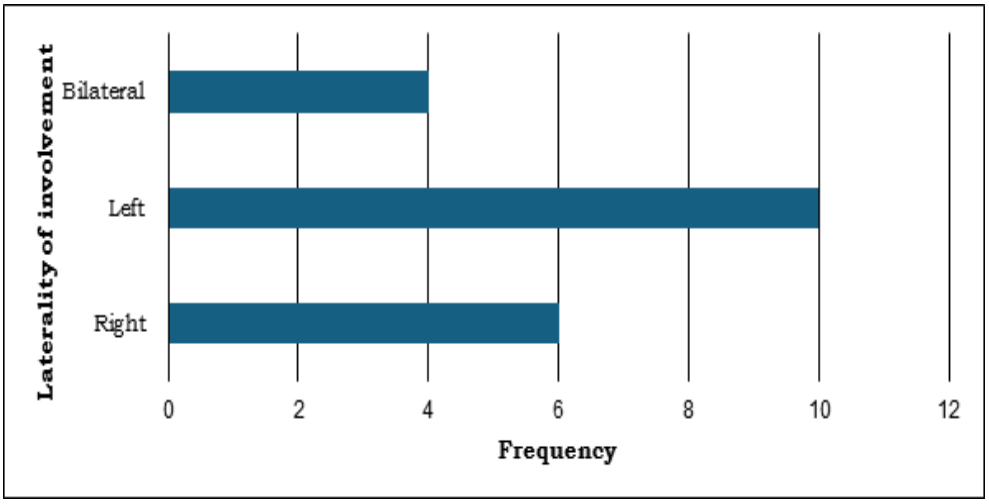

Figure 5: Laterality of Involvement in Displaced Calcaneal Fractures

Figure 5 shows a focus on the laterality of involvement in the 20 patients with displaced calcaneal fractures. Left-sided involvement: The majority of fractures affected the left side (50% with 10 patients). Right-sided involvement: Less common, with 30% of fractures (6 patients) affecting the right side. Bilateral involvement: 20% of cases (4 patients) had fractures on both sides. Potential factors could include individual dominance, specific fall patterns, or inherent anatomical differences. The presence of bilateral fractures suggests mechanisms of injury impacting both sides simultaneously or potentially high-energy events.

Table 3: Time Interval between Trauma and Surgery

Time interval between admission and surgery	Frequency	Percentage
5-8 days	4	26.67
9-11 days	8	53.33
12-15days	3	20
Total	15	100

Table 3 shows the distribution of time intervals between trauma (fracture) and surgery for n=15(75%) of patients with displaced calcaneal fractures. The rest n=5(25%) fractures were managed conservatively. The majority of surgeries (53.33%) were performed between 9 to 11 days after the injury. A significant portion (26.67%) of surgeries happened within 5-8 days. Fewer surgeries (20%) were conducted between 12-15 days after the trauma.

Table 4: Post-operative Immobilization

Post-operative immobilization	Frequency	Percentage
10-12 weeks	10	50%
13-16 weeks	8	40%
17-19 weeks	2	10%
Total	20	100

Table 4 shows the duration of postoperative immobilization for 20 patients who underwent treatment for displaced calcaneal fractures. The majority of patients (50%) required immobilization for 10-12 weeks. Another 40% needed immobilization for a longer duration, between 13-16 weeks. A smaller group (10%) had the shortest immobilization period of 17-19 weeks. The table shows that the typical post-operative immobilization period for these fractures falls between 10 and 16 weeks, with most patients needing 10-12 weeks. Shorter immobilization periods were associated with less complex fractures or early signs of healing, while longer durations might be necessary for more severe injuries or delayed healing.

Table 5: Time of union of calcaneal fractures

Time of union	Frequency	Percentage
10-12 weeks	10	50%
13-16 weeks	8	40%
17-19 weeks	2	10%
Total	20	100

This table shows the time it took for calcaneal fractures to heal (achieve union) in 20 patients who underwent surgery. The majority of fractures (50%) achieved union within 10-12 weeks after surgery. Another 40% of fractures healed between 13-16 weeks. Only 10% of fractures took longer, with a union time of 17-19 weeks. This table suggests that the typical time for healing after surgical intervention for displaced calcaneal fractures is 10-16 weeks, with most patients achieving union within 10-12 weeks. Fracture severity: More complex fractures might take longer to heal. Individual healing rates: Some patients naturally heal faster than others. Surgical technique: Different surgical approaches might influence healing time. Compliance with post-operative care: Following rehabilitation protocols properly can promote faster healing.

Table 6: Range of movements (ROM) at 10 months

Range of movements	Frequency	Percentage
Full range	11	55
Mild restriction	4	20
Moderate restriction	3	15
Severe restriction	2	10
Total	20	100

Table 6 shows the distribution of ankle joint range of motion (ROM) at 10 months post-surgery in 20 patients who underwent surgery for displaced calcaneal fractures. Majority with full ROM: The majority of patients (55%) achieved a full range of motion at 10 months. Mild and moderate restrictions: A significant portion of patients (20% and 15%, respectively) had mild or moderate restrictions in their ankle movement. Limited number with severe restriction: Only 2 patients (10%) had severe ROM limitations.

Table 7: Outcome in Intra-articular Calcaneal Fractures

Intra Articular	Surgical	Percentage	Conservative	Percentage
Excellent	9	60	0	0
Good	3	20	2	40
Fair	2	13.33	2	40
Poor	1	6.67	1	20
Total	15	100	10	100

Table 7 compares the outcomes of patients with intra-articular calcaneal fractures treated with either surgical or conservative management. ***Surgical group:*** 60% of patients achieved an "excellent" outcome. 20% achieved a "good" outcome. 13.33% had a "fair" outcome. 6.67% had a "poor" outcome. ***Conservative group:*** No patients achieved an "excellent" outcome. 40% achieved a "good" outcome. 40% achieved a "fair" outcome. 20% had a "poor" outcome. This table shows that surgical intervention may be associated with better outcomes compared to conservative management for intra-articular calcaneal fractures. A higher proportion of surgically treated patients achieved "excellent" and "good" outcomes, while the conservative group had no patients with "excellent" outcomes and a higher percentage with "fair" and "poor" outcomes.

Discussion

In this study, the outcomes of calcaneal fractures were evaluated using various methods. Two different parameters were used to compare outcomes, and the correlation between the two parameters was evaluated. The results of the present study were compared with those of similar previous studies. The average age incidence of intra-articular calcaneal fractures presenting to the MGM hospital is 31.7 years. In Mallikarjun et al. [8] the mean age was 28.2 years. In the study by K Prasad et al. [9] the mean age was 35 years. In Ahmed et al 56 mean age was 35 years. Calcaneal fractures commonly occur between 21-45 years of age. In the present study, 20 patients (15 were males and 5 were females. The majority were males indicating that calcaneal fractures were more common in males. K Prasad et al. [9] in a similar study found 90.90% males and 9.10% females. Ahmed et al. [10] in their study of calcaneal fractures found 75.75% males and 24.24% cases of calcaneal fractures. Side involvement in this study showed 50% left-side involvement, 30% right-side involvement, and 20% bilateral involvement. Ahmed et al. [10] in their study found a common site was the right side in 54.54% of side involvement in 45.45% of cases and no case of bilateral involvement. K Prasad et al [9] study found 60% right side involvement and left side 35% involvement and 15% bilateral involvement in the cases. In this study, the mean Bohler's angle in preoperative surgical cases was 13.925 °, and post-surgery after angle was 22.370 degrees the mean correction achieved by surgery in this study was 8.445 °. Similarly, in conservative cases, the mean Bohler's angle was 16 °, and postoperatively, there was no angle correction, and the measurement was the same as the treatment

angle. Mallikarjun et al. [8] in their study found the mean Bohler's angle was 13.4 degrees and the mean post-operative angle was 19.9 degrees, they achieved a correction of 5.6 degrees. The correction achieved in our study was found to be better than that of Mallikarjun et al. [8] In the present study there was no calcaneal osteomyelitis compared to other studies ZWIPP and Mallikarjun et al. [8] Among 15 surgically managed cases there were n=2 cases of ankle pain, n=1 case of peroneal tendinitis, n=1 case of subtalar arthritis complications in comparison to other studies were relatively fewer, and few were closer to studies in the literature. In the conservatively managed cases, malunion, peroneal tendinitis, and heel pain were observed, which could have been avoided if the cases had been managed surgically. Malunion was encountered only in conservatively managed cases and can be avoided by surgical management Compared to other similar series [11, 12] the results of conservative management in the present study were poor. This may be due to early weight bearing, lack of immobilization for the required time due to noncompliance of patients, or improper selection, that is, cases that required fixation but due to comorbid conditions, presenting 3 weeks after trauma, refusal to undergo surgery were included in the study, and follow-up was performed. The outcomes of surgically managed cases are comparable to those of other studies and superior to those of all studies, as depicted in Table 8. Among the operatively managed cases, excellent results were observed in cases managed with calcaneal plates.

Table 8: outcome of surgical management of calcaneal fractures in comparison with other studies

Series	Year	Cases	Excellent	Good	Fair	Poor
Sanders et al. [13]	1992	120	25%	40.8%	10.8%	23.3%
Zwipp et al. [14]	1992	90	16.4%	44.7%	32.4%	6.5%
Richard et al. [15]	2002	20	37.5%	25%	12.5%	25%
Mallikarjun et al. [8]	2014	30	40%	40%	20%	0%
Present Study	2022	20	60%	20%	13.33%	6.67%

Table 9: Outcome of conservative management of calcaneal fractures in comparison with other studies

Series	Year	Cases	Excellent	Good	Fair	Poor
Crosby et al. [11]	1993	30	27%	20%	17%	37%
Richard et al. [15]	2002	27	18.5%	18.5%	25.9%	37%
R Dwivedi et al. [16]	2020	15	33.33%	46.66%	13.33%	6.67%
Present Study	2022	5	0%	40%	40%	20%

A comparison of conservative management with other studies indicated that none of the cases in this study achieved excellent results; however, 40% each achieved good and fair results, and 20% had poor results. Crosby et al. [11] and Richard et al. [15] found poor results in 37% of cases as depicted in Table 9. In our conservative group, the results and functional outcomes of displaced fractures were poorer than those of displaced fractures because conservative management was performed in grossly displaced communited fractures, few were unfit for surgery, few were reported late 3 weeks after injury, and patients refused surgical treatment.

Conclusion

In our study, open calcaneal fractures had good outcomes when surgery was performed, and functional results were better when restoration of Bohler's angle was performed. The restoration of subtalar congruency is necessary for optimal outcomes. tensile L-shaped lateral approach is associated with minimal postoperative wound complications, better visualization of the subtalar joint, and a wide space for lateral plate fixation. Conservative management resulted in no change in the restoration of Bohler's angle, and few cases had poor outcomes. Hence, it can be concluded that open reduction and internal fixation can be considered for closed displaced intra-articular fractures of the calcaneum wherever it is feasible.

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