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COMPARATIVE ANALYSIS OF EARLY FUNCTIONAL OUTCOMES IN OPERATIVE VS NON-OPERATIVE TREATMENT OF DISPLACED INTRA-ARTICULAR CALCANEAL FRACTURES: A PROSPECTIVE STUDY

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ABSTRACT

Background: Objective is to compare the radiological, clinical, and functional outcomes of operative and non-operative treatment of adults with displaced intra-articular calcaneal fractures. This was a prospective, randomized trial. This study was conducted at Bolan Medical Complex Hospital Quetta from March 2024 to March 2025.

Materials and Methods: Patients were randomly assigned to operative (Group A, n=39) and non-operative (Group B, n=39) groups. Group A received open reduction and internal fixation (ORIF, n = 23) or minimally invasive subtalar screw fixation (n = 16), while Group B received RICE protocol and casting. Inclusion criteria included skeletally mature patients with Sanders Type II-IV and an intra-articular step-off>2 mm. Radiographic analysis, clinical examination, and AOFAS scores were obtained at 1, 2, 3, 6, and 12 months.

Results: The mean age was 35.4 (operative) and 36.9 years (non-operative), with 85% male and falls as the main cause (72%). Operative group showed superior Bohler's angle (22.1° ± 3.15 vs. 17.5° ± 3.01, p=0.0013) and Gissane angle (135.8° ± 7.12 vs. 140.2° ± 6.68, p=0.0016), but similar union time (10.3 ± 2.15 weeks vs. 10.9 ± 2.40 weeks, p=0.34). AOFAS scores were higher operatively (85.6 ± 7.80 vs. 81.4 ± 9.10, p=0.017), with more excellent/good outcomes (66% vs. 44%) and fewer poor (10% vs. 31%). Complications included chronic pain (18% vs 36% in non-operative), infections (13% in operative only), and subtalar arthritis/deformity (0% vs 33% in non-operative).

Conclusion: Operative management provides better anatomical repair and functional outcomes than non-operative treatment, but at the expense of higher surgical morbidity. Larger, longitudinal studies are needed.

Keywords: Displaced intra-articular calcaneal fractures, operative treatment, non-operative management, AOFAS score.

INTRODUCTION

The calcaneus, commonly known as the heel bone, is the foundation of the hindfoot. It bears considerable weight during locomotion and absorbing the impact forces.[1] Displaced intra-articular fractures of the calcaneus are a severe subset of these injuries, in which the bone's articular surfaces become fragmented and displaced, especially at the subtalar joint.[1,2] These fractures usually result from high-energy mechanisms, such as falls from height or motor vehicle collisions, leading to axial compression and flattening and widening of the bone, while disrupting joint congruity.[1,3]

Epidemiologically, calcaneal fractures account for approximately 60% of tarsal bone injuries and 1-2% of all fractures, with intra-articular types accounting for up to 75% of cases, mostly affecting young adults between 20 and 40 years of age in occupational or recreational accidents.[1] Bilateral involvement occurs in up to 10% of cases, and associated injuries, such as spine fractures, are common in nearly 10% of patients.[4] The Sanders classification system is a useful tool for evaluating severity based on posterior facet fragmentation (type II indicates two fragmented pieces; higher types indicate greater comminution and a worse prognosis).[5] Computed tomography has an important role in early diagnosis, as articular involvement is not well recognized on plain radiographs.[4,5]

Historically, surgeons have favored conservative treatment of these fractures due to limited understanding of their complex geometry and the unavailability of some predictable fixation methods.[3] Treatment initially included rest, elevation, ice, and splint immobilization below the knee to encourage the healing.[6] Although this enabled pieces to occupy their displaced location and offered short-term pain alleviation and improved movement, it frequently led to long-term chronic misalignment.[3,6] Persistent destabilization of the subtalar joint and heel deformity increased the rate of development of the arthritis, leading to chronic pain and functional impairment.[7] Most patients have experienced stiff, deformed feet that have made normal footwear impossible to wear, making walking difficult and, in some cases, necessitating the use of aids.[5]

Recent imaging modalities (e.g., the introduction of computed tomography and three-dimensional reconstructions in the 1970s) enabled precise fracture mapping and precise preoperative planning.[1,3] At the same time, improved surgical techniques and dedicated implants allowed reconstruction of important parameters, such as calcaneal height and width (20-40° normal), the gissane angle (140° normal), and the general structure of the heel.[1,7] Several approaches were described, including the classic lateral extensile procedure, smaller incisions through the sinus tarsi, and combined approaches to optimize fragment management and implant placement.[7] Specialized anatomical plates and screws have been developed to stabilize the reduction and secure the fragments.[5]

Nevertheless, surgery is associated with a higher incidence of adverse events, including skin necrosis, wound dehiscence, infection, and edema, which can compromise restoration.[5] This indicates a high degree of heterogeneity, and multiple systematic reviews and randomized trials have attempted to establish the best protocol to achieve the best results.[5,8,9] These studies have indicated that operative strategies provide superior articular realignment and, hence, superior functional and clinical outcomes, though at a higher complication rate than non-surgical approaches.[3,5] The treatment dilemma remains unresolved, and there is no clear-cut evidence of a universally more effective approach in all dimensions.[5] Consequently, clinicians must balance potential benefits and risks to decide which interventions to use in individual cases.[3]

To fill these gaps, this prospective study will evaluate 78 patients with displaced intra-articular calcaneal fractures and assess radiographic, clinical, and functional outcomes using the American Orthopedic Foot and Ankle Society (AOFAS) hindfoot score.

MATERIALS AND METHODS

This prospective study involved 74 participants with displaced intra-articular calcaneal fractures who underwent surgical repair. The study was approved by the Institutional Ethical Committee. Informed consent was provided in writing to all participants before inclusion. The sample consisted of 74 patients, four of whom were bilaterally fractured, and 78 calcaneal fractures were reported. Patients were randomly selected into either the operative group (Group A, n=39) or the non-operative group (Group B, n=39). Homogeneity was established by strict inclusion and exclusion criteria.

Inclusion criteria were skeletally mature patients with closed, displaced intra-articular calcaneal fractures with an intra-articular step-off of more than 2 mm. Fractures were classified as Sanders type II, III, or IV. Patients having congenital malformations, pathological fractures, open fractures, or major soft-tissue compromise (extensive blistering, severe swelling, large abrasions, or prior local skin pathology) were excluded. In addition, patients with refractures, those who had undergone hindfoot surgery before, or those with other comorbid fractures of the other tarsal bones were excluded.

Injuries were addressed at presentation. Hemodynamic stabilisation of the patients was performed, and a comprehensive general and systemic investigation was conducted. Laboratory surveillance, including complete blood count, renal and liver function tests, electrolytes, and viral markers, was performed routinely. Imaging began with calcaneal axial and lateral radiographs and, when requested, a routine trauma series. Fractures were initially stabilized with a below-knee slab and supported in a Bohler frame. After confirmation of intra-articular involvement, three-dimensional reconstruction computed tomography scans were performed in all cases.

Patients in the non-operative group initially received the RICE protocol (rest, ice, compression, elevation) and a below-knee slab for support. After the swelling had subsided, a below-knee calcaneal cast was applied, with reduction methods including traction, medio-lateral compression, and manual correction of the heel deformity. The ankle was kept in neutral to prevent equinus contracture. The cast was maintained for 6 weeks, and radiographic union was assessed. Subtalar, ankle, and toe range-of-motion exercises

were implemented after removal of the cast. Non-weight bearing was recommended for 10 to 12 weeks until radiographic union was observed. Weight-bearing began around the 12th week, progressing to full weight-bearing by the 16th week. Patients were advised to wear soft-soled, lightweight shoes that cover the whole foot (e.g., sports shoes) and to avoid barefoot walking and uneven terrain initially.

For the operative group, initial management was the same as in the non-operative group: RICE and below-knee slab. Surgery was planned when the swelling had decreased significantly, which is indicated by the wrinkle sign on the skin. Based on fracture patterns, open reduction and internal fixation by plating through a standard lateral approach or minimally invasive techniques through a subtalar approach were performed. Postoperatively, the patient was immobilized for six weeks in a below-knee splint and remained non-weight bearing for 10 to 12 weeks until union.

Follow-up was done at standard intervals: one, two, three, six, and twelve months after treatment. Outcomes were measured by radiological, clinical, and functional assessment. The AOFAS score was the primary functional and clinical evaluation tool, comprising pain, function, and alignment sections, with a maximum of 100 points representing ideal results.

RESULTS

This study compared outcomes of displaced intra-articular calcaneal fractures in 78 patients (two with bilateral fractures), divided equally into operative (Group A, n=39) and non-operative (Group B, n=39) groups. Group A included 23 patients treated with open reduction and internal fixation (ORIF) via calcaneal plates and 16 with minimally invasive subtalar screw fixation. Patients, aged 18-60 years (mean: 35.4 years for Group A, 36.9 years for Group B), were predominantly male (n=66, 85%) with 12 females (n=12, 15%). Falls from height (n=56, 72%) and road traffic accidents (n=14, 18%) were primary injury causes. Sanders classification via CT showed Group A with 13 Type II (33%), 18 Type III (46%), and 8 Type IV (21%), and Group B with 12 Type II (31%), 8 Type III (21%), and 19 Type IV (49%) [Table 1].

Table 1: Demographic and Fracture Characteristics of Patients (n=78)

Parameter	Operative (Group A, n=39)	Non-Operative (Group B, n=39)
Mean Age (years)	35.4	36.9
Sex (Male/Female)	34/5	32/7
Injury Mechanism		
- Fall from Height	28 (72%)	28 (72%)
- Road Traffic Accident	7 (18%)	7 (18%)
Sanders Classification		
- Type II	13 (33%)	12 (31%)
- Type III	18 (46%)	8 (21%)
- Type IV	8 (21%)	19 (49%)

In Group A, the mean injury-to-surgery interval was 4.4 days. ORIF procedures averaged 125.1 minutes, while minimally invasive surgeries took 71.3 minutes. Follow-up averaged 12.7 months, union at 10.3 weeks. Group A had a mean Bohler's angle of 22.1° and a Gissane angle of 135.8°, indicating effective anatomical restoration [Table 2].

Table 2: Comparison of Radiological and Clinical Outcomes Between Both Groups

Parameters	Group	n-Number	Mean	Standard Deviation	P-Value	Significance
1. Radiological Parameters						
a) Bohler's Angle (°)	Operative	39	22.1	3.15	0.0013	Significant
	Non-Operative	39	17.5	3.01		
b) Gissane Angle (°)	Operative	39	135.8	7.12	0.0016	Significant
	Non-Operative	39	140.2	6.68		
c) Radiological Union (weeks)	Operative	39	10.3	2.15	0.34	Non-Significant
	Non-Operative	39	10.9	2.40		
2. Clinical Parameter						
a) AOFAS Score	Operative	39	85.6	7.80	0.017	Significant
	Non-Operative	39	81.4	9.10		

Complications were more common in the non-operative group (Group B) than in the operative group (Group A). Persistent pain occurred in 7 patients (n=7, 18%) in Group A and 14 patients (n=14, 36%) in Group B. Superficial infection was found in 4 cases (n=4, 10%) in Group A and in no cases in Group B. Deep infections occurred in 1 patient (n=1, 3%) in Group A, while none were observed in Group B. Implant loosening was seen in 2 patients (n=2, 5%) in Group A. Subtalar arthritis and heel widening/varus deformity were noted exclusively in Group B, with 6 cases (n=6, 15%) and 7 cases (n=7, 18%), respectively [Table 3].

Table 3: Complications in Operative and Non-Operative Groups

Complication	Operative (Group A, n=39)	Non-Operative (Group B, n=39)
Persistent Pain	7 (18%)	14 (36%)
Superficial Infection	4 (10%)	0 (0%)
Deep Infection	1 (3%)	0 (0%)
Implant Loosening	2 (5%)	0 (0%)
Subtalar Arthritis	0 (0%)	6 (15%)
Heel Widening/Varus Deformity	0 (0%)	7 (18%)

The operative group achieved superior outcomes, with Excellent (n=11, 28%) and Good (n=15, 38%) results surpassing non-operative Excellent (n=5, 13%) and Good (n=12, 31%). Conversely, Poor outcomes were higher in Group B (n=12, 31%) than Group A (n=4, 10%) [Table 4].

Table 4: AOFAS Outcome Distribution for Operative and Non-Operative Groups

AOFAS Outcome	Operative (Group A, n=39)	Non-Operative (Group B, n=39)
Excellent	11 (28%)	5 (13%)
Good	15 (38%)	12 (31%)
Fair	9 (23%)	10 (26%)
Poor	4 (10%)	12 (31%)

DISCUSSION

This study compared operative and non-operative treatments for displaced intra-articular calcaneal fractures in 78 patients. The operative group showed a mean Bohler's angle of 22.1° compared to 17.5° in the non-operative group, with a significant difference (p=0.0013). This improvement contributes to anatomical realignment as a functional adaptation, as described by Stark et al., who found that minimally invasive surgery increased Bohler's angle from 24 degrees preoperatively to 28 degrees at follow-up in 59 cases.[10] However, our finding contrasts with that of Pfluger et al., in which operative restoration reached 29 ° but was poorly correlated with function, compared with our anatomical gains.[11] From Gissane's angle, operative treatment in our study achieved 135.8°, which was significantly closer to normal than the non-operative 140.2° (p=0.0016), contributing to hindfoot alignment. This result is similar to that of the same study by Pfluger et al., in which postoperative Gissane reached 117 ° in operative cases, with weak correlation to improved motion.[11] In contrast, Selim et al. found inconsistent Gissane reporting across studies, with no pooled benefits, indicating heterogeneity in non-standardised measurements.[5]

Clinically, the mean AOFAS score was 85.6 in the operative group versus 81.4 in the non-operative group (p=0.017), indicating modest functional improvement with surgery. This aligns with a comparative study, where operative AOFAS exceeded non-operative by about 6 points at one year.[12] However, the meta-analysis by Selim et al. no significant AOFAS difference, possibly due to heterogeneous trials including older techniques.[5]

Persistent pain occurred in 7 patients (18%) in Group A and 14 (36%) in Group B, indicating a doubled risk with non-operative care. This findings goes in contrast with a study, reporting no significant difference in pain scores at two years between minimally invasive surgery and non-operative care, though surgery aided complex cases.[13] However, the study by Talia et al. corroborate our finding, where non-operative management led to residual hindfoot pain from malunion in up to 50% of cases, driven by joint incongruity.[14] Superficial infections occurred in 10% of operative cases, with none non-operatively. Similarly, deep infections were seen in 3% operatively, absent non-operatively. This compares to the Cochrane data reported by Lewis et al., where superficial infections hit 14% in surgical arms across seven studies and 5.3% deep infection rate in one surgical trial, thus pointing to elevated wound risks in surgery.[15]

Moreover, implant loosening impacted 2 patients in Group A, absent in Group B. This minor issue contrasts with a study, which found no implant failures in their operative cohort, possibly due to shorter follow-up.[16] Subtalar arthritis and varus deformity developed in 6 and 7 patients in Group B, respectively, with none in Group A. Our operative protection echoes Talia et al., where surgery reduced arthritis progression via joint restoration, versus non-operative risks of 20-30% arthrodesis needs. Similarly, the authors reported that attributing non-operative widening to unaddressed collapse in patients.

The operative group in this study demonstrated better functional outcomes based on the AOFAS score distribution. Poor outcomes were also lower. This pattern suggests that surgical intervention may enhance patient satisfaction and hindfoot function through improved joint congruence. These findings align with a prospective study of 112 patients, where the operative arm achieved 35% excellent and 35% good AOFAS ratings, against 0% excellent and 12% good non-operatively, with poor results at 24% versus 35%.[17] Similarly, Talia et al. emphasized operative advantages in functional recovery for selective fracture patterns, reporting equivalent or superior patient-reported metrics in Sanders type II/III cases.[14] However, the higher proportion of fair outcomes in both groups indicates persistent challenges like stiffness or mild pain regardless of approach. This is consistent with the study by Kumar

et al., which found fair results were minimal at 6% operatively but dominant at 53% non-operatively, highlighting variability in cohort selection.[17] Overall, AOFAS trends in our data favor surgery for reducing poor outcomes, however this goes against a meta-analysis of four studies, which showed equivalent functional scores at mid-term follow-up, attributing parity to complication offsets in operative cases.[15]

This study is limited by several factors. The sample size included 78 patients with limited statistical power to detect differences between treatment groups. Selection bias may have affected patient allocation because randomization did not adequately control for baseline comorbidities or lifestyle factors. The relatively short mean follow-up period (12.7 months) may not cover long-term outcomes such as late-onset arthritis. Future studies should incorporate larger cohorts, longer follow-up periods, and standardized surgical protocols to minimize bias and enhance generalizability, thus better explaining heterogeneity in treatment effects.

CONCLUSION

Surgical treatment of displaced intra-articular calcaneus fractures provides better functional and clinical results than non-operative management. While both groups had nearly identical radiological union times, operative intervention resulted in better restoration of key anatomical parameters, including Bohler's and Gissane angles, thereby decreasing the incidence of persistent pain and subtalar arthritis. However, surgery is associated with a greater risk for complications, which include superficial and deep infection, implant failure, extended hospital stay, and higher cost. In contrast, conservative management is free of these surgical risks but comes at the cost of inferior anatomical correction and higher rates of long-term complications. Overall, operative management shows better short-term outcomes in terms of functional and anatomic restoration in these complex fractures.

REFERENCES

1. Davis D, Seaman TJ, Newton EJ. Calcaneus fractures. StatPearls [Internet]: StatPearls Publishing; 2023.
2. Wei N, Zhou Y, Chang W, Zhang Y, Chen W. Displaced intra-articular calcaneal fractures: classification and treatment. Orthopedics. 2017;40(6):e921-e9.
3. Biz C, Refolo M, Zinnarello FD, Crimì A, Dante F, Ruggieri P. A historical review of calcaneal fractures: from the crucifixion of Jesus Christ and Don Juan injuries to the current plate osteosynthesis. International orthopaedics. 2022;46(6):1413-22.
4. Dhillon MS, Prabhakar S. Treatment of displaced intra-articular calcaneus fractures: a current concepts review. SICOT-J. 2017;3:59.
5. Selim A, Ponugoti N, Chandrashekar S. Systematic review of operative vs nonoperative treatment of displaced intraarticular calcaneal fractures. Foot & ankle orthopaedics. 2022;7(2):24730114221101609.
6. Rammelt S, Sangeorzan BJ, Swords MP. Calcaneal fractures—should we or should we not operate? Indian journal of orthopaedics. 2018;52(3):220-30.
7. Leigheb M, Codori F, Samaila EM, Mazzotti A, Villafane JH, Bosetti M, et al. Current concepts about calcaneal fracture management: a review of metanalysis and systematic reviews. Applied Sciences. 2023;13(22):12311.
8. Chirayath A, Dhaniwala N, Kawde K. A comprehensive review on managing fracture calcaneum by surgical and non-surgical modalities. Cureus. 2024;16(2).
9. Wei N, Yuwen P, Liu W, Zhu Y, Chang W, Feng C, et al. Operative versus nonoperative treatment of displaced intra-articular calcaneal fractures: a meta-analysis of current evidence base. Medicine. 2017;96(49):e9027.
10. Stark M, Popp D, Schmoelz L, Doering K, Stark K, Nia A. Mid-term results of intra-articular calcaneal fractures treated with minimally invasive two-point distractor. Wiener klinische Wochenschrift. 2025;137(17):544-50.
11. Pflüger P, Zyskowski M, Greve F, Kirchhoff C, Biberthaler P, Crönlein M. Patient-reported outcome following operative and conservative treatment of calcaneal fractures: A retrospective analysis of 79 patients at short-to midterm follow-up. Frontiers in Surgery. 2021;8:620964.
12. Kamath KR, Mallya S, Hegde A. A comparative study of operative and conservative treatment of intraarticular displaced calcaneal fractures. Scientific Reports. 2021;11(1):3946.
13. Ahluwalia R, Lewis TL, Musbahi O, Reichert I. Minimally invasive surgery vs nonoperative treatment for displaced intraarticular calcaneal fracture: a prospective propensity score matched cohort study with 2-year follow-up. Foot & Ankle International. 2024;45(5):456-66.
14. Talia AJ, Shepherd DW, Roshan-Zamir S. Displaced, intra-articular fractures of the calcaneus: review of non-operative management, open reduction internal fixation and novel minimally invasive techniques. The Foot. 2025:102160.
15. Lewis SR, Pritchard MW, Solomon JL, Griffin XL, Bruce J. Surgical versus non-surgical interventions for displaced intra-articular calcaneal fractures. Cochrane Database of Systematic Reviews. 2023(11).
16. Sturz-Jantsch GD, Winter M, Hajdu S, Haider T. Analysis of Calcaneal Fracture-Related Complications—A Retrospective Chart Review. Journal of Clinical Medicine. 2025;14(15):5535.
17. Kumar V, Verma S, Kamboj P, Dhara R, Raj P, Jain R, et al. Comparative analysis of clinicoradiological results in calcaneal fractures: Conservative versus operative management. Journal of Arthroscopic Surgery and Sports Medicine. 2025.