



## Comparison of Sinus Tarsi Approach with Screws vs Lateral Extensile Approach with Plates in Sanders Type Two and Three Calcaneal Fractures: A Non-Randomized Study

Santosh Borkar, MD,<sup>1</sup> Rajiv Munde, MD,<sup>1</sup> Shrirang Godbole, MD,<sup>2</sup> Suraj Doshi, MD,<sup>1</sup> Rhythm Tahilramaney, MD,<sup>1</sup> Bhushan Adhari, MD,<sup>1</sup> Sameed Ahmed, MD<sup>1</sup>

<sup>1</sup>Department of Orthopaedics, Maharashtra Institute of Medical Education and Research, Pune, India

<sup>2</sup>Department of Orthopaedics, Bharati Vidyapeeth Medical College and Hospital, Pune, India

### ABSTRACT

**Background.** Intra-articular calcaneal fractures, particularly of the joint depression type, present significant surgical challenges. The traditional lateral extensile approach (LEA), although providing excellent exposure, is associated with notable soft tissue complications, such as wound necrosis and infection. The sinus tarsi approach (STA), a minimally invasive technique, aims to minimize these complications while maintaining comparable outcomes. This study aimed to compare the functional, radiological outcomes, and complications of STA with cannulated cancellous (CC) screw fixation versus LEA with plating in the management of joint depression-type intra-articular Sanders Type 2 and 3 calcaneal fractures.

**Methodology.** A prospective, non-randomized comparative study was conducted at a tertiary care center (BSTRH and MIMER Medical College, Talegaon Dabhade), involving 56 adult patients (aged > 18 years) with acute (< three weeks) intra-articular joint depression (Sanders Type 2 and 3) calcaneal fractures, diagnosed via radiographs and CT scan. All surgeries were performed by a senior orthopaedic trauma surgeon with more than 10 years of experience. Patients were allocated into two groups of 28 each: Group A underwent STA with CC screw fixation, while Group B received LEA with plate fixation. Surgical intervention was performed after soft tissue readiness, followed by standard postoperative care. Patients were evaluated at one, three, six, nine, and 12 months postoperatively using the American Orthopaedic Foot and Ankle Society hindfoot score (AOFAS), Visual Analogue Scale (VAS), and radiological parameters including Bohler's angle, Gissane angle, and calcaneal height and width. Complication rates, operative time, and hospital stay were also analyzed.

**Results.** STA resulted in significantly shorter operative times (59.1 vs. 98.4 minutes,  $p < 0.001$ ) and hospital stays (4.7 vs. 7.42 days,  $p < 0.001$ ). AOFAS scores at 12 months were comparable between STA (mean 80.57) and LEA (mean 77.33). Postoperative VAS scores were significantly better in the STA group (1.67 vs. 2.04;  $p = 0.044$ ). Radiographic outcomes were similar between groups. STA demonstrated fewer complications, including superficial infection (3 vs. 5), deep infection (0 vs. 2), and sural nerve injury (0 vs. 1).

**Conclusion.** The sinus tarsi approach with cannulated screw fixation offers equivalent functional and radiological outcomes to the lateral extensile approach while significantly reducing soft tissue complications, operative time, and hospitalization. It presents a safe and effective minimally invasive alternative for treating intra-articular calcaneal fractures with joint depression (Sanders Type 2 and 3).

**Keywords.** calcaneal fracture, sinus tarsi approach, lateral extensile approach, cannulated screw fixation, AOFAS score, minimally invasive surgery

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Corresponding author: Rhythm Tahilramaney, MD  
Maharashtra Institute of Medical Education and Research, Talegaon Dabhade, Pune, 410507, India  
Tel. No.: (+91) 8966833404  
E-mail: gerine.sy@gmail.com  
ORCID: <https://orcid.org/0009-0002-5399-8153>

## INTRODUCTION

Calcaneal fractures are the most common fractures of the tarsal bones and represent approximately 1% to 2% of all adult fractures, with nearly 75% being intra-articular.<sup>1-3</sup> Among these, joint depression-type fractures, as per the Essex-Lopresti classification,<sup>4,5</sup> are particularly challenging due to their complex anatomy and the potential for long-term disability. Among these, joint depression-type fractures classified by the Sanders CT-based system (Types 2, 3, and 4) require adequate reduction and fixation. Restoration of the articular congruity, calcaneal height, width, and alignment is essential to achieving favorable outcomes.<sup>6-8</sup>

The lateral extensile approach (LEA) has traditionally been the standard surgical method for treating displaced intra-articular calcaneal fractures.<sup>9-13</sup> While this approach provides excellent visualization and facilitates anatomic reduction and plate fixation, it is associated with significant soft tissue complications, including wound edge necrosis, infection, and sural nerve injury. These complications are attributed to the disruption of the lateral calcaneal artery and extensive soft tissue handling.

The sinus tarsi approach (STA) has emerged as a less invasive alternative that aims to minimize soft tissue morbidity. It allows adequate access for reduction and fixation of the posterior facet while preserving the vascular supply and

reducing the risk of wound complications.<sup>14-19</sup> However, concerns remain about whether this limited exposure permits adequate reduction and stabilization, particularly when using cannulated cancellous screws rather than plates.<sup>20,21</sup>

Because of the limited data comparing functional and radiological outcomes between these two approaches, there remains uncertainty regarding the optimal surgical technique for Sanders Type 2 and 3 calcaneal fractures.<sup>14,16,22-32</sup> Therefore, this study was conducted to compare the sinus tarsi approach with cannulated screw fixation versus the lateral extensile approach with plating in terms of post-operative recovery, radiological parameters, functional outcomes, and complication rates.

## METHODOLOGY

This was a prospective, non-randomized comparative study conducted in the Department of Orthopaedics at BSTRH and MIMER Medical College, Talegaon Dabhade (a tertiary care center), between June 2022 and June 2025. The study aimed to evaluate and compare the outcomes of two surgical approaches for treating Sanders Type 2 and 3 calcaneal fractures: the sinus tarsi approach (STA) using cannulated cancellous (CC) screw fixation, and the lateral extensile approach (LEA) using plate fixation.

### Ethics statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

A total of 56 patients were included in the study, with 28 patients in each group. The sample size was determined based on the estimated patient inflow for the given fracture pattern over three years. Patients were selectively enrolled based on the presence of specific fracture characteristics and their informed written consent to participate in the study. Preoperative X-ray radiographs and CT scans were taken for all the patients (Figure 1).

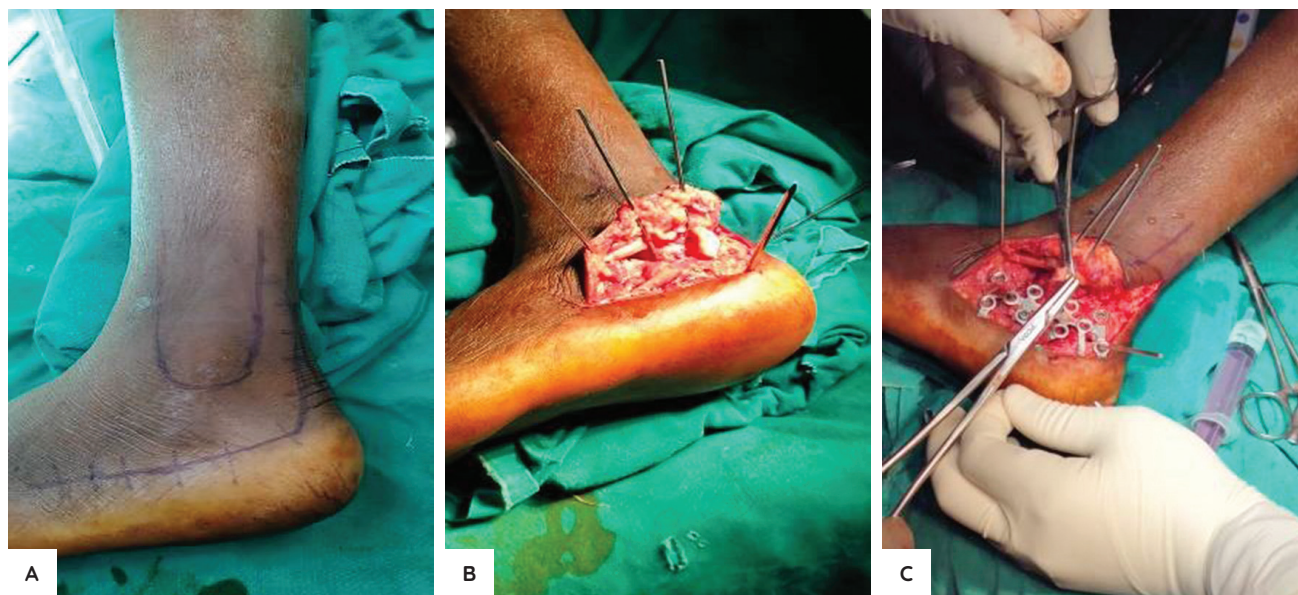
**Inclusion criteria:** adult patients (age > 18 years AND < 65 years) presenting within three weeks of trauma with closed, Sanders Type 2 and 3 calcaneal fractures.

**Exclusion criteria:** open fractures, extraarticular fractures, Sanders Type 1 and 4 fractures, pathological fractures, poly-trauma, and patients with uncontrolled diabetes or peripheral vascular disease.

Patients underwent surgery once the soft tissue condition was deemed appropriate, typically indicated by the presence of the wrinkle sign.



**Figure 1.** Preoperative X-ray showing calcaneus fracture. Lateral view of the right heel demonstrating a displaced intra-articular calcaneal fracture (A); Axial (Harris) view showing widening of the heel and lateral wall blowout (B); Oblique view illustrating comminution of the calcaneal body (C); Lateral view highlighting collapse of the posterior facet and decreased Böhler's angle (D).



**Figure 2.** Intraoperative photos showing the lateral extensile approach (LEA) for calcaneal fracture fixation. Skin marking of the extensile lateral L-shaped incision (A); elevation of the full-thickness fasciocutaneous flap with Kirschner wire retraction exposing the lateral wall and posterior facet (B); fracture reduction and internal fixation under direct visualization (C).

### Lateral Extensile Approach (LEA)

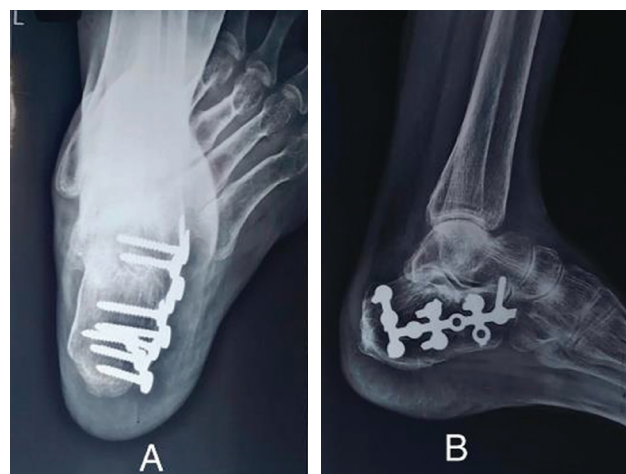
The patient was positioned in a lateral decubitus position. A thigh tourniquet was applied, and the limb was prepared and draped. A standard L-shaped lateral incision was made. The vertical line was placed midway between the lateral malleolus and the Achilles tendon, and the horizontal line was positioned just below the peroneal tendons, extending towards the base of the fourth metatarsal. A full-thickness fasciocutaneous flap was elevated subperiosteally to expose the entire lateral surface of the calcaneus, the calcaneocuboid joint, and the posterior facet of the subtalar joint (Figure 2A and 2B). Care was taken to protect the sural nerve and the peroneal tendons, which were retracted superiorly.

The fracture fragments were anatomically reduced using reduction clamps and provisionally fixed with K-wires. The reduction was confirmed, under fluoroscopic guidance, to restore Böhler’s and Gissane’s angles, as well as the height and width of the calcaneus. An L-shaped pre-contoured calcaneal locking plate was then applied and secured with screws in a step-by-step fashion to achieve stable internal fixation (Figures 2C and 3).

### Sinus Tarsi Approach (STA)

The patient was placed in a lateral decubitus position, and a tourniquet was applied to the thigh. The skin was prepared and draped.

A small, approximately 3 to 5 cm incision was made within the sinus tarsi, extending from a point 1 cm distal to the tip of the lateral malleolus towards the base of the fourth metatarsal. The incision allowed access to the subtalar joint and the lateral wall of the calcaneus, minimizing soft tissue



**Figure 3.** Immediate postoperative X-rays following calcaneal fracture fixation via lateral extensile approach (LEA). Antero-posterior view showing anatomical alignment and screw placement (A); lateral view demonstrating restoration of calcaneal height and contour with plate and screw fixation (B).

disruption. The peroneal tendons and the sural nerve were identified and protected by gentle retraction (Figure 4).

A small distractor was placed in the sinus tarsi to open the subtalar joint and provide visualization of the depressed posterior facet fragment. The fragment was disimpacted and elevated using a specific elevator, restoring the articular surface. The reduction was then held with a provisional K-wire. The reduction and restoration of Böhler’s angle were checked using fluoroscopy (Figure 5).

Final fixation was achieved with cannulated cancellous screws. The screws were inserted percutaneously from the posterior tuberosity or lateral calcaneal wall, passing through



**Figure 4.** Intraoperative photos showing the sinus tarsi approach (STA).



**Figure 5.** Intraoperative C-arm fluoroscopic image in the supratrochlear axial (STA) view demonstrating instrument positioning across the fracture site.

the elevated fragment to hold the reduction and support the posterior facet. The number and position of screws were determined by the fracture pattern and the stability achieved. This minimally invasive technique aimed to provide stable fixation while reducing the risk of wound complications.

Postoperatively, all patients followed a standardized rehabilitation protocol that included non-weight-bearing mobilization for eight weeks, followed by partial to full weight-bearing as tolerated. Sutures were removed on postoperative day 14. Clinical and radiological assessments were performed at one, three, six, nine, and 12 months.

**Primary outcome measures** included the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score and the Visual Analogue Scale (VAS) for pain.

**Radiological parameters** such as Bohler's angle, Gissane angle, calcaneal height, and width were evaluated on lateral and axial X-rays at each follow-up. We did not do postoperative CT scans routinely if we were satisfied with postoperative X-rays alone.

**Secondary outcomes** included operative time, length of hospital stay, and the incidence of complications such as infection, sural nerve injury, and wound edge necrosis.

**Minimum follow-up** was 12 months for all patients. No patients were lost to follow-up.

**Statistical analysis** was performed using SPSS version 26.0. Continuous variables were presented as means with ranges

and compared using independent-samples t-tests or paired t-tests, as appropriate. Categorical variables were expressed as counts and percentages and analyzed using the Chi-square test. A  $p$ -value of  $< 0.05$  was considered statistically significant. Although a formal power analysis was not performed, the sample size was deemed sufficient based on previous similar comparative studies and clinical experience.

Efforts were made to minimize selection and treatment bias by using uniform inclusion criteria and standardized operative protocols. While patient allocation was not randomized, consecutive eligible cases were included to limit referral and diagnosis bias.

## RESULTS

A total of 61 patients were assessed for eligibility during the study period. Five patients were excluded due to the presence of open fractures ( $n = 2$ ), uncontrolled diabetes ( $n = 1$ ), pathological fracture ( $n = 1$ ), and refusal to participate ( $n = 1$ ). Fifty-six patients who met the inclusion criteria were enrolled and completed follow-up, with 28 patients in the sinus tarsi approach (STA) group and 28 in the lateral extensile approach (LEA) group. The distribution of fracture severity (Sanders classification) was assessed for both groups. In the LEA group, 16 patients were classified as Sanders Type 2 and 12 patients as Type 3. In comparison, the STA group had 18 patients with Type 2 and 10 patients with Type 3 fractures. The mean follow-up period was 11.4 months (range, 11 to 12 months).

**Table 1.** Outcomes of the two groups

Parameter	STA Group	LEA Group	p-value
Operative time (mins)	59.1 ± 8.2	98.4 ± 10.11	$p < 0.001^*$
Hospital stay (days)	4.7 ± 1.73	7.42 ± 2.26	$p < 0.001^*$
AOFAS at 9 months	80.57 ± 7.8	77.33 ± 8.29	$p = 0.142$
Post-op VAS	1.67 ± 0.97	2.04 ± 0.97	$p = 0.044$
Bohler's angle	27.27 ± 3.98	28.60 ± 4.71	$p = 0.267$
Gissane angle	124.69 ± 6.88	126.60 ± 4.58	$p = 0.348$
Calcaneal height	45.03 ± 4.65	44.88 ± 4.75	$p = 0.853$
Calcaneal width	46.04 ± 4.01	46.84 ± 4.77	$p = 0.569$
Superficial infection	3	5	$p = 0.041^*$
Deep infection	0	2	$p = 0.150$
Sural nerve injury	0	1	Absent in STA

\* $p < 0.05$ ; significant

### Demographic and operative data

The average age in the STA group was 39.1 years (range, 21–56 years), while the LEA group had a mean age of 37.3 years (range, 23–55 years) ( $p = 0.432$ ).

The mean operative time was significantly lower in the STA group at 59.1 minutes (range, 48–72 minutes) compared to 98.4 minutes (range, 83–112 minutes) in the LEA group ( $p < 0.001$ ).

The average length of hospital stay was also shorter in the STA group at 4.7 days (range, 3–8 days), compared to 7.42 days (range, 5–11 days) in the LEA group ( $p < 0.001$ ).

### Functional outcomes

At 12 months follow-up, the mean AOFAS hindfoot score was 80.57 (range, 67–93) in the STA group and 77.33 (range, 62–90) in the LEA group. The difference was not statistically significant ( $p = 0.142$ ).

The mean postoperative VAS score was significantly better in the STA group at 1.67 (range, 0–3) compared to 2.04 (range, 1–4) in the LEA group ( $p = 0.044$ ).

### Radiological outcomes

Postoperative radiographs demonstrated restoration of key parameters in both groups. Bohler's angle, Gissane angle, calcaneal height, and calcaneal width were comparable (Table 1). The double dome sign of the posterior facet was eliminated from postoperative radiographs, suggesting anatomical or near-anatomical reduction, which is essential for minimizing the risk of post-traumatic subtalar arthritis.

### Complications

The STA group had fewer soft tissue complications compared to LEA. In the STA group, three patients (10.7%) developed superficial wound infections, all of which resolved with daily dressing and oral antibiotics under IPD care. In the LEA group



**Figure 6.** Immediate postoperative radiographs showing stable internal fixation with multiple screws: supratrochlear axial (STA) view (A) and lateral view (B).



**Figure 7.** Post op picture showing superficial wound infection (LEA).

(25%), five patients developed superficial wound infections and two developed deep wound infections (Figure 7). Superficial wound infections were treated with daily dressing and oral antibiotics under IPD care. Deep wound infections required debridement with antibiotic cover. Multiple debridements and culture-guided antibiotics were given. None of the patients required plastic surgery or flap coverage. Wound edge necrosis was seen in two patients in the LEA group and none in the STA group. Sural nerve injury occurred in one patient (manifesting as paresthesia or dysesthesia) only in the LEA group, probably due to excessive retraction during surgery. This was managed with physiotherapy and neurogenic medications and eventually recovered in three months.

No cases of nonunion, hardware failure, or loss of reduction were observed in either group at the final follow-up.

The primary surgical objective remained the achievement of anatomical congruity of the posterior subtalar facet. If good articular reduction were not achieved, the long-term functional outcomes will likely be poor, resulting in post-traumatic arthritis. As the follow-up period was less than a year, post-traumatic arthritis could not be assessed.

## DISCUSSION

This study was conducted to evaluate whether the sinus tarsi approach (STA) with cannulated cancellous (CC) screw fixation can provide comparable outcomes to the traditional lateral extensile approach (LEA) with plating for joint depression-type intra-articular calcaneal fractures, while offering advantages in terms of reduced soft tissue complications, operative time, and hospital stay.

The shorter operative time and decreased hospital stay in the STA group are consistent with previous research that highlights the efficiency of minimally invasive techniques. The sinus tarsi approach, with its limited incision and reduced dissection, allows earlier surgical intervention (once soft tissue edema resolves), whereas the extensile lateral approach often necessitates longer waiting periods (once wrinkle sign appears). These operative advantages align with findings reported by Shuler et al.<sup>13</sup> and Kwon et al.,<sup>25</sup> who demonstrated reduced operative times and hospitalizations with STA compared to LEA.

The primary concern with STA has been whether it allows adequate visualization for anatomical reduction, especially when relying on screw fixation instead of plating. In our study, radiological outcomes, including Bohler's angle, Gissane angle, calcaneal height, and width, were satisfactorily restored in both groups, with no statistically significant differences. These findings mirror those of Ma et al.<sup>28</sup> and Yeo et al.,<sup>30</sup> suggesting that STA can achieve anatomical restoration equivalent to that of the LEA.

Functional outcomes, as assessed by the AOFAS score, were slightly better in the STA group, but the difference did not reach statistical significance. The postoperative VAS scores were significantly lower in the STA group, indicating better subjective pain relief and potentially greater patient comfort. This may be attributed to less tissue trauma and reduced implant-related irritation. The absence of sural nerve injuries and wound-related complications in the STA group further supports this.

Our results reinforce the growing consensus in orthopedic literature that minimally invasive approaches can deliver comparable outcomes with fewer complications in selected fracture patterns.<sup>14,15,27,29</sup> However, one must be cautious in generalizing these results. LEA still holds importance in more comminuted or Sanders Type 4 fractures where full visualization is necessary for complex reconstructions, which were not the focus of our study.<sup>31</sup>

The primary limitation of the study was the non-randomized, comparative design. Patient allocation was not randomized, but patient grouping was based on shared decision-making between the patient and surgeon, following a detailed explanation of both procedures & choice of patients. We also used uniform inclusion criteria and standardized operative protocols from an experienced senior surgeon at a single

institute to further minimize selection and treatment biases. The sample size was considered sufficient based on similar comparative studies, with a standard sample formula from our statistician. We acknowledge that future randomized controlled trials with larger sample sizes are warranted to validate and extend these findings. Finally, we only used CC screws in the STA group and did not compare outcomes of plating via the sinus tarsi approach, which is becoming increasingly popular.<sup>16,22</sup>

Despite these limitations, this study adds valuable prospective data to the ongoing discussion regarding the optimal approach for intra-articular calcaneal fractures (Sanders Type 2 and 3). The sinus tarsi approach with screw fixation appears to be a safe, effective, and less morbid alternative to the extensile lateral approach for joint depression-type fractures. Future randomized controlled trials with larger sample sizes, including Type 4 fractures, are warranted to validate and extend these findings.

## CONCLUSION

The sinus tarsi approach with cannulated screw fixation provides functional and radiological outcomes comparable to the lateral extensile approach with plating in the management of joint depression-type intra-articular calcaneal fractures (Sanders Type 2 and 3). Additionally, it significantly reduces operative time, hospital stay, and soft tissue complications. These findings support the use of the sinus tarsi approach as a safe and effective minimally invasive alternative for appropriately selected fracture patterns.

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All authors reviewed and approved the final manuscript.

## STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

## CREDIT AUTHOR STATEMENT

**SB:** Conceptualization, Validation, Writing – original draft preparation, Visualization, Supervision; **RM:** Methodology, Validation, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration; **SG:** Software; **SD:** Validation, Funding acquisition; **RT:** Formal analysis, Data curation, Writing – original draft preparation; **BA:** Investigation; **SA:** Resources.

## DATA AVAILABILITY STATEMENT

The datasets generated and analyzed in this study are included in the published article.

## AUTHOR DISCLOSURE

The authors declared no conflict of interest.

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None.

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