

Sinus Tarsi Approach Combined with Posterolateral Approach versus Extended Lateral Approach for Calcaneal Fractures: A Retrospective Cohort Study

Jianbo Jia

jianbo19860908@126.com

Fudan University

Jiawen He

Fudan University

Dejian Li

Fudan University

Huang Yan

Fudan University

Xinhua Jiang

Fudan University

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Abstract

Background

Minimally invasive techniques are being increasingly employed in calcaneal fractures (CFs) surgery to minimize soft-tissue complications. This retrospective cohort study (RCS) compared the combined sinus tarsi approach with the posterolateral approach (STA-PLA) and the extended lateral approach (ELA) for Sanders type II and III fractures using an atomical locking plate (ALP) to objectively assess the differences in clinical efficacy and safety.

Method

We conducted a RCS. 150 patients with CFs treated between January 2018 and December 2023 were identified and categorized into the STA-PLA group (n = 75) and the ELA group (n = 75) based on the treatment modality they received. The primary outcomes were operative parameters (surgical time, fluoroscopy frequency, blood loss) and complication rates. Secondary outcomes included hospitalization stay, radiographic reduction quality (Gissane's and Böhler's angles), and functional outcomes assessed by MFS and AOFAS score.

Results

The STA-PLA group demonstrated a significantly shorter injury-to-surgery interval and superior perioperative outcomes (operative time, blood loss, hospitalization duration) compared to the ELA group (all $P < 0.05$). Both groups showed significant postoperative improvement in Gissane's and Böhler's angles, with no intergroup difference. Functional scores (AOFAS, MFS) at final follow-up were excellent and comparable between groups. All patients achieved bony union without fixation failure. However, the overall complication rate was significantly lower in the STA-PLA group (6.67% vs. 20.00%, $P < 0.05$). Complications in the STA-PLA group were minor (wound necrosis, transient nerve injury), while the ELA group had five deep infections requiring reoperation.

Conclusion

Although both approaches yield outstanding final radiographic and functional outcomes, the STA-PLA technique demonstrates superior perioperative efficiency and a notably lower incidence of complications, particularly regarding deep wound infections. This represents a safe and efficacious approach for patients at high risk of soft-tissue complications. Surgeons should weigh the technical requirements against the benefits of this method.

Introduction

CFs are predominantly caused by falls from heights, with over 65% of tarsal fractures being calcaneal fractures^[1, 2]. Approximately 65.9% of these fractures involve the intra-articular region. For displaced intra-articular calcaneal fractures (DIACF), conservative treatment can lead to severe complications and cause joint dysfunction^[3, 4]. Recent evidence indicates that surgical treatment yields better outcomes and is now the preferred approach for most patients^[4 – 6].

Two common approaches for DIACFs are the ELA and the STA. The ELA has been favored due to its extensive surgical exposure of the subtalar facet and its ability to apply ALP in intra-articular CFs.^[7–8] Nevertheless, the risk of postoperative complications associated with this approach reaches as high as 28.1–42.9%. These complications encompass soft-tissue necrosis, postoperative infection, nerve injury, and traumatic osteoarthritis, all of which stem from large-scale incisions and soft-tissue separation^[9, 10]. Soft-tissue necrosis is the most severe complication, which may lead to wound infection or nonunion. This will result in an extended treatment period and increased costs for patients, while they have to endure greater psychological and physical stress.

To minimize soft-tissue complications, the less invasive STA was developed, offering reduced trauma, direct posterior facet visualization, and decreased adhesions, with favorable outcomes reported^[11–5]. However, compared with the ELA, its small incision limits exposure of the subtalar joint, calcaneal tuberosity, and lateral calcaneus. This increases reduction difficulty, reduces fixation strength, and may prolong the recovery process^[16]. Therefore, the optimal surgical approach for treating DIACFs remains controversial. The ELA poses risks to the soft tissues, whereas the STA encounters challenges in achieving anatomic reduction and strong fixation^[17].

To address these limitations, we innovatively combined the STA-PLA with an ALP for the treatment of CFs. This RCS assesses the clinical effectiveness of this innovative technique in comparison with the traditional ELA.

Patients and Methods

A total of 150 patients with who received treatment between January 2018 and December 2023 were identified from the hospital database. Based on the actual treatment modality documented in the medical records, they were categorized into the STA-PLA group (n=75) and the ELA group (n=75). The inclusion criteria were as follows: (1) Individuals aged between 18 and 65 years; (2) Acute, closed calcaneal fracture presenting within 24 hours of injury; (3) Sanders type II or III CFs on CT^[18]; (4) Provision of written informed consent for both the surgical procedure and participation in the study. Patients were excluded for any of the following: (1) Sanders type I or IV fractures; (2) Open fractures; (3) Significant comorbidities such as peripheral vascular disease, diabetic neuropathy, or immunocompromised state; (4) History of previous trauma or surgery involving the ipsilateral foot; (5) Unlikely to adhere to the follow-up protocol.

The average follow-up period was 27.08 ± 10.08 months (range: 16–38) in the STA-PLA group and 27.12 ± 9.80 months (range: 15–40) in the ELA group. The mean age was 38.31 ± 9.64 years (range: 23–65) in the STA-PLA group and 41.28 ± 11.90 years (range: 24–65) in the ELA group, with a male predominance observed in both groups (94.67% and 96.00%, respectively). The mean BMI was comparable between the two groups (25.08 ± 2.88 kg/m² vs. 25.53 ± 2.13 kg/m²), with ranges of 18.4–31.9 and 19.1–31.6, respectively. No statistically significant disparities were detected in the distribution of the injury side (right side: 57.33% vs. 58.67%), injury mechanism (falls from height: 78.67% vs. 84.00%), or Sanders fracture types (Type II: 56.00% vs. 62.67%) (all p > 0.05), as summarized in Table 1. Baseline data indicated that the STA-PLA group and the ELA group shared similarities in crucial characteristics, including follow-up duration, age, gender, and BMI, suggesting the comparability of the two groups at the onset of the study.

Table 1: Comparison of Baseline Data across the Two Groups

Parameter	STA-PLA group (N=75)	ELA group (N=75)	Statistical value	P-value
Mean age (y)	38.31±9.64	41.28±11.90	2128.00	P>0.05
Sex			0.150	P>0.05
Male	71 94.67%	72 96.00%		
Female	4 5.33%	3 4.00%		
Fracture side			0.027	P>0.05
Right	43 57.33%	44 58.67%		
Left	32 42.67%	31 41.33%		
Injury mechanism			0.703	P>0.05
Fall from height	59 78.67%	63 84.00%		
Traffic accident	16 21.33%	12 16.00%		
Sanders classification			0.619	P>0.05
Type II	42 56.00%	47 62.67%		
Type III	33 44.00%	28 37.33%		
Mean BMI (kg/m ²)	25.08±2.88	25.53±2.13	2804.00	P>0.05
Mean follow-up (mo)	27.08±10.08	27.12±9.80	2564.00	P>0.05

Data are presented as Frequency Count (%), or Mean ± Standard Deviation.

Surgical Procedure

In this RCS, all surgical operations were executed by two senior foot and ankle surgeons. each possessing over a decade of experience. A standardized implant set (Watson Company) was employed to minimize technical variables and control for potential confounders in the analysis of outcomes.

Surgical Technique for the STA-PLA Group.

Patients were positioned in a lateral orientation. The procedure commenced with a 3–4 cm incision made over the sinus tarsi (Fig. 1B). Through this incision, the collapsed talar articular surface and the calcaneocuboid joint space can be exposed, enabling direct visual reduction of the articular fragments. Subsequently, a second 3–4 cm longitudinal posterolateral incision was made (Fig. 1C). A subcutaneous tunnel was carefully created between these two incisions, while the sural nerve and peroneal tendons were meticulously protected. Under direct visual inspection, the height, width, and articular surface of the calcaneus were anatomically restored. The anatomical locking plate was then introduced through the posterolateral incision and advanced through the tunnel along the lateral wall of the calcaneus, followed by fixation with locking screws. Initially, a screw was inserted at the anterosuperior part of the calcaneus as depicted in the figure (Fig. 1D) to evaluate the appropriateness of the plate's position. Intraoperatively, satisfactory reduction and implant position were confirmed by C-arm fluoroscopy (Fig. 1D–E). Place the drainage tube and carefully suture the subcutaneous tissue and skin (Fig. 1F).

Fig. 1. Intraoperative photographs and imaging of the STA-PLA surgical procedure. (A–C) Surgical approaches implemented through the STA in combination with the PLA. (D–E) Intraoperative fluoroscopic images. (F) Clinical photograph presenting the appearance of the surgical wounds subsequent to closure.

Surgical Technique for the ELA Group.

Patients were positioned in a lateral orientation. An extended lateral L-shaped incision was made, with the vertical segment positioned along the anterior margin of the Achilles tendon and the horizontal segment aligned with the plantar skin boundary. A full-thickness flap was elevated to expose the lateral calcaneal wall, while carefully protecting the sural nerve and peroneal tendons. Under direct visual inspection, the width, height, and articular surface of the calcaneus were anatomically restored. Subsequently, an identical anatomical locking plate to that utilized in the STA-PLA group was applied. The calcaneal spur screw was inserted initially to establish stability of the medial column. Correct reduction and implant position were verified using C-arm fluoroscopy, followed by placement of a drain and standard layered closure of the wound.

Postoperative Management and Rehabilitation Protocol

All patients followed a standardized postoperative protocol, with drains removed within 24–48 hours and a 24-hour antibiotic course. Under orthopedic and physical therapy supervision, they underwent a three-phase rehabilitation program. Phase transitions were based on radiographic healing and pain-free exercise tolerance. Phase I (weeks 1–2) focused on edema control, pain relief, and protection. Phase II

(weeks 3–6) involved range-of-motion exercises and partial weight-bearing. Phase III (weeks 7–12) emphasized strengthening, proprioception, and full weight-bearing to restore function.

Outcome Assessment

Perioperative data, including operative duration, blood loss, fluoroscopy usage, and hospitalization details, were retrospectively extracted from medical records and surgical logs. Radiographic measurements of Gissane's and Böhler's angles were obtained from available preoperative and postoperative imaging studies. Functional outcomes were assessed using the MFS and AOFAS score based on documented follow-up evaluations. Complications, such as wound-related issues and sural nerve injury, were systematically identified through review of clinical notes and complication registries.

Statistical Analysis

Data analysis was conducted using SPSS 22.0 (IBM, USA). Continuous variables were assessed for normality (Shapiro-Wilk test) and variance homogeneity (Levene test). When the data satisfied the assumptions of normal distribution and homogeneity of variance, the independent samples t-test was adopted for inter-group comparisons; conversely, the Mann-Whitney U test was implemented. Categorical data were subjected to the chi-square test. A statistical significance difference is considered when $P < 0.05$ (two-tailed test).

Results

The STA-PLA group presented a notably shorter mean duration from injury to surgery (3.23 ± 0.68 days; range: 2–5) in comparison to the ELA group (8.04 ± 1.63 days; range: 4–12) ($P < 0.05$; Table 2). Likewise, the STA-PLA group manifested superior perioperative results, encompassing a shorter operative duration (88.05 ± 7.01 minutes, range: 75–102 vs. 103.52 ± 6.88 minutes, range: 86–114), reduced intraoperative blood loss (67.35 ± 9.42 mL, range: 49–86 vs. 100.20 ± 12.54 mL, range: 90–135), and a shorter hospitalization period (10.51 ± 2.31 days, range: 5–16 vs. 19.77 ± 6.58 days, range: 12–44) (all $P < 0.05$). Conversely, fluoroscopy was utilized more frequently in the STA-PLA group (7.96 ± 1.39 times, range: 4–14) than in the ELA group (7.32 ± 1.98 times, range: 5–10) ($P < 0.05$).

Radiographic assessment indicated substantial postoperative improvement in both groups. The Böhler angle increased significantly from $11.49^\circ \pm 3.50^\circ$ (range: 5.1° – 20.4°) preoperatively to $29.75^\circ \pm 2.61^\circ$ (range: 26.6° – 37.5°) postoperatively in the STA-PLA group, and from $9.81^\circ \pm 4.41^\circ$ (range: 1.6° – 18.4°) to $30.48^\circ \pm 2.86^\circ$ (range: 26.18° – 39.86°) in the ELA group (both $P < 0.05$). The Gissane angle decreased significantly from $151.44^\circ \pm 5.46^\circ$ (range: 140.5° – 161.7°) to $126.11^\circ \pm 4.48^\circ$ (range: 115.3° – 135.4°) in the STA-PLA group and from $153.77^\circ \pm 6.25^\circ$ (range: 142.3° – 164.1°) to $127.33^\circ \pm 4.87^\circ$ (range: 118.6° – 136.4°) in the ELA group (both $P < 0.05$). Postoperatively, no statistically significant differences in these radiographic parameters were identified between the two groups ($P > 0.05$).

At the final follow-up, there were no significant differences in functional outcomes between the two groups, as corroborated by the AOFAS and MFS (both $P > 0.05$). The STA-PLA group attained mean scores of 94.76 ± 3.68 (AOFAS; range: 86–100) and 95.87 ± 3.14 (MFS; range: 89–100). On both scales, 88.0% of patients were rated as excellent and 12.0% as good, and no 'fair' outcomes were reported. In contrast, the ELA group had mean scores of 93.47 ± 7.90 (AOFAS; range: 86–100) and 93.99 ± 8.97 (MFS; range: 89–100). The outcome distributions were 80.00% excellent, 16.00% good, and 4.00% fair for AOFAS, and 80.00% excellent, 13.33% good, and 6.67% fair for MFS (Tables 3, 4).

In both groups, all patients achieved bony union, and no cases of reduction loss, fixation failure, or subtalar arthritis necessitating arthrodesis were observed during the follow-up period. The overall complication rate in the STA-PLA group (6.67%, 5/75) was notably lower compared to that in the ELA group (20.00%, 15/75) ($P < 0.05$; Table 5). In the STA-PLA group, complications included 4 cases of wound edge necrosis, which were cured via local wound management, and 1 case of transient sural nerve injury that recovered spontaneously. In the ELA group, complications included 6 cases of wound edge necrosis, 2 cases of transient sural nerve injury that resolved spontaneously, 2 cases of superficial infections successfully treated with nursing care and antibiotics, and 5 cases of deep infections. These deep infections were addressed through vacuum-assisted closure (VSD) drainage, surgical debridement, and subsequent implant removal, resulting in complete recovery within five months across all cases.

Table 2

Comparison of Intraoperative Conditions, Hospitalization Durations, and Postoperative Imaging Results between the Two Patient Groups

Parameter	STA-PLA group (N = 75)	ELA group (N = 75)	Statistical value	P-value
Mean operative time (min)	88.05 ± 7.01	103.52 ± 6.88	373.50	P < 0.05
Intraoperative blood loss (mL)	67.35 ± 9.42	100.20 ± 12.54	0.000	P < 0.05
Mean Fluoroscopy frequency (times)	7.96 ± 1.39	7.32 ± 1.98	2087.00	P < 0.05
Mean hospital stay (d)	10.51 ± 2.31	19.77 ± 6.58	140.00	P < 0.05
Mean time to surgery (d)	3.23 ± 0.68	8.04 ± 1.63	29.00	P < 0.05
Böhler angle (°) Preoperative	11.49 ± 3.50	9.81 ± 4.41	2223.50	P > 0.05
Böhler angle (°) Postoperative day 3	29.75 ± 2.61	30.48 ± 2.86	2424.00	P > 0.05
Gissane angle (°) Preoperative	151.44 ± 5.46	153.77 ± 6.25	2475.00	P > 0.05
Gissane angle (°) Postoperative day 3	126.11 ± 4.48	127.33 ± 4.87	2385.00	P > 0.05

Data are presented in the form of Mean ± Standard Deviation.

Table 3

Clinical outcomes evaluated by the AOFAS score at the final follow-up

Parameter	STA-PLA group (N = 75)	ELA group (N = 75)	U-value	P-value
Excellent (90–100)	66 (88.00%)	60 (80.00%)	2565.00	P > 0.05
Good (75–89)	9 (12.00%)	12 (16.00%)		
Fair (50–74)	0 (0.00%)	3 (4.00%)		
Poor < 50	0 (0.00%)	0 (0.00%)		

Table 4
Clinical outcomes based on the MFS at the final follow-up

Parameter	STA-PLA group(N = 75)	ELA group(N = 75)	U-value	P-value
Excellent (90–100)	66 (88.00%)	60 (80.00%)	2574.00	P > 0.05
Good (75–89)	9 (12.00%)	10 (13.33%)		
Fair (50–74)	0 (0.00%)	5 (6.00%)		
Poor < 50	0 (0.00%)	0 (0.00%)		

Table 5
Postoperative Complications in the Two Groups

Parameter	STA-PLA group	ELA group	Statistical value	P-value
Superficial infection	0 (0.00%)	2 (2.67%)	5.769	P < 0.05
Wound edge necrosis	4 (5.33%)	6 (8.00%)		
Deep infection	0 (0.00%)	5 (6.67%)		
Sural nerve injury	1 (1.33%)	2 (2.67%)		
Total complications	5 (6.67%)	15 (20.00%)		

Data are presented as Frequency Count (%).

Discussion

CFs constitute approximately 2% of the total fractures, predominantly affecting young adults (80–90% of cases) ^[19]. Non-operative treatment often leads to significant residual impairments, hindering patients' reentry into the labor market. Therefore, surgical intervention is recommended, despite the relatively high complication rates: wound-related problems range from 7.57% to 32.8%, and neurovascular injuries occur in 9.1–25% of cases ^[20–22]. Among them, the ELA continues to be widely employed in clinical practice owing to its extensive exposure, optimal visualization, uncomplicated surgical dissection, and facilitated fracture reduction, despite the non-negligible risk of postoperative wound complications ^[23, 24]. Conversely, the STA is notably advantageous. Tarsal sinus incisions and their modifications are well-reported, as they enable direct visualization of the posterior articular facet and are associated with a lower incidence of soft tissue complications. Surgical stabilization remains the gold standard for displaced intra-articular fractures ^[25–29].

Currently, the commonly used internal fixation implants in clinical practice include K-wires, cannulated screws, ALP, and mini-locking plates combined with cannulated screws. Suitable internal fixation methods should be selected according to different surgical approaches. Song et al. ^[29] found that a minimally invasive calcaneal locking plate with a medial support screw provided superior stability for

small articular fragments in Sanders type II fractures. Sato et al. ^[30] reported that locking plates maintained correction better than screw fixation when using the sinus tarsi approach. Biomechanical studies by Ren and Wu also demonstrated the biomechanical advantage of plates over cannulated screw fixation ^[31].

Clinical investigations have demonstrated that patients participating in early postoperative weight-bearing activities exhibit superior functional outcomes ^[32, 33]. Conversely, extended non-weight-bearing durations frequently result in osteoporosis and joint stiffness. Fortunately, attaining firm fixation prior to commencing weight-bearing exercises can substantially enhance functional recovery.

In the present study, the ALP framework structure, fastened with locking screws, constructs a rigid fixation system. This provides a stable environment for the fracture site and reduces or eliminates the risk of calcaneal reduction loss. Consequently, patients can engage in partial weight-bearing approximately four weeks after surgery. In contrast, for patients treated with minimally invasive percutaneous K-wires or CS, doctors advocate a non-weight-bearing period of 12 weeks due to insufficient fixation strength ^[34, 35]. Early postoperative weight-bearing is not advisable, which prolongs the overall recovery process. Arora et al. ^[36] reported the use of minimally invasive percutaneous K-wires for displaced calcaneal fractures, yielding favorable results. Nevertheless, patients are required to wear a plaster cast for three weeks and remain non-weight-bearing for three months, gradually progressing to full weight-bearing over six months.

Consequently, it is posited that in the management of calcaneal fractures, the selection of a suitable surgical approach to prevent incision-related skin complications and the utilization of biomechanically superior internal fixation are of equal significance. Inadequate internal fixation strength invariably results in the prolonged application of external fixators and the delay of postoperative weight-bearing activities, which may impede the functional recovery of the injured limb. Early surgical intervention and functional rehabilitation exercises are also of considerable importance, as they can potentially shorten the rehabilitation period, allow patients to reintegrate into normal daily life and work earlier, and relieve their psychological and financial burdens.

In the present study, an innovative approach is put forward to tackle this crucial problem. By employing an ALP for the management of CFs within the framework of the STA-PLA, this novel surgical method considers both the mitigation of incision-related complications and biomechanically more advantageous internal fixation. This innovative approach has the potential to become a promising therapeutic alternative for displaced intra-articular calcaneal fractures associated with fractures of the calcaneal body and tuberosity.

The primary perioperative advantage of the STA-PLA group is the notably shortened time from injury to surgery. This accelerated timeline presumably reflects the less extensive soft-tissue dissection demanded by the minimally invasive characteristic of STA-PLA. It enables surgery to be carried out before substantial swelling occurs, as opposed to the ELA approach, which is more invasive and often

necessitates a delay for swelling to subside ^[37–39]. As a result, the STA-PLA group experienced a shorter operative duration, reduced intraoperative blood loss, and a shorter hospital stay. These factors jointly contribute to a decrease in surgical stress, a reduction in resource utilization, and potentially enhanced patient comfort in the early postoperative period ^[39]. The trade-off was a statistically higher frequency of fluoroscopy utilization in the STA-PLA group. This is an expected requirement for ensuring accurate percutaneous reduction and placement of the ALP, emphasizing the technique's reliance on intraoperative imaging.

Notably, despite these procedural discrepancies, both techniques exhibited comparable efficacy in achieving the primary goal of fracture management, specifically anatomic restoration. In both cohorts, the postoperative Böhler and Gissane angles were significantly corrected, and no inter-group differences were observed. This validates that a minimally invasive approach does not compromise the quality of radiographic reduction when performed skillfully ^[40]. This conclusion is further corroborated by the absence of reduction loss or fixation failure in either group.

(Fig. 2–5).

At the last follow time, the functional outcomes measured by the MFS and the AOFAS score were excellent and demonstrated no statistically significant difference between two groups. This finding suggests that once the bony union, which was achieved in all patients, is attained, the long-term functional outcome is excellent regardless of the surgical approach employed. Although not statistically significant, the slightly higher proportion of "excellent" ratings in the STA-PLA group may imply a tendency towards more consistent outcomes.

The most compelling evidence in support of the STA-PLA approach is the significantly lower overall complication rate (6.67% vs. 20.00%). Although minor complications, such as wound edge necrosis and transient nerve injury, were identified in both groups, the occurrence of deep infection, a severe and resource-intensive complication, was confined to the ELA group (5 cases vs. 0). This distinct difference can be directly attributed to the minimal disturbance of soft tissue and the smaller surgical incision inherent in the STA-PLA technique. These characteristics more effectively preserve the vascular supply and reduce the devitalization of tissue fragments, thereby facilitating wound healing and augmenting resistance to infection ^[41–42]. The requirement for subsequent procedures (debridement, VSD, implant removal) in cases of deep infection further underscores the clinical and economic burden associated with such complications.

This retrospective cohort study exhibits several intrinsic limitations. The single-center design might introduce center-specific biases, which restricts generalizability and calls for subsequent multicenter validation. Blinding surgeons was unfeasible owing to the retrospective nature and surgical features; despite the fact that procedural standardization and blinded outcome assessment partially compensated for this, potential performance bias still remains. Health economics evaluation was excluded, lacking crucial data on cost-effectiveness and return-to-work for policy-making. The

retrospective framework inherently entails risks of selection bias, information bias, and confounding, thus requiring confirmation through prospective or larger-scale cohort studies.

Conclusions

In conclusion, while both approaches yield outstanding final radiographic and functional outcomes, the STA-PLA technique demonstrates superior perioperative efficiency and a notably lower incidence of complications, particularly regarding deep wound infections. It is a safe and effective approach for patients at high risk of soft-tissue complications. Surgeons should weigh the technical requirements against the benefits of this method.

Declarations

Author Contribution

Authors' Contributions[J.J.]: Conceptualization, Methodology, Writing – Original Draft, Review & Editing. [D.L.]: Investigation, Data Analysis, Validation.[J. H.]: Investigation, Data Analysis, Validation.[Y.H.]: Review & Editing.[X. J.]: Resources, Supervision, Project Administration, Review & Editing.All authors have read and approved the final manuscript.

Data Availability

The data that support the findings of this study are available from the Scientific Research Management Platform of Shanghai Pudong Hospital, but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. The data are, however, available upon request and with the permission of the Scientific Research Management Platform of Shanghai Pudong Hospital.

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Figures

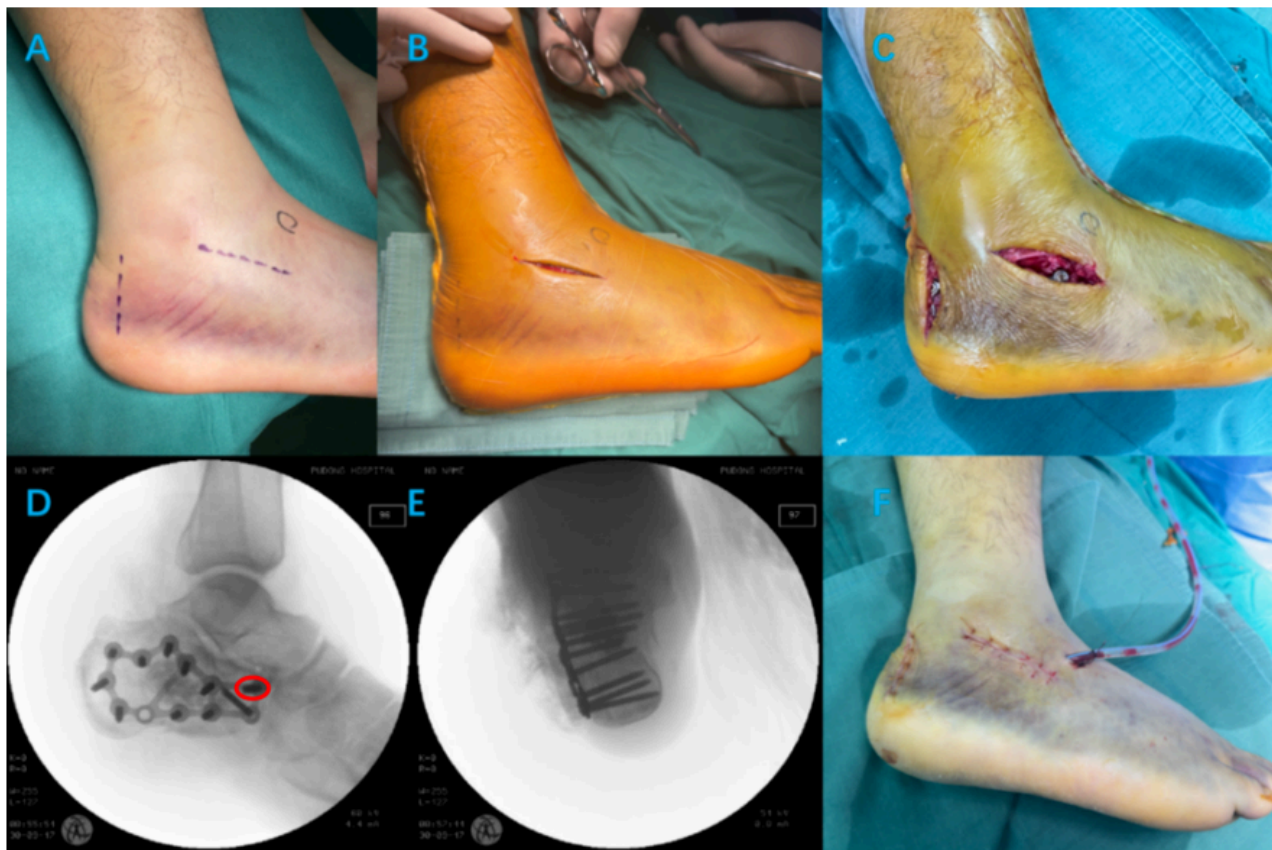


Figure 1

Intraoperative photographs and imaging of the STA-PLA surgical procedure. (A-C) Surgical approaches implemented through the STA in combination with the PLA. (D-E) Intraoperative fluoroscopic images. (F) Clinical photograph presenting the appearance of the surgical wounds subsequent to closure.



Figure 2

Imaging of a 45-year-old male following a high-fall event. (A) Anteroposterior and (B) axial radiographs of the calcaneus.

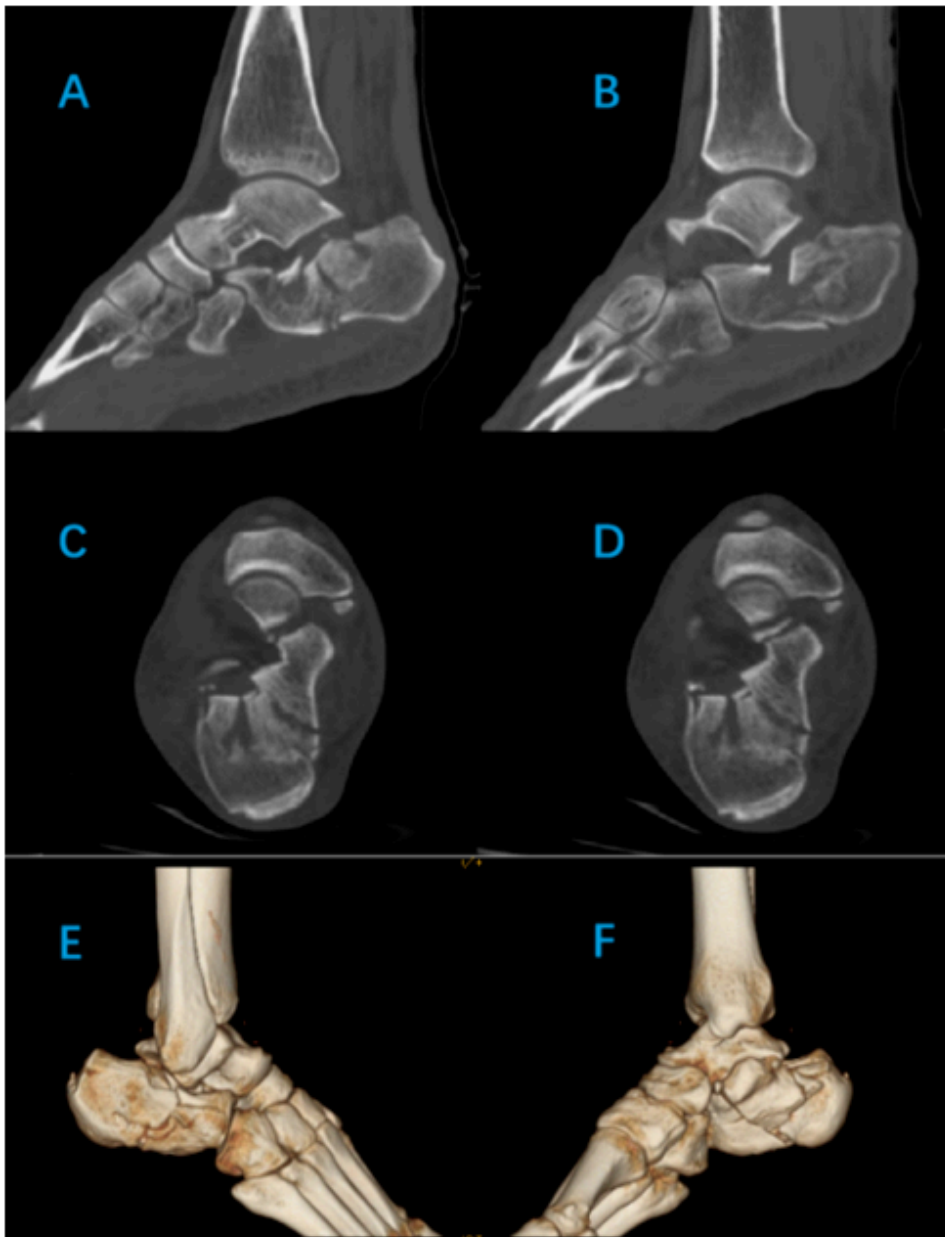


Figure 3

CT scans indicating a diagnosis of a type III calcaneal fracture. Consecutive axial images (A-F) depict the orientations of the fracture lines and the extent of displacement.

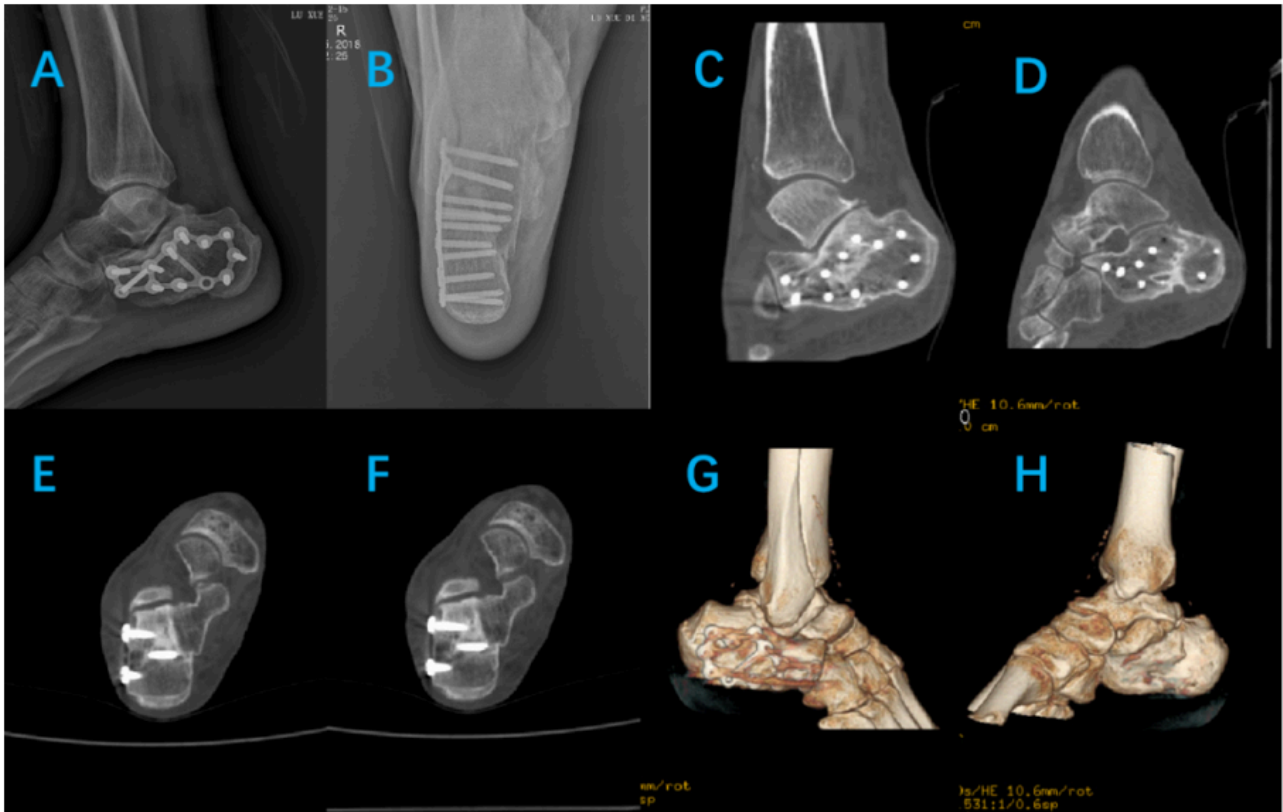


Figure 4

Follow-up imaging assessment performed 12 months after STA-PLA surgery. A-B: Postoperative lateral and axial X-ray films; C-H: Postoperative CT scans.



Figure 5

A-B: At the final follow-up, the functional outcomes were deemed satisfactory.