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Research Article

Comparison of Sinus Tarsi Versus Percutaneous Surgery in Displaced Intra-articular Calcaneal Fractures: Clinical, Radiological, and Pedobarographic Outcomes

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ABSTRACT

Objective: The objective is to compare the clinical, radiological, and pedobarographic outcomes of patients with intra-articular calcaneal fractures treated with sinus tarsi approach (STA) or percutaneous screw fixation postoperatively.

Methods: A consecutive cohort of 66 patients who underwent STA or percutaneous screw fixation for calcaneal fractures between January 2020 and June 2023 was documented. Patients who were at least 18 years of age and had more than 12 months post-operative follow-up were included in the study. Patients with orthopedic injuries to the ipsilateral or contralateral lower extremity, a prior history of lower extremity surgery, congenital deformities, neurological disorders, the utilization of drugs that may influence walking patterns and stability, open foot wounds, or any mental condition that could impair walking were excluded from the study.

Results: Of the patients, 24 underwent percutaneous screw fixation, while 42 underwent mini-open STA. No significant statistical differences were identified between the two groups in terms of demographic data, except for fracture classification. More advanced fracture patterns were observed in the sinus tarsi group. While statistically significant differences were found in the Talo-first metatarsal angle (P = .001), Talonavicular coverage angle (P = .001), Meary's angle (P = .001), and the angle between the medial cuneiform and fifth metatarsal (P = .022), no differences were observed in other radiological measurements. Clinically, significant differences in American Orthopaedic Foot and Ankle Society (AOFAS) (P = .005) and visual analog scale (VAS) (P = .049) scores were observed between the two groups. In dynamic pedobarographic analysis, when comparing the injured and uninjured extremities, significant differences were observed in the injured extremity of the sinus tarsi group in terms of forefoot maximum force (N) (P = .001) and hindfoot maximum pressure (N/cm^2) (P = .001).

Conclusion: While the STA group showed better functional and radiological outcomes, pedobarographic analyses revealed deficiencies in pressure and force distribution in the injured extremity within the STA group. These findings suggest that discrepancies in load and pressure distributions may not always be associated with functional and radiological outcomes, and despite consisting of patients with more severe fractures, ensuring the opening of the posterior facet and achieving joint reduction would increase patient satisfaction rates.

Keywords: Calcaneal fractures, sinus tarsi approach, percutaneous screw fixation, pedobarographic analysis, radiological evaluation

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INTRODUCTION

Calcaneal fractures comprise more than half of tarsal bone fractures and account for 1% to 2% of all bone fractures.[1] Approximately 75% of calcaneal fractures are classified as displaced intra-articular calcaneal fractures (DIACF).[2] Despite extensive research on the treatment of DIACFs, debates continue regarding the optimal approach.[3, 4] A review of the literature indicates that independent meta-analyses have shown that surgically treated DIACFs have faster return-to-work times and more satisfactory clinical and radiological outcomes.[3,4] In contrast, conservative treatment is often associated with subtalar arthritis, malunion, and poor functional outcomes.[5,6] The main topic of today's discussion is determining which surgical approach provides the most effective outcomes for DIACFs.[7]

The extensile lateral approach (ELA) has been used as the standard treatment in open surgery for DIACFs for many years.[7,8] This technique facilitates fracture reduction due to its ability to provide extensive visualization. In soft tissue mobilization, the bone is exposed with full-thickness flaps, and the application of the 'no touch technique' is included.[9] Despite the meticulous techniques employed, the ELA is still associated with significant wound healing complications, with reported rates varying between 5.8% and 43%. The fragile skin over the lateral calcaneal wall often leads to wound complications.[8,9] These complications include necrosis of the wound edges, dehiscence, hematoma, infection, and sural nerve injury.[10-12] Incidences of wound edge necrosis have been reported to range from 2% to 11%, soft tissue infections from 1.3% to 7%, and overall wound complication rates can reach up to 25%.[5,13,14]

Wound-related complications have guided orthopedic surgeons in the development of less invasive methods in this process. Recently, several minimally invasive techniques have been introduced, such as percutaneous fixation, external fixation, and arthroscopy-assisted methods using medial, lateral, or posterior approaches.[6,9,10,15,16] Among these techniques, the sinus tarsi approach (STA) has become popularized due to its advantages, such as limited skin incision, a lower rate of wound complications, and direct access to the posterior facet.[9,17,18] According to some authors, the limited access of minimally invasive approaches (MIA) to the joint line and their inability to provide adequate soft tissue looseness have been claimed to lead to deficiencies in fracture manipulation and reduction, complicating the procedures further.[9,19] However, research has shown that, despite limited access, STA allows for acceptable reduction of the posterior facet using plates and/or screws.[6,9,18] Percutaneous approaches were originally applied mainly to tongue-type fractures due to concerns about achieving proper joint reduction.

Radiological imaging of the foot and ankle is frequently used to detect pathologies in this area. However, they are not dynamic images and do not provide clear information about the functionality of the patient's foot. Pedobarography, which has been used as a diagnostic and evaluation method for a long time, is of great importance for this functional analysis. This gait analysis technique offers highly accurate measurements of ground reaction forces during both walking and standing. It facilitates a static assessment of foot function and balance in a standing position, as well as a dynamic evaluation of pressure distribution on the plantar surface throughout all phases of the gait cycle. These devices deliver numerical values for pressure and visually represent the pressures on the plantar surface using a specific color scheme. Sequential images illustrate the pressure and contact areas from initial ground contact to the lift-off phase. Due to these benefits, pedobarography is increasingly used in some centers for foot and ankle disorders.[20,21]

This study aims to compare the clinical, radiological, and pedobarographic outcomes of patients with DIACF treated with STA or percutaneous screw fixation postoperatively.

MAIN POINTS

- The sinus tarsi approach provided better clinical (AOFAS) and radiological outcomes with less postoperative pain.
- Reduced weight and pressure distribution were observed in the STA group due to more complex fractures, though this did not fully align with functional outcomes.
- The percutaneous group included simpler fractures, while the STA group dealt with more complex ones, which influenced the study's overall results.

METHODS

Patient Selection

It is a retrospective study that has been approved by the Ankara Bilkent City Hospital 2nd Clinical Research Ethics Committee Presidency (Approval number: E2-23-3577 Date: 27.03.2023). A consecutive cohort of 66 patients who underwent fixation for DIACF using either plate fixation with STA or percutaneous screw fixation between December 2020 and June 2023 at a hospital with a Level 1 trauma center was recorded and analyzed. The surgeries were performed through a mini open incision over the sinus tarsi or using the Modified Essex-Lopresti/Westheus closed reduction technique by two senior surgeons.[22-24] In the sinus tarsi group, the surgery was performed with a single L- or T-shaped plate (Figure 1) as described by Kikuchi and his collegeus.[25]

In the percutaneous group, the joint was indirectly reduced and the surgery was performed using 2 or 3 cannulated screws (Figure 2), as described by Ebrahimpour and his colleagues.[26]

Radiological images included anteroposterior, lateral, and calcaneal projections of the ankle. Preoperative computed tomography (CT) scans were also utilized for all patients. Twenty four patients were excluded due to concomitant injuries in the same extremity, neurological problems, and previous lower extremity surgeries. There were 90 patients who met the inclusion criteria, but 24 did not attend regular follow-ups. Therefore, 66 patients were included in the study. The treatment complications were classified into major and minor categories. Conditions requiring revision surgery, such as osteomyelitis, nonunion, and loss of reduction, are considered major complications, while superficial wound-related issues (such as suture dehiscence, drainage, etc.) and symptomatic implants are classified as minor complications.

Clinical and Radiological Evaluation

Pain was evaluated using a 10 cm visual analog scale (VAS), with 0 indicating no pain and 10 signifying the most severe pain possible.[27] The active range of motion (ROM) of both ankles was assessed using a universal goniometer, following the guidelines established by the AOFAS. The ankle movements in the coronal and sagittal planes were assessed twice with the patient seated, and the average value was documented.[28]

Radiographs were obtained while the patient was standing, capturing dorsoplantar and lateral views of both feet. Fracture patterns were classified based on the Sanders classification.[5] Digital measurements included Kite's angle (talocalcaneal angle), talo-first metatarsal angle, and talonavicular coverage angle in the dorsoplantar view. In the lateral view, Meary's angle (talo-first metatarsal angle), lateral talocalcaneal angle, calcaneal pitch angle, Böhler's angle (the angle formed by two tangent lines to the calcaneus), Gissane angle (the intersection of the posterior facet and anterior process slopes), and the distance between the medial cuneiform and fifth metatarsal were recorded.[29,30]

Pedobarographic Evaluation

Pedobarographic measurements were performed using the Zebris FDM type 3 gait platform (Zebris Medical GmbH, Germany). Patients walked on the 10-meter-long platform for two minutes, during which data were collected from the sensor-equipped section of the platform, recorded on a computer, and analyzed using manufacturer-developed software. Both extremities were evaluated in the patients. Gait measurements, plantar force, and pressure distributions were recorded.

Statistical Analysis

The study data were analyzed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, released in 2013). The normality of the data was examined using the Shapiro-Wilk test, and Levene's test was applied to assess variance homogeneity. For group comparisons, independent t-tests, Welch tests, or Mann-Whitney U tests were used.

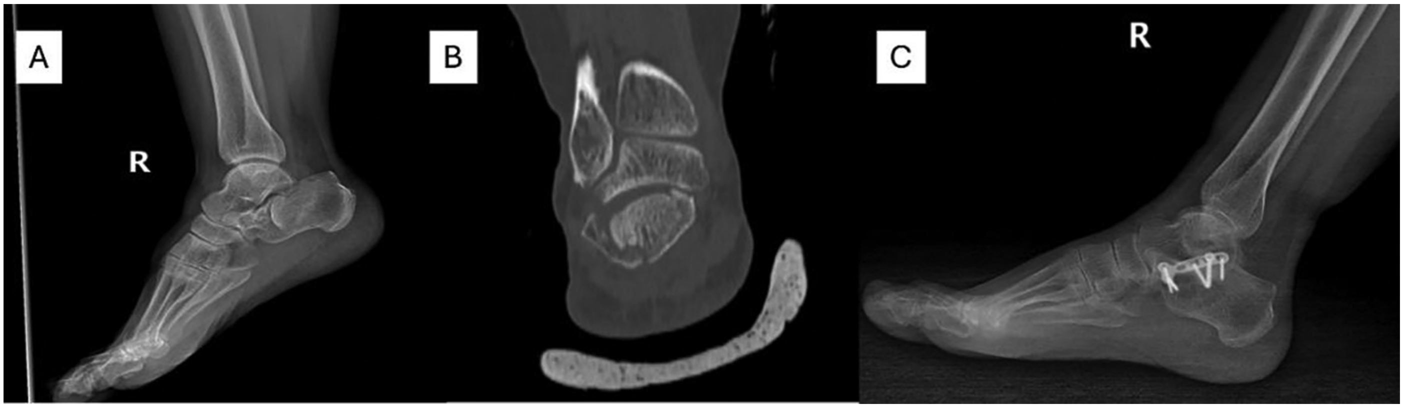

Figure 1. A patient operated on using the sinus tarsi approach. (A) Preoperative lateral X-ray image of the patient with a calcaneal fracture. (B) Coronal CT scan showing intra-articular comminution of the calcaneal fracture. (C) Postoperative lateral X-ray image showing fixation of the calcaneal fracture with a T-plate.

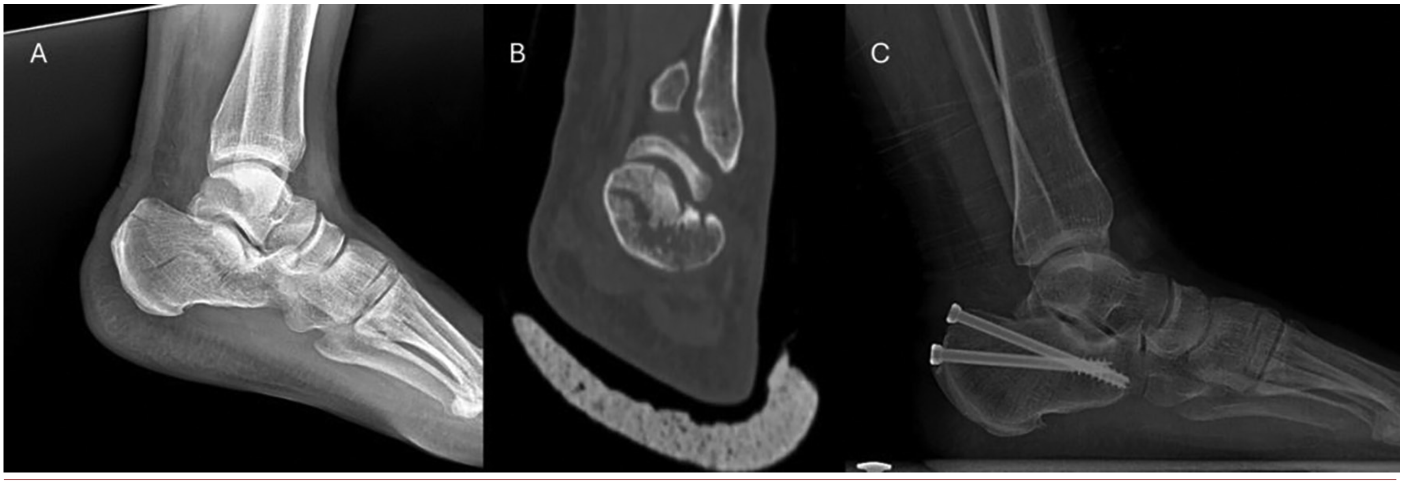

Figure 2. A patient operated on using percutaneous screws. (A) Preoperative lateral X-ray image of the patient with a calcaneal fracture. (B) Coronal CT scan showing intra-articular comminution of the calcaneal fracture. (C) Postoperative lateral X-ray image showing fixation of the calcaneal fracture with with 2 cannulated screws.

Fisher's exact test was employed for categorical variables. A 2-way analysis of variance (ANOVA) was performed to investigate the effect of injured versus uninjured limbs and stable versus unstable fractures on the outcome measures. The association between numerical variables was assessed using Pearson correlation or Spearman's rho. Continuous variables were presented as means with standard deviations or as medians with range values, depending on the context. Categorical data were presented as frequencies and percentages. In statistical analyses, a significance level of .05 and above was considered significant.

RESULTS

Of the patients, 24 underwent percutaneous fixation, and 42 underwent STA fixation (Figure 3).There were no significant statistical differences between the groups in terms of patient age (*P* = .810), side of injury (*P* = .575), gender (*P* = .768), and follow-up duration (*P* = .763) (Table 1). According to the Sanders classification, most patients in the percutaneous group were type 2A, whereas the STA group primarily consisted of type 3AB patients. A statistically significant difference in classification between the two groups was observed (*P* = .001). While no major complications were observed in either group, minor complications included superficial wound infections in 5 patients in the STA group and in 3 patients in the percutaneous group, with no statistically significant difference detected between the two groups.

In the radiological evaluation using weight-bearing X-ray images, no significant differences were found between the groups for kite angle (*P* = .810), lateral talo-calcaneal angle (*P* = .186), Bohler's angle (*P* = .207), Gissane angle (*P* = .508), and calcaneal pitch angle (*P* = .400). However, significant differences were found in the talus-first metatarsalangle (*P* = .001), talonavicular coverage angle (*P* = .001), Meary's angle (*P* = .001), and medial cuneiform-fifth metatarsal angle (*P* = .022) (Table 2).

Clinically, significant differences were observed between the two groups in AOFAS (*P* = .005) and VAS (*P* = .049) scores (Table 3).

In dynamic pedobarographic analysis, when comparing the injured sides, significant differences were found in the midfoot (*P* = .007) and hindfoot (*P* = .031) maximum pressure (N/cm^2) values. In the percutaneous group, comparing the injured and uninjured sides revealed a significant difference in the forefoot time to maximum force (% of stance time) (*P* = .032), while no significant differences were observed in other measurements. In the STA group, significant differences were found in the forefoot maximum force (N) (*P* = .001), heel maximum pressure (N/cm^2) (*P* = .001), and heel time to maximum force (% of stance time) (*P* = .024) between the injured and uninjured sides, while no significant differences were found in other measurements (Table 4).

In butterfly and foot progression gait analyses, no significant differences were found between the injured and uninjured sides within each group or between the two groups (Table 5).

DISCUSSION

The most important findings of this study are that the STA group demonstrated significantly better clinical outcomes, as evidenced by a higher AOFAS score and less postoperative

Table 1. Demographics of the Study Groups

Characteristic	Percutaneous Group (n = 24)	Sinus Tarsi Group (n = 42)	P
Age (months)			
Mean ± SD	42.8 ± 11.2	43.4 ± 13.0	.810*
Median (min-max)	48 (22-54)	43 (18-64)	
Side			
Left	12 (50%)	18 (42.9%)	.575⁺
Right	12 (50%)	24 (57.1%)	
Sex			
Male	20 (83.3%)	31 (73.8%)	.768
Female	4 (16.7%)	11 (26.2%)	
Sanders Classification			
2A	15 (62.5%)	0 (0.0%)	
2B	0 (0.0%)	3 (7.1%)	
2C	0 (0.0%)	3 (7.1%)	
3AB	6 (25.0%)	18 (42.9%)	**.001⁺**
3AC	0 (0.0%)	0 (0.0%)	
3BC	0 (0.0%)	9 (21.4%)	
4	3 (12.5%)	9 (21.4%)	
Follow-up (months)			
Mean ± SD	30.1 ± 12.1	29.5 ± 12.5	.763*
Median (min – max)	34.0 (14.0-43.0)	36.0 (12.0-47)	

*Mann-Whitney U test, ⁺Pearson Chi Square test.

pain compared to the percutaneous group. Radiological findings indicated that both groups exhibited hindfoot varus, and there was a significant reduction in forefoot adduction in the percutaneous group compared to the STA group. Joint reduction has been achieved better in the STA group despite a more severe fracture morphology, due to direct visualization of the joint. Therefore, it seems reasonable that there is less pain in the STA group. Pain is likely to result from post-traumatic subtalar arthritis as a consequence of inadequate joint reduction.

Dynamic pedobarographic analyses revealed a significant reduction in the average maximum force (N) in the forefoot and the average maximum pressure (N/cm^2) in the hindfoot of the injured extremity in the sinus tarsi group compared to the healthy extremity. When comparing the injured extremities between the groups, the percutaneous group showed significantly lower average maximum pressure (N/cm^2) in the midfoot, while the STA group showed significantly lower average maximum pressure (N/cm^2) in the hindfoot.

Table 2. Radiological Measurements of the Study Groups

Measurement (degree)	**Percutaneous Group (n = 24)**	**Sinus Tarsi Group (n = 42)**	***P****
Kite's anlgle			
Mean ± SD	14.3 ± 7.1	13.0 ± 9.6	.810
Median (min-max)	11.9 (6.1-25.0)	14.1 (-10.2-28.3)	
Talus – first metatarsal angle			
Mean ± SD	-6.3 ± 8.8	4.8 ± 7.3	**.001**
Median (min-max)	-8.5 (-25.6-11.3)	2.7 (-3.1-20.5)	
Talonavicular coverage angle			
Mean ± SD	12.2 ± 7.2	0.6 ± 9.2	**.001**
Median (min-max)	13.8 (0.6-24.9)	3.8 (-20.4-10.7)	
Meary's angle			
Mean ± SD	12.4 ± 6.3	4.7 ± 6.8	**.001**
Median (min-max)	12.6 (2.3-22.0)	5.1 (-10.0-16.5)	
Lateral talo-calcaneal angle			
Mean ± SD	33.9 ± 14.7	32.0 ± 11.6	.186
Median (min-max)	41.2 (6.3-47.7)	31.0 (8.9-62.2)	
Bohler's angle			
Mean ± SD	22.0 ± 8.0	24.0 ± 15.0	.207
Median (min-max)	25.0 (8.0-31.4)	26.0 (-14.2-46.4)	
Gissane angle			
Mean ± SD	130.2 ± 13.4	132.1 ± 10.1	.508
Median (min-max)	129.0 (104.0-150.0)	131.5 (115.0-153.0)	
Medial cuneiform – fifth metatarsal angle			
Mean ± SD	5.5 ± 1.9	6.5 ± 3.0	**.022**
Median (min-max)	5.0 (3.6-10.0)	5.6 (0.1-12.0)	
Calcaneal pitch angle			
Mean ± SD	13.9 ± 4.4	14.2 ± 5.7	.400
Median (min-max)	13.5 (8.2-22.0)	15.0 (0.0-22.2)	

*Mann-Whitney U test.

Table 3. Clinical Scores Comparison Between the Study Groups

Score	**Percutaneous Group (n = 24)**	**Sinus Tarsi Group (n = 42)**	***P****
AOFAS Score			
Mean ± SD	63.2 ± 21.9	79.7 ± 13.5	**.005**
Median (min – max)	56.0 (37.0-100.0)	76.5 (54.0-100.0)	
VAS Score			
Mean ± SD	3.7 ± 2.1	3.0 ± 1.6	**.049**
Median (min – max)	4.0 (0.0-6.0)	3.0 (0.0-5.0)	

*Mann-Whitney U test.

Chronic pain after foot and ankle fractures is a prevalent and important issue that requires attention, as patients commonly report enduring pain following these injuries. This pain adversely influences functionality and quality of life. In this study, postoperative pain severity was assessed using the VAS score. The average VAS score was 3.7 ± 2.1 in the percutaneous group and 3.0 ± 1.6 in the STA group, with a statistically significant difference between the groups (*P* = .049). While there are studies in the literature comparing VAS scores following percutaneous or open reduction and internal fixation (ORIF) treatment of DIACF, comparisons specifically involving the STA are limited.[20,31] This study observed that patients treated in the STA group experienced less postoperative pain compared to those in the percutaneous group, which contradicts the existing literature.[32] These findings highlight the critical importance of the quality of posterior facet reduction in reducing chronic postoperative pain.

In our study, the mean postoperative AOFAS score was 63.2 ± 21.9 in the percutaneous group and 79.7 ± 13.5 in the STA group, demonstrating a statistically significant difference (*P* = .005). In line with authors who consider this procedure the gold standard for calcaneal fractures, we observed

Table 4. Pedobarographic Assessments For The Forefoot, Midfoot and Heel.

	Pedobarographic Parameter		Percutaneous Group Mean ± SD Median (min-max)	Sinus Tarsi Group Mean ± SD Median (min-max)	*P**
Forefoot	Maximum Force (N)	Injured extremity	555.6 ± 229.9 577.7 (223.4-818.6)	506.6 ± 223.3 564.8 (223.2-838.3)	*.548*
		Uninjured extremity	576.3 ± 222.7 605.2 (162.7-836.3)	654.1 ± 195.6 708.7 (260.7-851.9)	
		P*	.853	**.001**	
	Maximum pressure (N/cm²)	Injured extremity	29.7 ± 15.6 30.3 (7.6-51.5)	27.2 ± 13.4 23.5 (9.8-50.4)	*.471*
		Uninjured extremity	28.6 ± 12.8 29.0 (6.9-50.2)	31.2 ± 9.8 30.8 (16.2-51.1)	
		*P**	.853	.083	
Midfoot	Maximum Force (N)	Injured extremity	208.9 ± 60.8 194.7 (123.8-292.0)	200.8 ± 78.0 218.4 (35.2-313.5)	.819
		Uninjured extremity	223.0 ± 48.3 222.1 (160.9-290.4)	174.8 ± 79.1 155.3 (31.3-313.2)	
		*P**	.577	.159	
	Maximum pressure (N/cm²)	Injured extremity	14.6 ± 3.5 14.3 (9.8-22.3)	15.7 ± 3.9 16.1 (8.0-24.3)	**.007**
		Uninjured extremity	15.9 ± 5.6 14.4 (9.8-26.4)	14.4 ± 3.9 14.2 (8.5-22.8)	
		*P**	.780	.058	
Heel	Maximum Force (N)	Injured extremity	520.1 ± 129.1 564.2 (255.2-677.8)	509.7 ± 151.2 527.2 (179.5-714.4)	.719
		Uninjured extremity	506.1 ± 116.7 540.1 (300.8-690.1)	532.2 ± 148.9 556.3 (202.3-692.8)	
		*P**	.265	.091	
	Maximum pressure (N/cm²)	Injured extremity	28.8 ± 6.1 26.5 (22.1-41.6)	26.2 ± 5.8 24.2 (17.5-36.6)	**.031**
		Uninjured extremity	29.5 ± 9.3 25.1 (20.0-48.5)	30.0 ± 5.2 29.2 (22.7-39.6)	
		*P**	.457	**.001**	

*Mann-Whitney U test.

superior clinical outcomes in patients who underwent open reduction compared to those who received percutaneous reduction.[31,33]

Previous studies have shown that varus heel, loss of height, and decreased forefoot adduction are common issues following DIACF and can be detected through radiological measurements.[34-36] Çolak and colleagues compared the injured side with the uninjured side after surgical treatment of DIACF and reported an increase in hindfoot varus, a decrease in medial arch height, and an increase in forefoot adduction on the injured extremity using radiological and pedobarographic measurements.[34] Varus deformity of the hindfoot is commonly seen after trauma, and this deformity can lead to undesirable conditions such as osteoarthritis in the posterior facet, stress fractures, compression of the peroneal tendons, stiffness in the subtalar joint, and anterior ankle impingement.

In our current study, we found no statistically significant difference in kite and lateral talocalcaneal angles, which assess hindfoot varus, and calcaneal pitch angle, which evaluates medial arch height, between the injured extremities in both groups. The lack of comparison between injured and uninjured extremities might have contributed to these results. However, significant differences were observed in talus-first metatarsal and talonavicular coverage angles, which assess forefoot adduction, between the 2 groups. Our findings indicate that patients treated with percutaneous screws exhibited a greater tendency toward forefoot adduction.

Weight is transferred to the upper articular surface of the calcaneus through the axial loading of the talus's 3 articular facets. The primary load transfer happens at the posterior facet surfaces. A collapse of the posterior facet is indicated by a reduction in Böhler's angle and an increase in Gissane's angle, both of which are directly associated with functional outcomes and the severity of the injury. In our study, no significant differences were found in Böhler's and Gissane's angles between the injured limbs in both groups. While the average values of Gissane's angle were within the normal range in both groups, the average values of Böhler's angle were slightly lower than the normal range in both groups. Previous studies have demonstrated a statistically greater improvement in Böhler's angle in patients treated with the classic open technique compared to those treated with percutaneous screws. The absence of a significant difference in our study may be attributed to the higher number of Sanders type 3 patients in the STA group.

Since 2000, studies using dynamic pedobarographic measurements have shown a variety of results concerning patient numbers, treatments, follow-up periods, outcome scores, and pressure measurement parameters. However, many have reported similar results in regional foot pressure measurements after intra-articular fractures. Studies by Jansen et al.[37] and Colak et al.[34] have reported elevated midfoot pressure on the injured side compared to the healthy side following calcaneal fracture surgery. Another study found a reduction in hindfoot pressure, along with increased pressure in the lateral and midfoot regions of the forefoot.[38]

In our study, pedobarographic analysis showed that patients in the sinus tarsi group bore significantly less weight and pressure in both the forefoot and hindfoot of the injured extremity compared to the uninjured extremity during walking. We believe this condition may be due to the higher number of patients with more fragmented fractures, as classified by Sanders, in the STA group.

Table 5. Comparison of Butterfly Parameters and Foot Rotation Angle of the Study Cohorts

	Pedobarographic Parameter		Percutaneous Group Mean ± SD Median (min-max)	Sinus Tarsi Group Mean ± SD Median (min-max)	P*
Butterfly parameters	Length of gait line (mm)	Injured extremity	230.0 ± 18.8 239.2 (203.0-249.0)	218.5 ± 33.6 230.9 (134.9-250.5)	*.254*
		Uninjured extremity	225.5 ± 26.5 235.4 (171.7-250.2)	222.6 ± 25.0 231.7 (161.3-249.0)	
		P*	.353	.840	
	Single limb support line (mm)	Injured extremity	90.1 ± 45.1 110.9 (13.3-133.1)	79.7 ± 43.3 96.1 (11.1-143.5)	*.119*
		Uninjured extremity	95.0 ± 40.4 110.6 (22.9-18.9)	98.4 ± 29.8 105.6 (38.4-134.0)	
		*P**	0.642	0.053	
Geometry parameters	Foot rotation angle (degree)	Injured extremity	9.0 ± 5.8 8.5 (0.0-16.7)	8.4 ± 8.3 6.2 (-1.2-32.6)	*.254*
		Uninjured extremity	10.0 ± 5.1 8.6 (4.4-18.9)	7.3 ± 6.8 6.1 (-3.9-16.9)	
		P*	.457	.747	

*Mann-Whitney U test.

Our study is valuable for comparing 2 surgical approaches pedobarographically, radiologically, and clinically. However, it has certain limitations. Our study is retrospective, and the effects of the pre-injury characteristics of the injured foot were not considered. In the percutaneous group, there was a higher representation of type 2 patients according to the Sanders classification, which led to a significant difference in classification between the groups and negatively affected the results of the STA group.

CONCLUSION

While the STA group showed better functional and radiological outcomes, pedobarographic analyses revealed deficiencies in pressure and force distribution in the injured extremity within the STA group. These findings suggest that discrepancies in load and pressure distributions may not always be associated with functional and radiological outcomes, and despite consisting of patients with more severe fractures, ensuring the opening of the posterior facet and achieving joint reduction would increase patient satisfaction rates.

Ethics

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Ankara Bilkent City Hospital 2nd Clinical Research Ethics Committee Presidency (Approval number: E2-23-3577; Date: 27.03.2023)

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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Footnotes

Author Contributions

Concept – H.A.; Design – H.A., E.V.; Supervision – A.F.; Funding-Y.K.; Materials – Y.E.; Data collection &/ or processing – Y.E., Ş.G.; Analysis and/or interpretation –V.B.; Literature search – Ş.G.; Writing – H.A.; Critical review – A.F.

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