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Original Research

Does Grafting Matter in Surgically Treated Calcaneal Fractures? A Retrospective Analysis

Baris Ozkul,[1] Hanifi Ucpunar,[2] Kutalmis Albayrak,[1] Muhammed Bilal Kurk,[1] Muhammed Mert,[1] Gokhan Pehlivanoglu,[1] Muharrem Kanar[3]

[1]Department of Orthopaedic Surgery and Traumatology, Metin Sabanci Baltalimani Bone Diseases Training and Research Hospital, Istanbul, Türkiye
[2]Medical Park Bursa Hospital, Bursa, Türkiye
[3]Department Orthopedics and Traumatology, Sisli Hamidiye Etfal Training and Research Hospital, Istanbul, Türkiye

Abstract

Objectives: The role of bone grafting in the surgical treatment of displaced intra-articular calcaneal fractures (DIACFs) remains controversial. Although bone grafts are commonly used to restore joint congruity and support anatomical reduction, recent evidence favors minimally invasive approaches that may eliminate the need for routine grafting. This study aimed to evaluate the impact of bone graft use on radiological parameters and functional outcomes in Sanders Type II, III, and IV calcaneal fractures treated surgically.

Methods: This retrospective cohort study included 115 patients who underwent open reduction and internal fixation (ORIF) for DIACFs between 2016 and 2022. Fractures were classified using the Sanders classification and subgrouped as grafted (+) or non-grafted (–). Böhler and Gissane angles and calcaneal height were measured at four time points. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score. Intergroup and intragroup comparisons were made using appropriate statistical methods.

Results: Of the 115 patients, 38 had Type II, 43 had Type III, and 34 had Type IV fractures. Demographics and follow-up durations were comparable across groups ($p>0.05$). Both grafted and non-grafted groups demonstrated significant postoperative improvements in radiological parameters ($p<0.05$), which gradually declined over time. No statistically significant intergroup differences were observed at any time point ($p>0.05$). AOFAS scores and superficial wound infection rates were also similar.

Conclusion: Bone grafting did not yield superior radiological or functional outcomes in Sanders Type II, III and IV DIACFs treated with ORIF. These findings support a selective approach to grafting, especially in cases with significant comminution or bone loss, and align with current trends favoring biologically friendly and minimally invasive techniques.

Keywords: Bone graft, calcaneus fracture, sanders classification

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Calcaneus fractures are among the most frequently encountered tarsal bone fractures in the foot, typically resulting from high-energy trauma.[1] These fractures, accounting for approximately 1% to 2% of all skeletal fractures, lead to significant morbidity.[2] Particularly, displaced intra-articular calcaneal fractures (DIACF) are complex injuries requiring anatomical reduction and stable fixation.[3]

Address for correspondence: Baris Ozkul, MD. Department of Orthopaedic Surgery and Traumatology, Metin Sabanci Baltalimani Bone Diseases Training and Research Hospital, Istanbul, Türkiye
Phone: +90 542 427 72 32 **E-mail:** drbarisozkul@hotmail.com

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According to the Sanders classification, Type 2, Type 3, and Type 4 fractures are evaluated based on the degree of posterior subtalar joint facet involvement, and treatment approaches remain a subject of debate.[4] While conservative and surgical treatment options are discussed for Type 2 and 3 fractures, surgical intervention is generally unavoidable for Type 4 fractures due to their high comminution rate.[5] However, the necessity of graft usage and its impact on long-term clinical outcomes among these surgical options are yet to be clearly defined.[6] Furthermore, bone quality itself, which is independent of fracture morphology, may also influence radiological and functional outcomes.[7]

Current literature highlights the advantages of graft use in replacing bone loss and restoring joint congruity.[8] Conversely, some studies suggest that graft use may increase infection risk and surgical morbidity.[9] Recent advancements in minimally invasive techniques have reportedly reduced the need for grafting and accelerated postoperative healing.[10, 11] Moreover, recent systematic reviews have demonstrated that percutaneous and minimally invasive approaches can achieve comparable radiological and functional outcomes to traditional open techniques, while significantly lowering the rates of soft tissue complications and postoperative infections.[12, 13] While the question of the need for grafting in calcaneal fractures has been explored, our study uniquely analyzes a large cohort with granular subgroup analysis by Sanders type, offering a fresh perspective within the existing literature.

We hypothesized that there would be no significant difference in radiological and functional outcomes between patients treated with and without bone grafting in Sanders Type II, III, and IV intra-articular calcaneal fractures treated with open reduction and internal fixation. This study aims to evaluate the effects of graft use on radiological and functional outcomes in intra-articular calcaneal fractures and to compare these findings with current literature.

Methods

This retrospective study evaluated patients who underwent surgical treatment for intra-articular calcaneal fractures at our institution between 2016 and 2022. Patient records, including radiographic images (X-ray and computed tomography[14] and operative notes, were comprehensively reviewed. Fractures were classified according to the Sanders classification into Type II (Group A), Type III (Group B), and Type IV (Group C). Each group was further subdivided based on the use of bone grafts during surgery: grafted (+) and non-grafted (–) (Table 1). In our study, we used cancellous allografts for bone grafting.

A total of 141 patients were initially screened. Following the application of exclusion criteria and the removal of patients with incomplete follow-up data, 28 patients were excluded. Thus, 115 patients were included in the final analysis. Among them, 38 had Type II fractures (15 grafted, 23 non-grafted), 43 had Type III fractures (21 grafted, 22 non-grafted), and 34 had Type IV fractures (20 grafted, 14 non-grafted). Demographic characteristics, radiographic parameters, and the American Orthopaedic Foot and Ankle Society (AOFAS) Score[15] were evaluated and compared between grafted and non-grafted subgroups within each fracture type. Radiographic parameters such as Böhler and Gissane angles, as well as calcaneal height, were measured using standard lateral radiographs in accordance with previously described methods.[16, 17]

Inclusion Criteria

- Patients with unilateral, displaced intra-articular calcaneal fractures
- Closed fractures
- Age between 16 and 65 years
- Availability of preoperative CT and X-ray images, and postoperative lateral and axial radiographs of the calcaneus

Table 1. Demographic characteristics and clinical data of grafted and non-grafted patients according to Sanders classification.

	Tip II Graft (-)	Tip II Graft (+)	Tip III Graft (-)	Tip III Graft (+)	Tip IV Graft (-)	Tip IV Graft (+)
Age (Mean±SD)	39.8±10.7	36.6±9.0	40.8±9.2	39.1±11.8	37.6±10.7	39.5±10.9
p	0.198[m]		0.584[m]		0.843[m]	
Sex (Female) n	6	3	6	7	6	3
p	0.666$^{X^2}$		0.665$^{X^2}$		0.156$^{X^2}$	
Sex (Male) n	17	12	16	14	8	17
p	0.666$^{X^2}$		0.665$^{X^2}$		0.156$^{X^2}$	
Follow-up Time (Mean±SD)	42.6±20.4	47.4±20.5	40.8±19.6	47.9±22.2	27.4±11.3	31.1±11.3
p	0.419[m]		0.295[m]		0.188[m]	
AOFAS Score (Mean±SD)	79.1±13.2	78.9±14.0	72.3±8.0	74.8±7.7	60.9±11.3	57.1±12.7
p	0.846[m]		0.261[m]		0.435[m]	

AOFAS: American Orthopaedic Foot and Ankle Society; SD: standard deviation.

- Sanders Type II, III, or IV fractures
- Undergoing open reduction and internal fixation with plates and screws via the extensile lateral approach.[1]

Exclusion Criteria

- Open fractures (n=4)
- History of previous calcaneal surgery (n=3)
- Concomitant fractures of the foot or ankle (n=5)
- Follow-up period of less than 12 months (n=7)
- Incomplete radiological or clinical follow-up data (n=9)

A total of 28 patients were excluded based on the criteria above.

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional review board on February 26, 2025, with approval number: 241, meeting number: 33.

Statistical Analysis

Descriptive statistics were presented as mean±standard deviation, median (minimum–maximum), frequency, and percentage, where appropriate. The distribution of variables was assessed using the Kolmogorov-Smirnov test. For comparisons between two independent groups with non-normally distributed quantitative data, the Mann-Whitney U test was used. The Wilcoxon signed-rank test was applied to evaluate changes in paired non-normally distributed quantitative data. The Chi-square test was used for the analysis of categorical variables. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software version 22.0 (IBM Corp., Armonk, NY, USA).

For the evaluation of radiological changes across the four time points (preoperative, early postoperative, third postoperative month, and final follow-up), the Wilcoxon signed-rank test was applied for intragroup comparisons. This allowed the assessment of temporal changes within both grafted and non-grafted groups. Intergroup comparisons at each time point were performed using the Mann–Whitney U test. The corresponding results are presented in Tables 2, 3 and 4. Future research should consider reporting effect sizes and conf*0idence intervals to improve the understanding of clinical significance.

In this manuscript, ChatGPT (OpenAI, GPT-4o version) was used solely for language editing purposes. No artificial intelligence tools were involved in data analysis or scientific content generation.

Table 2. Böhler angle measurements at four time points and intergroup/intragroup comparisons in grafted and non-grafted subgroups across Sanders fracture types

	Group A (Sanders Tip 2)				**Group B (Sanders Tip 3)**				**Group C (Sanders Tip 4)**		
	Graft (-) Mean S.D.	**Graft (+) Mean S.D.**	**p**		**Graft (-) Mean S.D.**	**Graft (+) Mean S.D.**	**p**		**Graft (-) Mean S.D.**	**Graft (+) Mean S.D.**	**p**
Böhler Angle				**Böhler Angle**				**Böhler Angle**			
Preop	9.5±7.1	8.5±4.1	0.822^{m}	Preop	6.4±7.4	6.7±5.8	0.608^{m}	Preop	3.2±7.7	1.4±5.8	0.185^{m}
Early Postop	27.4±9.7	29.1±8.6	0.560^{m}	Early Postop	28.5±8.1	26.5±7.5	0.318^{m}	Early Postop	24.4±6.4	24.0±3.9	0.684^{m}
3. Month	28.1±7.5	26.9±6.7	0.519^{m}	3. Month	25.6±7.6	26.1±6.3	0.971^{m}	3. Month	19.4±6.1	18.1±7.1	0.634^{m}
Final follow-up	26.9±7.1	25.3±8.0	0.822^{m}	Final follow-up	23.4±9.9	25.6±7.0	0.243^{m}	Final follow-up	14.8±7.6	13.3±6.4	0.505^{m}
Change relative to the preop				Change relative to the preop				Change relative to the preop			
Early Postop	17.9±8.7	20.7±10.8	0.393^{m}	Early Postop	22.1±9.8	19.9±10.4	0.661^{m}	Early Postop	21.2±10.6	22.6±7.2	0.382^{m}
Intragroup change p	0.000	0.001		Intragroup change p	0.000	0.000		Intragroup change p	0.001	0.000	
3. Month	18.7±8.4	18.4±7.5	0.881^{m}	3. Month	19.2±8.7	19.4±9.1	0.971^{m}	3. Month	16.1±8.2	16.7±8.6	0.790^{m}
Intragroup change p	0.000	0.001		Intragroup change p	0.000	0.000		Intragroup change p	0.001	0.000	
Final follow-up	17.4±8.0	16.8±9.7	0.905^{m}	Final follow-up	17.0±8.9	18.9±10.0	0.443^{m}	Final follow-up	11.6±7.1	11.9±7.5	0.985^{m}
Intragroup change p	0.000	0.001		Intragroup change p	0.000	0.000		Intragroup change p	0.001	0.000	

SD: Standard deviation; Preop: preoperative; Postop: postoperative. ^{m}Mann-whitney u test / ^{w}Wilcoxon test; ^{m}Mann-whitney u test / ^{w}Wilcoxon test; ^{m}Mann-whitney u test / ^{w}Wilcoxon test

Table 3. Gissane angle measurements at four time points and intergroup/intragroup comparisons in grafted and non-grafted subgroups across Sanders fracture types.

	Group A (Sanders Tip 2)				Group B (Sanders Tip 3)				Group C (Sanders Tip 4)		
	Graft (-) Mean S.D.	Graft (+) Mean S.D.	p		Graft (-) Mean S.D.	Graft (+) Mean S.D.	p		Graft (-) Mean S.D.	Graft (+) Mean S.D.	p
Gisanne Angle				**Gisanne Angle**				**Gisanne Angle**			
Preop	132.7±12.1	133.0±10.3	0.787^{m}	Preop	139.5±14.0	141.7±12.6	0.381^{m}	Preop	145.8±18.6	146.4±12.2	1.000^{m}
Early Postop	121.8±10.2	120.7±8.7	0.881^{m}	Early Postop	123.1±6.9	124.4±9.8	0.502^{m}	Early Postop	126.1±9.4	126.2±7.9	0.924^{m}
3. Month	123.0±9.9	122.4±7.1	0.811^{m}	3. Month	127.5±9.0	125.2±6.8	0.179^{m}	3. Month	129.6±10.7	132.7±8.5	0.293^{m}
Final follow-up	124.5±10.1	123.5±8.0	0.881^{m}	Final follow-up	129.5±9.5	127.4±7.1	0.617^{m}	Final follow-up	132.3±12.7	142.0±14.8	0.059^{m}
Change relative to the preop				Change relative to the preop				Change relative to the preop			
Early Postop	-10.9±13.5	-12.3±11.1	0.491^{m}	Early Postop	-16.5±14.1	-17.3±11.2	0.770^{m}	Early Postop	-19.6±19.5	-20.3±8.0	0.717^{m}
Intragroup change p	0.002	0.004		Intragroup change p	0.000	0.000		Intragroup change p	0.005	0.000	
3. Month	-7.7±12.6	-10.6±11.2	0.288^{m}	3. Month	-12.1±15.6	-16.5±10.9	0.177^{m}	3. Month	-16.2±17.6	-13.7±6.5	0.834^{m}
Intragroup change p	0.006	0.016		Intragroup change p	0.003	0.000		Intragroup change p	0.007	0.000	
Final follow-up	-8.3±10.2	-9.5±12.1	0.419^{m}	Final follow-up	-10.0±18.8	-14.3±12.3	0.215^{m}	Final follow-up	-13.5±17.4	-4.4±6.8	0.101^{m}
Intragroup change p	0.001	0.016		Intragroup change p	0.042	0.000		Intragroup change p	0.012	0.024	

SD: Standard deviation; Preop: Preoperative; Postop: Postoperative. ^{m}Mann-whitney u test / ^{w}Wilcoxon test; ^{m}Mann-whitney u test / ^{w}Wilcoxon test; ^{m}Mann-whitney u test / ^{w}Wilcoxon test.

Table 4. Calcaneal height measurements at four time points and intergroup/intragroup comparisons in grafted and non-grafted subgroups across Sanders fracture types

	Group A (Sanders Tip 2)				Group B (Sanders Tip 3)				Group C (Sanders Tip 4)		
	Graft (-) Mean S.D.	Graft (+) Mean S.D.	p		Graft (-) Mean S.D.	Graft (+) Mean S.D.	p		Graft (-) Mean S.D.	Graft (+) Mean S.D.	p
Calcaneus Height				**Calcaneus Height**				**Calcaneus Height**			
Preop	37.5±3.1	36.0±3.2	0.192^{m}	Preop	35.0±4.7	34.2±3.4	0.685^{m}	Preop	32.1±2.6	34.4±4.0	0.155^{m}
Early Postop	49.9±4.8	50.7±4.8	0.567^{m}	Early Postop	48.2±4.4	48.4±3.7	0.874^{m}	Early Postop	40.1±4.1	43.9±2.6	0.054^{m}
3. Month	49.1±5.5	49.4±6.7	0.419^{m}	3. Month	47.6±5.6	48.1±3.3	0.871^{m}	3. Month	38.2±4.1	42.1±3.1	0.534^{m}
Late Postop	48.7±5.0	48.6±5.0	0.881m^{m}	Late Postop	45.3±5.0	46.1±3.4	0.323^{m}	Late Postop	35.8±4.2	37.6±3.4	0.142^{m}
Change relative to the preop				Change relative to the preop				Change relative to the preop			
Early Postop				Early Postop				Early Postop			
Intragroup change p	0.000	0.001	^{m}	Intragroup change p	0.000	0.000	^{m}	Intragroup change p	0.001	0.000	^{m}
3. Month				3. Month				3. Month			
Intragroup change p	0.000	0.001	^{m}	Intragroup change p	0.000	0.000	^{m}	Intragroup change p	0.001	0.000	^{m}
Final follow-up				Late Postop				Late Postop			^{m}
Intragroup change p	0.000	0.001	^{m}	Intragroup change p	0.000	0.000	^{m}	Intragroup change p	0.003	0.009	

SD: Standard deviation; Preop: Preoperative; Postop: Postoperative. ^{m}Mann-whitney u test / ^{w}Wilcoxon test; ^{m}Mann-whitney u test / ^{w}Wilcoxon test; ^{m}Mann-whitney u test / ^{w}Wilcoxon test.

Results

A total of 115 patients (84 males, 31 females) with intra-articular calcaneal fractures were included in the study. Fractures were classified into Sanders Types II, III, and IV, and each type was further divided into grafted (+) and non-grafted (–) subgroups (Figs. 1-3). Baseline demographic characteristics, including age, sex, follow-up duration, and AOFAS scores, were similar across subgroups (p>0.05) (Table 1).

Tables 2, 3, and 4 summarize the measurements of Böhler angle, Gissane angle, and calcaneal height, respectively, across four time points—preoperative, early postoperative, 3-month follow-up, and final follow-up—for both grafted and non-grafted subgroups in each Sanders type.

Across all Sanders fracture types, intergroup comparisons revealed no significant differences between grafted and non-grafted subgroups at any time point for any of the radiographic parameters (p>0.05).

Intragroup analysis showed that both grafted and non-grafted subgroups experienced statistically significant postoperative improvements in Böhler angle and calcaneal height, as well as a significant reduction in Gissane angle when compared to preoperative values (p<0.05 for all).

However, the magnitude of change from preoperative measurements did not differ significantly between the grafted and non-grafted groups for any of the radiographic parameters across all Sanders types.

Over the course of follow-up, Böhler angle and calcaneal height exhibited a gradual decline from the early postoperative period, though values remained significantly elevated compared to baseline. Conversely, Gissane angle showed a slight increase over time following its initial

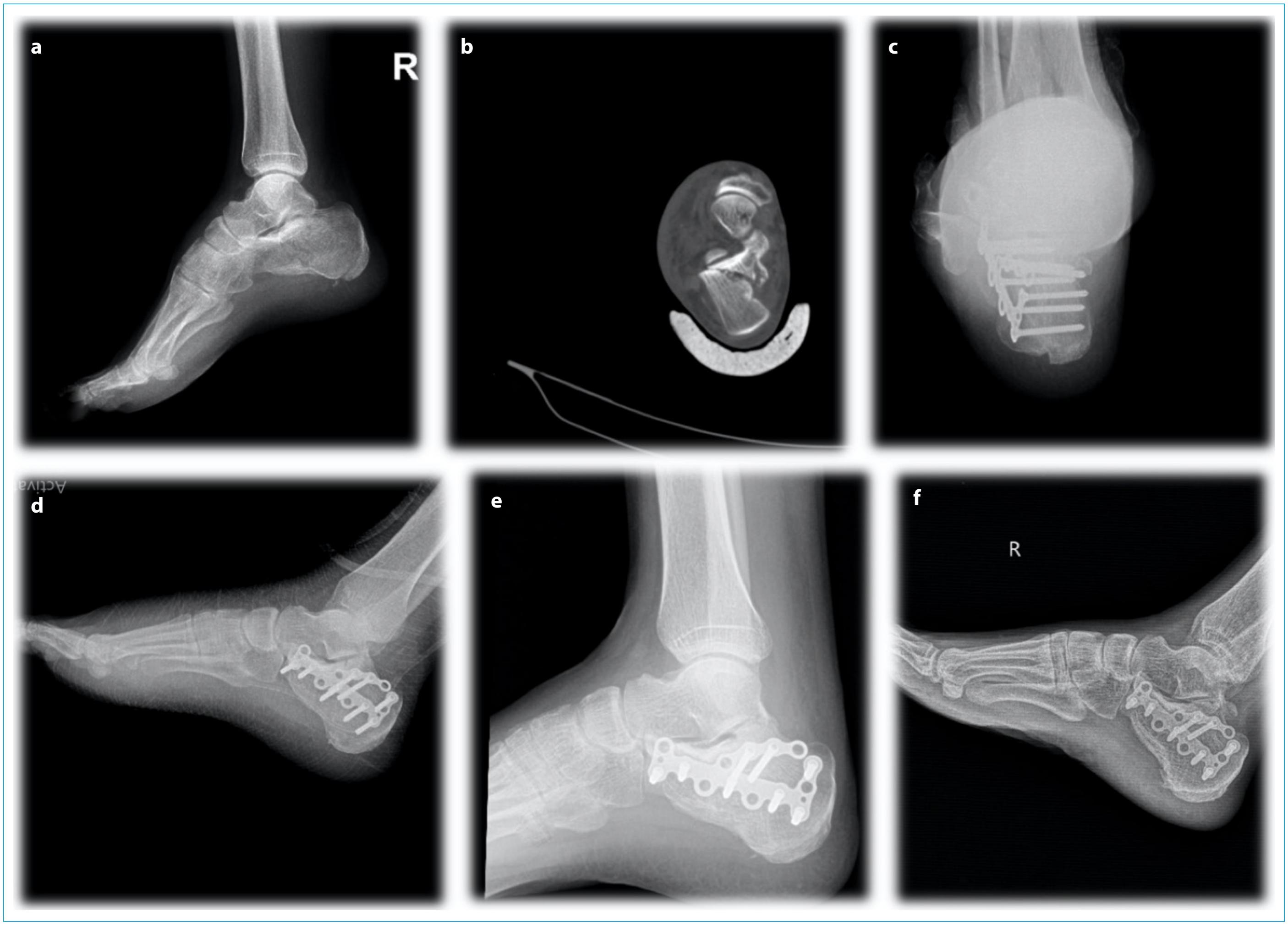

Figure 1. Representative Case of a Sanders Type II Calcaneal Fracture Treated Without Bone Grafting.

(a) Preoperative lateral X-ray; **(b)** axial CT image demonstrating the Sanders Type II classification; **(c)** postoperative axial X-ray of the calcaneus; **(d)** early postoperative lateral X-ray; **(e)** lateral X-ray at 3-month follow-up; **(f)** lateral X-ray at final follow-up.

Figure 2. Sanders Type III Calcaneal Fracture Treated with Bone Grafting.

(a) Preoperative axial CT image demonstrating Sanders Type III fracture configuration; **(b)** preoperative lateral X-ray; **(c)** early postoperative lateral X-ray; **(d)** lateral X-ray at 3-month follow-up; **(e)** lateral X-ray at final follow-up.

postoperative decrease (Figs. 4-6). These temporal changes were consistent between grafted and non-grafted groups, without statistically significant intergroup differences.

Postoperative complications included superficial wound infections in 16.6% of non-grafted patients and 18.5% of grafted patients, with no statistically significant difference ($p>0.05$). All superficial infections were effectively managed with antibiotics or minor debridement. CRPS was observed in both groups and was treated successfully with conservative measures. Overall, the use of bone grafts during ORIF did not result in superior outcomes in radiological parameters or functional recovery as measured by the AOFAS score.

Discussion

In this retrospective cohort study, we assessed the impact of bone grafting on radiological and functional outcomes in patients with displaced intra-articular calcaneal fractures treated with open reduction and internal fixation. A total of 115 patients classified as Sanders Type II, III, or IV were evaluated. Bone grafting was not associated with significant improvements in radiographic parameters or AOFAS scores throughout the follow-up period. The AOFAS Ankle-Hindfoot Scale, despite its widespread use, has been reported to exhibit ceiling effects, particularly in its pain and alignment subscales, limiting its sensitivity in detecting subtle functional differences over time.[18] Complication rates, including superficial infection, were also comparable. These findings suggest that bone grafting may not provide

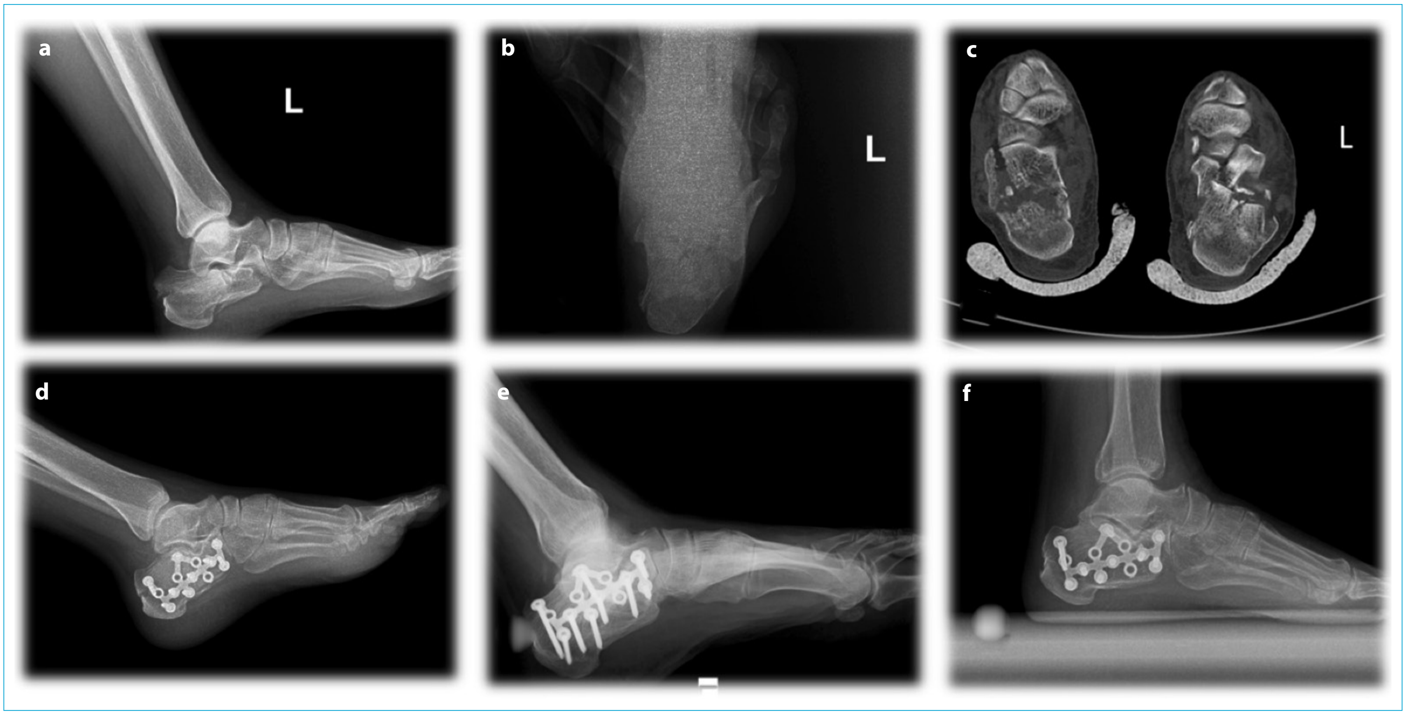

Figure 3. Sanders Type IV Calcaneal Fracture Treated with Bone Grafting

(a) Preoperative lateral X-ray; **(b)** preoperative axial calcaneal X-ray; **(c)** preoperative axial CT scan showing comminuted fracture morphology; **(d)** early postoperative lateral X-ray; **(e)** lateral X-ray at 3-month follow-up; **(f)** lateral X-ray at final follow-up.

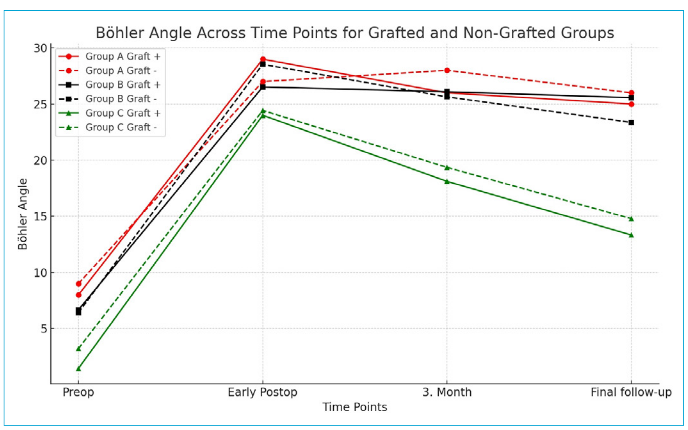

Figure 4. Böhler Angle Changes Over Time:

This graph shows Böhler angle improvements in all Sanders subgroups after surgery, with a gradual decrease over time. Solid lines represent grafted patients; dashed lines represent non-grafted.

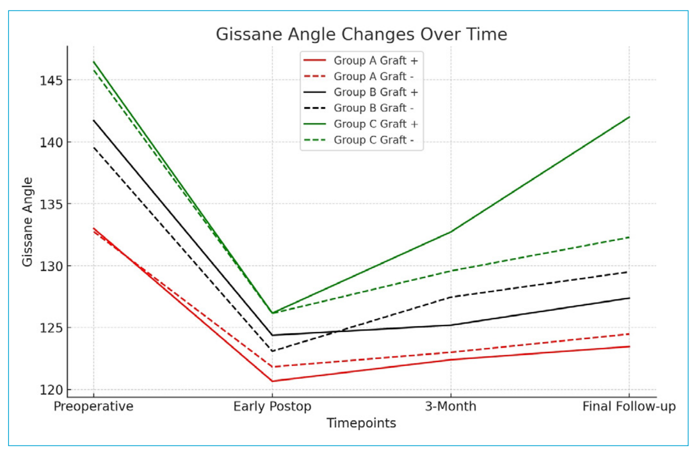

Figure 5. Gisanne Angle Changes Over Time:

This graph shows a postoperative decrease in Gissane angle across all Sanders subgroups, with a slight upward trend later. Solid lines for grafted patients; dashed lines for non-grafted.

additional clinical or radiographic benefit in the routine management of these fractures and should be considered selectively based on fracture morphology and bone loss. This approach is consistent with the broader trend in orthopedic surgery favoring biologically friendly techniques, as also demonstrated in deformity correction studies employing the Ilizarov method without bone grafting.[19]

Zheng et al.,[17] in their meta-analysis, reported a significantly higher AOFAS score in patients who received grafts, although no significant differences were found in Böhler's angle, Gissane's angle, calcaneal height, or width. In our study, no significant differences in AOFAS scores were observed between groups with and without graft usage. Another meta-analysis also found no significant difference in postoperative functional outcomes with graft usage, which is consistent with our findings.[5] In the current literature, there is no clear consensus on the optimal graft type for calcaneal fractures, and no studies explicitly compare the

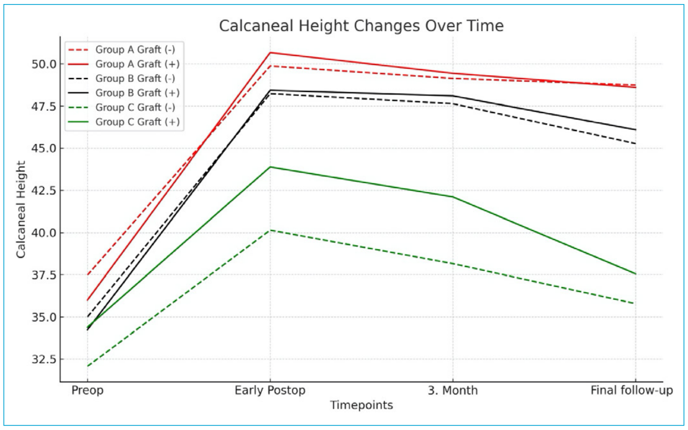

Figure 6. Calcaneal Height Changes Over Time:

This graph shows an increase in calcaneal height after surgery, with some decline during follow-up. Solid lines indicate grafted; dashed lines non-grafted patients.

outcomes of different graft types.[5, 6, 17, 20-23] In our study, the comparison between grafted and non-grafted subgroups within each Sanders classification (Type II, III, and IV) revealed no statistically significant differences in age, sex, follow-up duration, or AOFAS scores. These findings are consistent with previous studies that reported comparable functional outcomes between grafted and non-grafted patients.[20, 21] Longer follow-up studies may reveal potential differences in AOFAS scores between groups. Consistent with our data, Park et al.[2] reported that bone defects following calcaneal fracture surgery spontaneously filled within one year and functional outcomes were independent of graft usage. Wilkinson et al.[8] demonstrated that the need for grafting was reduced in patients treated with minimally invasive techniques, a finding supported by systematic reviews showing that these approaches yield favorable outcomes with less soft tissue morbidity and reduced need for bone augmentation.[13] Although open reduction is traditionally favored for restoring anatomical landmarks, evidence from meta-analyses suggests that percutaneous techniques achieve similar restoration of Böhler and Gissane angles without the increased risk of wound complications.[12] Furthermore, literature suggests that postoperative wound complications are more common in cases with extensive incisions and graft usage may increase the risk of infection.[24] Hammond and Crist[25] reported that percutaneous techniques reduced infection rates and the need for grafting. Despite the use of conventional incisions and fracture approaches in our study, no clinical or radiological differences were observed between groups. Swords et al.[26] argue that graft usage does not provide a significant contribution to postoperative functional recovery and advocate for the preference of minimally invasive techniques. From a surgical perspective, the primary rationale for bone grafting has traditionally been to fill bone voids and maintain the height of the posterior facet. However, recent evidence indicates that with modern fixation techniques—particularly locking plates and improved intraoperative imaging—adequate stabilization can often be achieved without the need for grafts.[27, 28] In line with this, our findings support the trend toward more selective use of grafts, reserving them for cases with significant bone loss or comminution. Radiologically, Böhler angle and calcaneal height increased significantly following surgery, with a gradual reduction in these gains during follow-up. In contrast, Gissane angle decreased postoperatively but exhibited a slight upward trend over time. These changes, however, were not significantly different between the grafted and non-grafted groups, suggesting that bone grafting does not influence the preservation of postoperative alignment throughout the follow-up period. Tian et al.[5] reported that Gissane's angle showed a statistically significant difference favoring the graft group in the long-term, yet emphasized that this difference was of limited clinical relevance. Similarly, Brunner et al.[27] found no measurable benefit of bone graft use on the preservation of Böhler's and Gissane's angles during follow-up, supporting our findings. Consistent with previous studies, our findings suggest that the decrease in Böhler angle and calcaneal height and the increase in Gissane angle observed over time may result from remodeling and subsidence at the fracture site during healing. These changes could influence load distribution and subtalar joint biomechanics. However, in our study, these radiographic changes did not translate into significant differences in clinical or functional outcomes between grafted and non-grafted groups.[2, 17, 22]

However, our study suggests that approaches that do not damage bone biology during surgery may not yield different results from minimally invasive procedures. Nevertheless, literature has shown that percutaneous screw fixation without grafting in Sanders Type II and III fractures provides high patient satisfaction and stability.[3] The crucial point is not graft usage, but rather appropriate stability provision, which may be a more important factor on outcomes. These findings support that graft usage does not provide additional short- and medium-term stabilization. Complications that may be associated with graft use are also important. Wei et al.,[9] in their review, reported that autologous iliac graft harvesting can cause minor complications (wound infection, hematoma, nerve damage) at a rate of 6-39% and major complications (deep infection, chronic pain, revision surgery) at a rate of 1-10%. He et al.,[21] in a prospective study, also reported a significant increase in postoperative infection rates in patients who received grafts. Furthermore, other studies have suggested that bone graft use may prolong operative time and increase the risk of wound complications. Abidi et al.[29] identified graft usage as a factor associated with impaired wound healing, while Longino and Buckley[20] reported higher infection rates in the grafted group, though this difference was not statistically significant.

In our study, although the number of non-grafted patients was higher, the rate of superficial wound infections was comparable between the groups and did not reach statistical significance. This finding suggests that infection development is likely more influenced by surgical technique—particularly the extent of soft tissue handling—than by the use of graft material itself. These results are in line with meta-analytic evidence indicating lower complication rates associated with percutaneous approaches compared to conventional open techniques, largely due to better soft tissue preservation.[12, 13] This study is strong in terms of comprehensively evaluating the effects of graft use on radiological and functional outcomes in intra-articular calcaneal fractures and comparing it with current literature. The study is notable for including almost all calcaneal fracture types (Sanders Type II, III, and IV), covering a wide age range, and having clearly defined inclusion and exclusion criteria.

However, the retrospective design of this study, potential biases in patient selection, and the relatively small sample size should be considered as limiting factors. Although effect sizes and confidence intervals were not included in the current analysis, we recognize that incorporating these measures would strengthen the clinical interpretation of the findings. We have therefore highlighted this as a limitation and suggested the inclusion of effect sizes and confidence intervals in future research. Additionally, our study did not analyze the potential impact of different graft types on outcomes due to limited data and lack of consensus in the literature; future studies focusing on this aspect would be beneficial. Specifically, the non-grafted subgroup in Sanders Type IV fractures (n=14) may lack sufficient statistical power to detect moderate effects, thus warranting caution in generalizing the findings to all Sanders Type II, III, and IV fractures. Additionally, the variability in surgical techniques used and differences in surgeon experience should be acknowledged as potential confounding variables. Future prospective, randomized controlled trials may overcome these limitations and contribute to more definitive conclusions.

Conclusion

The findings of this study demonstrate that graft use in calcaneal fractures does not provide a significant advantage in terms of preserving Böhler's angle, calcaneal height, and functional outcomes. Due to the risk of additional morbidity and potential complications, graft use should not be routinely recommended except in selected cases.

Our results support the current shift in the literature toward more conservative and biologically friendly techniques, aligning with meta-analytic evidence that highlights the safety and efficacy of percutaneous reduction without routine grafting.[12]

Disclosures

Ethics Committee Approval: The study was approved by the of Metin Sabanci Baltalimani Bone Diseases Training and Research Hospital Ethics Committee (date: 26.02.2025, no:241).

Informed Consent: The authors declared that written informed consent was obtained from all participants before their inclusion in the study.

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