

Complication Rates Are Similar Between Patients Aged <50 and >50 Years in Calcaneus Fractures Treated With the Sinus Tarsi Approach

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Abstract

Background: The sinus tarsi (ST) approach for calcaneus fractures has gained popularity in recent years with an increased interest in shifting to less invasive approaches for calcaneal fracture fixation allowing for adequate fixation if complications do not arise. Although the ST approach has gained acceptance as standard for calcaneus fracture fixation, the literature surrounding early complications rates based on age differences for this specific approach and pathology is lacking. The objective of this study was to determine if rates of complications based on age varied for patients undergoing open reduction and internal fixation (ORIF) of closed calcaneus fractures using the ST approach.

Methods: A retrospective review of patients undergoing ORIF for closed calcaneus fractures from 2012 to 2020 was performed. Inclusion criteria were based on an age greater than 18 years, surgical management of a closed calcaneus fracture using a ST approach, requirement of a preoperative computed tomographic scan, and a minimum of 180 days' follow-up. Patients were divided into 2 groups: those aged <50 years and those aged >50 years.

Results: A total of 196 fractures were included with 114 fractures in the <50-year age group and 82 fractures in the >50-year age group. Mean age was 34.2 and 59.7 years in the younger and older groups, respectively. The older group had similar rates of wound dehiscence (1.2% vs 4.4%, $P = .204$), superficial surgical site infection (1.2% vs 2.6%, $P = .490$), deep infection (9.8% vs 7.9%, $P = .648$), and nonunion (4.9% vs 3.5%, $P = .633$) compared with the younger group. Rates of 30-day readmission, unplanned reoperation, and symptomatic hardware were not significantly different. Postoperative Bohler and Gissane angles were not significantly different between both groups.

Conclusion: Older patients with intraarticular calcaneus fractures treated via the ST approach maintain complication rates similar to those in younger individuals.

Level of Evidence: Level III, retrospective study.

Keywords: calcaneus fracture, age, sinus tarsi, hindfoot, injury

Introduction

The calcaneus is the most commonly injured tarsal bone constituting approximately 60% of all tarsal fractures and 2% of all fractures in the body.^{3,17,21} The optimal management of displaced intraarticular calcaneal fractures remains controversial and surgical treatment of patients with this

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injury is technically challenging.^{4,14,23} With the well-documented complications of nonoperative management (eg, malunion and subtalar arthritis),^{2,22} the advancement of surgical techniques over the years has led to an increased adoption of operative treatment.^{16,27}

If wound complications can be avoided, anatomical reduction and stable fixation of intraarticular calcaneal fractures leads to predictable improvement in functional outcomes.^{1,24,25} Previous investigations have suggested nonoperative management of these fractures may be preferred in patients aged >50 years as they are more likely to experience poor outcomes,^{5,19} but several more recent studies have put this perspective into question.^{10,11,24,28} The traditional surgical approach for operative fixation of calcaneal fractures has been the extensile lateral approach, yet this technique is often associated with increased rates of wound complications.^{4,18,20} As a result, there has been an increased interest in shifting to less invasive approaches for calcaneal fracture fixation. One such approach is the sinus tarsi approach, which has similar efficacy as the extensile lateral approach with a lower rate of wound complications.^{4,7,18,20,26,30,31} However, no study identifies the complications associated with the differences in age for this relatively new approach.

The purpose of the present study was to compare postoperative complication rates between younger and older patients with intraarticular calcaneus fractures undergoing open reduction and internal fixation (ORIF) via the sinus tarsi approach. We hypothesized that complication rates would be comparable between these 2 groups.

Methods

Study Design

After obtaining institutional review board approval, all patients undergoing ORIF for calcaneus fractures via the sinus tarsi approach from January 2012 to January 2020 at a single tertiary care institution were retrospectively identified. All patients were either treated by 2 fellowship-trained foot and ankle surgeon or 2 fellowship-trained orthopaedic trauma surgeons. The use of the sinus tarsi approach vs the extensile lateral approach was used at the discretion of the surgeon. After 2015, all 4 surgeons converted to using strictly sinus tarsi approaches for calcaneus fractures. Prior to 2015, extensile lateral approach was used as one of the approaches. Inclusion criteria consisted of patients aged ≥ 18 years who underwent ORIF of a closed calcaneus fracture with a minimum of 180 days' follow-up. Patients with open calcaneal fractures or those without a preoperative computed tomographic scan were excluded from the study. Patients were separated into 2 groups based on age: patients aged <50 years and those aged >50 years. The age of 50 years was selected to create the age groups in

order to be consistent with previous literature.^{5,10,12,28} Implants were selected at the discretion of the surgeon. All patients received boot immobilization for at least 8 weeks following surgery, with aspirin for anticoagulation unless contraindicated.

Variables

Medical records were reviewed for demographic data including age, gender, race, body mass index, tobacco use, diabetes, and American Society of Anesthesiologists (ASA) grade. Using preoperative imaging, each fracture was categorized according to the Sanders classification. Additional preoperative variables recorded included mechanism of injury and surgical time. The primary outcomes included development of wound dehiscence, superficial surgical site infection, deep infection requiring operative incision and drainage, and nonunion. Nonunion was defined as subsequent healing on radiographic imaging with at least 3 months of follow-up. Secondary outcomes included postoperative Bohler angles, postoperative Gissane angles, painful implants that required removal, any readmission within 30 days of discharge, or unplanned return to the operating room.

Statistical Analysis

Data were extracted and aggregated in Microsoft Excel (v.16). Statistical analysis was performed with IBM SPSS 27. Normality of continuous variables was assessed via the Shapiro-Wilk test. Numerical values were reported as mean \pm SD, and proportions were reported as percentages. Continuous variables were assessed using Mann-Whitney *U* tests, whereas categorical variables were assessed via chi-square or Fisher exact tests. *P* values of <.05 were considered statistically significant.

Results

Patient Characteristics

A total of 426 patients were originally identified with the following exclusions: 116 were treated with the extensile lateral approach, 18 patients had open fractures, 58 patients had inadequate follow-up, and 27 patients lacked preoperative computed tomographic scan. A total of 207 patients were included in the study, with 108 patients in the <50-year age group and 78 patients in the >50-year age group. Eleven (5.3%) patients had bilateral calcaneal fractures. Average follow-up for this study was 546 ± 220 days (range 180-2742). Baseline characteristics of this study cohort are summarized in Table 1. The <50-year age group had a mean age of 34.2 (18-49) years and consisted of 75 (65.8%) males, whereas the >50 age group had a mean age of 59.7 (50-91) years with 60 (73.2%) males. The <50-year age

Table 1. Patient Demographics.

	Age <50 y (n=114 Fractures)	Age >50 y (n=82 Fractures)	P Value ^a
Age, mean ± SD	34.2 ± 8.5	59.7 ± 7.1	<.001
BMI, mean ± SD	27.6 ± 5.4	28.2 ± 6.1	.500
Sex, males, n (%)	75 (65.8)	60 (73.2)	.271
Race			
White	79 (69.3)	55 (69.3)	.259
African American	22 (29.3)	22 (26.8)	
Other	13 (11.4)	5 (8.1)	
ASA classification			<.001
1	10 (8.8)	3 (3.7)	
2	65 (57.0)	21 (25.6)	
3	36 (31.6)	56 (68.3)	
4	3 (2.6)	2 (2.4)	
Diabetes mellitus	7 (6.1)	13 (15.9)	.027
Current tobacco use	66 (57.9)	28 (34.1)	.001

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.

^aBolded P values indicate statistical significance ($P < .05$).

group had a higher proportion of patients with ASA class I and II (8.8% vs 3.7% and 57.0% vs 25.6%, respectively), whereas the >50-year age group had a higher proportion of ASA class III patients (68.3% vs 31.6%), which was statistically significant ($P < .001$). The younger group also had a significantly higher proportion of active smokers compared to the older group (57.9% vs 34.1%, $P = .001$). There were no statistically significant differences in race, sex, body mass index, or diabetes between the 2 groups.

Injury and Operative Characteristics

The most common mechanism of injury was motor vehicle accident in the <50-year age group (52.8%), whereas the most common mechanism was fall from height in the >50-year age group (52.6%), which was statistically significant ($P < .001$). The most common type of calcaneal fracture in both groups was Sanders type II, with 55 (48.2%) of the fractures in the <50-year age group and 39 (50.0%) in the >50-year age group ($P = .573$). Average time to surgery (10.0 vs 8.8 days, $P = .412$), the proportion of patients receiving preoperative nerve blocks (44.7% vs 40.2%, $P = .531$), and rates of placement of external fixation (14.9% vs 12.2%, $P = .592$) were not statistically different between the younger and older groups. Outcomes can be found in Table 2.

Outcomes

Primary outcomes for this study can be found in Table 3. The younger group had a higher rate of wound dehiscence (4.4% vs 1.2%, $P = .204$) and superficial infection (2.6% vs 1.2%,

$P = .490$); however, they were not statistically significant. The older group had a higher rate of deep infections (9.8% vs 7.9%, $P = .648$) compared to the younger group but this was not statistically significant. Fourteen (12.3%) fractures in <50-year age group had implant removal compared to 15 (18.2%) fractures in the >50-year age group ($P = .631$). Gissane and Bohler Angles did not significantly differ on postoperative radiographs. Average length of stay was 1 day longer in the >50-year age group, but this was not statistically significant (7.3 vs 6.2 days, $P = .313$). There were no differences in 30-day readmission rates and reasons for unplanned reoperation between the 2 groups. Lastly, 1 patient (0.9%) in the younger group had sepsis (none in the >50-year-old group) and 2 patients (2.6%) in the older group developed deep vein thrombosis (none in the <50-year-old group); neither of these findings were significant.

Discussion

In this study, we found that complications rates for calcaneus fractures treated via a sinus tarsi approach are comparable between patients older than the age of 50 and patients under the age of 50. In patients of any age, displaced intraarticular calcaneal fractures managed nonoperatively, commonly lead to malunion, subtalar osteoarthritis, and poor functional outcomes.⁸ Although the extensile lateral approach has historically been used for the operative treatment of displaced intraarticular calcaneal fractures, it requires a larger incision and has higher rates of wound complications when compared to less invasive approaches such as the sinus tarsi approach.^{13,15,30} Although the use of the lateral extensile was not investigated in this study, the

Table 2. Injury and Operative Characteristics.^a

	Age <50 y (n=114 Fractures)	Age >50 y (n=82 Fractures)	P Value ^b
Mechanism of injury			<.001
Motor vehicle accident	57 (52.8)	25 (32.1)	
Motorcycle accident	2 (1.9)	1 (1.3)	
Pedestrian vs automobile	1 (0.9)	5 (6)	
Fall from standing	6 (5.2)	9 (11.5)	
Fall from height	42 (38.9)	41 (52.6)	
Other	6 (5.6)	1 (1.3)	
Sanders classification			
I	3 (2.6)	2 (2.4)	.941
II	55 (48.2)	43 (52.4)	
III	38 (33.3)	26 (31.7)	
IV	18 (15.8)	11 (13.4)	
Time to surgery, d, mean \pm SD	10.0 \pm 8.0	8.8 \pm 11.8	.412
Preoperative nerve block	51 (44.7)	33 (40.2)	.531
Use of external fixation	17 (14.9)	10 (12.2)	.592
Surgical time, min	167.9 \pm 85.9	155.2 \pm 90.3	.318

^aUnless otherwise noted, values are n (%).

^bBolded P values indicate statistical significance ($P < .05$).

Table 3. Primary Outcomes.^a

	Age <50 y (n=114 Fractures)	Age >50 y (n=82 Fractures)	P Value
Wound dehiscence	5 (4.4)	1 (1.2)	.204
Superficial infection	3 (2.6)	1 (1.2)	.490
Deep infection	9 (7.9)	8 (9.8)	.648
Nonunion	4 (3.5)	4 (4.9)	.633
30-day readmission	2 (1.8)	5 (6.2)	.102
Unplanned reoperation	18 (15.8)	2 (2.6)	.089
Symptomatic hardware	19 (16.7)	18 (22.0)	.351
Reason for return to OR			.631
I&D	4 (22.2)	5 (23.8)	
Implant removal	14 (77.8)	15 (71.4)	
Other	0 (0.0)	1 (4.8)	
Bohler angle, degrees, mean \pm SD	28.9 \pm 7.4	28.4 \pm 8.1	.619
Gissane angle, degrees, mean \pm SD	129.8 \pm 8.4	128.8 \pm 7.6	.406

Abbreviations: I&D, irrigation and debridement; OR, operating room.

^aUnless otherwise noted, values are n (%).

use of the sinus tarsi approach allows for minimally invasive treatment of displaced calcaneal fractures with low rates of wound complications.

Studies have suggested that patients aged >50 years are more likely to experience poorer outcomes after operative treatment of calcaneal fractures,⁹ some with limited evidence for such claims.^{5,19} More recent studies have shown that operative management can be safely performed in the elderly with satisfactory outcomes, particularly in patients without comorbidities, but none of these investigations assessed the sinus tarsi approach in this patient

population.^{10,11,28} A 2005 study by Herscovici et al¹¹ study reviewed 35 patients aged >65 years who underwent operative treatment of calcaneal fractures, with an average follow-up of 44 months and all but 1 patient being treated via the lateral extensile approach. In this study, the average American Orthopaedic Foot & Ankle Society (AOFAS) score was 82.4 and 97% of patients achieved union; however, 43% of patients developed at least 1 complication, with subtalar osteoarthritis being most common (34%). Despite these findings, the authors concluded that age did not play a role in soft tissue complications or infections and

that these complications were mainly in patients with multiple comorbidities. In a similar study, Gaskill et al¹⁰ compared patients aged >50 years to patients aged <50 years who underwent operative fixation of displaced intra-articular calcaneus fractures with an average follow-up of approximately 9 years. No patients in this study were treated via the sinus tarsi approach. The authors found that patient-reported outcomes were significantly better in the older group and that complication rates were comparable between the younger and older age groups (35% vs 38%, $P = .18$).¹⁰ In their 2017 study, Su and Cao²⁸ compared operative vs nonoperative treatment in 60 patients over the age of 60 years with Sanders II-III calcaneus fractures. The authors concluded that ORIF can be safely performed in elderly patients who lack surgical contraindications.²⁸ In the present study, we found that rates of surgical site infections, wound dehiscence, painful hardware, length of stay, 30-day readmissions, and unplanned reoperations were similar between patients younger and older than the age of 50. All patients were treated via the sinus tarsi approach, which may explain the lower complication rate in the present study (16.1%) as compared to the reported rates as high as 54% in previous literature.^{6,10,11,28} Interestingly, the rate of infections was nonsignificantly higher in the younger group which may be accounted for by the increased incidence of smokers in this population as well as in the present study.

The present study is not without limitations. First, our study is limited by the inherent weaknesses of its retrospective design, such as relying on the accuracy of previously collected data and the inability to assess patient-reported outcomes as is seen in prior investigations. Second, there was a significantly higher proportion of active smokers in the younger group, which may contribute to the comparable complication rates between the 2 groups. Third, we were unable to perform regression modeling to control for potential confounders because of too few complication events. Fourth, our study was performed at a single level 1 trauma center, which may reduce the external validity of our findings and may also be compromised by surgeon bias. Further, the specific approach used by the surgeon also can contribute to surgeon bias. At our specific institution, surgeons use the sinus tarsi approach as the standard approach for calcaneus fractures except for rare cases of significant soft tissue damage, which included significant fracture blisters and open injuries requiring flap coverage. Lastly, in order to assess early complication rates, we decided to keep our minimum follow-up at 180 days. However, this short follow-up time does not allow us to address the longer-term outcomes and further longer-term studies are needed to address patients with calcaneus fractures.

The proportion of elderly individuals in the United States is steadily increasing with predictions that the number of Americans aged 65 years and older will reach 88.5 million

by 2050.²⁹ As the population continues to age, calcaneal fractures in the elderly population will continue to increase, and optimal management of these patient populations should be clearly delineated. The current study found that early complication rates following operative fixation of closed, intra-articular calcaneal fractures via the sinus tarsi approach are similar between younger and older individuals. These findings suggest that older patients with calcaneus fractures may safely undergo surgical fixation via this approach. The authors do not believe that age should be used as a variable that impacts the decision to treat calcaneal fractures surgically when the sinus tarsi approach can be used to surgically treat calcaneal fractures. Future studies with larger sample sizes and that are prospective in nature may be helpful in further assessing the association between age and postoperative complications after operative treatment of calcaneal fractures.

Ethical Approval

Ethical approval for this study was obtained from The University of Alabama at Birmingham Institutional Review Board (IRB-300000265)

Declaration of Conflicting Interests

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