

Original Research Article

STUDY OF INTRA-ARTICULAR CALCANEUM FRACTURE TREATED WITH MINIMALLY INVASIVE SINUS TARSI APPROACH AND CANCELLOUS SCREW FIXATION

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 Received
 : 28/01/2025

 Received in revised form : 15/03/2025
 Accepted

 Accepted
 : 04/04/2025

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DOI: 10.70034/ijmedph.2025.2.251

Source of Support: Nil, Conflict of Interest: None declared

Int J Med Pub Health 2025; 15 (2); 1396-1401

ABSTRACT

Background: Aim: The aim of this study was to evaluate the effectiveness of the minimally invasive sinus tarsi approach combined with cancellous screw fixation in the treatment of depressed commented intra-articular calcaneal fractures, assessing fracture healing, functional recovery, and complication rates.

Materials and Methods: This study included 16 patients with intra-articular calcaneal fractures who presented to our institution between 2017 and 2022. All patients were treated surgically using the minimally invasive sinus tarsi approach with cancellous screw fixation. Inclusion criteria included closed, displaced fractures with depression and tongue-type fractures in patients aged 20-70 years. The fractures were classified using Sanders' classification system, and postoperative follow-up included radiographic imaging and AOFS functional scoring at 1, 2, and 3 months.

Results: The majority of patients were male (75%), with falls from height (56.25%) being the most common cause of injury. Sanders' Type II fractures (43.75%) were most common. All patients underwent successful surgery with a 3 cm incision, and the fixation was achieved using cannulated cancellous screws and raft screws. Postoperative radiographs showed 100% alignment at the 1-month follow-up, with 93.75% of patients demonstrating stable reduction at 2 months. Functional outcomes were favorable, with 62.5% of patients achieving a good result, 25% excellent, and 12.5% poor. Complications were minimal, with only 6.25% of patients experiencing infection or delayed healing.

Conclusion: The minimally invasive sinus tarsi approach combined with cancellous screw fixation offers an effective, safe, and minimally disruptive method for managing displaced intra-articular calcaneal fractures. The technique results in favorable fracture healing, functional recovery, and a low complication rate. This approach is a promising alternative to traditional open surgical methods, although further studies with larger cohorts are necessary to confirm these findings.

Keywords: Minimally invasive, sinus tarsi approach, cancellous screw fixation, intra-articular calcaneal fractures, fracture healing.

INTRODUCTION

Intra-articular fractures of the calcaneus are among the most challenging injuries to manage in orthopedic trauma. These fractures often result from high-energy mechanisms such as falls from height or motor vehicle accidents. The calcaneus, being the largest and strongest bone in the foot, plays a crucial role in supporting body weight and facilitating movement, particularly during walking and running. Therefore, injuries to the calcaneus, especially intra-articular fractures, can lead to significant functional impairment and long-term disability if not managed appropriately. These fractures are characterized by their involvement with the subtalar joint, which is essential for normal foot function, and can result in pain, stiffness, deformity, and loss of motion.^[1]

Historically, the management of calcaneal fractures was predominantly surgical, with open reduction and internal fixation (ORIF) being the standard treatment. However, open surgical approaches often come with complications such as wound infection, wound dehiscence, skin necrosis, and delayed healing, especially when the fracture is complicated by severe soft tissue injury. Moreover, large surgical exposures can disrupt the integrity of surrounding structures and prolong recovery time. As a result, the need for less invasive techniques has gained prominence in recent years.^[2]

The minimally invasive sinus tarsi approach represents one such technique that has emerged as an effective alternative for the management of calcaneal fractures. The sinus tarsi approach is favored due to its ability to provide good exposure to the subtalar joint while minimizing soft tissue disruption. It involves a small incision made over the lateral aspect of the foot, at the level of the sinus tarsi, through which fracture fixation can be performed. This method provides a sufficient view of the fracture while minimizing the risk of complications associated with larger incisions, including wound infections and delayed healing.^[3]

In addition to the minimally invasive approach, the choice of fixation method is crucial for the successful management of calcaneal fractures. The goal of fixation is to restore the anatomical alignment of the bone and stabilize the joint. Among the various fixation options, cancellous screw fixation has proven to be an effective and reliable technique for maintaining stability and achieving proper reduction in intra-articular fractures of the calcaneus. Cancellous screws are designed to provide secure fixation by compressing the bone fragments together, promoting healing while preserving the integrity of the joint surface.^[4]

One of the key advantages of using the sinus tarsi approach in conjunction with cancellous screw fixation is the ability to minimize soft tissue dissection while still achieving a stable reduction. The sinus tarsi incision allows for precise placement of screws in critical areas of the calcaneus, such as the sustentaculum tali, which is an important region for restoring the anatomical alignment of the subtalar joint. This technique also reduces the risk of complications associated with more traditional open approaches, such as wound infections and prolonged recovery.^[5]

The sinus tarsi approach has been increasingly utilized in the treatment of intra-articular calcaneal fractures, with several studies demonstrating its advantages in terms of reduced soft tissue trauma, shorter hospital stays, and faster recovery times compared to conventional open techniques. Furthermore, the technique has shown promising results in achieving good functional outcomes, with patients experiencing less pain, better range of motion, and improved overall foot function postoperatively. Despite the advantages of the minimally invasive sinus tarsi approach and cancellous screw fixation, there are certain challenges and limitations that must be considered. The technique requires a thorough understanding of the anatomy of the foot and careful planning to avoid neurovascular injury. In addition, the surgeon must be proficient in the use of fluoroscopy to ensure proper screw placement and alignment. While the sinus tarsi approach can be highly effective for many patients, it may not be suitable for all types of calcaneal fractures, particularly those with severe comminution or significant bone loss, where more extensive surgical approaches may be necessary.^[6]

The success of this treatment modality also depends on various patient-specific factors, such as age, activity level, bone quality, and the presence of comorbid conditions. For example, elderly patients or those with poor bone quality may face difficulties with bone healing, which can influence the overall outcome of the procedure. In such cases, a comprehensive treatment plan that takes into account the individual characteristics of the patient is essential for achieving optimal results.

In our study, we have included 16 cases of intra articular calcaneal fractures treated by sinus Tarsi approach and cancellous screw fixation.

MATERIALS AND METHODS

This study was conducted on 16 patients who presented with intra-articular calcaneal fractures at our institution from 2017 to 2022. All patients were treated using the minimally invasive sinus tarsi approach with cancellous screw fixation. Ethical approval for the study was obtained from the institutional review board, and informed consent was taken from each patient.

Inclusion Criteria

- Intra-articular calcaneal fractures involving depression and tongue-type fractures.
- Closed fractures without associated soft tissue injury.
- Patients aged between 20 and 70 years.

Exclusion Criteria

- 1. Extra-articular fractures.
- 2. Open fractures.

- 3. Patients presenting later than two weeks postinjury (since manipulation beyond this period is difficult).
- 4. Fractures complicated by compartment syndrome.
- 5. Paediatric fractures.
- 6. Upon admission, patients were started on antioedema measures to control swelling. The surgical procedure was performed as soon as possible, without waiting for the swelling to subside, given the minimally invasive nature of the approach.

The surgery was performed under spinal anaesthesia. Patients were positioned laterally on the operating table to allow for intraoperative imaging. Lateral, axial, and Broden's views of the calcaneus were obtained using fluoroscopy to guide the reduction and fixation. Fractures were classified according to Sanders' classification system, which was used to assess the fracture pattern and plan the surgical approach.

To begin the reduction process, a Steinmann pin was inserted from the posterior to anterior direction to correct any heel varus or valgus alignment. Temporary reduction was achieved using Kirschner (K) wires, which were introduced to hold the fracture in place.

A 3 cm skin incision was made over the sinus tarsi, and the approach was used to elevate the depressed joint fragment. Once the joint fragment was elevated, it was temporarily held in position using K-wires. Final fixation of the reduced fracture was achieved using cannulated cancellous screws. No bone augmentation was used to fill any bone defects, as the focus was on achieving stable fixation with the cannulated screws. Raft screws were also used to maintain the reduction and stabilize the fragments.

After the surgery, patients were kept non-weight bearing for a period of 6 weeks to allow for optimal healing. Partial weight bearing was initiated at 6 weeks postoperatively, as tolerated based on the patient's pain levels. Patients were instructed to perform ankle and calf exercises to promote joint mobility and muscle strength recovery.

Postoperative evaluation was carried out using standard X-ray imaging. X-rays were taken immediately after the operation, as well as at one month, two months, and three months to assess the progress of fracture healing and to check for any complications. Ankle exercises and calf exercises are started after surgery. Patients were evaluated using AOFS score.

RESULTS

Table 1: Patient Demographics

The demographic characteristics of the patients in this study revealed a broad age distribution. The patients were primarily between 20 and 50 years of age, with 25% falling within the 20-30 years range and 31.25% in the 31-40 years range. Older patients

(aged 51-70) represented a smaller portion, with each age group (51-60 years and 61-70 years) consisting of 12.5% of the total sample. This indicates that calcaneal fractures occur frequently in working-age adults, although they can affect people across the entire age spectrum. Regarding gender, the study sample was predominantly male, comprising 75% of the patients, while females represented 25%. This is consistent with literature that suggests males are more prone to traumatic injuries due to higher exposure to activities such as manual labor and recreational sports. In terms of the cause of injury, the majority of fractures (56.25%) resulted from falls from height, which is common in high-energy trauma cases. A significant proportion (37.5%) were due to motor vehicle accidents, while the remaining 6.25% of cases were related to sports or work-related accidents. These findings align with the general understanding that calcaneal fractures are often associated with high-impact events.

Table 2: Fracture Classification (Sanders'Classification)

The fractures in this study were classified according to Sanders' classification system, which is used to categorize intra-articular calcaneal fractures based on the number and displacement of fracture lines. Most of the fractures in this cohort were of Type II (43.75%) and Type III (31.25%). Type II fractures are typically characterized by two fracture lines, while Type III fractures involve more complex comminution of the bone. Type IV fractures, which involve severe comminution and disruption of the subtalar joint, were less common, accounting for 25% of the cases. This distribution suggests a moderate to severe level of injury among the patient population, as Type II and Type III fractures often require surgical intervention for proper alignment and stabilization.

Table 3: Surgical Details

All patients in this study underwent surgery using the minimally invasive sinus tarsi approach, which was employed in 100% of the cases. This approach involves a small incision near the sinus tarsi to elevate and reduce the depressed fracture fragment, offering the benefits of reduced soft tissue disruption and faster recovery. The incision size was uniform at 3 cm for all patients, ensuring consistency in the procedure. For fixation, all patients received cannulated cancellous screws, which are effective in maintaining reduction and providing stability to the fracture. Raft screws were also used in all cases to further stabilize the reduced fragments. Temporary fixation with K-wires was used in all patients to maintain the fracture reduction during the procedure. Postoperative management involved 100% of patients remaining non-weight bearing for 6 weeks to allow for optimal healing and prevent displacement of the fracture. Partial weight-bearing was initiated at 6 weeks, as tolerated by the patient's pain levels. The average duration of surgery was 85 minutes, reflecting the relatively quick nature of the minimally invasive technique.

Table4:PostoperativeFollow-UpandRadiographic Findings

Radiographic follow-up was carried out at various time points post-surgery. Immediately after the surgery, all patients (100%) showed good alignment with no complications, indicating that the reduction and fixation were successful. At the 1-month followup, callus formation was visible on X-ray in the majority of patients, and all fractures showed stable fixation, suggesting early signs of bone healing. At 2 months, 93.75% of patients demonstrated stable reduction and early healing signs, while 6.25% showed slightly delayed healing but still had no major complications. By the 3-month follow-up, 87.5% of patients had continued to progress with fracture healing, and no new complications were observed. This progression highlights the effectiveness of the surgical approach and fixation method, leading to good fracture union in most cases. **Table 5: Functional Outcomes (AOFS Score)**

The functional outcomes (from b beare) The functional outcomes were assessed using the AOFS score, which evaluates recovery based on factors such as pain, mobility, and overall function. Of the 16 patients, 62.5% (10 patients) achieved a "Good" outcome, indicating that most patients were able to return to their daily activities with minimal discomfort. Four patients (25%) achieved an "Excellent" score, meaning they had an optimal recovery with little to no pain and good functional range of motion. However, 2 patients (12.5%) had a "Poor" outcome, which suggests that a small proportion of patients had persistent issues with pain or mobility despite the surgical intervention. Overall, the results were favorable, with the majority of patients showing a significant recovery.

Table 6: Complications

In terms of complications, the study reported a low incidence of adverse events. Only 6.25% of patients experienced an infection, which is a relatively low complication rate, given the nature of the surgery. Another 6.25% of patients experienced delayed healing, but this did not result in significant functional impairment or require additional surgeries. The majority of patients (87.5%) had no complications, further supporting the safety and efficacy of the minimally invasive sinus tarsi approach combined with cancellous screw fixation.

Table 1: Patient Demographics		
Demographic Characteristics	Number of Patients (n = 16)	Percentage (%)
Age Range		
20-30 years	4	25%
31-40 years	5	31.25%
41-50 years	3	18.75%
51-60 years	2	12.5%
61-70 years	2	12.5%
Gender Distribution		
Male	12	75%
Female	4	25%
Cause of Injury		
Fall from height	9	56.25%
Motor vehicle accident	6	37.5%
Other (sports, work-related)	1	6.25%

Table 2: Fracture Classification (Sanders' Classification)

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Fracture Type	Number of Patients (n = 16)	Percentage (%)	
Type II	7	43.75%	
Type III	5	31.25%	
Type IV	4	25%	

Table 3: Surgical Details

Surgical Parameters	Number of Patients (n = 16)	Percentage (%)
Type of Approach		
Sinus tarsi approach	16	100%
Incision Size		
3 cm incision	16	100%
Fixation Method		
Cancellous screws	16	100%
Raft screws	16	100%
Use of K-wires for temporary fixation	16	100%
Duration of Non-weight Bearing	16	100%
6 weeks	16	100%
Partial Weight Bearing		
Initiated at 6 weeks	16	100%
Mean Duration of Surgery	85 minutes	-

Table 4: Postoperative Follow-Up and Radiographic Findings			
Time Point	X-ray Findings	Number of Patients (n = 16)	Percentage (%)
Immediately Post-op	Good alignment, no complications	16	100%
1 Month	Callus formation in majority, stable fixation	16	100%
2 Months	Stable reduction, signs of healing	15	93.75%
3 Months	Fracture healing progressing, no complications	14	87.5%

 Table 5: Functional Outcomes (AOFS Score)

Result	Frequency	Percentage (%)
Excellent	4	25
Good	10	62.5
Poor	2	12.5
Total	16	100

Table 6: Complications			
Complication	Number of Patients (n = 16)	Percentage (%)	
Infection	1	6.25%	
Delayed Healing	1	6.25%	
No Complications	14	87.5%	

DISCUSSION

This study evaluated the use of the minimally invasive sinus tarsi approach combined with cancellous screw fixation for the treatment of displaced intra-articular calcaneal fractures.

Our patient population showed a broad age range, with the majority of fractures occurring in workingage adults (20-50 years), which is consistent with existing studies. Buzzi et al. (2019) reported that calcaneal fractures primarily affect individuals in their 30s and 40s, who are more likely to engage in high-risk activities such as manual labor or sports. This aligns with our finding that the most common cause of injury was falls from height (56.25%), followed by motor vehicle accidents (37.5%).^[7]

Fracture classification in this study was done using Sanders' system, which showed that the majority of patients (43.75%) had Type II fractures, followed by Type III (31.25%) and Type IV fractures (25%). This distribution is consistent with the findings of Bai et al. (2018), who reported that Type II and Type III fractures are the most common forms of intraarticular calcaneal fractures treated surgically. These fractures are typically more complicated and require careful surgical intervention for proper alignment and stabilization.^[8] Veltman et al. (2013) also discussed how these fractures require prompt and accurate treatment to avoid complications such as posttraumatic arthritis or poor functional outcomes. Our results of treating predominantly Type II and Type III fractures align with these reports, suggesting that the sinus tarsi approach is suitable for managing these complex fractures.^[9]

The minimally invasive sinus tarsi approach was utilized in all cases, and the findings from our study show promising results in terms of reduced soft tissue disruption and faster recovery. This approach was consistent with the findings from Pitts et al. (2019), who compared radiographic and postoperative outcomes using sinus tarsi versus traditional extensile lateral approaches. Their study found that the sinus tarsi approach, while technically challenging, provides adequate fixation and reduces complications associated with larger incisions and more extensive tissue dissection. This approach was also used effectively in our study, with 100% of patients achieving good alignment and fixation postoperatively.^[10]

Additionally, the use of cannulated cancellous screws and raft screws for fixation has been well-supported in the literature. Bai et al. (2018) noted that the sinus tarsi approach combined with screws is a viable alternative to the more traditional methods, showing similar or superior outcomes in terms of fracture healing and stability.^[8] The results from our study, with a 100% fixation rate and minimal complications, are consistent with those from other studies such as those by Buzzi et al. (2019), who found that ORIF via the extended lateral approach was effective in providing stable fixation for calcaneal fractures.^[7] Postoperative radiographic follow-up revealed that most patients showed good alignment and early signs of healing within the first month, with stable fixation observed in all cases at the 1-month follow-up. These findings align with the results reported by Ma et al. (2021), who found that the modified sinus tarsi approach led to stable fixation and quicker recovery compared to the extensile lateral approach.^[11] At 2 and 3 months, our study demonstrated that 93.75% and 87.5% of patients had stable reductions and continued to show fracture healing, respectively. This is consistent with the findings from Veltman et al. (2013), who reported that appropriate surgical interventions, such as screw fixation, led to a successful fracture union in most patients.^[9]

The functional outcomes, assessed using the AOFS score, revealed that the majority of patients (62.5%) achieved a "Good" outcome, and 25% achieved an "Excellent" score. These results are similar to those found by Pitts et al. (2019), who observed favorable functional outcomes in patients treated with sinus tarsi approach and screw fixation, with the majority reporting satisfactory recovery.10 However, 12.5% of patients in our study had a "Poor" outcome, suggesting that a small proportion of patients may

experience persistent functional limitations. Kwon et al. (2015) also noted that delayed treatment or complications can affect functional outcomes, which may be the case for the two patients in our cohort who reported poor recovery.^[12]

In terms of complications, our study reported a low incidence of adverse events, with only 6.25% of patients experiencing infection and another 6.25% experiencing delayed healing. These rates are consistent with findings from Smyth et al. (2018), who noted that the incidence of complications such as infection and wound healing issues is relatively low when using the sinus tarsi approach, compared to traditional open approaches.^[13] Shuler et al. (2001) also discussed the role of Bohler's angle in influencing healing, but our study did not find a significant correlation between correction of this angle and improved outcomes. The overall low complication rate supports the conclusion that the minimally invasive approach provides a safe and effective method for treating calcaneal fractures.^[14]

CONCLUSION

In conclusion, the minimally invasive sinus tarsi approach combined with cancellous screw fixation proves to be an effective and safe method for treating displaced intra-articular calcaneal fractures. The study demonstrated favorable outcomes in terms of fracture healing, functional recovery, and a low complication rate. Most patients achieved good to excellent functional results, with minimal soft tissue disruption and quicker recovery compared to traditional open surgical approaches. This technique offers a promising alternative for managing calcaneal fractures, though further studies with larger cohorts are needed to validate these findings.

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