


Intra-articular Calcaneus Fractures: Current Concepts Review

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Abstract

Calcaneal fractures are the most common fracture of the tarsal bones and represent 1% to 2% of all fractures. Roughly 75% of these fractures include intra-articular involvement of the posterior facet of the calcaneus. Intra-articular calcaneal fractures are challenging injuries to manage for both patients and surgeons given their association with both early and late complications. This article aims to review the management, classification systems, surgical approaches, and care regarding intra-articular calcaneal fractures. A review of the current literature yielded treatment strategies that aim to reduce complications such as soft tissue injury or loss of articular reduction while maintaining satisfactory clinical outcomes. The purpose of this article is to review these current concepts in the management of intra-articular calcaneal fractures.

Level of Evidence: Level V, expert opinion.

Keywords: intra-articular calcaneus fractures, calcaneus, posterior facet, extensile lateral approach, sinus tarsi approach, percutaneous fixation, arthroscopic-assisted reduction and internal fixation

Introduction

Calcaneal fractures are the most common fracture of the tarsal bones and represent 1%-2% of all fractures.^{5,35} Of these fractures, roughly 75% are intra-articular in the posterior facet of the calcaneus.³³ These devastating injuries to the lower extremity usually occur as a result of high-energy trauma from falls or motor vehicle accidents causing axial loading. These fractures are often life-changing, and health outcomes have been found to be comparable to myocardial infarction and chronic renal disease.⁵⁶ Many challenges arise for surgeons because of early and late complications associated with intra-articular calcaneal fractures, and the optimal management of these fractures has been widely debated in the literature.^{1,3-5,19,21,27,39,43,45,52,53,63} The purpose of this article is to review the current concepts in management of intra-articular calcaneal fractures.

Anatomy and Radiology

The calcaneus is the largest of the tarsal bones and has 4 articular surfaces—the posterior, middle, and anterior facets that articulate with the talus, whereas the articular surface for

the cuboid is found distally (Figure 1). Medially, the sustentaculum tali supports the middle facet and provides a groove for the flexor hallucis longus tendon inferiorly. The tuberosity is found on the posterosuperior surface of the calcaneus, and the peroneal tubercle is found on the lateral surface, beneath which the peroneus longus tendon passes. The anterior process of the calcaneus is located on the most distal aspect of the calcaneus, and serves as the origin for the bifurcate ligament, which inserts on both the cuboid and navicular.²²

When viewing the calcaneus on a lateral radiograph, there are 2 angles of clinical significance that can be used to

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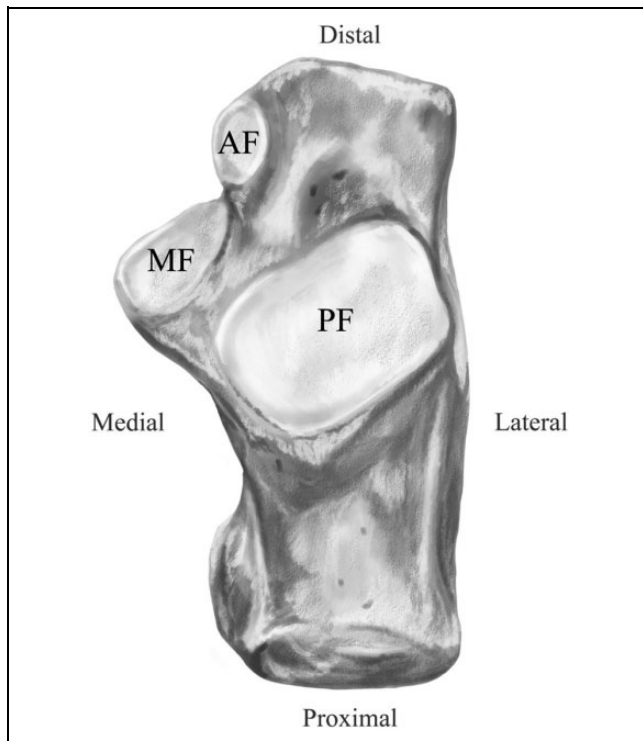


Figure 1. Superior view of a right calcaneus depicting the articular surfaces that comprise the subtalar joint. AF, anterior facet; MF, middle facet; PF, posterior facet.

determine the position of the posterior facet. The Böhler, or tuber, angle is measured by drawing 2 lines: from the highest point of the anterior process to the highest point of the posterior facet and from the highest point of the posterior facet through the highest point of the tuberosity. The intersection of the 2 lines at the superior portion of the posterior facet creates the angle. A normal Böhler angle is between 25 and 40 degrees, and decreased values are seen with intra-articular fractures as the posterior facet collapses inferiorly (Figure 2A).³³ The Gissane, or “critical,” angle is measured at the intersection of a line drawn along the posterior subchondral bone of the posterior facet and a line drawn from the anterior process of the calcaneus down to the inferior portion of the posterior facet. A normal Gissane angle is between 120 and 145 degrees, and this angle may be increased or decreased with intra-articular fractures, depending on the position of the foot and direction of force at the time of injury (Figure 2B).^{31,33} Although interrater reliability and utility in diagnosis are excellent using the Böhler angle, the Gissane angle has been found to lack sufficient sensitivity, specificity, and interrater reliability to be used for diagnosis in emergency department settings.³¹ In addition to lateral radiographs, the Harris projection is used, which is an axial heel radiograph tilted 45 degrees caudally with respect to the long axis of the foot. This view allows for evaluation of subtalar joint displacement, heel widening, and varus deformity (Figure 2C).²³

Classification

Intra-articular calcaneal fractures involve a primary fracture line running through the posterior facet of the calcaneus, forming a superomedial fragment and superolateral fragment. The superomedial fragment is described as the constant fragment, as it is fixed firmly to the talus by the deltoid and interosseous talocalcaneal ligaments.⁷ Although several classification systems exist, these fractures are most often described using the Sanders and Essex-Lopresti classification systems.⁴² In the Sanders classification system, fracture patterns are classified based on the number of fracture lines through the posterior facet seen on semicoronal CT image at the widest portion of talus. Type I fractures are nondisplaced fractures, irrespective of the number of fracture lines. Type II fractures involve 1 fracture line with a 2-part fracture. Type III fractures have 3 parts with a centrally depressed articular fragment. Type IV fractures are highly comminuted consisting of at least 4 articular segments.^{44,45} Fracture lines are described as A through C, with A representing lateral fracture lines, B representing fractures lines through the middle of the posterior facet, and C representing medial fracture lines adjacent to the sustentaculum tali. Thus, type II and type III fractures can be further classified based on the specific combination of fracture lines (Figure 3). This classification system is widely used when discussing different treatment strategies and also is of prognostic value. For example, a longitudinal series of surgically treated patients including 108 fractures and an average follow-up of 15.2 years found that patients with type III fractures were 4 times more likely to require subtalar arthrodesis than type II fractures.⁴⁶

The Essex-Lopresti classification system uses the planes of the primary and secondary fracture lines in order to classify fracture patterns. The primary fracture line always occurs through the posterior facet, creating 2 fragments. The secondary fracture line either occurs in the axial plane or behind the posterior facet, creating 2 unique fracture patterns. The first, the joint-depression type fracture, occurs when the secondary fracture line extends across the body of the calcaneus to exit just behind the posterior facet. As a result, a free fragment involving the posterior facet is formed and is depressed (Figure 4).^{7,14} Classic radiographic findings of the joint-depression type fracture include decreased Böhler angle, decreased Gissane angle, calcaneal shortening, calcaneal widening, and varus deformity.³³ The second fracture pattern, the tongue-type fracture, occurs less commonly and is described as a secondary fracture line running posteriorly underneath the facet to the tuberosity in the axial plane (Figure 4).¹⁴ These fractures are associated with posterosuperior displacement of the tuberosity due in part to the pull of the Achilles tendon. As a result, these fractures may lead to skin tenting of the posterior heel with risk of subsequent pressure necrosis, and thus can require urgent

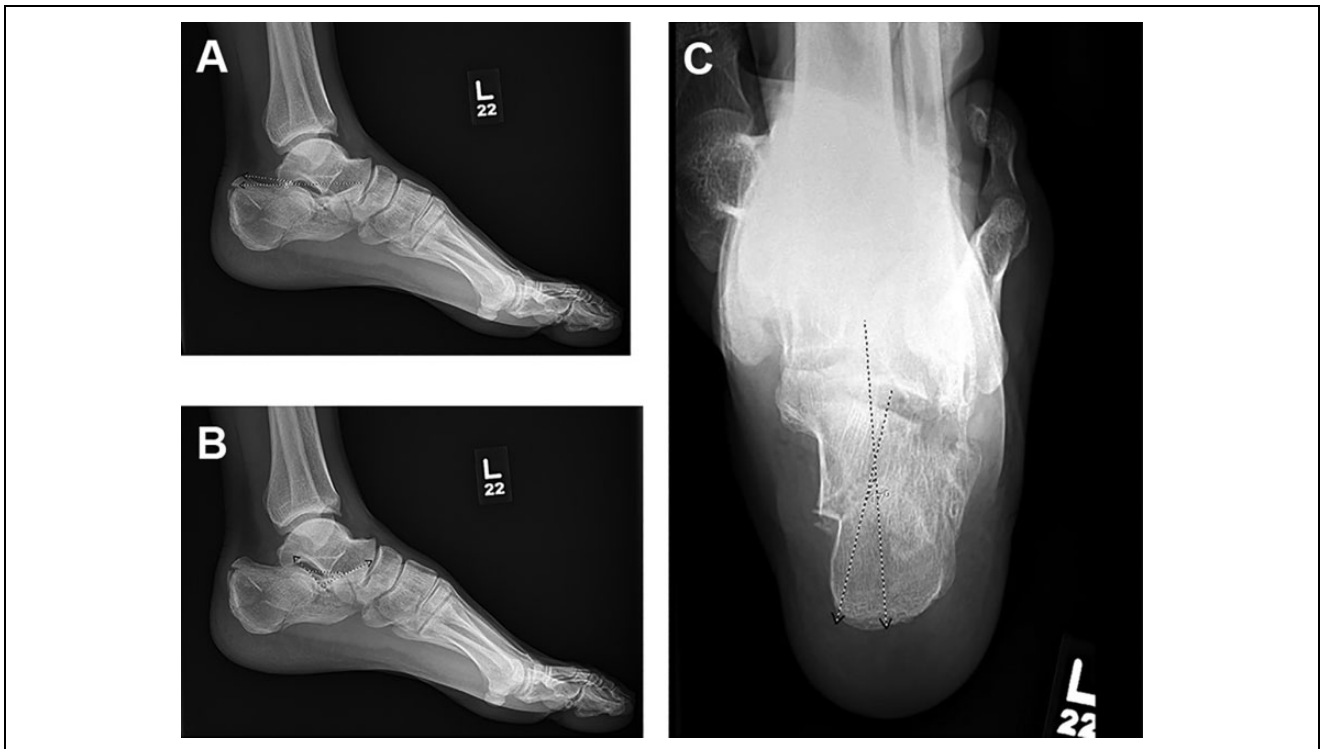


Figure 2. (A) Left foot lateral radiograph of a 41-year-old male demonstrating a calcaneus fracture with posterior facet involvement. Note the Böhler angle of negative 8 degrees and (B) the Gissane angle of 106 degrees, both indicating collapse of the posterior facet. (C) Left Harris axial radiograph of a 41-year-old male with a calcaneus fracture demonstrating 17 degrees of varus deformity.

operative management.^{16,50,60} Serial physical examinations should be performed in patients with tongue-type fractures to identify blanching and other signs of skin breakdown over the fracture site.⁵⁰

Operative vs Nonoperative Management

There is some debate between conservative vs surgical management of intra-articular calcaneal fractures, because of variable results between the 2 management strategies.^{1,3-5,21,26,27,39,53,63} Regardless of management strategy, all patients presenting with calcaneus fractures should be evaluated for associated injuries, including vertebral and contralateral calcaneal fractures, which occur nearly 10% of the time.^{40,57} This may require radiographs or advanced imaging modalities, and should be performed on a case-by-case basis. Complications associated with calcaneal fractures include compartment syndrome, fracture blisters, skin tenting with wound necrosis, sural nerve pathology, tarsal tunnel syndrome, peroneal tendon subluxation, subtalar and calcaneocuboid arthritis, and malunion.^{1,50,59}

Nonoperative Management and Indications

Nonoperative management typically involves immobilization in a very well-padded fiberglass or plaster splint in neutral ankle position, followed by conversion to a well-

padded cast in neutral ankle position once swelling has subsided. Patients are kept nonweightbearing for 10-12 weeks, or until fracture union is confirmed on radiography.⁵² The authors recommend cast exchanges frequently if there is any concern for soft tissue compromise.

An unequivocal indication for nonoperative management is a nondisplaced (<2-mm) Sanders type I intra-articular calcaneal fracture.^{1,4,5,13,21,27,39,53,63} Patients with operative fracture patterns but who have comorbid conditions such as a smoking history, poorly controlled diabetes, severe peripheral vascular disease, or low functional status may also be managed nonoperatively.⁵² Additionally, patients with life-threatening injuries, poor soft tissue envelopes secondary to fracture blisters, trauma, and edema may be considered for initial nonoperative management with follow-up management of fracture malunion/subtalar arthritis, if needed.^{8,52} Although advanced age may be another relative contraindication for all types of surgery, acceptable outcomes after surgical treatment of intra-articular calcaneal fractures have been demonstrated in patients older than 65 years, and a retrospective review of 175 patients treated surgically found no difference in clinical outcomes based on age group.^{17,24}

The potential disadvantages of nonoperative management include the inability to anatomically reduce the posterior facet, decreased functional recovery, increased rates of subtalar and calcaneocuboid arthritis, risk for malunion, and increased rates of subtalar arthrodesis.^{1,4,9,27,36,53}

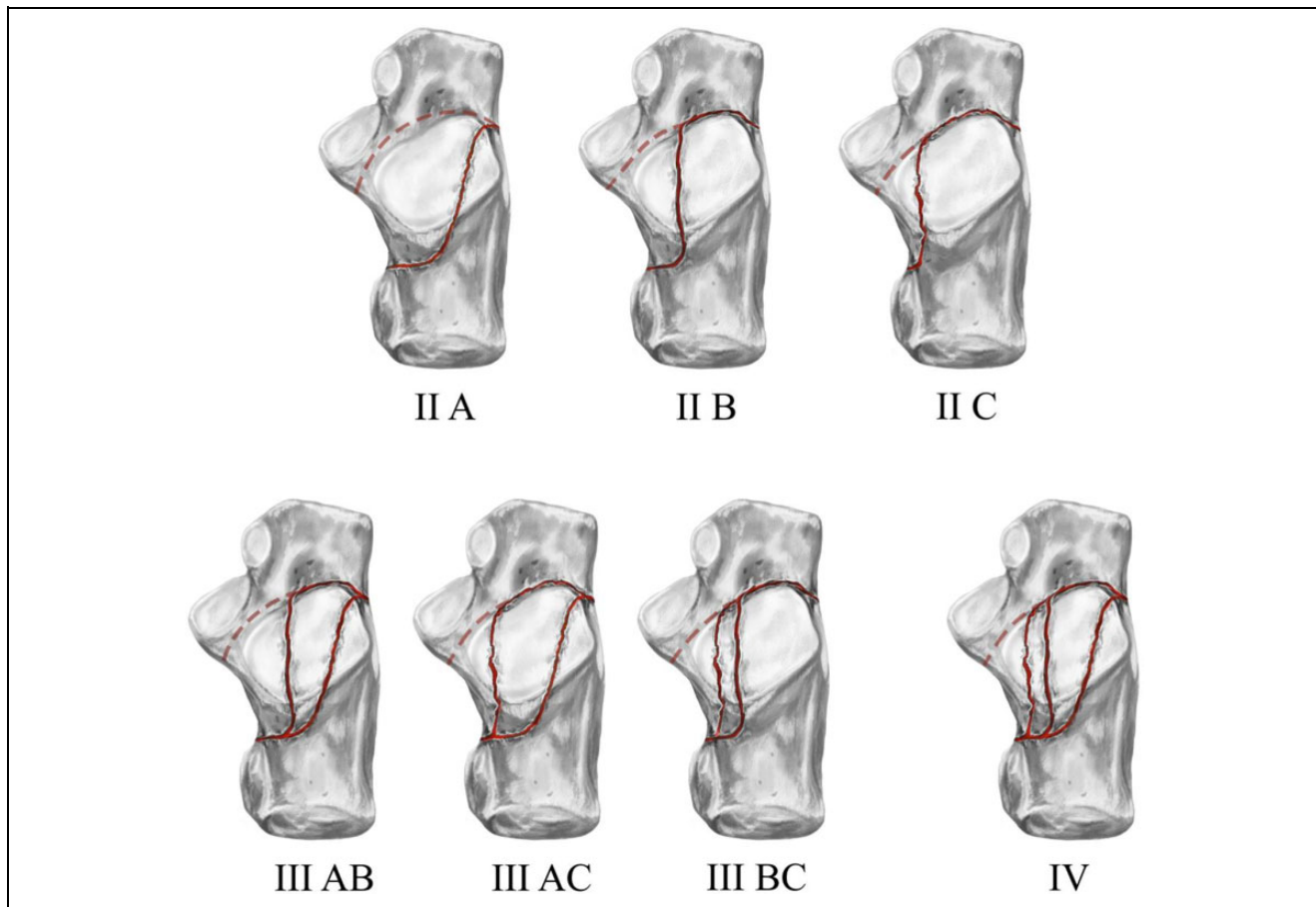


Figure 3. Superior view of right calcaneus depicting Sanders Type II, Type III, and Type IV fractures. “A” represents lateral fracture lines, “B” represents middle fracture lines, and “C” represents medial fracture lines adjacent to the sustentaculum tali. Drawings courtesy of Morgan Rogers, MA.

Operative Management Indications

Operative management is generally indicated with open fractures, tongue-type fractures that put the soft tissue at risk for breakdown, and displaced (>2-mm) intra-articular calcaneal fractures where anatomic joint restoration is possible in a proper surgical candidate. Again, the overlying soft tissue will dictate much of the surgical decision making, and the authors recommend that surgery be postponed until the soft tissue envelope demonstrates wrinkling, resolution of fracture blisters and swelling, and other signs that portend good wound healing. The optimal surgical approach for displaced intra-articular fractures, including Sanders type II, III, and IV fractures, the joint-depression type fracture, and tongue-type fractures, depends on the surgeon’s comfort with the different methods, the patient’s comorbidities, and fracture/soft tissue characteristics.

Randomized Controlled Trials

Multiple randomized prospective clinical trials have been performed evaluating the outcomes of operative vs nonoperative management of displaced intra-articular calcaneal

fractures, with quite variable results.^{1,4,21,26,53} Thordarson and Krieger⁵³ published the first randomized clinical trial in 1996 evaluating operative vs nonoperative management of intra-articular calcaneal fractures. In this study of 30 patients with either Sanders type II or type III fractures, patients were randomized to either a nonoperative group or operative group using the L-shaped extensile lateral approach. The authors were able to demonstrate a significant difference in the American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot functional outcome scale for operatively treated patients (86.7) compared to nonoperative management (55.0) ($P < .0001$).⁵³ The study was limited by small sample size and short-term follow-up between the 2 groups (average of 14 months and 17 months for the nonoperative and operative groups, respectively).⁵³ Nevertheless, the authors advocated for surgical management of intra-articular calcaneal fractures.

In a larger multicenter prospective randomized clinical trial, Buckley et al analyzed 309 patients with displaced intra-articular calcaneus fractures managed operatively and nonoperatively with 2- to 8-year follow-up.⁴ An L-shaped extensile lateral approach was used on all patients in the

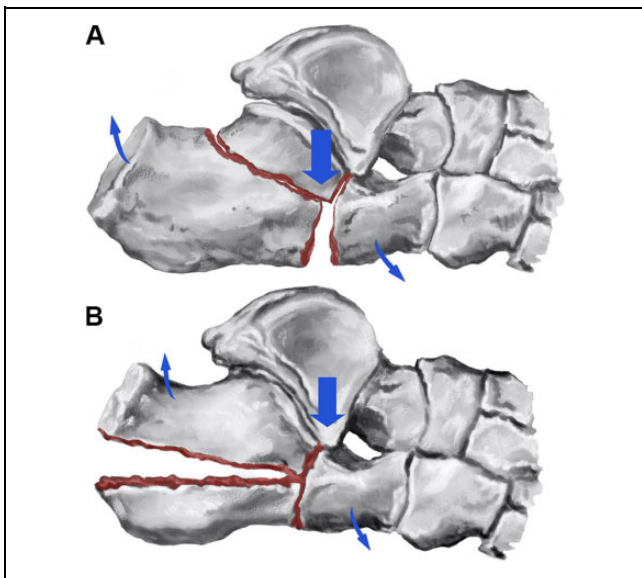


Figure 4. Lateral view of right foot depicting Essex-Lopresti (A) joint-depression and (B) tongue-type fractures. Axial load through subtalar joint leads to depression of posterior facet. Tension from Achilles tendon leads to posterosuperior displacement of the tuberosity, especially in tongue-type fractures. Drawings courtesy of Morgan Rogers, MA.

operative group. This study concluded that without group stratification, there was no difference in operative vs nonoperative management. However, subgroup analysis demonstrated statistically significant improvements in SF-36 scores with surgery in women, patients not receiving workers' compensation, younger patients, and patients with highly displaced fractures.⁴ This study also determined that patients managed nonoperatively were 5.5 times more likely to require secondary subtalar arthrodesis than their operatively managed counterparts, a finding that has been reproduced in recent literature.^{4,36} They also found that patients with Sanders type II fractures were 2.74 times more likely to score above the mean on SF-36 scores when treated operatively vs nonoperatively.⁴ A follow-up study on this patient cohort found that patients with Sanders type IV fractures were 5.5 times more likely to require secondary subtalar fusion than those with a Sanders type II fracture, and that patients with Böhler angle <0 degrees at presentation were 10 times more likely to require fusion than those with an angle >15 degrees.⁹

Another multicenter randomized clinical trial with an 8- to 12-year follow-up found no difference in outcomes between operative vs nonoperative management at 1-year or 8- to 12-year follow-up.¹ Like previous studies, an extensile lateral approach was used for all operative patients. Patients were non-weight bearing for at least 6 weeks in both cohorts, and ankle range of motion exercises were encouraged in both groups. Although clinical outcomes were not significantly different at final follow-up perhaps because of insufficient cohort size of 42 operative and 40

nonoperative patients, data trended toward improved outcomes with surgical management. Additionally, radiographically evident subtalar arthritis was reduced by 41% in surgically treated patients.¹ An important limitation of the study was the relatively higher proportion (36%) of patients in the operative arm with residual subtalar displacement (>2 mm) when compared to operative arms in previous studies.^{1,3,4} Although not consistently reproduced, studies have shown that radiographic restoration of the Böhler angle may correlate with improved functional outcomes.^{4,5,26} The increased proportion of residual subtalar displacement may explain this study's failure to reach statistical significance.

A recently published randomized clinical study evaluated 2-year outcomes among operative vs nonoperative management of intra-articular calcaneal fractures, also using an extensile lateral approach for the operative group. This study included 151 patients and found no difference in treatments at 2 years over an array of outcome measures including the Kerr-Atkins functional score, 36-Item Short Form Health Survey (SF-36) score, AOFAS score, return to work percentage, clinical measurements, and gait measurements.²¹ The authors also found no difference in the primary outcome of Kerr-Atkins scores between treatment arms during subgroup analysis of Sanders type II fractures, Sanders type III/IV fractures, males, or females. The authors concluded that there is no justification for surgical treatment of displaced intra-articular calcaneal fractures.²¹ This most recent study contradicts the prior positive outcomes and indicators for surgical treatment of displaced intra-articular calcaneal fractures seen in previous studies.

Meta-analyses

Despite the multiple randomized controlled trials performed, the optimal treatment for displaced intra-articular calcaneal fractures has not yet been elucidated. Various meta-analyses have been published in an attempt to clarify mixed results from key randomized controlled studies. These studies found a trend toward improved clinical outcomes with surgical management of calcaneal fractures; however, they lacked statistical significance in most cases.^{27,39,63} The studies additionally identified an increased risk of complications with surgical management.^{27,63}

The first meta-analysis, performed by Randle et al, analyzed 6 articles that evaluated operative vs nonoperative management of intra-articular calcaneal fractures with at least 12 months' follow-up. The meta-analysis failed to show statistically significant differences in clinical outcomes. The authors believed this may have been due to the small number of subjects that ultimately were eligible for statistical analysis, inclusion of nonrandomized studies, and the lack of consistent documentation of pain and functional outcomes across the studies.³⁹

A second meta-analysis performed by Jiang et al included 10 clinical trials evaluating operative vs nonoperative management of intra-articular calcaneus fractures with a total of

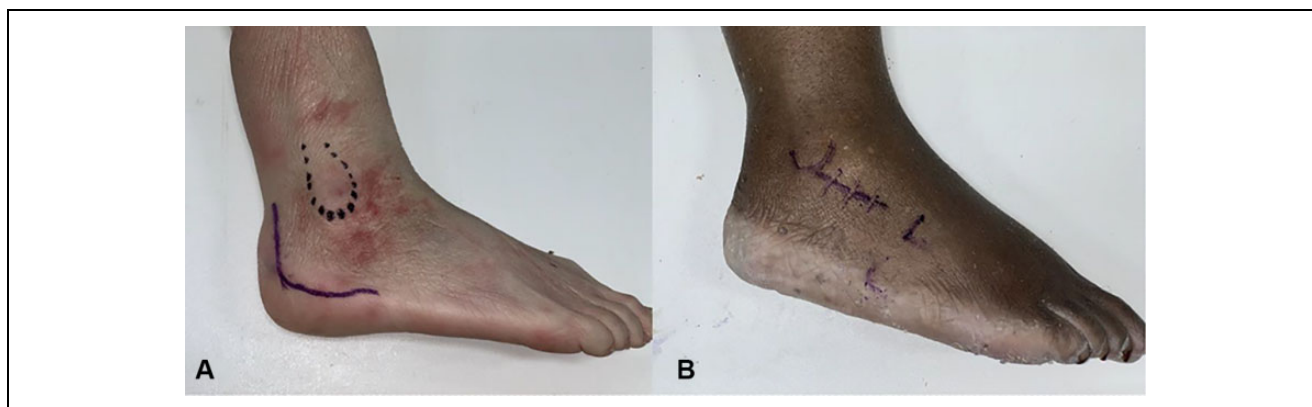


Figure 5. Clinical photographs demonstrating planned incision for (A) an L-shaped extensile lateral approach and (B) a limited-incision sinus tarsi approach.

891 patients with no operational contraindications or pre-existing foot abnormalities.²⁷ Their analysis revealed several positive findings of statistical significance associated with operative management. The authors found that in comparison to nonoperative management, surgical management demonstrated superior restoration of the Böhler angle ($P < .001$), reduction of calcaneal height loss ($P < .001$), and reduction of calcaneal widening ($P < .001$). Surgically treated patients were less likely to require increased shoe size ($P < .001$) and more likely to be able to resume preinjury work ($P = .004$) than the nonsurgical patients. However, surgical patients also experienced a higher total rate of complications when compared to their nonsurgical counterparts (22.8% vs 16.2%, $P = .008$).²⁷

A third meta-analysis performed by Zhang et al demonstrated similar surgical outcomes, including improved anatomic joint restoration and increased complication rates relative to nonoperative management. The authors also substantiated additional positive outcomes of reduced pain with walking ($P < .01$) and increased comfort with shoe wear ($P < .01$) in the operative group.⁶³ These findings were attributed to improvement in anatomical alignment obtained with surgical treatment.^{53,63}

Surgical Approaches

Although there will likely continue to be debate surrounding operative vs nonoperative management of these fractures, novel surgical approaches and techniques have been developed over the last few decades in an attempt to better avoid soft tissue complications and more accurately restore the posterior facet. Open reduction and internal fixation (ORIF) of the calcaneus has traditionally been performed through an extensile lateral approach using plate and screw constructs. A range of minimally invasive approaches have been under development, however, with the aim to reduce wound and infectious complications. These newer approaches have lowered complication rates and maintained comparable clinical and radiologic outcomes.^{11,29,30,51,54,58,62} The minimally

invasive approaches include limited-incision sinus tarsi approach, percutaneous fixation, and arthroscopic-assisted fracture reduction. Clinicians are still in the process of determining which specific fracture patterns are most suitable for these approaches, but generally speaking, they may be beneficial in patients with soft tissue compromise, increased wound healing risk factors, and minimal comminution.²⁵

Extensile Lateral Approach

The L-shaped extensile lateral approach (ELA) with subsequent ORIF has been the workhorse operative approach for displaced intra-articular calcaneal fractures. The horizontal limb of the incision is in line with the fifth metatarsal, whereas the vertical limb extends between the Achilles tendon and posterior margin of the lateral malleolus (Figure 5).^{12,20,32} The sural nerve and some of the lateral calcaneal branches of the peroneal artery are elevated anteriorly, and further dissection allows elevation of the peroneal tendons within this thick soft tissue flap as well.¹² A clear view of the subtalar joint allows for easy manipulation and operative fixation of the fracture fragments and the thick soft tissue flap allows for decreased risk of sural nerve injury and peroneal tendon subluxation.⁵³

This approach allows for excellent visualization of the posterior facet, which is required when trying to repair multiple displaced and impacted articular fracture segments or when performing a primary subtalar arthrodesis. Of importance, the ELA is generally not performed within 2 weeks of the injury due to extensive skin edema which may cause wound healing/closure complications. The “wrinkle sign,” or reappearance of wrinkles on the lateral hindfoot after swelling has subsided, may be interpreted as adequate improvement of edema and is often used as an indicator that the patient is ready for surgery.^{33,44,52}

Although this approach provides direct visualization and fixation of the fracture, there are a range of complications that may occur. It has been associated with significant wound and infectious complications up to 37% and 20%,

respectively.^{5,25,43} Wound dehiscence may occur, most frequently at the angle of the incision.⁵⁹ It has been postulated that disruption of the lateral calcaneal branches of the peroneal artery may cause local tissue ischemia, leading to wound healing complications.³² Additional complications include peroneal tendon injury/irritation, neuritis/neuroma of the sural nerve, and injury to the flexor hallucis longus tendon when placing screws through the constant fragment from a laterally based incision that does not allow for visualization of the flexor hallucis longus as it courses beneath the sustentaculum tali.³³

Medial Approach

A medial approach has historically been used, with a 5-cm incision parallel to the sole of the foot made just posterior to the neurovascular bundle.⁶ The proposed benefits of this approach were decreased wound and infectious complications and decreased time non-weight bearing.^{6,13,41} This approach has fallen out of favor, however, in part because direct visualization of the subtalar joint is not provided. Moreover, 2 prospective studies attempting to achieve fixation through a medial approach ultimately used an additional lateral incision in 23% and 57% of cases, respectively.^{6,41}

Limited-Incision Sinus Tarsi Approach

The limited-incision sinus tarsi approach (STA) employs a 2- to 4-cm incision from the tip of the lateral malleolus toward the base of the fourth metatarsal and allows for visualization and reduction of articular fragments while minimizing soft tissue dissection (Figure 5).^{25,30} Plate and screw constructs are most often used in combination with this approach. There are multiple theoretical benefits of this approach. First, decreased manipulation of soft tissue should result in decreased wound and infectious complication rates. Second, this approach reduces the need for peroneal dissection and likely resultant irritation and/or subluxation. Last, the approach allows for easy conversion to traditional ELA should there be a need intraoperatively or in future scenarios.²⁵

Although the STA highlights advances in calcaneal fracture care, minimally invasive approaches are not without complications. Infection rates are vastly reduced relative to the ELA, and one meta-analysis of minimally invasive surgical approaches for intra-articular calcaneus fractures revealed a total infection rate of 2.1%. Nevertheless, infections still occur after these procedures and must be watched for, and individual studies evaluating the STA have shown superficial infection rates of up to 14% in their cohorts.^{29,34} Additionally, these techniques may not allow for adequate fracture visualization and manipulation.²⁵ This may ultimately lead to subpar fracture reduction with subsequent subtalar arthritis and poor clinical outcomes. Iatrogenic injury to the sural nerve may also occur because unlike open extensile approaches to the calcaneus, the sural nerve is not directly visualized in percutaneous/minimally invasive approaches.²⁵ Surgical timing is

also an important consideration when using these innovative techniques, as fractures older than 3 weeks become more difficult to manipulate through conservative incisions because of callus formation.^{25,33} Surgeons treating calcaneal fractures via minimally invasive techniques should be prepared to convert their incisions to open extensile ones if fracture care is at all compromised.

Percutaneous Fixation

Percutaneous fixation can be achieved through a range of methods, including external fixators, K-wires, cannulated screws, and interlocking calcaneal nails (Figure 6).^{2,10,18,25,28,37,47,55,64} These methods have been applied to multiple fracture patterns with signs of improved anatomical and functional outcomes, but specific fracture patterns may be more amenable to the percutaneous approach than others. One study noted that only 52% of patients who underwent distraction and percutaneous fixation for joint depression-type fractures had good to excellent outcomes, whereas 100% of tongue-type fractures treated with this technique had good to excellent outcomes.¹⁰ An additional study involving 36 Sanders type IIC fractures and 5 Sanders type IIB fractures managed with percutaneous K-wire fixation showed good to excellent functional outcomes on the Maryland foot scale in 85% of patients, with slightly better results in the type IIC cohort.⁵⁵ These favorable outcomes with Sanders type II fractures have been replicated in multiple studies, but the outcomes in more comminuted patterns are less clear and more research is required.^{2,28,37}

Percutaneous fixation of calcaneal fractures is advantageous because of the utilization of smaller incisions and has been associated with decreased postoperative wound healing complications and infection rates, with infectious complication rates ranging from 2.4% to 14.8% across several studies.^{10,28,47} A study using a minimally invasive posterolateral incision followed by percutaneous screw fixation demonstrated decreased wound infection rates (6.7% vs 37.1%) as well as significantly shorter lengths of stay (9.7 ± 2.8 days vs 11.7 ± 2.6 days) when compared to open reduction and plate fixation.²⁸ Percutaneous fixation is also advantageous because it can be used in patients with soft tissue compromise.¹⁵

A novel approach to percutaneous fixation has been the use of interlocking calcaneal nails.^{2,15,18,48,64} The methodology involves a minimally invasive posterior approach with intrafocal reduction of the fracture followed by internal fixation with a locking intramedullary nail. A study performed by Simon et al demonstrated a mean AOFAS score of 87 in Sanders type II patients and 84 in Sanders type III patients, with a 0% infection rate among the 69 fractures.^{18,48} A study using an identical operative approach showed a mean AOFAS score of 88 in all Sanders type II and III patients also with a 0% infection rate.¹⁵ Amlang et al² examined a different strategy, which involved initial reduction and fixation through a sinus tarsi incision followed by an additional posterior incision below the Achilles tendon insertion and

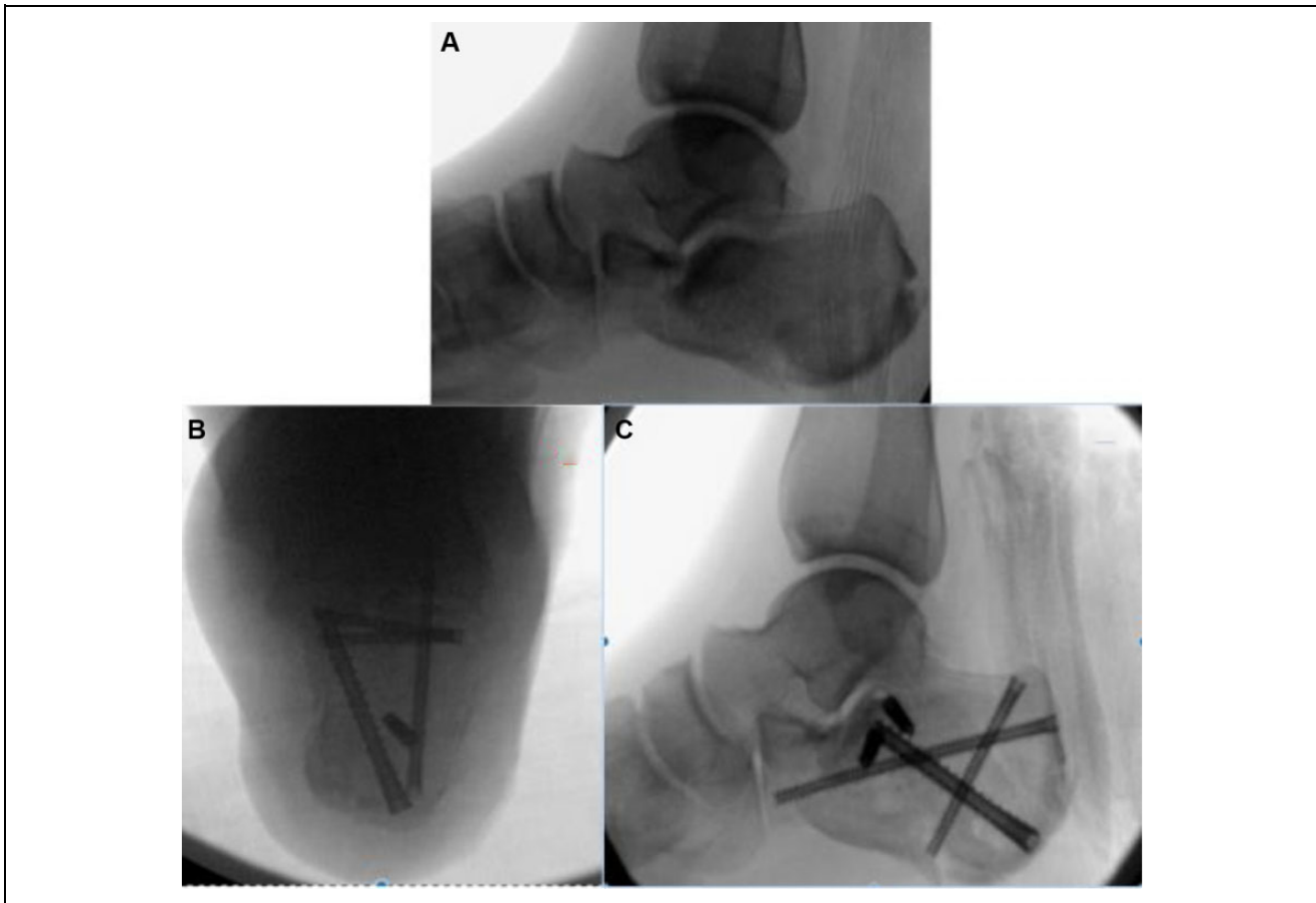


Figure 6. (A) Preoperative fluoroscopic lateral view of displaced intra-articular calcaneus fracture. Intraoperative fluoroscopic (B) Harris and (C) lateral views of calcaneus fracture after percutaneous fixation. Used with permission from Anish Kadakla, MD.

placement of an intramedullary nail with locking screws. Of the 103 patients who underwent surgery, the authors reported an excellent mean AOFAS score of 92.6 at 12 months, and a wound infection rate of 2.9%. These studies also reported a reduction in operative time when compared to other operative approaches, with a procedure time less than 60 minutes in the vast majority of cases.^{15,18,48} Although the data are still limited on the use of interlocking calcaneal nails, there seems to be merit regarding its usage.

Disadvantages of percutaneous fixation include increased risk for residual subtalar displacement, potentially less rigid fixation when using screws or K-wires as compared to plate fixation, and inability to manage significant posterior facet depression or fractures more than 7-10 days old.⁴⁷ One study found that nearly 15% of patients managed with percutaneous screw fixation experienced osteoarthritis with residual pain after 1 year and were indicated for secondary subtalar arthrodesis.⁴⁷

Arthroscopic-Assisted Reduction and Internal Fixation

Arthroscopy has been implemented in the treatment of intra-articular calcaneal fractures, and allows for direct

visualization of fracture reduction, direct assessment of chondral defects, and removal of intra-articular loose bodies.^{25,49} Standard anterolateral and posterolateral portals are used for viewing and alternatively can be used for the introduction of shavers and other arthroscopic instruments. Although appealing, this adjunct in the surgical management of intra-articular calcaneal fractures increases surgical time, has a steep learning curve, can exacerbate soft tissue swelling via fluid introduction, and creates a more complicated operative setup for the surgeon.²⁵

There remains promise, however, regarding this novel adjunct to surgical treatment. Early studies have shown that the use of arthroscopic assistance can improve SF-36 scores, AOFAS scores, and restoration of the Böhler angle.^{25,38,61} One study involving percutaneous fixation of Sanders type IIA and IIB fractures noted an excellent mean AOFAS score of 92 with 0% wound dehiscence and infection rate when reductions were confirmed with subtalar arthroscopy.³⁷ As the technology of ankle arthroscopy continues to improve, the application of arthroscopy in fracture care may become more accessible for surgeons planning to use these techniques.

Summary

Intra-articular calcaneal fractures are morbid injuries with well-documented complications associated with both operative and nonoperative management strategies. There appears to be some agreement that Sanders type I fractures are best managed nonoperatively, and that Sanders type IV fractures should be managed operatively with ORIF or primary subtalar fusion in the appropriate patient. Any open fracture or fracture pattern that places the soft tissue envelope at risk for necrosis, like the tongue-type fracture, should also undergo urgent surgical management. The optimal management of other fracture patterns within the Sanders and Essex-Lopresti classification schemes, however, remains a topic of debate.

Operative management appears to be beneficial in patients where anatomic restoration is possible, and recent literature has focused on minimally invasive approaches and trended toward improved outcomes with surgical management in comparison to nonoperative treatment. These surgical advancements in approaches have allowed for decreased wound and infectious complications in operative treatment of intra-articular calcaneal fractures without compromise of patient outcomes. At this time, however, further studies are needed to clarify specific operative indications and to determine the ideal surgical approach for displaced intra-articular calcaneal fractures when operative management is indicated.

Ethics Approval

Ethical approval was not sought for the present study as no patients or cadaveric specimen were involved in this review article.




Declaration of Conflicting Interests

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