Calcaneal Fracture Management

Extensile Lateral Approach Versus Small Incision Technique

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KEYWORDS

• Calcaneus fracture • Extensile lateral approach • Percutaneous fixation calcaneus

KEY POINTS

- Calcaneal fracture management continues to be an area of sustained interest.
- Extensile lateral approach to the calcaneus carries significant risks of wound complications and infection.
- Small incision techniques may reduce risks and improve recovery.
- Less invasive techniques have been shown to reduce risk of wound-healing complications.

INTRODUCTION

Intra-articular calcaneus fractures have long been a vexing problem for the treating orthopedic surgeon. First described by Malgaigne in 1843, calcaneus fractures were not consistently diagnosed until the development of radiography in the late 1890s. The most common tarsal bone fracture, calcaneal fractures currently account for approximately 2% of all fractures; displaced intra-articular fractures represent 60% to 75% of all calcaneal fractures.

Historically these fractures were treated nonoperatively; but over the past few decades, surgical fixation has become more prevalent. Cotton[1] identified the poor outcome associated with treatment without reduction and favored closed manipulation using a hammer to reduce the lateral wall and reimpact the fracture and suggested that open reduction is contraindicated. By the 1920s, Cotton[2] reported on his treatment of

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healed malunions. He continued to endorse initial reduction in acute cases of calcaneal fractures to reduce the morbidity seen with malunions. In 1952, Essex-Lopresti[3] showed good results with open reduction through a lateral approach and stated that joint-depression fractures require formal open reduction with internal fixation. Operative management again fell into disfavor in the 1950s after Lindsay and Dewar[4] presented results that suggested primary subtalar fusions were being performed unnecessarily and that operative intervention of acute calcaneus fractures had many complications. Kitaoka and colleagues[5] evaluated gait analysis outcomes of 16 of 27 patients treated conservatively with casting. Most patients exhibited altered gait patterns, particularly on uneven ground, confirming nonoperative management led to at least some persistent functional impairment. Crosby and Fitzgibbons[6] reviewed their results of conservative management with casting. They showed good results of closed treatment of nondisplaced fractures and poor results of displaced fractures of the posterior facet based on computed tomography (CT) scans. They suggested operative treatment was indicated for displaced fractures of the posterior facet.

NONOPERATIVE VERSUS OPERATIVE MANAGEMENT

Several studies have been published comparing nonoperative and operative management, many with contradicting results. Jarvholm and colleagues[7] and Parmar and colleagues[8] compared operative versus nonoperative treatment and found no difference in clinical outcome and that problems associated with internal fixation did not justify operative management. There were several limitations to their studies making meaningful conclusions difficult to reach. Studies by Agren and colleagues[9] and Ibrahim and colleagues[10] reported no significant advantage to surgical management. Agren and colleagues[9] found that surgical intervention was associated with a higher risk of complications and no improvement in outcome measures with surgical management at 1 year. However, at an 8- to 12-year follow-up there was a trend toward better outcomes with regard to patient-reported visual analog scale (VAS) pain and function scores and better physical component of the 36-Item Short Form Health Survey (SF-36) scores in the operative group. These results did not reach significance. There was also an increased prevalence of radiographically documented posttraumatic subtalar arthritis in the nonoperative group; however, the need for secondary subtalar arthrodesis was not increased. Ibrahim and colleagues[10] showed no difference at a 15-year follow-up between surgical and nonsurgical management. On the other hand, studies by O'Farrell and colleagues,[11] Leung and colleagues,[12] and Crosby and Fitzgibbons[13] showed better results with surgical intervention. A randomized, prospective study by Thordarson and Krieger[14] compared operative versus nonoperative management for displaced fractures. This study showed statistically significant improvement in functional results and overall outcome in the surgically treated group, confirming that operative intervention could lead to improved outcomes. Buckley and colleagues[15] reported on a prospective, randomized controlled trial comparing operative versus nonoperative treatment of displaced intra-articular calcaneal fractures. Their results showed no significant difference in outcome measures, including SF-36 and VAS scores, between operative and nonoperative management. However, nonoperative treatment did result in a subtalar fusion rate for failed outcomes 6 times higher than the operative group.

SALVAGE OF CALCANEAL MALUNION

Nonoperative management of intra-articular calcaneus fractures increases the risk for malunion and posttraumatic subtalar arthrosis. Fractures left untreated result in

significant displacement leading to altered morphology and function. The resultant morphology can adversely affect the function of the surrounding joints and soft tissues. Sequelae following nonoperative treatment of calcaneus fractures include loss of height, heel widening, subfibular and calcaneocuboid joint impingement, varus heel alignment, and posttraumatic subtalar arthrosis (**Fig. 1**).[4,5] Symptomatic complaints following calcaneal malunion may include lateral hindfoot pain due to subfibular impingement, anterior ankle pain due to loss of height resulting in a more horizontal talus and anterior ankle impingement, and pain due to posttraumatic arthrosis of the subtalar or calcaneocuboid joints. Functionally, the ankle, subtalar, and transverse tarsal joints can all be affected by calcaneal malunion.

The reconstructive procedures to correct calcaneal malunions are technically demanding and carry significant risks of complications as well. Distraction bone-block subtalar arthrodesis was originally described by Gallie[16] and modified by Carr and Benirschke[17] to help correct hindfoot alignment (**Fig. 2**). Stephens and Sanders[18] reported a CT-based classification system for calcaneal malunions based on the coronal CT images and a treatment protocol based on this classification system. Surgical treatment included lateral wall exostectomy with peroneal tenolysis for type I malunions, lateral wall exostectomy with peroneal tenolysis and distraction subtalar arthrodesis for type II malunions, and lateral wall exostectomy with peroneal tenolysis and distraction subtalar arthrodesis with calcaneal osteotomy for type III malunions. Clare and colleagues[19] then reported long-term results using this classification and treatment protocol. In their series, they treated 40 type II and III malunions with an initial fusion rate of 93%. Overall their protocol was shown to be effective at relieving pain, improving patient function, and reestablishing a plantigrade foot. They noted significant difficulty with restoring talocalcaneal height in type III nonunions; given the technical difficulties encountered, they concluded that patients with displaced intra-articular calcaneal fractures benefit from initial operative intervention. Radney and colleagues[20] reported their results for a series of patients who underwent subtalar arthrodesis for painful posttraumatic subtalar arthrosis. One group had been treated surgically initially and underwent an in situ subtalar fusion while the second group had been treated nonoperatively and developed a painful malunion, which was treated with distraction subtalar arthrodesis. Their results showed improved outcomes and fewer wound complications in patients undergoing subtalar fusion after originally being treated surgically with open reduction internal fixation compared with patients

Fig. 1. Heel widening and varus alignment is noted at the left heel following nonoperative management of a calcaneus fracture.

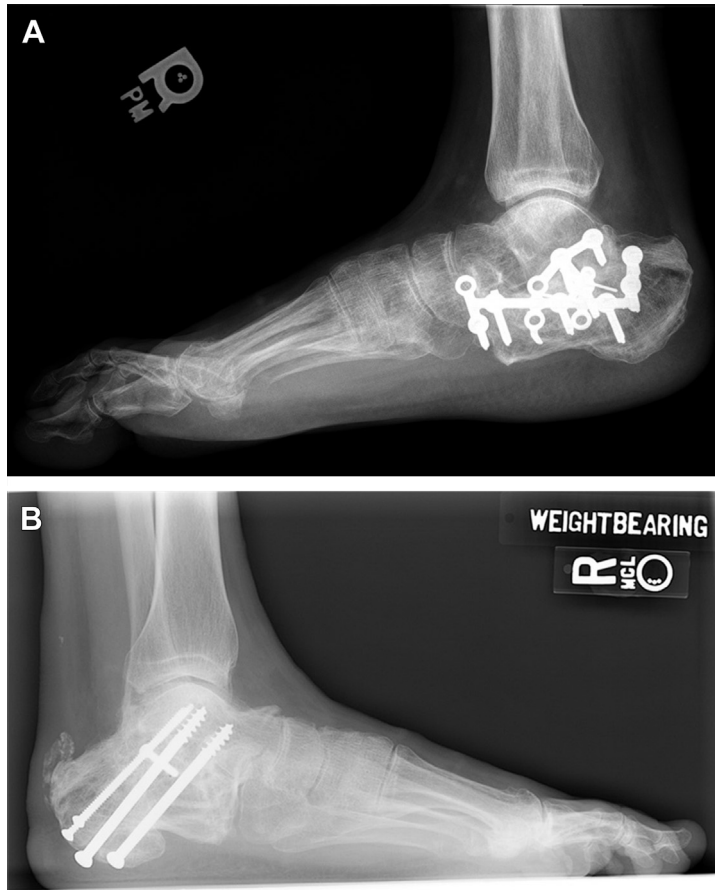

Fig. 2. (*A*) Lateral view of a calcaneal malunion with flattening of Bohler angle. (*B*) Lateral view following distraction bone block subtalar arthrodesis for salvage of calcaneal malunion.

originally being treated nonoperatively. Given these results, the authors recommend open reduction internal fixation of displaced calcaneal fractures when appropriate.

SURGICAL MANAGEMENT

Extensile Lateral Approach

Surgical management of intra-articular calcaneus fractures can be technically demanding with regard to reduction and fixation and also carries a high risk of complications.[9,10,21–25] The traditional extensile lateral approach for open reduction internal fixation of calcaneus fractures creates an L-shaped soft tissue flap that depends on the lateral calcaneal branch of the peroneal artery, which is vulnerable to injury during the extensile approach.[24–27] When the extensile lateral approach is inappropriately placed, the sural nerve is also in danger (**Fig. 3**). Although the extensile approach offers good visualization of the posterior facet for fracture reduction and direct access to the lateral wall, expertise is required to minimize high rates of complications with regard to wound healing and infection (**Fig. 4**).[21–23,28] Timing of surgical intervention is

also important with regard to the extensile lateral approach. Surgeons must wait until soft tissue swelling and any blisters have resolved before proceeding with the extensile lateral approach. Once the calcaneal fracture is reduced, most investigators advocate for lag screw fixation of the posterior facet with placement of a neutralization plate on the lateral wall of the calcaneus (Fig. 5). Postoperatively, patients are allowed to begin working on range of motion once the incision is well healed. Weight bearing is commenced once there is adequate fracture healing, typically 2 to 3 months after surgery.

Small Incision Techniques

Recently, there has been increased interest in using less invasive surgical techniques for treating intra-articular calcaneus fractures. Less invasive techniques may reduce the risk of complications from surgical intervention and may allow for accelerated recovery following surgical intervention. Less invasive techniques can be reasonably used with displaced tongue-type fractures and joint-depression–type fractures with 2 fracture fragments of the posterior facet. Joint-depression–type fractures in patients with significant medical comorbidities may also benefit from fixation with less invasive techniques. Surgical timing is also important with regard to less invasive techniques. Less invasive techniques are more reliable when done within the first 2 weeks of injury when the fracture fragments are easily manipulated. Recent studies have shown promising results with less invasive techniques with regard to lower complication rates.

Limited-incision sinus tarsi techniques have been used to minimize the amount of soft tissue dissection while allowing for fracture reduction and stabilization. A distinct advantage to sinus tarsi approaches is the ability to directly visualize the posterior facet reduction, the anterolateral fragment at the anterior process, and the lateral wall. Kline and colleagues[29] reported on a series of 112 fractures treated either with an extensile lateral incision or a less invasive technique with a sinus tarsi approach. The investigators found significantly lower rates of wound complications and secondary surgery with the

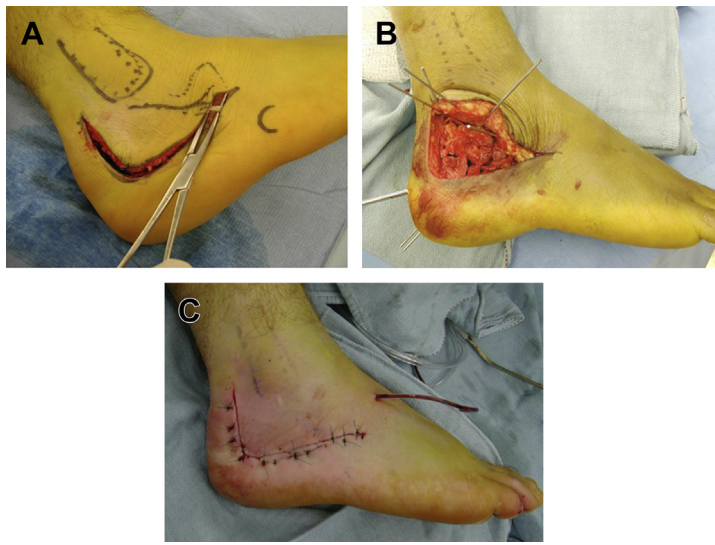

Fig. 3. (*A*) Extensile lateral incision with sural nerve identified. (*B*) Extensile lateral approach with Kirschner wire retraction in place. (*C*) Extensile lateral approach following closure.

Fig. 4. (*A*) Wound necrosis at the apex of the extensile lateral approach with exposed hardware. (*B*) Extensive skin necrosis following the extensile lateral approach.

Fig. 5. (*A*) Preoperative lateral view of joint-depression calcaneus fracture. (*B*) Preoperative axial view of joint-depression calcaneus fracture. (*C*) Postoperative lateral view of joint-depression calcaneus fracture. (*D*) Postoperative axial view of joint-depression calcaneus fracture.

less invasive technique. Outcomes reported were similar between the two groups, and both techniques had a union rate of 100%. Xia and colleagues[30] reported on a randomized controlled trial of 117 calcaneus fractures comparing an extensile lateral approach with a limited sinus tarsi approach. Their study showed decreased surgical times and lower wound complications with the less invasive technique. Significantly higher Maryland Foot Scores were also found in the less invasive group.

SMALL INCISION FIXATION SURGICAL TECHNIQUE

The authors use a small incision technique for some displaced tongue-type fractures and joint-depression–type fractures without significant comminution of the posterior facet. During surgical intervention, patients are placed in the lateral decubitus position using a beanbag or alternative positioner with all bony prominences well padded (**Fig. 6**). The authors do place a thigh tourniquet, but this is not routinely used during

Fig. 6. Patient is placed in the lateral decubitus position on a beanbag with all bony prominences well padded.

Fig. 7. Markings are made for the lateral extensile incision, and small incisions are made in line with the extensile incision.

the case unless there is substantial bleeding. The distal fibula and base of the fifth metatarsal are outlined, and the standard extensile lateral approach is outlined in case it is necessary to transition to this approach following an attempt at reduction through small incisions (Fig. 7). Fluoroscopy is brought in from the end of the bed so that lateral and axial images can be obtained (Fig. 8). Using fluoroscopy, a lateral image is obtained to mark the level of the displaced posterior facet fragment. A small subcentimeter incision is made in the skin at this level along the horizontal limb of the extensile lateral approach, and blunt dissection is carried out down to the lateral wall of the calcaneus. A second small incision is made at the posterior heel, and a 4.0- or 5.0-mm Schanz pin is placed posteriorly into the calcaneal tuberosity. With a tongue-type fracture, the Schanz pin is placed into the tongue fragment to assist in

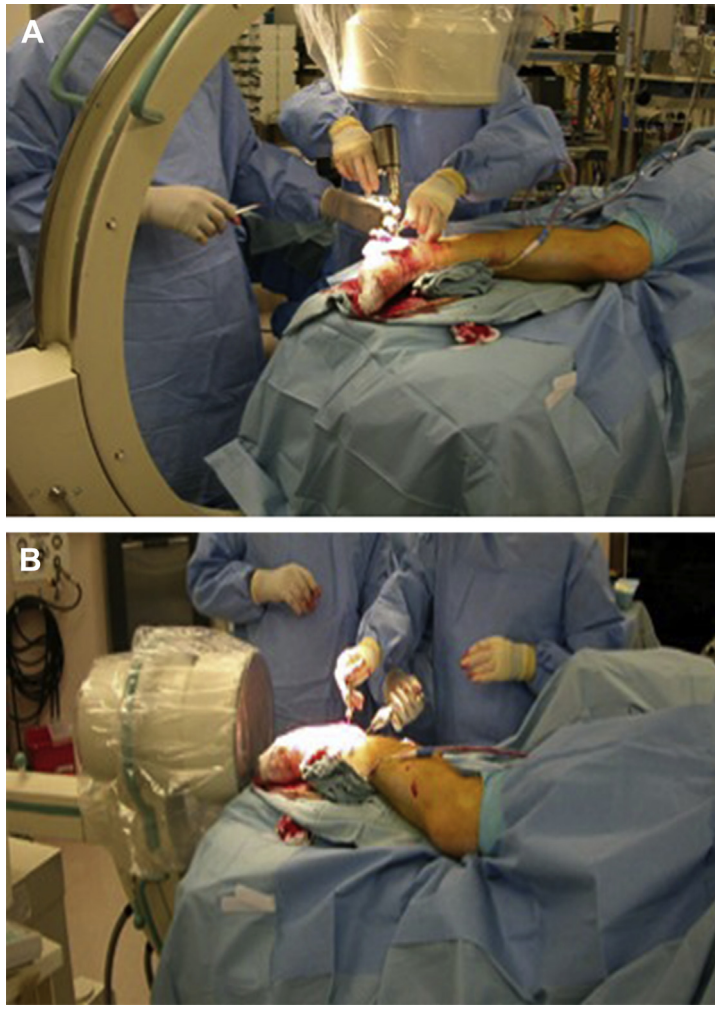

Fig. 8. (*A*) Fluoroscopy is brought in from the end of the bed to allow for obtaining a lateral view. (*B*) An axial view can also be obtained by bringing fluoroscopy in from the end of the bed.

reduction; with a joint-depression–type fracture, the Schanz pin is placed into the tuberosity to assist in reduction of the tuberosity fragment. A freer or arbeitsgemeinschaft fur osteosynthesefragen (AO) elevator is then inserted through the initial small incision on the horizontal limb to assist in reduction of the posterior facet

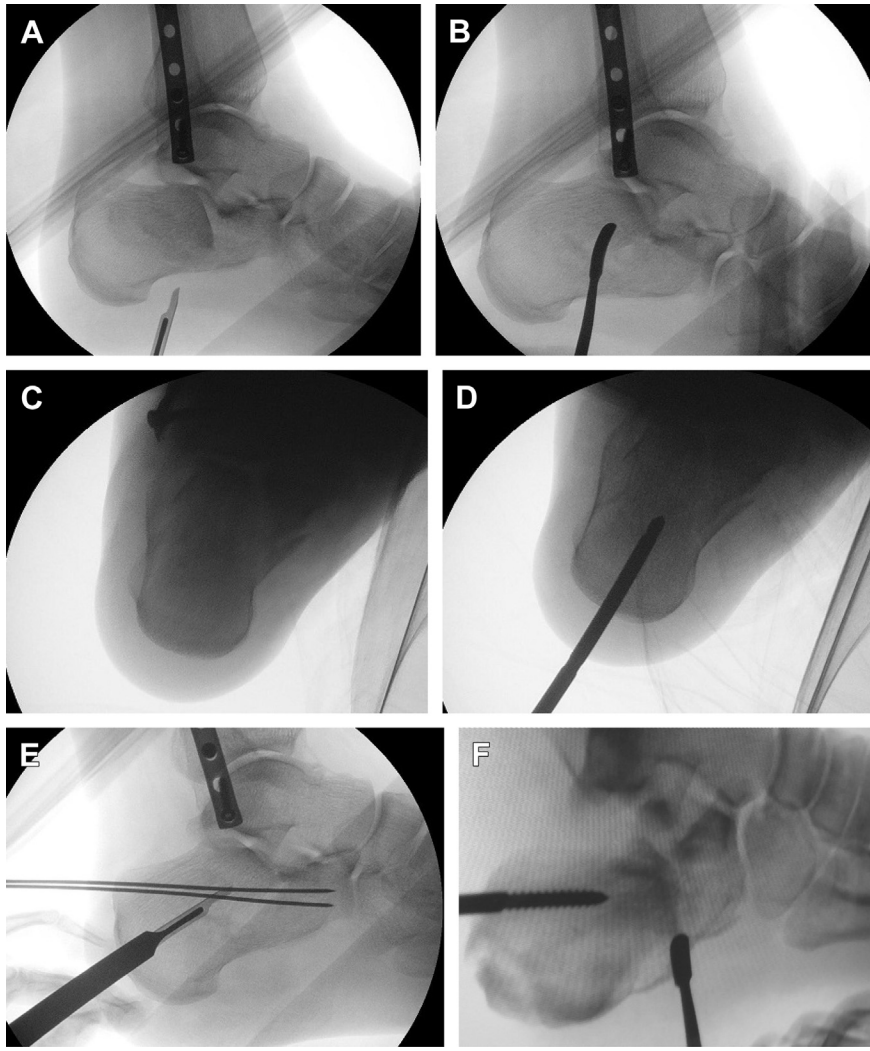

Fig. 9. (*A*) Site of the displaced posterior facet fragment is identified with fluoroscopy, and a subcentimeter incision is made in line with the plantar limb of the extensile lateral incision. (*B*) An elevator is inserted to reduce the displaced posterior facet fragment. (*C*) Axial view of a joint-depression calcaneus fracture before placement of a Schanz pin and reduction. (*D*) With joint-depression–type fractures, a Schanz pin is placed into the tuberosity fragment to assist in reduction of the tuberosity. (*E*) Once the posterior facet is reduced, 2 guidewires are placed just below the posterior facet and critical angle of Gissane. The knife blade is marking the posterior facet for placement of the lag screw across the posterior facet. (*F*) For tongue-type fractures, a Schanz pin is placed into the tongue fragment to assist in reduction.

fragment. The posterior facet fragment is reduced; joint-depression fractures, the tuberosity is reduced with a combination of distraction for length, rotation out of varus, and medialization. Once reduced, 2 guide pins or Kirschner wires are placed from the superior aspect of the calcaneal tuberosity beneath the posterior facet and critical angle of Gissane and into the anterior process of the calcaneus (Fig. 9). Adequate reduction and placement of guide pins are confirmed with fluoroscopic views,

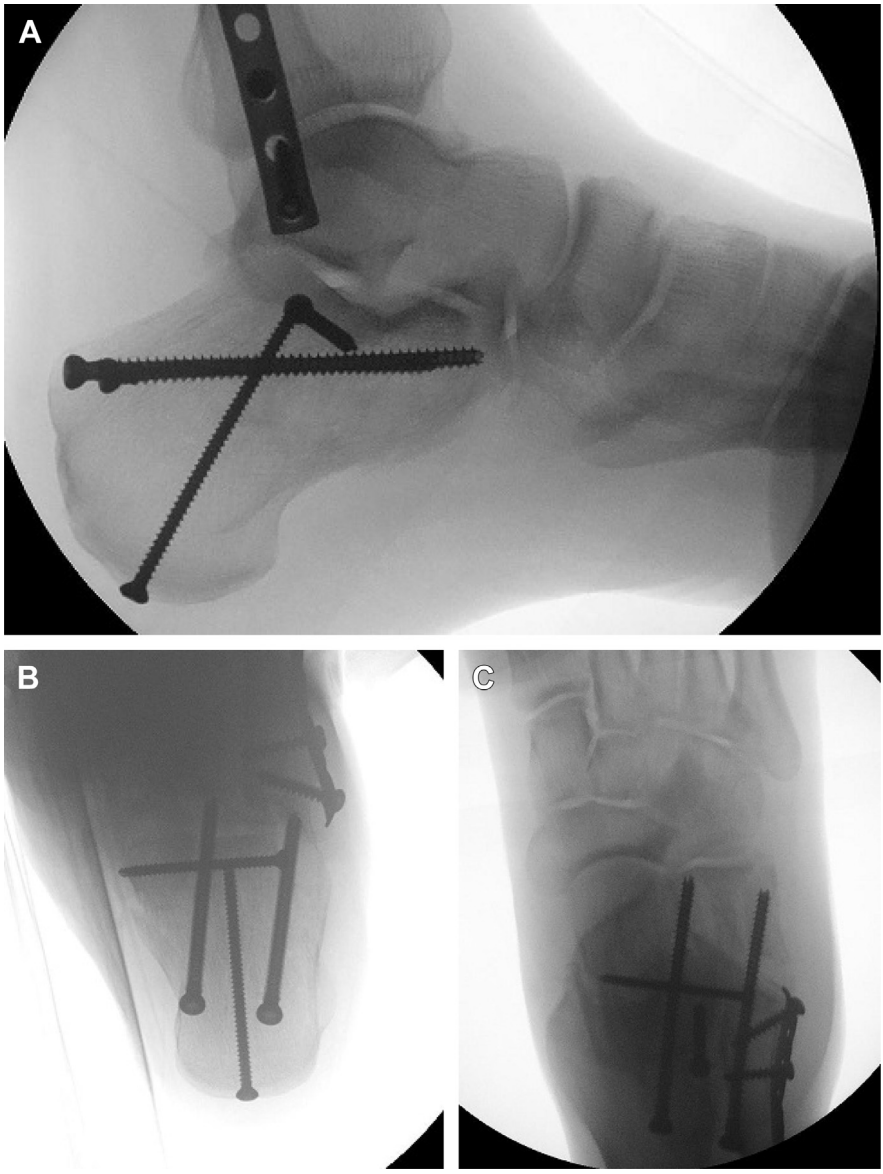

Fig. 10. (*A*) Lateral view with screws in place following small incision technique. (*B*) Axial view showing screw placement with small incision technique. (*C*) AP foot view showing screw placement with small incision technique.

including a lateral and axial view of the calcaneus, an AP view of the foot, and Broden views of the calcaneus to evaluate the posterior facet reduction. Once reduction is confirmed, the authors then proceed with placement of screws in the same path as the guidewires. The authors prefer to use cannulated 4.5- or 5.5-mm fully threaded screws. The lateral hindfoot is marked just plantar to the posterior facet using fluoroscopy, and a small incision is made in the skin with blunt dissection through the subcutaneous tissue down to the lateral calcaneus. A 3.5-mm cortical screw is then placed using lag technique across the posterior facet fracture fragment securing the lateral posterior facet fragment to the medial sustentaculum fragment and giving compression across the posterior facet fragment. A small incision is then made at the plantar aspect of the heel for placement of a 3.5-mm screw as a kickstand from the plantar aspect of the calcaneal tuberosity to just inferior to the posterior facet. In joint-depression–type fractures, the placement of 2 more 3.5-mm fully threaded screws from the plantar aspect of the tuberosity into the anterior process of the calcaneus may be warranted to assist in holding reduction of the tuberosity fragment. Fluoroscopy is used to obtain final lateral and axial views of the calcaneus, an anteroposterior (AP) view of the foot, and Broden views of the calcaneus to assure adequate reduction and good placement of hardware (**Fig. 10**). The incisions are closed with a 4-0 nylon suture (**Fig. 11**). The incisions are dressed, and patients are placed in a posterior splint or a tall controlled ankle motion (CAM) boot. Postoperatively, range-of-motion exercises are started either immediately or 1 to 2 weeks after surgery. Weight bearing is commenced at 6 to 8 weeks after surgery or when fracture healing seems adequate to begin weight bearing on follow-up radiographs.

EXTENSILE LATERAL VERSUS SMALL INCISION TECHNIQUE

The senior author and his colleagues have undertaken a prospective study evaluating the extensile lateral approach versus minimally invasive reduction and small fragment fixation for tongue-type calcaneus fractures. These data remain unpublished to date; however, their study showed a significant difference in length of hospital stay and time to weight bearing between the two groups. They also showed improved musculoskeletal function assessment (MFA) scores at 1 year in the small incision group (**Table 1**).

Fig. 11. Closed incisions used for small incision calcaneus fixation technique.

Table 1
Results of unpublished data from senior author comparing an extensile lateral approach with a small incision technique for tongue-type calcaneus fractures

	Small Incision	Extensile Lateral	Overall	*P* Value
Hospital stay (d)	1.6	3.7	2.8	<.001
Time to weight bearing (wk)	12.3	20.5	16.8	.03
Pain (VAS) (1–10)	2.6	3.1	2.9	NS
MFA scores (6 wk)	41.1	46.1	—	—
MFA scores (3 mo)	36.0	40.9	—	—
MFA scores (6 mo)	23.5	29.9	—	—
MFA scores (12 mo)	17.0	28.9	—	—

Abbreviation: NS, no significance.

SUMMARY

Treatment of displaced intra-articular calcaneus fractures has long been a controversial topic among orthopedic surgeons. Historically, nonoperative management was the treatment of choice; but over the past few decades, operative management has become more prevalent, with studies showing improved outcomes following surgical management.

Surgical intervention with an extensile lateral approach continues to be most prevalent; however, there is recent interest in less invasive techniques for fixation of displaced calcaneal fractures. The extensile lateral approach allows for direct visualization of the posterior facet reduction; however, it carries risks of wound-healing complications and infection. Less invasive techniques have been shown to have less wound-healing complications. Small incision techniques can be used for certain tongue-type fractures and for joint-depression fractures with minimal comminution. Joint-depression fractures with extensive posterior facet comminution are less amenable to small incision techniques. The authors allow for an accelerated recovery following fixation with a small incision technique in a hope to reduce the significance of loss of range of motion.

Studies have shown advantages to less invasive techniques recently, and unpublished data by the senior author and his colleagues show advantages with regard to hospital length of stay and time to weight bearing. Although the authors recognize these techniques may be a compromise between reducing the risks associated with the extensile lateral approach and accepting a possible imperfect reduction, they think that the benefits of the small incision techniques outweigh the drawbacks. Given the results of recent studies and the authors' experience, they do think that small incision techniques are a viable option for surgical management of specific calcaneus fracture types, including tongue-type calcaneal fractures and joint-depression fractures without significant comminution of the posterior facet.

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