Chapter 9
Calcaneus Fracture: Extended Lateral Approach

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Case

The patient is a 44-year-old male who sustained a closed injury to his left hindfoot after a fall from height.

On physical examination, his left hindfoot was grossly swollen, ecchymotic, with notable heel widening. He was diffusely tender to palpation along the medial and lateral aspects of his heel. No neurovascular deficits were noted. Radiographs (Fig. 9.1a, b) demonstrate a right calcaneus fracture with intra-articular extension into the posterior facet.

The left lower extremity was immobilized in a bulky cotton short-leg splint with strict elevation precautions to assist with edema control. A CT scan was obtained to further evaluate the injury. This revealed two displaced fracture lines

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extending into the posterior facet (Sanders type 3 AC [1, 2]) with lateral wall diastasis and calcaneal tuberosity varus angulation (Fig. 9.2a–c).

The patient was indicated for surgical treatment and underwent open reduction and internal fixation using an extended lateral approach. Postoperatively, the patient remained non-weightbearing for a total of 8 weeks. Sutures were removed at 2 weeks during which time the patient was transitioned from a splint to a walking boot to allow early ankle and subtalar range of motion.

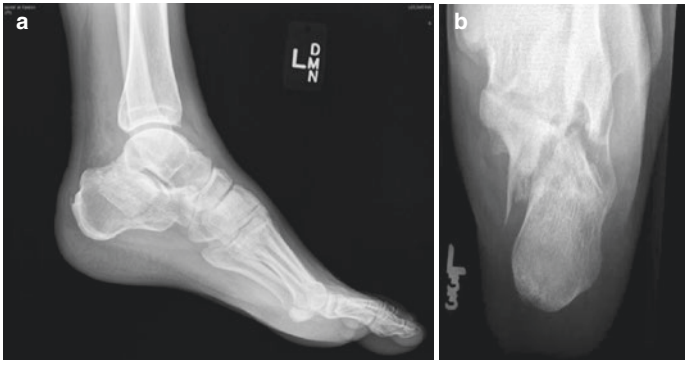

FIGURE 9.1 Injury lateral (**a**) and Harris heel (**b**) views of the hindfoot

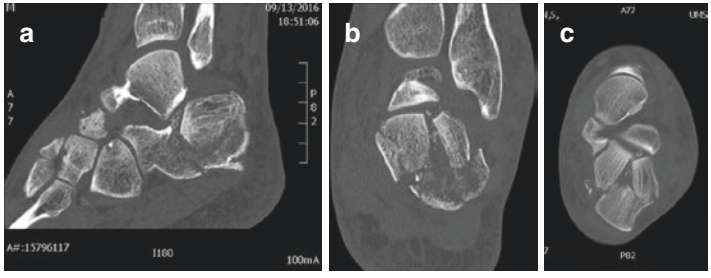

FIGURE 9.2 CT scan images including illustrative sagittal (**a**), coronal (**b**), and axial (**c**) reconstructions

Background

The calcaneus is the most commonly fractured tarsal bone and can be very challenging to treat. Injury is usually the result of direct axial loading to the heel most commonly due to falls from height or motor vehicle collisions. Spine fractures or contralateral calcaneus fractures can occur in 10–15% of patients. Functionally, the calcaneus is important in support of the entirety of body weight with ambulation, hindfoot range of motion through the subtalar joint, and appropriate force transmission from the hindfoot to the midfoot during normal gait.

Imaging

Obtaining appropriate imaging is essential to characterizing the fracture pattern and developing a plan for reduction and fixation. Basic imaging should include AP, lateral, and Harris axial heel view radiographs as well as computed tomography (CT scans). One should evaluate the obtained imaging for the following characteristics: posterior facet joint depression, coronal malalignment and diastasis, the extent of calcaneal tuberosity shortening and angulation as well as the presence and extent of intra-articular involvement. Intraoperatively, contralateral lateral and Harris view fluoroscopic images are helpful for comparative purposes when assessing reduction.

Indications

All displaced calcaneus fractures are amenable to open reduction and internal fixation. Contraindications to surgical treatment may include smokers who are unwilling to abstain from smoking, vasculopathic patients, uncontrolled diabetic patients, and elderly, low-demand patients. Nondisplaced or minimally displaced fractures may also be managed nonoperatively [3].

Relative indications for surgery include poor heel position and shape, displaced articular involvement, no medical contraindications to operative care, open fractures, compliant patients younger than 60 years of age, and nonsmokers [4].

Surgical fixation aims to reduce the fractured calcaneus to its normal anatomy, restore the critical angle of Gissane as well as Bohler's angle, and recreate the congruity of the subtalar joint [3]. Anatomic reduction of the articular surface and correction of the typical deformities affecting the tuberosity (varus angulation, shortening, flattening, and widening) are the surgical goals with the goal of minimizing the long-term risk of symptomatic subtalar arthritis and facilitating normal shoe wear and hindfoot mechanics [5]. Rigid internal fixation allows for early motion of the ankle and subtalar joints.

Soft Tissue Management

Most calcaneal fractures are associated with significant soft tissue injury often the result of high energy trauma. In addition to the osseous injury, the soft tissues are significantly affected resulting in a tender, ecchymotic, swollen, and deformed heel [5]. Oftentimes fracture blisters will develop around the hindfoot. Some authors suggest leaving these closed for as long as possible. Our approach is to unroof the blisters early and begin dressing changes to facilitate epithelial repair and potentially shorten the time course to definitive surgery. If still present at the time of definitive fixation, blisters should be unroofed prior to surgical prep to minimize risk of inoculating the surgical wound with bacterial species which frequently colonize the blister fluid.

Vascular Supply

The blood supply to the calcaneus and its overlying soft tissue may predispose it to avascular necrosis and wound healing complications. The calcaneus receives its blood supply from medial and lateral calcaneal arteries [6].

Disruption of the lateral blood supply may result from both the inciting trauma or possibly in during the surgery. Interruption of this blood supply may cause a significant nutrient deficiency in the lateral half of the calcaneus. The remaining blood supply therefore is reliant on the medial penetrating vascularization [6].

Approach

Setup

The patient should be placed in a lateral decubitus position with the operative calcaneus up. Our preference is to use a radiolucent extension to the end of a standard operating room table to allow for more extensive fluoroscopic access. The patient should be brought to the end of the bed so that the foot can be accessed from both sides as well as the end of the Table. A nonsterile tourniquet should be placed above the knee on the operative extremity. The fluoroscopic imager should be positioned orthogonally to the axis of the body. Folded blankets are stacked around and on top of the nonoperative extremity as depicted (Fig. 9.3) to create a flat surface on which to operate.

Landmarks and Incision

After the leg has been prepped and draped, the extensile lateral approach is marked on the skin. The inferior limb of the incision is made performed just anterior to the lateral edge of the Achilles tendon to best preserve the lateral calcaneal artery which is responsible for the majority of the supply to the corner of the soft tissue flap. The inferior limb of the incision is carried at the transition point of the glabrous skin and is carried to the base of the fifth metatarsal. Once the skin and subcutaneous tissue is incised, the soft tissue envelope is sharply elevated as a full-thickness flap including

FIGURE 9.3 Lateral positioning of patient on regular OR table demonstrating use of blankets to support lower extremity and provide flat operating surface

release of the calcaneofibular ligament (Fig. 9.4). This is critical to preserving the flap's viability and maximizing surgical site healing. The flap is elevated in a subperiosteal fashion proximally to the subtalar joint and anteriorly to expose the calcaneocuboid joint. The peroneal tendons are also elevated from the peroneal tubercle and reflected dorsally to maximize exposure of the lateral calcaneus and subtalar joint. Kirschner wires are placed into the distal fibula, cuboid, talus, and cuneiforms to serve as retractors and minimize the risk of excessive retraction of the lateral heel flap. Grasping of the skin edges with forceps or use of self-retaining retractors

FIGURE 9.4 Intraoperative clinical photo showing full-thickness soft tissue flap elevated and K-wires providing retraction

should be minimized during flap elevation and skin hooks are a preferred mode of retraction to minimize surgical trauma to the soft tissues.

Caution

The lateral extensile approach to the calcaneus has been associated with a high soft tissue complication and infection rate, in some instances as high as 25% [1, 3].

Reduction Maneuver

The use of the lateral approach allows excellent exposure to the entire calcaneus. This case illustrates a classic fracture pattern where the posterior facet articular surface is fractured into multiple segments and depressed plantarly. The calcaneal tuberosity becomes angulated into a hindfoot varus position. The lateral wall of the tuberosity is typically displaced laterally and mobilized during the operation to allow

access to the articular fragments (Fig. 9.5). Sequence of surgery varies depending upon surgeon preference, fracture pattern, and displacement. Although the medial portion of the posterior facet articular surface is often assumed to remain in a reduced position, elevation of this fragment against the inferior surface of the talus is often necessary to provide a stable reference for reduction of the impacted lateral articular fragments. These lateral fragments may need to be temporarily mobilized further laterally while the tuberosity reduction is performed since shortening of the tuberosity may block the ability to elevate the lateral articular fragments into an anatomically reduced position. An osteotome can be placed across the obliquity of this primary fracture line beneath the posterior facet and used to lever the calcaneal tuberosity out of varus angulation, bring the tuberosity out to appropriate length, and restore height. This maneuver may be aided by placement of a 5.0 mm Schanz pin into the tuberosity (Figs. 9.6 and 9.7). A separate V-shaped cortical fragment defining the angle of Gissane is often present between the posterior facet and anterior process and reduction of this fragment often facilitates restoration of the

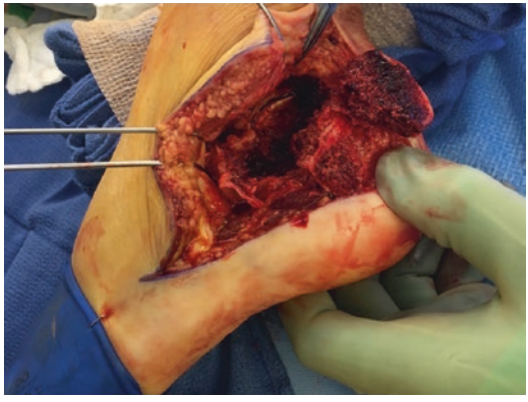

Figure 9.5 Intraoperative clinical photo showing mobilization of lateral wall fragment to reveal intra-articular impaction of the lateral articular surface of the subtalar joint and medial articular "constant fragment"

FIGURE 9.6 Intraoperative lateral fluoroscopic image demonstrating reduction of articular surface with mini-fragment lag-screw fixation and restoration of calcaneal tuberosity height and length

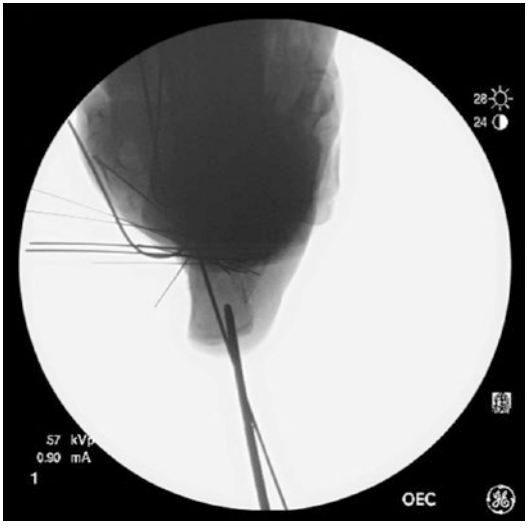

FIGURE 9.7 Intraoperative Harris heel fluoroscopic image demonstrating correction of varus malalignment of calcaneal tuberosity

relationship between these structures and may precede or follow elevation of and anatomic reduction of the depressed lateral articular fragments. Multiple small-diameter smooth K-wires provide provisional fixation of the multiple reduced fracture fragments (Figs. 9.6 and 9.8) while lateral and Harris heel fluoroscopic imaging confirms the reduction. Once reduction is confirmed, wires can be replaced with mini-fragment screws and a laterally based plate to buttress the lateral cortex and provide fixed-angle raft screw support of the articular surface (Fig. 9.9).

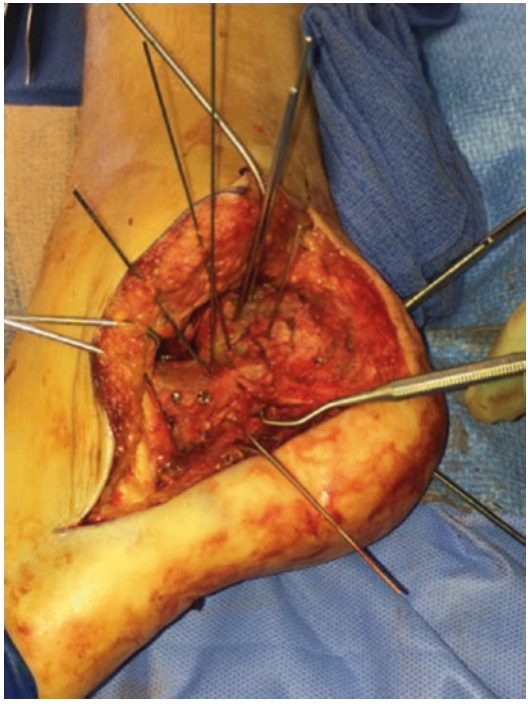

FIGURE 9.8 Intraoperative photo demonstrating reduced fracture with mini-fragment lag-screw and provisional K-wire fixation

FIGURE 9.9 Final fixation construct consisting of precontoured locking calcaneal plate

Closure

Closure consists of interrupted 3-0 vicryl sutures in the dermis. Placement of all dermal sutures prior to knot-tying has been advocated, but we prefer to tie each knot as the suture is placed. We do recommend starting closure at the corner and working outward (distally and proximally) to avoid translating skin edges inadvertently. To minimize surgical trauma to the flap, the skin is then reapproximated with 3-0 nylon sutures applied in an Allgower-Donati fashion (Fig. 9.10). Final fluoroscopic images confirm the reduction (Fig. 9.11a, b).

FIGURE 9.10 Final wound closure over drain with 3-0 nylon sutures placed using Allgower-Donati technique

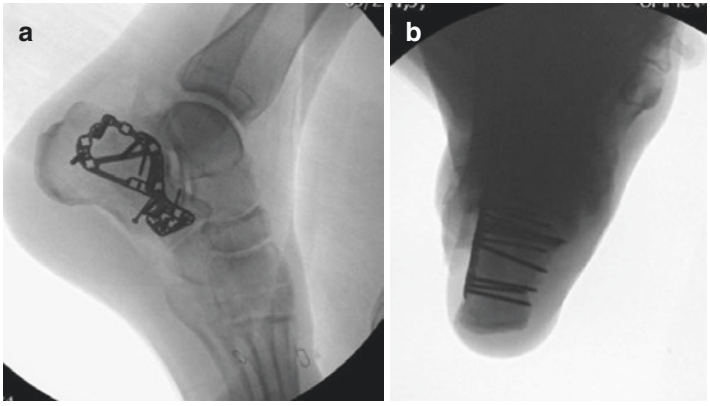

FIGURE 9.11 Final postoperative lateral (**a**) and Harris heel (**b**) fluoroscopic views

Salient Points/Pearls

- Hindfoot varus can be difficult to correct since the surgical approach is laterally based. A 5.0 mm Schanz pin placed in the postero-superior aspect of the calcaneal tuberosity allows for multiplanar manipulation of this fragment to assist in restoration of length, height, and valgus alignment.
- Kirschner wires allow for maintenance of provisional reduction. These wires may be applied lateral to medial or may be placed percutaneously from the tuberosity into the posterior facet to maintain proper height.
- A lamina spreader can be a useful tool to restore tuberosity length and height and posterior facet height during surgical reduction.
- Bone grafting is rarely indicated in calcaneus surgery. Although large cancellous bone voids may frequently be present between the posterior facet and posterior tuberosity secondary to comminution or impaction, these usually heal uneventfully without grafting in the calcaneus. When necessary, cancellous allograft chips may be used.
- Bone graft substitutes are usually not necessary nor worth the additional cost. Tri-cortical allograft may also be used to augment the axial stability in rare cases.

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