12 Calcaneal fracture

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12.1 Introduction

The calcaneus is the most frequently injured tarsal bone. Approximately 75% of these injuries are intra-articular, and almost all occur due to an axial load such as a fall from a height or a motor vehicle accident. Approximately 10% of patients will have a spine fracture as well due to the axial load. Approximately 10% of injuries are bilateral and fewer than 5% are open. Many calcaneal fractures are work-related, as they result from a fall from height, especially in males age 35-45 years. These fractures frequently result in long-term disability with potentially severe economic impact on the patient.

Historically, treatment of displaced intra-articular calcaneal fractures has varied from non-operative management with or without closed reduction, to open reduction with internal fixation by various surgical approaches, to primary arthrodesis. The popularity of non-surgical treatment was related to the potential for surgical wound complications and possibly osteomyelitis in some patients. However, over the past two decades the pendulum has swung back towards surgical management due to improved surgical techniques and less soft tissue stripping.

12.2 Pathoanatomy

The axial load that causes a displaced intra-articular calcaneal fracture leads to crushing and sheering injury of the bone. The problems caused by this include:

- Intra-articular incongruity with the development of arthritis or arthrosis of the subtalar and/or calcaneocuboid joint
- Lateral wall blowout leading to peroneal tendon impingement and/or calcaneofibular impingement
- Varus malalignment of the heel
- Widened heel due to the lateral bulge
- Shorter heel height leading to the malleoli being close to the ground and thus rubbing against a shoe heel counter
- Decreased ankle dorsiflexion caused by a relatively dorsiflexed position of the talus within the crushed calcaneus
- Elevated Achilles tendon insertion leading to weakening of the gastrocnemius-soleus complex
- Shortening of the calcaneus resulting in a decreased lever arm upon which the gastrocnemius-soleus complex can work

Thus, non-operative management of a displaced calcaneus fracture results in a maligned position with multiple structural abnormalities in addition to an incongruous joint surface.

### 12.3 Clinical Presentation

Patients usually present after a fall from a height with complaints of heel pain and a variable degree of swelling (Figure 1). The integrity of the skin should be assessed and the presence of blisters noted. Patients can also develop compartment syndrome in the “calcaneal compartment,” which if left untreated, can lead to claw toe deformities.

![Figure 1. Note swelling and blister formation along lateral hindfoot following a closed calcaneal fracture.](image)

The clinical examination should include passive extension of the toes to evaluate for unexpected pain, especially in the deep arch. Prior to considering surgery, evaluate the patient for the “wrinkle sign,” which means the skin wrinkles with dorsiflexion and eversion of the hindfoot — a rough guide as to whether the swelling is at an acceptable level to allow for an extensile approach.

### 12.4 Radiographic Evaluation

Patients should be assessed with plain radiographs, including lateral and axial Harris views of the hindfoot. An oblique view can be helpful for visualizing the calcaneocuboid joint. Intraoperatively, Broden views, which visualize the posterior facet, can be useful. They are obtained by internally rotating the foot approximately 45 degrees with the ankle in neutral position and angling the beam in 10-degree increments from 10 to 40 degrees off vertical.
Computed tomography (CT) scan has become a routine tool for evaluating the three-dimensional anatomy of the injury (Figure 2). Reconstructed images are obtained in coronal, transverse, and sagittal planes. CT can be helpful for (1) preoperative planning, including deciding whether to proceed with surgical fixation or primary fusion; (2) intraoperative decision-making with regard to fracture reduction and orientation of hardware; and (3) preoperative patient discussion about the potential outcome, as highly comminuted fractures in general fare more poorly.

Figure 2. Coronal CT scan through both heels demonstrating split posterior facet, varus, medial cortical overlap. The dorsal wedge shape of the posterior tuberosity fragment will preclude reduction of the articular fragment until it is reduced.

12.5 Classification Systems

With plain radiographs, fractures can be classified as either joint depression or tongue type.

With joint depression fractures, a secondary fracture line exits the dorsal surface of the posterior calcaneus with the displaced portion of the posterior facet being impacted into the body of the calcaneus (Figure 3).

Figure 3. Schematic diagram of a joint depression fracture. Note the secondary fracture line that exits dorsally on the posterior tuberosity.
A **tongue-type fracture** has a secondary fracture line exit directly posteriorly, such that a portion of the Achilles tendon is attached to this displaced fragment posteriorly (Figure 4).

![Schematic diagram of tongue-type fracture. Note that the secondary fracture line exits the posterior aspect of the posterior tuberosity.](image)

**Figure 4.** Schematic diagram of tongue-type fracture. Note that the secondary fracture line exits the posterior aspect of the posterior tuberosity.

The most commonly used calcaneal fracture classification is the Sander's classification. This system is illustrated in Figure 5. It is based on the number of articular fragments on a coronal CT scan through the posterior facet:

- **Type I** - Non-displaced
- **Type II** - Two articular fragments
- **Type III** - Three articular fragments
- **Type IV** - More than three articular fragments

This classification is further subcategorized with A, B, C, depending on the location of the fracture lines in the posterior facet.

![Diagram of Sander's CT classification of intra-articular calcaneal fractures.](image)

**Figure 5.** Diagram of Sander's CT classification of intra-articular calcaneal fractures.
12.6 Conservative Treatment

Non-displaced fractures (Sander’s Type I) should be treated non-operatively. In general, patients should be placed in a bulky compression dressing (Jones dressing) until the initial swelling subsides. The dressing can then be replaced by a removable splint or boot to begin range-of-motion exercises of the ankle and, more important, the subtalar joint. They should be kept non-weight-bearing for at least 6 weeks after injury.

Some patients with displaced intra-articular calcaneal fractures may be better treated without surgery, especially those with significant comorbidities, heavy smokers, and noncompliant patients; it is always left to the surgeon’s judgment which patient is best treated with surgery. Standard open treatment does have a significant risk of wound healing problems and infection in certain patients, such as smokers and patients with diabetes, who are often best treated non-operatively to avoid major wound complications.

12.7 Operative Treatment

Prior to surgical treatment, swelling should subside until a wrinkle sign is present; there is a much higher risk of a wound healing problem when operating on a significantly swollen foot. The most commonly used approach for surgical treatment of displaced intra-articular calcaneal fractures is an extensile L-shaped approach (Figure 6). This has been popular for the last 15-20 years and allows for excellent visualization of the fracture. A full-thickness flap is elevated off the lateral wall of the calcaneus with retraction pins in the tip of the fibula, neck of the talus, and the cuboid. There is significant morbidity from this approach, including pain and swelling post-operatively and a significant risk of wound healing complications that can lead to infection.

![Figure 6. Intraoperative photograph showing L-shaped extensile approach with retraction pins in tip of fibula, neck of talus, and cuboid.](image)

A Schanz pin can be placed in the posteroinferior calcaneus and used to facilitate an indirect reduction of the posterior tuberosity of the calcaneus (Figure 7). In general, low-profile implants are used to minimize soft tissue tension on the wound (Figure 8). A radiographic example of a patient treated via a lateral extensile approach is presented in Figures 9a-f.
**Figure 7.** Diagram demonstrating Schanz pin in calcaneal tuberosity. The tuberosity is indirectly reduced with the pin by 1) pulling out to length, 2) out of varus, 3) medially translated.

**Figure 8.** Note low-profile implant on the lateral surface of the calcaneus to minimize skin tension and hold reduction.

**Figure 9a.** Preoperative lateral radiograph of displaced joint depression fracture. Notice "crescent sign" showing the amount of impaction of the articular fragment into the body of the calcaneus.
Figure 9b. Preoperative axial, Harris radiograph demonstrating medial fracture line and varus malalignment.

Figure 9c. Preoperative coronal CT scan demonstrating Sanders Type II B fracture.

Figure 9d. Postoperative lateral radiograph showing anatomic reduction of joint surface with lateral plate and screws.
Due to the high rate of wound complications, more surgeons have begun using percutaneous or minimally invasive methods of treatment. The Essex-Lopresti method is an accepted method of reducing fractures, especially tongue-type, Sander’s type IIC fractures. The more limited sinus tarsi approach with subcutaneous plating and indirect reduction of the posterior tuberosity has also resulted in less post-operative swelling/pain and acceptable joint reduction. Some surgeons use percutaneous reduction techniques with minimally invasive incisions and small bone elevators to reduce the articular fragments and percutaneous screw fixation of the fracture fragments.

In patients with comminuted joint surfaces (Sander’s type IV) or severe articular cartilage damage, open reduction to restore calcaneal anatomy with subsequent primary fusion of the subtalar joint is also an accepted method of treatment and likely leads to a shorter period of disability. Reduction and primary fusion are technically easier than a subtalar fusion in the presence of a severe calcaneal deformity that requires osteotomy or distraction fusion to correct the malalignment of the entire calcaneus.

**12.8 Complications**
The most severe complication of calcaneal fracture surgery is a wound infection, which usually follows delayed wound healing. Some studies have documented rates of wound complications greater than 40%. Waiting until the skin wrinkles and fracture blisters have healed decreases the risk of wound complication/infection. Other risks include arthrosis of the subtalar joint with stiffness in spite of open reduction and internal fixation, with early motion or post-traumatic arthritis of the subtalar joint. Conservatively treated displaced fractures have multiple problems as outlined in the pathoanatomy section.

12.9 Outcomes

Most authors of studies on calcaneal fractures agree that non-surgical treatment leads to persistent functional deficit. The most definitive studies have been by Buckley et al in a multi-center Canadian trial evaluating operative vs nonoperative treatment. With a study population of more than 300 patients from multiple sites, they found that without stratification of patients, functional results were the same after non-operative or operative care.

However, when they looked at subgroups of patients, they found that those receiving workers compensation had a worse outcome in general. Women fared better after surgical reduction, as did patients who:

- Were not receiving workers compensation
- Were less than 29 years old
- Had a less severely displaced fracture
- Had a light workload
- Had an anatomic reduction

In a subsequent study, they noted that the overall cost of care of patients was less with surgical care than non-surgical management due to the need for additional surgery for fusion and for the higher disability cost from a longer period of missed work in the non-operatively managed group of patients.

Another smaller series of 30 patients with displaced calcaneal fractures who were randomized to surgical vs non-surgical treatment found far superior results in the surgically treated group, but with a shorter follow-up period than the Buckley study.

12.10 References


12.11 Acknowledgments

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