4.1 Extraarticular fracture (beak)

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1 Case description

A 78-year-old woman was walking out her front door to get the mail. She tripped over the doorway and had immediate onset of pain and inability to ambulate. The injury was closed. Comorbidities included only osteoporosis. The patient was independent in all activities of daily living and was otherwise healthy.

X-rays revealed an extraarticular posterior tuberosity avulsion or "beak" fracture AO/OTA 82A1 (**Fig 4.1-1**).

2 Preoperative planning

Indications for surgery

Prompt identification of the injury and the need for early surgical fixation are necessary for a successful recovery.

Surgical indications include a marked displacement of the tuber and loss of function of the Achilles with plantarflexion weakness. Additionally, surgical fixation is indicated to prevent soft-tissue breakdown posteriorly. Displacement of the fracture fragment may cause posterior soft-tissue breakdown as a result of pressure-related ischemia and necrosis. The patient should be counseled as to the high risk of complications from this injury, including soft-tissue breakdown, failure of fixation, and pain with shoe wear.

Fig 4.1-1a–b Preoperative images.
a–b Lateral (**a**) and axial (**b**) x-rays demonstrating an avulsion (beak) fracture with marked displacement.
c The displaced fragment causes injury to the posterior soft tissues and must be addressed in a timely manner to avoid pressure necrosis from developing.

Considerations for surgery

Surgical approaches include a direct posterior approach or use of the vertical limb of the lateral extensile approach. In open injuries the wound is typically transverse and treatment through the traumatic wound is required, with vertical and distal extension at the corners if needed.

Reduction is critical in restoring the anatomy and function of the hindfoot. The fractured tuberosity must be brought back down to the rest of the tuber to repair the plantar flexion mechanism of the foot. The tuber reduction must also be correct in rotation, as rotational malalignment will interfere with the heel contour of shoes, causing irritation. Occasionally, this fracture fragment will extend into the posterior facet but most commonly it is an extraarticular injury.

Procedures such as a tendo-Achilles lengthening or gastrocnemius recession may be necessary at the time of surgery. The contralateral limb should be evaluated for the presence of equinus contracture. If present, it may be assumed that the injured limb also has a contracture. Procedures may be necessary to treat preexisting equinus or alternatively help with contracture, which may have developed from the time of injury. Generally, the greater the displacement, the more likely the patient has concomitant equinus.

Surgical intervention for extraarticular beak fractures is difficult. This fracture pattern is most commonly seen in patients who may have altered bone density, diabetes, and neuropathy. If any of these risk factors are present, they must be considered during planning. Numerous techniques exist and share the goal of restoration of normal anatomy as well as counteracting the deforming forces. There is no single ideal way to provide stability to this injury pattern and all are at risk of failure.

The soft tissues posteriorly are often traumatized and usually not amenable to incisions. The vertical limb of the lateral extensile approach allows the incision to be placed in better soft tissues and works well for this injury.

3 Operating room set-up

Patient positioning	Lateral decubitus on a radiolucent table (injured side up)
Anesthesia options	General or spinal anesthesia. Complete muscle relaxant is necessary to decrease the deforming force of the gastrocnemius soleus complex
C-arm location	Monitor on the opposite side of the table with the image intensifier entering at an oblique angle from the foot of the bed
Tourniquet	At the discretion of the surgeon. Generally, it improves fracture visualization
Tips	Avoid positioning the patient with the knee extended. Having the knee bent with the operative foot closest to the surgeon relaxes the gastrocnemius and may be beneficial at the time of reduction

For illustrations and overview of anesthetic considerations, see Chapter 1: General considerations in foot and ankle surgery. For illustrations and overview of patient and C-arm positioning for calcaneus fracture treatment in the lateral decubitus position refer to Chapter 3: Calcaneal fractures.

Equipment

- Reduction clamps
- K-wires
- Small locking plates
- Screws for lag screw placement (may be small or large fragment)
- Suture for augmentation if necessary
- C-arm
- Plaster for postoperative splinting

4 Surgical procedure

The contralateral limb should be thoroughly examined for any preexisting equinus. If present, it will be necessary to address the equinus to aid in reduction. This can be assessed by performing the Silfverskjöld is used to determine if contracture is present in the achilles or in the gastrocnemius. This test should be performed on the contralateral limb.

The fracture is approached using a small vertical incision on the lateral side of the foot. The incision is essentially the vertical limb of a standard extensile lateral approach (**Fig 4.1-2a**). After the incision is made, all fracture hematoma is removed using suction and careful use of a curette. Care is in manipulating the fracture fragments, as these fractures occur in the soft cancellous bone of the calcaneal body. Bone loss, resulting in the loss of the ability to obtain an accurate fracture reduction read, is a risk if aggressive curettage is performed. When all the hematoma is removed, a point-to-point reduction clamp is placed over the superior ridge of the calcaneus. If the fragment is large, a small incision can be made posterior and a Schanz pin can be placed axially to act as a joystick in the fragment. Reduction is achieved by plantar flexion at the ankle while carefully closing the reduction clamp and manipulating the Schanz pin (**Fig 4.1-2b**). Assessment of reduction should be made at both the anterior and posterior aspects of the fracture to avoid rotational malalignment. The fracture is then held provisionally with multiple K-wires and additional reduction clamps, as necessary.

If using a small locking plate, place it onto the lateral aspect of the calcaneus. Drill sleeves and K-wires are placed through the plate into the proximal fragment. If using non-variable angle locking (VAL) plates, the K-wires must be placed through the plate before insertion of independent lag screws, as placement of lag screws may first block the trajectory needed for the locking screws in the proximal fragment. Lag screws are then inserted from the superior ridge of the calcaneus, making sure the length is appropriate to penetrate the plantar cortex (**Fig 4.1-2c**). If the fragment is large, additional screws may be directed from posterior into the anterior process. Locking screws are then inserted into the proximal limb of the plate (**Fig 4.1-2d**).

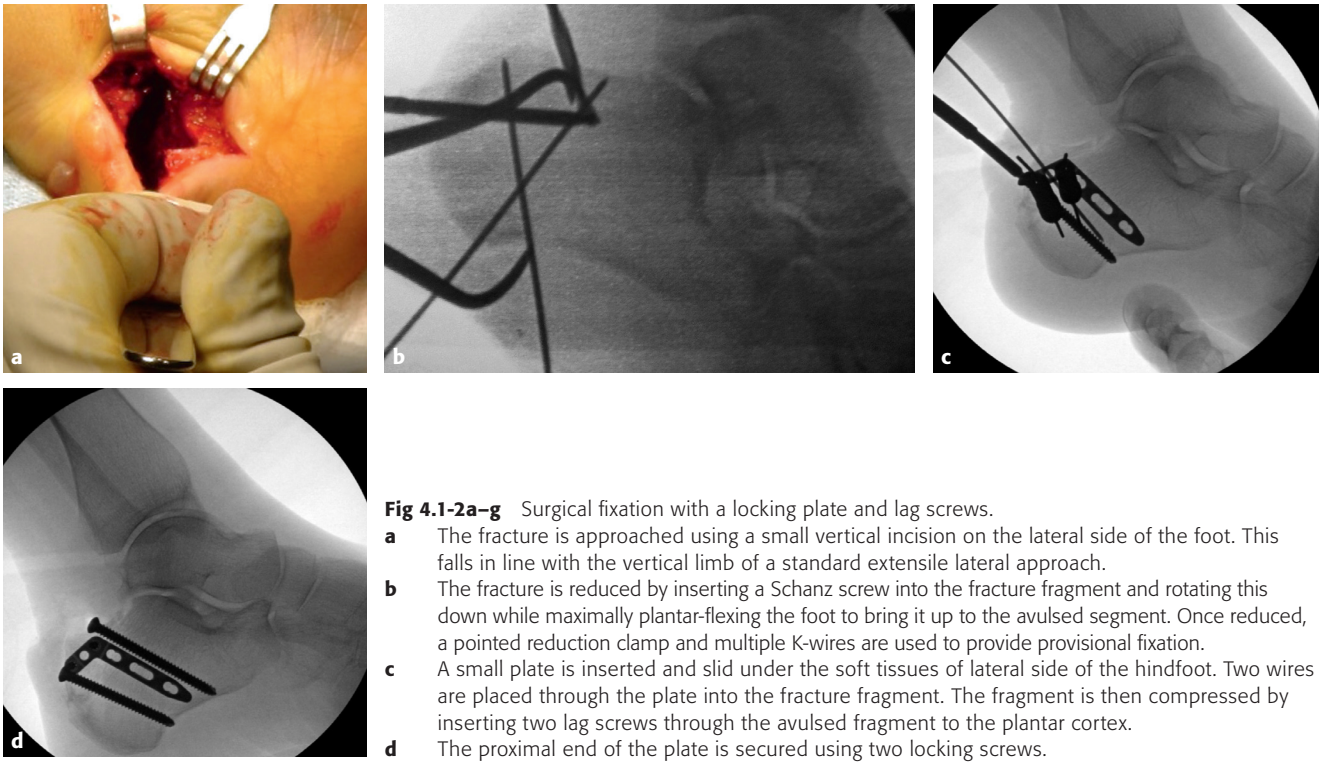

Fig 4.1-2a–g Surgical fixation with a locking plate and lag screws.
a The fracture is approached using a small vertical incision on the lateral side of the foot. This falls in line with the vertical limb of a standard extensile lateral approach.
b The fracture is reduced by inserting a Schanz screw into the fracture fragment and rotating this down while maximally plantar-flexing the foot to bring it up to the avulsed segment. Once reduced, a pointed reduction clamp and multiple K-wires are used to provide provisional fixation.
c A small plate is inserted and slid under the soft tissues of lateral side of the hindfoot. Two wires are placed through the plate into the fracture fragment. The fragment is then compressed by inserting two lag screws through the avulsed fragment to the plantar cortex.
d The proximal end of the plate is secured using two locking screws.

The plate is compressed either by using an external compression device or by standard compression plating techniques. A small incision is made using x-ray guidance to place the incision directly over the distal end of the plate. A standard screw is then inserted using compression plating techniques through the second to last screw hole. (**Fig 4.1-2e**). The last step is locking the most plantar and distal hole in the plate (**Fig 4.1-2f**). Finally, all provisional fixation is removed. The wound is closed (**Fig 4.1-2g**) and the ankle is splinted in slight plantar flexion to avoid pull of the gastrocnemius soleus complex.

5 Pitfalls and complications

Pitfalls

Failure to appropriately obtain and maintain reduction
The foot should be reduced to the displaced fragment as opposed to trying to pull the fragment down to the foot. Maximum plantar flexion may be necessary until fixation is complete.

The tuberosity fragment may be of poor bone density or comminuted. Often clamps or other reduction aids will further damage the displaced segment. Sutures may be placed in the distal portion of the Achilles tendon and used to aid in reduction by pulling the sutures distal, decreasing the pull on the displaced fragment.

Tendo-Achilles lengthening and/or gastrocnemius lengthening are often necessary at the time of fixation and should be part of the anticipated surgical plan.

Catastrophic loss of posterior soft tissues
Delay in surgical treatment may result in catastrophic loss of the posterior soft tissues including the Achilles attachment. These injuries must be recognized and treated with urgency. If surgery must be delayed, the foot should be splinted in plantar flexion.

Loss of bony insertion
If the fractured portion with the Achilles is small or the bone density is excessively poor, sutures may be placed in the Achilles tendon to help reduce the fracture fragment by pulling the Achilles distally, reducing the risk of creating comminution of the fracture fragment. The sutures may be removed after use, or alternatively, placed through a transverse drill hole in the calcaneus to provide a secondary means of fixation. On rare occasions, small fragments may be removed, and the Achilles reattached to the calcaneus with suture anchors or pull-through sutures.

Fig 4.1-2a–g (**cont**) Surgical fixation with a locking plate and lag screws.
e A small incision is made with x-ray guidance.
f A standard screw is inserted using compression plating techniques through the second to last screw hole. The final locking screw is inserted in the most plantar and distal hole in the plate to complete the construct.
g Final wound closure.

Complications

Soft-tissue breakdown

Soft-tissue problems are present in most of these fractures. They range from bruising and blistering of the posterior skin to full thickness necrosis. Unlike many calcaneus fractures, this fracture pattern requires prompt attention. Surgery should be performed early to restore the normal bony morphology of the posterior aspect of the calcaneus to prevent soft-tissue breakdown. If splinting is necessary, the splint should be applied with the ankle in maximal plantar flexion to attempt to bring the foot up to the displaced fragment. Carefully advise the patient to avoid placing direct pressure on the posterior soft tissues of the heel. Pillows used to elevate the foot should be placed behind the calf to avoid pressure on the posterior aspect of the calcaneus (different case: **Fig 4.1-3**).

Fig 4.1-3 Different case: failure a patient presented belatedly after inadequate initial treatment. Necrosis of the posterior soft tissues occurred. A large soft-tissue defect was present after debridement of non-viable tissue. The patient required a below-knee amputation.

Failure of fixation

This fracture pattern occurs most commonly in individuals with decreased bone density, diabetes, and neuropathy either individually or in some combination. Fixation is at risk in all patients. Equinus may be a preexisting factor and may need to be addressed at the time of fixation (different case: **Fig 4.1-4**).

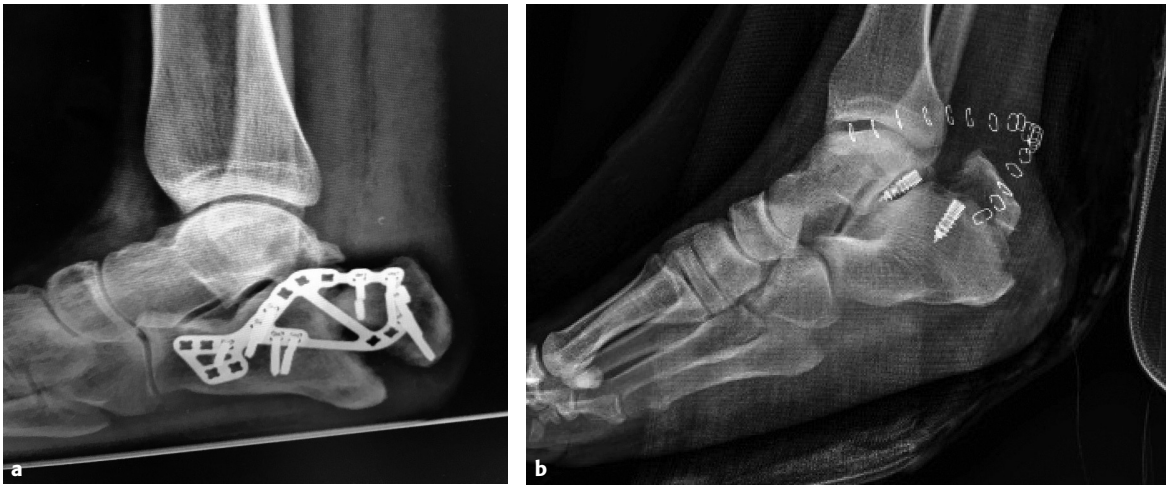

Fig 4.1-4a–b Different case: of fixation.

a Failure of fixation of a fracture treated with a lateral plate. Screws in the posterior superior portion of the plate have failed and there is loss of reduction.

b Failure of fixation of a fracture with attempted fixation with suture anchors.

Malunion

Partial failure of hardware leads to displacement but not complete failure of fixation. This may lead to malunion of the tuber fragment but not failure of open reduction and internal fixation (different case: **Fig 4.1-5**).

6 Alternative techniques

There is no consensus on the most successful fixation construct for these injuries. Treatment options include screws, locking plates, suture anchors, suturing through the distal Achilles and then through drill holes, lateral plates, posterior plates, and lateral extensile plates. All are options, but none are immune to failure (different case: **Fig 4.1-6**).

Fig 4.1-5a–c Different case: malunion of the posterior calcaneus.
a–b Malunion results in an abnormal shape to the contours of the hindfoot and will commonly interfere with shoe wear.
c A patient with a malunited avulsion fracture experiences chronic wound problems with shoe wear due to the underlying bony prominence.

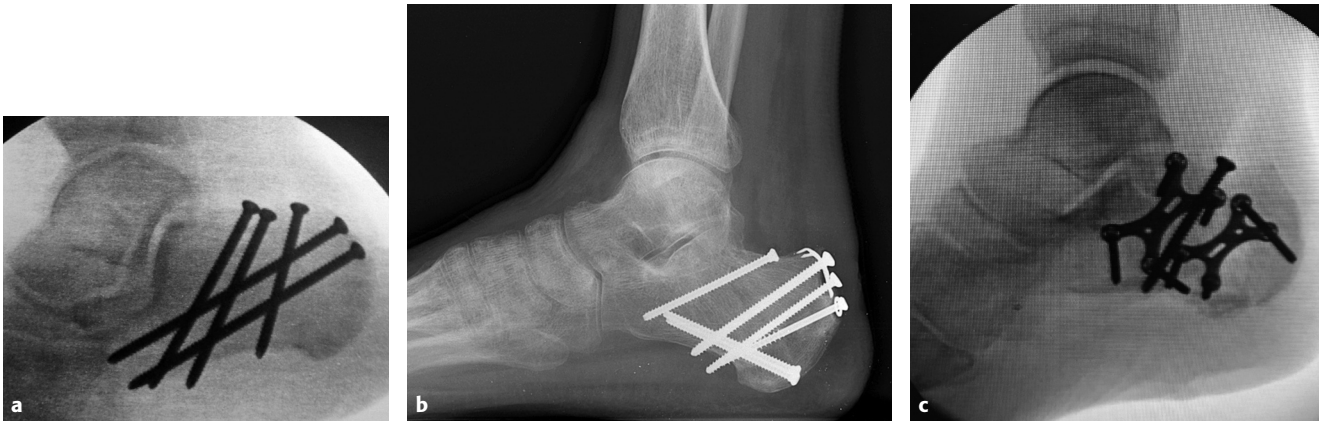

Fig 4.1-6a–c Different case: Alternative fixation options include fixation by screws only (**a**), screws and a posterior plate (**b**), and alternative combinations of locking plates and lag screws (**c**).

7 Postoperative management and rehabilitation

The patient is advised not to place pillows directly under the posterior aspect of the heel when elevating the limb, as doing so can further damage the traumatized tissues. Patients should be carefully informed and reminded that rehabilitation activities must be progressed slowly. Most patients with this fracture have decreased bone density and are at risk of fixation failure. Additionally, many have altered sensation and pain may not deter the patient from increasing activities and will not be a reliable indicator of complications developing.

The patient should be splinted in some degree of equinus to decrease tension on the fixation construct. The amount of equinus is dependent on stability of the construct and the quality of the bone. The patient is seen at 2 weeks postoperatively for suture removal and then advanced to a neutral position. In extreme cases a heel wedge may be used and gradually diminished over time.

Range of motion of the ankle and subtalar joint typically are initiated 6–8 weeks postoperatively. The patient will maintain non-weight bearing until x-rays show union.

Implant removal

Implants are only removed if they cause irritation over time. This most often occurs with shoe wear. Patients with this fracture pattern often have sensitivity to the posterior aspect of the calcaneus with shoe wear. With appropriate reduction and implant placement the hardware is typically asymptomatic and patients with this fracture return to normal footwear (**Fig 4.1-7**).

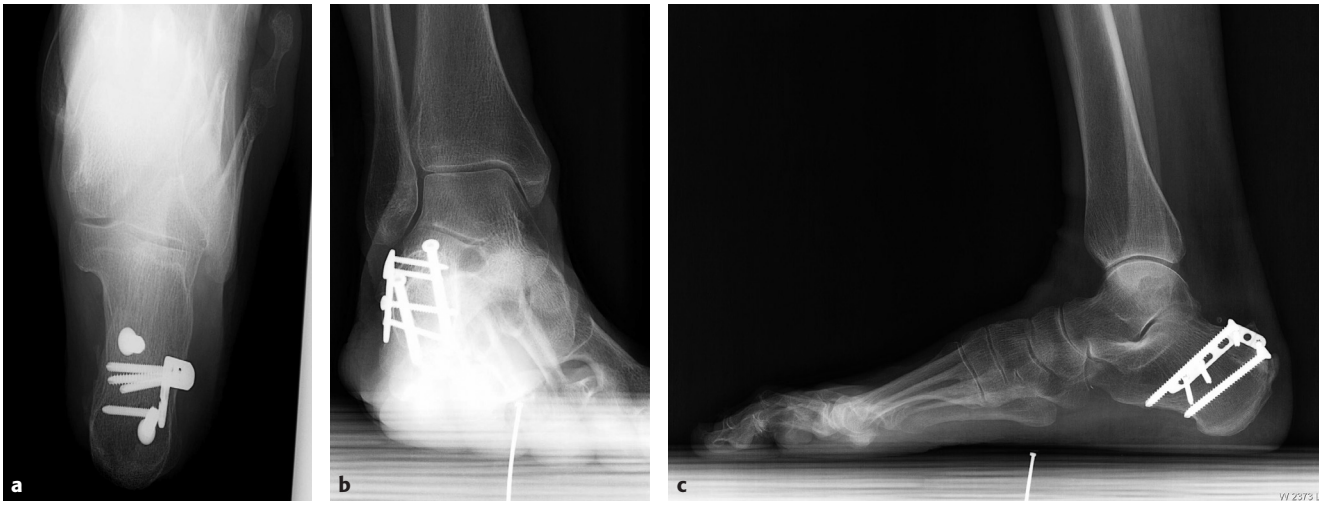

Fig 4.1-7a–c Final x-rays taken 3 years after injury demonstrate a well-aligned and healed fracture. The patient is asymptomatic and wears normal footwear.

8 Recommended reading

Beavis RC, Rourke K, Court-Brown C. Avulsion fracture of the calcaneal tuberosity: a case report and literature review. *Foot Ankle Int.* 2008 Aug;29(8):863–866.
Lee SM, Huh SW, Chung JW, et al. Avulsion fracture of the calcaneal tuberosity: classification and its characteristics. *Clin Orthop Surg.* 2012 Jun;4(2):134–138.
Swords MP, Rammelt S, Sands AK. Non-extensile techniques for treatment of calcaneus fractures. In: *Operative Techniques: Foot and Ankle Surgery.* 2nd ed. New York: Elsevier; 2018:319–326.