Talar Neck Fractures

4

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Introduction

The talus is a complex bone with unique anatomy. As it is very dense, it takes a significant amount of force to cause a fracture. These uncommon fractures account for 0.1–0.85% [1] of all fractures and typically result from high-energy trauma. When they do occur, they can lead to significant impairment of lower extremity function. Fractures of the talar neck comprise nearly 50% of all talus fractures [1]. These fractures are associated with injury and dissociation of the surrounding joints and warrant prompt management.

Anatomy

The talus is comprised of the head, neck, and body. Cartilage covers two thirds of its surface area, giving it numerous surfaces to articulate with adjacent bones. There are no muscular or tendinous attachments, so the bone is stabilized by the surrounding joint capsule and ligaments. The body of the talus resides in the ankle mortise and has five articular surfaces. The talar head sits

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in a deep socket, sometimes referred to as the *acetabulum pedis*, that is comprised of the navicular, anterior/middle calcaneal facets, and surrounding ligaments. The neck of the talus is a relative weak point of the bone. Instead of being covered in articular cartilage, it has multiple foramina for the extramedullary blood supply to enter the bone and is comprised primarily of cancellous bone.

This unique blood supply of the talus is comprised of branches from the posterior tibial, anterior tibial, and perforating peroneal arteries. This is covered in more depth in a previous chapter, but careful consideration of the blood supply is necessary during surgical treatment of talar neck fractures.

Fracture Patterns and Classifications

Talar neck fractures occur with axial loading and forced dorsiflexion of the foot. This drives the relatively weak cancellous bone of the talar neck into to the anterior tibial plafond. If the foot continues to dorsiflex, the fracture propagates though the talar neck into the subtalar joint, causing subluxation or dislocation of the talar body from the calcaneus. Continued foot dorsiflexion causes distraction of the posterior ankle, allowing for subluxation or dislocation of the talar body from the ankle mortise. Forced hindfoot supination drives the neck and body into the medial

malleolus, leading to dorsal medial failure in compression and lateral failure in tension. This typically results in medial comminution, medial shortening, and varus malposition.

The Hawkins classification of talar neck fractures is derived from the degree of involvement of the surrounding joints based on radiographic assessment (Fig. 4.1). This classification system is not only useful descriptively, it has been demonstrated to correlate with prognosis. Type I fractures are nondisplaced fractures of the talar neck with less than 1 mm of fracture displacement. The fracture line does not involve any articular surface and theoretically only disrupts the anterolateral blood supply. This is associated with a 0–13% risk of avascular necrosis (AVN). Type II fractures involve displacement of the subtalar joint. This disrupts the vasculature entering the neck anterolaterally and through the sinus tarsi while often sparing the medial body vessels and

carries a 20–50% risk of AVN. Type III fractures have dislocation of the talar body from the subtalar and tibiotalar joints, effectively disrupting all three blood supplies to the body and carrying a 20–100% AVN risk. The body is often extruded posteromedially and can impinge on the posterior tibial neurovascular bundle. The type IV injury category, subsequently added by Canale and Kelly, involves subluxation or dislocation of the talonavicular joint and carries 70–100% AVN risk and the poorest outcomes [2, 3].

Vallier et al. subclassify type II fractures into type IIa, where the subtalar joint is subluxed, versus type IIb, where the subtalar joint is dislocated. They demonstrated via a retrospective review no AVN in type I and IIa fractures, 25% AVN in type IIb fractures. The rates of subtalar arthritis were similar (21% in type IIa, 25% in type IIb), but tibiotalar arthritis increased from 5.3% in type IIa to 13% in type IIb [3].
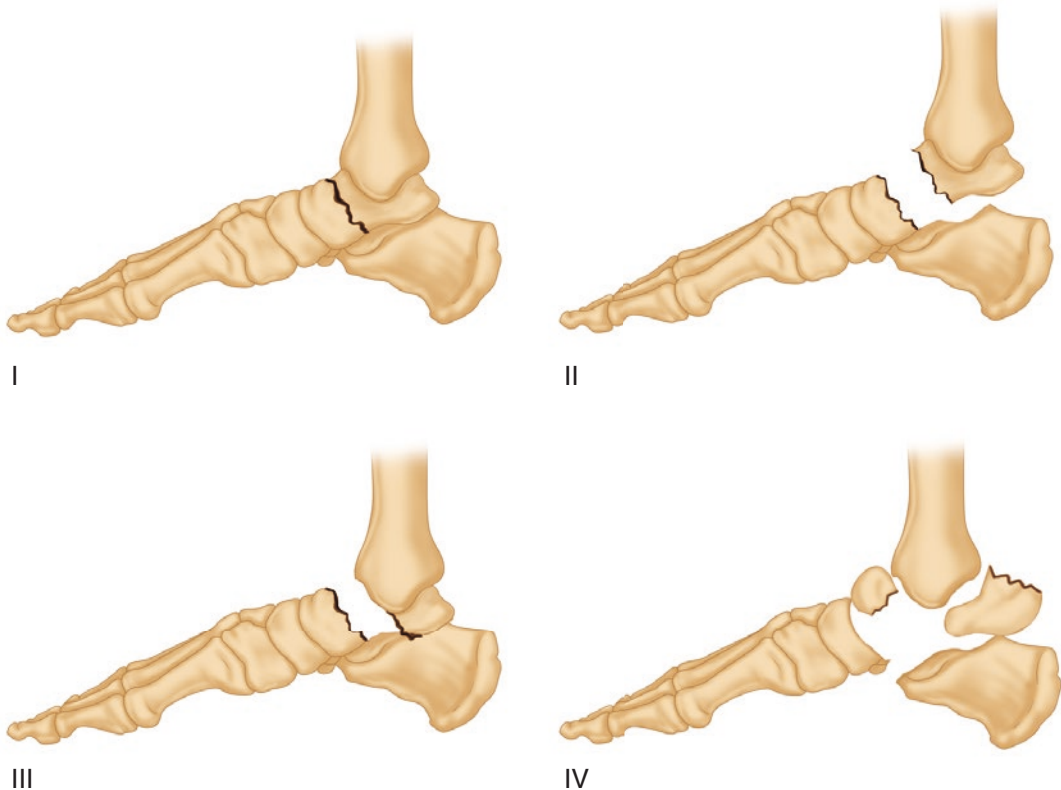

Fig. 4.1 The Hawkins Classification. Type I: nondisplaced talar neck fractures. Type II: with subtalar disruption. Type III: wtih subtalar and tibiotalar disruption. Type IV: with subtalar, tibiotalar, and talonavicular disruption

Evaluation and Treatment

Assessing the mechanism and energy of injury is important to determine the severity of the injury. High-energy axial load injuries are associated with increased comminution, articular cartilage damage, and ligamentous injuries that increase the risk of post-traumatic arthritis. Obtaining the patient's comorbidities can guide the treatment course. A thorough neurovascular exam is important to document given that type III and IV fractures are associated with posterior tibial nerve injury and possible skin tenting or compromise.

Radiographic evaluation should start with the standard anteroposterior (AP), lateral, and oblique views of the ankle and foot. The Canale view may be helpful to assess the talar neck and will show the amount of shortening and angulation. A computer tomography (CT) scan is important to obtain to understand the fracture pattern for surgical planning.

Temporary stabilization of the fracture with an adequately padded splint should be placed prior to definitive management. If there is peritalar dislocation or skin compromise, reduction should be expeditious to avoid neurovascular compromise or further skin necrosis. If closed reduction is not successful in the emergency department, the patient may require use of an external distractor or open reduction techniques in the operating room.

Open fractures account for 20–25% of all talus injuries and are associated with increased rates of AVN and post-traumatic arthrosis [4]. Initial management involves immediate antibiotic administration upon arrival to the hospital to decrease risk of infection. Urgent wound irrigation and debridement should be performed.

Previous teachings pertaining to definitive surgical management of talus fractures were to undergo immediate open reduction internal fixation to minimize the risk of AVN and subsequent joint arthrosis. However, recent literature has not supported this notion. Vallier et al. showed no difference in rates of osteonecrosis with immediate fixation versus delayed or staged fixation. However, they do advocate for urgent and expeditious closed reduction either in the emergency or operating room despite not showing a difference in AVN for initial up to 18 hours [2–4]. Type III and type IV fractures may be difficult if not impossible to be reduced closed and often require percutaneous or open approach for reduction.

Surgical Technique

The patient should be placed supine on the operative table. A bolster should be placed underneath the buttock on the affected extremity to prevent excessive external rotation. A pneumatic tourniquet may be placed on the thigh. A ramp or bolster may be used to elevate the operative extremity. Conversely, a triangle may be used for alternative positioning. C-arm fluoroscopy should come in to the surgical field from the opposite side of the table. The authors recommend getting pre-operative fluoroscopic lateral and Canale views of the contralateral side prior to draping for more challenging fracture patterns. In terms of equipment, small stainless steel screws (2.0–3.5 in diameter), small plates accommodating 2.0 and 2.4 screws, along with K-wires are standard implant. The authors have found that small-diameter titanium screws in the particularly dense talar bone are easily stripped or broken. Headless screws – stained or titanium, so long as they have a deep-seated head for a screw driver as well as absorbable K-wires or cut threaded K-wires, may play a role in articular fragment fixation. A headlight, small self-retaining retractors (or handheld retractors), and dental picks are often helpful.

A dual-incision approach is the current standard for open reduction internal fixation of displaced talus fractures. Even minimally displaced fractures on X-ray can be deceiving in terms of rotation and shortening. The visualization afforded from a dual-incision approach ensures accuracy of fracture reduction. There is no evidence to suggest an increased risk of osteonecrosis with a dual-incision approach [3, 4]. The anteromedial approach allows exposure of the medial talar head, the neck, and the anteromedial one third of the body (Fig. 4.2). The superficial landmarks include the medial malleolus, tibialis

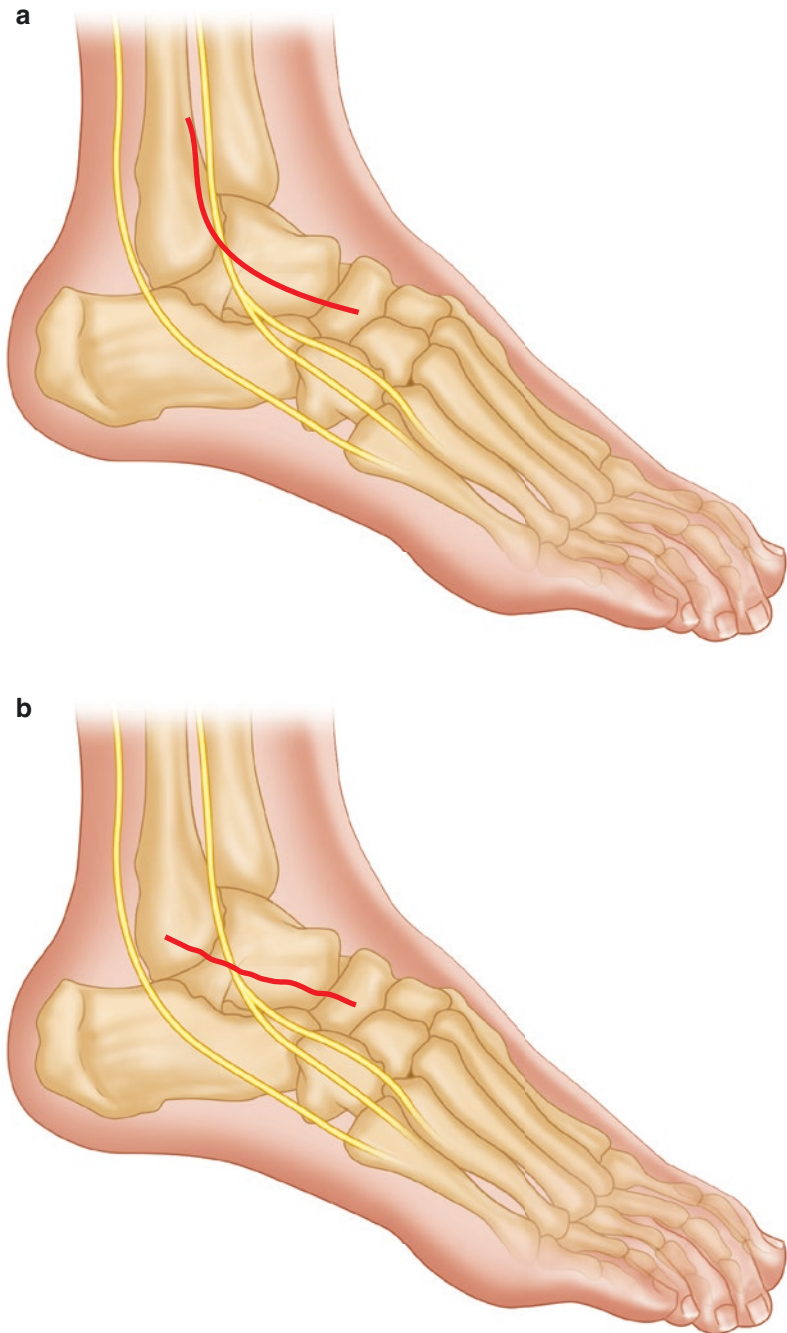**Fig. 4.2** The antero-
medial approach to the
talar neck
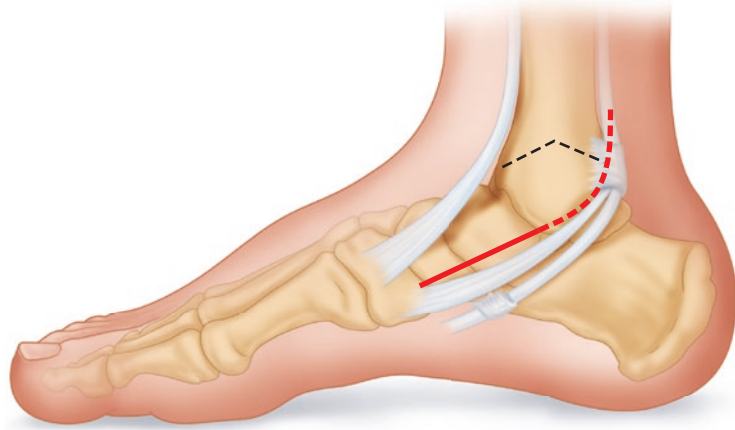
anterior, and tibialis posterior. Skin incision is made starting from the anterior edge of the medial malleolus and continued distally to the medial cuneiform. It should be placed midway between the tibialis anterior and posterior. The saphenous vein and nerve will be encountered in the proximal portion of the incision. Extensive dissection dorsal and plantar should be avoided to preserve the remaining blood supply at the neck of the talus. Proximal extension through the deltoid ligament should be avoided at all costs as this may be the only remaining blood supply for the talar body. Periosteal elevation on the talar neck should be kept to a minimum for fracture reduction. When dorsal and medial comminution is present, care should be taken to preserve the dorsal soft tissue attachments to the comminuted fragments while attempting to correct the medial shortening and varus malpositioning.

The anterolateral approach allows exposure of the lateral process, anterolateral neck, and half of the body (Fig. 4.3a, b). The superficial landmarks are the fourth metatarsal, the fibular, and antero-lateral tibia. Skin incision is made between the tibia and fibula and extending distally in line with the fourth ray to the base of the fourth metatarsal, this essentially being the distal extension of the anterolateral pilon approach. A modification can be made where the proximal extent of the inci-sion aims toward the ATFL insertion on the distal fibula and can be thought of as a dorsal sinus tarsi

approach. This allows better exposure of the lat-eral talar process in addition to the lateral talar neck. Care should be taken to maintain an ade-quate skin bridge between the anteromedial and anterolateral incisions. The skin flap should not be undermined to protect the dorsalis pedis and surrounding vasculature. The superficial peroneal nerve will be encountered and should be pro-tected. The anterior compartment can be elevated and retracted medially. The extensor digitorum brevis is elevated and retracted distally and later-ally. The anterior capsule can be elevated off of the distal tibia, and the sinus tarsi fat pad can be removed for more exposure of the talar neck and lateral process.

A medial malleolar osteotomy is utilized when fracture extends into the posterior body or if there is a talar body dislocation that is not able to be reduced. The deltoid ligament should be intact to allow adequate blood supply to the medial malleolus and talus for healing. Disruption of the deltoid ligament is a contraindication for osteotomizing the medial malleolus. First, the anteromedial incision is extended proximally, and the capsule is elevated off of the bone to expose the medial malleolus. Drill holes should be made perpendicular to the planned osteotomy to allow for screw fixation. The osteotomy is then made with an oscillating saw or drill holes and thin osteotomes. An apex-proximal chevron oste-otomy can be used to help with subsequent

fixation. The trajectory is started proximally and aimed distally in an oblique path to exit the medial colliculus. The posterior tibial tendon and neurovascular bundle should be protected posteriorly. The osteotomy should be finished with an osteotome at the level of the cartilage. The medial malleolus can be flipped distally to expose the talar body. Repair of the osteotomy involves reduction of the medial malleolus and placing small-fragment screws into the predrilled holes fixation with adjunctive small or mini-fragment plating where appropriate.

Once the fracture is exposed, reduction can then be achieved under direct visualization of both the medial and lateral sides. Typically, the fracture can be keyed in on the side with less comminution – typically the lateral side which fails in tension. Once the lateral side is reduced, bone reduction forceps and small K-wires may be used to provisionally stabilize the reduction. The medial side should be examined to appreciate any translational and rotational malreduction, and, if necessary, the reduction should be adjusted to ensure anatomic reduction of the fracture. Medial-sided reduction, in the face of comminution, can be challenging. Often, a series of plantar reads and clues from the articular cartilage to judge rotation are employed. However, these fragments may not be amenable to fixation. In the case of severe comminution, the authors have utilized structural allograft or autograft to maintain medial length and prevent varus malreduction or late varus collapse. Provisional fixation with bone reduction forceps and K-wires can then be used to stabilize the medial side. For simple talar neck fractures, one or two 3.5-mm fully threaded screws may be placed using the anteromedial approach. They are countersunk into the talar head, placed across the fracture into the talar body in the sagittal plane. Care must be taken not to compress the medial side when medial comminution is present to avoid varus malreduction. This is usually only reserved for non-displaced fractures.

Some studies have suggested that screws placed posterior to anterior (PA) have biomechanical advantages over screws placed anterior to posterior (AP). PA screws can be placed down the axis of the talus to provide uniform compression, whereas AP screws are placed eccentrically from the anteromedial side. Whereas AP screws violate the chondral surface of the talonavicular joint, PA screws violate the chondral surface of the posterior talar body. These PA screws are placed using a percutaneous posterolateral approach, placing the sural nerve and flexor hallucis longus (FHL)

tendon at risk. The rate of transient sural nerve palsy can be as high as 25% [5]. Additionally, the supine positioning needed to perform the dual-incision approach for anatomic reduction makes placing posterior instrumentation difficult. While some biomechanical studies have demonstrated possible increased stiffness and yield point of PA versus AP screws, clinical outcomes have been shown to be comparable between the two [5–7]. The authors have no experience with this technique.

Headless compression screws are another option, allowing placement of screws through the talar head without need for countersinking. Additionally, the variable pitch of the screws allows for compression across simple fracture patterns. Capelle et al. demonstrated in cadaveric model that cannulated headless compression screws did not have a significant difference in load at failure compared to conventional cannulated screws but trended toward earlier displacement and increased construct stiffness [8]. One thing to consider though is whether or not compression is desirable where the screw is being placed. Again, this relies on a situation with no comminution and no or minimal displacement – an uncommon occurrence.

With increasing comminution and displacement of the fracture, different strategies have been used to augment the fixation construct. Use of mini-fragment plates have been shown to be a stiffer construct than screw fixation alone [9]. These plates may be placed onto the side with greater comminution to buttress the fracture or conversely onto the opposite side to maintain length, rotation, and alignment [10]. Sagittally oriented screws may also be used in addition to further stabilize the fracture. The most common construct utilizes a four-hole mini-fragment plate laterally contoured to fit in the axilla of the talar neck. The distal extent of the plate can come up to the articular margin of the talar head. It is critical that the proximal extent of the plate does not impinge on the tibio-talar-fibular articulation in dorsiflexion. As the foot is often plantarflexed during fixation, this needs to be

assessed. Independent fragment screws or wires can be used outside the plate, but constructs which cross the fracture line prior to application of compression should be discouraged. As the obliquity of the screws in reference to the typical fracture line will not itself create compression, compression must be externally applied through clamps and held as hardware is placed laterally. Care must be taken during insertion, as these are unicortical screws.

Medially, when comminution exists, fixation acts as a medial strut to preserve length and prevent shortening. Due to the broad footprint of the medial malleolar articulation with the talus, there is very little room for plate placement. Typically, screws place on the margin of the talar head or through the cartilage of the talar head are used. Abduction of the forefoot and navicular can provide this exposure. Again, care should be taken as to the screws trajectory to keep it unicortical. Lateral and dorsal articular perforation must be avoided. Several screws can be placed from the medial side if needed, but with limited exception due to the broad articulation between the talus and medial malleolus, the medial talus cannot take a plate.

Maceroli et al. examined the results of medial screw fixation augmented with a lateral mini-fragment construct in 26 patients. They found an 11.5% nonunion rate attributed to open Hawkins type IV fractures. AVN was seen in 27% based on radiographic follow-up. Post-traumatic arthritis developed in 38% of patients, four of which required subsequent arthrodesis [11].

Once fixation has been placed, screw lengths have been verified, and fluoroscopy has been taken to ensure no evidence of malreduction, the tibiotalar articulation is aggressively ranged to ensure fracture stability. Any motion in the fracture site is risky, given the fixation only consists of small sized hardware. Risk of fixation failure needs to be minimized as development of a persistent talar nonunion is catastrophic.

In the event of fixation failure, some "bailout" options do exist but should not be regularly employed. Fibular osteotomy be utilized to expose the posterolateral talus when needed. The anterolateral approach is extended proximally, and care is used to protect the superficial peroneal nerve. The anterior distal tibiofibular ligaments are incised, and the osteotomy is started three centimeters above the articular surface in a transverse or oblique fashion. The osteotomy is made with an oscillating saw, taking care to protect the peroneal tendons posteriorly. The lateral malleolus is then retracted posteriorly. The osteotomy can be fixed with standard small-fragment plates and screws and repair of the incised anterior distal tibiofibular ligaments. As the posterolateral talus is not an area of considerable articulation, particularly on the plantar surface, fixation can be extended with the understanding that hardware removal may have to occur. A small chamfer can be cut in the lateral wall of the talus to recess the plate. This technique is demonstrated in the case studies. A similar technique can be employed medially with a medial malleolar osteotomy if needed, though this osteotomy is usually more common to address articular fractures if the body.

When talus fractures are associated with injuries of the surrounding bones, modifications to the dual-incision approach are made to gain access to each fractured bone. When the tibial plafond requires fixation, the anteromedial and anterolateral incisions may be extended proximally. The sustentaculum tali may be injured and may need independent fixation. If this is encountered, the posterior tibial tendon, flexor digitorum longus, and flexor hallucis longus tendon should be inspected and addressed if injured. If a fleck sign is seen arising from the lateral malleolus, the peroneal tendons should be inspected for injury and addressed. In rare cases where the calcaneus and talus are both fractured, the lateral approach to the calcaneus can be modified into an "S-shaped" curve to incorporate the sinus tarsi and ending in the anterolateral approach (Fig. 4.4).

Fig. 4.4 Anterolateral approach modified into an "S-shaped" curve to address calcaneal and talar fractures
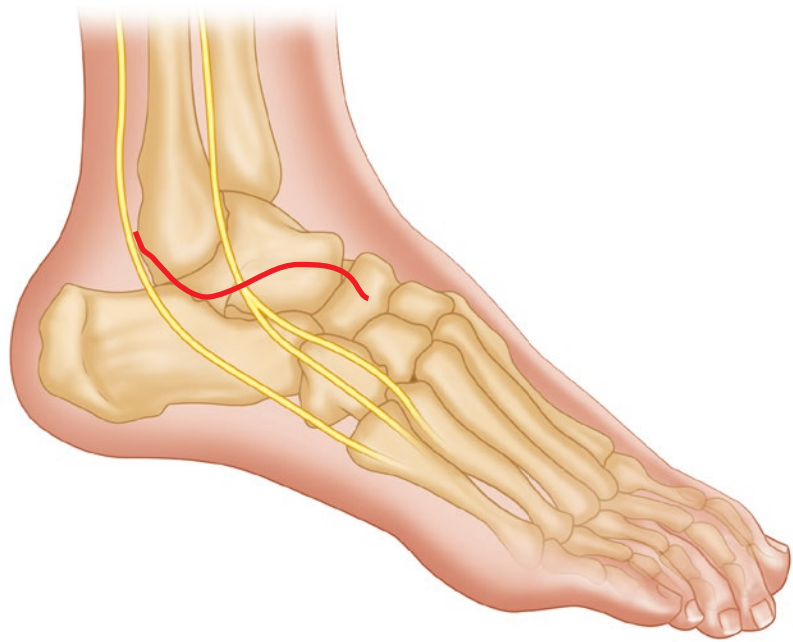
Postoperative Course

Immobilization of the foot and ankle is achieved with a well-padded splint. Patients are made non-weight-bearing for 10 to 12 weeks. After the wounds are healed, at approximately the 2-week mark, range of motion can be initiated, and sutures can be removed based on stability of the wound. At the 6–8-week mark, X-rays are taken to evaluate maintenance of reduction, healing, and signs of AVN. The "Hawkins sign," a subchondral lucency in the talar body, may be seen during this time period and is a positive predictor of talar revascularization. When this sign is present, the risk of AVN is low. However, absence of the "Hawkins sign" does not predict development of AVN. CT scans may be useful to evaluate progress of union when X-rays are indeterminate. The use of MRI is controversial but may be reserved to assess union or development of AVN if reoperation is needed.

Outcomes

Functional outcomes of patients with talar neck fractures vary widely throughout the literature, and there is no standardized modality to assess long-term outcomes. In many studies, the Hawkins clinical evaluation for functional outcome is used to assess pain, limp, ankle motion, and subtalar motion. These studies showed that up to 20% of patients with talar neck fractures had an "excellent" outcome, 35% had a "good" outcome, 22% had a "fair" outcome, and 22% had a "poor" outcome [12]. In these studies, patients with a lower fracture grade in the Hawkins classification tended to have more "excellent" outcomes, and patient with higher grade fractures tended to have more "poor" outcomes. Other studies make use of the Foot Function Index (FFI), Short Form-36 (SF-36), and American Orthopaedic Foot and Ankle Society (AOFAS) Hindfoot Scoring Systems. Vallier et al. showed FFI scores of 25.3 for pain

and 34.4 for disability for their patient cohort [2]. Vints et al. reported SF-36 scores of 42.71 for Physical Component Summary and 48.29 for Mental Component Summary [13]. In their study, Annappa et al. reported average AOFAS scores of 79.5 in type II fractures, 69.3 in type III fractures, and 57.5 in type IV fractures [14].

Development of post-traumatic arthrosis is a difficult problem to treat. The incidence of subtalar arthritis varies widely in the literature (4% to 100% with an average of 49%) [15, 16]. This can be a result of chondral damage during the initial traumatic insult or nonanatomic reduction of the talus. Allowing for early range of motion while maintaining non-weight-bearing precautions may decrease postoperative stiffness of the subtalar joint but does not predict the onset of arthrosis. Even the presence of a well-reduced talus does not preclude the development of arthrosis. While subtalar joint stiffness or arthritis can be asymptomatic, it will often lead to a stiff foot that, if stiff in a varus or hyper values posture, may change the biomechanics weight-bearing. For patients who remain symptomatic despite conservative management, arthrodesis is an effective operation for pain relief and foot shape correction.

Avascular necrosis is another common sequela of talar neck fractures. It is primarily a consequence of blood supply disruption during the initial trauma and possibly from the subsequent surgery. The incidence is approximately 25–30% for all fracture types, with newer studies published after the year 2000 showing lower AVN rates especially in Hawkins type II and III fractures [15–17]. Focal AVN without subchondral collapse frequently occurs without major sequelae. In these cases, the cartilage survives and the bone can be replaced over time with creeping substitution. In the cases with collapse of the talar dome, arthrodesis is the main option.

Improper reduction or inadequate fixation of talar neck fractures can lead to malunion or nonunion. Malunion can occur with small amounts of displacement and has been seen in up to 20–37%

of cases [17]. Nonunion is more uncommon and can be as high as 4–5% [16]. The common malreductions include leaving the talus shortened and in varus. This leads to medial column shortening in the foot and significantly changes the biomechanics of the peritalar joints. If the talar body is left in plantarflexion, the talar neck will dorsally prominent and can impinge on the anterior tibial plafond. If discovered relatively early, revision open reduction and repeat fixation may be appropriate to correct the issue. An osteotomy may be necessary to regain anatomic reduction. If left untreated, peritalar arthritis will develop. This necessitates salvage arthrodesis to correct the foot deformity and alleviate pain.

Wound and soft tissue complications arise typically due to the high energy nature of talar neck fractures. When using the dual-incision approach, care must be used when handling the soft tissue envelope. In patients with excessive swelling, a staged approach to surgery is reasonable to allow for the swelling to resolve. However, any patients with peritalar displacement, skin tenting, or neurovascular compromise should be immediately reduced. With open fractures accounting for 20–38% of all fractures, wound management is critical to treatment success. Deep infections have been shown to develop in as high as 21% of cases [17]. Management of infections requires serial irrigation and debridement with appropriate antibiotic coverage. Removal of hardware may be required in the process of treating a deep infection.

Subsequent case examples illustrate some common techniques and pitfalls of talar fixation.

Case and Complication Examples

Case 1: A 53-year-old female, status post motor vehicle accident presents to the emergency room as a transfer from an outside hospital after stabilization in an external fixator. Her past medical history includes alcohol abuse and smoking (Figs. 4.5, 4.6, and 4.7).
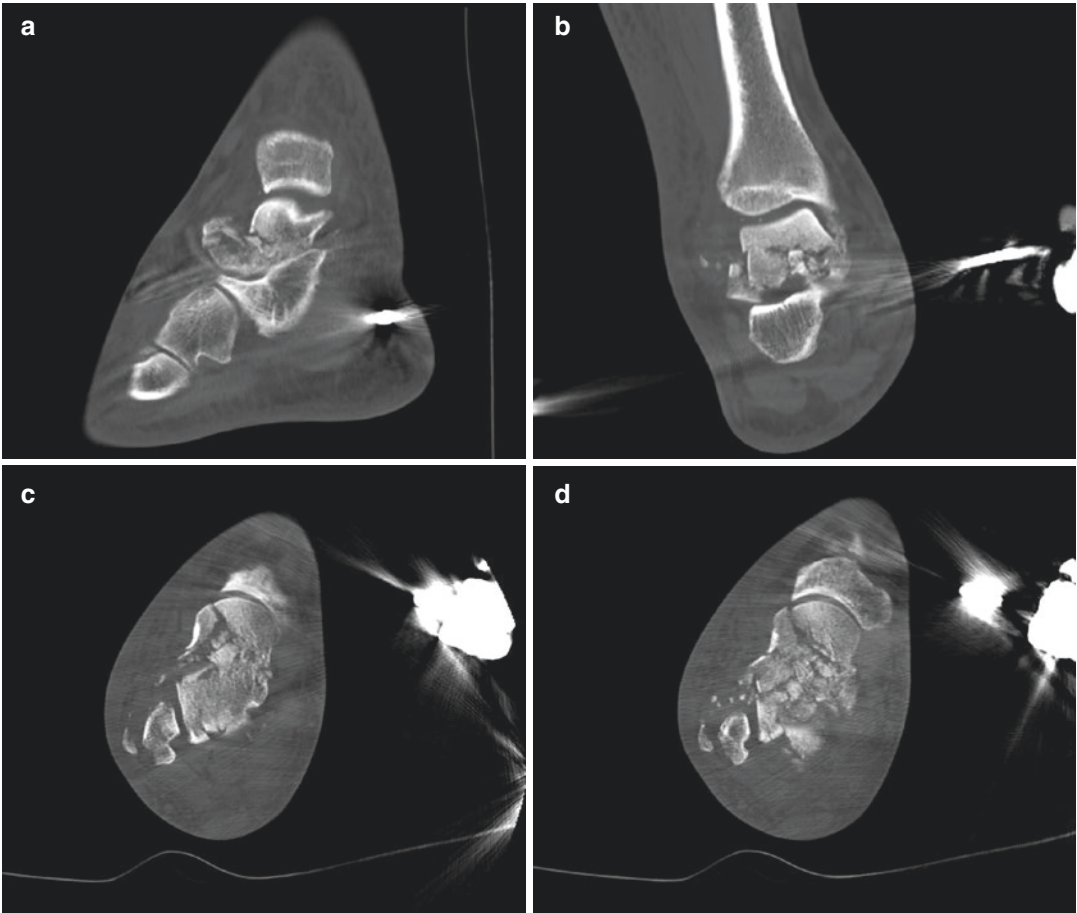
Fig. 4.5 (**a–d**) Preoperative CT scans demonstrating marked dorsal and medial comminution with considerable involvement of the subtler surface best appreciated on coronal cut
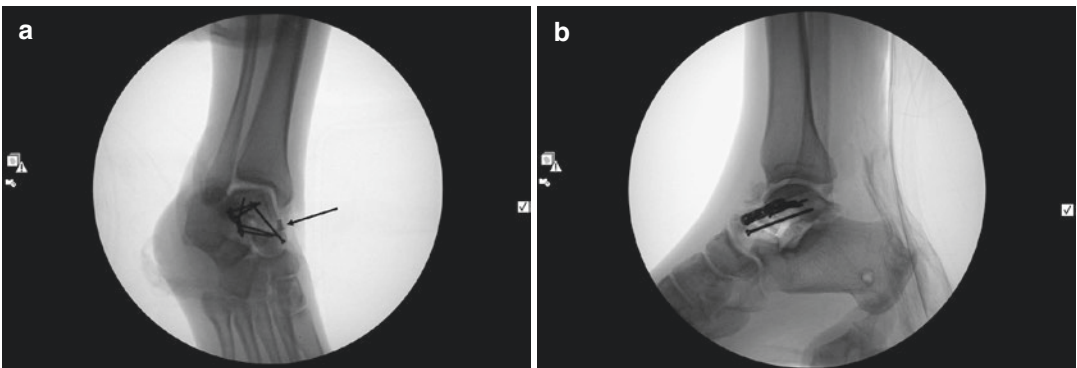

Fig. 4.6 (**a**, **b**) Intraoperative fluoroscopy pictures demonstrating a typical fixation strategy of contoured lateral plate and medial position screw to prevent varus malreduction. Note the inclusion of structural iliac crest bone graft (ICBG) medially to prevent shortening and to fill fracture gap (arrow) with backfilled grafting. The Canale view shows good alignment of the fracture. The lateral view shows considerable subtler articular incongruity
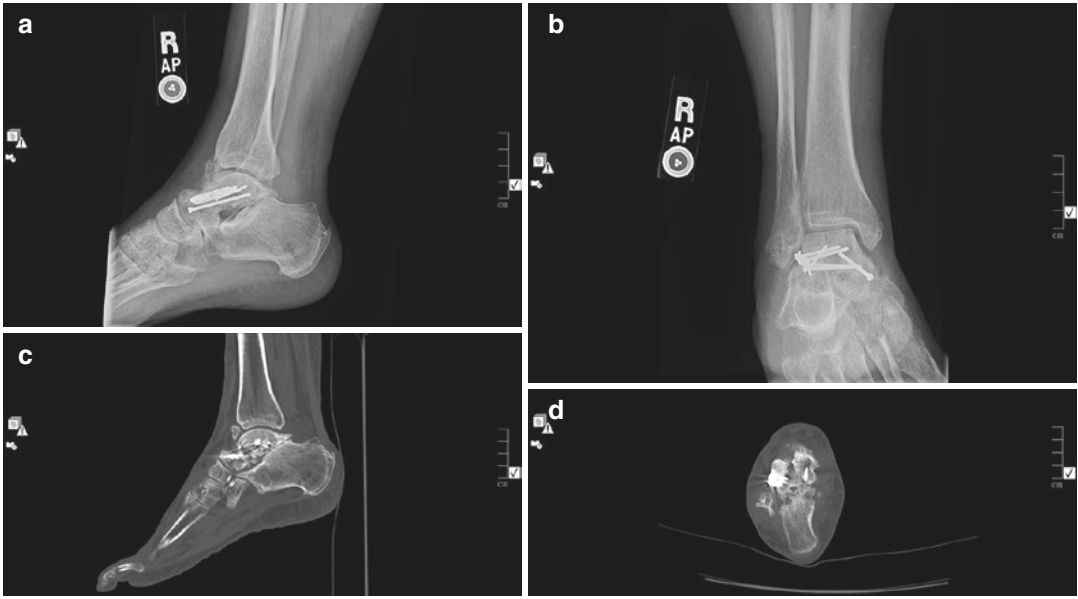
Fig. 4.7 (**a**–**d**) Postoperative films at 18 months with CT confirmation demonstrating integration of ICBG structural graft (best seen on axial CT), union, maintenance of talar blood supply, and severe post-traumatic subtalar arthritis. Patient continues to have severe pain and will undergo anterior ankle debridement and subtalar fusion. No clinical varus is present
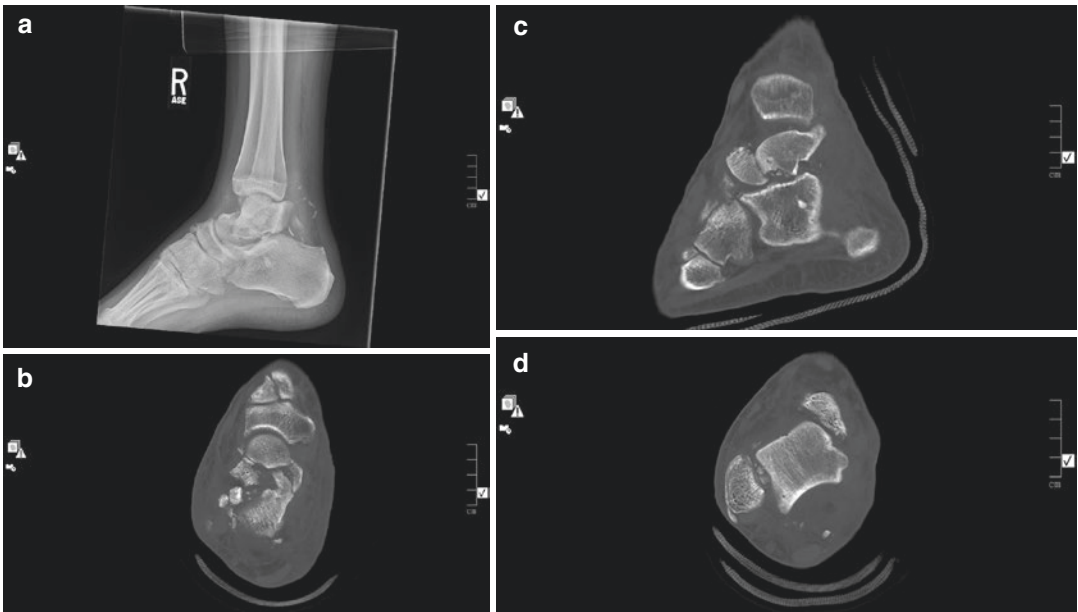

Fig. 4.8 (**a**–**d**) Lateral radiograph, axial and coronal CT images of a displaced talar neck fracture with dislocations of the tibiotalar and subtalar joints

Case 2: A 32-year-old male who is previously healthy, status post motor vehicle accident presents with a severe fracture dislocation of his talus. There is a 90-degree displacement of the talar body with subtalar joint dislocation best noted on axial CT (Figs. 4.8a–d, 4.9, and 4.10). Note that these axial images appear as coronal cuts of the talar body. This fracture pattern has a high likelihood of AVN.
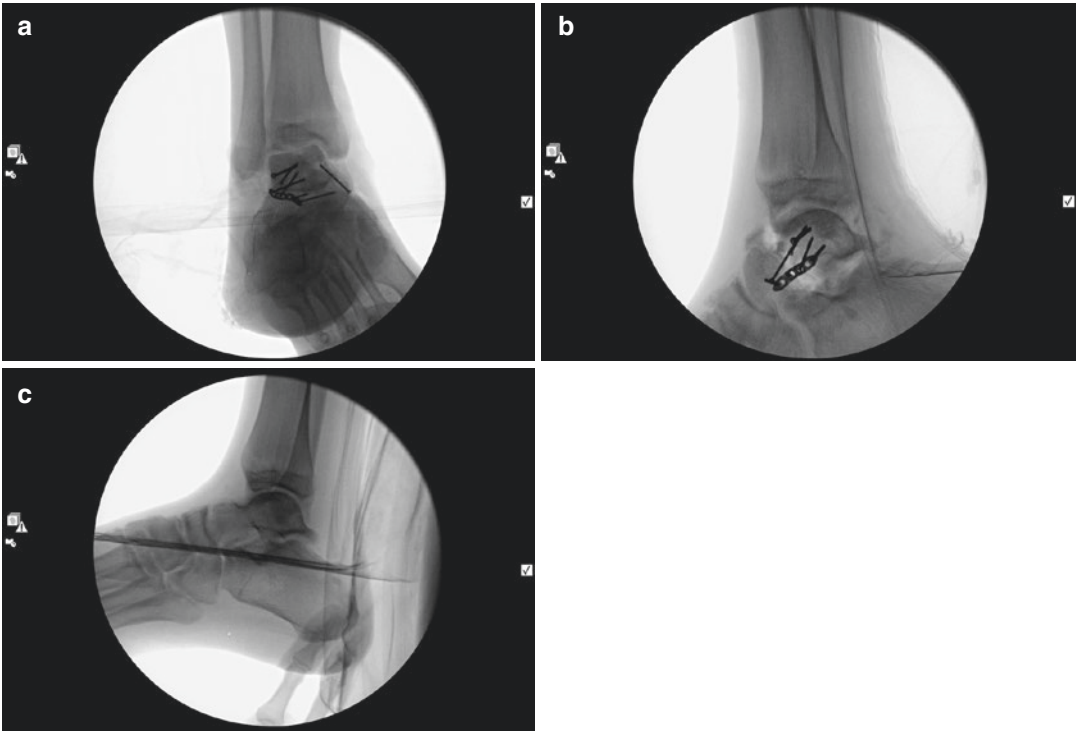
Fig. 4.9 (**a–c**) Intraoperative fluoroscopy shows that despite the use of a structural graft measuring 1.5 cm in length, there is still marked shortening of the talar neck. The decision was made to accept the shortening given that structural integrity was present instead of creating a large gap. Contralateral fluoroscopy views are included for comparison
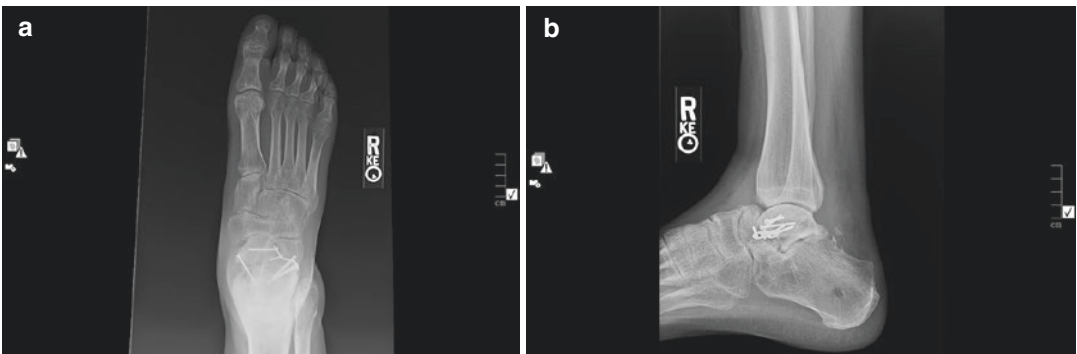

Fig. 4.10 (**a, b**) Final X-rays on follow-up demonstrate union with marked shortening of the talar neck at 3 years. The patient, however, is surprisingly ambulating without pain and only has mild residual stiffness. There is no marked deformity of the foot or subsequent collapse of the talar dome, but the decreased joint space is suggestive of AVN

Case 3: A 43-year-old female who is previously healthy, status post poly-trauma in a motor vehicle accident is transferred from an outside hospital following numerous surgeries (Figs. 4.11, 4.12, and 4.13).

Case 4: A 22-year-old female, status post motor vehicle accident with a right talar neck fracture and a left lateral talar process fracture (Figs. 4.14, 4.15, and 4.16).

Fig. 4.11 (**a–d**) X-ray and CT scans from the outside hospital show severe comminution and displacement of the talus. A common independent shoulder piece is best seen on axial views, and numerous independent subtalar pieces are seen on sagittal views. These findings are hallmarks of high-energy injuries that involve both columns of the talus
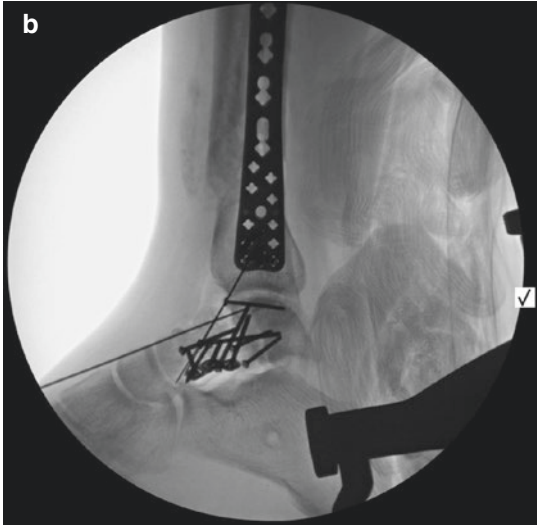
Fig. 4.12 (**a–e**) Intraoperative fluoroscopy shows the process of fixation. Initial attempts at fixation utilized structural allograft in an attempt to restore anatomy. Intraoperative testing revealed gross motion at the fracture due to marked comminution and proximal extent of bone loss under the articular surface of the talar body. Subsequent fibular osteotomy was required to extend the fixation proximally within the articular zone of the talofibular joint to achieve stability. Mild dorsiflexion in the fracture reduction was accepted due to extremely limited bone stock and multiple attempts at stabilization. Revision open reduction internal fixation of tibia was also performed at that time
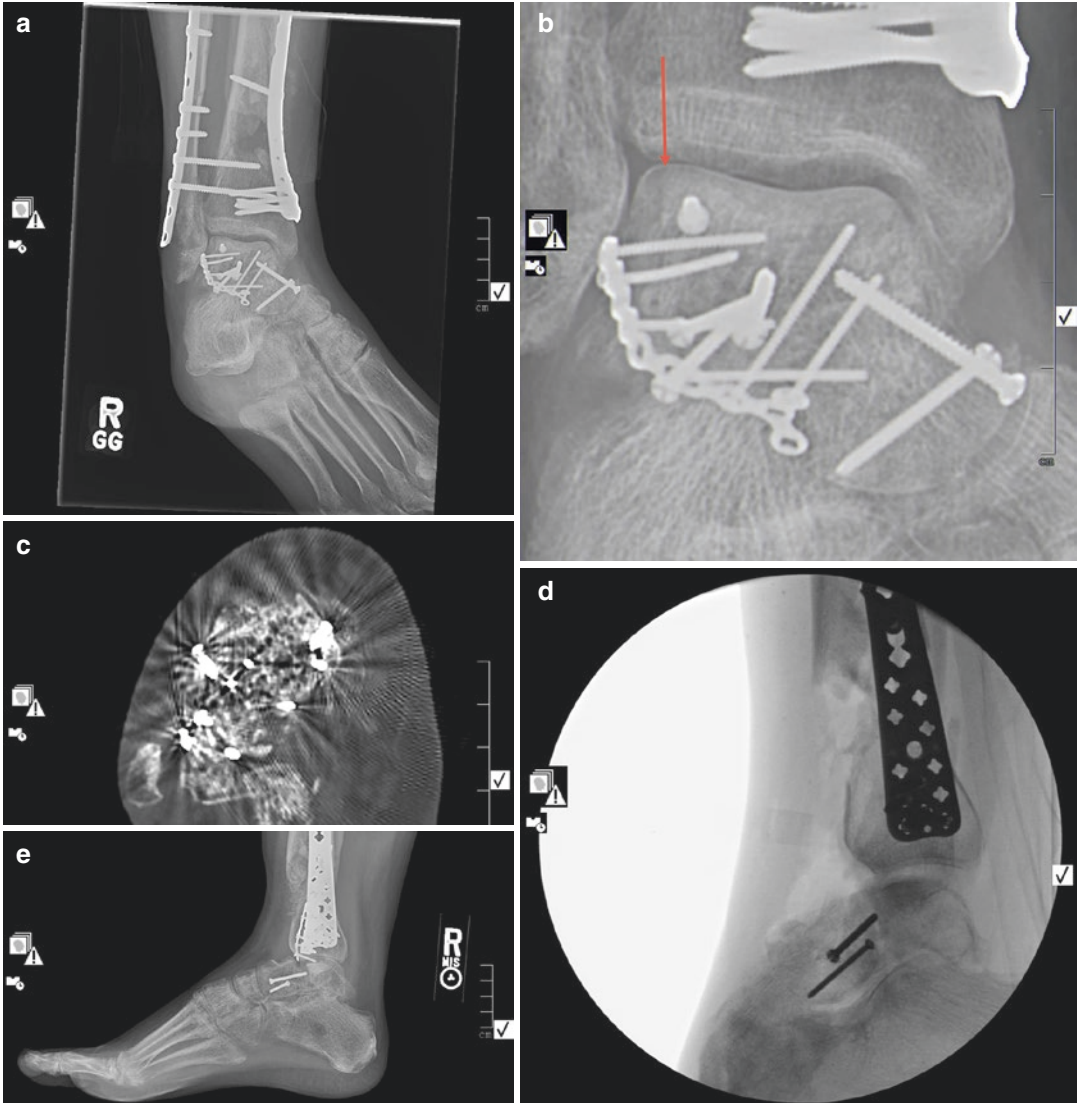

Fig. 4.13 (**a–e**) Postoperative follow up at 3 months demonstrates the "Hawkins sign," suggesting revascularization of the talar body. CT scan at 4 months was taken but was difficult to assess union due to hardware scatter. Patient developed mild clinical varus and pain with 2 months weight-bearing. At 6 months, the decision was made to undergo removal of hardware and inspection of union. Partial union with fibrous tissue was encountered and grafted at that time, along with grafting of tibia and removal of lateral talar hardware. Weight-bearing was then reinitiated at 9 months and closely followed with serial radiographs. At the 13th-month follow-up, X-rays showed mild dorsal subluxation and mild varus consistent with postoperative fluoroscopy. Patient is currently ambulating with minimal pain and has reasonable function. He has been able to return to work at a desk job
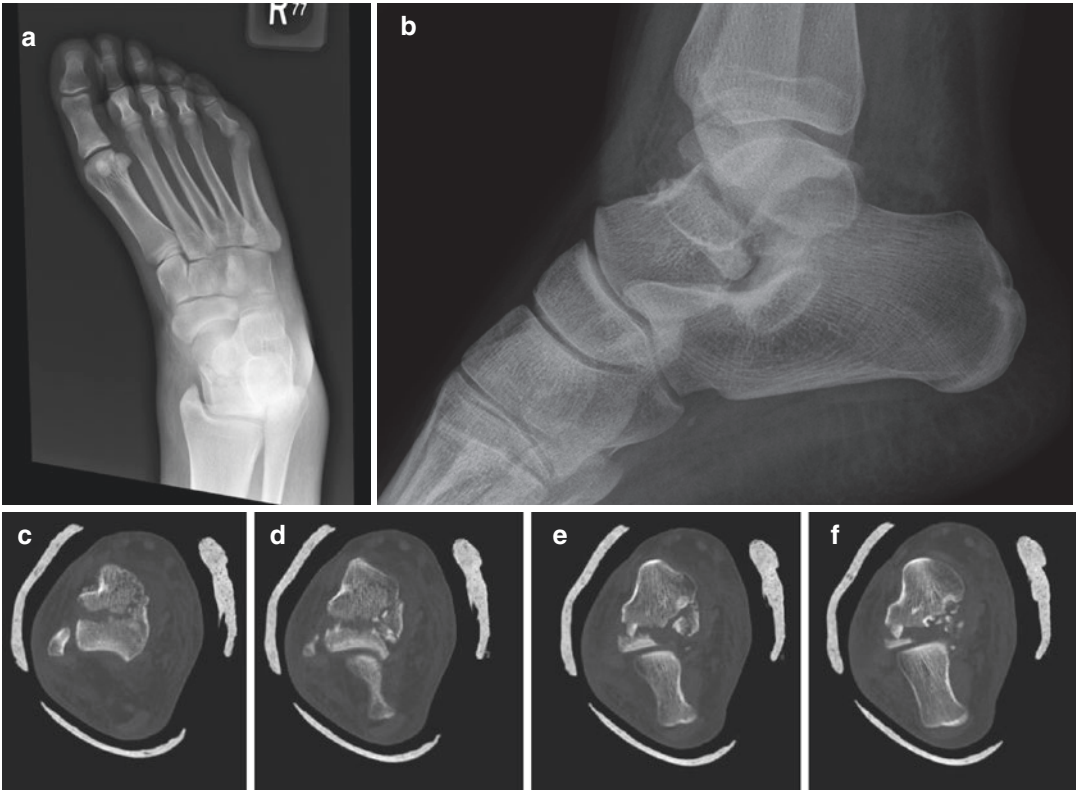
Fig. 4.14 (**a**–**f**) Radiographs and CT demonstrate a displaced talar neck fracture with comminution present at the neck medially and inferiorly, which extends into the subtalar joint. Laterally, the fracture involves the body and is more simple in nature

Fig. 4.15 (**a–d**) Intraoperative fluoroscopy notes the use of instruments and provisional fixation through the two standard approaches. A modified clamp is in place medially (dorsal to the area of comminution). This clamp is being counteracted by a lag screw which has been inserted laterally as the first item of definitive fixation. This screw will resist any tendencies toward varus during the remainder of the ORIF. The definitive fixation construct consists of two mini-fragment lag screws laterally through a plate that acts as a washer, and two positional fully threaded 3.5 cannulated screws inserted through the talar head. These two screws serve two purposes; they strut the area of inferomedial comminution, while they maintain the compression of the dorsomedial neck that was obtained via the modified clamp

Fig. 4.16 (**a**–**d**) In postoperative follow-up at 6 months, the patient was ambulating without an assistive device and was not reporting pain. She noted difficulty with travers-ing uneven ground. Her imaging demonstrated union in appropriate alignment without evidence of avascular necrosis. Her subtalar joint had narrowed

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