# Talus Fractures: Surgical Principles

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**KEYWORDS**

• Talus • Fracture • Open reduction • Foot • Ankle

Surgical treatment of talus fractures is challenging for even the most skilled foot and ankle surgeons. Complicated fracture patterns combined with joint dislocation of variable degrees requires accurate assessment, sound understanding of principles of fracture care, and broad command of internal fixation techniques needed for successful surgical care. Elimination of unnecessary soft tissue dissection, a low threshold for surgical reduction, and liberal use of malleolar osteotomy to expose body fractures and detailed attention to fracture reduction and joint alignment are critical to the success of surgical reconstruction.

Descriptions of talus fractures are well documented[1–8] with little remaining to be said with regard to fracture pattern and classification schemes. Complications, such as infection, malunion, posttraumatic arthritis, osteonecrosis, and talar collapse, have been well documented and shown to be frequent complications of talus fractures.[7–12]

The vascular supply to the talus is robust receiving branches from all the vessels that supply distal runoff to the foot. Several studies have documented the extensive extraosseous and intraosseous blood supply to the talus.[13–17] Despite the rich circulation to the talus the vessels are easily compromised with injury of the talus by fracture and joint dislocation. Restoration of the extraosseous blood supply can only occur with accurate restoration of joint alignment. Restoring the intraosseous anastomoses, which are necessary for fracture healing and revascularization of the talar body, relies on anatomic fracture reduction and rigid internal fixation.

The most clinically significant complication after talar neck fracture is avascular necrosis (AVN) with collapse of the talar body. The incidence of radiographic AVN after talar neck fractures has been previously well documented.[7,8,18,19] More recently, MRI studies have shown the incidence of AVN to be higher with more accurate diagnostic imaging.[18,19] Thordarson and colleagues[18] were able to demonstrate radiographic evidence of AVN did not correlate with MRI findings except in cases in which greater than 50% of the talar body had AVN. Talar collapse, however, did not necessarily correlate with amount of AVN in the talar body. Vallier and colleagues[9] found AVN with collapse in

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31% of displaced talar neck fractures. In addition, there was no correlation between time to surgical reduction and development of AVN. AVN was more common in injures with medial neck comminution and open injuries signifying a higher energy injury pattern.[9]

Surgical care of talar body fractures is appropriately included in the same discussion of talar neck fractures. Fractures of the talar body are even more rare than talar neck fractures and are generally believed to be caused by high-energy axial loading of the tibiotalar joint. Posttraumatic arthritis, AVN, and malunion are common consequences of talar body fractures.[20–25] Vallier and colleagues[11] showed that 50% of body fractures that developed AVN eventually collapsed. By the nature of the injury, body fractures involve more of the articular surface of the tibiotalar joint and subtalar joint. Inokuchi and coworkers[20] suggested a consistent way to differentiate neck and body fractures based on the involvement of the subtalar joint, which may be valid for research purposes but does not have significant influence on surgical decision making. Surgical approaches and exposure of talar body fractures is difficult given the confines of the ankle joint and the medial and lateral malleoli.

Titanium internal fixation which causes less ferromagnetic interference with postreduction magnetic resonance scanning is generally recommended for surgical care (**Fig. 1**).[18] Less image distortion of the talar body allows for accurate assessment of avascular changes in the talar body. To date no studies have shown improved outcomes with titanium with respect to AVN or fracture healing. Often mini or small fragment plates can be used in addition to screws with the added disadvantage of soft tissue dissection from the body and neck of the talus.

## SURGICAL TREATMENT OF TALAR NECK FRACTURES

Indications for open reduction and internal fixation should be liberal. The consequence of fracture malunion and subtalar varus will often lead to deformity and stiffness which requires early secondary reconstruction.[10] Grade 1 injuries without displacement should refer only to those fractures which have no displacement of the neck fracture. CT scanning accurately assesses the absence of neck fracture


**Fig. 1.** Postreduction MRI of talus fracture with titanium fixation. There is a distinct signal void over the internal screws but little distortion of the remainder of the talar body. The degree of avascular necrosis can be assessed in the talar body.

displacement. Varus malalignment in the subtalar joint can be evaluated with plain radiographs of the foot demonstrated by a reduction in the talocalcaneal angle and increased coverage of the talar head (**Fig. 2**). Injuries meeting these criteria (ie, no displacement and no varus malalignment of the subtalar joint) are truly nondisplaced and usually require 6 weeks of immobilization for fracture healing. There is some controversy, however, surrounding the minimally displaced neck fracture with subtle varus rotational malalignment of the subtalar joint. In most circumstances the authors believe these injuries should undergo open reduction and internal fixation. Fracture stabilization allows early rehabilitation which minimizes stiffness in the hindfoot. Radiographs taken after casting should assess the talometatarsal axis and the position of the lateral process of the talus to the floor of the sinus tarsi.

Higher grades of injury almost exclusively require open reduction and internal fixation even in cases in which the closed reduction achieved reduction of the fracture. The dislocated talar body often is locked posterior to the subtalar facet in Grade 2 injuries and the posterior malleolus in Grade 3 injuries. Immediate closed reduction should always be attempted in the emergency department. After conscious sedation is administered, the knee is flexed to relax the gastrocnemius muscle. Distal traction and posterior manual pressure is applied to the dislocated talar body in Kagers triangle. A reasonable closed reduction can usually be achieved. Once relocated the ankle is splinted in slight plantarflexion to prevent recurrent posterior dislocation (**Fig. 3**).

Infrequently, the dislocated talar body becomes locked behind the posterior malleolus and closed reduction is unsuccessful. Urgent surgical reduction is necessary for these injuries. A femoral distractor applied to the medial side of ankle with a half pin in the tibia and one in the calcaneus is used to create separation between the calcaneus and posterior malleolus (**Fig. 4**). An additional posterior approach to reduce the

**Fig. 2.** Anteroposterior view of a nondisplaced talar neck fracture with varus hind foot alignment seen with loss of the talometatarsal axis and covering of the talar head. This subtle radiographic finding is suggestive of "varus" or external rotation malalignment of the subtalar joint.

**Fig. 3.** Talar neck fracture after closed reduction and splinting. The ankle is held in slight plantarflexion to keep the talar body from dislocation.

talar body is not necessary. After appropriate distraction is applied a simple medial arthrotomy exposes the joint and dislocated talar body. Reduction of the body into the mortise is easily achieved. Alternatively, a Steinman pin can be placed through the Achilles tendon to aid in the reduction of the talar body.

The ideal surgical approach allows for direct and accurate exposure of the fracture allowing visualization of the anterior ankle joint. In addition, the surgical approach should allow for accurate placement of internal fixation. The authors favor the medial utility approach advocated by Sigvard T. Hansen, MD.[26] The incision is centered over the midline of the medial column and can be extended distally to the first metatarsophalangeal joint and posteriorly to the anterior border of the Achilles tendon for

**Fig. 4.** Femoral distractor placed with one pin in the calcaneal tuberosity and one in the tibia aids in restoring separation between the calcaneus and tibia in an irreducible Grade 3 injury.

exposure of the posterior ankle and talus if necessary (**Fig. 5**). By design the incision is between the inner nervous planes and avoids most important neurovascular structures. Care should be taken to avoid unnecessary dissection of the soft tissue from the talar neck. Often the transverse fracture of the neck is posterior to the ankle capsule and a simple linear arthrotomy allows for visualization across the entire ankle, making reflection of the soft tissue of the talar neck unnecessary. For simple fracture patterns without medial comminution or bone loss a single medial approach is all that is necessary for accurate fracture reduction. A linear arthrotomy of the talonavicular joint and medial capsular reflection allows for exposure of the medial articular surface of the talar head (**Fig. 6**). Screws placed through the medial marginal articular surface are closer to perpendicular to the fracture and are countersunk beneath the articular surface. Occasionally, the navicular tuberosity is enlarged and a detriment to axial screw placement. A trough can be made in the navicular tuberosity with a power burr, which allows for better axial placement of screws. In the absence of medial neck comminution the interdigitation of the fracture with reduction affords excellent stability, and interfragmentary compression is recommended. When comminution of the medial neck is present or there is significant bone loss interfragmentary compression is generally not recommended because shortening of the medial neck occurs and varus malunion results (**Fig. 7**). There are two ways to assess whether proper length and alignment has been restored to the talar neck. The Canale view[8] is a modified oblique view of the foot to assess the length of the medial neck. Additionally, the talometarsal axis is assessed for residual malalignment (**Fig. 8**).

In cases of medial neck comminution with significant bone loss a medially placed plate and supplemental bone grafting in indicated.[27] The authors use distal tibial bone graft, which is harvested from the distal medial tibial crest (**Fig. 9**). This bicortical graft can be hand milled to fill any defect in the medial neck. The graft can then be secured with a medial bridge plate. Chateau and colleagues[27] showed in a small series of 23 comminuted neck fractures medial plating was effective and gave similar short-term results compared with screw fixation. An alternative to medial cortical bone graft and plating is initial reduction and fixation of the lateral side of the neck fracture first. Lateral neck comminution is less common, and with anatomic reduction of the lateral neck fracture with interfragmentary compression the length of the medial neck is restored. Positional screw fixation on the medial side adds stability.

**Fig. 5.** Medial utility approach centered over the medial midline of the medial column and can be extended proximal and distal as necessary.

**Fig. 6.** Medial exposure of talar neck with linear arthrotomy of ankle and talonavicular joint. The fracture can be visualized inside the ankle capsule. The soft tissue is not dissected from the dorsal talar neck. The medial articular surface of the talar head is exposed for placement of fixation.

The anterolateral approach is necessary for fractures in which there is significant comminution of the medial neck with bone loss or fracture fragments involving the lateral talar neck or lateral process, which require open reduction internal fixation or debridement (**Fig. 10**). The anterolateral approach is made lateral and parallel to the extensor digitorum longus. The extensor digitorum brevis muscle belly is divided or

**Fig. 7.** Varus malunion of talar neck fracture resulting from compression of medial neck comminution. Increase talar head coverage and reduction on the talocalcaneal angle suggest varus malunion.


**Fig. 8.** Radiographic assessment of talar neck fracture after open reduction internal fixation. The Canale view and talometatarsal axis are additional indicators of proper reduction.

reflected laterally to allow for accurate and wide visualization of the lateral neck and lateral talonavicular joint. Dissection can be carried laterally over the body and lateral process to reduce lateral process fracture and debride bone debris in the sinus tarsi. Dissection into the sinus tarsi or beneath the talar neck should be avoided to minimize additional disruption of the tenuous blood supply.

Reduction of subtalar joint subluxation is often overlooked after fracture reduction and often leads to varus malalignment and postreduction stiffness. Subtle posterior translation and external rotation malalignment occasionally persists after fracture reduction. The best way to assess this is a lateral projection of the foot with the forefoot loaded. The author recommends using intraoperative radiographs verifying the reduction of the lateral process of the talus reduced to the floor of the sinus tarsi with ankle in dorsiflexion after fracture reduction. If the subtalar joint cannot be anatomically reduced a retrograde Steinman pin can be used to stabilize the subtalar joint while the ligamentous complex heals (**Fig. 11**).

The posterior approach for stabilization of talar neck fractures has been advocated,[28–31] although there are several disadvantages to this technique. Advocates of this technique cite that is a more stable fixation construct.[29] Placement of screws from the posterior aspect of the talus is technically difficult and positioning can be difficult. Additionally, more dissection is needed over the posterior talar body further compromising the tenuous blood supply. Damage to the flexor hallucis longus tendon, posterior ankle joint impingement on the screw heads, placement into the sinus tarsi, or violation of the subtalar joint with seating of the screws are all potential complications of posterior screw placement. In addition, as the screws are placed through the talar neck one must pay close attention to the oblique view of the neck intraoperatively to ensure that the screws do not traverse the sinus tarsi (**Fig. 12**).

## SURGICAL TREATMENT OF TALAR BODY FRACTURES

The most significant obstacle to proper reduction of talar body fracture is adequate exposure. Without adequate exposure of the trochlear surface of the talus, reduction and fixation cannot be accomplished. Sneppen and Buhl[24] described fractures of the body generally with five separate categories: (1) transchondral fractures; (2) osteochondral fractures; (3) body fractures (coronal, sagittal, or horizontal shear fractures); (4) process fractures (posterior and lateral); and (5) crush fractures of the whole body. Isolated process fractures and osteochondral fractures can be treated with a direct surgical exposure and internal fixation or arthroscopic reduction. Complex fractures

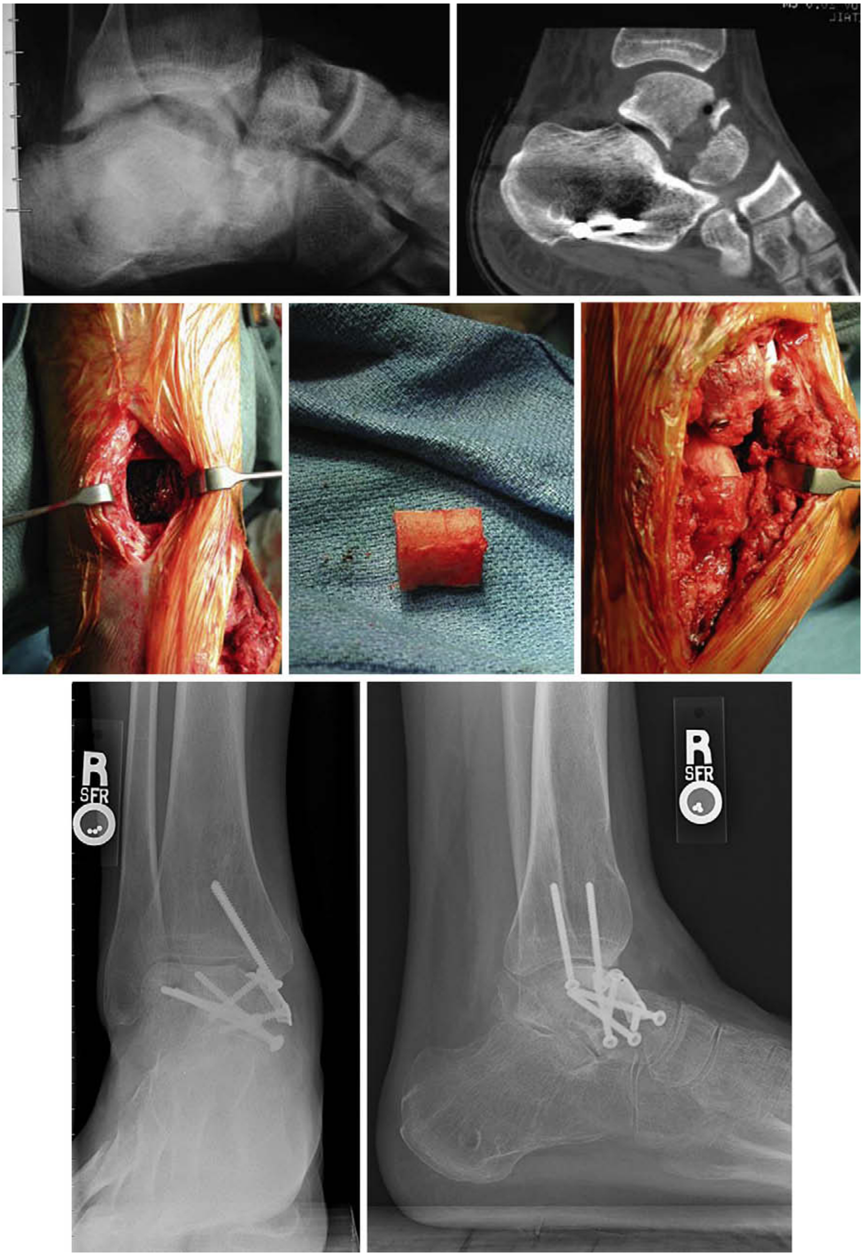


**Fig. 9.** Grade 4 open neck fracture with significant bone loss of the neck. A corticocancellous graft harvested from the distal medial tibia is hand milled to reconstruct the talar neck. The neck fracture is stabilized with positional screws and a two-hole plate. One year follow up after open reduction. Avascular necrosis without collapse developed in this patient.

**Fig. 10.** Anterolateral approach. The incision is made lateral and parallel to the extensor digitorum longus tendon. The inferior extensor retinaculum is divided and the extensor digitorum brevis muscle belly can be split or reflected laterally to allow for accurate and wide visualization of the lateral neck and lateral talonavicular joint.

of the talar body require visualization of the trochlear surface of the talus for anatomic reduction. Direct exposure can be accomplished with medial or lateral malleolar osteotomy. Osteotomy allows for direct exposure of the articular surface and eliminates the need for soft tissue dissection around the ankle joint. A direct transosseous approach is often made possible through an existing medial malleolar fracture.

Medial malleolar osteotomy is the most common osteotomy performed for reduction of complex talar body fractures.[32] The medial malleolus is exposed from a direct medial incision. Careful attention to make the osteotomy enter the ankle joint just lateral to the axilla of the ankle joint ensures the entire trochlear surface of the joint can be visualized. The screw holes for reduction of the malleolus are predrilled to facilitate anatomic reduction of the malleolus after talar reduction (**Fig. 13**). The medial malleolus is reflected inferior to expose the talar body. The area of the talus just above

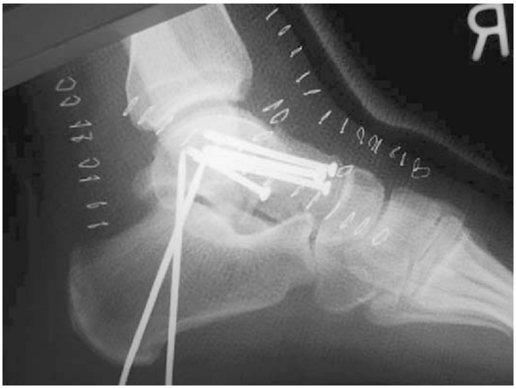

**Fig. 11.** Retrograde pinning of the subtalar joint. The lateral process of the talus is reduced to the floor of the sinus tarsi and pinned ensuring proper reduction of the subtalar joint.

**Fig. 12.** Posterior screw placement. Oblique views of the hindfoot are needed to ensure the placement of the lateral screw does not violate the sinus tarsi, which is a common mistake leading to poor reduction. The land of the screw cannot encroach into the subtalar joint when seating the screw. Notice the prominence of the screw heads with plantarlexion of the ankle joint.

the deep deltoid ligament is often a good area for screw placement in difficult fracture patterns of the talar body. The screws can be placed in a subarticular fashion and buried in the subchondral bone to ensure no impingement with ankle motion occurs.

The fibular door osteotomy[28] described by Hansen is valuable for complex fractures of the lateral body of the talus. The primary indication for fibular osteotomy is a comminuted lateral talar body fracture involving both the lateral plafond and the lateral talar process. Often these fractures are difficult to expose. The fibular osteotomy is made through a straight lateral incision. Intraoperative imaging ensures the transverse osteotomy is made into the syndesmotic recess. A periosteal sleeve, which includes the anterotalofibular ligament and calcaneofibular ligament, is reflected in one soft

**Fig. 13.** Medial malleolar osteotomy. Using fluoroscopic guidance to ensure the osteotomy is made just lateral to the axilla of the tibia ensures visualization of the trochlear surface of the talus.

tissue envelope for later repair. The fibula is then opened like a "door" on the posterior peroneal retinacular and ligamentous "hinge" (**Fig. 14**). The exposure allows for complete visualization of the lateral talus and trochlear surface without excessive soft tissue dissection into the sinus tarsi. Fixation of the fibular osteotomy can be done in a number of ways based on surgeon preference.

Fractures of the talus present significant surgical hurdles for the foot and ankle surgeon. There is no dogmatic way to approach all fractures and surgical algorithms are inadequate to include all variations of the injury. Even with accurate and appropriate surgical care morbidity is common. Sanders and colleagues[33] showed the need for secondary reconstructive surgery in 1 year was 24% and increased to 48% at 10 years. Additionally, varus malalignment led to more pain and lower functional outcome scores when compared with patients in which alignment was evaluated as normal. In contrast, patients who avoided complications, such as AVN and varus malalignment, scored significantly better in functional outcomes. The most common reason for secondary surgery was subtalar arthritis.[33]

With any complex fracture the basic tenets of fracture care apply and talus fractures are no exception. Physical examination, reduction of dislocations, splinting, and medical observation of the patient are the foundation for surgical care. Assessment of the soft tissue envelope should guide the foot and ankle surgeon to the appropriate time for fracture reduction. Each fracture should be assessed individually and often CT scanning is a valuable tool for surgical planning. The surgical plan should include a direct well-planned surgical exposure to the fracture and allow for direct reduction and placement of fixation, avoidance of soft tissue complications by allowing sufficient time for soft tissue edema to subside, eliminating unnecessary soft tissue dissection, anatomic fracture reduction, and joint realignment.

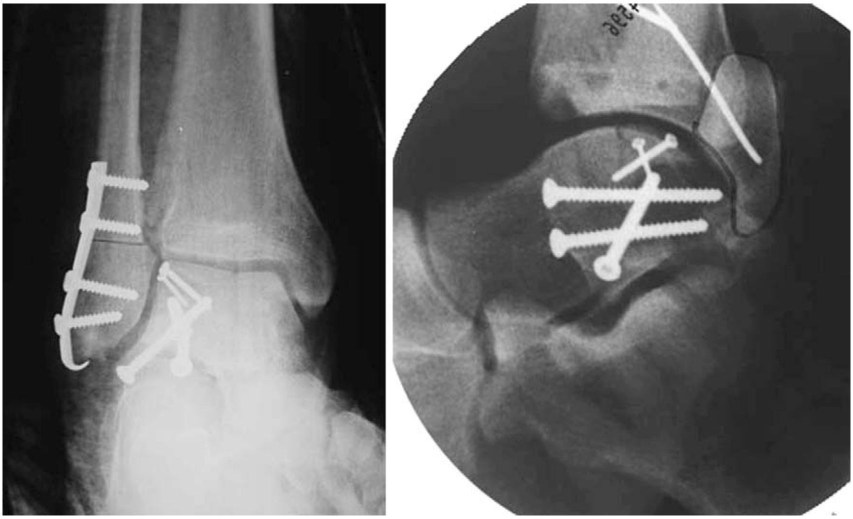

**Fig. 14.** Fibular door osteotomy. Transverse osteotomy made at the level of the syndesmotic recess. The soft tissue and ligamentous attachments are reflected as a single sleeve distally and are easily reattached with suture and drill holes made into the fibula after reduction of the talus and fixation of the osteotomy. The fibula is rotated posterior on the soft tissue hinge.

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