5 Talar Body Fractures

Mai P. Nguyen and Heather A. Vallier

Abbreviations

AO	Arbeitsgemeinschaft fur Osteosynthesesfragen
OTA	Orthopaedic Trauma Association
PTOA	Post-traumatic osteoarthrosis

Introduction

Epidemiology

Talar body fractures are rare, accounting for less than 1% of all fractures [1–3]. They usually occur when axial compression is applied between the tibial plafond and the calcaneus during high-energy events such as falls from height or motor vehicle collisions. Less common than talar neck fractures, talar body fractures may be difficult to differentiate from talar neck fractures, resulting in a wide range of reported prevalence. Talar body fractures account for between 6% and 40% of talus fractures [2–5]. Talar neck fractures are also frequently associated with fractures of the talar body [4]. Due to their rarity, stringent blood supply, and complex anatomy, talar body fractures are not well understood and are often associated with complications and poor long-term function.

M. P. Nguyen
Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, MN, USA

H. A. Vallier (✉)
Department of Orthopaedic Surgery, Case Western Reserve University, Cleveland, OH, USA
e-mail: hvallier@metrohealth.org

Anatomy

Since the majority of the talar surface is covered by cartilage, its blood supply is relatively sparse, leaving the talus susceptible to osteonecrosis after injuries [5, 7–9]. In addition, because of its vital position, injuries to the talus can alter the alignment, disrupting the functions of ankle, hindfoot, and midfoot.

Inokuchi and colleagues defined talar neck fractures as fractures that occur anterior to the lateral process of the talus, whereas talar body fractures extend into or posterior to the lateral process [6]. This distinction is important as body fractures can affect the congruity of both the tibiotalar and subtalar joints. Even after anatomic reduction and fixation of these fractures, the hinge movements of the ankle and rotation through the subtalar joint can be greatly limited, causing considerable stiffness, secondary arthritis of adjacent joints, and resultant disability.

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Evaluation

Physical Examination

Most talar body fractures are caused by high-energy events; thus, a thorough history and physical exam according to the Advanced Trauma Life Support guidelines should be performed first, followed by a focused exam of the injured extremity. The exam should include careful neurovascular and soft tissue evaluations. Soft tissue trauma may be severe with talar body fractures, especially if dislocation is associated. Approximately 20–25% of talar body fractures are open fractures, occurring more frequently with greater initial fracture displacement [2, 4, 10].

Imaging

Plain ankle and foot radiographs should be obtained to characterize the fracture pattern and to identify adjacent injuries. The Canale view with the beam angled approximately 75 degrees cephalad and the foot pronated 15 degrees offers an axial view of the talar neck and is especially helpful when there is an associated talar neck fracture [11]. Computerized tomography scans may be helpful for preoperative evaluation of severely comminuted injuries. Magnetic resonance imaging is rarely indicated in the acute setting.

Classifications

AO/OTA Classification

The AO/OTA classification has designated 81-C for talar body fractures. The fractures are grouped according to increasing severity and worse prognosis [12, 13]. C1 fractures are superior talar dome fractures and involve only the tibiotalar joint. C2 fractures have a coronal fracture through the body of the talus, extending into the subtalar joint. Inokuchi has differentiated the coronal talar body fracture and talar neck fracture based on the inferior extent of the fracture and the lateral process, with talar body fractures extending posteriorly, causing more involvement with the subtalar joint (Fig. 5.1) [6]. The posteriorly displaced half of the body likely has been depleted of its blood supply and has a greater risk for osteonecrosis. C3 fractures carry the worst prognosis with both tibiotalar and subtalar involvement (Fig. 5.2).

Fig. 5.1 Coronal fracture through the talus includes the posterior portion of the talar body, as the fracture is posterior to the subtalar joint, and is associated with a subtalar dislocation, as in this lateral injury radiograph

The AO/OTA classification is the newest and most comprehensive fracture classification for the talar body. The patterns represent injuries seen in clinical practice, and the classification promotes consistency in description, which is useful for communication, research, and publication [13].

Sneppen Classification

Sneppen and colleagues, in their series of 51 talar body fractures, described a classification system based on the mechanism and location of injuries [1]. They include three mechanisms of talar body fractures: compression, shearing, and crush. Within shearing types, they identified coronal and sagittal orientation of the fracture lines.

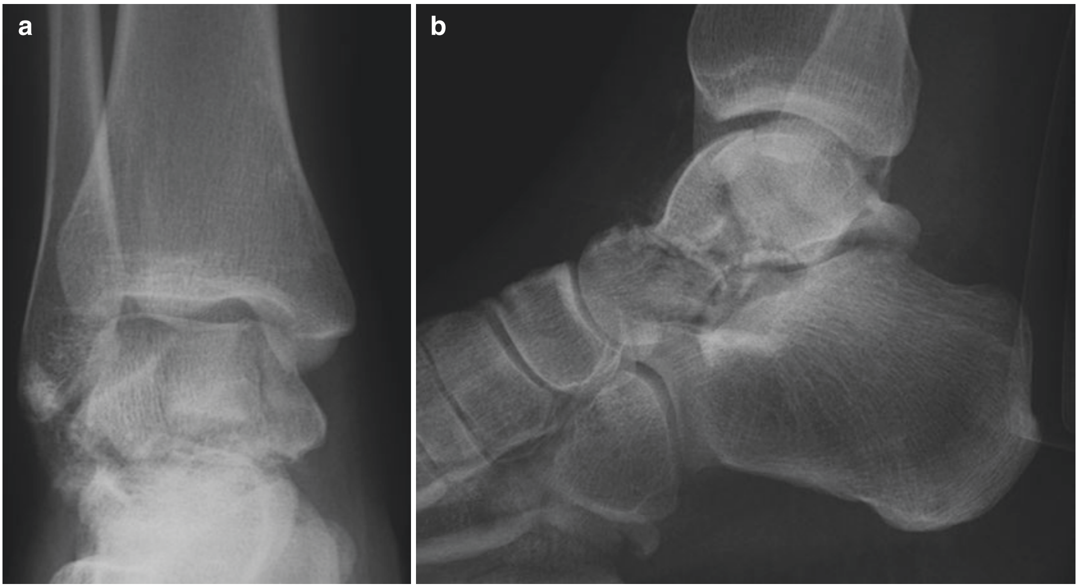

Fig. 5.2 Injury ankle radiographs depict a comminuted talar body and associated talar neck fracture (type C3), seen in the anteroposterior and lateral views

A. Compression fractures exclusively involve the ankle joint.
B. Shearing fractures, coronal type, involve both ankle and subtalar joints.
C. Shearing fractures, sagittal type, involve both ankle and subtalar joints.
D. Posterior tubercle.
E. Lateral tubercle.
F. Crush fractures.

Boyd and Knight Classification

Boyd and Knight classified talar body fractures according to the plane of the fracture line [14]. A type I fracture is a coronal or sagittal shear fracture, while a type II fracture occurs in the horizontal plane.

Treatments

Since the talus has a central role in the functions of the foot and the ankle, reestablishing talar anatomy is essential to optimize function. Treatment goals focus on accurate restoration of the articular surface and osseous mechanical alignment. Optimal treatment of talar body fractures requires a thorough understanding of the anatomy, recognizing the full extent of the bony and soft tissue injuries, and careful handling of soft tissue is paramount to minimizing early complications. With the exception of medically unstable or nonambulatory patients, nonoperative management is typically reserved for non-displaced talar body fractures. Reports of closed management of talar body fractures demonstrate poor long-term results with high rates of osteonecrosis and post-traumatic osteoarthrosis (PTOA), reaching 100% in some series [1, 15–17]. In the vast majority of cases, the standard of care for talar body fractures with any displacement is open reduction and internal fixation to maximize long-term function [2, 4, 10].

Acute Management

Acute treatment of talar fractures necessitates meticulous soft tissue management. Standard treatment of open fractures includes intravenous antibiotics and tetanus prophylaxis, followed by urgent surgical debridement. Associated dislocations can cause tenting of the neurovascular bundle and may present with impending skin necrosis. Thus, urgent reduction in the emergency room or operating room is recommended in order to avoid catastrophic complications.

After provisional reduction, some fractures may be adequately maintained in a short-leg splint or, if needed, additional temporary Kirschner wire fixation or external fixation may be employed for unstable injuries.

Timing of Definite Management

While reduction of dislocations and debridement of open injuries should be performed urgently, timing of definitive surgery should be based on the injury to the surrounding soft tissues, usually from 1 to 3 weeks after the fracture. The extremity should be splinted and elevated to facilitate swelling reduction. Previously, it was believed that urgent fixation would promote revascularization of the talar body and minimize the incidence of osteonecrosis. However, recent reports have demonstrated no association between timing of fixation and development of osteonecrosis [2, 10, 18]. Rather, delaying surgical intervention to optimize the soft tissue envelope has resulted in fewer soft tissue complications than historical reports [2, 4, 10].

Once swelling has subsided and the patient is optimized for surgical intervention, definitive fixation should be performed to restore the anatomy.

Surgical Approaches

Surgical approach is based on the fracture location and pattern. For example, an isolated sagittal fracture in the talar body may be approached through a single incision, anteromedially or anterolaterally, depending on the fracture location. While most talar body fractures can be addressed anteriorly with the patient supine, fractures posterior to the medial malleolus can be accessed through a posteromedial exposure (Fig. 5.3).

Posterior Approach

The posteromedial approach can be performed with the patient positioned supine using a bump underneath the *contralateral* hip, which effectively externally rotates the injured leg to maintain the hindfoot directed toward the surgeon. The surgeon stands on the other side of the table and places a small bump beneath the prepped hindfoot to further optimize visualization and radiography. Intraoperative radiography in this position is performed with the fluoroscopy machine entering on the injured side of the body. The lateral view is most easily obtained, while gentle manipulation of the injured leg, by extending the knee and internally rotating the hip, will facilitate the ankle mortise view without moving the C-arm.

A posteromedial approach may also be performed with the patient in the prone position. Care should be taken to position the injured limb slightly elevated, so that lateral imaging will not be obscured by the contralateral leg.

The incision is made between the posterior edge of the medial malleolus and the medial border of the Achilles tendon. Sharp dissection without undermining of subcutaneous tissue is recommended to minimize iatrogenic trauma. The deep interval can be made either anterior or posterior to the flexor digitorum longus tendon, depending on the fracture location. The adjacent neurovascular bundle should be identified and protected throughout the procedure. The fracture will be visualized once the thick posterior capsule is incised, and screw fixation can be performed in the posterior to anterior direction [4, 20].

Anteromedial Approach

The anteromedial approach utilizes the interval between the tibialis anterior and tibialis posterior tendons with the incision extending from the anterior aspect of the medial malleolus toward the navicular [20]. Once the talonavicular joint capsule is incised, the medial aspect of the talar neck is exposed. Care should be taken to avoid inferior dissection so as not to disrupt talar blood supply. The anterior and medial articular surfaces of the talar body are readily visualized, and the middle facet of the subtalar joint is also visible. Further visualization of the posterior aspect of the medial aspect of the talar body can be obtained through a reflected medial malleolar

Fig. 5.3 Injury radiographs show a comminuted fracture dislocation of the posteromedial talar body (**a**, **b**), with a lateral view demonstrating improved alignment after closed reduction (**c**). Computerized tomography provides details regarding the fracture pattern (**d**, **e**). After resolution of soft tissue swelling to an acceptable level, open reduction and internal fixation were performed through a medial malleolar osteotomy (**f**, **g**). The associated talonavicular dislocation was reduced and temporarily stabilized with a Kirschner wire

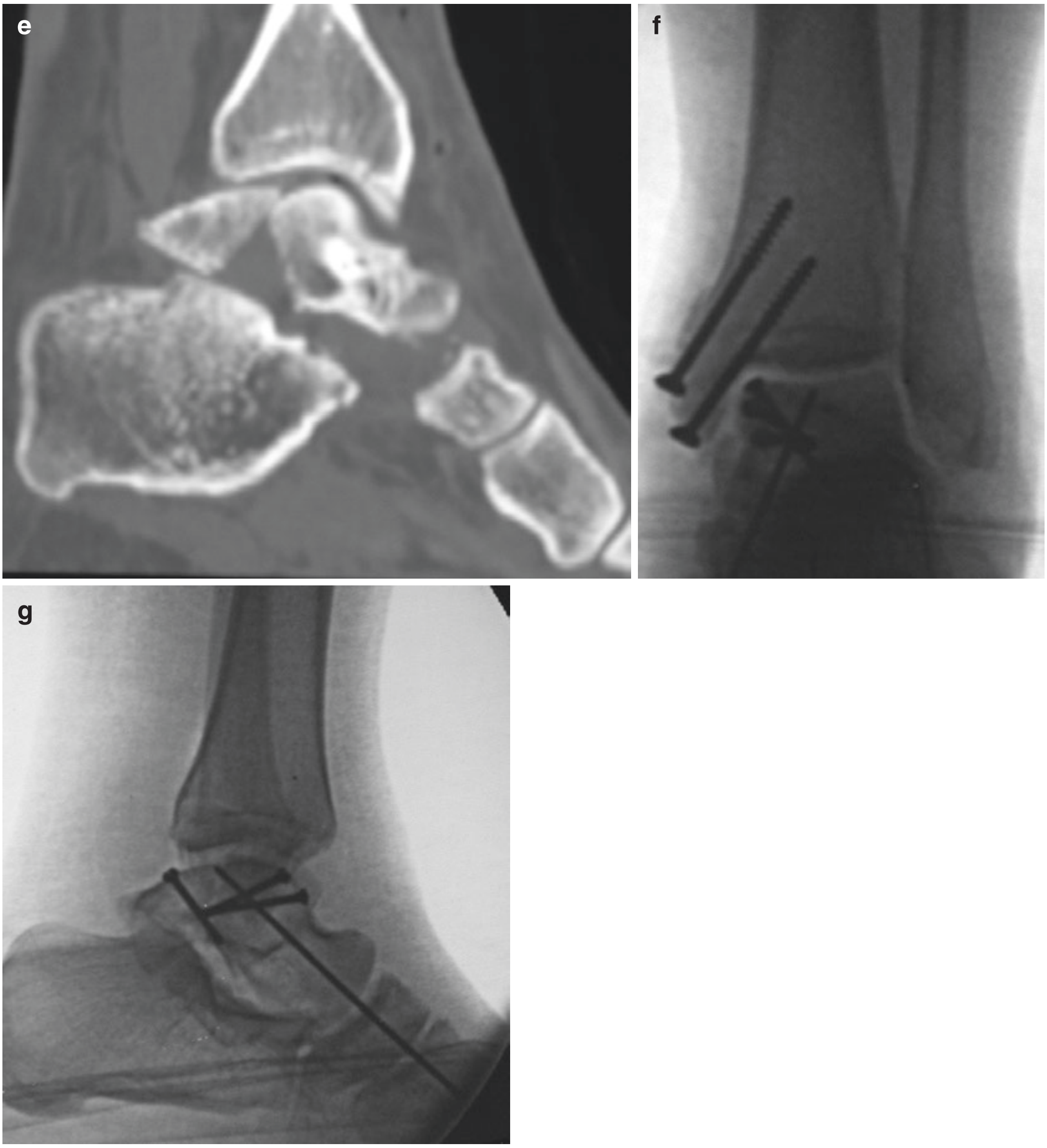

Fig. 5.3 (continued)

fracture or an osteotomy. The oblique medial malleolar osteotomy is performed after predrilling [20, 22, 23]. The deltoid ligament must be carefully protected to maintain the deltoid artery (Fig. 5.4).

Anterolateral Approach

The anterolateral approach is started just proximal to the tibiotalar joint, medial and adjacent to the peroneus tertius tendon, and is directed distally, parallel to the fourth metatarsal [20]. Superficial peroneal nerve branches must be identified and protected throughout. Full thickness skin flaps should be created sharply. The tibiotalar capsule is incised, exposing the ankle joint, and devitalized synovium is excised. Distally, the extensor digitorum brevis is elevated, exposing the lateral cortex of the talar neck. The talofibular gutter, lateral process, and lateral talar neck are now accessible (Fig. 5.5).

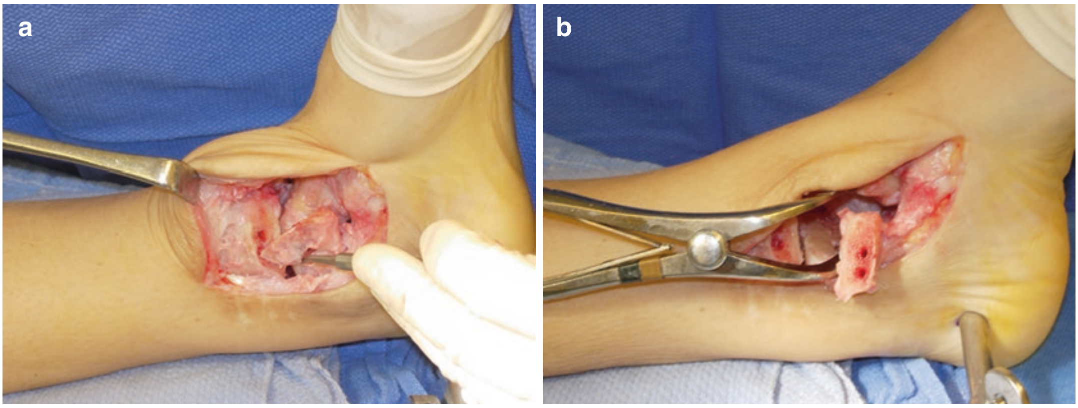

Fig. 5.4 Intraoperative photographs demonstrate the anteromedial approach to a talar body and neck fracture. A medial malleolus osteotomy has been performed after predrilling with a 2.5-mm drill to facilitate later repair (**a**). The medial malleolus remains attached inferiorly to the deltoid ligament. Upon reflection, the talar body is easily visualized and is more accessible for reduction and fixation (**b**)

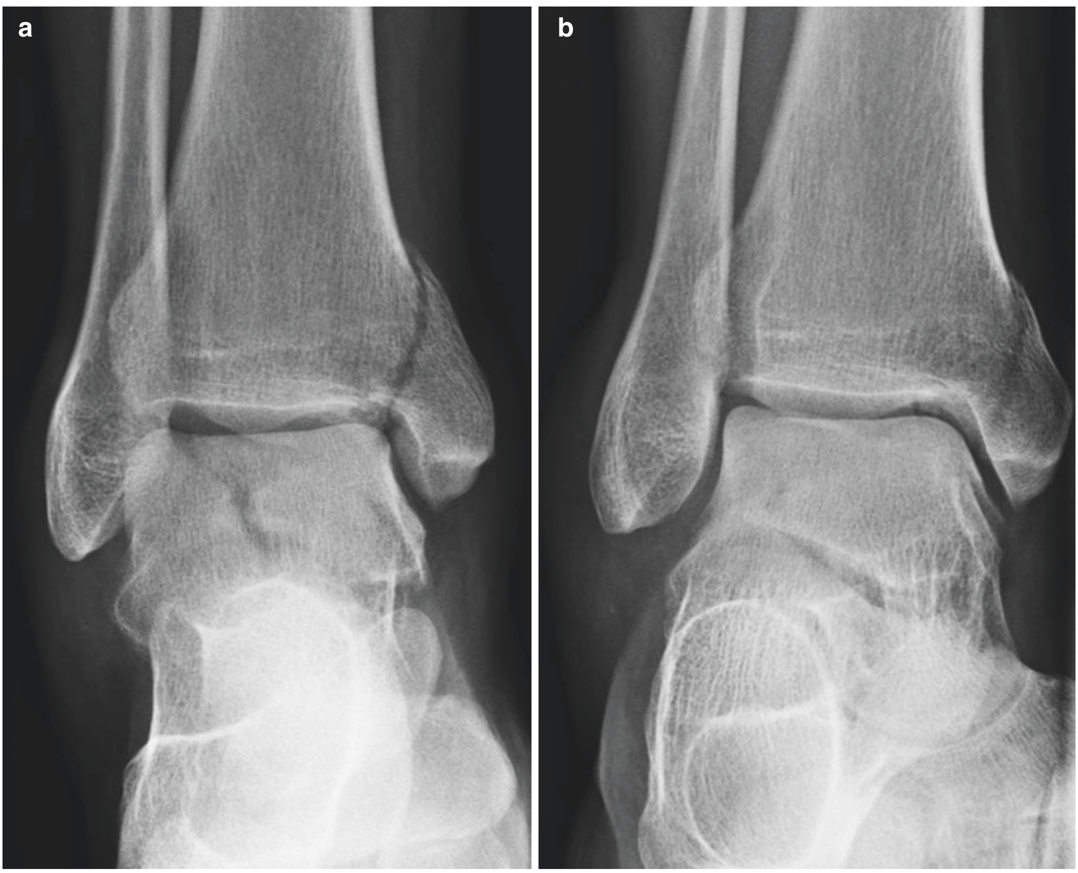

Fig. 5.5 Injury ankle radiographs of a lateral talar body fracture in association with a medial fracture of the tibia plafond. Anteroposterior, mortise, and lateral views are shown (**a**–**c**). Open reduction and internal fixation of the talar body was performed through an anterolateral exposure (**d**, **e**), promoting visualization of the lateral aspect of the talar body including the dome. Direct reduction was obtained, and provisional Kirschner wires were placed, followed by mini-fragment screw fixation. The first screw was placed with interfragmentary compression. Reduction and fixation of the talar body were followed by open reduction and internal fixation of the tibia plafond through an anteromedial exposure. The articular facture was anatomically reduced, and fixation was achieved with a small fragment plate applied as a buttress

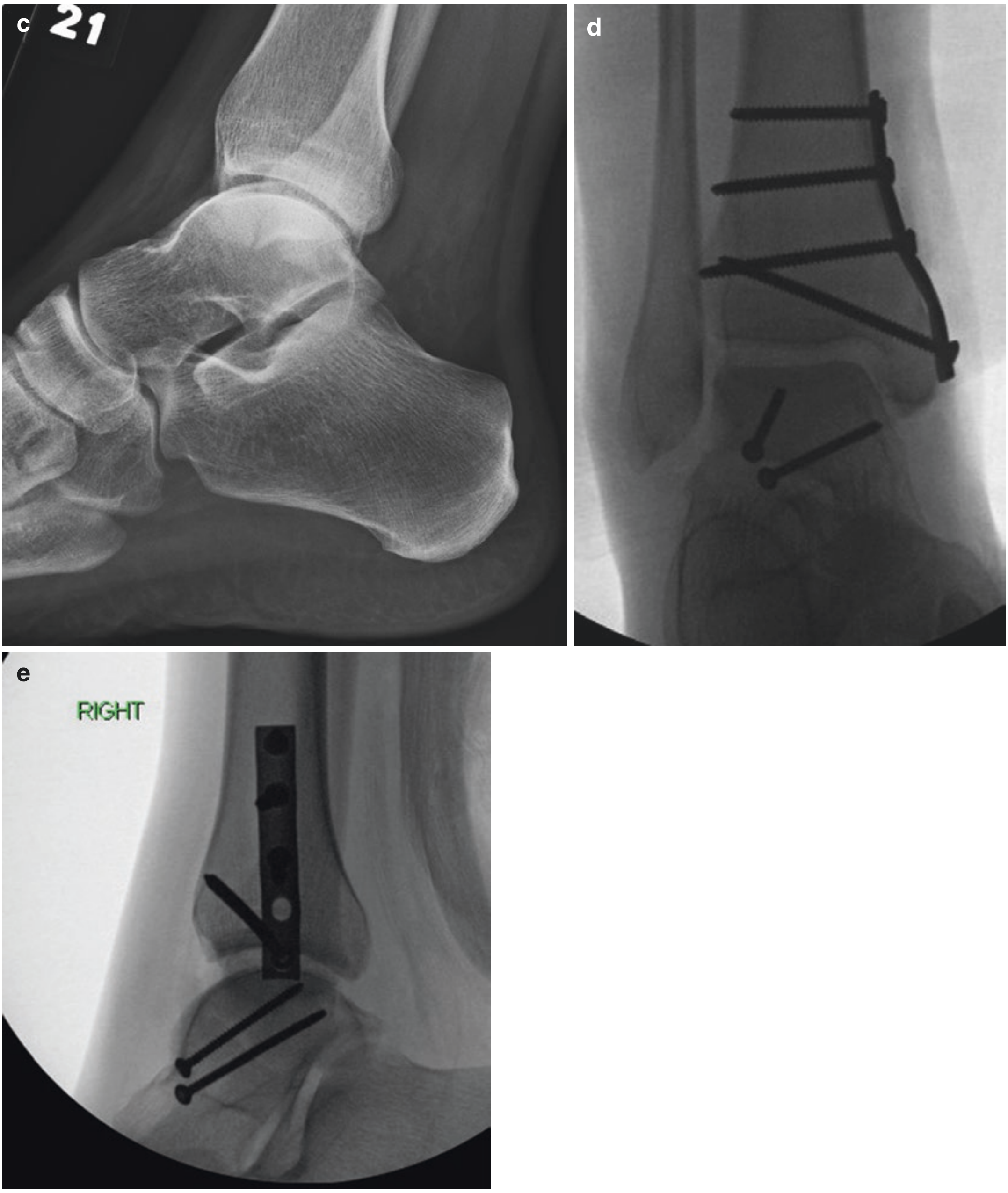

Fig. 5.5 (continued)

Similar to the medial malleolar osteotomy over the medial side, an osteotomy of the distal part of the fibula may be indicated to gain access to the posterior portion of the lateral aspect of the talar body.

Other tactics to increase exposure include plantarflexing the foot to improve visualization of the talar dome. Also, the use of a universal distractor or a temporary external fixator may facilitate intraoperative exposure further (Fig. 5.6).

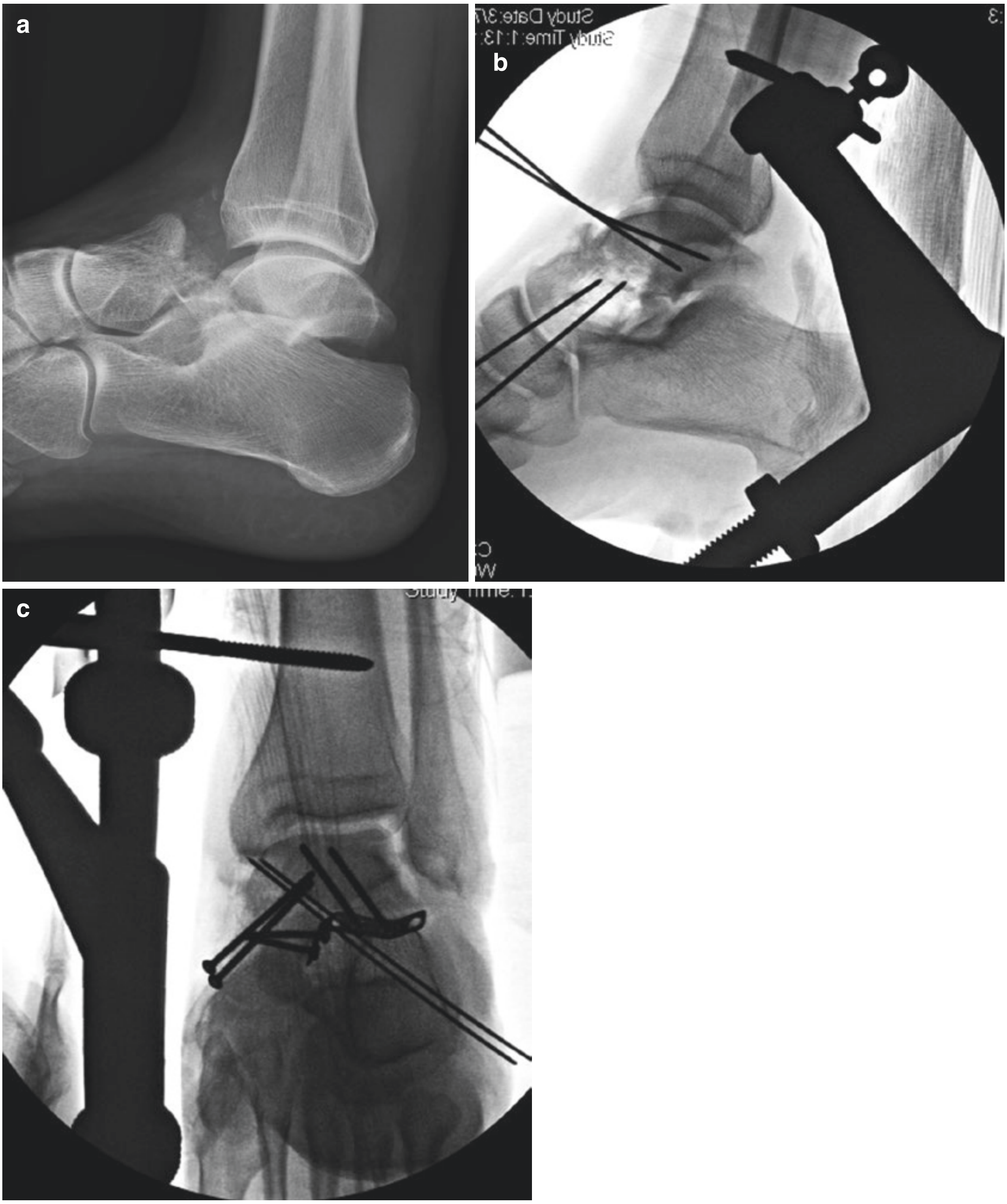

Fig. 5.6 Lateral ankle radiograph shows a talus fracture dislocation (**a**). Often, the talar body will be displaced posteromedially and will not be reducible via closed means. Reduction of the body is prohibited by intervening capsule and by the adjacent posterior tibialis and long toe flexor tendons. Urgent reduction in the operating room is recommended. An anteromedial exposure provides access to the ankle and subtalar joints, with the talar body still displaced. Intraoperatively, a universal distractor may be applied with Schanz pins in the medial tibia and calcaneus to provide distraction and to facilitate reduction of the talar body. This also promotes better intraoperative visualization (**b**, **c**). Consideration should be given to extending the ankle capsulotomy as needed to enlarge the access to the displaced talar body. A Schanz pin or stout Kirschner wires directed into the fractured surface of the talar body may be effective in grasping the talar body to reduce it back to the tibia and calcaneus

Dual Anteromedial and Anterolateral Approaches

Complicated talar body fractures with coronal displacement, comminution, or associated talar neck fractures are more likely to require dual approaches for accurate visualization [4, 19–21]. The patient is usually positioned supine on a radiolucent operating table. A lateral hip bump is helpful to position the foot at a perpendicular to the floor to facilitate direct visualization and imaging.

While the usage of dual surgical exposures has not been shown to increase the risk for osteonecrosis, surgeons must be mindful of the talar blood supply. Plantar dissection along the talar neck is avoided in order to protect the tarsal canal blood supply, and the fibers of the deltoid ligament should also be preserved.

Reduction and Fixation Techniques

The talus is mostly covered by articular cartilage [5]. Anatomic reduction should be the primary goal of surgical intervention, as PTOA may be minimized and function optimized with an accurate reduction. Reduction should be assessed by direct visualization and radiographic evaluation. While Kirschner wire fixation can be done provisionally to hold reduction intraoperatively, rigid fixation with mini-fragment implants (1.8 mm, 2.0 mm, 2.4 mm, 2.7 mm) is advocated to maintain fracture alignment and to promote early range of motion. The small, cruciform head screws can effectively secure osteochondral fractures without being prominent on the articular surface [4]. Devitalized fragments that do not contribute to joint stability or articular congruence may be removed. Associated talar neck fractures may be stabilized with small fragment or mini-fragment axial screws and with mini-fragment plates, depending on fracture orientation and associated comminution [4, 20].

For coronal plane fractures, screws may be effective on the medial side, starting at the edge of the talar head and directed longitudinally into the posterior talar body. Longitudinal screws may also be placed laterally from anterior along the talar neck to posterior within the talar body, depending on the fracture pattern, but often plates are utilized on the lateral side. Plates may aid in stabilizing combinations of talar neck and body fractures, with or without lateral process fractures. In coronal talar body fractures with an intact lateral process, fixation with screws in the retrograde fashion from the firm cortical bone of the lateral aspect of the talar neck into the talar body may be adequate. For fractures with associated lateral process involvement, mini-fragment screws and plates are utilized. Occasionally nonreconstructable osteochondral process fragments are excised, and the lateral process may be medialized, as needed to provide osseous continuity, while minimizing articular offset and gap [4].

For sagittal talar body fractures, lag screw fixation after an osteotomy is appropriate. Screws may be countersunk to prevent implant prominence.

Spanning external fixation or Kirshner wire fixation can be used in adjunct to internal fixation in cases of severe fracture comminution or bone loss. These devices can be removed in the outpatient clinic after 4–8 weeks [4].

Meticulous closure with modified Allgower-Donati sutures or a tension-relieving suture technique is recommended to distribute tension over a larger volume of skin and soft tissue. Suction drainage should be employed liberally to prevent hematoma accumulation, which could contribute to wound dehiscence. Postoperatively, the ankle and foot are immobilized in a splint initially. This provides support for the soft tissues to facilitate wound healing, and it provides relief of pain and anxiety for the patient. Range of motion is initiated once the surgical and traumatic wounds are adequately healed after surgery. No weight-bearing is permitted approximately for the first 12 weeks. Radiographs should be obtained in follow-up for monitoring of union, osteonecrosis, and long-term PTOA.

Treatment Controversies

Although stainless steel implants remain commonplace, some have advocated for titanium screws, which will allow for magnetic resonance imaging to better detect osteonecrosis [21, 24, 25]. Controversy exists regarding this practice, as identification of osteonecrosis will ultimately occur with plain radiography, and activity limitations after diagnosis of osteonecrosis have not been shown to alter the propensity for osseous collapse [3, 4]. Biodegradable implants have also been reported [10]. However, enhanced clinical outcome has never been related to implant composition. Arthroscopic and percutaneous techniques have been described with some success in treatment of non-displaced talar body fractures [24, 26, 27]. However, anatomic reduction should never be compromised regardless of fixation techniques. In rare cases of comminuted talar body fractures that were non-amenable to fixation, primary arthrodesis may be considered [2, 17, 21, 28].

Results

Talar body fractures are often devastating injuries, commonly associated with complications. Recovery lasts for 1–2 years. Early complications are usually soft tissue related, which occur within a few weeks after the injury. Late complications affecting physical functions may not develop for several months after the injury. It is important to counsel patients about their prognosis and long-term expectations. There have only been a few reports describing outcomes of talar body fractures [1–3], while most publications reviewing talus fractures do not distinguish talar body fractures from other fractures of the talus. In Table 5.1, we attempted to isolate the outcomes of talar body fractures from other fractures in each series.

Early Complications

Early literature on immediate surgical management of talar fractures reported high rates of soft tissue complications, up to 77% [1, 17, 29]. These complications included wound dehiscence, skin necrosis, and infection. More recently, protection of the delicate soft tissue envelope around the foot and ankle by urgent reduction of dislocations, administration of intravenous antibiotic prophylaxis for open injuries, and meticulous handling of soft tissues have resulted in a reduction of such early complications to 2–10% in more recent studies [2, 4, 10]. These series advocated for delayed definite surgical procedures until soft tissue swelling improves, usually 1–3 weeks after the injury. Naturally, wound complications correlate with the severity of soft tissue injuries, and open fractures and degloved wounds are associated with greater risk for wound problems [2, 10, 30]. Vallier et al. reported eight early complications among 38 patients, including three superficial infections treated with oral antibiotics, four with partial wound dehiscence, and one with skin necrosis treated with dressing changes [2]. There was one deep infection in an open fracture, which required two irrigation and debridement procedures. In rare cases, amputation is performed due to deep infection, again associated with severe soft tissue injuries [10].

Late Complications and Outcomes

In general, nonunion is rare, ranging from 5% to 12% [4, 10, 18]. Nonunion occurs more often after open fractures versus closed fractures [2, 10]. The mean time to union is approximately 3 months [10]. Malunion ranges from 0% to 37%, and will lead to PTOA, manifested by pain and stiffness of the ankle and subtalar and transverse talar joints [1–4]. However, malunion is likely underestimated in published reports, as it is difficult to adequately evaluate talar alignment based on plain radiographs.

The most common complication of talar body fractures is PTOA, followed by osteonecrosis [2, 4, 10]. Chondral injury and osteochondral loss, and destruction of vascular supply secondary to the initial injury, are clear factors that are related to these complications, respectively. PTOA has been reported in up to 50–100% of patients, despite our best effort with modern techniques of reduction and fixation [2, 10]. Ideally, careful

Table 5.1 Summary of complications and outcomes of published series of talar body fractures

Study	No. of talar body fractures	Follow-up	Infection	Nonunion	Malunion	Avascular necrosis	Post-traumatic arthritis	Outcomes
Coltart et al. (1952) [17]	15					15/15	High	
Mindell et al. (1963) [15]	3 body fractures and 7 fracture dislocation	Mean 4.5 years		0		3/7 with fracture dislocation	6	2/7 satisfactory after fracture dislocation and 3/3 after fracture only
Kenwright et al. (1970) [16]	6	Mean 4 years				1 of 2 with dislocation		2/6 satisfactory
Sneppen et al. (1977) [1]	51	Mean 23 months	2 skin necrosis and infection	3	30/51	8/51	28/51	Complaint severity, disablement assessment, and work status
Elgafy et al. (2000) [21]	11	Mean 30 months	2			3/11	9/10	AOFAS, Ankle-Hindfoot Score, Maryland Foot Score, Hawkins evaluation criteria
Vallier et al. (2003) [2]	38 with minimum of 1-year follow-up	Mean 33 months	3 superficial infection, 4 wound dehiscence, 1 skin necrosis	0	1	10/26 (with complete radiographs)	17/26 tibiotalar, 9/26 subtalar	Mean FFI 32, mean MFA 29.4
Lindvall et al. (2004) [10]	8	Mean 74 months	3/7 open fractures (mixture of talar neck and body fractures)	12%		50%	100%	Mean AOFAS 57.0
Ebraheim et al. (2008) [3]	19	26 months	2 superficial infection, 1 wound dehiscence, 1 skin necrosis, 1 deep infection	1 delayed union	1	7	11/19 tibiotalar, 6/19 subtalar	AOFAS Ankle-Hindfoot scoring, excellent in 4, good in 6, fair in 4, and poor in 5
Bellamy et al. (2011) [18]	< 7 body fractures in 17 patients	Mean 16 months				7/17	5/17	

surgical dissection, followed by accurate articular and axial reduction and fixation will minimize surgical contributions to late complications.

Most patients report pain at long-term follow-up [10]. Prior studies support that PTOA occurs more commonly after talar body fractures than with talar neck fractures, as both the subtalar and tibiotalar joints are involved in most talar body fractures [1, 16, 17, 24]. However, Lindvall et al. demonstrated no differences in union rate, osteonecrosis, or PTOA between talar neck and body fractures in their series of 16 isolated talar neck and 8 isolated body fractures [10]. This study was likely underpowered to identify a difference between these groups. Secondary procedures such as ankle or subtalar arthrodesis or total ankle arthroplasty are effective pain-relieving procedures, as long as mechanical alignment is restored.

The incidence of osteonecrosis is approximately 40% after talar body fractures, with half associated with collapse [2]. Because of progressive damage to the blood supply to the talar body with greater initial fracture displacement, the risk of osteonecrosis is associated with severity of the original injury. Osteonecrosis and collapse usually develop within 14 months of surgery, while revascularization of the talar body without collapse occurs after a mean of 10.4 months [2]. Hawkins described a relative decrease in the density of the talar body versus adjacent structures secondary to osseous resorption during disuse, indicating a present blood supply [29]. Approximately half of the patients with this early finding will undergo revascularization of the talar body without collapse. The absence of Hawkins' sign, however, does not mean that osteonecrosis is imminent, and the presence of the sign does not guarantee complete revascularization of the talus [10].

Previous report of nonoperative treatment of talar body fractures by Sneppen in the 1960s resulted in a high rate of functional disability and PTOA [1]. In the largest series of talar body fractures treated with modern open reduction and internal fixation, even though the authors were able to achieve anatomic reduction on plain radiographs in 21/26 patients, PTOA in the tibiotalar joint occurred in 17 (65%) and in the subtalar joint in 9 (35%), more common after both comminuted fractures and open injuries [2]. PTOA was associated with worse functional outcome scores including the Musculoskeletal Function Assessment (MFA) and the Foot Function Index (FFI). Worse functional outcomes were also seen in association with advanced PTOA and osteonecrosis that progress to collapse in other studies [2, 10, 31]. In general, functional outcome scores for patients with talar body fractures have indicated higher level of impairment compared to patients with other hindfoot injuries [2, 10, 32].

In summary, fractures of the body of the talus are uncommon and poorly defined. With careful attention to surgical timing and technique, complications should be limited to those associated with characteristics of the initial injury including direct damage to the soft tissues, blood supply, cartilage, and bone. Complications are common, and long-term functional outcomes are limited after severe injuries.

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