7 Posterior Talar Process Fractures

M. Kareem Shaath and Mark R. Adams

Anatomy

The talar body has five surfaces: lateral, medial, superior, inferior, and posterior. The posterior talar process is composed of a medial tubercle and a larger lateral tubercle. The lateral tubercle is the one most usually seen on a lateral radiograph of the ankle. The inferior portion of the posterior process is covered by articular cartilage, and it forms the posterior 25% of the posterior articular facet of the subtalar joint [1, 2]. This structure therefore contributes to subtalar joint stability [3, 4] and consideration should be made to reduce and fix any displacement to optimize preservation of the subtalar joint.

There is a sulcus between the two tubercles which provides passage for the flexor hallucis longus (FHL) before it reaches the sustentaculum (Fig. 7.1) [5]. Anatomical dissection of this region can be seen in Fig. 7.2 [6], while magnetic resonance imaging (MRI) and anatomical cross sections can be seen in Fig. 7.3 [7]. The posterolateral tubercle when fused to the posterior talar body is referred to as a Stieda process. When the Stieda process is separate from the lateral tubercle, it is known as an os trigonum [8]. It is a congenital, rounded ossicle found in up to 50% of the population [9–11] and may occur unilaterally [1]. The os trigonum may be connected to the lateral talar tubercle by a synostosis which is known as a trigonal process. The posterior talofibular ligament and the fibulotalocalcaneal ligament of Rouviere and Canela Lazaro attach to the lateral tubercle. The posterior third of the deltoid ligament and the medial limb of the bifurcate talocalcaneal ligament attach to the medial tubercle [12].

Wildenaur was the first to describe in detail the blood supply to the talus [13]. Haliburton [14] confirmed his findings and Mulfinger and Trueta [15] provided the most complete description of the complex arterial circulation which has since been studied extensively [16–18]. Greater than half of the surface of the talus is covered by articular cartilage, limiting the area available for vascular perforation. Vascularity to the talus is limited to the talar neck, the medial surface of the talar body, and the posterior process [14]. The blood supply comes from three main arteries and their branches, listed in order of significance: the posterior tibial artery, the anterior tibial artery, and the perforating peroneal arteries [15–17, 19, 20]. There are two discrete vessels that form a sling inferior to the talus, the artery of the tarsal canal (a branch of the posterior tibial artery), and the artery of the tarsal sinus (a branch of the peroneal artery)

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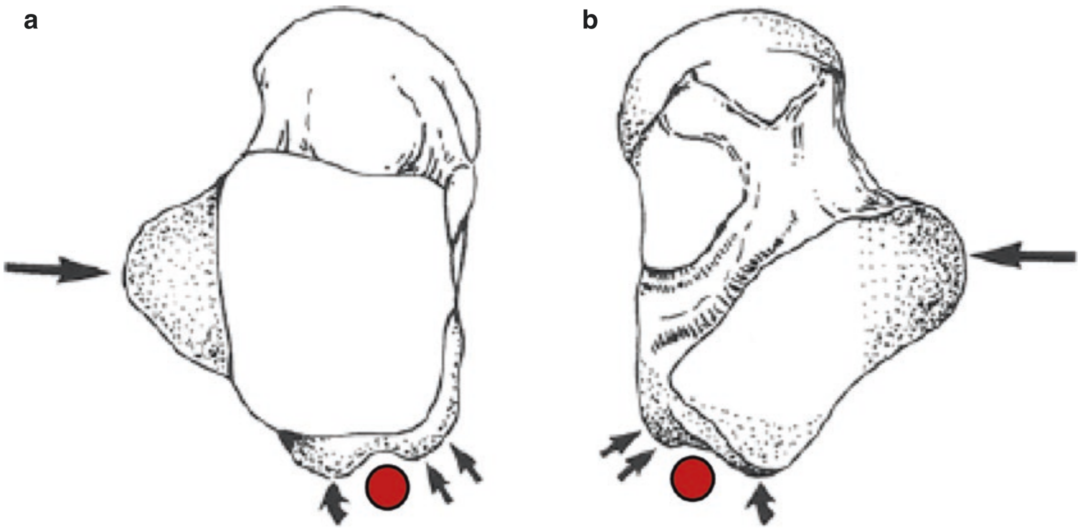

Fig. 7.1 Superior (**a**) and inferior (**b**) views of talus indicate the lateral processes (arrow) and the medial (double arrows) and lateral (curved arrows) tubercles of the posterior process. The FHL tendon is represented by the sphere

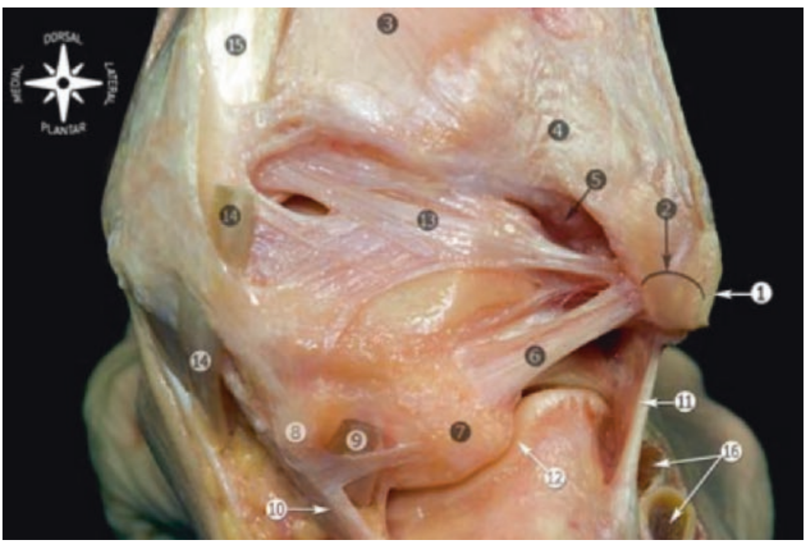

Fig. 7.2 Posterior view of the anatomic dissection of the ankle ligaments. (1) Tip of the fibula; (2) peroneal groove of the fibula; (3) tibia; (4) superficial component of the posterior tibiofibular ligament; (5) deep component of the posterior tibiofibular ligament or transverse ligament; (6) posterior talofibular ligament; (7) lateral talar process; (8) medial talar process; (9) tunnel for flexor hallucis longus tendon; (10) flexor hallucis longus retinaculum; (11) calcaneofibular ligament; (12) subtalar joint; (13) posterior intermalleolar ligament; (14) flexor digitorum longus tendon (cut); (15) tibialis posterior tendon; (16) peroneal tendons

(Fig. 7.4) [17, 19–21]. The main arterial supply to the talus is the artery of the tarsal canal, which provides an additional branch that penetrates the deltoid ligament and supplies the medial wall [20]. Direct branches of the posterior tibial artery via calcaneal branches travel in the connective tissues that attach to the posterior tubercles and supply the posterior process [15, 20].

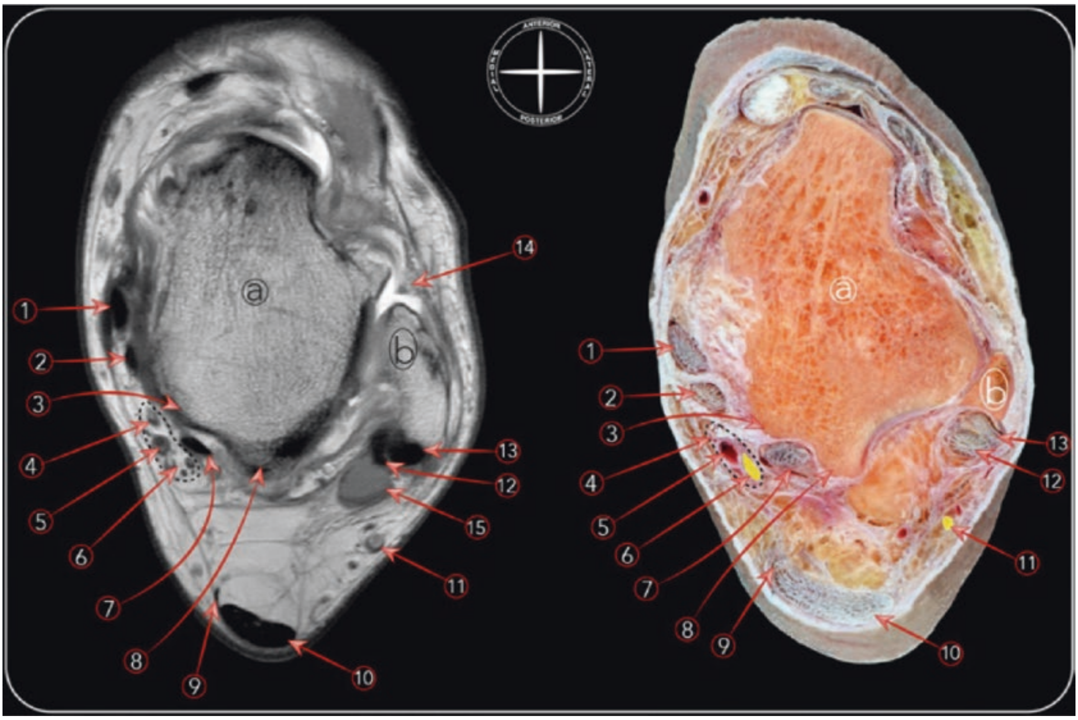

Fig. 7.3 MRI and cross section of a cadaveric specimen showing comparative anatomy at the level of the talus and relationship between the FHL tendon and the posterior tibial neurovascular bundle (highlighted by dotted line). (a) Talus; (b) lateral malleolus; (1) posterior tibial tendon; (2) flexor digitorum longus tendon; (3) posteromedial talar tubercle; (4) tibial vein; (5) posterior tibial artery; (6) tibial nerve (highlighted in yellow); (7) flexor hallucis longus tendon; (8) posterolateral talar tubercle; (9) plantaris tendon; (10) calcaneal tendon; (11) sural nerve (highlighted in yellow); (12) peroneus longus tendon; (13) peroneus brevis tendon; (14) anterior talofibular ligament; (15) hypertrophied peroneus longus muscle belly

Fractures of the Posterolateral Tubercle

Mechanism of Injury

There are two common mechanisms of injury to cause fracture of the posterior process of the talus. First, forced plantar flexion of the foot causes compression of the posterolateral tubercle between the posterior tibial plafond and the calcaneus [1, 22–27]. This may cause a fracture of the posterolateral process, separation through the fibrous attachment of an os trigonum, or if the os trigonum is attached to the talus by bone, a fracture of the resulting trigonal process [22, 28]. This is the most common mechanism and commonly occurs in ballet dancers and soccer players [22, 28–31]. This has been associated with the "pointe" or "demi-pointe" or muscular imbalances such as gastrocnemius equinus [23, 31].

The second mechanism of injury involves excessive dorsiflexion and inversion of the ankle, which results in increasing tension in the posterior talofibular ligament which avulses the lateral tubercle of the posterior facet [32–37]. This is alternatively known as a Shepherd fracture [38]. Some have suggested that pain may be due to a failure of fusion of the secondary ossification center of the posterior process with the talar body [39].

The entire posterior process may fracture from a medial subtalar dislocation [3, 4, 40, 41], which may present as an open injury over the anterolateral ankle as the skin is disrupted by the dislocation. There have been no reports of a posterior process fracture with a concomitant lateral subtalar dislocation.

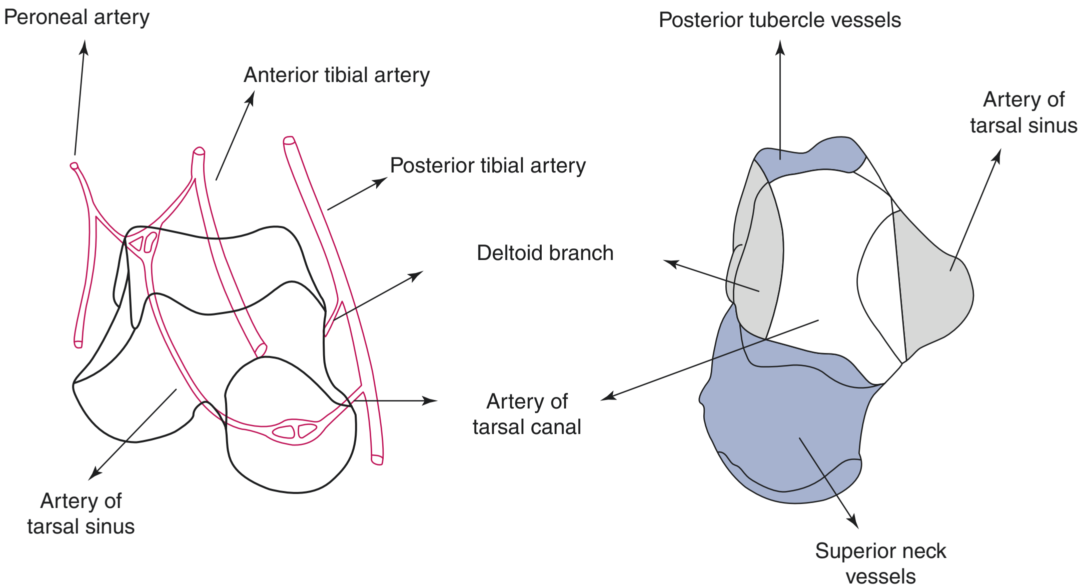

Fig. 7.4 The blood supply to the various regions of the talus. The artery of the tarsal canal provides the predominant blood supply to the talar body

Clinical Evaluation

Patients usually give a history of sudden uncontrolled injuries to the foot, such as from catching the heel on a step when going down stairs, kicking a ball [1], or from impingement pain caused by active ankle plantarflexion during ballet en pointe [29–31, 42]. Continued pain in the posterior ankle after an injury warrants a high level of suspicion for a posterior talus injury. Patients may experience edema in their posterior ankle, pain, and feelings of instability that may be worsened by running, jumping, or descending stairs [12, 43]. Schrock et al. suggest that pain that is aggravated by squatting on a plantar-flexed foot suggest a posterior process fracture [44].

On examination, the patient may exhibit tenderness anterior to the Achilles tendon, posterior to the talus. Crepitus may be palpated with plantar flexion of the foot. Pain may be elicited with motion of the great toe as the FHL is in the groove adjacent to the injured lateral tubercle of the posterior process [12, 28].

Patients with missed fractures may have chronic, unremitting ankle pain which may be due to fracture nonunion and other factors. These other factors include soft tissue impingement, inflammation, micromotion at the nonunion site, and FHL irritation or synovitis. Occult posterior process fractures have been reported to cause symptoms of tarsal tunnel syndrome [45]. Displaced fracture fragments have been found to impinge on the tarsal tunnel structure. Reduction and fixation of the fragment leads to a resolution of symptoms [45].

Radiographic Evaluation

The lateral tubercle of the posterior process of the talus and os trigonum is best seen on a lateral radiographic view of the ankle. One must remember that in an acute fracture, the fracture surfaces are rough and irregular, whereas an os trigonum is characterized by smooth, well-corticated surfaces. Contralateral comparison films may offer value, but the os trigonum is reported to be unilateral in more than two-thirds of cases [1]. Paulos et al. suggest the use of a 30-degree subtalar oblique view to distinguish between an acute fracture and an os trigonum [12]. The posterior process fracture fragment may appear larger and extend farther into the body than an os trigonum.

Technetium-99m (Tc-99m) bone scans are an important technique for evaluating posterior process fractures [46, 47], and they may be used to diagnose an acute fracture of the posterior process of the talus [12]. A technetium bone scan will be positive in all patients with a fracture of the posterior process of the talus [12]. They may also be useful in distinguishing occult fractures from normal ossicles, as an ossicle will not demonstrate an increase in uptake [48].

When suspicion is high, but radiographs are negative, a computed tomography (CT) scan may also provide additional information. Multiplanar CT scanning with fine 1-mm cuts allows accurate assessment of location, size, displacement, and comminution of any fragments [49]. It may demonstrate an irregular anterior border to the fragment, which is suggestive of an acute fracture [49]. If a subtalar dislocation is present, CT scans should always be considered [50]. Subtalar dislocations rarely occur in isolation, and CT scanning may reveal associated posterior process fractures not visualized on plain radiographs [51].

Magnetic resonance imaging (MRI) may be used to delineate soft tissue injury and may identify additional edema [52, 53]. A symptomatic os trigonum secondary to posterior ankle impingement may exhibit bone marrow edema, but edema within the talus itself should raise suspicion for fracture of the posterior process [52, 53]. MRI may also provide detail regarding the condition of adjacent soft tissue structures [54].

Treatment

The treatment recommended for small (<1 cm) and minimally displaced (<2 mm) fractures of the posterior process of the talus is conservative [55]. The patient can be immobilized in a short-leg walking cast with the foot in 15 degrees of equinus for 4–6 weeks [12]. Given that the lateral process of the of talus transfers as much as 16–17% of the weight borne by the foot through the fibula, premature weight-bearing risks fracture displacement [56]. If patients continue to be symptomatic for 6 months after conservative treatment, some authors have suggested surgical excision [12, 23]. If fragments are too small or comminuted for internal fixation, surgical excision has been suggested to allow early mobilization and avoid the risk of painful nonunion [27, 57]. After excision of the fragment, the patient's ankle is immobilized briefly, and subsequently an aggressive stretching and strengthening therapy program is initiated [29–31, 42].

If a large fracture fragment of the posterior process is present, it may be amenable to operative fixation. Large intraarticular fractures (25% of the subtalar facet) are best fixed with an open technique [34, 50, 58]. The preferred surgical approach to the posterior process varies, and CT may be used to determine the most appropriate surgical approach [49]. Howse recommends a medial approach as the lateral approach interferes with the peroneal tendons and may cause postoperative stiffness [23]. Howse recommends making a 3–4-cm incision behind the medial malleolus which allows access to the posterior ankle by retracting the FHL tendon medially, thereby protecting the neurovascular bundle [23]. Figure 7.5 shows the proximity of the neurovascular bundle and FHL tendon [7].

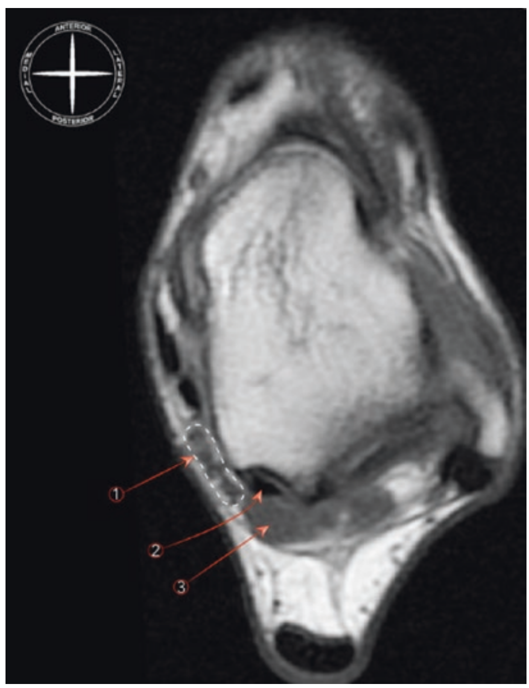

Fig. 7.5 (1) Posterior tibial neurovascular bundle; (2) FHL tendon; (3) Low-lying muscle belly of FHL

Others advocate the use of a posterolateral approach between the peroneal tendons and the Achilles tendon [59]. A 5-cm incision is made between the Achilles tendon posteriorly and the peroneal tendons anteriorly. The sural nerve must be protected and it usually lies medial to the incision. The peroneal tendons are retracted anteriorly and the FHL is retracted medially. The subtalar joint is subsequently incised vertically which exposes the posterior talus. Fragment fixation may be performed with small screws (1.5, 2.0, or 2.4 mm) due to the small area [40, 56, 60]. We have found that a small plate may be used as well. Mao et al. developed a minimally invasive technique for fixation of a posterior talar process fracture [40]. They obtained reduction through closed means and stabilized the fragment with two guide pins. A self-drilling 4.5-mm cannulated screw is then placed directed from posterior to anterior, through the fracture fragment into the body of the talus [40].

Others suggest that an arthroscopic approach may be used [43]. Surgical decompression or fragment excision may be performed arthroscopically through a two-portal posterior approach with the patient prone. The posterior talus may be viewed through posteromedial and posterolateral portals adjacent to the Achilles tendon at the level of the medial malleolus (Fig. 7.6) [7, 61]. Arthroscopic instruments should remain lateral to the FHL tendon to avoid injury to the posterior tibial neurovascular bundle [62]. Arthroscopic approaches are not recommended for anatomic reduction and fixation [56].

Outcomes

Paulos et al. reported that one-third of their patients had relief with conservative treatment of their posterior process fractures and were only symptomatic occasionally [12]. The rest of their cohort failed conservative treatment and underwent steroid injection with an additional 4 weeks of casting. This was unsuccessful in nearly 90% of their patients, and the rest underwent surgical removal of the bony fragment, which relieved their symptoms. Long-term follow-up was not available in this study, and unfortunately there are no comparative studies on excision versus ORIF of these fractures.

Hedric and Mcbryde [63] reported on 30 cases of posterior ankle impingement over 10 years. Greater than half of their patients (63%) had radiographic evidence of an os trigonum or a posterior process fracture. The remaining patients (33%) had an intact posterior process. There were 18% available for follow-up, and greater than half (60%) improved with nonsurgical treatment, while 40% (eight patients) required surgical excision. They had good to excellent results in 18 patients and a fair result in 1 patient.

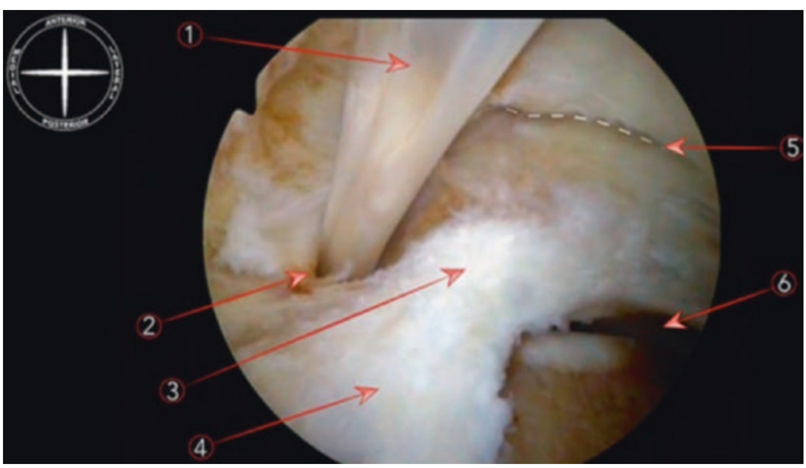

Fig. 7.6 (1) FHL tendon; (2) FHL retinaculum; (3) Posterolateral talar tubercle; (4) Talocalcaneal ligament (posterior fibers of the fibula talocalcaneal ligament); (5) attachment of the posterior ankle joint capsule; (6) subtalar joint; (7) posterolateral talar tubercle (resected)

Marotta and Micheli [30] had 16 dancers who underwent excision of an impinging ossicle (no fracture present) through a posterolateral approach. All their patients were hampered with participation in dance and all failed nonsurgical treatment. Twelve patients who were available for follow-up underwent surveys at an average of 28 months postoperatively, and all had improvement in their symptoms of impingement. Eight patients (67%) had occasional discomfort.

Complications

The primary complications are chronic pain and late arthrosis [54]. Nonunions, which may be symptomatic, are likely when fractures are not diagnosed and treated acutely [12, 64, 65]. Patients may remain symptomatic for a long period of time even with appropriate treatment [12]. Large fragments produce articular incongruity and, consequently, arthrosis of the subtalar joint, necessitating subtalar arthrodesis [51, 66]. As these are articular injuries, further study is required to determine whether ORIF can improve outcomes with regard to arthrosis.

Fractures of the Posteromedial Tubercle

Fractures of the medial tubercle of the posterior process of the talus are much less common than fractures of the lateral tubercle. This fracture was described in 1974 by Cedell, and it now bears his name. These fractures tend to be diagnosed as an ankle sprain and are often not seen on the AP and lateral radiographs of the ankle joint [45, 66–68]. This injury should be suspected when the patient has pain mimicking an ankle sprain after a combined dorsiflexion and pronation injury [67]. Other mechanisms of injury include direct trauma to the posteromedial facet [69], impingement of the sustentaculum tali in supination [70], and forced dorsiflexion in high-energy trauma [71]. To aid in diagnosis, along with a CT Scan, Ebraheim et al. recommend obtaining two oblique views at 45 and 70 degrees of external rotation to expose the posteromedial talus and identify posteromedial tubercle fractures [72].

Cedell reported on four cases of fractures of the medial tubercle that he believed were secondary to avulsion of the fragment by the posterior talotibial ligament with the ankle dorsiflexed and pronated [67]. In this situation, the posterior deltoid ligament avulses the medial tubercle [45, 64, 65, 67, 68]. Cedell's patients were treated by immobilization as they were initially misdiagnosed with an ankle sprain. Although the injuries seemed to heal, when patients resumed athletic activity, they had a recurrence of medial pain and edema. Three-fourths of the patients subsequently required excision of the fragment and returned to normal function.

Stefko et al. reported a case of a painful nonunion causing a tarsal tunnel syndrome. In that case, the fragment was excised, subsequently resolving all symptoms [45]. Ebraheim presented four cases of a Cedell's fracture. Two of the fractures were missed initially and progressed to painful nonunions. Of the two acute fracture patients, one presented with a concomitant tarsal syndrome due to the displaced fracture fragment. Three of the patients sustained a concurrent subtalar dislocation. The two fractures that presented acutely underwent operative fixation, while one patient with a nonunion underwent excision. The last patient refused surgery. All approaches were curved posteromedial incisions centered behind the medial malleolus, first mobilizing the neurovascular bundle, allowing clear access to the fracture [66]. They used a cannulated Herbert screw and Kirschner wires (K-wires) to augment their fixation [2]. They recommend that nondisplaced fractures be treated closed, while displaced fractures undergo operative fixation. They did also note that it was difficult to reduce the medial fragment due to difficulty visualizing the reduction [66].

Conclusion

Posteromedial and posterolateral process fractures of the talus are rare events. Although the literature on the subject is limited, certain elements are consistent. Conservative management frequently fails to achieve a successful outcome, as many patients deal with issues such as nonunion, posterior ankle impingement, and tarsal tunnel syndrome. Various methods of surgery exist for acute management of these injuries. Long-term data is necessary to determine whether ORIF portends a more favorable prognosis than other methods of surgical treatment.

Case Example

The patient was a 37-year-old male who was injured in a motor vehicle collision and presented with right ankle pain and deformity. He sustained a medial subtalar dislocation and underwent closed reduction in the trauma department. For continued concerns of instability of the subtalar joint, he was placed in a medially based external fixator. We routinely obtain AP, mortise, lateral, Broden view, and a "reverse" Broden view to assess the medial ST joint. If any suspicion of a fracture to the posterior talar process is present, a CT scan is obtained as well. A CT scan was obtained, which revealed a posteromedial fracture of the talus with associated marginal impaction. He was indicated for operative stabilization of this fragment to improve subtalar joint congruity and stability.

In the operating suite, the patient was placed prone on a standard bed with a radiolucent foot extension. We have found that a headlight is helpful when performing these procedures. A lower extremity positioner or a knee wedge is placed to assist with patient positioning. A mini-fragment set and Kirschner wires should be available in the room along with a large external fixator with distraction capability or a universal distractor. A fluoroscopic unit with 12″ image intensifier is placed on the contralateral side of the injury. If the patient presents with a concurrent subtalar dislocation (Fig. 7.7), external fixation is employed. External fixation may also be used to distract the joint to assess with visualization. The medially based external fixator is tensioned to resist deformity. If the fracture fragments are amenable to internal fixation and the patient can tolerate surgical treatment, we prefer using the posteromedial approach as it provides a direct approach to the fragments with excellent visualization. The incision is made just medial to the Achilles tendon, and the FHL is moved medially to allow access to the talus and concurrently protects the neurovascular bundle. The axial CT cuts may allow for planning the incision and the eventual approach (Fig. 7.8).

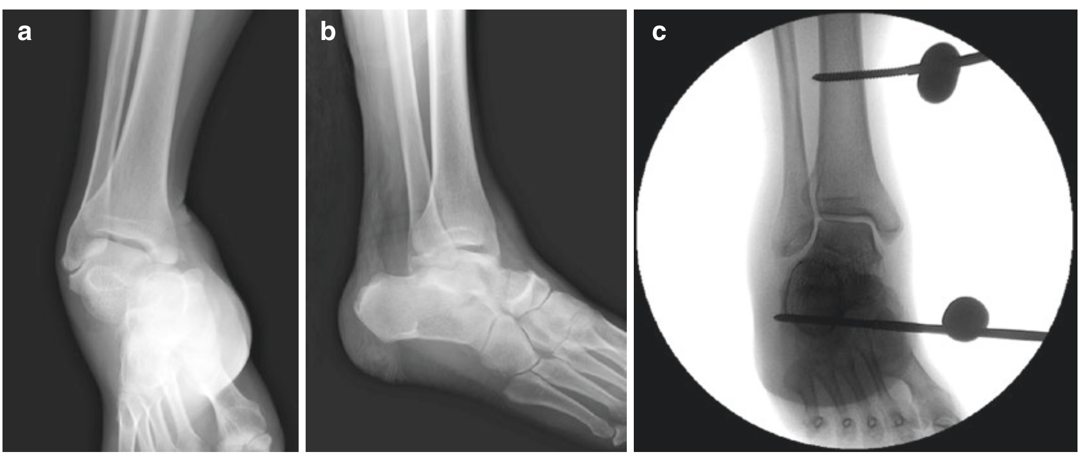

Fig. 7.7 (**a**, **b**) Subtalar dislocation with associated posteromedial talus process fracture. (**c**) Medially based external fixator that is tensioned to resist deforming forces while concurrently off-loading the subtalar joint

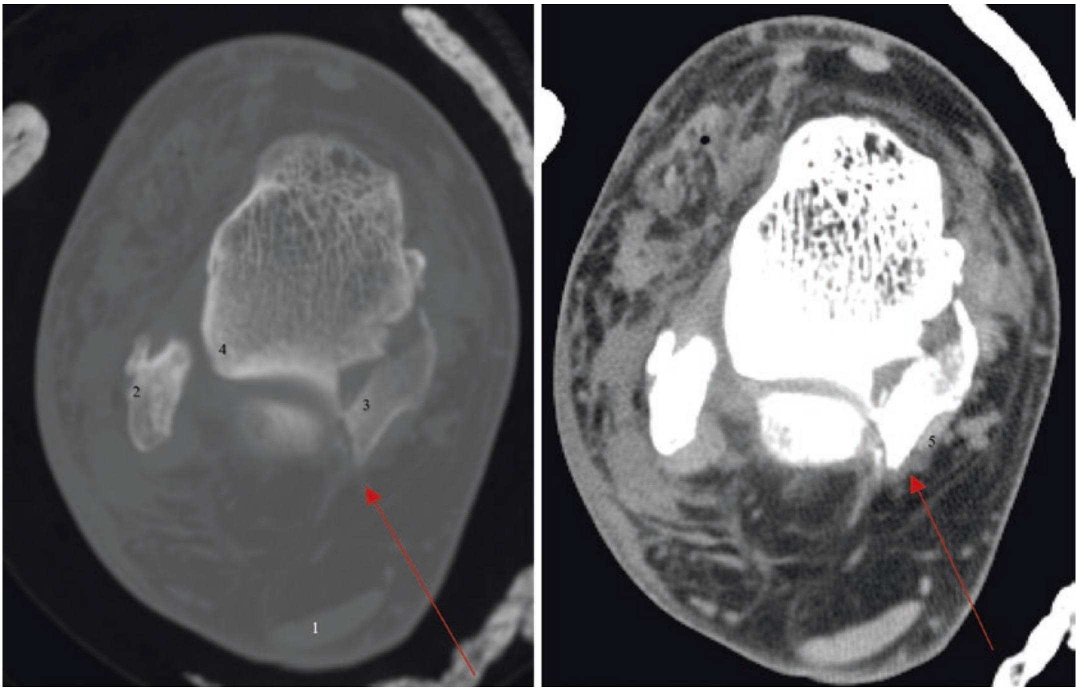

Fig. 7.8 (1) Achilles Tendon; (2) Fibula; (3) Posteromedial and Posterolateral Processes; (4) Lateral Talar Process; (5) FHL Tendon; Red Arrow: Intended Location for Incision and Approach

When approaching the fragments, marginal impaction is addressed first (Fig. 7.9). An osteotome is placed on the superior edge of the talar dome as this location provides cancellous bone to protect the articular segment. The articular fragment is returned to its anatomic position, and provisional reduction is held with small-diameter K-wires (Fig. 7.10). We prefer plate fixation, and use a mini-fragment plate. There is a small, nonarticular, zone on the posterior aspect of the talus upon which the plate may be placed. The plate in this scenario essentially functions as a washer. We have found that when visualizing this fracture pattern under direct visualization, nondisplaced fracture lines are present that are not available on CT scan. Plate fixation allows us to address these

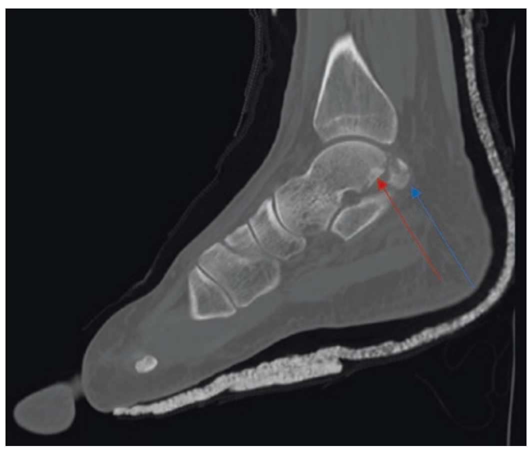

Fig. 7.9 Red arrow, marginal impaction; blue arrow, fracture fragment

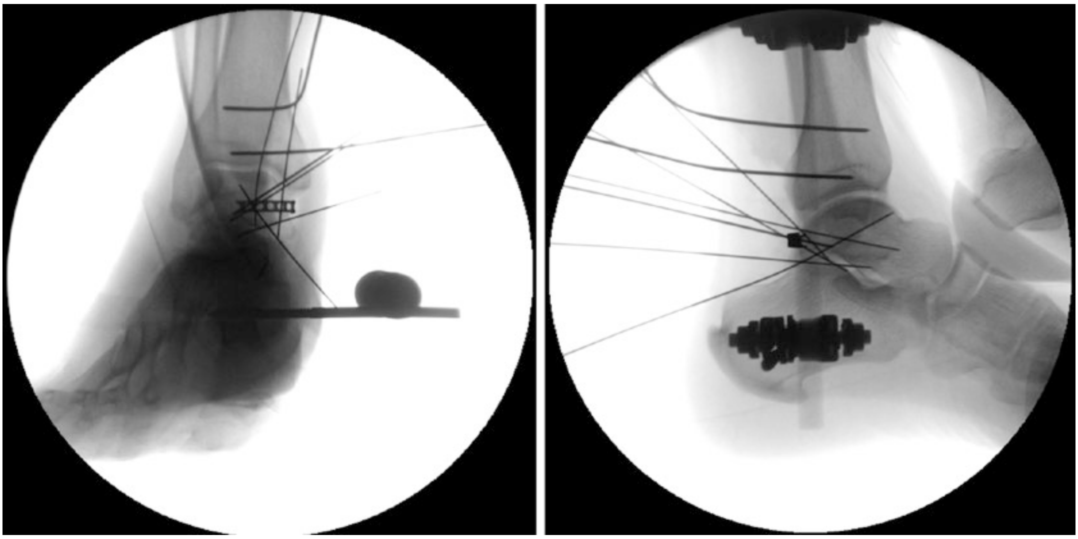

Fig. 7.10 K-wire fixation is used to provisionally stabilize fracture fragments. Distraction can be generated through the external fixator to aid in visualization of the tibiotalar and subtalar joints

fractures by using lag screws to stabilize them into the talar body. If multiple fragments are present, a spring hook plate may be created by using another 2.0 plate. The hooks may be impacted into the fragment and further stabilized with a screw (Fig. 7.11). The reduction is then assessed visually and fluoroscopically. We use Broden and "reverse" Broden views to visualize the subtalar joint (Fig. 7.12). We use Allgower-Donati sutures when closing the skin. Again, if an external fixator is present, it may be tensioned to off-load fracture fixation.

Postoperatively, patients are made non-weight-bearing for 12 weeks. Isometrics of the foot and passive toe range of motion may begin immediately with other modalities to limit edema. External fixation, if present, is removed at 6 weeks, and active range of motion of the ankle may be initiated at that time. If external fixation was not initially utilized, active range of motion of the ankle is initiated in 2–3 weeks after suture removal. The patient begins partial progressive weight-bearing between weeks 12 and 18, and a proprioceptive and strengthening program is initiated from 18 weeks onward. Six-month radiographs of the patient are found in Fig. 7.13.

Fig. 7.11 Plate fixation, stabilizing fracture fragments. Hooks on the plate are impacted into fracture fragments

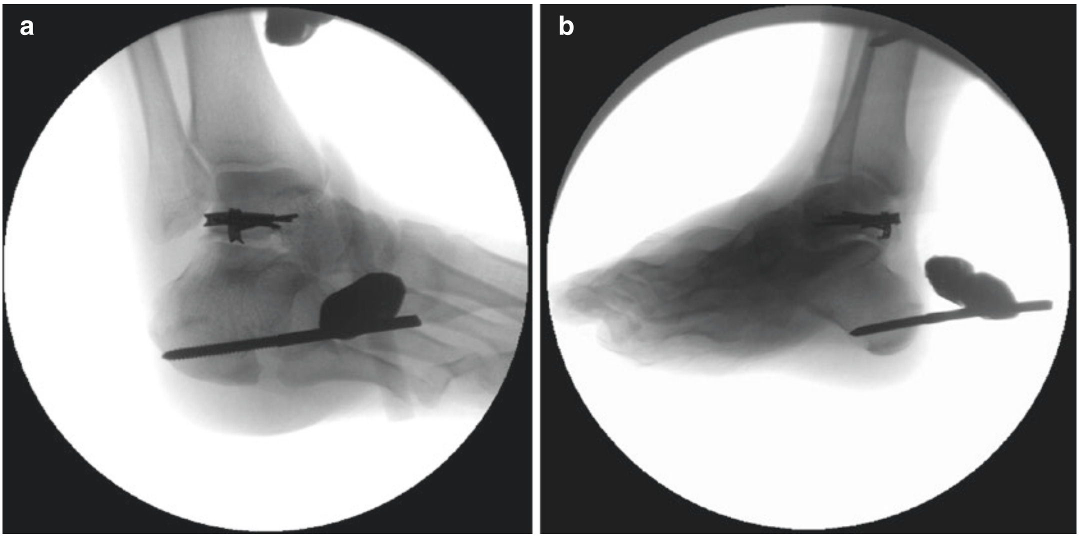

Fig. 7.12 (**a**) Broden view; (**b**) reverse Broden view

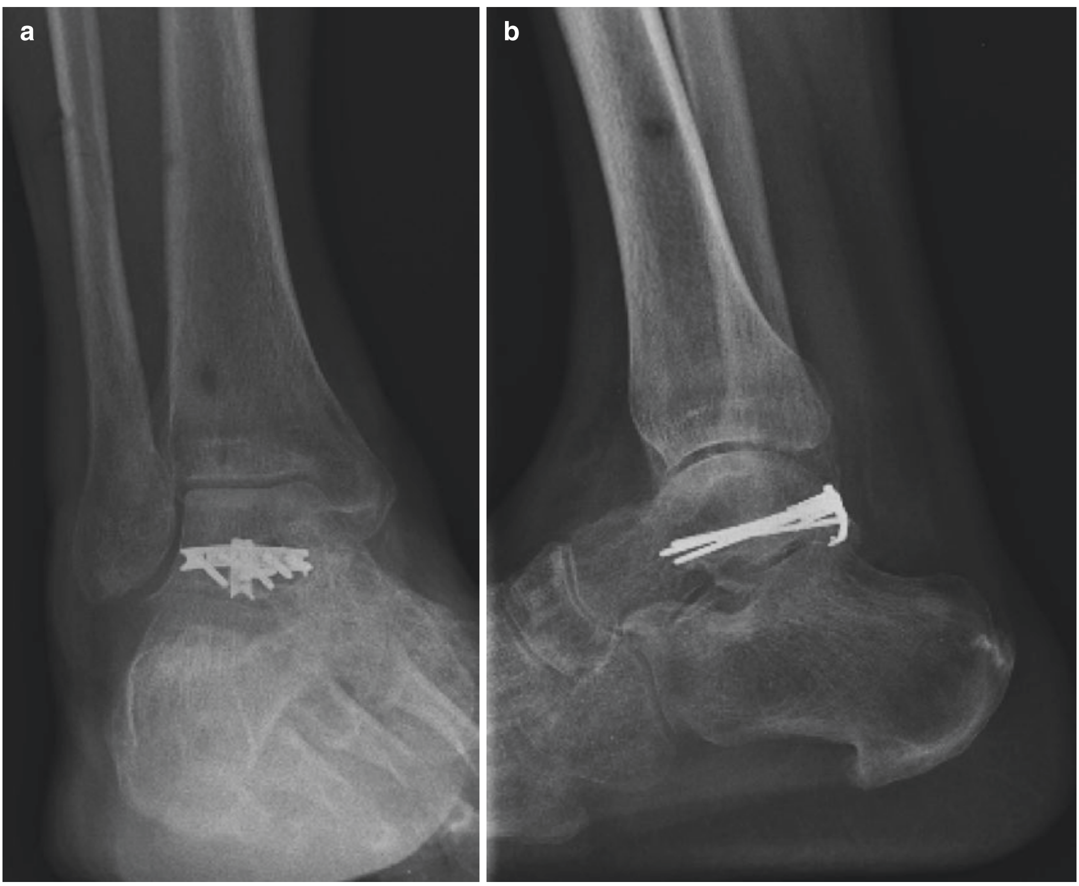

Fig. 7.13 (**a**) Broden's view of subtalar joint; (**b**) Lateral view

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