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Open Talar Neck Fracture With Medial Subtalar Joint Dislocation: A Case Report

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ABSTRACT

We present a unique case of an open talar neck fracture with medial subtalar joint dislocation. This rare and traumatic injury was treated with immediate open reduction of the subtalar joint and open reduction internal fixation of the talar neck fracture. After a follow-up of 2.2 years, highlighted by numerous complications including posttraumatic arthritis, soft tissue abscess, and fibrotic adhesions, the patient recovered sufficiently to return full activity.

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Fractures of the talus are not common injuries, accounting for 0.85% of all fractures (1). They usually occur with high-energy mechanisms, such as motor vehicle accidents and falls from a height. This injury was once termed *aviator's astragalus* by Anderson (2), who described a fracture of the talus sustained during forced dorsiflexion that occurred during crash landings of World War I pilots. Talar neck fractures account for 30% of all talar fractures (3). Dislocations of the subtalar joint, tibiotalar joint, and the talonavicular joint can accompany talar neck fractures. The most frequently used classification system with talar fractures is the Hawkins (3) classification system, which categorizes based on the degree of dislocation of the body of the talus from the surrounding joints. Canale and Kelly (4) later added an additional type, which noted dislocation at the talonavicular joint.

The most common concomitant injury is subtalar joint dislocation, which account for 1% to 2% of all dislocations (5). Currently, the most common method of describing dislocation of the subtalar joint is based on the direction of the foot in relation to the talus. Broca (6) was the first to provide nomenclature by classifying the injury as inward, outward, or backward. The most common direction of displacement is medial secondary to a plantarflexion inversion injury mechanism, which resembles and has been termed an acquired clubfoot deformity (7). Medial displacement occurs in between 80% and 85% of patients, with lateral displacement appearing between 15% and 20% of the time, and the remaining occurring in the anterior and posterior positions (8).

Open fractures are also frequently found in conjunction with these dislocations and are considered a serious complication. Additionally, the Gustilo-Anderson classification (9) can be used as a guideline when treating open fractures to administer proper antibiotic therapy. When sustaining a traumatic open fracture dislocation injury, complications such as neuritis, avascular necrosis (AVN), osteoarthritis, infection, malunion, and nonunion are a common result. The open fracture in our case study is classified as a Gustilo-Anderson IIIA based on the severity and soft tissue deficit (10). One of the major concerns with this particular type of fracture is disruption of the blood supply to the talus and the subsequent AVN. We present a case of an open Hawkins type II talar neck fracture with medial subtalar joint dislocation, which was treated with an open reduction internal fixation.

Case Report

We report on a case of a male, aged 57 years, who presented to the emergency department after falling 22 feet from a ladder, catching his left foot between the rungs resulting in an open fracture dislocation of his talus. After the accident, the patient crawled to his vehicle and drove himself to the hospital. On arrival to the emergency department, assessment of the patient revealed an obvious open gross deformity with exposed bone of his left foot and ankle, which was visibly contaminated with dirt. On physical examination, the talar body as well as the entire anterior ankle joint was observed to be extruding from an 8-cm soft tissue defect on the lateral aspect of the left foot and ankle with a

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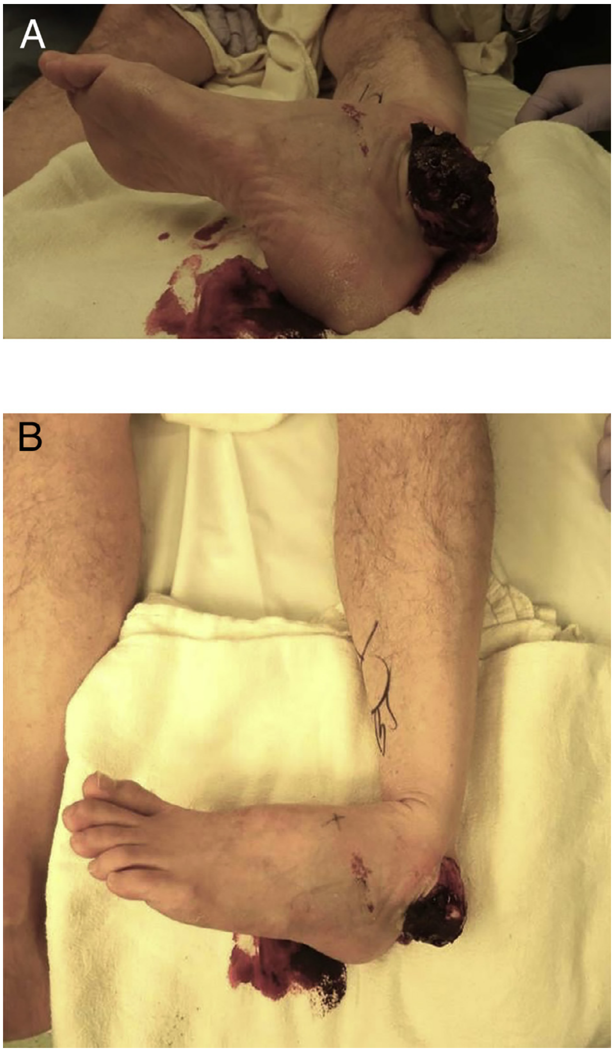

Fig. 1. (*A*) Visibly contaminated 8-cm soft tissue defect on the lateral left ankle with complete subtalar joint dislocation. (*B*) Anterior view exhibiting the extent of the open fracture dislocation deformity.

complete medial subtalar joint dislocation. (Fig. 1*A*, *B*) The dorsalis pedis pulse was graded at 2 out of 4, but the posterior tibial pulse was nonpalpable and nonaudible. Capillary refill time to the injured extremity was 4 seconds to all digits of the left foot compared with the right foot, which was immediate. Sensation was intact to the digits and motor function was also intact to the digits. Owing to the posterior tibial artery being compromised and the severity of the injury, the patient was immediately taken to the operating room. Preoperatively, the patient was started on intravenous cefazolin and clindamycin. The patient was placed supine on the operating table under general anesthesia with a thigh tourniquet applied to the left lower extremity. Intraoperative radiographs confirmed a talar neck fracture with a complete medial subtalar joint dislocation without disruption of the talonavicular or ankle joint (Fig. 2). Soil and debris were embedded at the talar neck fracture site and in the ankle joint (Fig. 3). The wound was irrigated with 6 L of antibiotic solution under pulsed lavage.

Open reduction was performed by distraction, plantarflexion, and supination of the foot to accomplish simultaneous reduction of the subtalar joint along with the talar neck fracture. Temporary fixation was then obtained by placing 2 guide wires from the 4.0-mm cannulated set within the talus. A 3-cm linear incision was made dorsally just lateral to the tibialis anterior tendon and the fracture was then fixated with two

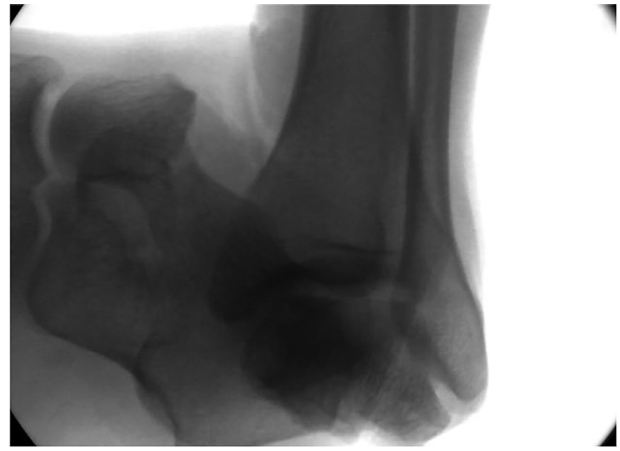

Fig. 2. Intraoperative anteroposterior projection of the talar neck fracture with medial subtalar joint dislocation with the talonavicular joint maintained.

Fig. 3. Intraoperative view of the distal tibia and talar body with embedded soil and debris within the fracture site.

4.0-mm cannulated screws. One screw was directed anterior to posterior through the dorsal incision and the other placed posterior to anterior through the existing laceration to achieve concentric compression. Proper anatomical reduction of the fracture was achieved. (Fig. 4*A*, *B*) Wound assessment revealed the anterior talofibular, calcaneofibular, and posterior talofibular ligaments along with the peroneal retinaculum were completely disrupted and were repaired. Further inspection of the soft tissue on the lateral aspect revealed the peroneal tendons to be intact and coursing properly. Skin closure was completed with 3-0 Vicryl and nylon suture, and silastic drains were inserted.

After successful reduction and screw fixation with the tourniquet released, the neurovascular status was noted to be intact, with a palpable posterior tibial artery. The patient's left lower extremity was then placed in a posterior mold fiberglass splint and he was instructed to remain non-weightbearing. The patient was admitted for 72 hours for intravenous gentamicin, cefazolin, clindamycin, and pain

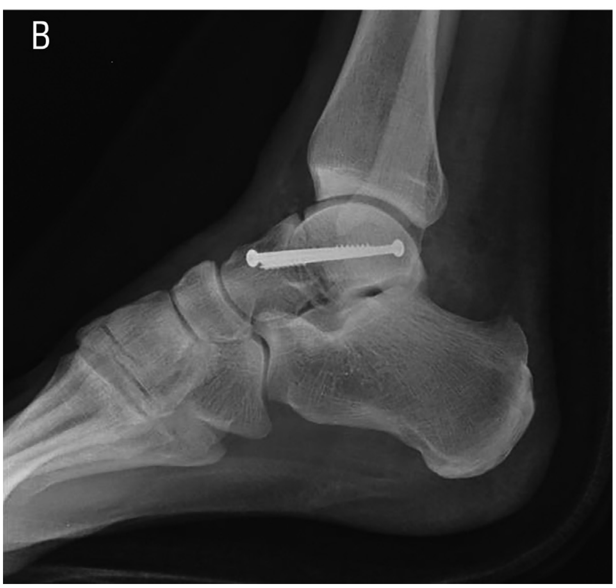

Fig. 4. (*A*) Immediate postoperative mortise projection. (*B*) Immediate postoperative lateral projection with anatomical reduction and antegrade−retrograde opposing lag screws. Noted minimal bone loss within dorsal fracture site owing to use of a burr for further soil contamination removal.

Fig. 5. Lateral projection 7 weeks postoperative of the Hawkins sign, sclerosis of the body of the talus, with the beginning stages of arthritis within the subtalar joint.

Fig. 6. Fourteen weeks postoperative lateral projection displaying delayed osseous union at fracture site , sclerosis of the body, with arthritis in the subtalar joint.

management. The patient was discharged on sulfamethoxazole and trimethoprim and kept non-weightbearing. The patient continued to be followed in our clinic and was transferred in to a controlled ankle motion boot 3 weeks postoperatively. At 7 weeks, a positive Hawkins sign could be appreciated on a standard lateral radiograph, but not on an anteroposterior or mortise view (Fig. 5). At 8 weeks, he was transitioned to partial weightbearing.

At 14 weeks postoperatively, increased hypertrophic and osseous bone formation within the subtalar joint consistent with posttraumatic arthritis and common with subtalar joint dislocation first appeared (Fig. 6). Also at this time, 2 blebs formed along the lateral aspect of the left ankle consistent with an abscess, and the patient was taken for incision and drainage, as well as bone biopsy with antibiotic bead placement. The bone biopsy was negative, but the surgical culture was positive for *Serratia fonticola* and the patient was then placed on 6 weeks of intravenous ertapenem by infectious disease. At 21 weeks, the patient was complaining of severe anterior ankle pain and motion was limited to approximately −15° of dorsiflexion to the left ankle joint and no motion within the subtalar joint. An arthrotomy and adhesiotomy was then performed, releasing extensive fibrotic adhesions from the ankle and talonavicular joint, and lengthening the contracted Achilles tendon. At 26 weeks, complete radiographic healing of the original fracture was noted (Fig. 7). The patient's last session of physical therapy was at 33 weeks with noted positive 5° of dorsiflexion to the left ankle. The patient continued to be followed periodically in clinic for 2.2 years postoperative and is currently being seen on an as-needed basis enjoying asymptomatic independent ambulation and a return to full activities.

Discussion

High-velocity, severe, open fractures predispose the individual to a greater chance of complications and an overall poor prognosis owing to

Fig. 7. Twenty-six weeks postoperative lateral projection showing complete radiographic healing at the fracture site, residual sclerosis interspersed with radiolucent areas in the body of the talus, and progression of the arthritic changes within the subtalar joint.

increased risks of AVN, subtalar joint arthritis, malunion, and infection. Proper open fracture management is of utmost importance when treating these types of injuries. Along with the primary survey and resuscitation per the Advanced Trauma Life Support protocols, principals have been established that encourage decreased rates of infection, improves bony union, and restores function (11). These principles include assessing and classification of the injury, prevention of infection, wound management, and fracture stabilization. As discussed, the Gustilo and Anderson classification (9), which was later modified by Gustilo et al (10) is the most accepted and widely used classification system for open fractures. Type I includes a minimally contaminated wound, which measures <1 cm. Type II is a moderate soft tissue injury with adequate soft tissue coverage and minimal comminution, which measures >1 cm. Type III has 3 subtypes. Type IIIA is a fracture with extensive soft tissue injury with adequate periosteal coverage. Type IIIB is a fracture with extensive soft tissue injury with periosteal stripping with contamination, with the possibility of further soft tissue coverage. Type IIIC is a fracture with arterial injury requiring repair. When treating according to the classifications the assessment of the injury needs to be accurate. According to Zalavras and Patzakis (12), to improve the accuracy of the classification of open factures, the extent and severity of the injury should be assessed only during surgery, after wound exploration and debridement, and not at presentation in the emergency department. Considering that open fractures have direct communication of the fracture with the outside environment, these injuries should always be considered contaminated. The severity of the injury correlates with the probability of infection, with Gustilo et al (9) reporting infection risks ranging from 0% to 2% for type I fractures, 2% to 10% for type II fractures, and 10% to 50% for type III fractures. Patzakis and Wilkins (13) found that, with progression of the Gustilo and Anderson classification, the rates of infection increased from 1.4% for type I to 3.6% for type II to 22.7% for type III fractures. The high suspicion of infection with open fractures drives the administration of intravenous antibiotic therapy as early as possible and is therapeutic in nature versus prophylactic. An open fracture without initial antibiotic treatment has been shown to result in increased rates of infection. In a study by Patzakis et al (14), a first-generation cephalosporin was shown to have a statistically significant reduction of 2.4% in infection rate with the administration of cephalothin compared with 13.9% with no antibiotic treatment.

Open fracture dislocations have a high rate of contamination and infection, which correlate with increased morbidity and poor outcomes. The infection rates range from 15% to 38% for open talar fractures in the literature (4,15,16). The usual initial treatment for open talar injuries is intravenous antibiotics with irrigation and debridement. Associated soft tissue injury, interrupted blood supply, and the incidence of dead spaces complicate effectively treating the infection, and a deep infection with a persistent draining wound can often be encountered. Coltart (17) concluded that excision of the talus is usually necessary once the talus becomes infected. Marsh et al (15) also recommended primary talar body excision for open injuries, which the talus extrudes through the wound, particularly if there is significant associated contamination.

With any open injury, wound irrigation and proper debridement should be instituted in a timely fashion. Open fracture management within 6 hours or the golden period from the initial injury is commonly quoted without adequate clinical evidence. In 1898, Friedrich (18) found that guinea pigs with open wounds and that were treated within 6 hours survived, and all those that were treated after 8.5 hours died. More recently in the literature, a number of studies are challenging that notion (13,19–21). Patzakis and Wilkins (13) found that 6.8% of 396 open fracture wounds debrided within 12 hours became infected and that 7.1% of 708 debrided after 12 hours became infected. Bednar and Parikh (19) reviewed 82 open fractures and found no significant difference in deep infection rates with those treated within or after 6 hours. They concluded that the 6-hour rule showed no benefit in fracture management and was predicated mainly on historical opinion and laboratory data. Skaggs et al (20) reported on a study involving patients <18 years of age, showing that 3% of 344 open fractures treated within 6 hours became infected versus only 2% of 210 treated ≥7 hours after injury became infected. Early antibiotic administration is likely more significant than the time of injury to surgical debridement.

Surgical debridement and irrigation are of absolute importance in decreasing the prevalence of infection and should be initiated in an emergent manner. Removal of all devitalized tissue should be performed from superficial to deep with sharp debridement (11). After removal of nonviable skin and fascia, the muscle viability needs to be evaluated by inspecting color, contractibility, consistency, and bleeding. Debridement of bone is accomplished in the same manner. Removal of foreign material or contamination from bone ends can be performed with a small curette or, as in the presented case study, a power bur. All larger bone fragments should be retrieved for possible reconstructive and fixation purposes. After all debridement and removal of devitalized soft tissue, irrigation can be performed. Options regarding the type of delivery method, volume, and additives vary. A study that included a survey of 984 international orthopedic surgeons found no consensus but that a low-pressure irrigation system with normal saline in the amount of <3 L for grade I, 3 to 6 L for grade II, and grade III were preferred (22). Anglen (23) recommended 3 L, 6 L, and 9 L for grades I, II, and III, respectively, with high pressure for highly contaminated wounds and low pressure for low level of contamination. Anglen (24) also compared soap with antibiotic solutions in a prospective, randomized study and concluded that a nonsterile soap additive, such as castile solution, was at least as effective as the use of bacitracin solution.

Osseous stabilization in open fracture management is an important principle that expedites soft tissue healing, allows for mobilization, reduces pain, and facilitates functional rehabilitation. There are various forms of stabilization including internal fixation, external fixation, and casting. The method chosen for fixation of the fracture is contingent on the location of the fracture, extent of soft tissue damage, and contamination. Casting or splinting is usually an initial treatment for temporary fractures stabilization until surgical intervention can take place. External fixation is beneficial in the presence of severe soft tissue damage, highly contaminated, and/or comminuted open fractures. The functionality of this method allows for expedited stabilization and avoids hardware implantation without further vascular disturbance or soft tissue damage. Internal fixation with plate, screws, or both is appropriate when rigid fixation is needed. Combinations of different methods may also be implemented given the situation. As in the present case scenario, talar neck fractures are suitable for screw fixation. A posterior approach, either by percutaneous or open access, has been found to provide superior compression over anterior approach alone. Swanson et al (25) found that posterior-driven 4.0-mm screws could be placed more perpendicular to the fracture line, and therefore provided improved stability and compression. Screws may also be placed in opposing directions, as in the present case and in the literature. Abdelkafy et al (26) presented 8 patients with an oblique talar neck fracture, which were treated with an antegrade–retrograde opposing lag screw fixation and found that this form of fixation seemed to provide satisfactory fixation and functional outcomes. Primary arthrodesis is also a viable option, along with initial osseous stabilization in high-energy complex talar fractures in addition to the presence of possible noncompliance and problematic social circumstances.

AVN is a frequent complication with an increasing occurrence directly correlating with the severity of the talar dislocation and damage to the vascular supply. The major arteries supplying the talus that can be at risk are the dorsalis pedis, posterior tibialis, and peroneal arteries. The sinus tarsi artery, which normally branches primarily from the dorsalis pedis artery, supplies the lateral aspect of the body, neck, and head of the talus. The peroneal artery anastomoses with the posterior tibialis artery through the calcaneal branches and the dorsalis pedis artery through the sinus tarsi via the perforating peroneal artery. The posterior tibialis artery branches to form the artery of the tarsal canal, which supplies the middle of the body of the talus. The deltoid branches, which arise from the artery of the tarsal canal, supply the medial aspect of the talus and are usually the last remaining sources of blood supply in cases of fracture dislocations (27). Intraosseous blood supply to the head and neck originate directly from the anterior tibial artery and from the sinus tarsi artery. The artery of the tarsal canal provides most of the intraosseous supply to the body. Haliburton et al (28) described a sling anastomosis of the sinus tarsi artery and the artery of the tarsal canal, which enters anteroinferiorly at the neck of the talus and is the major contributor to the blood supply to the body. The more severe the injury, the more likely disruption of these vessels will occur and, thus, the greater the chance AVN will develop. Peterson and Goldie (29) found that displaced talar neck fractures result in disruption of the dorsalis pedis artery, artery of the tarsal canal, and the sinus tarsi arteries. Hawkins (3) and Vallier et al (30) found that, especially in Hawkins group II injuries, 42% and 39% of the patients developed AVN, respectively. Patients who sustain open fractures are found to develop osteonecrosis significantly more frequently than patients with closed fractures. AVN is recognized radiographically as sclerosis of the talar body and is usually a late occurrence after an injury, although it can be seen as early as 4 weeks and as late as 10 months (3,31,30,27,32). A possible earlier sign to predict the likelihood of an AVN is the Hawkins sign, which is a band of radiolucency found in the subchondral bone of the talar dome. It can be seen radiographically on anteroposterior and mortise views 6 to 8 weeks after the fracture dislocation (3). The finding is a sign of disuse osteopenia, and is used as a prognostic sign of revascularization, and is indicative of remodeling. Penny et al (33) concluded that, if this lucent line was absent in the talus but found in the distal tibia, AVN can be presumed. The absence of the Hawkins sign is not necessarily considered a prerequisite for AVN and was found to have a sensitivity of 100% and a specificity of 57.7% by Tezval et al (32). Additionally, Canale and Kelly (4) found that, out of 23 patients with a positive Hawkins sign, 1 developed AVN, and 6 out of 26 patients without a Hawkins sign did not develop AVN. The presence of AVN can also be found using magnetic resonance imaging, along with the extent of necrosis to the talar dome. If it does develop, distinction between partial and total AVN is of importance to guide proper treatment plans. The talar dome can eventually undergo revascularization by creeping substitution or can lead to talar dome collapse. Vallier et al (30) found that revascularization occurred on average at 35 weeks and talar dome collapse occurred on average at 39 weeks. He also concluded that progression to talar dome collapse was found to occur in 89% of the cases of AVN with open fractures in their study (30).

The incidence of malunion from inadequate reduction, which can occur dorsally or plantarly and/or in a varus or valgus position, is a pertinent concern and commonly found to be the main culprit leading to adverse outcomes in these patients. Canale and Kelly (4) found, especially in Hawkins type II fractures, that malunited fractures usually resulted in a dorsal or varus position. Dorsally positioned malunions resulted in pain with restricted dorsiflexion, whereas the more common varus malunion resulted in a varus positioned foot with rotational deformity causing increased weightbearing and ground reactive forces to the lateral aspect of the foot. These malunions increase the odds of secondary degenerative changes, especially in the subtalar joint, and should be addressed. Appropriate identification of these malunions should be confirmed radiographically. Dorsal or plantar malunions can be evaluated on a lateral radiograph, whereas varus and valgus malalignment can be identified on a modified anteroposterior technique introduced by Canale and Kelly (4). The foot is placed in maximum equinus and positioned in 15° of pronation with the beam directed 75° from the horizontal plane. Poor results from these type II fractures are almost invariably owing to subtalar symptoms and usually represent the sequelae of varying amounts of malunion (33).

Posttraumatic arthritis was briefly mentioned as being associated with these complications, such as AVN and malunion, but even with adequate anatomical reduction and internal stable fixation with intact blood supply, it can still be a common complication. Canale (31) found that subtalar joint arthritis occurred in 69% of talar neck fractures, and most frequently with types II, III, and IV. Ebraheim et al (34) expanded on this, concluding from a systematic review that posttraumatic arthritis presented in 25.00% of type I fractures, 41.33% of type II fractures, 54.23% of type III fractures, and 72.73% of type IV fractures. Their findings correlate with Szyszkowitz et al (35), who state that the severity of the injury directly correlates with the incidence of arthritis and Vallier et al (30), who identified trends associating posttraumatic arthritis and history of an open fracture. This likelihood of arthritis increases the necessity of secondary reconstructive procedures consisting of subtalar or tibiotalar joint arthrodesis in the presence of intractable pain and limitation at the involved joints.

In conclusion, severe traumatic injuries involving the talus are rare and prone to several debilitating complications, which frequently lead to a poor prognosis. These complications are significantly magnified with associated open fracture dislocations with an even higher rate of morbidity. A stepwise approach, including proper antibiotics, timing of surgery, and anatomical reduction and fixation, all play a vital role in minimizing complications and improving overall functional capacity of the patient.

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