Talar Neck Fracture Reduced and Stabilized with an Ilizarov External Fixator: A case report with three year follow up

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The authors report a case of a Grade 3 Tscherne, isolated Hawkins Type III fracture that was treated with open reduction and external fixation. The Ilizarov technique simplified the surgery by allowing the reduction of the diastasis using a tensioned olive wire, providing distraction of fracture bones externally, and aid in reduction of the talus without the need for multiple, extensive dissection. The patient responded very well to the surgery, despite occurrence of avascular necrosis of the talus and three years status post surgery. The patient has good range of motion, is pain-free, and ambulates without difficulty despite having avascular necrosis.

Key words: Talar fracture, Hawkins classification, Hawkins sign, Ilizarov technique, diastasis, avascular necrosis.

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Talar fractures have been described since the early 1600's.[1] In early literature, open talar fractures had an 84% mortality rate.[3] Due to the high mortality rate, surgeons advised extreme measures such as below knee amputations or talectomy.[1] Since then, the surgical technique for these fractures has vastly improved. However, these types of fractures, thought not fatal, still prove to be very challenging today. Talar fractures are rare, making up only 3% of all foot fractures.

Talar fractures can be classified as open or closed. The Tscherne soft tissue classification system describes both open and closed fractures.[9,17] (Table 1) For the closed soft tissue injuries, Tscherne uses a grading system from 0-3 and is based on the amount of the injury. Grade 0 is minimal soft tissue damage from indirect violence. Grade 1 is a superficial abrasion or contusion caused by pressure from within. Grade 2 is a deep contaminated abrasion associated with local skin or muscle contusion and may encompass a compartment syndrome. Grade 3 consists of extensive skin contusion or crushing, underlying severe muscle injury, decompensated compartment syndrome, and associated vascular injury.[9]

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Grade 1	Superficial abrasion or contusion caused by pressure from within
Grade 2	Deep contaminated abrasion with local skin or muscle contusion. May have compartment syndrome.
Grade 3	Extensive skin contusion or crushing with severe muscle injury and vascular injury. Decompensated compartment syndrome noted.

Table 1 Tscherne Classification.

Type I	Non-displaced talar neck fracture	Rare to see AVN
Type II	Talar neck fracture with mild displacement. Subluxing of subtalar joint.	15.8-75% chance of AVN
Type III	Talar neck fracture with moderate displacement. Subluxing of subtalar and ankle joint.	33-75% chance of AVN
Type IV	Talar neck fracture with severe displacement. Subluxing of subtalar, ankle, and talonavicular joint.	95-100% chance of AVN

Table 2 Hawkins Classification. (AVN – avascular necrosis)

Talar fractures can be further divided into three anatomical locations: neck, body and head. Talar neck fractures comprised of 50% of all talar fractures.[2] The most commonly used classification system for talar neck fractures is Hawkin's Classification (Table 2). This classification has four types, which are differentiated by the degree of displacement. Type I is a non-displaced talar neck fracture. Type II is a talar neck fracture with mild displacement and subluxing from the subtalar joint. Type III is displacement of the talar body with dislocation of subtalar and ankle joint. Type IV is a combination of Type III with dislocation of the talonavicular joint.[1] The higher the grade, the greater the risk is for complications.

Blood supply to the talus may be an issue if one delays reduction or inadequately treats these fractures.[3] Avascular necrosis (AVN) of the talar body and arthrosis after displaced talar neck fractures is quite common; the higher the grade, the larger chance of AVN. In an article by Gholam et al, they described nine cases of Hawkins Type III fractures, and eight of the nine developed arthrosis.[3] In Hawkins Type I fractures, it is quite rare to see AVN. However in Hawkins Type II, there is a 15.8%-75% chance.[1] In Hawkins Type III, the chance of AVN increases to 33-75%.[1] Hawkins Type IV has the highest chance, reaching almost 100% due to the amount of displacement and disruption of the blood supply to the talus.[1] Subchondral atrophy of the talar dome, also called Hawkins Sign, indicates an intact blood supply to the talus.[3] It is essential to be aware of AVN so it can be treated promptly.

Various treatment options exist for talar neck fractures. Some surgeons prefer using a compression screw across the fracture fragment, while others prefer a plate. In a study performed by Charlson, et al., plate fixation and screw fixation were compared. No statistical difference between either method was found. Plate fixation may provide more control of the anatomical alignment, but has no biomechanical advantage over screws alone.[4] There are very few cases reported in the literature of an isolated talar neck fractures treated with external fixation. However, there are many cases of multiple fractures (talus with calcaneus or talus with medial/lateral malleolus) successfully treated with external fixation. The purpose of this paper is to report a Grade 3 Tscherne, isolated and displaced Hawkins Type III talar neck fracture that was specifically treated with open reduction and external fixation. By determining how much soft tissue injury and the extent of talar fracture, external fixation can be more superior to internal fixation. In this case, the Ilizarov technique is ideal when there is soft tissue injury, vascular compromise, and displaced talar neck fracture.

Figure 1A and B Note the severe contracture of all the toes. (A) Note the contracted hallux and lack of blood flow to the medial ankle where the talar body is compressing the skin and posterior tibial artery. (B)

Figure 2A and B Non-weight bearing lateral view. Note the overlap of the talus onto the calcaneus. (A) Note the fracture fragments in the ankle. (B)

Case Report

The patient is a 40 year-old correctional officer who was riding a recreational vehicle at the time of his injury. (Fig. 1A and B) He reported jumping off the vehicle due to faulty breaks, resulting in a severe talar neck fracture. (Fig. 2A and B). The mechanism of the traumatic injury was that of hyperdorsiflexion of the foot against the tibia in an axial force with impingement of the talar neck.

As the force continued, there was a medial and dorsal displacement fracture of the talus, and disruption of the interosseous talocalcaneal ligament. Also, the posterior and subtalar joint capsule were disrupted. As the ankle supinated, there was increased force of the talar neck against the medial malleolus resulting in subluxation of the subtalar joint and ankle joint. It was quite severe such that the medial ankle was blanching and becoming necrotic.

Figure 3 1) Medial surface of the talus. 2) Anterior or distal surface of the talus. 3) Lateral surface of the talus. 4) Posterior process of the talus with entrapped flexor hallucis longus (FHL) and posterior tibial (PT) tendons and PT artery. Note that the toes are at the upper left and the leg is at the lower right.

Figure 4 Dislocated and rotated talus. 1) Medial surface of the talus where the deltoid ligament is shown to be torn. 2) The posterior aspect of the talus: The posterior tibial tendon, posterior tibial artery and FHL are entrapped. 3) Lateral surface of the talus. 4) Talar dome. 5) Anterior surface of the talus.

The flexor hallucis longus (FHL) and flexor digitorum longus (FDL) tendons were also contracted, such that the hallux and lesser toes were severely plantarflexed.

The dorsalis pedis artery was palpable, but the posterior tibial (PT) artery was being compressed and not palpable or heard using a Doppler. There was soft tissue damage and vascular supply was compromised. The patient opted to have surgery and informed consent was obtained from him to allow us to study and present this case. An open reduction was performed with the use on an Ilizarov frame immediately.

Surgical Technique

A large curvilinear incision was made on the medial ankle overlying the talus, extending distally and proximally from the area of blanching. (Fig. 3) The incision was deepened to the subcutaneous tissue and then to the deep tissue. The entire talar dome was noted at the incision site. (Fig. 4) The deep tissue was retracted. Once past the deep tissue, we noted that the posterior tibial artery was being compressed by the talar body. The talar body was exposed, and it was completely displaced and rotated out of the ankle and subtalar joint. There was a large hematoma and multiple small fracture fragments in the ankle joint. The hematoma was evacuated, and the small fracture fragments were removed. The wound was also copiously irrigated with bacitracin-impregnated saline. Then, attempt at relocating the dislocated and fractured talus was performed; however, there was much contraction of the tibia onto the calcaneus that it was extremely difficult to retract. Thus an external fixator was employed to distract the tibia from the calcaneus in order to relocate the talus.

First, two tibial rings were applied to the lower leg. Then a foot plate was applied, and all the wires were appropriately tensioned. Several distraction rods were used to connect the tibial rings to the foot plate, and then the foot was distracted. By distracting the tibia from the calcaneus, it made it much easier to rotate the talus and slide it between the tibia and calcaneus back into anatomical alignment. The fractured talus was anatomically reduced and held in place by an external fixator. Once the fracture was reduced, the severe skin tension on the medial side of the foot decreased.

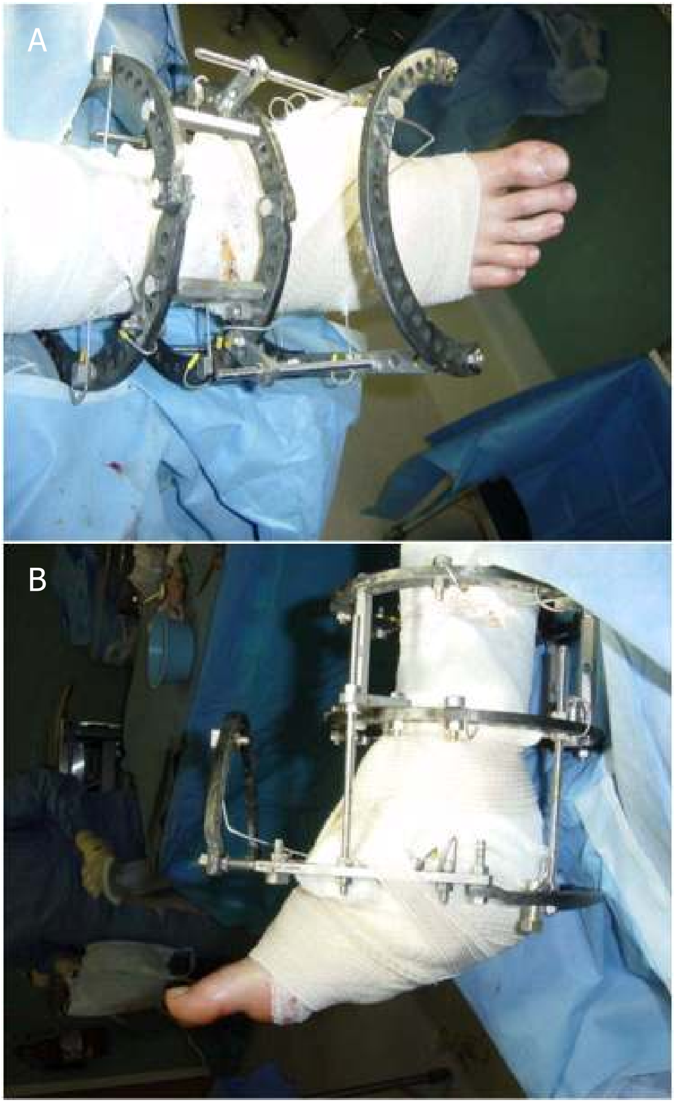

Figure 5A and B Post-operative site with the Ilizarov Frame.

A Doppler placed over the PT artery now showed good blood flow. Also, the FHL and FDL tendons became more relaxed, and the contracture over the hallux and lesser toes were reduced. A series of photographs shows the alignment of the Ilizarov frame directly after surgery (Figs. 5A and B, 6) and at 3 weeks after surgery. (Figs. 7A and B)

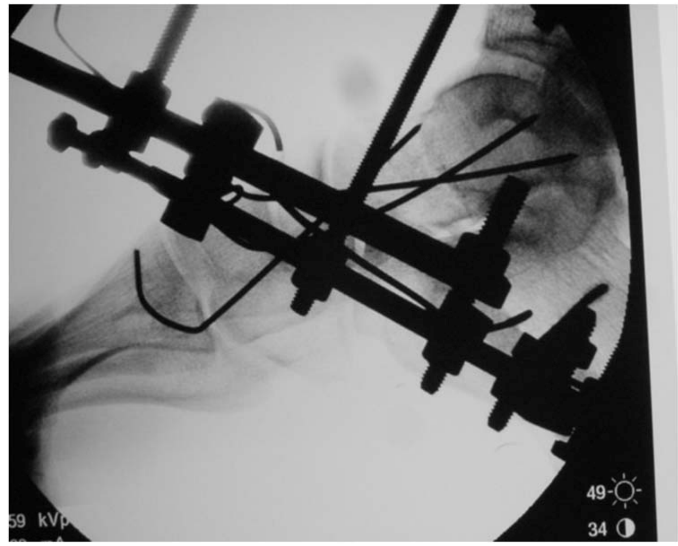

Figure 6 Post-operative reduction of the talar fracture in good alignment.

Results

A one year follow-up showed that his hallux range of motion was normal and his ankle healed in good alignment and anatomical position. This was accompanied with good range of motion, without pain, and with normal ambulation. However, despite the proper care and good post operative alignment, there was still sclerosis of the talar body which indicated that there was indeed avascular necrosis present. He remained non-weight bearing for 6 months and then weight bearing using a pneumatic cam walker for an additional 6 months. After this the patient went back to working 8 hours a day as a corrections officer and it was explained to him of the possible collapse and further complications from the osteonecrosis of the talus and to limit any vigorous activities. He was again followed up at 2 years and at 3 years after the initial traumatic event. He did have an increase in plantar flexion, and adequate dorsiflexion towards the end of the follow-up. He had no pain and was satisfied with the surgical outcome. He however, did have sclerosis of the talus but without any evidence of collapse. (Table 3)

Time after surgery	Pain Scale (1-10)	Range of motion ankle	Patient function	Signs of AVN
6 months	3	5 DF 10 PF	Non-Ambulatory	Sclerosis of the talus
1 years	1	10 DF 15 PF	Ambulatory	Sclerosis of the talus
2 years	1	10 DF 20 PF	Ambulatory	Sclerosis of the talus
3 years	1	10 DF 25 PF	Ambulatory	Sclerosis of the talus

Table 3 Patient 3 year follow-up results. (DF – dorsiflexion, PF – plantarflexion, AVN – avascular necrosis)

Discussion

The complex nature of high energy talus fractures can pose complications that can challenge most foot and ankle surgeons. The complexity arises because of the blood supply to the talus being extremely vulnerable after a traumatic injury.[10] Short term complications can result in skin necrosis, wound dehiscence, and infection.[11,12] Additional complications of comminuted fractures involving the talar neck and body carry a risk of AVN due to the retrograde blood supply.[13] Injury to the joints surrounding the talus can cause irreversible osteochondral damage that could lead to possible early post traumatic arthritis or arthrosis. In this report, we have a patient with a closed talar neck fracture with vascular comprise. The case is further complicated by additional factors that included the medial ankle developing blanching and ultimately becoming necrotic, the posterior tibial artery being compressed, and the FHL and FDL tendons being contracted such that the hallux and lesser digits were severely plantarflexed.

Treatment options evolved from reduction and immobilization, to limited fixation, and currently, open reduction internal fixation being performed on most talar fractures.[14] Included in the literature are recommendations for primary arthrodesis or talectomy for severe talar fractures.[15] In this case, an external fixator was applied due to the severe contracture of the tibia onto the calcaneus. The Ilizarov external fixator allowed for distraction of the tibia from the calcaneus and this allowed for reduction and rotation of the talar body in its anatomical location.

Also, because of the volatile nature of the fracture and the additional soft tissue complications and its increased probability for an osteonecrosis sequelae, external fixation was utilized because it is commonly implemented and indicated for compromised soft tissue structures and gross instability.[16]

In this case, the patient was destined to have avascular necrosis due to the talar neck fracture which according to the literature has up to a 75% chance to develop the condition even with the utmost care and precautions.[1,14] This was exacerbated by the ruptured medial deltoid ligaments causing a dislocation of the talus. In examining the talus, it is a unique bone in the foot in that it has no muscular attachments with about 60% of the talus is covered with articular cartilage. These anatomical features make the talus vulnerable to dislocation. Extreme forces can cause dislocation of the talus out of the ankle mortise with disruption of the strong ligamentous attachments and this may have accounted for the medial deltoid ligament ruptures present in this patient.

This dislocation most likely caused tremendous vascular damage to this already intricate arrangement of vessels that are highly vulnerable to injury. The anterior tibial, PT, and perforating peroneal arteries serve as the vascular supply to the talus. The artery of the tarsal canal is a branch of the PT, and it supplies most of the talar body, the medial talar wall, and the undersurface of the talar neck. The artery of the tarsal canal anastamoses with the artery of the sinus tarsi, which is a branch of the perforating peroneal artery, and these vessels supply the inferior aspect of the talar body and neck.[18]

Figure 7A and B Three weeks post- operative view.

Figure 8A and B Six months after surgery.

As the talus dislocates from the ankle mortise, there is sequential failure of the talar blood supply. Since the blood supply to bone and soft tissue are so intertwined, it has been noted that osteonecrosis was highest in cases in which no soft tissues remained attached to the talus.[19]

In this patient, this risk of avascular necrosis was increased and seen when the soft tissue along the medial aspect of the foot became de-vascularized and necrotic.

It is recommended that the patient should be non-weight bearing or protected weight bearing until the avascular necrosis resolves,[19,20] however there is no definitive evidence to suggest that full weight bearing with avascular necrosis leads to secondary complications such as collapse of the talar dome and tibiotalar arthritis. [21] This is further exemplified by this case where the patient, even at a three year follow up with avascular necrosis of the body of the talus, shows that his ankle is in good alignment, has not collapsed, shows no evidence of varus or valgus, has good range of motion, no pain, and ambulates normally. (Figs. 8A and B, 9, 10A and B)

Figure 9 Three years after the initial injury.

By using the Ilizarov External Fixator, the talus was immobilized and held in place such that no axial pressure was placed onto the talus while healing took place.

Conclusion

Talar fractures are very complicated with a high incidence of AVN. We feel that if there is much difficulty in reducing the talar fracture from the tight tibial collapse onto the calcaneal surface, an external fixator is very beneficial in distracting the tibia from the calcaneus. In the above case, we used the multiplaner Ilizarov external fixator. He did have a severe fracture and dislocation of the talus which eventually resulted in AVN. At this moment, the patient states that he is pain free, and examination showed good ankle and subtalar joint range of motion. It is very important to have the patient frequently visit the office to make sure the talus is not collapsing and to explain to the patient that possible future surgeries, such as total ankle joint implant, subtalar joint arthrodesis, triple arthrodesis, or ankle fusion, may be necessary if the talus collapses as a consequence of AVN.

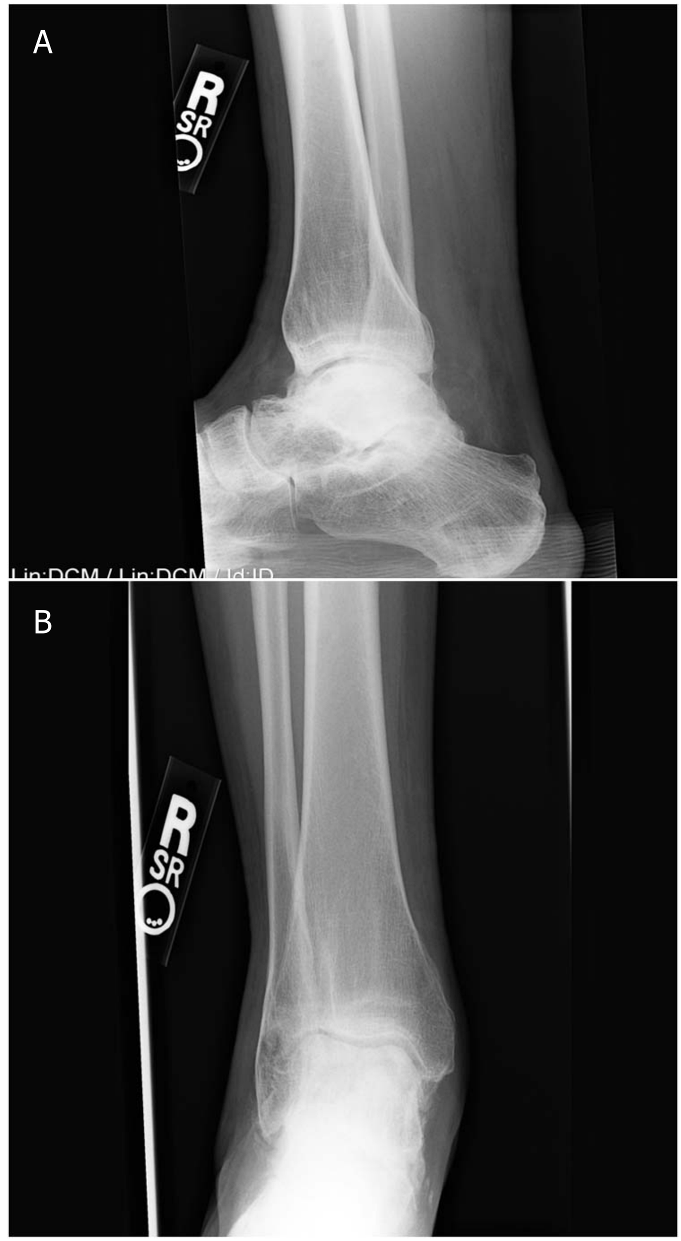

Figure 10A and B Weight-bearing lateral view of the ankle, three years status post-operative, shows AVN of the talus, but good alignment. There is no pain, no collapse of the talus, and the patient has good ankle range of motion. (A) Weight-bearing anterior posterior view of the ankle, three years status post-operative shows AVN of the talus, but good ankle joint congruity. (B)

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