

## Case Report

# Calcaneal tuberosity fractures through prior Schantz pin sites in patients with diabetic neuropathy

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## ABSTRACT

Schantz pin placement in the calcaneal tuberosity is a common procedure known to be complicated by pin site infections and nerve injuries. Fractures through Schantz pin sites has been reported mostly in diaphyseal bone. This case series highlights three patients with type 2 diabetes mellitus and diabetic neuropathy who were fixed in an external fixator frame with a pin through the calcaneal tuberosity. At an average of 13 weeks, the patients presented with fracture through the pin site at the calcaneal tuberosity. One patient was treated with open reduction and internal fixation of the calcaneus and two patients were treated nonoperatively. These cases suggest that placement of calcaneal pins in patients with diabetic neuropathy harbors risk of iatrogenic fracture, a complication that has not been reported in the literature.

## 1. Introduction

Schantz pin placement in the calcaneal tuberosity is a common procedure. Pins are inserted for a myriad of reasons, most commonly during ankle-spanning external fixator placement. Optimal pin placement is based upon risk of injury to the medial vascular and sensory nerve structures [1–3]. Presented here are three diabetic patients who sustained calcaneal tuberosity fractures through previous Schantz pin sites, despite apparent optimal placement.

## 2. Case series

A 5 year retrospective review of all patients undergoing calcaneal Schantz pin placement between 2011–2016 in a single institution was performed. Over that period, 133 trans-calcaneal pins were placed with either a 5 mm or 6 mm centrally threaded calcaneal pin. Apart from the patients illustrated below, no post-instrumentation fractures of the calcaneal tuberosity were identified.

### 2.1. Case 1

A 59 year old male with non-insulin dependent type II diabetes mellitus who sustained a closed pronation abduction ankle fracture with syndesmosis disruption following a ground level fall (Fig. 1A). A non-smoker with no history of steroid use and no prior history of lower extremity trauma, the patient exhibited a hemoglobin A1c level of 7.1

near the time of injury. He had a stocking glove peripheral neuropathy from his mid-calf distally. There was no history of Charcot arthropathy based upon comprehensive lower extremity imaging.

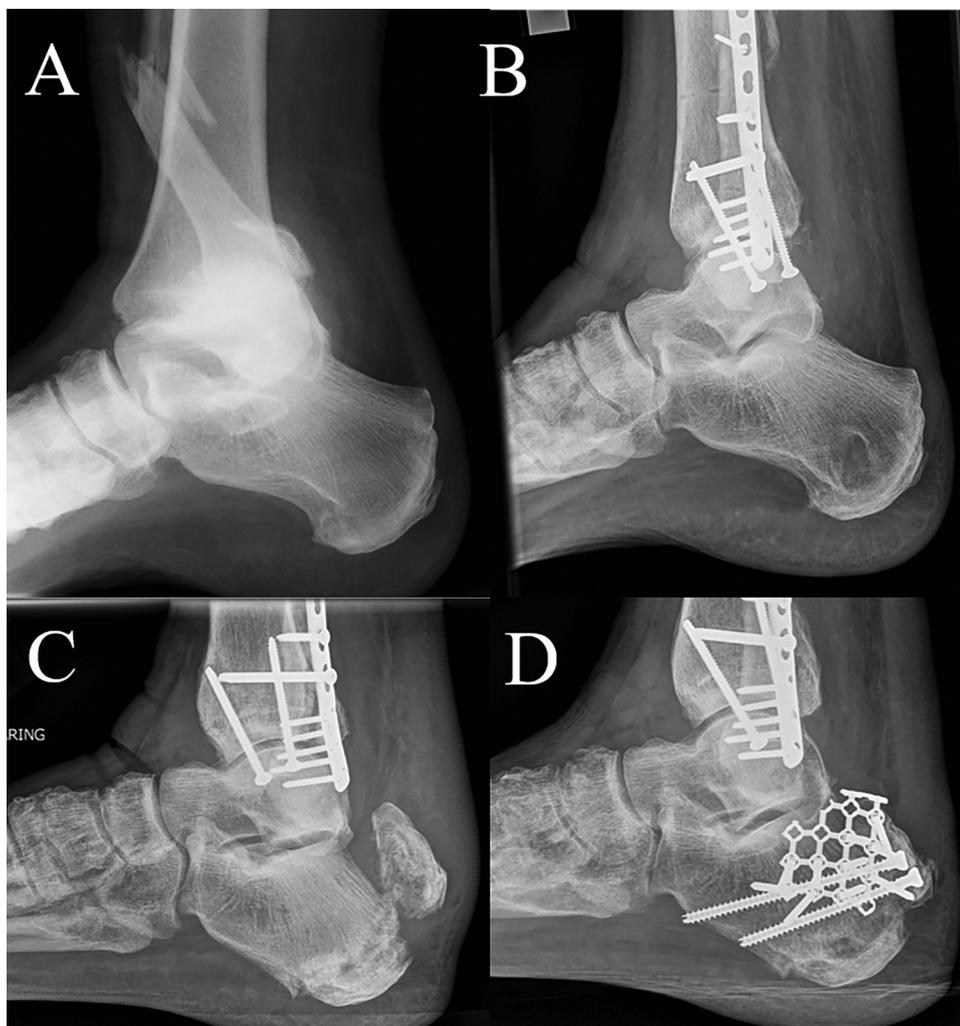
This patient was treated in a staged manner due to the formation multiple serous fracture blisters. A spanning external fixator was applied. A 5 mm cancellous pitch centrally threaded Steinman pin was placed into the medial calcaneus under fluoroscopic guidance in the manner described by Casey, et al. [3]. Two weeks later, the fracture underwent uneventful open reduction and internal fixation (Fig. 1B) at which time the calcaneal pin was removed. The peri-operative period was uneventful. He was prescribed nonweightbearing for 10 weeks after which he was allowed 50% weightbearing. Following compliance with partial weightbearing, the patient returned two weeks later complaining of swelling without pain in the ankle. He denied any new trauma to his affected limb. Radiographs revealed a calcaneal tuberosity fracture through the prior calcaneal pin tract (Fig. 1C). The fracture was initially treated closed with protected weightbearing. After 6 weeks from detection of the calcaneal tuberosity fracture, greater than 3 months from the original ankle fracture, the fracture fragment was still not healed. The patient elected to undergo tuberosity fragment fixation and gastrocnemius release. For this most recent procedure, the patient experienced uneventful healing, and a greater than 6 month follow up demonstrated healing of all fractures (Fig. 1D). He was able to return to his pre-injury level of functioning including his occupation as an office worker.

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**Fig. 1.** Case 1. (A) Lateral ankle radiograph demonstrating a pronation abduction ankle fracture. The patient was treated in a staged manner with a spanning external fixator followed by (B) open reduction internal fixation of the lateral and medial malleoli. (C) 12 weeks following removal of the external fixator the patient complained of ankle swelling, Radiographs revealed a calcaneal tuberosity fracture through the prior calcaneal pin tract. (D) The patient had tuberosity fragment open reduction internal fixation. Lateral ankle radiographs demonstrated fracture healing at 6 months follow up.

## 2.2. Case 2

A 46 year old male with insulin dependent diabetes. He sustained a comminuted Gustilo-Anderson Type III-A pilon fracture. A non-smoker with no steroid use history, the patient exhibited a hemoglobin A1c level of 9.1 two weeks prior to injury. The patient similarly demonstrated bilateral stocking glove neuropathy from his mid-calf distally. The patient exhibited no signs or symptoms of Charcot arthropathy based upon radiographic or clinical assessment.

Due to soft tissue swelling, the patient was treated in a staged manner as proposed by Sirkin et al. [4], with the initial intervention consisting of wound debridement and irrigation, wound closure, and application of a distraction ankle-spanning external fixator as previously described. The patient underwent an uneventful open treatment of his tibial pilon fracture once soft tissue quiescence was achieved at 5 weeks at which time calcaneal pin was removed.

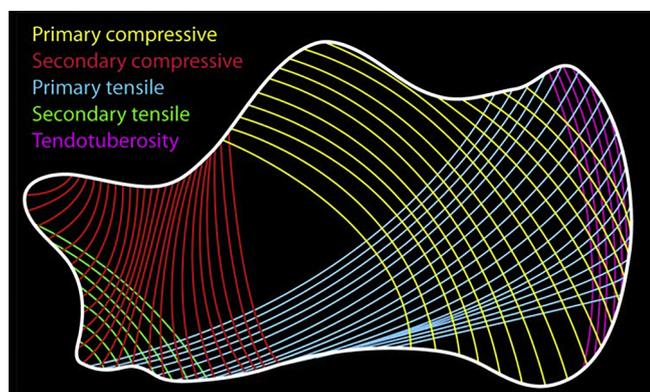
He was prescribed weightbearing as tolerated 14 weeks after the definitive internal fixation. At 7 months after the index procedure, he complained of new heel pain. He denied any new trauma to his leg. His radiographs exhibited an extra-articular fracture of the posterior calcaneus. He was made nonweightbearing for three months followed by weightbearing as tolerated in a CAM boot. The calcaneus fracture went on to heal without complication.

## 2.3. Case 3

The patient presented to the emergency department in a subacute fashion, 2–3 weeks after the occurrence of the injury, with significant ankle swelling and medial skin compromise. The decision was made to treat this patient initially in a staged fashion. A spanning external fixator was applied in the manner previously described. Due to a poor soft tissue envelope, open reduction was not performed and the patient was treated definitively in the external fixator. His external fixator was removed at 5 weeks. He was permitted weightbearing as tolerated at 6 weeks. Three months from his original injury, the patient returned to clinic with a new displaced avulsion fracture of the calcaneal tuberosity. He denied recent trauma. An attempt was made to treat the tuberosity fracture closed. This patient did not return for subsequent follow up.

## 3. Discussion

Schantz pins are commonly placed into the calcaneal tuberosity. The principle complications seen in this procedure are pin site infections and injury to cutaneous sensory nerve branches that traverse the operative field on the medial side. To diminish the risk of iatrogenic nerve injury, a safe zone for calcaneal pins has been described [3]. This area defined as being posterior to half the distance from the posteromedial



**Fig. 2.** Compressive forces are transmitted from the subtalar joint to the inferior aspect of the calcaneal tuberosity. Tensile forces are transmitted longitudinally along the length of the calcaneal body. The optimal site for Schantz pin placement is at the intersection of the compressive and tensile stresses, which might be prone to complications such as fractures (with permission from Behrang Amini, MD/PhD).

calcaneus to the inferior medial malleolus and one-third the distance from the posteromedial calcaneus to the navicular tuberosity. Despite meticulous adherence to this method, anatomical variations in the lateral plantar and medial calcaneal nerve in particular is still possible, and the authors allude that more posterior placement within this zone is the safest.

Fractures through pin sites are a known complication of Schantz pin placement, nearly exclusively reported in regions of diaphyseal bone [5–7]. Hearty reported on a distal femur fracture through a pin track one year after removal that resulted from low-energy twisting injury [8]. Another case series reported late fractures through tibial pin tracks used in navigated total knee arthroplasty. These fractures occurred at an average of 12.6 weeks post-op, similar to the time course of our patients (13 weeks) [7]. The pediatric population has been shown to be vulnerable as well, with reports on five patients with pin tract fractures of the femur [5].

The calcaneus may be prone to this complication biomechanically. Within the calcaneus, compressive forces are transmitted from the subtalar joint to the inferior aspect of the tuberosity. Likewise, tensile forces are transmitted longitudinally along the length of the calcaneal body (Fig. 2). The optimal site for Schantz pin placement is at the intersection of the compressive and tensile stresses [9]. One cadaveric study examined the biomechanics of calcaneus pin sites and suggested that 6 mm external fixator pins creates a 22% reduction in compressive load to failure of the calcaneus and pose a significantly large stress riser. In light of their findings, the authors suggested that weightbearing precautions may be warranted after pin removal [10]. We are aware of no series reporting such fractures *in vivo*.

This series highlights another complication of pins even when placed within the “safe zone.” Diabetic patients are inherently prone to lower extremity fractures. The Women’s Health Initiative found an increased risk of hip, ankle, and foot fractures in female diabetics [11]. A separate meta-analysis found an increase in hip fracture risk in all diabetics. In fact, long-term diabetes and neuropathy *independently* raise the risk of both hip fractures and fractures in general [12,13]. Of particular note given the patients presented here, the density of calcaneal bone in Charcot foot is known to be lower than that of normal controls, and Type I diabetics have been shown to be more prone to calcaneal fractures than the general population [14,15].

None of these patients developed pin site infections or any other complications related to external fixation. They also exhibited no clinical or radiographic evidence of Charcot arthropathy. Further, the fractures in all three patients were discovered in routine follow-up radiographs, and only one of them had a concomitant complaint of mild

heel pain. They were identified at 9, 12, and 18 weeks (mean 13 weeks) after removal of the external fixator. It is possible to postulate that the lack of feedback inhibition from pain upon weightbearing results in continued stress across the structurally weakened tuberosity, which potentiates the risk of fracture, even at physiological load of running and walking [10]. Disuse osteopenia further adds to the risk of fracture, particularly in neuropathic patients who commonly exhibit preinjury osteopenia. This problem is compounded by the nonweightbearing prescription given to the patient for 6 weeks, possibly longer.

#### 4. Conclusion

Three diabetic patients with lower extremity peripheral neuropathy are presented that sustained post instrumentation fractures of the calcaneus through external fixator pin-sites in the setting of previous ankle fractures. To our knowledge, this rare complication has not been reported in the literature and might be overlooked or underreported by surgeons. These cases suggest that placement of calcaneal Steinman pins in this physiologically compromised population may be may not be completely benign in this respect, and that surgeons should be cognizant of the risk and raise awareness in the diabetic population. This complication may become more relevant as the prevalence of diabetes in the United States is expected to rise to 36 million by 2030 [16].

#### Brief summary

##### *What is known?*

- Schantz pin placement in the calcaneal tuberosity is a common procedure especially in spanning external fixator of the ankle.
- Common complications of Schantz pins placement are pin site infections and nerve injuries.
- Fractures through Schantz pin sites is a known complication, reported nearly exclusively in diaphyseal bone.

##### *What this study adds?*

- This study reports three diabetic patients that sustained post instrumentation fractures of the calcaneus through external fixator pin-sites.
- The cause of this complication is likely related to diabetic neuropathy causing insensate foot and the biomechanical compromised location of the pin site.
- Surgeons should be cognizant of this iatrogenic complication of a common surgical procedure in diabetic patients.

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All authors disclose that they have no financial and personal relationships with other people or organizations that could inappropriately influence this work.

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