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Staged Management of High-Energy Complex Tibial Pilon Fractures

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Introduction

High-energy tibial 'pilon' fractures are the result of axial loading of the tibia with the talus being driven into the distal tibia. This leads to exploding of the distal tibial articular surface with impaction of comminuted metaphyseal bone, and occasional extension to proximal diaphyseal bone. Based on 126 pilon fractures using plain film radiography and CT, Topliss et al. described variability of pilon fracture fragments involving the anterolateral, posterior-lateral, anterior, posterior, and medial plafond, as well as 'die-punch' fragments occurring in severe plafond fractures (2). Such high-energy fractures are typically associated with immense injury to the surrounding soft-tissue envelope. Acute open reduction internal fixation through traumatized soft tissue has been inadvisable due to the limited muscle coverage between skin and bone in the lower extremity, and has been associated with increase wound complications. McFerran et al. reported 12/35 (34%) traumatic pilon fractures treated with early open reduction internal fixation, developed significant wound complications and/or deep infection (3). Teeny and Wiss reported that 58 high-energy pilon fractures treated with early internal fixation, and 36 cases secondary to high-energy trauma involving MVA or a fall from height, resulted in 50% with soft tissue complications and 37% with deep infection (1). Treatment objectives are to restore articular congruency and reconstruct articular block to the diaphysis, and to allow early restoration of motion.

Background

High energy tibial 'pilon' fractures present a unique challenge to the patients and surgeon. Such injuries present an immense problem to the surrounding soft-tissue envelope. Due to the nature of the injury and the risk of soft tissue compromise, pilon fractures often require a staged approach. Temporary fixation with a spanning external fixator is recommended if definitive internal fixation is delayed. Bone et al. treated 18 severe pilon fractures, including 10 open fractures (3 Grade II, 7 Grade III), with spanning delta-frame external fixation with limited open reduction, and reported no wound complications or deep infection throughout a 12-month follow-up (7). Rüedi and Allgöwer noted that if patients were treated based on the principles of pilon fractures – restoration of the length of the fibula, reconstruction of the articular surface of the tibia, application of autograft for management of any metaphyseal bony defect, and plate stabilization of the medial tibia (8). Perioperative complications include: malreduction, inadequate fixation, and intra-articular penetration of hardware, all of which may be minimized by preoperative planning and meticulous operative techniques (9).

Figure 1. Pre-operative radiographic imaging of left tibial pilon fracture.

Figure 2. Open injury of left tibial pilon fracture.

Methods

All 11 patients (age range: 29-60 years) initially presented to AHMC ED via EMS, GSW of 15. Initial plain-film radiographs were obtained prior to appropriate bedside reduction under conscious sedation. Patients were divided into Group 1 with 6 open fractures (55%) and Group 2 with 5 closed fractures (45%). All 11 patients were treated under the care of the same surgeon. A staged protocol was than utilized for management of both closed and open injuries, consisting of our staged algorithm. The protocol consisted of immediate closed reduction/stabilization of the ankle fracture dislocation in the Emergency Department under the use of IV conscious sedation. Plain film radiographs were obtained pre- and post- closed reduction, and within 6 -8 hours all 11 patients were taken to the operating room for immediate application of delta external fixation, with irrigation & debridement for open injuries. Pre-operative CT imaging was obtained for surgical planning. Patients with isolated injuries were discharged after initial stabilization and re-admitted for definitive reconstruction. Soft tissue swelling was closely monitored for an average of 7-14 days. Formal open reduction internal fixation was performed once soft tissue swelling subsided. All patients were evaluated via chart, radiographs, and physical examination for a minimum of 12 – 18 months.

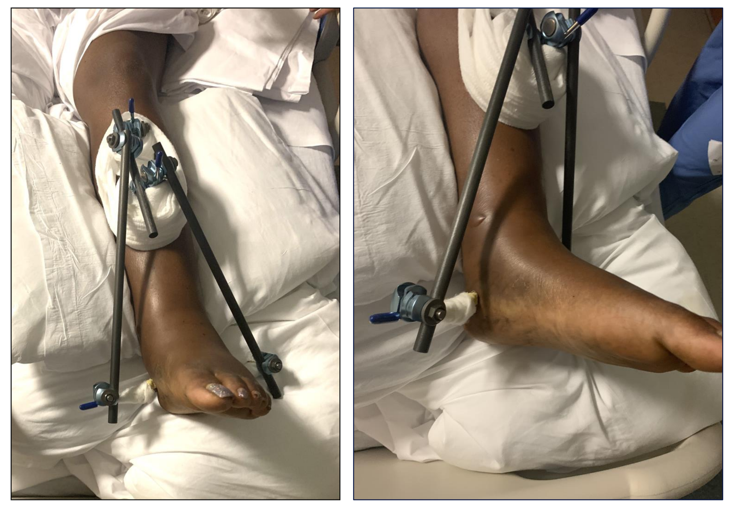

Figure 3. Application of delta external fixation for left tibial pilon fracture.

Figure 4. CT imaging after application of external fixation to further guide surgical planning.

Tibial Pilon Fracture (n = 11)

Closed Reduction/Stabilization in Emergency Department

Initial Surgical Intervention

Closed Injury (n = 5)

Open Injury (n = 6)

Washout & Exploration

Serial Debridement

Application of Antibiotic Beads

Application of Delta External Fixation

Pre-Operative Planning/CT Imaging

Staged Management of Soft Tissue Swelling & Coverage (7-14 days)

Definitive Open Reduction Internal Fixation

Figure 5. Flowchart detailing staged approach for management of high-energy complex tibial pilon fractures.

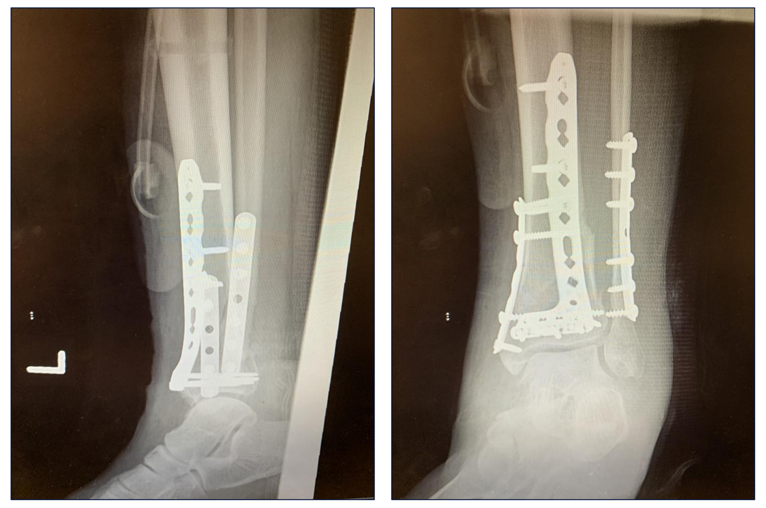

Figure 6. Definitive internal fixation with incisional wound vac.

Results

Follow-up was possible in all 11 patients. 10/11 (91%) patients demonstrated surgical wound healing with appropriate radiographic evidence of fracture healing. 1 patient demonstrated post-operative wound complication with failure of hardware in the fibula. The patient returned to the operating room at 12 weeks for additional irrigation and debridement, removal of hardware and application of negative pressure wound vac. Despite post-operative complications, outpatient clinical examination of the ankle joint revealed adequate range of motion with minimal pain. The remaining patients (91%) observed over 18 months experienced sufficient soft tissue and bone healing, with return to weight-bearing at 4 months. Adequate management of soft tissue injury and swelling is an important consideration for optimal surgical outcomes and reduced complications (6). A staged approach has proven to be effective in the treatment of both open and closed pilon fractures by minimizing the risk of post-operative soft tissue complications, and allowing for early stabilization of the injury through initial application of a spanning delta-frame external fixator.

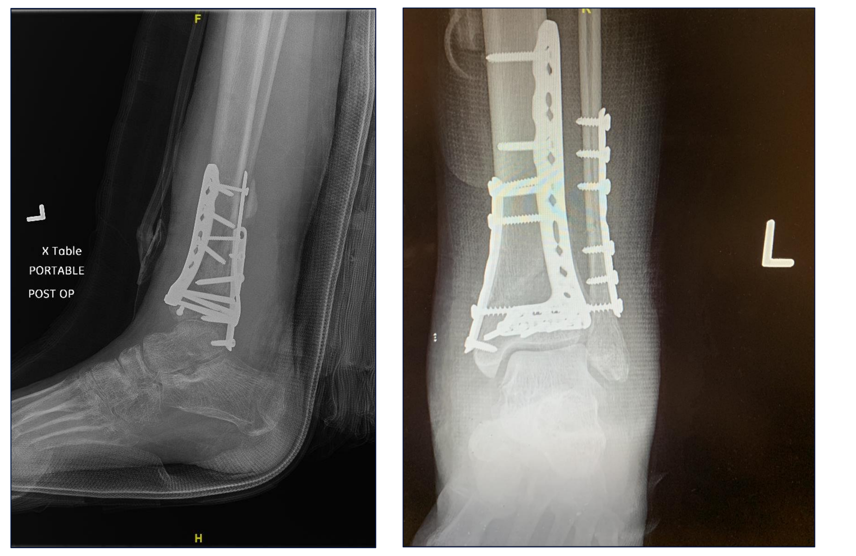

Figure 7. Definitive internal fixation with incisional wound vac.

Figure 8. Post-operative wound complications resulting in debridement with removal of fibular hardware

Conclusion

All patients initially underwent stabilization of the injury utilizing external fixation, with irrigation and debridement for open injuries. CT imaging was obtained to further guide surgical planning, and definitive fixation was performed once soft tissue swelling subsided. The majority of patients experienced adequate wound healing post-operatively, and demonstrated radiographic evidence of appropriate bone healing. One patient experienced surgical wound complications and failure of hardware in the fibula. Management of soft tissue injury and swelling is an important consideration for optimal surgical outcomes and reduced complications. Therefore, approaching distal tibial fractures utilizing a staged algorithm presents an appropriate method for adequate fracture and soft tissue healing.

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