

# Open Reduction Internal Fixation of a Type IV Supination External Rotation Injury: A Case Report

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## Abstract

Supination external rotation (SER) type IV injury presents the foot and ankle surgeon with an interesting dilemma on how to reduce and fixate the injury. The authors present a technique in which the fibular and medial malleolar fractures are fixated using classic AO technique, and the decision not to fixate the posterior tibial fracture is made based on fragment size and alignment. The patient went on to heal uneventfully and to regain full activity of the injured limb.

## Introduction

Ankle fractures are commonly classified by either a system devised by Lauge-Hansen or one by Danis and Weber. In 1948, Lauge-Hansen published an ankle fracture classification according to causative mechanisms based on the position of the foot at the time of the injury and the direction in which the ankle was displaced by the deforming force (1). Danis and Weber's ankle fracture classification is based on the level of the fibular fracture, and, pioneered by the AO-ASIF group, this scheme has become known as the 'surgical classification' (2).

A SER type IV injury occurs when the foot is in a supinated position and the leg is externally rotated upon it. The force of the injury starts antero-lateral at the anterior inferior tibiofibular ligament causing either rupture or fracture at lateral tibia (Tillaux-Chaput fracture) or anterior tibia (Wagstaff fracture); proceeds to cause fibula fracture or rupture of the lateral collateral ligament of the ankle; followed by posterior inferior tibiofibular ligament rupture or avulsion of posterior tibia (Volkman fracture); ending at the medial malleolar fracture or deltoid ligament rupture. Danis and Weber type B injury has a fibular fracture located at the level of the ankle joint.

## Case Report

A 33 year-old female presented for follow up from the emergency department for an ankle injury. The patient related that three days ago she was walking at home in the hallway when she turned her right ankle, and fell to the ground. The patient could not bear weight following the fall and immediately went to the Emergency Department, where an ankle fracture was diagnosed with a follow up recommended at the Cleveland Foot and Ankle Clinic. Patient pain level was 10/10, with 10 being the worst, at the initial visit, and related taking hydrocodone/acetaminophen 7.5/750 mg to help control the pain. Patient had an unremarkable past medical history with exception of the chief complaint, and admitted to tobacco use consisting of smoking. Lower extremity physical exam revealed palpable dorsalis pedis and posterior tibial pulses, capillary fill time was immediate, skin temperature was increased at the area of incidence, and neurological sensation was intact. No open lesions were noted, right foot showed evidence of ecchymosis, edema, erythema, guarded motion with inability to move, and pain to palpation of both medial and lateral malleoli. Figure 1 shows non-weight bearing radiographs that were performed of the right ankle. Figure 1A is a Mortise ankle view that shows the apparent medial malleolar transverse avulsion fracture, whereas the oblique fibular fracture is not that evident. Figure 1B is an ankle AP view that shows similar findings as the mortise view. There is no increase in the medial gutter clear space due to the avulsion fracture rather than a deltoid rupture, which can be examined radiographically from the medial clear space. In Figure 1C a lateral ankle view shows the fibular fracture and the posterior tibial fracture. The patient was scheduled for open reduction with internal fixation four days later.



(A)

(B)

(C)

**Figure 1** Mortise, AP, and Lateral non-weight bearing ankle views, respectively

### **Literature Review**

The trimalleolar fracture should not be overtreated, and most posterior malleolus fractures are an avulsion of the posterior malleolus at the edge of the ankle joint due to attachments of the posterior tibiofibular ligament (3). It is important to keep in mind that isolated posterior tibial fractures do occur, but are rare (4). The fibular fracture is referred to as the dominant fracture in repair of ankle fractures, and restoration of its anatomic length takes precedence over repair of inferior tibiofibular syndesmosis (2). The Vassal principle states that the reduction of the major fracture fragment, the fibular fracture in this case, should allow other fracture fragments to fall into proper anatomical alignment. Based on this principle with reduction of the lateral malleolus, the posterior tibial fragment is usually brought into near-anatomic position (5). Numerous sources recommend Open Reduction Internal Fixation (ORIF) of this posterior fragment if greater than one fourth of the articular surface is involved (6,7,8). However, if the fracture is less than 25% of the tibial articular surface, treatment is to leave it alone even if it is displaced (4). When the posterior fragment is large and displaced, the difficulty in reducing it is that the cortical margins are used for the reduction landmarks because the articular surface cannot be seen (4). The larger fragment is easily fixated with lag screws from anterior to posterior through small anterior incisions, but can also be fixated from a posteromedial incision if

the fracture extends along the entire posterior surface of the tibia (2). The fibular fracture is the dominant fracture and with accordance to the Vassal principle should be fixated first, with the use of interfrag screws and/or plates (7). The medial malleolar fracture can then be fixated with either a Steinmann pin or screws (7). If the patient is not a surgical candidate or refuses surgery, then the best attempt at a closed reduction is made and a greater amount of displacement is accepted, with the patient being made aware of the potential long-term sequelae (4).

### **Treatment Plan**

Four days after presenting to the clinic the patient arrived at the surgery center for the required surgical intervention. The procedure, anesthesia, postoperative course, risks, and potential complications were explained to the patient prior to the surgery.

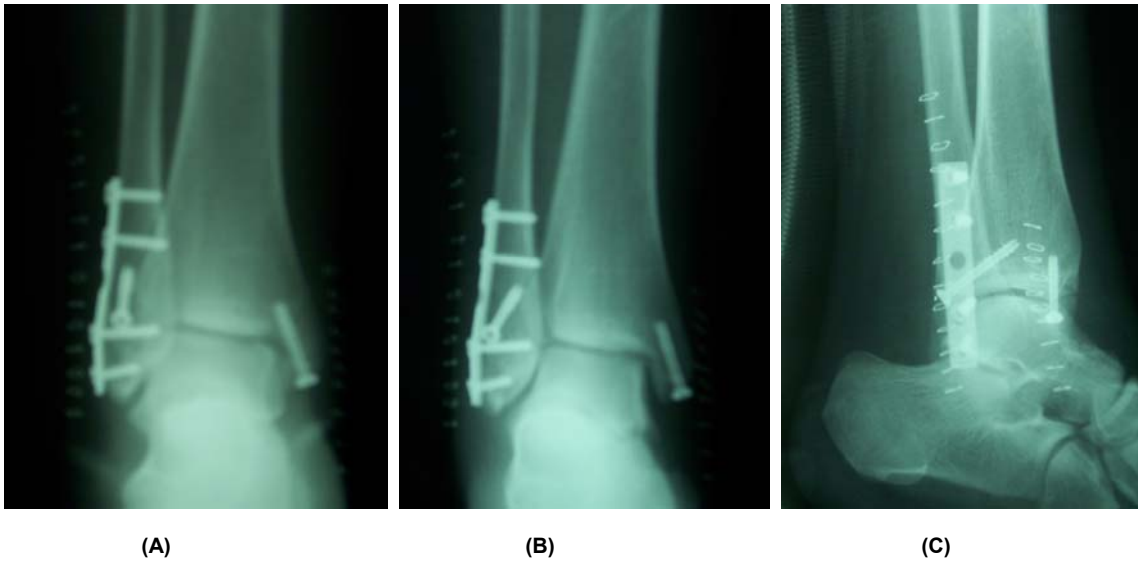
The patient was taken to the preoperative area where an IV line was established and the chart was reviewed. A 2g dose of IV cefazolin was administered to the patient IV piggyback approximately 30 minutes before surgery for preoperative prophylaxis. After a medical review, the patient was taken to the operating room and placed in a supine position. An adequate general anesthesia was administered to the patient, then a local block of 20 cc 0.5% bupivacaine plain was performed in a high ankle block fashion. The foot was prepped and a pneumatic thigh tourniquet was used for hemostasis. Attention was then drawn to the lateral side of the ankle, where an eight centimeter linear incision was made over the fibula with a ten blade. Meticulous dissection was carried down through the subcutaneous layer, where all superficial venous structures were hand tied with the use of 1-0 absorbable suture. All neurovascular structures were atraumatically retracted, and then dissection was continued to the level of the periosteum.

The periosteum was reflected with use of a periosteal elevator at the fracture site of the fibula, where a complete spiral fracture measuring approximately five centimeters was noted as well as an approximate 3 mm shortening of the fibula. The fibular fracture was manually reduced and maintained with the use of a bone clamp, the C-arm was utilized to view the reduction. Following confirmation of proper reduction, a 0.045" k-wire was inserted through the fracture and utilized as a guide wire. A 4.0 x 16.0 mm cannulated interfrag cortical screw was then inserted

perpendicular to the fracture site of the fibula following the proper lag technique sequence. A five hole 1/3 tubular plate was then bent to the shape of the fibula, placed over the fracture and stabilized with the following screws: fully threaded 3.5 x 16.0 mm and 4.0 x 20 mm, partially threaded cancellous 4.0 x 18.0 mm and 4.0 x 14.0 mm. The C-arm was again utilized. It was noted that good fibular reduction was obtained, and the posterior tibial fracture had realigned anatomically, as did the medial malleolar fracture. The periosteum was reapproximated and sutured with use of 2-0 Vicryl and the subcutaneous tissue followed with 3-0 Vicryl. The skin was closed utilizing staples.

It was then decided intra-operatively to ORIF the medial malleolar fracture. A six centimeter incision was than made over the medial malleolus using a ten blade. Dissection was carried out in the same manner as over the fibula. A transverse medial malleolar fracture was noted and was reduced with a bone clamp. C-arm guidance was utilized to place a 0.045" guide wire. A cannulated 4.0 x 24.0 mm cancellous screw was inserted over the guide wire using proper technique at approximately 45 degree angle to the fracture site. The periosteum, subcutaneous tissue, and skin were closed in the same fashion as done laterally. The C-arm was again used to assure proper alignment of the hardware and good anatomical reduction of the fracture fragments. Dry sterile dressing was applied consisting of Betadine-soaked Adaptic, 4x4 gauze, Kling, and Kerlix. Radiographs were then taken and can be seen in Figure 2. A posterior splint was applied, and the patient was transferred to the recovery room with vital signs stable and vascular status intact to digits 1 through 5 of the right foot.

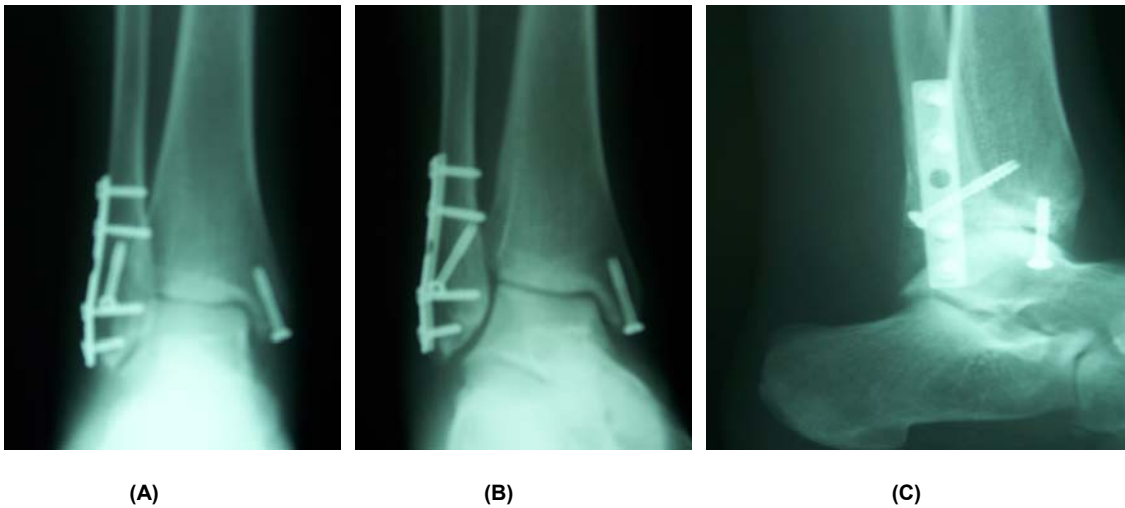
The patient was given a surgical shoe in recovery and was instructed to maintain strict non-weight bearing status of the extremity until the first follow up visit. A prescription for oxycodone/acetaminophen 5mg/325mg and zolpidem 10mg were dispensed with proper instruction. The patient was to call the on-call podiatry resident if any problems arose before the first post-op appointment.



**Figure 2** Post-operative right ankle radiographs AP, Mortise, and Lateral, respectively

Patient was seen for the first post-op visit six days following surgery and reported doing well. The patient denied any signs of infection and admitted to being non-weight bearing. The incision sites were well coapted with skin staples intact with no signs of dehiscence or infection. No radiographs were taken; new prescriptions for meperidine 50mg, hydroxyzine 25mg, and cephalexin 500mg were given with instructions for use. The patient returned for post-op visit two, seven days later, related that the pain was decreasing and noticed no signs of systemic infection. The patient admitted to being non-weight bearing, as directed. Surgical sites were inspected showing no signs of local infection or dehiscence. A below the knee cast was applied with instruction to remain non-weight bearing, and the patient was advised to begin taking ibuprofen for pain. The patient returned to clinic two weeks later and related to have been following instructions and complained of no signs of systemic infection. Cast was removed and skin incision was well coapted with no signs of dehiscence or local signs of infection. Staples were removed and incision site along with fractures sites showed no pain on palpation or range of motion. Figure 3 shows the x-rays that were performed at this time. Radiographs revealed that the fractures sites were healing as expected and no signs of osseous infection, malunion, or non-union were noted. Patient was given a CAM walker and was instructed to remain non-weight bearing. After two additional weeks and no significant changes, the patient stated that the area

was virtually pain free. She was instructed to remain in the CAM walker and could begin to bear weight partially. One month later follow up x-rays revealed healed fracture sites and no pain on palpation of the right ankle. The patient was sent for two weeks of physical therapy to help begin full weight bearing activities. Returning to clinic three weeks later, the patient was doing 95% better from initial presentation.



**Figure 3** Right ankle AP, mortise, and lateral views, respectively

### Discussion

The case presented by the authors is an excellent representation of the literature for a SER type IV injury. The fibular fracture was first brought to proper length and fixated with an interfrag screw and a plate, while the medial malleolar fracture was fixated with cancellous screws (2). More of the current literature recommends screw and plate fixation, while the dated literature recommends Steinmann pin fixation for the medial malleolar fracture. Numerous literature sources stated that the posterior tibial fracture would only need fixation if greater than 25-33%, otherwise the fracture should realign according to the Vassal principle (6,7,8). Once the fibular fracture was fixated for this patient, the C-arm indicated that the posterior tibial fracture (which was less than 25% of the articular surface) did indeed realign itself. Previous cases would recommend fixating the posterior tibial fracture based on ORIF principles, whereas the current literature and this specific case goes against that train of thought. The one relative complication that was involved with this case was that the patient was a smoker. It has been proven that

smoking does indeed decrease bone healing and can lead to prolonged healing or non-union (9). The patient could also have been non-compliant and not followed the strict non-weight bearing post-operative requirement, which could have led to fracture displacement, hardware failure, and eventual poor outcome (10). This type of traumatic incident followed by invasive surgery can also lead to complex regional pain syndrome (CRPS), and the surgeon needs to be aware of this condition if pain management would become an issue (11). This case did not present any of these complications, but the foot and ankle surgeon needs to be aware and prepared to treat any type of complication.

### **Conclusion**

In conclusion, the SER type IV fracture is not an easy fracture to fixate adequately and presents the surgeon with intra-operative decisions on how to fixate. As Miller stated in Myerson's Foot and Ankle Disorders and did numerous other authors, the posterior tibial fragment does not need fixation unless greater than 25-33% of the articular surface is affected (3,6,7,8). This case presented the Volkmann fracture, but was less than the required percentage as stated by the literature. The surgeon followed the literature and chose not to ORIF the fracture as it aligned properly according to the Vassal principle once the fibular fracture was fixated. This case was a successful outcome and is a good example that proper treatment of an ankle fracture will lead to an asymptomatic, happy patient.

### **Attributes**

Special thanks to Dr. Marc Dolce, DPM for this case.

### **References**

1. Lauge-Hansen, N: "Fractures of the ankle." *Arch Surg*, 56: 259-317, 1948.
2. Vogler, H, and Bauer, G: "Ankle fractures: Pathomechanics and treatment," *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery*, Vol 2, Banks A, Downey M, Martin D, et al, 1897, Lippincott Williams and Wilkins, Philadelphia, PA, 2001.

3. Miller, S: "Ankle fractures," *Myerson Foot and Ankle Disorders*, Vol 2, Myerson M, 1341, W.B. Saunders Company, Philadelphia, PA, 2000.
4. Gumann G: "Ankle fractures," *Foot and Ankle Trauma*, 2<sup>nd</sup> ed, Scurran B, 731, Churchill Livingstone, New York, 1996
5. Yablon I, Heller F, and Shouse L: "The key role of the lateral malleolus," *Journal of Bone and Joint Surgery*, 59: 169, 1977.
6. McDaniel W, and Wilson F: "Trimalleolar fractures of the ankle: an end result study," *Clin Orthop*, 122: 37, 1977.
7. Wilson, F: "Fractures and dislocations of the ankle," *Rockwood and Green: Fractures in Adults*, Vol 2, 1665, JB Lippincott, Philadelphia, PA, 1984.
8. Tile M: "Fractures of the ankle," *The rationale of operative fracture care*, Vol 2, Schatzker J, and Tile M, 267, Berlin, 1994.
9. Ray R: "Principles of internal fixation," *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery*, Vol 2, Banks A, Downey M, Martin D, et al, 65, Lippincott Williams and Wilkins, Philadelphia, PA, 2001.
10. Torbjorn A, Dalen N, Holmber S, et al: "Early weight bearing of displaced ankle fractures," *Acta Orthop Scand*, 58: 535, 1987.
11. Colton A, and Fallat L: "Complex regional pain syndrome," *The Journal of Foot and Ankle Surgery*, 35: 287, 1996.