CHAPTER 9

MANAGEMENT OF AN OPEN ANKLE FRACTURE: A Case Report

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An open fracture is a surgical emergency with potential devastating complications and prolonged rehabilitation. An open fracture is defined as a fracture in which bone has penetrated the skin, and injury to the underlying soft tissue has occurred. The three basic objectives in the management of any open fracture are to prevent infection, obtain bone union, and restore function.[1-3] The degree of soft tissue loss, amount of contamination, fracture stability, and presence of arterial injury are the major determinants to the prognosis of open fractures.

Gustilo offers four essential features of open fractures that must be addressed to treat these injuries properly.[2] First, it is important to recognize life-threatening situations and stabilize the patient before beginning formal treatment of the open fracture. Second, the degree of soft tissue and bony injury varies greatly, and it is these factors that determine the treatment plan and subsequent prognosis. Third, all open fractures are considered contaminated. At least 70% of open fractures are contaminated with bacteria at the time of injury.[4] Fourth, open fractures are a surgical emergency and should be treated within eight hours if possible.

CLASSIFICATION

Open fractures are classified based on soft tissue injury and skeletal involvement. Gustilo and Anderson described the most widely used classification system to grade open fractures into three categories, type I, type II and type III.[4]

A type I fracture is an open fracture with a wound less than one centimeter in length. There is minimal contamination, little soft tissue involvement, and intact vascular status. The fracture is usually a simple transverse or short oblique fracture with minimal comminution.

A type II open fracture presents with a wound greater than one centimeter in length, with minimal to moderate contamination, and without extensive soft tissue damage, skin flaps, or avulsions. The fracture is similar to a type I fracture but with minimal to moderate comminution.

A type III open fracture has a wound greater than five centimeters in length with more extensive soft tissue damage. Any open fracture over eight hours old is considered to be a type III fracture. Type III open fractures are subdivided into three groups. Type IIIA fractures have extensive soft tissue injury with moderate contamination but with enough viable soft tissue to ensure fracture coverage. Type IIIB fractures display more soft tissue loss with massive contamination, periosteal stripping, and bone exposure possibly requiring a flap for soft tissue coverage. Type IIIC fractures are associated with vascular injury necessitating surgical repair.

TREATMENT

Treatment of open fractures is based on the administration of appropriate antibiotics, thorough irrigation and debridement, fracture stabilization, early wound closure, and aggressive rehabilitation.[5] Early antibiotic administration is a main objective in the management of open fractures, since infection increases the likelihood of complications.[6] Antibiotic therapy for open fractures should be considered therapeutic rather than prophylactic.[4]

Cultures should be obtained in the emergency room and again in the operating room after irrigation and debridement. A Gram's stain and aerobic and anaerobic cultures should be obtained each time. Cultures obtained prior to treatment yield the highest return for positive cultures. However, infections of open fractures most often correspond to the intraoperative cultures obtained.[7]

A penicillinase producing *Staphylococcus aureus* is the most frequently found organism in the open fracture. More recently, an increased incidence of infections due to *Enterococcus* and *Pseudomonas aeruginosa* have been found.[7] A first or second generation cephalosporin is adequate treatment for type I open fractures. Type II and III open fractures should be treated with the cephalosporin plus an aminoglycocide for additional coverage of gram negative organisms. If the

open fracture is the result of a farm injury where contamination with *Clostridium perfringes* is possible, 10 million units of penicillin G should be added per day in divided doses.[8]

The appropriate antibiotics should be instituted within three hours of injury. Antibiotic treatment should be continued for three days after an open fracture, and also an additional three days after a soft tissue coverage procedure. The patient must always be appropriately immunized against tetanus in all open fractures.

IRRIGATION AND DEBRIDEMENT

Antibiosis is second only to adequate irrigation and debridement in the treatment of open fractures. With few exceptions, patients with open fractures should be taken to the operating room for a formal surgical irrigation and debridement. The wound should be irrigated with copious amounts of normal saline or lactated ringers solution. Up to ten liters of irrigation may be required in a heavily contaminated wound, while two to four liters is routinely needed for type II and type III open fractures.[9] A pulsatile lavage system is ideal to aid in reducing contamination and removing debris. Any visualized foreign debris should be removed. All nonviable skin and soft tissue should be excised. Exposed tendon with intact peritenon may be preserved, but early soft tissue coverage must be performed. Scully et al. noted the "four C's" for evaluation of muscle viability: color, capacity for bleeding, contractility, and consistency of tissue.[10] Free bony fragments that are contaminated or do not add stability should be removed. Otherwise, debridement of bone should be conservative.

FRACTURE STABILIZATION

Early fracture stabilization functions to preserve soft tissue and neurovascular structures, as well as to decrease the likelihood of infection. Stabilization and realignment of an open fracture also allows for earlier range of motion, and promotes soft tissue healing. In severe open fractures, external fixation has been the standard treatment. External fixators allow for the placement of pins at remote sites away from the open fracture site. External fixators however, are cumbersome and not applicable to many open fractures of the foot.

Open reduction with rigid internal fixation is becoming more accepted as the standard treatment of open fractures. Internal fixation offers improved anatomic alignment, rigid compression, and early mobilization. Internal fixation for open fractures does require additional incisions which may further compromise bone and soft tissues. The foreign material of screws and plates used in internal fixation may increase the risk of infection although metal, per se, does not promote bacterial growth or dissemination in vitro.[11]

Immediate open reduction with internal fixation is recommended in type I and most type II open fractures. In general, open reduction with internal fixation has not been recommended in most type III open fractures due to the high rate of infection. However, type III open fractures of the rearfoot and ankle, and most intra-articular fractures throughout the body, are now considered to be amendable to internal fixation.[12]

WOUND CLOSURE

Many surgeons feel that open fractures should not be primarily closed. However, other physicians believe that type I and the majority of type II open fractures can be closed primarily, if adequate irrigation and debridement have been carried out. Primary closure should only be performed if there is no further evidence of contamination, and the wound has been open for less than eight hours. An alternative is partial closure of the wound, meaning to primarily close any additional incisions or extensions to the open wound while leaving the original injury site open. Type III open fractures, or other open fractures not primarily closed at initial surgery, should be left open with delayed primary closure undertaken in three to ten days. The decision of when to perform delayed closure is based on culture results and clinical observation of the wound. Delayed closure may consist of sutures, split thickness skin grafts, or tissue flaps. Healing by secondary intention (allowing the wound to granulate) should be a last choice for wound coverage since the incidence of complications is much higher.[13]

COMPLICATIONS

Potential complications of open fractures include soft tissue infection, osteomyelitis, nonunion, delayed union, limb shortening, gangrene, and limb loss. Infection is the most important complication to

avoid since other complications are substantially reduced when infection is prevented.

CASE HISTORY

A 46-year-old white female presented to the emergency room by ambulance approximately one hour after falling down a step and twisting her left foot and ankle. The patient's left foot and leg were in an external splint and ice had been applied to the left ankle. Upon examination, a three centimeter laceration was noted at the distal aspect of the medial malleolus. The medial malleolus was protruding through the wound. The wound was relatively clean without significant obvious contamination. The left foot appeared to be in a valgus position in relation to the ankle. The patient's neurovascular status was found to be intact (Fig. 1). Radiographs

Figure 1. Medial view of an open ankle fracture, with the medial-malleous in view.

taken in the emergency room revealed a spiral-oblique fracture of the distal fibula beginning at the joint line and extending ten centimeters proximally as a large posterior spike. The talus was dislocated laterally approximately two centimeters with a significant medial clear space at the ankle joint (Figs. 2A,2B).

Treatment in the emergency room consisted of the administration of analgesics and continued ice and elevation. The patient's medical history was significant for mild depression controlled with medication. The patient denied the use of other medications, as well as any allergies to medications. Laboratory studies obtained were noncontributory. The patient elected to have immediate open reduction with internal fixation of this open ankle

Figure 2A. Preoperative anterior-posterior radiograph.

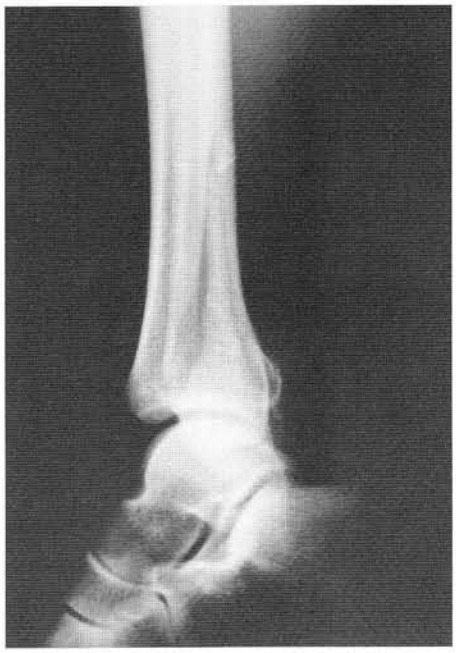

Figure 2B. Preoperative lateral radiograph.

fracture-dislocation (supination external rotation stage IV). This injury was classified as Gustilo type II open fracture.

Gentamicin and cefazolin were administered preoperatively to the patient. Tetanus toxoid was also administered intramuscularly. The patient was taken to the operating room where surgery was carried out under general anesthesia with a pneumatic thigh tourniquet for hemostasis.

PROCEDURE

Initially, the medial laceration with the exposed medial malleolus was copiously irrigated with normal saline. Cultures, (aerobic and anaerobic) and a Gram's stain were obtained. The medial malleolus was then manually reduced to its normal position. Temporary nonabsorbable sutures were placed in the medial wound to prevent desiccation of tissues until after the fibular fracture was addressed.

Attention was then directed to the lateral left leg and ankle, where a ten centimeter incision was made over the lateral aspect of the fibula. Standard dissection principles were used to expose the fibula fracture (Fig. 3). After adequate reduction, a

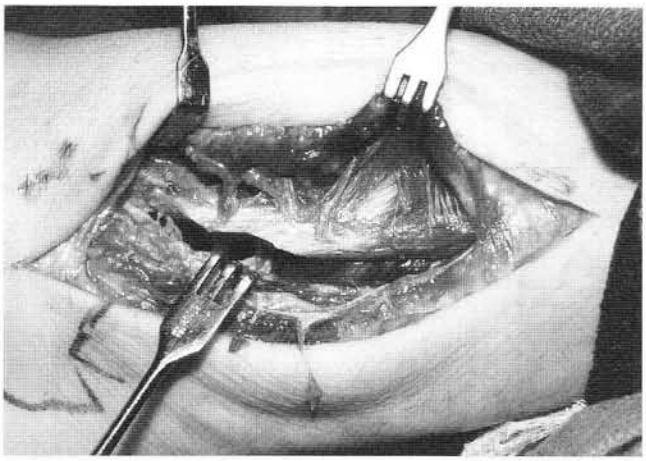

Figure 3. Intraoperative view of spiral-oblique fibular fracture.

4.0-mm partially threaded cancellous screw was placed across the fracture line as a lag screw in proper AO technique. A five hole 1/3 tubular neutralization plate, stabilized with 3.5-mm cortical screws, was then placed on the lateral aspect of the fibula overlying the lag screw and fracture line.

After copious irrigation, the torn anterior ankle joint capsule and the ruptured anterior-inferior tibiofibular ligament were repaired using a nonabsorbable suture. The lateral incision was then closed in respective layers with absorbable sutures.

Attention was then directed back to the medial aspect of the left ankle joint where the traumatic laceration was lengthened approximately one centimeter, producing a four centimeter wound for repair of the deltoid ligaments. Necessary dissection was performed to expose the ruptured deltoid ligaments. After isolation and debridement of frayed ligamentous ends, the ligament was repaired with nonabsorbable suture. The incision was irrigated with copious amounts of normal saline and was then closed in normal layered fashion with absorbable suture (Figs. 4A, 4B). The thigh tourniquet was released after approximately one hour of inflation. Sterile dressings and a below-knee Jones compression cast were applied to the left lower extremity.

Figure 4A. Postoperative anterior-posterior radiograph.

Figure 4B. Postoperative lateral radiograph.

A dressing change was performed with final cast application at the third postoperative day. Cefazolin and gentamicin were both continued for 24 hours postoperatively. Intraoperative cultures revealed no growth of organisms. The patient was discharged non-weight bearing on the left lower extremity with the use of a walker.

DISCUSSION

This type-II open SER-IV ankle fracture was appropriately handled in both the emergency room and intraoperatively. The open wound exposed the medial malleolus rather than the fibula, which was fractured. Most literature describes the complications associated with open fractures as a result of direct contamination of the fracture site. Since the fracture site in this case was not exposed, hence not contaminated by the external environment, concern was not as great regarding potential infection and associated complications. Even though current recommendations are for three days of appropriate antibiotics postoperatively, antibiotics were discontinued after a 24-hour course.

Open fractures are relatively rare in the lower extremity. Less than five percent of lower extremity fractures or dislocations are considered to be open fractures, with the majority of these consisting of open digital fractures. Ankle fractures present as an open fracture in less than two percent of the cases.[11] Although rare, when open fractures do present in the emergency room, they must be handled appropriately and promptly. Aggressive irrigation and debridement is the key to successful treatment and favorable prognosis of open fractures. Appropriate antibiosis must be considered therapeutic and not prophylactic. These measures will help to assure the three primary goals in the management of open fractures: to prevent infection, obtain adequate fracture healing, and to restore normal function of the injured extremity.

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