CHAPTER **28**

CURRENT TRENDS IN THE MANAGEMENT OF ACUTE OPEN FRACTURES

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INTRODUCTION

Open fractures are complex fractures that communicate with the external environment through a break in the overlying skin. The management of these injuries is often challenging because when compared with closed fractures, they are more often complicated by soft tissue injury, infection, and delayed or nonunion. Whether dealing with a hallux laceration with associated distal phalanx fracture, or an open tibia-fibular fracture, the desire to prevent post-traumatic osteomyelitis warrants that open fractures be treated as surgical emergencies.

In 1976, Gustilo and Anderson presented a classification and treatment recommendations for open fractures that is still considered the gold standard in their evaluation and management.[1] Their Type III injury was further defined in 1984, which led to the following classification scheme.[2] A Type I injury is a fracture with an associated wound of 1.0 cm or less that is clean or has minimal contamination. Type II injuries are those with lacerations greater than 1.0 cm without extensive soft tissue damage, flaps or avulsions, and moderate contamination. The Type III injury is divided into 3 subgroups and includes open fractures with extensive soft tissue damage and a wound greater than 5.0 cm. Type IIIA injuries have adequate soft tissue coverage of fractured bones, whereas Type IIIB injuries have extensive soft tissue loss with periosteal stripping and are complicated by severe contamination. The Type IIIC injury includes any arterial injury that requires repair. It should also be noted that farm injuries, fractures greater than 8 hours old, and high velocity gunshot wounds are automatically considered Type III injuries regardless of wound size.

Open fractures have an estimated annual incidence of 11.5 per 100,000 with 40% occurring in the lower extremity.[3] This requires that the podiatric physician be well versed in the current trends in their management.

ASSESSMENT AND MANAGEMENT

The primary goals of the physician treating an open fracture should be to prevent infection, promote fracture healing, and a timely restoration of function. The management of open fractures may seem overwhelming, and the treatment protocol daunting. However, if these injuries are approached in a stepwise manner, the task can be simplified and optimal care can be rendered to the patients.

Emergency Room/Initial Assessment

One can assume that once the podiatric or trauma surgeon is called to assess an open fracture, the primary survey of the patient has been completed. However, this should not be taken for granted and the protocols set forth by the Advanced Trauma Life Support System should be strictly adhered to. All other serious or life threatening injuries should be identified and the patient should be stable before proceeding with management of the open lower extremity fracture. Once the patient is stable, every attempt should be made to get the patient from the emergency department to the operating theatre within 6 hours of the injury if at all possible.

A complete neurovascular examination should be performed immediately to ensure that there is no active bleeding or gross limb threatening compromise. This should include noting the presence or absence of pulses, the color and temperature of the affected limb compared with the contralateral limb, and an attempt should be made to assess sensory and motor function.

Although the assessment of plantar sensation may be difficult, it should be noted that maintenance of plantar sensation has been an important prognostic indicator of the salvageability of a limb. If there is neurovascular compromise attempt must be made to realign the fracture into a more anatomic position to reduce undue pressure on skin and neurovascular structures.[3] Once the neurovascular status and fracture have been stabilized, then a thorough history of injury should be obtained, which will be useful in guiding the subsequent treatment plan.

Antibiotics should be started as soon as possible to lessen the chances of severe soft tissue infection and post-traumatic osteomyelitis. Tetanus prophylaxis should also be administered promptly according to Infectious Disease Society of America guidelines. In 1974, Patzakis et al conducted a randomized controlled trial that found that

a first generation cephalosporin is effective in prevention of infection in open fractures. Their study also revealed that Staphylococcus aureus is isolated in greater than 50% of grade I and II open fractures, and in grade III fractures there is usually an addition of a gram negative bacteria.[4] Recent, subsequent studies have supported these results and have confirmed the effectiveness of first generation Cephalosporins in grade I and II fractures with the addition of an aminoglycocide for grade III fractures.[5-7]

Controversy exists on the efficacy of obtaining pre and/or post-debridement wound cultures to aid in the selection of antibiotics. However, even though in many institutions this is the standard of care, current literature questions their usefulness. It has been found that only 8% of organisms grown on pre-debridement culture, and 25% of those grown on post-debridement culture go on to cause infection. And, 7% and 12% of patients with negative cultures, pre and post-debridement respectively, eventually become infected. It is the current recommendation that pre or post-debridement cultures not be routinely obtained.[8] Organisms grown may bind the physician to cover bacteria that are mere nosocomial contaminants, and not actual causes of infection. Therefore, for Grade I and II fractures, antibiotic agents that provide adequate coverage of S aureus are sufficient for prophylaxis/treatment. Ancef 1gram intravenous every 8 hours is the antibiotic of choice, however if there is an allergy, clindamycin has been shown to be as effective in these injuries. The addition of an aminoglycocide, usually a weight based dose of gentamycin (5mg/kg) either once daily or divided doses, is effective against gram negative organisms isolated in Grade III injuries. Penicillin G, as a third agent, should be added for those fractures contaminated with soil or that were exposed to a farm environment.[8-10] Antibiotics should be immediately initiated and continued until 48 hours after wound closure, and the approach to their administration should follow the historical as well as supportive current literature outlined in Table 1.[7]

Operating Room Protocol

Once the patient has been stabilized and appropriate antibiotics initiated, he or she should be brought to the operating room, preferably within 6-8 hours of the injury. Irrigation of the wound is paramount in the management of open fractures to remove debris as well as aid in the debridement process. Although it is intuitive that irrigation is obviously beneficial in the treatment process, there is little evidence that supports the volume or type of irrigation that is most optimal. Arbitrarily, it has been recommended that Grades I, II, and III fractures receive 3, 6, and 9 liters of irrigation respectively because the typical volume of a normal sterile saline bag is 3 liters.[8] There is also no clear guidelines as to whether there should be additives to the saline solution. Some authors advocate the use of antiseptics like betadine or hibiclins which would reduce bacterial load; however these solutions are toxic to host cells and may cause delayed wound healing. Antibiotics have also been studied for their usefulness in irrigation solutions. The 2 most studied were neomycin and bacitracin, and these have been shown to reduce the rate of infection when compared with sterile saline alone, but one must be concerned with the promotion of antibiotic resistance.

There has often been mention of the utility of surfactants within the irrigation solution because they disrupt the hydrophobic or electrostatic forces that drive the initial stages of bacterial surface adhesion. In essence, their primary role is the removal of bacteria. Unlike antibiotics and antiseptics, whose role is to kill bacteria.[8,11] Normal sterile saline should be routinely utilized for the

Table 1

FRACTURE TYPE	DEFINITION	INFECTION RATE	ANTIBIOTIC CHOICE
I	<1cm; minimal contamination and soft tissue damage	0-2%	1st Gen Cephalosporin
II	>1cm; moderate soft tissue damage	2-5%	1st Gen Cephalosporin
IIIA	Severe contamination and soft tissue damage, soft tissue coverage adequate	5-10%	1st Gen Cephalosporin + Aminoglycoside
IIIB	Sever contamination and substantial, inadequate soft tissue coverage	10-50%	1st Gen Cephalosporin + Aminoglycoside
IIIC	Arterial injury requiring repair	25-50%	1st Gen Cephalosporin + Aminoglycoside

Classification System of Gustilo, et al.

irrigation of open fractures; however the use of additives and volume of fluid is up to surgeon's preference and clinical acumen.

There is also no clear consensus on whether the irrigation should be delivered under pressure. Authors who advocate the use of simply a bulb syringe have shown that pulsed lavage systems remove significantly less inorganic material than bulb syringes and cause more tissue damage.[12] Even authors that claim pulsed lavage systems remove more contaminants agree that they cause damage to the structure of bone, interfere with fracture healing, and damage soft tissues.[13] Therefore, it is recommended that if pulsed irrigation is utilized, it be set at its lowest pressure, usually 50 psi.[14]

After adequate irrigation of the wound has been achieved, the task of stabilizing the fracture(s) must be undertaken. The decision must be made whether to perform a definitive treatment at the time of initial debridement or whether staged treatment is more prudent. This decision rests primarily on the severity of the fracture and condition of the surrounding soft tissues. Fixation of open fractures is paramount to protect soft tissues from further injury as well as promote early mobilization and return to function. There are several options for use in fracture stabilization ranging from external to internal fixation. And, there is no definitive evidence that supports use of one device over another. Therefore, experience and personality of the injury should guide the surgeon's planning in these situations.

Also of great importance is the timing of closure of the fracture and surgical wounds. The historical trend has been towards delayed closure, but this was mainly for the prevention of Clostridial infection in barnyard injuries. However, if adequate debridement has been performed, and appropriate antibiotics have been initiated, most trauma surgeons are advocating earlier closure of wounds either at initial debridement or within 24 hours of the injury. Patients who have early wound closure have been shown to have a lower rate of infection, shorter time to union of fracture fragments, and earlier return to function.[8] It should be noted that when necessary, because of the nature of an injury, delayed closure and even repeat debridement, if warranted, are appropriate. Vacuum assisted closure has also proven to be quite effective in areas where lack of soft tissue coverage prevents wound closure.

CONCLUSION

The management of open fractures may present a daunting task for the treating physician. However, if approached in a stepwise manner, proper, adequate care can be provided to the patient. The Gustilo-Anderson Classification still remains the gold standard when stratifying these injuries because of its vast prognostic significance. When managing open fractures, it is important to remember to start antibiotics immediately, irrigate and debride aggressively, and stabilize fracture fragments accordingly. The jury may still be out on the specific ways to approach these parameters, but the primary goal of the treating physician must remain prevention of infection, stabilization of fracture, and restoration of function.

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