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Review Article

Causes, complications, and treatment of open ankle fracture

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ABSTRACT

Open ankle fractures are uncommon (3-6%) among all ankle fractures. Emerging trends show that the incidence of low-energy open ankle fractures is prevalent in older women. The mechanism of open fracture management continues to pose difficulties for orthopaedic surgeons. A simple fall is responsible for just under half of all fractures caused by motor vehicle collisions (MVCs). Despite technological advancements and surgical methods, infectious and non-infectious rates remain problematic. The mainstay of care is to combine antibiotic therapy with thorough irrigation and debridement. To prevent additional soft tissue and vascular damage, these fractures must be stabilized immediately, preferably with an external fixator. When the residual infection has cleared and the soft tissue envelope is adequate, do a definitive open reduction and internal fixation, adapting the procedure to the patient and type of fracture. Functional outcomes could be enhanced by taking safeguards against preventable comorbidities to reduce postoperative complications.

Keywords: Open fracture, Ankle fracture, Infection

INTRODUCTION

An open fracture is a break in the bone that causes disruption of the skin and surrounding soft tissue, allowing the fracture haemorrhage and fracture to communicate with the outside world. They are orthopaedic emergencies, and the management of the open fracture is challenging. Ankle fractures account for 3.9% to 10.2% of adult fractures.[1] Open ankle fractures are uncommon (3-6% of all ankle fractures).[2] These fractures occurred frequently following high-energy processes and were generally more troublesome than closed fractures,[3] with the majority of the research on their management focusing on young men. Recent studies have shown, however, that the highest frequency of open ankle fractures now occurs in senior women, with simple falls being the most common cause of injury.[4,5]

Despite technological advancements and surgical methods, infectious and non-infectious disease rates remain problematic. The incidence of infection following an open fracture is a result of direct contamination, diminished vascularity, systemic impairment, and the requirement to insert metalwork for fracture stabilization. Several classification systems have emerged to grade these injuries. Gustilo and Anderson in 1976 [6] described the most widely used classification system, which was later updated in 1984.[7] The system is based on the laceration length, the extent of soft tissue damage, and the amount of comminution and contamination. This classification system aids in wound description, therapeutic decision-making, and prognostication.

Most of the literature published so far has focused on the management of these injuries, including the timing of surgery, the methods of fixation, and the outcomes of treatment. Due to the intricate Osseo-ligamentous complex, the fairly thin, soft-tissue coverage around the joint, the potential for wound infection and complications, and the risk of functional impairment in the patient due to multiple surgeries, the management of open ankle fractures remains a daunting prospect for the orthopaedic surgeon. To reduce complications, management objectives include early wound care and either immediate or phased fixation, depending on the wound status. This review will focus on the causation mechanisms, management choices, complications, and factors impacting the outcomes of open ankle fractures.

DISCUSSION

Mechanism of open ankle fracture

Most open fractures are caused by high-energy events or injuries, including MVCs or gunshots. Open fractures can also be caused by simple falls at home or fractures that happen while playing sports. During the 23-year study period, Bugler et al noticed that the most common cause of injury was a simple fall (49%), accounting for just under 50% of the fractures, with MVCs coming in second and accounting for 26% of fractures.[8] Ovaska et al reported that 20% (28 of 137) of the fractures were the result of high-energy trauma.[9] Research conducted 25 years ago found that 64% of open ankle fractures were caused by MVCs, while 10% were caused by gunshot wounds.[10] Simske et al reveal a higher incidence of high-energy trauma, with 43% of open ankle fractures attributable to road traffic incidents.[11] However, it appears that closed fractures have distinct damage patterns, with low-energy processes contributing to the majority of these fractures.

A simple fall from standing height is the most common cause of open ankle fractures in women older than 60, according to the latest research.[12] However, there is research evaluating low-energy open ankle fractures in elderly individuals.

Treatment

Every open ankle fracture requires an individual management strategy. The ultimate aims of open ankle fracture treatment include preventing functional impairment and saving the patient's life and limb. The following procedures are used to treat open ankle fractures:

Primary care

The treatment of open ankle fractures entails patient stabilization, including maintenance of the breathing, airway, and circulation, preceded by a comprehensive medical evaluation to determine the type and extent of the injury, the degree of wound contamination, bone or soft tissue loss, and the neurovascular condition of the fractured area.

Surgical management

Debridement

For orthopaedic surgeons, managing open fractures continues to be a difficulty. Immediate surgical debridement is the gold standard of care for open fractures, and the six-hour rule is supported in earlier studies; however, the latest conflicting evidence does not make it a golden rule. According to empirical studies, the timing of the procedure is less significant than the adequacy of debridement and the early administration of antibiotics. Non-viable tissue should be removed, including necrotic bone fragments and devitalized muscle.[13] The removal of devitalized tissue during the debridement process reduces bacterial burden and biofilm, as well as the likelihood of acute and chronic infection. There are situations in which more urgent debridement may be required for open lower extremity fractures. Vascular damage and/or severe faecal or soil contamination are examples of Type III injuries.[14] If surgery is to be prolonged for an open fracture, the temporizing care must incorporate sterilization and antiseptic protection. Once the wound has been dressed and splinted, the covering should not be removed until the patient has been transported to the operating room, since doing so can raise the infection rate. A digital snapshot can be captured at the initial exam and used for subsequent provider communication.

Irrigation

A vital part of open fracture care is wound irrigation to clear away debris and reduce bacterial infection. Some studies have explained the amount of irrigation and specific additives. There are little data regarding the exact volume required for the lavage of open fractures. Anglen et al proposed a protocol utilising 3 L for grade I injuries, 6 L for grade II injuries, and 9 L for grade III injuries.[15] Although there is no outcome data to support these recommendations, authors have advocated a variety of irrigation additives, but the scientific literature shows no conclusive evidence of their efficacy. Isotonic saline is regarded as the most appropriate and preferred irrigant because it is a non-toxic solution that does not damage the healing tissue.[16] A few other studies have argued for other irrigation solutions, including a recent Cochrane database review comparing saline against distilled water. However, this review found no difference in infection rates between water irrigation and isotonic saline.[17] The FLOW (Fluid lavage of open wounds) trial is a comprehensive study looking into the impact of different irrigation solutions and pressure on re-operation rates in open wounds due to infection or healing issues. In comparing saline with castile soap solution, saline was superior in preventing the rate of re-operation.[18]

Later, Olufemi et al suggested distilled water as an alternative to isotonic saline as an irrigation solution in open fractures of the lower limbs in a clinical trial.[19] Regarding irrigation delivery, high-pressure pulsatile lavage is the most effective method for removing pathogens and other impurities. High-pressure pulsatile lavage may have negative side effects, according to animal and in vitro research.[20-24] These effects include an increase in macroscopic bone damage, a decrease in mechanical strength during short-term follow-up, and a deepening of bacterial penetration into muscle.[25] However, Dirschl et al found that reoperation rates were the same irrespective of irrigation pressure, demonstrating that extremely low pressure is an acceptable and cost-effective choice for the irrigation of open fractures.[26]

Antibiotics

Antibiotic prophylaxis is a normal protocol before surgical procedures. Early administration of antibiotics is a crucial component in minimizing the incidence of infections. Patzakis et al demonstrated that the infection rate increases considerably if antibiotics are not administered within three hours of damage.[27] In another randomized controlled trial, Dellinger et al determined that 1-day antibiotic therapy is as effective as 5-day administration in reducing open fracture site infections in patients presenting to the emergency room.[28]

Controversy surrounds the type, dosage, and duration of antibiotics. The selection of antibiotics, however, should be based on local antimicrobial regimens and established guidelines. The organisms that cause wound infection are dependent on the trauma environment and the individual's skin flora. Gram-positive, gram-negative, anaerobic, and gas-forming organisms have been isolated from ankle fracture wounds most frequently. For open fractures, a preventive antibiotic with a larger spectrum of activity, such as a first-generation cephalosporin, is advised. In type III open fractures, the use of an additional aminoglycoside is advised.[29] There are no additional benefits to maintaining antibiotic medication beyond 24 to 48 hours in the postoperative period for the prophylaxis of surgical site infection (SSI), and extended antibiotic use may result in antibiotic resistance and a poor response to antimicrobial drugs.

Fracture fixation

There have been many significant advances in the surgical management of ankle fractures in recent years. Fracture fixation is essential for the protection of soft tissues, improvement of wound infection, fracture healing, and early functional outcome. Proper stabilization improves venous return, reduces edoema, promotes local neovascularization, and reduces inflammation. Both immediate internal fixation and delayed internal fixation have been studied in earlier investigations. Fixation using different devices may have different levels of stability. For fracture fixation, medical equipment such as plates, pins, intramedullary nails, wires, and screws is utilised.[30] External fixation alone, external fixation with limited internal fixation with screws or K-wires (hybrid), or internal fixation with plates and screws are all viable options for skeletal stabilization. When appropriate soft tissue coverage exists, internal fixation may be performed. In any other case, an external fixator may be employed.[31] The timing of fixation is determined by the state of the soft tissues. Open ankle fractures treated with immediate open reduction and rigid internal fixation (ORIF) are safe and have a favorable functional outcome.[32] During an open reduction, orthopaedic surgeons realign the bone fragments so that they are in their correct location. Internal fixation refers to the process of joining the bones physically. The surgeon may insert specific screws, plates, rods, wires, or nails into the bones to fix them in their precise position. This prevents aberrant healing of the bones. The use of internal fixation in the healing of open fractures necessitates extra caution owing to the high risk of infection associated with these injuries. Arthroscopically assisted ORIF offers an opportunity to evaluate and treat ligamentous and intra-articular pathology during the index procedure. Fractures of the medial malleolus can be repaired with a single screw.[33] Authors have recently demonstrated satisfactory outcomes with limited internal fixation incorporating uniplanar external fixation for calcaneus and tibial pilon fractures, which reduces soft tissue problems and infection rates.[34,35] In addition, researchers assert that limited internal fixation with multiplanar external fixation provides identical advantages as these other methods and permits immediate full-weight standing despite compromising the fragment-specific fixation achieved with soft-tissue-friendly low-profile implants.[36]

Soft tissue defect coverage

Open fractures with a loss of soft tissue remain difficult to manage. In open fractures, the function of soft tissue repair is not limited to wound coverage to prevent desiccation and infection. As a local source of stem or osteoprogenitor cells, growth factors, and vascular supply, soft tissues also help to promote fracture healing.

Available choices for covering include fasciocutaneous or muscle flaps. These may be rotational flaps, which are turned around a vascular pedicle in the local area, or free flaps from distant donor sites, which require vascular anastomosis.[37]

Mehta et al suggested slightly better fracture healing at 6 months with muscle flap coverage than patients who received fasciocutaneous flaps; no difference was seen at 1 year.[38] Fasciocutaneous flaps are being used with increasing frequency. Studies have shown no difference in bone healing or infection rates with the use of either fasciocutaneous or muscle flaps, as well as equivalent rates of limb salvage and functional outcomes with both options.[39,40] Without the necessity for muscle transfer, functional deficiencies may be less of a burden with fasciocutaneous flaps, and without the need for split-thickness skin grafting, aesthetic outcomes may also be improved.

Complication

Open fractures are associated with a higher complication rate compared to closed fractures. Infection is the most visible consequence of open fractures and a key obstacle to therapeutic effectiveness. Risk factors for infection following surgical management of an ankle fracture include diabetes mellitus, advanced age, alcohol use, and high-energy injuries.

Wound healing complications

The prevalence of wound healing problems, such as wound drainage, necrosis, and dehiscence, is influenced by age of the patient and comorbidity. There is an indication that individuals with diabetes and/or obesity have a higher risk of postoperative problems, such as severe infections and fixation loss.[41] Patients with additional comorbidities, including peripheral neuropathy and peripheral artery disease (PAD), have the highest rates of complications in the operative setting.[42] The comorbidity increases not only the complication rate but also the length of hospital stays and the costs of patient care. High rates of infection, wound healing complications, non-union, and loss of fixation are well-known complications associated with diabetic patients who have open ankle fractures. These results represent a 50% infection rate among patients with diabetes. Several chart review studies reported that 32% to 40% of the complications in open ankle fracture treatment are associated with diabetes mellitus.[11,43] According to the results of the treatment of open ankle fractures in the White et al study, patients with diabetes have a high rate of complications, with an infection rate of 36% and an amputation rate of 43%.[31] Blotter et al. reported a 2.76-fold risk of developing postoperative complications in diabetic patients who sustained ankle fractures (95% confidence interval, 1.57-3.97).[44] Moreover, patients with complex diabetes had a 3.8-fold increased risk of total complications, a 3.4-fold increased risk of non-infectious complications such as nonunion, malunion, or charcot arthropathy, and a 5-fold increased likelihood of having revision surgery or arthrodesis.[45] Sun et al reported a comparatively low SSI incidence rate of 4.37 percent, with occurrences of 3.05 % for superficial SSI and 1.32% for deep SSI. Polymicrobial causal agents were the most prevalent, trailed by methicillin-resistant *Staphylococcus aureus* and others. An open fracture, advanced age, high-energy accidents, incision cleanliness categories 2-4, surgeon level of archiater or vice archiater, higher body mass index, chronic heart disease, history of allergies, and preoperative neutrophils >75% were significant risk variables or predictors of SSI occurrence.[46]

The other most notable non-infectious complication following surgical management is malunion (bone heals in an abnormal position) and non-union (fractured bones fail to heal). These complications are prevalent in open ankle fractures because of the soft tissue damage, poor perfusion, and increased incidence of infection. Simse et al reported 6.7% non-union and 1.8% malunion in patients with open ankle fractures.[11] External fixators are safer than internal fixation for an infected nonunion fracture.[47]

Compartment syndrome

A painful possible complication that develops after tissue ischemia and swelling in a tight compartment following injury or fracture repair is increased tissue pressure within closed compartmental spaces, which may result in permanent muscle or nerve damage and a poor functional outcome. Acute compartment syndrome of the foot following open or closed ankle fractures is a distinct risk in all trauma patients and has been reported infrequently in the medical literature. Case reports have been published in posterior compartments as well as in all compartments implicated.[48,49] Early clinical diagnosis, confirmed by pressure measurements, prevented the sequelae previously reported. Casting may impede the early diagnosis of compartment syndrome. Excessive traction across the ankle joint when placing a spanning external fixator may cause compartment syndrome due to muscular compartment stretching. It is implied that all compartments are at risk from this type of fracture. Clinical awareness, early fasciotomy, and fracture fixation will prevent the potentially disastrous sequelae of compartment syndrome.

CONCLUSION

An orthopaedic surgeon is required for prompt treatment of open ankle fractures. The mainstay of care is to combine antibiotic therapy with thorough irrigation and debridement. To prevent additional soft tissue and vascular damage, these fractures must be stabilized immediately, preferably with an external fixator. When the residual infection has cleared and the soft tissue envelope is adequate, do a definitive open reduction and internal fixation, adapting the procedure to the patient and type of the fracture. The functional outcomes could be enhanced by taking safeguards against preventable comorbidities to reduce postoperative complications.

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