CHAPTER 39

PUNCTURE WOUNDS OF THE FOOT

Stephen V. Corey, DPM

Raymond McCarroll, DPM

Puncture wounds of the foot and ankle are frequently encountered by the podiatric physician. These injuries occur more commonly in the warmer months and are often associated with inadequate shoes. Traditional treatment of these innocuous-appearing injuries is often inadequate, consisting of superficial cleansing, tetanus prophylaxis, oral antibiotics, foot soaks, and occasionally radiographic examination.

Assuredly, appropriate tetanus prophylaxis and radiographic examination can hardly be considered inadequate. However, no studies have demonstrated the benefit of superficial cleansing or foot soaks; these techniques do not address the deep wound or liberate debris. Also, there have been no studies that have shown the efficacy of prophylactic oral antibiotics in treating puncture wounds. Additionally, the use of prophylactic antibiotics may select out easy-to-treat organisms and predispose the wound to be infected by multi-resistant bacteria. The purpose of this paper is to provide the podiatric physician with treatment guidelines to reduce the complications associated with puncture wounds.

COMPLICATIONS

Complications commonly associated with puncture wounds include soft tissue infections, bone infections and retention of foreign bodies. The incidence of soft tissue infection following a puncture wound has been reported to be as high as 10%, with a higher incidence occurring when a retained foreign body remains. In general, these soft tissue infections are the result of gram positive organism which can be treated with appropriate oral antibiotics. Septic arthritis (an ominous soft tissue infection resulting from a puncture) necessitates careful inspection of the wound channel and the course of the offending object. Treatment should be begun immediately, and usually consists of joint aspiration or arthrotomy. A delay in therapy can result in significant joint destruction, depending upon the organism.

Osteomyelitis is the most destructive complication following puncture wounds. The incidence of osteomyelitis appears to be related to the original injury and treatment. Injuries occurring through shoes, or with soil contamination have a increased risk for developing osteomyelitis. In addition, puncture wounds treated superficially have a greater potential for bone infection. In cases of delayed diagnosis, osteomyelitis may result. There has been a voluminous amount of literature documenting *Pseudomonas species* as the most common offending organism causing osteomyelitis secondary to puncture wounds.

Although infection is of immediate concern, other complications including foreign body granuloma and inclusion cyst formation should not be ignored because they may cause extended morbidity. These complications are more indolent in nature and may not require the same treatment urgency as is given to osteomyelitis.

A TREATMENT PROTOCOL

The goal of initial evaluation and treatment of a patient with a puncture wound includes converting a dirty wound to a clean wound and decreasing the potential for long-term sequelae by providing maximal inspection with minimal tissue damage. A complete and accurate history of the injury is very important. The time from injury until presentation, location of the injury, material from which the object is made, and materials through which the object has passed prior to puncture are all critical issues to determine the potential for complications. The physical and geographic location of the puncture along with its orientation, length, and shape are all important factors to consider when evaluating a puncture wound.

The patient's past medical history may also influence the initial treatment of the patient. Immuno-compromised states such as diabetes mellitus, HIV, or chronic steroid use may also significantly influence the initial treatment and may alter the long-term results. The patient's tetanus

status must also be addressed to insure adequate immunization. Review of all medications, allergies, and the patient's social and family history are also essential.

During examination, the patient's neurovascular status should be assessed. The presence of any local or systemic signs of infection are evaluated. The location and shape of the puncture is inspected to determine the local anatomic structures which may be involved. Radiographs should be obtained to assess the presence of retained foreign material, or osseous or joint involvement. If a bone or a joint is involved, immediate operative intervention should be considered in order to decrease the risk of bone or joint infection. The patient is also made aware of the possible need for long-term antibiotics. Each case which demonstrates bone or joint involvement should be assessed on an individual basis; only generalizations are made here.

If bone or joint involvement is not identified by radiographic examination, attention is then focused on the wound. A posterior tibial nerve block is performed to anesthetize the area. Occasionally an additional regional block may be needed (Fig. 1). Debridement of necrotic soft tissue and small stellate dysvascular flaps is performed to insure adequate drainage, and decrease the potential for infection. The wound is then dilated with a hemostat in order to gain exposure. Care must be taken to use a blunt object for dilation so that a new tract is not created by overzealous probing. Occasionally, a fifteen blade may be needed to make a 0.5 cm to 1.0 cm incision through the puncture wound to give adequate exposure.

The wound is probed with a hemostat or smooth forceps to evaluate the depth and course of the wound, and to determine the structures involved (Fig. 2). Punctures that penetrate the plantar fascia, or are greater than one centimeter in depth are associated with a higher incidence of infection. Joint or bone involvement necessitates a more aggressive approach to include intravenous antibiotics, oral antibiotics, and possibly surgical intervention depending on the clinical presentation.

Any foreign material identified radiographically or clinically should be removed. Listening and feeling for the object to come into contact with the probe while using the radiographs to give the orientation of any foreign debris is an invaluable technique. Prolonged blind probing is not recommended due to the increased potential for additional soft tissue damage and the possibility of driving a foreign body deeper into the soft tissues. If difficulty is encountered, a more formal open exploration using assistive devices such as fluoroscopy should be undertaken.

The wound is irrigated with 250 ml to 1000 ml of sterile saline via a 18 to 20 gauge angiocath and a 20 cc syringe. This high pressure irrigation allows for mechanical liberation of debris, and cleanses the wound with minimal soft tissue damage or irritation (Fig. 3). Care must be taken while irrigating to insure adequate outflow to prevent separation of tissue planes by extravasation of the irrigant. The use of betadine in the irrigant, even in the most dilute concentrations may cause irritation to the tissues especially if extravasation occurs. Its use is generally discouraged as it may predispose the clinician to think the wound is infected at

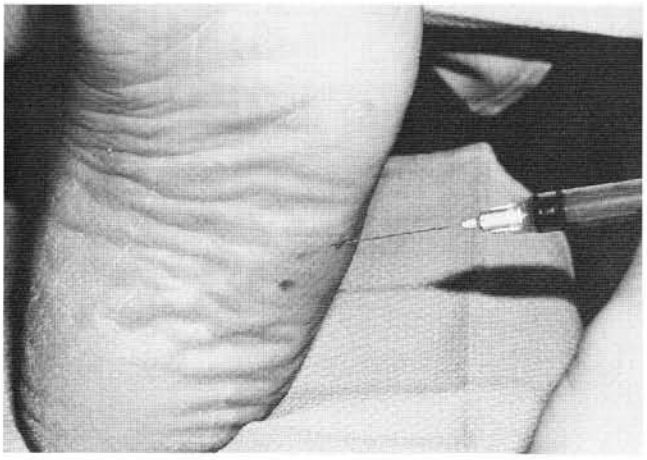

Figure 1. Anesthesia may be obtained through local infiltration around the puncture site, or by tibial nerve block.

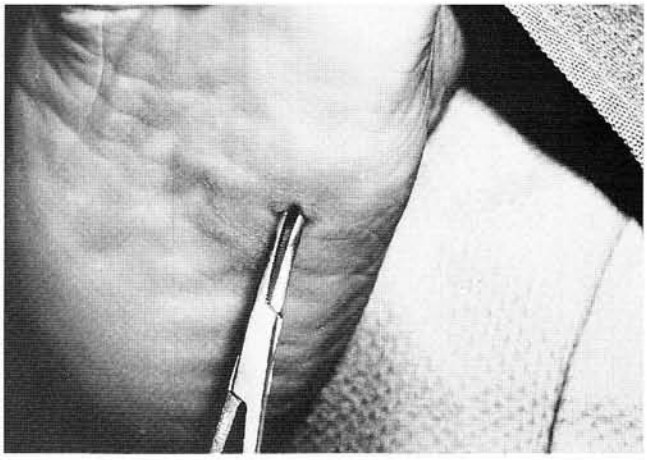

Figure 2. The wound is probed as necessary to determine the depth and path of injury, and to identify any foreign bodies.

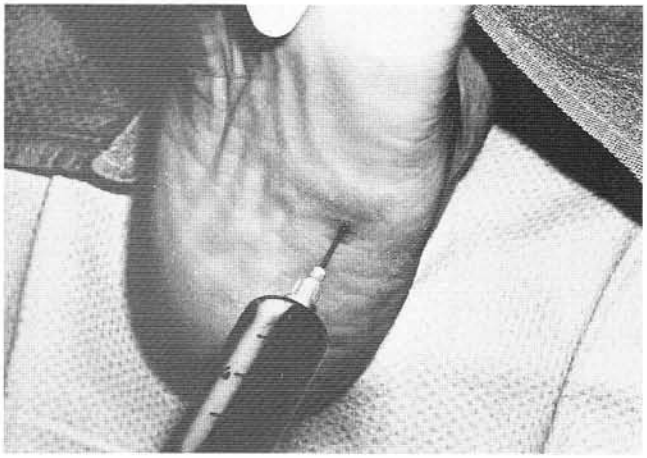

Figure 3. Irrigation allows for proper cleansing and mechanical debridement of the wound.

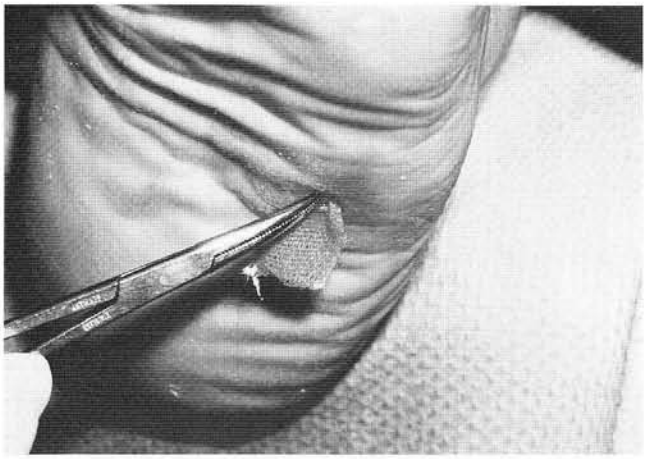

Figure 4. A drain prevents premature closure of the wound.

follow-up because of its erythematous and angry appearance. Other irrigating solutions, such as those impregnated with antibiotics may be used, but it is the mechanical properties of irrigation, not the solution itself, which is paramount.

The wound is then packed with a sterile penrose drain, sterile rubberband, or one-quarter inch plain packing to allow drainage and prevent the wound from closing. (Fig. 4) Soaking the foot is not recommended as there have been no studies which demonstrate its benefit and soaking may introduce infectious organisms from the solution or basin in which the foot is placed. The patient is instructed to remain non-weight bearing until the first follow-up visit, usually within three to five days of initial presentation.

This treatment protocol prevents rapid epithelialization or premature closure of the wound. Allowing the wound to heal from "inside out" is critical to preventing this complication associated with puncture wounds. Experience has shown that wounds which are not managed properly frequently epithelialize within the first 24 to 48 hours, thereby harboring organisms responsible for the complications associated with puncture wounds.

Several factors must be considered with this treatment protocol in determining the need for antibiotic therapy. If the patient presents greater than 24 hours from the time of injury, and demonstrates clinical signs of infection or is immuno-compromised, oral antibiotics to cover gram positive organisms are initiated. Cultures may also be considered in this patient population. Also, deep punctures which penetrate the plantar fascia may show an increased risk for infection which may predispose the clinician to use oral antibiotics. Abscesses, osteomyelitis, and septic arthritis obviously necessitate culture and sensitivity, intravenous antibiotics, and surgical intervention.

The author has used this treatment protocol in 278 patients with an infection complication rate of less than 2%. This protocol has allowed ample inspection to insure removal of foreign debris with minimal tissue damage, and has minimized long-term morbidity.

BIBLIOGRAPHY

Corey SV: Puncture wounds of the foot. In McGlamry ED, ed. *Reconstructive Surgery of the Foot and Leg, Update '88* Tucker, GA: Doctor's Hospital Podiatric Education and Research; 1988: 149-152.

Fitzgerald R, Cowan J: Puncture wounds of the foot. *Ortho Clin North Am* 6:965-972, 1975.

Jacobs NM, Rice TW: Puncture wound osteomyelitis. *J Pediatr* 107:645, 1986.

Jacobs RF, Adelman L, Sack C, Wilson CB: Management of pseudomonas osteochondritis complicating puncture wounds of the foot. *Pediatrics* 69:432, 1982.

Mahan KT, Kalish SR: Complications following puncture wounds of the Foot. *J Am Podiatry Assoc* 72:497-504, 1982.

Riegler HF, Rouston GW: Complications of deep puncture wounds of the foot. *J Trauma* 19:18, 1979.