

Management of Plantar Puncture Wounds In Children

Sairah Chachad, MD
Deepak Kamat, MD, PhD

Introduction

Puncture wounds are a common cause of minor trauma in children. These injuries can lead to serious infectious complications if not managed properly, especially if there is involvement of the plantar surface of the foot.¹ There is a striking paucity of data in the pediatric literature on the management of plantar puncture wounds. This review on the evaluation and management of plantar puncture wounds in children is based on existing data in children, extrapolation of appropriate adult data, and our own experience in clinical practice.

Epidemiology

Plantar puncture wounds are the most frequent type of puncture wounds seen in the pediatric emergency departments.¹ One re-

port states that over 4-year period 0.82% of the pediatric emergency department visits were for the treatment of plantar puncture wounds, and in another study 7.4% of patients with lower extremity trauma who came to the emergency department had plantar puncture wounds.² Other common sites for puncture injuries are the upper limb, legs, and trunk. These wounds are more common in the summer months when children are playing outdoors and often are barefoot. The common etiologic agents are nails, needles, glass, wood, plastic, and metal. Osteomyelitis is a relatively common complication in children, with an incidence ranging from 0.6% to 1.8%.³ The true incidence of complications associated with plantar puncture wounds is unknown, since not all people with such injuries seek medical attention.⁴

Pathogenesis

The most common organisms causing soft tissue infections are *Staphylococcus* and *Streptococcus*. *Pseudomonas aeruginosa* is the most frequent cause of osteomyelitis and osteochondritis of the foot, when the puncturing object penetrates through the sole of the shoe. According to one study, *Pseudomonas* grows well in the moist inner layers of the sole of actively used tennis shoes and it does not grow as readily in new or unused shoes.³ *P. aeruginosa* appears to involve the cartilaginous structures of the foot. The possible reason for invasion of the foot by this particular organism is the avascular nature of the cartilage and the relative greater amount of growth plate cartilage in children as compared with adults.⁴ It has also been postulated that perhaps the penetrating object may push foam particles contaminated with bacteria into the wound.¹ Other organisms that cause infections after penetrating wounds are *Serratia marcescens*, *Klebsiella*, *E. coli*, *Salmonella typhi*, and *Bacteroides melaninogenicus*.¹

Various factors are associated with the increased incidence of secondary infection and delayed wound healing of plantar puncture injuries. One of the most important factors is the depth of the wound.¹ Superficial wounds gen-

Clin Pediatr. 2004;43:213-216

From the Department of Pediatrics, West Virginia University, Morgantown, WV 26506.

Reprint requests and correspondence to: Deepak Kamat, MD, PhD, Children's Hospital of Michigan, 3901 Beaubien Blvd., Detroit, MI 48201.

© 2004 Westminster Publications, Inc., 708 Glen Cove Avenue, Glen Head, NY 11545, U.S.A.

erally have a better prognosis than deeply situated wounds. If there is breakage of the object, there could be a delay in wound healing, which leads to increased incidence of infection. Involvement of underlying structures such as blood vessels, nerves, tendons, and ligaments can give rise to vascular or neurologic complications. The highest risk of infection (osteomyelitis and septic arthritis) is in the region of the foot extending from the metatarsal neck to the distal toes.⁵ Embedded foreign bodies made of inert material such as gold may not cause any symptoms for a long time and their removal can be challenging, particularly if they are found buried in soft tissues.

History and Physical Examination

A detailed history of the injury is necessary to manage these injuries properly, to improve the

outcome, and to prevent complications. The size, nature, and condition of the penetrating object, mechanism of injury, location of the wound, and extent of soft tissue involvement and whether there is penetration of the footwear and contamination from the environment are some of the essential historical aspects to be noted by health care professionals.⁵ The other important factor is the time interval between the onset of the injury and commencement of medical attention. Chudnofsky and Sebastian⁶ state in their review article that the infection rate for early presenters was 2.2% as compared to 10.8% in late presenters. Identifying possible immunocompromised conditions (diabetes, chronic renal disorders, on immunosuppressive medications) of the child is also an important element of the history. Immunization history will determine the need for appropriate tetanus prophylaxis.

The area of the injury should be examined in great detail, and trimming of irregular wound edges or external cleansing of dirt and debris from the wound should be done if deemed necessary. If a laceration is present, it should be explored completely. A complete neurologic assessment of the affected limb should be performed and signs of vascular insufficiency should be looked for.

Diagnosis

Radiography is indicated if a wound examination is not fully possible or if there is a high index of suspicion of retained foreign material. Most of the causative objects are radioopaque and will be easily seen on a plain film (Figure 1). Certain objects such as wood and plastic are radiolucent and may require other radiologic diagnostic procedures such as ultrasound or computed tomography (CT) scan. Sonography has a



Figure 1. Foreign body identified in plantar aspect of the foot.

Management of Plantar Puncture Wounds

reported sensitivity, specificity, and accuracy of 90–100% and can localize a foreign body as small as 1×0.5 mm.⁷ It is particularly useful in detecting small metallic foreign objects that can cause artifacts on CT and magnetic resonance imaging. Sonographic evaluation has been reported to be questionable if a hyperechoic foreign body is located immediately adjacent to the echogenic bony cortex. Air in the soft tissues due to a puncture wound may also appear hyperechoic by ultrasound techniques and could potentially be mistaken for a retained foreign body. In a small number of cases, surgical exploration to localize suspected foreign bodies needs to be performed under fluoroscopic guidance using hypodermic needles.⁸ These procedures require general anesthesia. Blind wound-exploration, deep probing or coring, and high-pressure irrigation should not be performed.

Management

The management of plantar puncture wounds remains controversial, and recommendations range from simple cleansing of superficial wounds to surgical interventional techniques for deep and contaminated wounds.⁶

Conservative treatment is performed for children who present within 24 hours of sustaining an uncomplicated plantar puncture wound by a clean object, have a low risk of infection, and have no evidence of a retained foreign body. Conservative measures include rest, elevation of the foot, intermittent warm water soaks, and surface cleansing. According to an emergency department study done in 1995, application of dilute povidone-iodine solution

to the wound surfaces has been shown to reduce bacterial counts without adversely affecting the outcome of healing.⁹ It provides surface cleansing without the risk of infection. Because of *Pseudomonas* colonization of hexachlorophene when stored in open containers, its use for cleaning wounds is discouraged.⁴

Prophylactic antibiotic therapy is reserved for high-risk patients or for wounds at or distal to the metatarsophalangeal joints.⁵ The usual antibiotic prophylaxis is limited to staphylococcal and streptococcal species, in spite of the fact that a small number of patients have developed *Pseudomonas* osteomyelitis while receiving prophylactic antibiotics. Previous reports have indicated that the usual antistaphylococcal prophylactic antibiotics may promote the growth of gram-negative bacteria and might contribute to subsequent pseudomonal infections.⁴ If there is no evidence of a foreign body and the wound occurred more than 24 hours but less than 72 hours before, oral antibiotics for staphylococcal and streptococcal species such as first-generation cephalosporins or dicloxacillin may be given.¹ The patient should return within 48 hours to ascertain efficacy of treatment. Patients who do not show signs of clinical improvement with conservative measures and with outpatient antibiotic therapy or who present more than 72 hours after onset of injury with foot pain, swelling, erythema, or drainage from the wound should be treated with parenteral antibiotics.⁵ A complete blood count, erythrocyte sedimentation rate, and radiographs should be obtained to look for changes suggestive of osteomyelitis or osteochondritis. If after 48–72 hours of parenteral antistaphylococcal and antistrep-

tococcal treatment there is no improvement and/or if the penetrating object has gone through the sole of the shoe, *Pseudomonas* infection should be suspected and intravenous antipseudomonas antibiotics such as tobramycin, ticarcillin, or fluoroquinolones should be initiated. The clinical presentation of post-puncture wound osteomyelitis differs from signs and symptoms of hematogenous osteomyelitis.⁶ Most patients with puncture wound osteomyelitis are afebrile and appear nontoxic; the erythrocyte sedimentation rate is elevated, but the white count is usually normal.³ Postoperative antibiotic treatment of pseudomonal osteomyelitis involves a parenteral route for 10–14 days with the combination of an aminoglycoside and an antipseudomonal penicillin.⁴ Surgical referral is indicated in the presence of a deep or unrecoverable foreign body or for debridement of the wound in cases of suspected osteochondritis.⁵ The possibility of the puncture wound being infected with atypical mycobacteria must be entertained when bone specimens are sent for culture.

Tetanus prophylaxis is often forgotten in caring for children with penetrating wounds. If the child has received less than 3 doses of tetanus toxoid, the child should receive tetanus booster and Tetanus Immune Globulin (TIG). If the child has received more than 3 doses of tetanus toxoid, the child does not need TIG; however the child may need a tetanus toxoid if more than 5 years have elapsed since the previous dose. For a child less than 7 years of age, diphtheria and tetanus toxoid and acellular pertussis vaccine (DTaP) should be given; after 7 years of age, adult-type diphtheria and tetanus toxoid (dT) should be administered.¹⁰

Conclusion

If plantar penetrating wounds are managed appropriately, the outcome is generally good without residual deformity or any neurologic sequelae. Close follow-up of these injuries is essential, especially if the object has entered through the sole of the shoe, and the patient presents with tenderness, swelling, and inability to bear weight on the injured foot, since *Pseudomonas* osteomyelitis is a known complication of such wounds. Tetanus prophylaxis is an important part of management of plantar puncture wounds. There is considerable debate about whether a foreign body embedded in the foot should be removed surgically or left alone. One school of thought is to treat with conservative management

and observe closely for infection and other complications, whereas some clinicians believe in aggressive management and prompt removal of the foreign object. Observation may be acceptable if an object is buried deep in soft tissue and removal may prove difficult and potentially injurious to the child.

REFERENCES

1. Baldwin G, Colbourne M. Puncture wounds. *Pediatr Rev.* 1999;20:21-23.
2. Fitzgerald RH, Cowan JD. Puncture wounds of the foot. *Orthop Clin North Am.* 1975;6:965-972.
3. Saha P, Parrish CA, McMillan JA. *Pseudomonas* osteomyelitis after a plantar puncture wound through a rubber sandal. *Pediatr Infect Dis J.* 1996;15:710-711.
4. Inaba AS, Zukin DD, Perro M. An update on the evaluation and management of plantar puncture wounds and *Pseudomonas* osteomyelitis. *Pediatr Emerg Care.* 1992;8:38-44.
5. Wedmore IS, Charette J. Emergency department evaluation and treatment of ankle and foot injuries. *Emerg Med Clin North Am.* 2000;18:85-113.
6. Chudnofsky CR, Sebastian S. Special wounds: nail bed, plantar puncture, and cartilage. 1992;10:801-822.
7. Fessell DP, van Holsbeeck MT. Foot and ankle sonography. *Radiol Clin North Am.* 1999;37:831-858.
8. Mulhall KJ, Sheehan E, Kearns S, et al. Diagnosis and management of an intraarticular foreign body in the foot. *Ir Med J.* 2002;95:277-278.
9. Schwab RA, Powers RD. Conservative therapy of plantar puncture wounds. *J Emerg Med.* 1995;13:291-295.
10. American Academy of Pediatrics. Tetanus. In: Pickering LK, ed. *2000 Red Book: Report of the Committee on Infectious Diseases*, 25th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2000:566-568.