

Osteomyelitis Following Plantar Puncture Wound

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Abstract

Puncture wounds to the foot may be associated with bone and joint complications, especially when the etiological agent is *Pseudomonas aeruginosa*. The high affinity of this bacterium for cartilage tissue and the favorable environment for bacterial growth provided by sports shoes are two factors that contribute to a higher incidence of this pathology in children.

The present case report is intended as an alert to the importance of suspecting *Pseudomonas aeruginosa* as a pathogen in a pediatric plantar puncture wound and initiating the appropriate antimicrobial therapy to reduce the risk of complications.

Keywords: Child; Foot Injuries/complications; Osteomyelitis/etiology; Osteomyelitis/therapy; *Pseudomonas aeruginosa*; *Pseudomonas* Infections/diagnosis; *Pseudomonas* Infections/drug therapy; Wounds, Penetrating/complications

Introduction

Puncture wounds to the foot are frequent and predominantly affect the plantar region. They are commonly caused by an accidental puncture of the plantar region by sharp objects while walking (e.g. needles, glass, wood, metal objects). These wounds may progress to soft tissue infections, such as cellulitis, abscesses, or necrotizing infections. About 2% of these wounds cause osteoarticular complications like osteomyelitis, septic arthritis, or tenosynovitis.¹ Risk factors for infection include^{2,3}:

- The depth and location of the wound, with the metatarsophalangeal joints (body weight support regions) being more frequently involved;

- The type of footwear (rubber);
- The puncturing material (organic);
- The presence of a retained foreign body;
- Comorbidities such as diabetes mellitus and immunosuppression.

The main infection agents in a plantar puncture wound are *Staphylococcus aureus*, beta-hemolytic *Streptococcus*, and *Pseudomonas aeruginosa*, the latter often being underestimated, despite its high pathogenicity.⁴⁻⁶

Case Report

A previously healthy 11 year-old male adolescent was admitted to the emergency service due to pain and mild inflammatory signs (swelling and slight redness) at the left plantar surface of the first metatarsal head, following puncture trauma with an iron nail, six days earlier (Fig. 1). His immunizations, including tetanus vaccine, were updated. He had no fever but was taking ibuprofen three times a day. Plantar cellulitis was assumed, and he was discharged home medicated with oral flucloxacillin 100 mg/kg/day.

Three days later, he returned to the emergency service due to worsening pain at the first metatarsophalangeal joint, with limited mobility of the hallux. He presented swelling, redness, and heat of the plantar surface of the referred joint, without fluctuation or fistula formation. An analytical evaluation showed leukocytes 7,850 cells/ μ L and C-reactive protein 5.2 mg/dL. Blood culture revealed no growth. A radiograph of the foot was taken, and no relevant changes were observed. Ultrasonography revealed a thin layer of peritendinous fluid along the flexor *hallucis longus* tendon. Flucloxacillin was switched to oral amoxicillin and clavulanic acid and the patient was discharged home.

On day 12, he returned to the emergency service, reporting severe pain at the distal third of the left

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foot, which hindered walking and made weight-bearing impossible. On observation, there was marked redness and swelling of the plantar antero-medial surface, reaching the large dorsal surface of the foot and limitation in the active and passive mobilization of the first, second and third toes. Osteoarticular infection was hypothesized, despite the absence of fever. He maintained slightly elevated inflammatory markers (leukocytes 9520 cells/ μ L, C-reactive protein 3.25 mg/dL, sedimentation velocity 47 mm/hour). Bone scintigraphy, in the delayed phase, revealed an increased radiopharmaceutical uptake in the first metatarsophalangeal joint. He was admitted to the ward under intravenous antibiotic therapy with amoxicillin and clavulanic acid, 50 mg/kg/dose, every 8 hours. Due to a lack of clinical improvement, a magnetic resonance was performed, which revealed osteomyelitis of the first metatarsal and sesamoid bone with an abscess at the joint level (Fig. 2).



Figure 1. Foot puncture wound at the base of the left hallux (day 6).

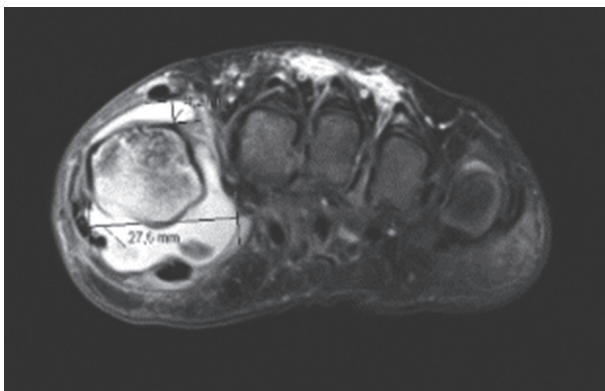


Figure 2. Osteomyelitis and abscess at the level of the first metatarsal, encompassing the sesamoid bones of the hallux with the destruction of the most medial.

A surgical approach with abscess drainage, debridement, and first metatarsal fenestration was carried out. *Pseudomonas aeruginosa* was isolated in the purulent exudate with no resistance identified for the antipseudomonal beta-lactams and fluoroquinolones. Treatment with ciprofloxacin (20 mg/kg/day) was initiated with slow but progressive clinical improvement. After four weeks of intravenous treatment, he was discharged home completing two more weeks of oral ciprofloxacin. In addition, he was referred for the outpatient pediatric rehabilitation service, which he attended three times a week.

He resumed physical activity in school three months after discharge, and about a month later, he suffered a diaphyseal fracture of the first metatarsal of the left foot (Fig. 3) while kicking a ball, which led to a further suspension of physical activity. The last radiograph performed four weeks after the removal of the plaster cast splint showed a united fracture with signs of bone callus (Fig. 4).

One year after the initial event, he still had pain with an intensity of 4/10. In the quality of life questionnaire Kidscreen-10, he presented a result of 37/50 and functional scores in the Oxford ankle and foot questionnaire (OxAFQ-C) dimensions were:

- Physical: 13 (54%);
- School and play: 12 (75%);
- Emotional: 12 (75%);
- Footwear: 3 (75%).

Two years later and after completing one and a half years of physical rehabilitation, he had a complete recovery. He currently has no pain or limitation of the activities of daily living and maintains regular physical exercise.

Discussion

The present case portrays the highly destructive osteoarticular capability of *Pseudomonas aeruginosa*. Because there were important risk factors at presentation, namely the existence of a nail puncture injury, the localization at the metatarsophalangeal joint and the use of rubber footwear, earlier antipseudomonal treatment could have been considered. The high pathogenicity and the delay in diagnosis may explain the subacute evolution complicated by pathological fracture of the first metatarsal and prolonged activity limitation. *Pseudomonas aeruginosa* can cause various skin, soft tissue, and bone infections, often associated with a worse outcome than other pathogens.⁷ Osteochondritis, osteomyelitis, and septic arthritis following a nail puncture wound to the foot is a well-described complication.^{8,9}



Figure 3. Radiograph of left foot showing a diaphyseal fracture of the first metatarsal after a minor trauma (kicking a ball).



Figure 4. United fracture with signs of bone callus one month after the fracture.

The high tropism of this bacterium for cartilage tissue, associated with the type of rubber sports shoes (trainers, slippers), in which humidity and the consistency of the material seem to be a favorable medium for bacterial

growth, constitute the two main factors contributing to the increased incidence of this infection in children.^{2,3,8}

Typically, there is a progressively worse disabling pain, accompanied by signs of inflammation at the site of the lesion and the affected bone/joint. However, despite these signs, there is no systemic inflammatory response in most cases, namely fever or significant elevation of acute phase markers. This may explain the delay in diagnosis, which occurs at a stage when an osteoarticular lesion is already established.³

The treatment of these infections consists of surgical debridement followed by antibiotic therapy for at least six weeks. Antibiotics with good antipseudomonal activity include ureidopenicillins in combination with beta-lactamase inhibitors (piperacillin-tazobactam), some cephalosporins (ceftazidime, cefepime), fluoroquinolones, and carbapenems. Fluoroquinolones as ciprofloxacin, are the only class of drugs available in oral formulation.¹⁰

The resistance of *Pseudomonas aeruginosa* to various antimicrobial agents limits the therapeutic choice in infections with this microorganism, which should be guided by the local susceptibility pattern.⁷

Due to the severity and diagnostic challenge, the authors reinforce the importance of suspecting of this pathogen after a plantar puncture wound and establishing early empirical effective antibiotic therapy.

WHAT THIS CASE REPORT ADDS

- Foot puncture wounds may lead to complications of the bones and/or joints, like osteomyelitis, septic arthritis, or tenosynovitis.
- *Pseudomonas aeruginosa* is one of the most frequently isolated agents in plantar infections following puncture wounds through rubber footwear.
- Bone infection by *Pseudomonas aeruginosa* may be associated with a major osteoarticular lesion in the absence of significant systemic signs, leading to a delay in diagnosis.
- In puncture wounds in the plantar region through rubber footwear, empirical antibiotic therapy should be active against *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

Conflicts of Interest

The authors declare that there were no conflicts of interest in conducting this work.

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Confidentiality of data

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

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Osteomielite Após Ferida Perfurante Plantar

Resumo

As feridas perfurantes dos pés podem associar-se a complicações ósseas e articulares, principalmente se o agente etiológico for a *Pseudomonas aeruginosa*. A elevada apetência desta bactéria pelo tecido cartilágneo e o ambiente favorável ao crescimento bacteriano proporcionado pelo calçado desportivo, constituem dois fatores que contribuem para o aumento da incidência desta patologia na criança. O presente caso clínico pretende alertar para a importância de suspeitar da *Pseudomonas aeruginosa* como agente

patogénico numa ferida perfurante plantar em idade pediátrica e instituir a terapêutica antimicrobiana adequada de forma a reduzir o risco de complicações.

Palavras-Chave: Criança; Ferimentos Penetrantes/complicações; Infeções por *Pseudomonas*/diagnóstico; Infeções por *Pseudomonas*/tratamento farmacológico; Osteomielite/etiologia; Osteomielite/tratamento; *Pseudomonas aeruginosa*; Traumatismos do Pé/complicações