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Diagnosis of foot foreign bodies with ultrasound: a case series from the pediatric emergency department

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Abstract

Aim: Foot foreign body injuries are prevalent among pediatric populations, posing diagnostic and management challenges. X-ray examination is the first choice used by emergency physicians for localization and removal of foreign objects but it has limited value when the foreign body is not radiopaque, leading to missed diagnoses of non-radiopaque foreign bodies, we recommend simultaneous use of point-of-care ultrasound (POCUS) to rule out foreign body in every case especially when history and clinical exam highly suggestive of foreign body. This case series highlights the diagnostic utility of X-ray and POCUS in the emergency department and its sensitivity in detecting radiopaque and as well radiolucent foreign objects. **Material and methods:** We describe a case series of foot foreign bodies in children, highlighting the clinical characteristics, diagnostic challenges, and utility of POCUS in the pediatric emergency department. Some patients had delayed presentation in the emergency department due to missed diagnosis in the first place. **Results:** Patient with sharp foreign bodies, such as glass, typically present with more pain and refusal to bear weight, and POCUS was also difficult, as while probing the area they experienced severe pain. Soft-tissue foreign bodies such as wood, glass and plastic may remain undetected on radiography, but are easily detected by bedside POCUS. **Conclusions:** This case series underscores the importance of early recognition and utility of POCUS as well as proper exposure X-ray imaging as the first choice for emergency physicians for ruling out foreign bodies in the foot.

Introduction

Foot foreign body injuries are frequently encountered in pediatric emergency departments (EDs) and can lead to significant morbidity if not managed promptly and appropriately. Children are prone to such injuries due to their curiosity and exploratory nature. Foreign bodies can range from simple objects like wood splinters to more complex items such as glass shards or metallic objects. While the majority of cases are minor and can be managed conservatively, some may require surgical intervention or specialized care. We describe a case series of foot foreign bodies in children, highlighting the clinical characteristics, diagnostic challenges, and utility of point-of-care ultrasound (POCUS) in the pediatric ED. Some cases had delayed presentation to the ED due to an initially missed diagnosis.

Case 1

A 12-year-old male, medically free with completed vaccination status, presented to our emergency department with his family, complaining of right foot pain persisting for one week. The pain began gradually, involving the plantar aspect of his right foot, and

had been intermittent over the past four years following an injury from a wooden toothpick at that time. He had a history of recurrent abscesses treated in different settings with frequent courses of oral antibiotics. An initial X-ray performed four years ago did not reveal any foreign body. The pain was associated with swelling of the foot and foul-smelling discharge, without fever or other systemic manifestations. On physical examination, the child appeared well, with normal vital signs. A 2 cm × 1 cm swelling was noted on the medial aspect of the distal first metatarsal plantar surface of the right foot, surrounded by redness and purulent discharge. Significant tenderness was elicited upon palpation of the hardened swelling, with a sensation of warmth around it. Range of motion of the toes and ankle was intact, and neurovascular assessment was normal. The initial ED impression was an abscess with surrounding cellulitis induced by long-standing foreign body impaction. Radiographic imaging of the foot did not reveal any foreign body (Fig. 1A). Therefore, a bedside POCUS was performed, revealing an elongated hyperechoic subcutaneous foreign body measuring 2.8 cm, surrounded by a small collection and diffuse edema (Fig. 1 B, C). The ED plan included wound culture, consultation with pediatric orthopedics for incision and drainage (I&D), and exploration to remove the retained toothpick, as well

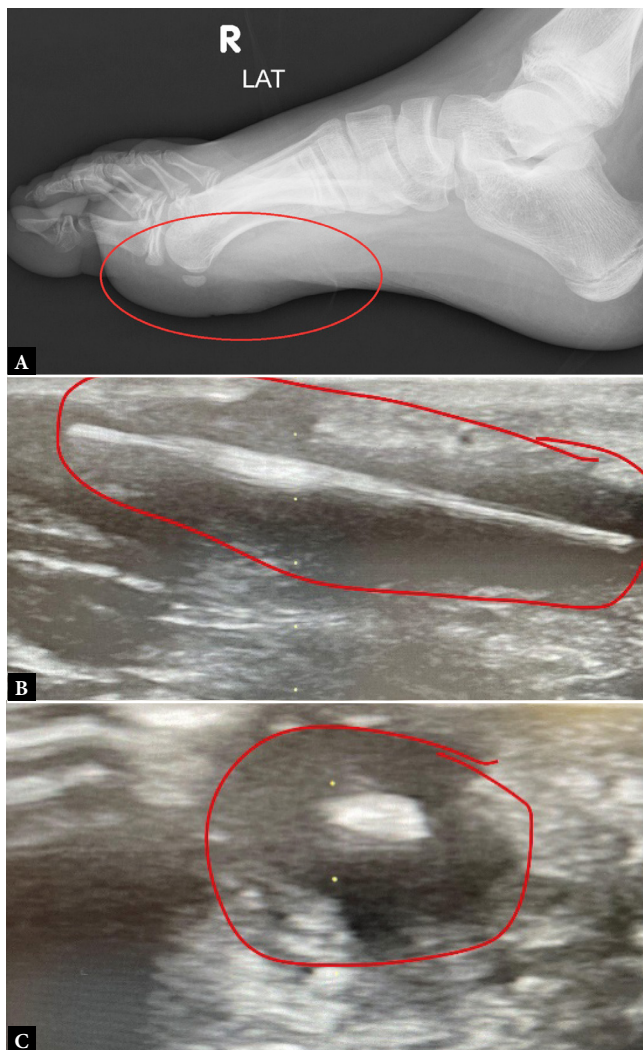


Fig. 1. A. X-ray of the right foot, lateral view, no visible foreign body. B, C. US of the right foot, thin linear foreign body visible

as ruling out osteomyelitis with advanced imaging such as MRI. The patient was admitted to the hospital, started on intravenous antibiotics, and underwent I&D in the operating room with foreign body retrieval and closure of the sinus tract. Wound culture grew methicillin-sensitive *Staphylococcus aureus* (MSSA), and appropriate antibiotics were administered. The patient was discharged in good condition after osteomyelitis was excluded, with resolution of symptoms and complete healing of the incision site observed at follow-up.

Case 2

A 13-year-old child was brought to the ED with complaints of limping. He had a history of stepping on glass two weeks earlier, and his mother suspected a retained foreign body in the foot.

He developed this pain while walking and was unable to bear full weight on the right heel as he felt mild pain, without swelling or signs of cellulitis in the right sole. Mild tenderness was noted in the right sole on pressure.

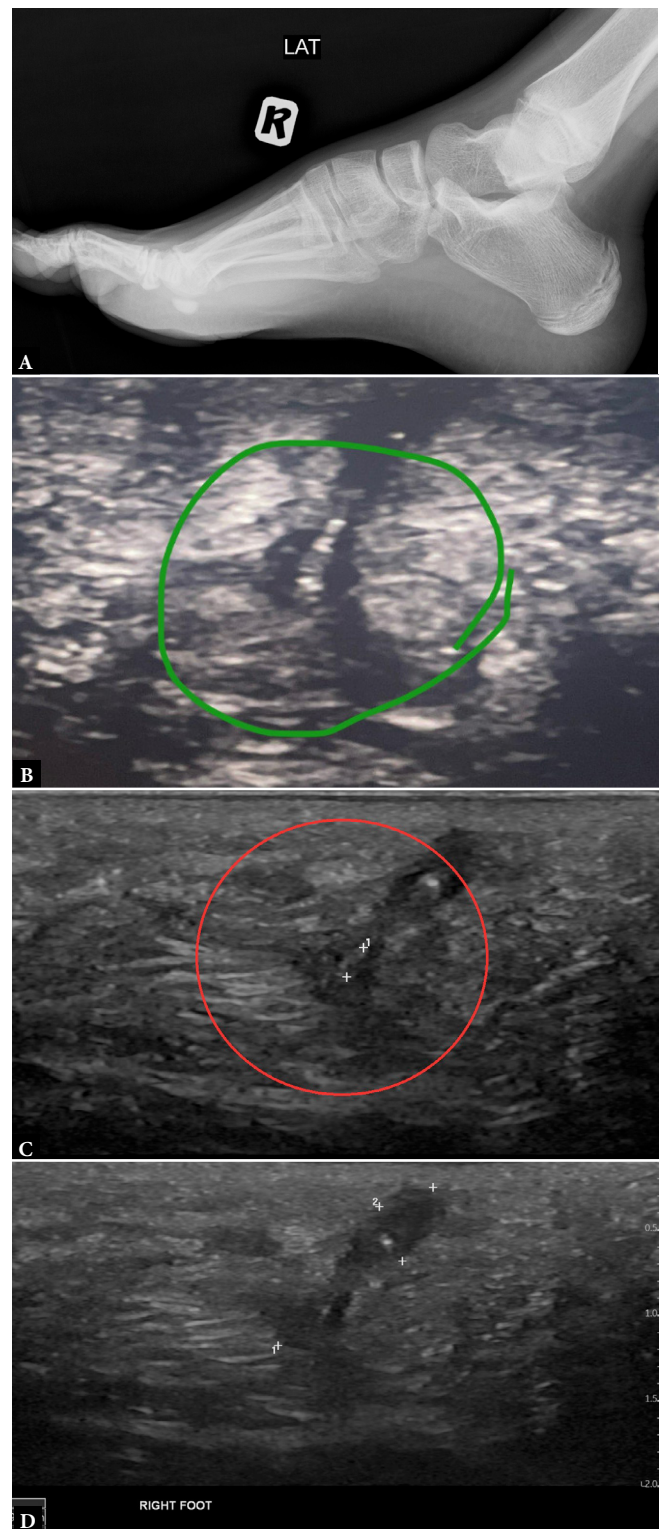


Fig. 2. A. Lateral view of the right foot, no visible foreign body. B. Bedside US of the right foot. C, D. As reported, there are a few small echogenic structures in the region of interest, the largest and deepest one measuring 0.1 cm, at a distance of about 0.9 cm from the skin. There is surrounding hypoechoogenicity without abscess. Another, more superficial linear echogenic focus, measuring about 0.2 cm in length, away from the skin breach 0.4 cm. Acoustic shadowing is present. There is surrounding hypoechoogenicity without abscess

X-ray showed no visible foreign body in the sole (Fig. 2 A). POCUS was performed and raised suspicion of a retained foreign body (Fig. 2 B). Confirmatory right foot US was done and reported by a radiologist with suspicion of a foreign body present in the right foot (Fig. 2 C, D). However, the parents left the ED without completing the treatment against medical advice.

Case 3

A previously healthy 7-year-old male presented with right foot swelling five days after stepping on glass and wood. He reported pain, skin discoloration, but no fever. Upon assessment, the patient appeared well, with age-appropriate vital signs. Local examination revealed a 2 × 1 cm swelling proximal to the 5th metatarsal of the small toe, accompanied by redness, tenderness, and fluctuation suggestive of abscess formation. X-ray of the foot was normal (Fig. 3 A). Bedside POCUS revealed a 1.5 × 0.8 cm abscess with an associated 1.5 cm echogenic structure, indicative of a foreign body, which was subsequently confirmed by official ultrasound (Fig. 3 B, C). The patient

was initiated on appropriate antibiotics, and orthopedic consultation resulted in successful surgical removal of the plastic foreign body. The patient was discharged after 24 hours with uncomplicated follow-up.

Case 4

An 11-year-old male presented to the pediatric ED 24 hours after stepping on glass the previous night. He sustained a small laceration on the plantar side of his right foot. There was mild bleeding initially, which had stopped, but the child had significant pain while walking and refused to bear weight on the foot despite the injury appearing to be minor. Initial X-ray revealed a small foreign body in the right foot between the first and second metatarsals (Fig. 4 A, B). Bedside ultrasound was attempted, but there was significant probe tenderness, as slight pressure would displace the underlying glass and cause severe pain. In this case, the history and examination were strongly suggestive of glass as a foreign body and after careful examination the X-ray showed a faint foreign object at the background between the first and second metatarsals, less likely to be an artefact.



Fig. 3. A. X-ray of the foot, lateral view (no visible foreign body). B, C. US of the foot (small hypoechoic subcutaneous collection measuring 2.3 × 0.4 cm, demonstrating increased peripheral vascularity, and internal linear echogenic structure measuring 1.7 cm, representing a foreign body)



Fig. 4. A, B. X-ray of the right foot, AP and lateral views (a radiopaque foreign body is noted in the plantar aspect between the 1st and 2nd metatarsal bones)

Case 5

A 4-year-old female presented to the ED with complaints. While playing, she accidentally stepped on a broken tile and had a minor laceration on the sole of her foot; bleeding had stopped but she continued to have pain at the site, which became worse on walking or any attempt to bear weight. There was a longitudinal laceration on the plantar surface of the left foot, measuring 2 cm × 0.5 cm. X-ray revealed a radiodense foreign body on the plantar aspect between the 2nd and 3rd metatarsals. No bone fracture or dislocation was found (Fig. 5 A, B). Ultrasound was attempted but again while probing the area the patient experienced severe pain and the US examination was stopped.

Case 6

A 3-year-old girl, medically healthy, came with a history of trauma while playing. She was accidentally struck on her left foot by a wooden



Fig. 5. A, B. X-ray of the foot, AP and lateral views revealing a radiodense foreign body in the plantar aspect between the 2nd and 3rd metatarsals

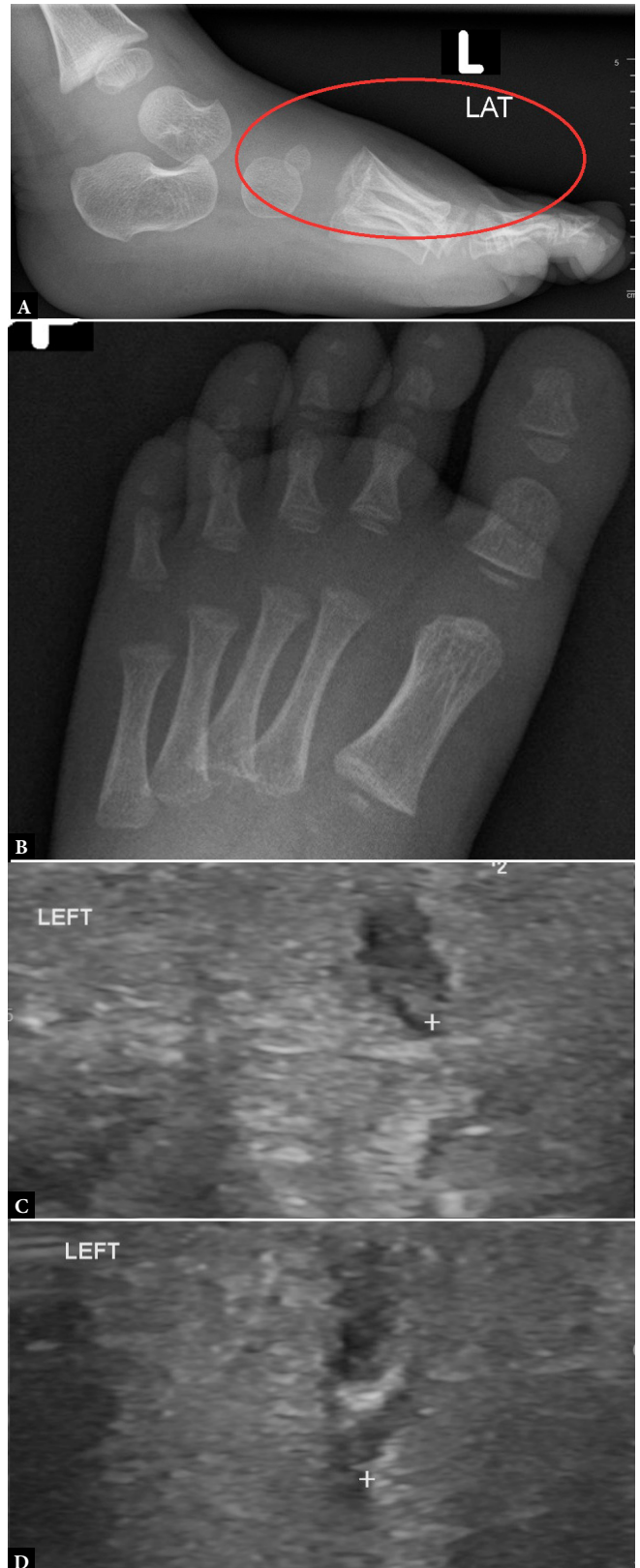


Fig. 6. A, B. Lateral view of the left foot showing soft tissue edema and swelling, and AP view showing no foreign body. C, D. The area of complaint (the left foot) reveals a heterogeneous area with a small collection measuring 0.4 × 0.5 × 0.7 cm. Linear hyperechogenic structure seen deeply at the base of the collection (potentially the foreign body)

stick. On examination, there was erythema on the dorsum of the left foot and a cystic fluctuation under the skin, suspected to be a pus-like collection. There was no history of fever. The child was able to bear weight and walk. He was vitally stable and appeared well. Tenderness was noted on the dorsal aspect of the left foot, with a noticeable collection under the skin. X-ray of the left foot (Fig. 6 A, B) showed no visible foreign body. The ultrasound revealed a small pocket collection with a linear object as the foreign body (Fig. 6 C, D).

Case 7

A 13-month-old girl was brought by her mother to the pediatric ED with left foot swelling and tenderness for the past three days. As the child started walking, the mother noted that she was not bearing weight and refused to stand and walk. Local examination showed swelling, erythema, and significant tenderness around the heel of the left foot and a small puncture wound. The mother gave a history of broken glass at home a few days prior. X-ray of the foot (Fig. 7) showed a foreign body superficially in the heel of the left foot. No POCUS was attempted. During orthopedic exploration, no foreign body was found. The child was discharged with oral analgesia and antibiotics.

Discussion

Pediatric foot foreign body injuries present unique diagnostic and management challenges due to the diverse physical nature of foreign bodies and variability in clinical presentation. Clinical suspicion, thorough examination, and appropriate imaging are crucial for accurate diagnosis and management in the pediatric population, considering the risk of medicolegal issues resulting from management failures⁽¹⁾. Children with podiatric foreign body injuries often present to the ED with discomfort or swelling, redness at the site of injury, with a history suggestive of foreign body penetration. In some instances, they may present late with recurrent soft tissue infection progressing to osteomyelitis, septic arthritis, pseudotumors resembling malignancy, or even migration of the foreign body to other critical tissues⁽²⁻⁶⁾.

In the ED, the use of radiographs to identify foreign bodies is crucial for localizing them relative to surrounding anatomical structures. Although routine radiography is the preferred imaging modality for the initial workup of radiopaque foreign bodies, several types of soft-tissue foreign bodies are not radiopaque and may remain undetected⁽⁷⁾. Thus, when a foreign body is non-radiopaque or very small, radiography may have limited utility⁽⁸⁾. Our case series highlights the value of ultrasonography in localizing and removing foreign bodies. Ultrasonography can easily identify foreign bodies, including glass shards, wood splinters, metal, and plastic, with a reported sensitivity of 90% and specificity of 96%⁽⁹⁻¹²⁾.

A high-frequency linear transducer is the optimal probe for visualizing superficial structures and identifying surrounding structures to guide the removal and minimize the risk of tissue injury. Visualization can be facilitated with gel pads or a water bath in small areas such as the fingers. All soft-tissue foreign bodies initially appear hyperechoic on sonography⁽⁸⁾. However, wooden foreign bodies may become less echogenic over time. The characteristic features of soft-tissue foreign bodies on sonography are increased by a surrounding hypoechoic halo of granulation tissue, edema, or hemorrhage^(8,13).



Fig. 7. Superficial foreign body at the heel of the left foot

Sonographic artefacts generated by soft-tissue foreign bodies aid in their identification. Such artefacts typically appear deep in relation to the foreign body on sonography and are independent of the material composition. The surface characteristics of the object influence the type of artefacts produced, particularly “clean” versus “dirty” shadowing⁽¹⁴⁾. Objects with a small radius of curvature or rough surface (e.g., a wooden toothpick or pencil) result in clean shadowing. Objects with a large radius of curvature or smooth surface (e.g. glass and metal) result in dirty shadowing and reverberation artefacts⁽¹⁴⁾.

Additionally, POCUS can assist in real-time retrieval of foreign bodies under local or regional anesthesia. The foreign body must be imaged in two planes, and the skin incision site and path must be predetermined. Injection of local anesthesia along the path can facilitate visualization and retrieval by incision, introducing surgical forceps, or using the needle localization technique as a marker for dissection and forceps entry^(7,15). After removal, the skin is disinfected, and the incision is closed with surgical strips, with sutures rarely needed. In cases requiring tissue dissection to remove foreign bodies, accurate localization is required for the safe removal of small or difficult-to-visualize objects. In most cases, foreign bodies can be removed in the ED, with surgical intervention reserved for complex cases or deep-seated foreign bodies. Multidisciplinary collaboration between pediatricians, orthopedic surgeons, and radiologists is essential for optimal outcomes.

Conclusion

Soft-tissue foreign bodies, such as wood, glass, and plastic, may remain undetected on radiography, but are easily detected by POCUS. This case series underscores the importance of early recognition and utility of POCUS as well as proper exposure X-ray imaging as the first-choice modality for the emergency physician for ruling out foreign bodies in the foot.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Author contributions

Original concept of study: AAB, RMA, JA. *Writing of manuscript:* AAB, RMA, JA. *Analysis and interpretation of data:* AAB, RMA, JA.

Final acceptance of manuscript: AAB, RMA, JA. *Collection, recording and/or compilation of data:* AAB, RMA. *Critical review of manuscript:* AAB, RMA.

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