



Radial Artery Injury from a Wooden Splinter: An Analysis of Imaging Modalities to Aid in Identifying Foreign Objects Associated with Puncture Wounds

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Abstract

Foreign body penetration of the upper extremity is a relatively common injury. The variety of potential foreign bodies and possible mechanisms of injury often make proper treatment difficult. Given the abundance of important structures that occupy a small space, foreign body penetrations of the hand and wrist can result in neurovascular, tendon, and bony injuries that require careful history and examination to ensure the correct diagnosis is not missed. Multiple imaging modalities can assist in diagnosis, and management may involve surgical intervention. We present a case of delayed presentation of a retained wooden splinter in the forearm with direct injury to the radial artery, together with analysis of various imaging modalities and the usefulness of each in diagnosing retained foreign bodies. After a thorough exam and confirmation with imaging, surgical exploration was performed. A traumatic radial arteriotomy was identified and repaired directly, and flow through the radial artery was preserved.

Keywords: Retained foreign bodies; Imaging modalities; Puncture wounds; Difficulties of diagnosis in penetrating wounds

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Introduction

Foreign body penetration of the upper extremity is commonly encountered by primary care and emergency physicians, as well as by hand surgeons. While there are many types of foreign bodies, wood, glass, metal slivers, and needles are the leading materials in accidental cases [1]. Once detected, foreign bodies are often removed either by the patients themselves or by clinicians; however, a retained foreign body can be difficult to diagnose and/or locate, which sometimes results in delayed treatment. Inappropriately managed wounds from foreign body penetration can have increased tissue damage, inflammation, infection, and delayed healing [2]. Depending on the location of the foreign body, injuries to arteries and nerves can also occur. Failure to identify and properly treat a retained foreign body can also result in a malpractice claim [3]. With a good history, physical exam, and appropriate imaging modalities, foreign body penetrations of the hand and wrist can be diagnosed and treated in an effective and timely manner. Depending on the type of injury, the treatment plan may involve operative intervention.

Case Presentation

A 67-year-old man presented for evaluation of a puncture wound on the volar surface of his right forearm. A month prior to the consultation, the patient sustained the injury while performing woodwork with a saw, but had no recollection of a foreign body penetration associated with the puncture. At the time of the injury, he experienced pulsatile bleeding that subsided with pressure and elevation. He denied loss of sensation or decreased range of motion in his injured hand. Initially, he sought care at an urgent care facility, where the wound was irrigated. Subsequently, the patient developed intermittent purulent and bloody drainage from the puncture wound with no associated erythema or fever. He returned to the urgent care facility a month later due to poor wound healing and continued drainage. A plain radiograph was performed and was unremarkable. He received a tetanus vaccination and trimethoprim/sulfamethoxazole and was discharged. Shortly afterward, he was seen post-operatively after a hernia repair. His general surgeon ordered an ultrasound of his forearm upon hearing his complaints of continued pain and wound concerns. This revealed a retained foreign body in his right forearm, prompting evaluation by our hand surgery team.



Figure 1: The wooden splinter entered the patient's radial volar forearm approximately 6 cm proximal to the wrist crease.

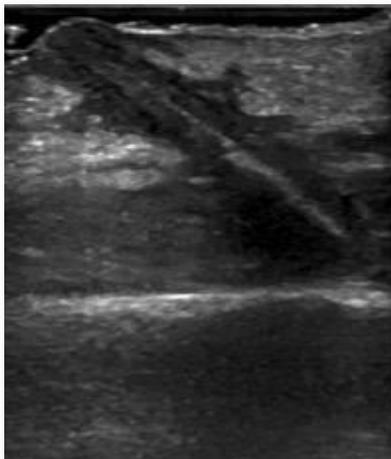


Figure 2: The patient's ultrasound, revealing direct penetration of the radial artery with the wooden splinter.

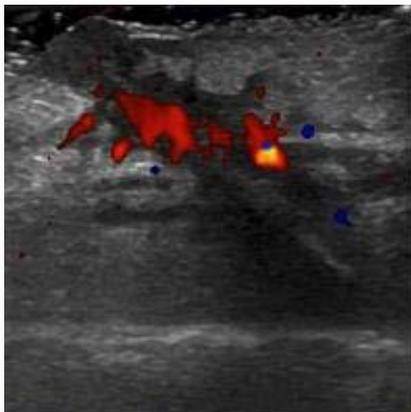


Figure 3: Color-still depiction on ultrasound of radial artery penetration by the wooden splinter.

Physical exam revealed a 0.5 cm mildly tender wound on the volar forearm with granulation tissue at the base and surrounding in duration (Figure 1). The wound was approximately 6 cm proximal to the distal wrist crease. His hand was well perfused with palpable radial and ulnar pulses, no palpable thrill, and a normal Allen's test. Ultrasound imaging revealed a linear foreign body consistent with a sliver of wood measuring 26 mm in length, extending 2.25 cm in depth into the forearm musculature, and directly penetrating the radial artery (Figure 2 and 3).

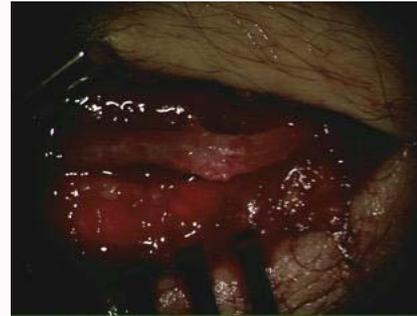


Figure 4: Intraoperative microscopic view of the 2 mm traumatic arteriotomy on the dorsal aspect of the radial artery with surrounding granulation tissue.



Figure 5: Extracted wooden splinter, measuring approximately 2.5 cm in length.

The patient was taken to the operating room electively for exploration. After careful dissection, the wooden splinter was removed, revealing a 2 mm traumatic arteriotomy of the dorsal aspect of the radial artery (Figure 4 and 5). The arteriotomy was repaired with a 9-0 nylon figure-of-eight suture. The patient's right hand was pink and warm, and Doppler ultrasound confirmed flow through the injured radial artery. The granulation tissue at the level of the skin was excised and the wound was closed. The patient was discharged on post-operative day 0 and had no complications. Final cultures from the wound were negative. At 3 weeks post-op, the patient continued to do well and expressed no concerns. His incision site had healed, and the right hand remained well perfused with no functional deficits observed.

Discussion

Nearly one third of traumatic wounds seen in the emergency department involve the hand and wrist, with retained foreign bodies present in over 10% of cases [4]. Foreign body penetrations can be sustained in a variety of different ways. In their retrospective review of foreign body penetrations of the hand and wrist, Hocaoglu et al. found that within their study cohort, the inciting events involved occupational trauma, routine house chores, motor vehicle crashes, self-administration of foreign body with the goal of secondary gain, injuries occurring during acts of crime, and injuries occurring as a result of psychiatric behaviors [2]. Patients who engage in machine work (involving high velocities of metal fragments) or woodworking are at an especially increased risk for injury due to retained foreign bodies. Potini retrospective review found that of 65 patients with retained foreign bodies, glass, metal, and wood were the most

common materials [4]. In addition to these, less common materials included bones of animals, gravel, mortar, Plastic, fiberglass, fish spine, screw, nail, thorns, bullets, and pencil lead [1].

Common acute symptoms of foreign body penetration include pain, swelling, and drainage from the entry site [1,4]; our patient had all of these symptoms. The chemical and physical characteristics of the foreign body may significantly influence the symptomatology as well as the management. Wood has the capability of serving as an unrecognized nidus for infection due to its porous consistency and may be associated with fistula, abscess or cellulitis. If adjacent to bone, it has the capability of causing osteomyelitis or septic arthritis if penetrating a joint [2]. Other organic materials such as splinters of plants, fish components and other animal tissues are generally capable of mounting a greater inflammatory reaction than inorganic materials [2]. Small retained metal or ceramic foreign bodies are generally better tolerated by patients, whereas wounds from larger foreign bodies are more likely to be symptomatic and necessitate removal [4]. Patients frequently present months to years after the initial foreign body injury, often with no residual signs of a foreign body on physical exam. A penetrating foreign body can cause neurovascular or tendon injury that may lead to functional impairment, associated fractures, infection, toxic or allergic reactions, and complications due to migration, poor cosmesis, and chronic pain [2]. These symptoms should prompt a complete work-up with imaging.

Particularly if the foreign body is not detectable on physical exam, the diagnosis must rely on imaging. In fact, the most common reason for missed diagnosis is reluctance to order plain radiography or further imaging at the initial presentation [3]. While glass, metal, and ceramic foreign objects may be easily identifiable on radiographs; organic materials such as wood are often not visible. Often, evidence of bony erosion on imaging due to an undetected foreign body such as wood may result in significant diagnostic confusion and raise suspicion for more serious clinical entities such as malignancy. In these situations, ultrasound is often a very reliable and sensitive imaging modality for identifying retained foreign bodies. On ultrasound, wooden foreign bodies are easily detectable as echogenic, linear structures. The lower cost and easily accessible nature of ultrasounds have made this imaging modality increasingly popular in evaluating possible foreign body injuries. Additionally, MRI may also be helpful in aiding the diagnosis; wooden foreign bodies and the surrounding inflammatory response are hypointense on T1-weighted images and hyperintense on T2-weighted images. Other potential diagnostic methods are CT or CT arthrography [5].

Management of foreign body injuries involving the hand and wrist varies depending on the depth of penetration associated injured structures, the patient's symptomatology, and time between injury and presentation. As the hand and wrist contain areas of high-volume real estate in a relatively small cross-sectional area, physicians should

have a high index of suspicion for deeper injury when presented with these patients. A detailed history is important and can help provide clues to diagnosis. For example, a history of pulsatile bleeding, as in our patient, can aid in identifying an arterial injury. A thorough hand and wrist exam can verify the presence of neurovascular or tendon injury in the majority of cases, though imaging should always be concurrently obtained. The ulnar and radial arteries should be assessed for hard signs of vascular injury, including absent pulse, pulsatile bleeding, expanding hematoma, bruit, or thrill. Temperature and capillary refill should also be documented, and an Allen's test should be performed. The site of injury should be assessed for skin changes, particularly granuloma formation, which is occasionally found in association with foreign body penetrations [5]. Once a foreign body injury has been diagnosed, a decision on how best to manage the injury must be made. Deep penetrating wounds with large foreign bodies should be explored operatively given the high likelihood for injury to a vital structure. Additionally, even in the presence of normal imaging, if the foreign body penetration occurred in close vicinity to a major artery or nerve (for instance, in the distal volar forearm), suspicion should remain high and the wound may need to be explored. Small but sharp penetrating foreign body injuries of the wrist or hand have the capability of doing a significant amount of damage despite their size, particularly if they are mobile. Contrarily, patients who are asymptomatic with small foreign bodies in less concerning anatomical areas do not necessarily have to undergo removal, as the risk of iatrogenic.

Conclusion

Foreign body penetrations of the wrist and hand are a common injury encountered in a variety of different scenarios with a multitude of foreign body materials. These injuries have the potential for causing harm to neurovascular structures, tendons, and bone. With a thorough history, physical exam, and appropriate imaging modalities, the diagnosis can be made and the foreign body removed in a safe and effective manner.

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