Intra-arterial Foreign Body following Radial Artery Cannulation Requiring Microsurgical Removal: Case Report and Review of the Literature

Shawn D. Feinstein¹ Reid W. Draeger¹

¹Department of Orthopaedics, University of North Carolina, Chapel Hill, North Carolina, United States

Address for correspondence Reid W. Draeger, MD, Department of Orthopaedics, University of North Carolina School of Medicine, 3102 Bioinformatics Building, CB #7055, Chapel Hill, NC 27599-7055 (e-mail: reid_draeger@med.unc.edu).

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Abstract

Keywords

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- complication
- radial artery cannulation
- microvascular repair

We report the case of a pediatric patient who underwent intra-arterial exploration and removal of foreign body after an arterial catheter cannula inadvertently fractured during removal and a fragment remained within the radial artery. The fragment was visualized using fluoroscopy intraoperatively and was successfully removed from the common digital artery to the index finger where it had migrated. We present the case as a rare complication of an exceedingly common procedure with a timely response to avoid further complication.

Introduction

Arterial catheterization is a vital procedure that is used ubiquitously throughout the hospital, both in critically injured and perioperative patients. It is estimated that more than 8 million arterial catheters are placed yearly in the United States.¹ Arterial catheters continuously and accurately measure blood pressure as well as heart rate and pulse contour to allow for immediate recognition of aberrant hemodynamic events and initiation of appropriate treatment. They also provide samples for blood gas analysis without the morbidity associated with repeat arterial puncture. While minor complication rates vary widely among studies, major complication rates for arterial cannulation are consistently very low, typically less than 1%.^{2–4} The most common complications of radial artery cannulation include temporary occlusion of the artery, thrombosis, hematoma formation, ischemia, infection, and bleeding at the puncture site.^{2–4} Retention of an intra-arterial foreign body following radial artery cannulation is quite rare, with only a few cases presented in the literature.^{5–12} When this rare complication occurs, however, early recognition and treatment are vital to prevent further adverse outcomes.

Case Report

We present the case of a 10-year-old girl who underwent intra-arterial exploration and removal of foreign body. The patient's past medical history is significant for situs inversus abdominus, heterotaxy syndrome, and an extensive cardiac history, including congenital third-degree heart block status post-pacemaker placement, bilateral superior vena cavae, an interrupted inferior vena cava, and complete atrioventricular septal defect status post-repair. She presented to the hospital for replacement of dual-chamber pacemaker generator, placement of epicardial pacemaker leads via thoracotomy, and bronchoscopy. A 22-gauge Arrow arterial line (Teleflex Inc., Wayne, Pennsylvania, United States) was placed into the left radial artery immediately preoperatively for continuous hemodynamic monitoring during the surgery. The surgery proceeded without complication, and the patient was admitted to the pediatric intensive care unit (PICU) postoperatively.

On postoperative day 1, the patient was in stable condition and to be transferred to the floor. The arterial line was removed by a nurse in the PICU prior to transfer. Per the nurse's report, as the clear Tegaderm (3M Health Care, St. Paul, Minnesota, United States) bandage and tape

securing the arterial line were peeled back, the site began bleeding before removal of the catheter. The catheter was then removed and pressure applied to the site until bleeding ceased. Upon inspection, the catheter tip was not intact and the PICU physician was notified. The vascular surgery service was consulted. The catheter tip was visualized on bedside ultrasound and was easily palpable on physical examination. The patient also endorsed pain on palpation over the arterial line insertion site. Initial extraction of the catheter was unsuccessful by vascular surgeons as they were not equipped to perform microsurgical arteriotomy and repair of the branches of the radial artery in the hand, where the catheter was believed to have migrated.

The following day, the patient underwent an arterial duplex ultrasound study of her left upper extremity, which visualized a catheter fragment measuring 2 cm in length within the radial artery that did not appear to occlude flow within the vessel, as evidenced by strong pulsatile flow just distal to the catheter. The hand surgery service was then consulted for removal of the retained arterial catheter fragment. Upon our examination, the patient had a benign-appearing incision over the volar radial aspect of her left wrist. There was no palpable foreign body. She had full motor function, and her sensation was intact throughout the hand. Her fingers were warm and well perfused. She had 2+ radial and ulnar pulses, and an Allen test revealed adequate collateral arterial circulation through the ulnar artery. Radiographs of the left hand and wrist revealed two small surgical clips but did not demonstrate the retained catheter fragment. After an extensive discussion regarding the risks and benefits of surgery, the patient's parents signed consent for left hand exploration with removal of foreign body and repair of the radial artery.

In the operating room, a tourniquet was used to improve visualization. The previous incision was reopened and extended 2 cm proximally and 5 cm in a distal radial direction. The site of arterial line placement was appreciated with evidence of early healing of the vessel, but no foreign body was identified at this location.

At this point, the tourniquet was deflated to hopefully improve visualization of the artery. An ultrasound probe was sterilely draped, but the foreign body was unable to be visualized with ultrasound. Next, intraoperative fluoroscopy was used to identify the location of the foreign body that was located distal to the surgical dissection in the common digital artery to the index finger. The tourniquet was reinflated, and a small counterincision was made directly over the fluoroscopically identified foreign body. The foreign body was then identified within the common digital artery to the index finger on the radial aspect of the index metacarpal (► **Fig. 1**). There was clear evidence of intimal damage to the artery at the distal most aspect of the foreign body (► **Fig. 2**). Using the operating microscope and microsurgical technique, a small arteriotomy was made at the level of the existing intimal damage and the foreign body was removed without difficulty (► **Fig. 3**). The 2-cm section of catheter was found to be intact, without evidence of further fragmentation (► **Fig. 4**). The vessel was irrigated with heparinized saline,

and then the arteriotomy site was repaired with 9-0 nylon sutures. The tourniquet was deflated, and the arterial repair site appeared patent, with brisk capillary refill of all digits. The wound was then irrigated and closed, and a soft dressing was applied.

Postoperatively, the patient's pain was well controlled, her fingers remained warm, and well perfused with brisk capillary refill, and she demonstrated full nerve function in her operative hand. She was discharged home 2 days after her orthopaedic procedure in stable condition. She was seen in follow-up 2 weeks postoperatively where she was noted to have mild paresthesias on the radial aspect of her index finger with slightly elevated two-point discrimination at 7 mL. The patient and her family were reassured that this was likely due to a neuropraxia injury that would likely resolve spontaneously over time. She was also referred to occupational hand therapy to maximize both range of motion and strength. Unfortunately, the patient was lost to follow-up after this appointment.

Discussion

Arterial cannulation and line placement is a common procedure both in the operating room and in intensive care units. Large cohort studies consistently demonstrate that arterial line placement is generally a safe procedure with infrequent complications. The rate of major complications is reliably reported as being less than 1%.²⁻⁴ One clinical review examined more than 19,000 radial artery cannulations over a 23-year period to identify the complications that occurred. The most common complication in this series was temporary occlusion of the artery, which ranged in incidence from 1.5 to 35% (with a mean of 19.7%), which the authors attribute to differing methods and level of effort to diagnose this complication. Importantly, they conclude that temporary occlusion itself has no serious consequences and that permanent occlusion is very rare, with a reported incidence of only 0.09%. This is likely due, at least in part, to the collateral circulation of both the radial and ulnar arteries to the hand. Other complications, including pseudoaneurysm formation, local infection, sepsis, and bleeding, have an average incidence of less than 1%.² Fracture or breakage of the arterial catheter is so rare that, to this point, it has only been described in case reports.

In this case, it is likely that the arterial cannula was cut with scissors when attempting to remove the clear Tegaderm bandage securing the hub to the skin. Luo et al⁵ report a similar case where scissors that were used to cut a Tegaderm bandage also likely severed an arterial cannula. They recommend taping the arterial cannula separately from other lines (e.g., peripheral intravenous access) and that no sharp tools be used while removing an arterial cannula. Moody et al⁶ report another case where the arterial cannula was inadvertently cut on removal. Shah et al⁷ report a case where the arterial cannula was likely damaged by a surgical needle while the catheter hub was being sewn to the skin. They recommend that all suture needles be kept clear of the cannula to prevent this from occurring. Finally, Ferguson et al⁸ and Brown⁹ report cases where an arterial cannula was

Fig. 1 Surgical exposure with forceps indicating radial artery.

severed by scissors that were being used to cut and release a securing stitch. Therefore, the authors of the latter study suggest suturing through the wings of the hub only.

Because we were unable to palpate the foreign body within the artery, we first used ultrasound to locate the foreign body, though we were unsuccessful. Moody et al⁶ report using ultrasound to provide real-time imaging at several times. They used ultrasound for the initial diagnosis and repeated the ultrasound immediately before proceeding to the operating room for removal to rule out distal migration of the fragment. They used ultrasound again intraoperatively as they were unable to palpate the cannula or identify the puncture site. Several other case reports have demonstrated success with the use of ultrasound to locate an arterial cannula, both

pre- and intraoperatively.^{10,13} We used fluoroscopy to visualize and locate the intra-arterial foreign body. Several case reports also used radiographs and/or fluoroscopy to locate the foreign body successfully.^{8–12} Our case demonstrates the vital importance of using imaging immediately preoperatively as well as intraoperatively to identify the location of the foreign body, as it had migrated distally. While distal migration is expected given the direction of arterial blood flow, two case studies demonstrated proximal migration of the arterial cannula fragment, likely due to arterial spasm.^{7,10} Finally, Luo et al⁵ used computed tomography (CT) with three-dimensional reconstruction to confirm the diagnosis and localize the arterial foreign body, as their case occurred in the middle of the night during which ultrasound was not available.

Fig. 2 View through operating microscope of catheter fragment within radial artery.

Fig. 3 View through the operating microscope of removing the catheter fragment after arteriotomy.

In our case, the PICU nurse who removed the arterial line immediately recognized a problem when the arterial site began bleeding before the cannula had been completely removed. This demonstrates the importance of visual inspection of arterial cannula after removal. Egwu et al¹² report a case of a patient who presented with wrist pain that began 4 days after a vascular surgical procedure in which an arterial line was used intraoperatively. A plain radiograph of the wrist demonstrated a 1-cm fragment of plastic catheter within the radial artery.

We elected to perform a small arteriotomy to expose and remove the intra-arterial foreign body. While this afforded adequate exposure to the foreign body, it also required repair of the artery after removal. Kim and Horton¹⁴ describe a case in which endoscopic technique using grasping biopsy forceps was performed to remove a misplaced embolization coil. Because of the small caliber of the vessel in our case, however, it may not have been feasible to use endoscopic technique to remove the foreign body.

Fig. 4 Removed catheter fragment.

Finally, our case is unique in that the hand surgery service was consulted and ultimately able to remove the intra-arterial foreign body. In every other case presented in the literature, the vascular surgery service was consulted and was able to remove the intra-arterial foreign body. Fellowship training in hand and upper extremity surgery affords the intimate knowledge of and experience with the hand, wrist, and forearm that is vital to protect vulnerable structures in these exploratory cases where extensive dissection may become necessary. In addition, a surgeon trained in microsurgical techniques offers the ability to diagnose and repair injuries to the small arteries of the hand, which occurred in our case. Knowledge of this rare but reported complication of radial artery cannulization by hand surgeons is important as they may be relied upon to perform microsurgical extraction of intra-arterial foreign bodies, especially when non-microsurgical extraction fails.

Based on our experience in this case, we recommend fixing the arterial line to the skin with an adhesive dressing only; any suture fixation to the skin should involve suturing through only the wings of the hub to keep the sharp suture needle away from the catheter itself. Next, avoid using sharp instruments such as scissors, if possible, during removal of the arterial line. If they must be used, the tips of the scissors must always be visualized and be kept away from the catheter. Immediately after removal, the arterial line catheter should be carefully visually inspected to ensure that the entire catheter has been removed with the hub. This requires staff to have knowledge of the appearance of the arterial line prior to insertion, including the length of the catheter itself. If there is any doubt as to the removal of the entire catheter, we recommend the use of ultrasonography or radiography to identify the fragment. We recommend repeating the radiographic study immediately preoperatively to locate the fragment and rule out migration as well as having the radiographic instrumentation available in the operating room should it be necessary to visualize the fragment intraoperatively. In our experience, a hand surgeon trained in microsurgical technique affords the best chance of successful removal without additional morbidity.

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Conflict of Interest

None declared.

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