

Extraction of radiolucent fractured wire components using intracardiac ultrasound during pulmonary vein isolation procedure



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Introduction

Invasive electrophysiology (EP) and interventional cardiac procedures are now commonplace in the delivery of health care, and with the continued evolution of procedures and techniques there will continue to be complications as a result. New equipment to support evolving techniques such as no-fluoroscopy EP study and ablation make complex cases safer and easier to complete. We report on an unusual complication during a no-fluoroscopy pulmonary vein isolation (PVI) procedure where a ProTrack transseptal wire (Baylis Medical, Toronto, Canada) fractured during transseptal puncture, leading to the uncoiling of extensive amounts of radiolucent metal wire material into the vasculature. This complication was managed using an intracardiac ultrasound catheter to target the fragments for extraction.

Case report

A 54-year-old man with a history of persistent, symptomatic atrial fibrillation was brought to the EP laboratory for anticipated PVI ablation. Access to bilateral femoral veins was achieved, and a no-fluoroscopy approach to the PVI was undertaken using a CARTO 3 electroanatomic mapping system (Biosense Webster, Irvine, CA). A small-curve Mobi 8.5F steerable sheath (Biosense Webster) was utilized, along with a Baylis RF transseptal needle and a ProTrack transseptal wire for transseptal passage. Anticipating a single puncture with 2 transseptal sheaths inserted, an 8.5F SL1 sheath (Abbott Medical, Chicago, IL) was also advanced to the heart with the mapping and ablation catheter, a Smart-Touch 3.5 mm contact force-sensing irrigated catheter (Biosense Webster). After creation of the electroanatomic map, an 8F SoundStar intracardiac ultrasound (ICE) catheter

(Biosense Webster) was advanced, and the left atrial structures and fossa ovalis were mapped using the CartoSound interface (Biosense Webster). The transseptal Mobi sheath and needle were dropped down from the superior vena cava (SVC) onto the fossa ovalis, which was mildly thickened, but otherwise unremarkable. Radiofrequency (RF) energy was delivered to the transseptal needle, which crossed into the left atrium, confirmed by saline contrast bubble injection. The dilator and sheath were fixed in position as the transseptal needle was removed from the sheath, and the ProTrack wire was advanced to support the transseptal passage of the catheter. The wire advanced to the tip of the dilator with ICE guidance and stopped abruptly at the end of the dilator, suggesting that the tip of the dilator was against the right atrial side of the fossa ovalis. The advancement of the wire was also seen on ICE; however, resolution of the imaging at 4.5 MHz frequency was suboptimal, and a small amount of wire may have exited the dilator tip unnoticed. It was readily apparent that the dilator was not properly positioned despite the successful passage of the needle into the left atrium, and hence multiple attempts at passing the wire or prodding the fossa were not performed. Given this failure to gain left atrial access, we then moved the sheath, dilator, and wire as a single unit to the IVC to reset for a second pass. However, we felt and saw transient tension on the fossa as the sheath was retracted. At this point, the wire would not retract easily, and excessive elasticity of the wire was noted suspicious for fracture. We activated fluoroscopy to interrogate the wire position; however, no clear abnormality was found as no wire was seen in the dilator and sheath and no fragments were seen in the heart ([Supplemental Video 1](#)). The dilator component and wire were then removed with manual traction, and we proceeded to reset the Mobi sheath into the SVC using the ablation catheter, followed by the guidewire and the dilator component. However, it was noted that the dilator would not return to the forward position on the Mobi sheath. We then pulled the sheath down into the heart and examined it with the ICE catheter ([Supplemental Video 2](#)). The ultrasound image revealed a snarl of foreign body wire material at the distal end of the Mobi catheter ([Figure 1](#)), possibly involving one of the side ports. Cine fluoroscopy

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KEY TEACHING POINTS

- New curved wires such as the ProTrack transseptal wire (Baylis Medical, Toronto, Canada) can be subject to fracture owing to their more complex construction.
- Fractured wire components may be invisible to standard fluoroscopy, despite the presence of substantial amounts of stainless steel wire as a result of very-thin-diameter components that constitute the wire itself.
- Intracardiac ultrasound remains an effective tool for visualizing all fragments of metal, as the thin-diameter metal components remain clearly visible on ultrasound imaging.
- Consideration of ultrasound scanning should be made in situations where retained wire fragments are suspected but not seen on fluoroscopic imaging.
- In the course of transseptal puncture, the use of high-quality intracardiac ultrasound imaging should be considered to ensure that the entirety of the interatrial septum is crossed by the transseptal sheath prior to removal of the transseptal needle.

with a 39 cm field of view was performed of the patient from head to groin, and no radiopaque material was visible outside the Mobi sheath, outside the SL1 sheath, or in the heart ([Supplemental Videos 1 and 3](#)). However, clearly there was a problem identified on the intracardiac ultrasound.

Given this finding, we immediately took steps to secure the foreign body debris: a 3.3F, 115 cm flexible alligator forceps (Cook Medical, Bloomington, IN) was advanced through the SL1 sheath and the foreign body fragments were snared and removed in this fashion, showing thin filamentous metal wire fragments consisting of the coil component of the wire ([Figure 2](#)). However, a significant amount of wire remained at the tip of the Mobi sheath. Once the wire fragments were free of the heart, we pulled all components to the IVC bifurcation to minimize the risk of cardiac perforation while we worked. We then attempted a trap-balloon technique¹ utilizing an 8 mm × 4 cm Powerflex over-the-wire angioplasty balloon (Cordis Medical, Fremont, CA) inserted to the end of the Mobi sheath, then did a low-pressure inflation to trap the wire components at the end of the sheath while retracting the entire sheath as a unit ([Supplemental Figure 1](#)). This was ineffective, as a significant amount of metal was stripped off when the sheath exited the vasculature with a thin strand protruding out of the body from the access site. However, this retained hardware could now be extracted by pulling on components in the ipsilateral second venous access through

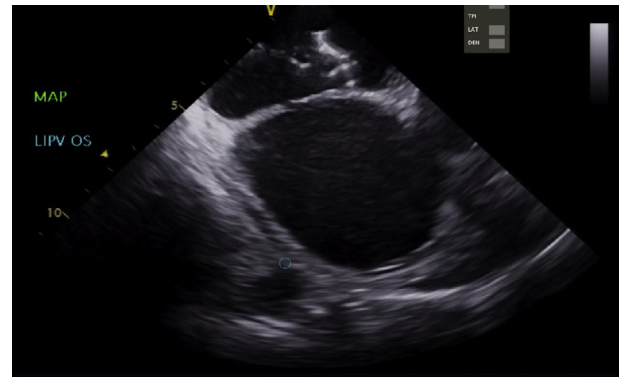


Figure 1 Intracardiac ultrasound image of wire fragment from fractured ProTrack wire (Baylis Medical, Toronto, Canada) in the right atrium. This segment was completely radiolucent. The visible sheath next to the fragment is an 8.5F SL1 sheath (Abbott Medical, Chicago, IL) with alligator forceps for securing the wire.

the SL1 sheath (watching the protruded fragments reenter the body and then exit out the SL1 sheath). The remaining fragments were then removed under ICE guidance in the distal venous structures. The ICE catheter was then advanced to the heart and imaging of the main pulmonary trunk, right ventricle, right atrium, and inferior vena cava and down to the access site was performed to confirm the absence of residual foreign material. Approximately 30 cm of unraveled metal wire was removed from the body in this fashion. It appeared that much of the metal wire was from the coil component of the wire ([Figure 3](#)). Given the time taken to extract the foreign material, the decision was made to cardiovert the patient and reschedule his PVI for a later date. He recovered without complications and was discharged the following day, continuing his oral anticoagulation.

Discussion

We believe this case provides some valuable insight to the potential complications that can arise from using complex wires in the course of invasive procedures, as well as novel techniques to address these complications successfully. The ProTrack wire is a unique wire designed to assist in safe transseptal passage and has been shown to decrease procedure times safely in MitraClip (Abbott Medical) procedures utilizing a 22F transseptal sheath.² The ProTrack has a soft spiral tip to allow for placement against the back of the left atrium for support while minimizing perforation risk³ ([Supplemental Figure 2](#)). The fracture of this wire has not been previously reported, to the best of our knowledge. Furthermore, much of the fragmented wire was not visible to standard fluoroscopy, and if we had not utilized ICE, we may have assumed that all wire fragments were removed from the body when there clearly was a significant amount remaining.

One of the pressing concerns for the authors is why the wire components were not visible to fluoroscopy. The ProTrack wire is constructed of grade 304 stainless steel (personal communication of author J.L. with Baylis Medical), a composite of iron, nickel, chromium, manganese, and



Figure 2 Same fragment of wire from [Figure 1](#) after removal. The very thin diameter of this stainless steel wire likely explains why it could not be seen with fluoroscopy.

carbon. This allows for unique properties, including corrosion resistance, strength, and flexibility. It is also naturally radiopaque, though it lacks the radiopacity of higher-atomic-weight compounds such as barium. The radiopacity of an object on fluoroscopy depends upon 4 factors⁴: depth of use in the body (shallow use in the dermal region able to attenuate radiation better vs the deeper coronary vasculature), the width of the artificial surface visualized, the energy of the imaging radiation source, and the atomic weight of the artificial surface. When one considers the 0.025 ProTrack wire, the diameter of the coil component is many times thinner than the normally radiopaque wire; hence the radiolucency of the coil wire fragments likely rests on its extremely small diameter alone. Fortunately, the visibility of the metal components on ultrasound was not affected and ICE remained an effective tool to properly address this complication.

Another item of concern was the apparent involvement of the side port of the Mobi sheath in wire entanglement. We believe the ProTrack wire did not get entangled in the side port during antegrade passage into the body, as the ProTrack wire was always advanced through the lumen of the dilator component. However, after the wire fractured and the dilator was removed, the remaining wire fragments were then exposed to the side ports and presumably became entangled as the mapping and ablation catheter was advanced through the sheath to advance the Mobi sheath back to the SVC for a second pass, which ultimately was aborted when the dilator component over a standard J wire failed to advance to the fully forward and locked position (remaining about 5 mm short of its final position, indicating that our standard J wire had not exited out the side port, as this would have resulted in at least 2 cm of the dilator remaining outside the body). It is our belief that some ProTrack wire fragments became entangled in the side ports, which fortunately

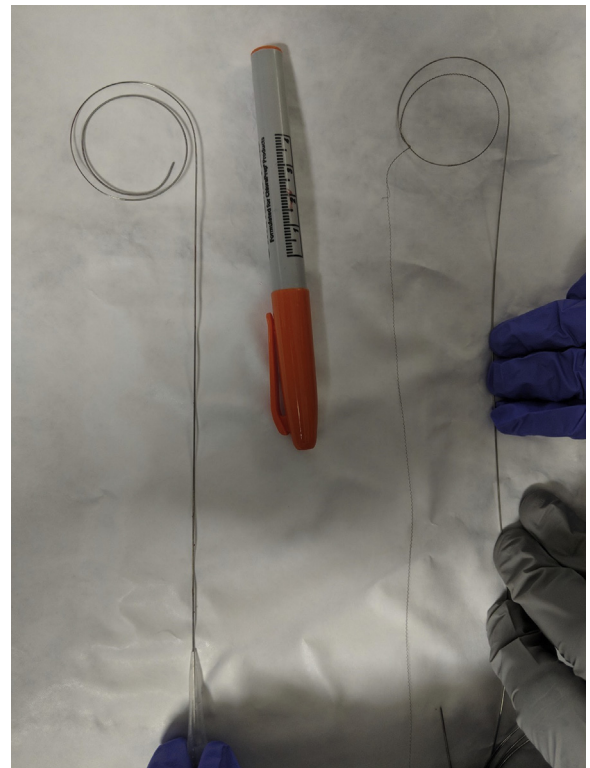


Figure 3 Photographs of a normal ProTrack wire (Baylis Medical, Toronto, Canada) (*left*), and the fractured ProTrack wire (*right*). Note extensive unraveling of the distal coil component portion of the wire.

prevented further embolization of wire fragments, but this also complicated removal, as the piecemeal extraction of the wire fragments through the SL1 sheath could not completely remove the hardware that was entangled with the Mobi sheath side port. We also believe that the use of the angioplasty balloon, to attempt to entrap the metal fragments and allow for extraction of the wire fragments as a single unit with removal of the sheath, actually ruptured the side port; however, in doing so, it then allowed the fragments to be pulled back into the body and out the ipsilateral access SL1 sheath by manual traction, as the binding point had now been released ([Supplemental Figure 3](#)). Caution regarding side port cannulation with curved wires is worth mention here, particularly in no-fluoroscopy cases, when wires are advanced into a sheath with side ports exposed in advance of the dilator component. The clue in these situations is generally the inability to advance the dilator component to the fully forward and locked position. Forcing the dilator forward typically will tear the side port to make it unusable for transeptal passage owing to the sheath deformation. This finding would also be readily apparent on ultrasound.

This patient underwent a repeat EP study after failing another trial of therapy on dofetilide with recurrent symptomatic atrial fibrillation. During this repeat study using a higher-quality ultrasound system (GE Vivid IQ 8 MHz, General Electric, Boston, MA), it was apparent that this septum had a thin primum layer, and a thicker secundum layer, which was missed on the initial ICE imaging with an older

ultrasound system (GE Vivid I 4.5 mHz, General Electric, [Supplemental Video 4](#)). It is the authors' belief that the transseptal needle punctured both layers with RF; however, the dilator component was stuck behind the second, thicker secundum layer. Hence when the RF needle showed left atrial access by saline contrast injection and was removed, access to the left atrium was lost, and the subsequent advancement of the ProTrack wire likely embedded within the fossa ovalis itself, leading to the wire fracture. A key lesson for the authors in this case was the importance of high-quality ICE in identifying both layers of the fossa, ensuring that the dilator component crossed both layers before removing the transseptal needle and advancing the transseptal wire. Ensuring this was accomplished on the second attempt led to an uneventful and successful PVI procedure for this patient.

Conclusion

Fractures of specialized wires can yield components that cannot be visualized under standard fluoroscopy, and intracardiac ultrasound should be utilized in these cases to prevent

inadvertent abandonment of hardware at the time of intravascular procedures.

Appendix Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2019.01.013>.

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