

A difficult entanglement: Guidewire entrapment within the submitral apparatus following transseptal access



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Introduction

We present the case of a patient with a remote history of open atrial septal defect (ASD) repair in whom a pulmonary vein isolation procedure was complicated by guidewire entrapment within the mitral valve apparatus. We describe the first reported successful use of a balloon dilation technique in this anatomical location to resolve the entrapment. A review of the literature pertaining to knotted intravascular wires and catheters, with a focus on mitral valve entrapment and cases specific to guidewires, is also provided.

Case report

Our patient was a 68-year-old man with a history of congenital ASD status post open stitch repair in 1974. He was referred to electrophysiology by his primary cardiologist owing to a history of paroxysmal atrial fibrillation and typical-appearing atrial flutter that was associated with a mildly reduced left ventricular ejection fraction (46%) and symptoms of dyspnea with exertion that limited his lifestyle. He had twice undergone synchronized cardioversion, but atrial fibrillation recurred. He was a lifetime nonsmoker who consumed less than 1 glass of wine per day, and had tested negative for sleep apnea. His medications included carvedilol, furosemide, losartan, and apixaban. His resting electrocardiogram was significant for left anterior fascicular block, right bundle branch block, and a corrected QT interval

of 505 milliseconds (Bazett). After a detailed shared decision-making discussion with his electrophysiologist, the patient opted for ablation rather than antiarrhythmic medication, given that his options were limited by reduced ejection fraction and baseline conduction abnormalities.

Owing to his history of ASD closure, a contrast-enhanced computed tomography (CT) scan of the chest was obtained prior to the procedure that showed moderate focal thickening but no shunting across the atrial septum. Immediately prior to the procedure, the patient was feeling well and had a normal physical exam. He was induced with general anesthesia for a planned pulmonary vein isolation and cavotricuspid isthmus ablation. Preoperative transesophageal echocardiography (TEE) was used to rule out left atrial or atrial appendage thrombus given that over 4 weeks had elapsed since his CT scan and for additional planning for the transseptal approach for what was expected to be potentially difficult transseptal access. TEE demonstrated no thrombus and evidence of prior stitch repair, with thickening of the septum around it. Femoral venous access was obtained for routine catheter placement including an 8F Soundstar (Biosense Webster Inc, Irvine, CA) intracardiac echocardiography catheter. Intravenous unfractionated heparin was administered continuously to achieve therapeutic activated clotting time.

Under continuous intracardiac echocardiography and fluoroscopic guidance, the NRG transseptal puncture needle (Baylis Medical Company, Inc, Montreal, Canada) was advanced through the 8.5F TorFlex guiding sheath (Baylis Medical Company) per institutional routine. The entire apparatus was withdrawn to the level of the inferior-anterior interatrial septum to avoid the area of prior repair. Radiofrequency energy was applied and the apparatus was easily advanced into the left atrium. The needle was withdrawn and a TorFlex 0.032" guidewire was advanced through the sheath. Our plan was to traverse this guidewire into a left pulmonary vein for subsequent dilation of the

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KEY TEACHING POINTS

- Guidewire entrapment in the mitral apparatus is an unusual but serious complication of left-sided cardiac procedures.
- An entrapped wire or catheter may be successfully freed using balloon dilation over a wire passed through the knot.
- A multidisciplinary approach is helpful to resolve equipment entanglement during cardiac procedures.

septal puncture per routine. However, on the first pass, the wire inadvertently advanced across the mitral valve and into the left ventricle, where it appeared to interact with the mitral valve apparatus, forming a knot (Figure 1). The wire could not be freed despite attempts to advance multiple sheaths over the wire. Attempts to advance a separate wire through the knot were periodically successful, but the position could not be maintained owing to inadequate sheath support. Intraoperative TEE was obtained and confirmed the diagnosis of entrapment but ruled out new mitral regurgitation.

After multiple failed attempts to release the wire, a multidisciplinary discussion of possible strategies and approaches took place between providers representing electrophysiology, interventional cardiology, cardiothoracic surgery, cardiac anesthesia, and interventional radiology. Consideration was given to an approach in which the wire would be pulled regardless of the resistance met, with preparation for emergent open repair if acute mitral regurgitation resulted. This approach was discarded out of concern for difficulty entering the chest in the setting of prior sternotomy and substantial bleeding owing to ongoing therapeutic anticoagulation with apixaban. Open removal was considered but would be delayed until apixaban wash-out. Based on the absence of attractive alternative options, the team decided to continue with endovascular methods.

A diagnostic sheath with 5F inner diameter was passed through the 8.5F TorFlex sheath over the 0.032" wire until resistance was met against the entangled wire. Alongside the 0.032" wire, and through this second sheath abutting the knot, a 0.014" stiff wire was passed and was directed through the guidewire knot. Over this wire, a noncompliant 3 mm balloon catheter was advanced and inflated with widening of the knot (Figure 2). A second noncompliant balloon of 6 mm was then advanced over the same wire, and inflation of this balloon resulted in release of the knotted guidewire (Figure 3). The balloon and 0.014" wire were removed. A sheath was then advanced over the previously knotted guidewire and the entire apparatus was withdrawn into the right atrium.

The decision was made to abort the remainder of the procedure given the length of time under general anesthesia, cumulative radiation exposure, and the late hour. Final TEE images showed no change in mitral regurgitation compared to the preoperative study. The patient had no further complications and was discharged in stable condition the following day.

Discussion

Endovascular knotting and entrapment is a rare but known complication most frequently reported in the venous circulation, chiefly with pulmonary artery catheters, but also with central venous catheters, pacemaker leads, cardiac catheters, or guidewires. In a case series of 113 reports of intravascular knots by Karanikas and colleagues¹ through 2002, nearly two-thirds were removed endovascularly. During electrophysiological procedures in particular, knotted wires and catheters have been reported within the femoral vein,² pulmonary vein,³ Chiari network,⁴ and cardiac chambers themselves, as in the case of permanent pacemaker lead entanglement.⁵ These entanglements can typically be released by catheter manipulation, by sheath advancement, or by applying various degrees of traction. Guidewires are generally less compliant than catheters and cannot be actively directed, making it more difficult to resolve knots. In the case series referenced above, there were 9 entrapped guidewires, and 5 (55%) required surgical removal. In the other 4 cases, the knotted wire was released by advancing a sheath over the wire to loosen the knot, an approach that has been used and reported since the 1970s but was unsuccessful in our case.⁶

Alternate approaches for resolving endovascular knots have been reported that may have been considered in the case of our patient, including the use of a deflector wire⁷ or endomyocardial forceps⁸ to hook the knot and pull it loose. However, these approaches carry an inherent risk of endovascular injury or device embolization. The balloon dilation technique reported here has been applied in other cases of endovascular catheter knotting, but not with the added complexity of entrapment around a cardiac structure. Tan and colleagues⁹ reported balloon dilation of a knotted pulmonary arterial catheter in the subclavian vein in 1997. A more recent report by Sasikumar and colleagues¹⁰ describes a balloon dilation technique to resolve a knotted catheter in the right atrium of an infant. In both of these cases, the knotted catheters made a relatively large loop, manipulation could be assisted by advancing a wire through the catheter, and they were not entrapped by a cardiac structure.

A review of case reports suggests that entrapment involving the subvalvular apparatus seems to carry greater potential morbidity. To the best of our knowledge, there are no published reports of guidewire entrapment within the mitral valve, but the review by Karanikas contained 3 cases of pulmonary arterial catheters that were entangled in the tricuspid chordal apparatus. All 3 patients required cardiectomy for retrieval. More recently, an increasing

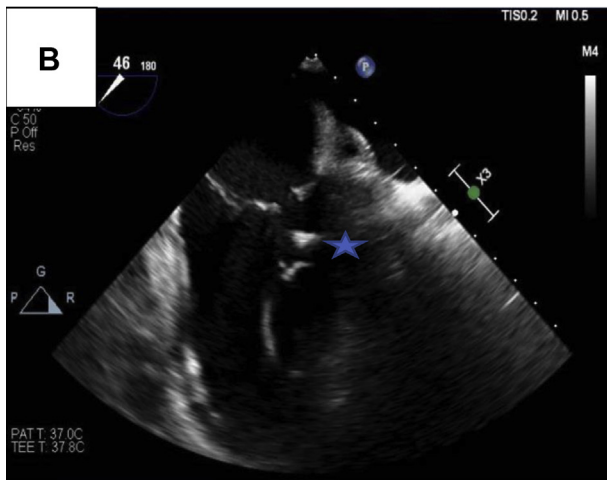
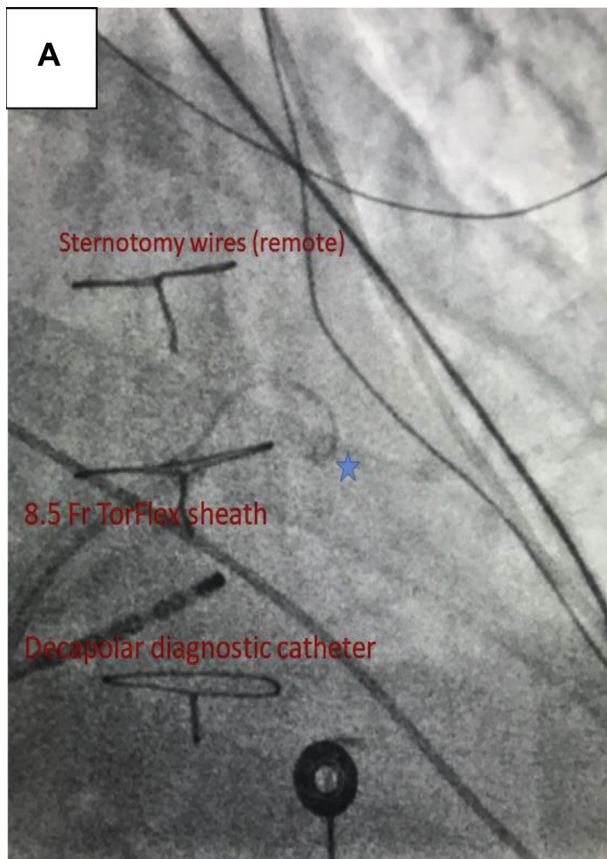


Figure 1 Initial images of 0.032 mm knotted guidewire (blue star) around submitral apparatus. **A:** Fluoroscopic image. **B:** Transesophageal echocardiography image.

number of operators have reported knotting or entrapment of circular mapping or ablation catheters within the chordal apparatus during ablation procedures.^{11–15} Despite extensive attempts to free these catheters endovascularly using sheaths and traction, nearly all of the patients described in these reports required cardiotomy. These reports include some serious complications during endovascular maneuvers, such as catheter fracture, ruptured chordae, acute mitral regurgitation, and papillary muscle rupture.

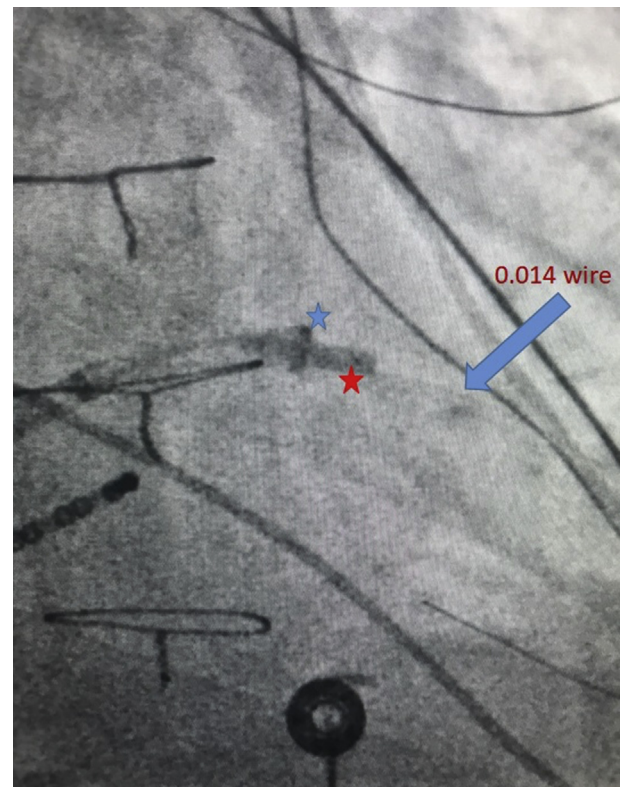


Figure 2 After a 0.014 mm wire was advanced through the knotted wire (blue star) a small noncompliant balloon (red star) was inflated to release the knot.

These cases, as well as the one presented here, draw attention to the risk of wire-related mitral valve entrapment. Since little is known about this rare but serious complication, we offer the following learning points from an analysis of our experience. Our transseptal approach (anterior/inferior) was chosen to avoid the prior area of ASD closure owing to its thickness as visualized on preprocedural CT and TEE. This increased thickness was expected to make the transseptal puncture significantly more difficult, possibly requiring balloon dilation, which we hoped to avoid. This approach likely increased the risk of inadvertent wire advancement into the left ventricle. Operators should consider this potential added risk when choosing a nonstandard transseptal puncture site. Secondly, the J tip of the 0.032" TorFlex wire is intentionally floppy in order to be nontraumatic, and that may have increased its propensity for entrapment. A stiffer wire may not have become entrapped so easily. Most important, the involvement of a multidisciplinary team resulted in a comprehensive discussion encompassing a broad range of expertise for consideration of a variety of possible solutions to this complication, without which this patient's outcome may not have been as favorable.

Conclusion

We presented a novel application of an endovascular balloon dilation technique to resolve a guidewire knot around the submitral apparatus. This technique has substantial advantages over open removal and is unlikely to cause damage to

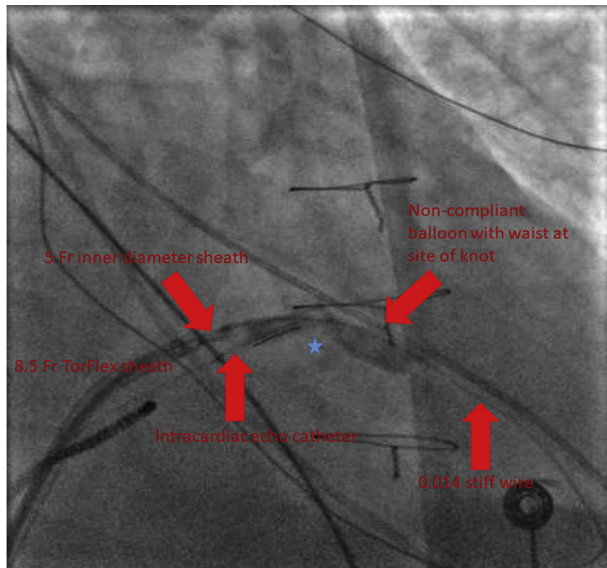


Figure 3 Balloon was upsized and subsequent dilation resulted in freeing of the knotted wire (*blue star*) from the mitral apparatus.

the surrounding anatomy. As part of a comprehensive multidisciplinary approach, this technique may be used to mitigate the substantial morbidity associated with the rare but vexing complication of guidewire entrapment.

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