Coronary sinus spasm with catheter entrapment and adjacent coronary artery compression during an ablation procedure in a child

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Introduction

Entrapment of catheters and guidewires is an infrequent but recognized complication of electrophysiological procedures. Most case reports involve ablation, circular mapping, or high-density mapping catheters trapped in native or prosthetic mitral valves[1,2] or Chiari networks.[3,4] Rare cases have been reported of catheters wedged in pulmonary[5] or iliac[6] veins, the tricuspid valve apparatus,[7] and the Thebesian valve.[8] Catheter-to-catheter entanglement has also been described, such as in a side hole of a sheath[9] or in the grid of a mapping catheter.[10] In several cases, the trapped catheter required surgical excision with or without concomitantly addressing damage to the involved cardiac structure. Herein, we describe the case of catheter entrapment in the coronary sinus of a young child during an electrophysiological intervention for supraventricular tachycardia.

KEY TEACHING POINTS

- Entrapment of catheters and guidewires is an uncommon but well-recognized complication of electrophysiology procedures.
- The complex array of circular and longitudinal smooth muscles surrounding the coronary sinus enables proximal sphincter-like contractility to optimize blood flow, but may also predispose to catheter-induced spasm.
- Spasm of the coronary sinus with catheter entrapment can be associated with mechanical compression of the adjacent coronary artery.
- A strategy of cutting the handle off the entrapped catheter, advancing a long sheath over the catheter, and delivering nitroglycerin inside the coronary sinus while applying gentle traction and countertraction could be effective in relieving the spasm.

Case report

A 6-year-old girl weighing 39.7 kg was referred for catheter ablation in the setting of paroxysmal supraventricular tachycardia, a structurally normal heart, and no ventricular preexcitation. Supraventricular tachycardia was first documented at 2 years of age, with frequent recurrent bouts despite antiarrhythmic drug therapy. Episodes often terminated with vagal maneuvers but occasionally required intravenous adenosine.

The procedure was performed under general anesthesia. Right and left femoral venous access was obtained under ultrasonic guidance without difficulty. A 3-dimensional anatomic map of the right atrium and coronary sinus was created using a 7F catheter via a right femoral venous approach (Navistar catheter, CARTO electroanatomic mapping system; Biosense Webster, Diamond Bar, CA). A 4F steerable decapolar catheter (Inquiry Decapolar; St. Jude Medical, St. Paul, MN) was introduced in the left femoral vein and directed to the coronary sinus. The catheter tip became entrapped in the proximal coronary sinus at or near the ostium of the middle cardiac vein. Efforts to reposition or retract the catheter using gentle traction were futile. A deflectable sheath (6.5F Destino Twist; Oscor, Palm Harbor, FL) was introduced in order to cannulate the coronary sinus for angiography. Attempts were unsuccessful with and without guidance by a second 4F steerable decapolar catheter within the sheath. The handle of the entrapped decapolar catheter was removed by cutting through the shaft to allow

KEYWORDS Catheter entrapment; Coronary sinus; Nitroglycerin; Catheter ablation; Supraventricular tachycardia
(Heart Rhythm Case Reports 2022;8:735–738)

Funding Sources: Dr Khairy is supported by the André Chagnon Research Chair in Electrophysiology and Congenital Heart Disease. Disclosures: The authors have no relevant potential conflicts of interest to disclose.
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https://doi.org/10.1016/j.hrcr.2022.07.021

a 5F sheath (Performer Guiding Sheath; Cook Medical, Bloomington, IN) to be positioned over the catheter and into the coronary sinus. Contrast injection through this sheath revealed complete obstruction of the proximal coronary sinus at the tip of the entrapped catheter, presumably owing to spasm (Figure 1). Selective coronary angiography showed severe narrowing of the circumflex artery adjacent to the site of obstruction (Figure 1C). The patient remained without ischemic changes on 12-lead electrocardiograms.

The cardiac surgical team was contacted for onsite surgical backup and readiness. The sheath was advanced near the tip of the entrapped catheter. Careful traction with countertraction maneuvers failed to release the catheter. Nitroglycerin (2.5 mcg/kg) was administered through the long sheath in the coronary sinus while applying traction and countertraction. The coronary sinus spasm subsided within 5 minutes and the decapolar catheter was freed. On inspection, no tissue was adherent to the tip of the retrieved catheter. Repeat coronary angiography showed restoration of unimpeded flow to the circumflex artery, normal venous return via the coronary sinus, and no evidence of coronary sinus dissection (Figure 2). No pericardial effusion was noted by "quick-look" transthoracic echocardiography.

The electrophysiological study was resumed without a diagnostic catheter placed in the coronary sinus. Orthodromic atrioventricular reentrant tachycardia via a concealed left lateral accessory pathway was diagnosed. The accessory pathway was successfully ablated by means of a retrograde aortic approach (Figure 3), as per standard local practice. Throughout, the patient remained hemodynamically stable and without ischemic electrocardiographic changes. Postprocedural transthoracic echocardiography was unremarkable, with no pericardial effusion or regional wall motion abnormality. The patient received an intravenous perfusion of heparin overnight in accordance with the institutional protocol for left-sided ablation procedures. She had an uneventful recovery and was discharged from hospital the following day with a 1-month prescription of aspirin (80 mg daily). At 3 months of follow-up, she remains arrhythmia-free off antiarrhythmic drugs.

Discussion

The coronary sinus is routinely cannulated during electrophysiological procedures to record left atrial and ventricular signals, offer a stable site for left atrial or ventricular pacing, serve as a reference for activation mapping, and provide anatomic landmarks for Koch's triangle and the mitral annulus. Associated complications are scarce. Catheter entrapment has been described during coronary sinus angiography[11] and in relation to lead implantation for cardiac resynchronization therapy.[12] One prior case reported entrapment of a resterilized "dumbbell"-shaped 7F quadripolar radiofrequency ablation catheter placed in the coronary sinus for anatomic landmarks in a 34-year-old man with atrioventricular nodal reentrant tachycardia.[13] It was removed by forceful traction under general anesthesia and paralysis, along with tissue adherent to the catheter tip.

To our knowledge, entrapment of any type of catheter in the coronary sinus of a child has not previously been published.

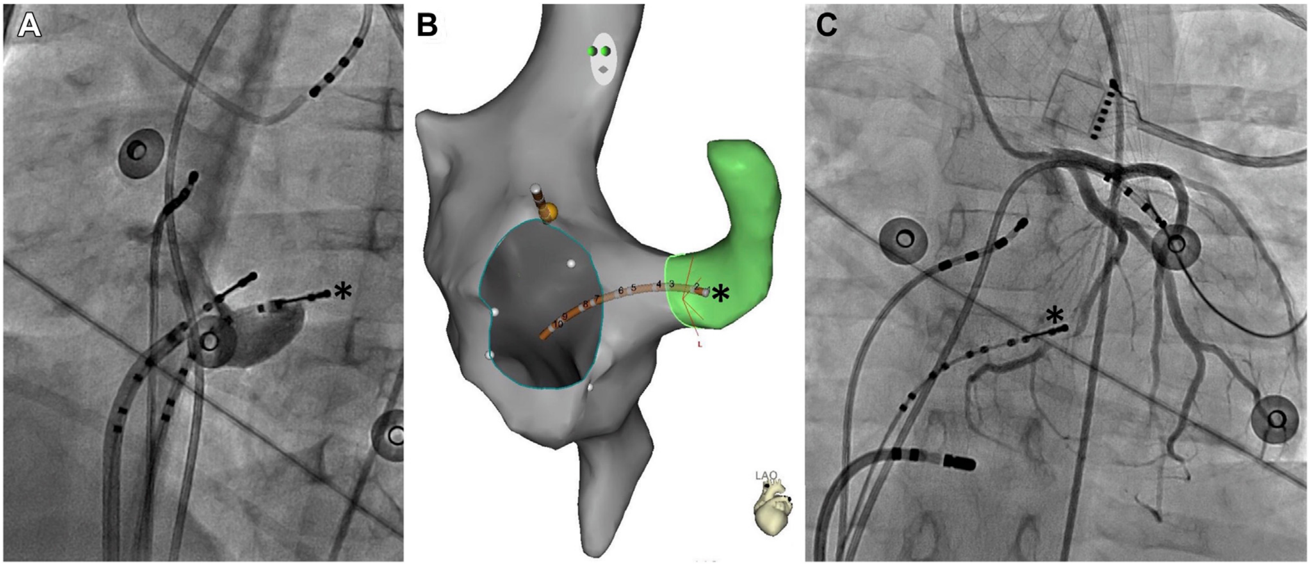

Figure 1 Coronary sinus vasospasm with entrapment of a diagnostic decapolar catheter and partial obstruction of the adjacent circumflex coronary artery. **A:** Left anterior oblique (LAO) view of coronary sinus angiography performed by injecting contrast through a long sheath mounted over the entrapped decapolar catheter. Complete obstruction of the coronary sinus is observed at the tip of the trapped catheter (*asterisk*). Also seen are 2 quadripolar diagnostic catheters, a second decapolar catheter in a steerable sheath, and a Judkins Left catheter in the aortic root for coronary artery cannulation. **B:** A similar LAO view on the CARTO mapping system (Biosense Webster, Diamond Bar, CA) where the tip of the entrapped catheter (*asterisk*) is seen in the proximal coronary sinus. The yellow sphere indicates the position of the His bundle. **C:** A right anterior oblique cranial view of left coronary angiography. Note the severe obstruction of the circumflex coronary artery adjacent to the site of spasm of the coronary sinus (*asterisk*). Also seen are 2 quadripolar diagnostic catheters and a 7F radiofrequency ablation catheter.

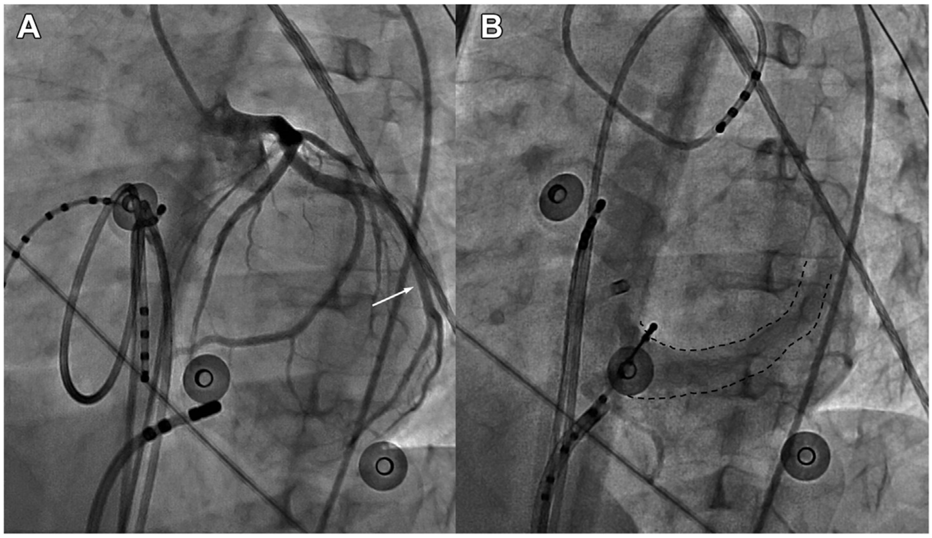

Figure 2 Coronary artery and venous phase coronary sinus angiography following extraction of the entrapped catheter. Left anterior oblique views of **A:** left coronary angiography and **B:** venous phase coronary sinus angiography are shown. Unobstructed flow is seen in the circumflex artery (*white arrow*) after retrieval of the entrapped catheter. Patency of the coronary sinus (outlined by the *dashed lines*) was restored.

Moreover, this case represents the first description of catheter entrapment due to coronary sinus spasm of a modern linear multipolar catheter and is the only report to document obstruction of the adjacent coronary artery. It also describes the step-by-step process used to successfully and safely retrieve the catheter. Key steps of the approach used include the following: (1) trial of gentle traction; (2) cutting the catheter handle to permit a long sheath to follow the catheter trajectory into the coronary sinus; (3) angiography of the coronary sinus and coronary arteries; (4) ensuring cardiac surgical backup; (5) careful traction/countertraction of the entrapped catheter and steerable sheath; (6) intra–coronary sinus injection of nitroglycerin with continued traction/countertraction; and (7) reimaging of the coronary artery and coronary sinus.

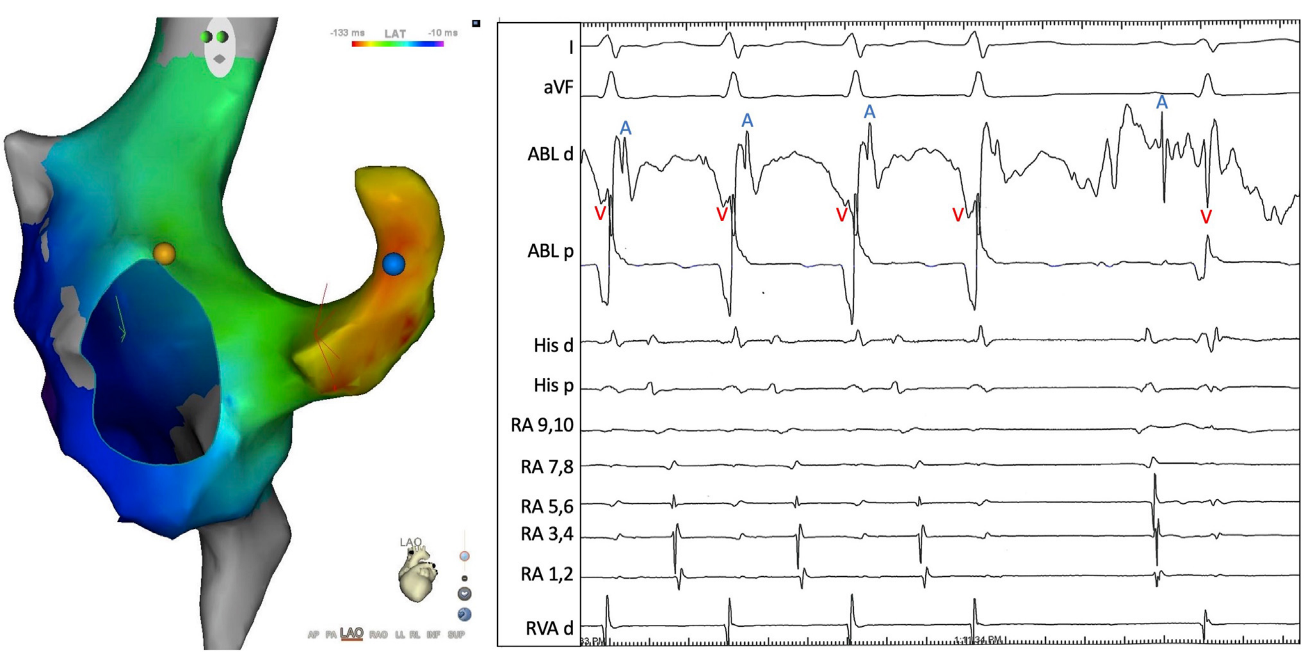

Figure 3 Ablation of the concealed left lateral accessory pathway. The left panel shows an electroanatomic map of the right atrium and coronary sinus in a left anterior oblique projection during orthodromic atrioventricular reentrant tachycardia. Local activation times are color-coded, with the site of earliest activation in red noted in the coronary sinus. The yellow sphere indicates the position of the His bundle and the blue sphere the site of successful ablation of the concealed left lateral accessory pathway reached by a retrograde aortic approach. The panel on the right shows surface leads I and aVF and intracardiac electrograms from the distal (d) and proximal (p) ablation (ABL) catheter, distal and proximal His catheter, decapolar reference catheter in the right atrium (RA) from proximal (9,10) to distal (1,2) electrode pairs, and distal right ventricular apex (RVA). During tachycardia, fused ventricular (V) and atrial (A) electrograms are noted at the tip of the ablation catheter. Tachycardia is terminated during radiofrequency ablation by retrograde block in the accessory pathway.

There is a paucity of literature addressing the underlying pathophysiology of catheter entrapment in veins. It could be hypothesized that the small size and/or stiffness of the 4F decapolar catheter played a role in inducing coronary sinus spasm by mechanical endothelial trauma and/or inflammation provoked by occluding a branch. Relief of spasm by local injection of nitroglycerin lends credence to the notion that a similar mechanism to arterial vasospasm may be at play, particularly with regard to the pivotal role of smooth muscle reactivity and constriction. Indeed, the coronary sinus is surrounded by a complex arrangement of circular and longitudinal smooth muscles that facilitate blood flow. Smooth muscle at the proximal segment of the coronary sinus may contribute to a sphincter mechanism that synchronizes coronary sinus and right atrial flow during atrial systole.[14] Additional factors implicated in the pathogenesis of coronary arterial vasospasm include endothelial dysfunction, oxidative stress, and autonomic and genetic elements.[15]

Obstruction of adjacent coronary arterial flow was a major factor in our proactive approach to extracting the entrapped catheter, as opposed to adopting a more conservative strategy of watchful waiting for the spasm to subside either spontaneously or after administration of a systemic vasodilator. The mechanism for severe obstruction of the adjacent circumflex coronary artery also remains speculative. Nevertheless, a mechanical compressive effect was suspected given that differing amounts of pressure and traction applied to the entrapped catheter resulted in variable degrees of coronary arterial occlusion and flow.

In conclusion, we report a rare complication of catheter entrapment of a multipolar catheter placed in the coronary sinus of a young child during an electrophysiological procedure. This case illustrates how coronary sinus vasospasm can be associated with obstruction to adjacent coronary arterial blood flow and suggests a potential role for concomitant coronary angiography and electrocardiographic monitoring for myocardial ischemia. This report also supports a trial of, and describes a technique to administer, intra–coronary sinus nitroglycerin to relieve the spasm in combination with gentle catheter traction and sheath counterpressure.

Acknowledgments

The authors thank Ms Jessie Monaco-Robillard for her expert technical support and provision of images obtained during the procedure.

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