

Percutaneous epicardial cryoablation of idiopathic premature ventricular contractions near the left anterior descending artery



Victor A. Abrich, MD, Win-Kuang Shen, MD, FHRS, Siva K. Mulpuru, MD, FHRS, Komandoor Srivathsan, MD, FHRS

From the Division of Cardiovascular Diseases, Mayo Clinic Hospital, Phoenix, Arizona.

Introduction

Idiopathic ventricular arrhythmias occur in structurally normal hearts.¹ When the burden of premature ventricular contractions (PVCs) exceeds 10%–20%, it may lead to cardiomyopathy, characterized by a decrease in systolic function and clinical congestive heart failure.² These arrhythmias are often targeted for ablation via an endocardial approach; however, some may have an epicardial origin, which may require ablation via the coronary venous system or using a pericardial approach.³ We present a patient who underwent epicardial cryoablation for treatment of idiopathic PVCs owing to proximity of the left anterior descending artery. The safety of epicardial cryoablation of PVCs in close proximity to a major coronary artery has not been previously reported.

Case report

A 17-year-old male patient with a history of epilepsy and bicuspid aortic valve was referred to our electrophysiology clinic for a second opinion regarding symptomatic high-density PVCs causing chest pain, dizziness, and a reduction in left ventricular ejection fraction to 40% without any regional wall motion abnormalities. He had previously undergone 4 PVC ablations, which included mapping of the right ventricular outflow tract (RVOT) and the coronary cusps but had immediate recurrence of high-density PVCs and frequent episodes of accelerated idioventricular rhythm (Figure 1). He was placed on flecainide at an outside facility. Owing to persistence of symptoms and the high burden of PVCs, the patient was referred for further evaluation and management. Therefore, he was taken to the electrophysiology laboratory for another PVC ablation.

Using the three-dimensional CARTO mapping system (Biosense Webster, Diamond Bar, CA), surrogate geometry of the RVOT was created using intracardiac echocardiographic

KEY TEACHING POINTS

- Epicardial cryoablation can be performed percutaneously by accessing the pericardial space through a subxiphoid approach.
- Epicardial cryoablation can be considered for epicardial idiopathic premature ventricular contractions that cannot be accessed through the coronary venous system with a radiofrequency ablation catheter.
- Cryoablation is reversible during the cryomapping mode and also provides catheter stabilization by adhering to tissue in order to reduce damage to adjacent structures.

images. Activation mapping was initially performed in the RVOT and did not identify an early origin. Next, a deflectable quadripolar mapping catheter was advanced through the coronary sinus to the anterior interventricular vein (AIV). Activation mapping at this location showed the local electrogram to be 20 ms ahead of the surface QRS. Pace mapping produced a 90% match using the PASO software (Biosense Webster). A balloon occlusion venogram was subsequently performed in the main body of the coronary sinus to delineate the anatomy. A 3.5 mm irrigated tip ablation catheter was advanced through an SL1 sheath into the coronary sinus via a right femoral vein approach; however, this was unable to be advanced to the AIV. Similarly, attempts to cannulate the AIV were unsuccessful using a 4 mm non-irrigated tip ablation catheter and also using a right internal jugular vein approach. At this point, the procedure was aborted without any ablation.

One month later, the patient was taken back to the electrophysiology laboratory for another ablation attempt, this time via an epicardial approach after obtaining subxiphoid pericardial access using a Tuohy needle. After deflectable quadripolar catheters were placed in the RVOT and the AIV, a 4 mm tip cryoablation catheter was positioned in the pericardial space, between the 2 catheters.

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Address reprint requests and correspondence: Dr Komandoor Srivathsan, Division of Cardiovascular Diseases, Mayo Clinic Hospital, 5777 E Mayo Blvd, Phoenix, AZ 85054. E-mail address: svrathsan.komandoor@mayo.edu.

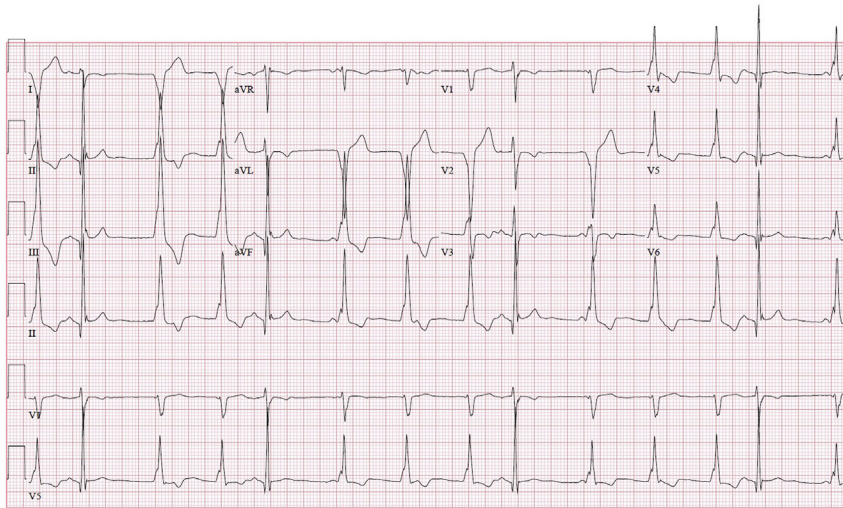


Figure 1 Electrocardiogram demonstrating frequent ventricular ectopy.

Unfortunately, spontaneous ventricular ectopy was absent after administration of intravenous fentanyl and midazolam for sedation, precluding activation mapping. Pace mapping from this location produced a 95% match using the PASO software (Figure 2). A coronary angiogram showed the cryoablation catheter to be 1.8 mm away from the left anterior descending artery (Figure 3A and B). Cryomapping was performed initially at a temperature of -30°C with no ST changes observed. Three applications of cryoablation were then performed at -80°C , totaling 684 seconds. A repeat coronary angiogram demonstrated no luminal narrowing of the left anterior descending artery. Following ablation, the PVC was not inducible with ventricular burst pacing up to a cycle length of 350 ms from 3 different locations during isoproterenol infusion. Postoperatively, he developed pericarditis, which was treated with colchicine and ibuprofen for 2 weeks. At a 4-month follow-up, the patient was no longer having any chest pain or dizziness, and his activity level had improved. A 24-hour Holter monitor demonstrated negligible burden of PVCs and an echocardiogram demonstrated an increase of his ejection fraction to 58%.

Discussion

The epicardial PVC in the case presented was found to be originating from the left ventricular summit, which is near the junction of the great cardiac vein and the AIV on the epicardium. Epicardial PVCs originating from the left ventricular summit can be successfully ablated from within the coronary venous system in 70% of patients, with long-term success. In our case, anatomic constraints precluded successful advancement of the ablation catheter to the AIV, even though a smaller mapping catheter was able to be maneuvered to that location. In this situation, epicardial mapping and ablation were warranted. The decision was made to avoid radiofrequency ablation because of the greater risk of damaging the nearby left anterior descending artery owing to sliding of the catheter along the epicardial surface during

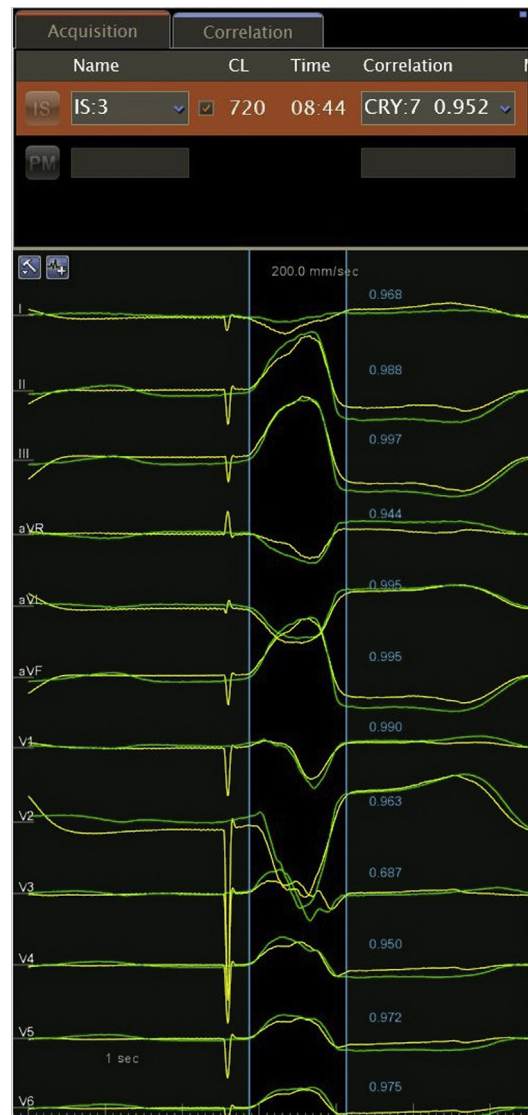


Figure 2 Pace-match in PASO (Biosense Webster, Diamond Bar, CA). The QRS of the ventricular ectopic (green outline) overlays the QRS of the paced beat (yellow outline).

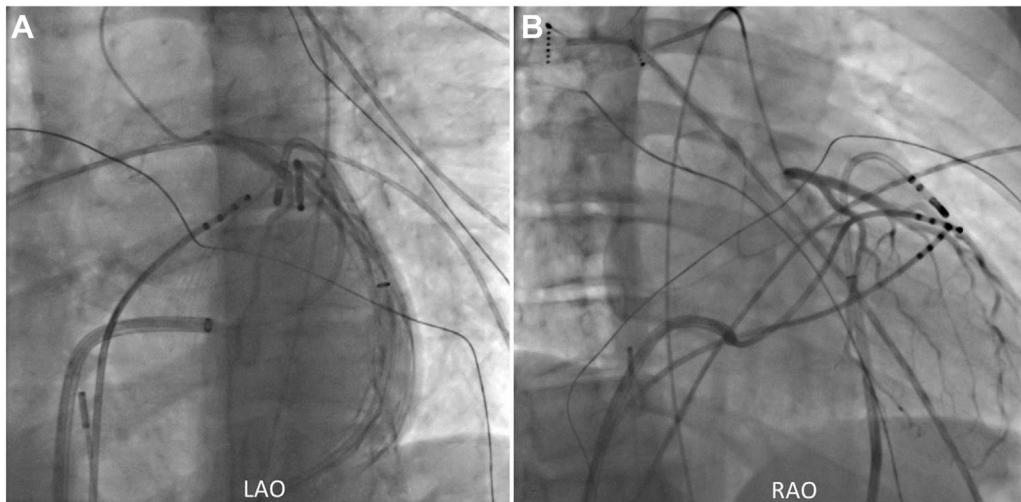


Figure 3 Fluoroscopic views during coronary angiography. **A:** Left anterior oblique (LAO) view with the quadripolar catheter in the right ventricular outflow tract (*left*), cryoablation catheter in the pericardial space (*middle*), and quadripolar catheter in the anterior interventricular vein (*right*). **B:** Right anterior oblique (RAO) view with the cryoablation catheter in the pericardial space (*top*), quadripolar catheter in the anterior interventricular vein (*middle*), and quadripolar catheter in the right ventricular outflow tract (*bottom*).

cardiac motion.⁴ Instead, a strategy employing cryoablation was chosen.

Cryoablation carries 2 advantages over radiofrequency ablation: (1) reversibility with cryomapping at a temperature of -30°C ,⁵ and (2) adherence to tissue during freezing to a temperature of -80°C (cryoadherence), providing catheter stabilization in order to reduce damage to adjacent structures during cardiac motion.⁶ Maximal lesion dimensions are produced when cryoablation is applied for 300 seconds.⁷ Application of cryoenergy has also been shown to be safe when delivered within 2 mm of a coronary artery without causing arterial stenosis in canine models⁸; however, application of cryoenergy directly on a coronary artery can cause transient occlusion without damaging the vessel if the internal diameter is >0.7 mm.⁹ Cryoablation has been successful in the treatment of idiopathic ventricular arrhythmias originating from the RVOT, coronary cusps, and great cardiac vein.^{6,10,11} Within the pericardial space, the absence of blood flow should theoretically enhance cryolesion formation; however, cryoablation and irrigated radiofrequency ablation have demonstrated comparable lesion sizes in animal models.¹² Limited data exist regarding outcomes for epicardial cryoablation using a percutaneous pericardial approach. One small study demonstrated successful epicardial cryoablation of ventricular tachycardia in 3 out of 6 patients.¹⁰ In contrast, a small study of epicardial ablation in children reported unsuccessful epicardial cryoablation in 2 patients with ventricular tachycardia.¹³ Similarly, epicardial radiofrequency ablation of idiopathic ventricular arrhythmias has been associated with low success rates, in part owing to the proximity of coronary arteries.^{14,15}

Conclusion

In the case described here, cryoablation of a ventricular ectopic focus arising from the left ventricular summit

was successful without acute damage to the left anterior descending artery; however, a normal postablation angiogram does not rule out the potential for long-term changes in vessel diameter at the site of ablation. The reduction in PVC burden resulted in an improvement in the patient's ejection fraction and symptoms. To our knowledge, this is the first reported case of percutaneous epicardial cryoablation for the treatment of idiopathic ventricular arrhythmias originating from the left ventricular summit. In situations where the ablation catheter cannot reach the AIV, percutaneous epicardial cryoablation should be considered as a safe and effective alternative.

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