Left ventricular summit ablation through open sternotomy with hybrid utilization of standard electrophysiology catheters and maneuvers

Anil Sriramoju, MBBS, Nareg Minaskeian, MD, Komandoor Srivathsan, MD, FHRS, Kristen A. Sell-Dottin, MD, Win-Kuang Shen, MD, FHRS

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

Introduction

Catheter-based radiofrequency ablation is the most common treatment option to prevent recurrent implantable cardioverter-defibrillator (ICD) therapies in patients with ventricular tachycardia (VT).[1] However, in patients with nonischemic cardiomyopathy, the radiofrequency ablation is considered ineffective owing to nonuniformity in the distribution of scar.[2] An epicardial scar may require ablation via the coronary venous system or using the pericardial approach.[3] In some patients with left ventricular summit VT, owing to proximity of proximal coronary vessels, inability to deliver adequate lesions within the anterior interventricular vein (even with impedance limiter turned off), and inaccessible pericardial space owing to adhesions, a surgical approach with epicardial mapping may have to be done. We present a patient with nonischemic dilated cardiomyopathy, recurrent VT, and ICD therapies, who after failure of percutaneous approaches underwent elective open sternotomy, mapping using a traditional electrophysiology catheter on a beating heart, and subsequent cryoablation. Open surgical epicardial entrainment mapping and cryoablation of summit VT has not been previously reported.

KEY TEACHING POINTS

- Epicardial ventricular tachycardia (VT) ablation via open sternotomy is feasible and effective in a patient with left ventricular summit VT who had dense pericardial adhesions and failed multiple prior ablation attempts.
- The advantage of median sternotomy is that it allows total exposure of nearly all ventricular myocardium through the mediastinum.
- The cryoablation technique provides enhanced catheter stabilization owing to tissue adherence, which reduces damage to adjacent tissues.

Case report

A 63-year-old patient with a history of recurrent VT (Figure 1), nonischemic cardiomyopathy, and chronic systolic heart failure with recurrent ICD therapies was referred for ablation. Comorbidities included deep vein thrombosis, history of pulmonary embolism on anticoagulation, morbid obesity, sleep apnea, and anxiety from recurrent ICD therapies.

KEYWORDS Cardiomyopathy; Cryoablation; Pericardial adhesions; Sternotomy; Ventricular tachycardia
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She had failed medical therapy with amiodarone and mexiletine and had previously undergone 2 VT ablation procedures including endocardial and attempted epicardial approaches. The coronary sinus approach was not feasible owing to the completely occluded great cardiac vein and anterior interventricular vein.[4] Percutaneous pericardial approach was not feasible owing to extensive pericardial adhesions.[5] Owing to recurrent VT, she was taken to the electrophysiology lab for another epicardial VT ablation via open sternotomy.

Median sternotomy was performed by a cardiothoracic team. ICD was used to induce clinical VT with a ventricular burst at 340 ms. During induced VT (identical morphology to clinical VT), the patient was hemodynamically stable; epicardial activation and entrainment mapping were done to identify critical isthmus using a PentaRay catheter (Boston Scientific, Marlborough, MA; Figure 2A). Entrainment mapping (Figure 3; stim-QRS/TCL = 30%, Stim-QRS = electrogram-QRS) was identified at the border between LV summit and anterolateral epicardial wall. Limited activation and voltage mapping were performed using the 3-dimensional CARTO mapping system (Biosense Webster, Diamond Bar, CA) (Supplemental Figure 1) but owing to interference from the metal retractor, the images were

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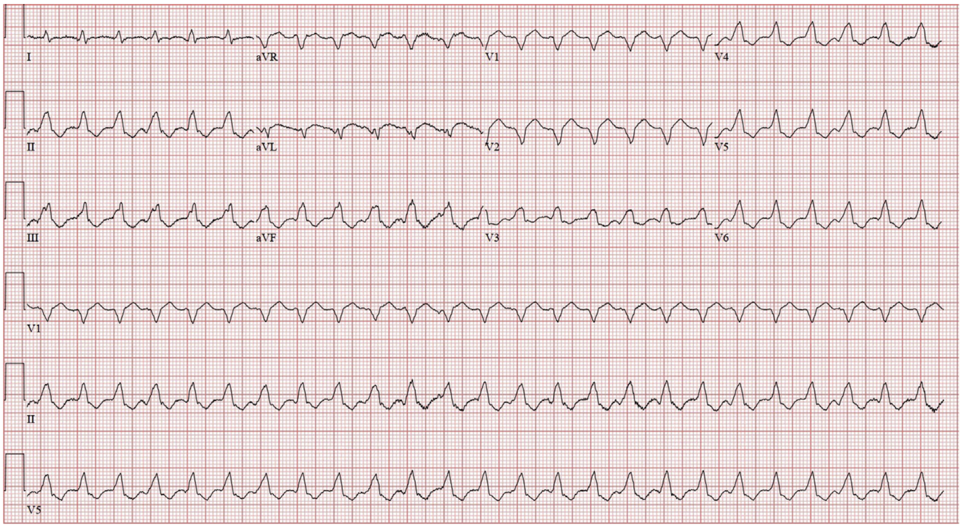

Figure 1 The electrocardiogram shows monomorphic ventricular tachycardia at 400 ms with left bundle branch block (LBBB) morphology. Prolonged maximum deflection index is suggestive of epicardial origin. Lead I is initially isoelectric and after 40 seconds becomes positive along with LBBB pattern, suggestive of septal exit site. With inferior axis, absence of S waves in V_6 and multiple attempts at endocardial mapping had shown lack of outflow tract early or diastolic electrograms. Epicardial left ventricular summit is the remaining area of interest.

rendered only at a certain distance from the retractor. Besides, concealed entrainment finding with diastolic electrograms reduced the need for comprehensive mapping. A 120-second cryoablation at this location was performed (Figure 2B). Three insurance lesions of similar duration were delivered to adjacent LV summit and bordering anterolateral region.

Subsequent programmed ventricular electrical stimulation did not induce any further VT.

The patient recovered in the hospital as per standard open heart surgery protocol. She was assessed during regular clinic visits by patient interview, 12-lead electrocardiogram, and device interrogation. At 6-month follow-up, ICD interrogation confirmed that the patient is free of any significant ventricular arrhythmias.

Discussion

Nonischemic dilated cardiomyopathy is frequently associated with ventricular arrhythmia of epicardial origin. Access to these areas can generally be accomplished using coronary venous branches or a percutaneous epicardial approach. In this instance, access to the coronary venous system and percutaneous pericardial approach failed.[3]

The subsequent decision involved a team discussion comprising the patient, cardiothoracic team, and cardiovascular/electrophysiology team members. A minimally invasive surgery vs median sternotomy approaches was discussed. Owing to morbid obesity, underlying pulmonary issues, and dense pericardial adhesions, open sternotomy was preferred over endoscopic, robotic ablation.[6] The patient agreed to undergo the procedure after being an active member of the group discussion.

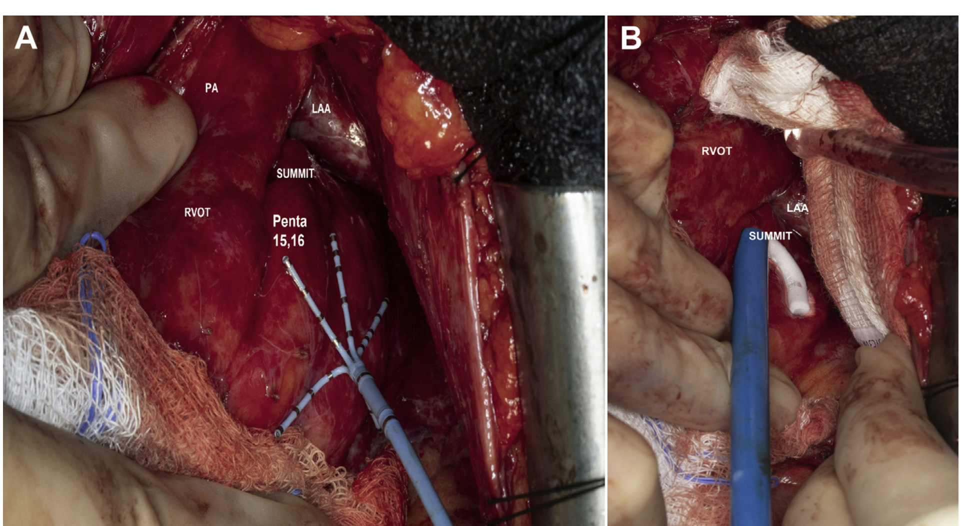

Figure 2 **A:** PentaRay catheter (Boston Scientific, Marborough, MA) on the anterolateral wall. LAA = left atrial appendage; PA = pulmonary artery; RVOT = right ventricular outflow tract. **B:** Surgical cryoprobe performing cryoablation encompassing the central isthmus.

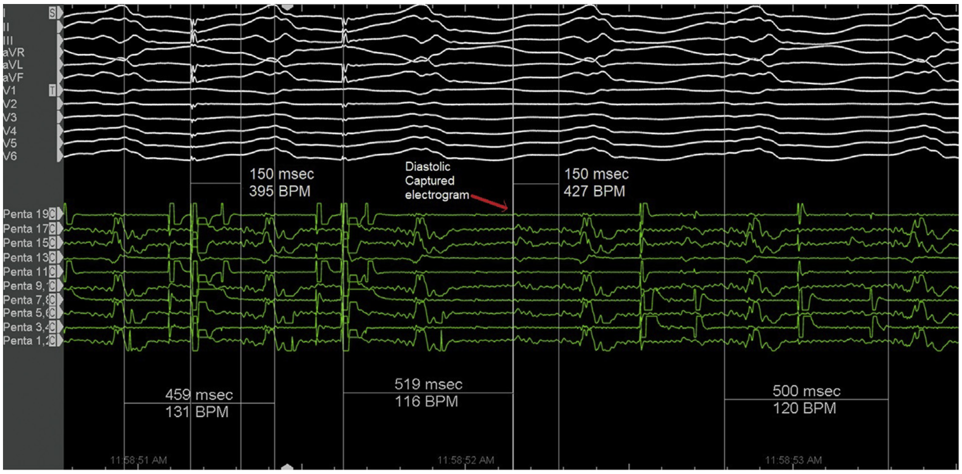

Figure 3 Concealed entrainment using the PentaRay catheter (Boston Scientific, Marborough, MA) from left ventricular summit and bordering anterolateral wall, revealing capture at the central isthmus. Stim to electrogram/TCL at 30% is within central isthmus, closer to exit site.

The advantage of median sternotomy is that it allows total exposure of nearly all of the ventricular myocardium through the mediastinum.[7,8] Additionally, complete exposure of the heart allows for vascular control in case of an injury and provides access for cardiopulmonary bypass in case of an emergency. Although irrigated radiofrequency ablation was available, cryoablation was considered safe by the team members owing to proximity of the scar to both the left anterior descending and circumflex coronary arteries in this position, and radiofrequency would be used as a bail-out strategy, in case of persistent inducibility.[9] The cryoablation technique also provides enhanced catheter stabilization, which reduces damage to adjacent tissues.[10,11]

The PentaRay catheter used for entrainment mapping has a small electrode size and close interelectrode spacing, which helps in better mapping resolution.[12,13]

Conclusion

Open sternotomy with epicardial VT mapping using conventional electrophysiology catheter carries the major advantage of direct anatomical visualization and enhanced catheter stability. Therefore, hybrid VT ablation is effective in patients with multiple failed ablation attempts and pericardial adhesions.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2021.09.011.

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