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diopathic ventricular tachycardia (VT) arising from the left ventricular (LV) summit can be challenging for catheter-based percutaneous ablation. We present a patient in whom endocardial and percutaneous epicardial ablations were not successful in eliminating VT. Subsequently, a minimally invasive surgical approach with robotic-assisted mapping, followed by minithoracotomy and cryoablation of the myocardium near the region of the proximal left anterior descending (LAD) coronary artery, was successful in eliminating arrhythmia.

Case Report

A 54-year-old man with a medical history significant for hypertension and sleep apnea presented with exertional palpitations associated with lightheadedness. Holter monitoring revealed frequent premature ventricular contractions (PVCs) and nonsustained VT. β-blockers were started (metoprolol 100 mg BID), but sustained VT was demonstrated on exercise stress testing performed while on β-blockers. Physical examination and laboratory evaluation were unremarkable. Coronary angiography documented normal epicardial coronary vessels with a normal LV ejection fraction (64%). Cardiac magnetic resonance imaging revealed mild LV hypertrophy without fibrosis or other structural abnormalities.

Despite optimal dose of β-blockers (metoprolol 100 mg BID) and calcium channel blockers (diltiazem CD 120 mg QD), the patient continued to have symptoms of lightheadedness and presyncope and was subsequently brought to the electrophysiology laboratory for further evaluation and treatment. On 12-lead ECG, the morphology of spontaneous PVCs was predominantly positive in the inferior leads with early precordial transition (V2). The ratio of QS complexes in aVL/aVR was <1, suggestive of origin from the inaccessible region of the LV summit.1

During electrophysiology study, sustained VT was easily inducible with burst pacing at 600 ms, with an identical morphology to spontaneous PVCs. Despite extensive mapping of the right and LV outflow tracts, aortic cusps, and the great cardiac vein, early activation times (10 ms pre-QRS) or excellent pace maps (87% EP Logix, VT template matching, Bard Electrophysiology, Lowell, MA) were not obtained. Therefore, ablation was not performed, and further attempts at medical therapy were made, by switching metoprolol to sotalol 120 mg BID, unfortunately with minimal therapeutic efficacy.

Given the patient’s continued symptoms despite antiarrhythmic medical therapy, he was brought back to the electrophysiology laboratory for epicardial mapping and ablation. Percutaneous epicardial access was obtained as per previously described techniques.2 A 97% pace match was obtained near the region of the proximal LAD, with better activation timing during spontaneous PVCs (~30 ms). Coronary angiography was performed, which demonstrated the LAD to be =1 cm from this site (Figure 2), so ablation was performed here using an open-irrigated catheter at 30 W (Thermacool, Biosense Webster, Diamond Bar, CA). However, after initial radiofrequency delivery, repeat angiography showed slow flow down the LAD (online-only Data Supplement Video S1A), and therefore further energy delivery was not performed. After administration of intracoronary nitroglycerin, repeat angiography documented return of TIMI 3 flow (online-only Data Supplement Video S1B). No ECG changes of ischemia or wall motion changes on intracardiac echocardiography were noted during this period. However, at this point, the procedure was terminated. Although spontaneous ectopy initially disappeared during radiofrequency energy application, it recurred after ~15 minutes.

The patient continued to have frequent presyncope with exertion and did not want to try other alternative antiarrhythmic medications. Therefore, we decided to attempt a novel, minimally invasive approach with the collaboration of the Cardiothoracic Surgery department to facilitate access to the target area. Electrophysiology catheters were placed at the right ventricular apex from the right femoral vein. PVCs with identical morphology to VT were easily inducible with low dose of isoproterenol (2 μg/min). The Da Vinci robot (Intuitive Surgical Inc, Sunnyvale, CA) was brought into the

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Figure 1. Surface 12-lead ECG showing premature ventricular contractions with inferior axis, early transition suggesting site of origin near the anterosuperior aspect of the left ventricle.

Figure 2. Fluoroscopic images in left anterior oblique (LAO) caudal and cranial views showing ablation catheter at the site of the best epicardial pace match. JL 4 indicates Judkins left angiographic catheter; RV, right ventricular catheter.

Figure 3. Intraoperative images showing pericardial dissection using Da Vinci robotic tools and pace mapping using an ablation catheter. LAA indicates left atrial appendage; LAD, left anterior descending.

Field, and 3 ports were inserted in the third, fifth, and seventh intercostal spaces. Under direct visualization, the pericardium was opened, and adhesions from the percutaneous epicardial ablation were dissected. Prior ablation lesions were identified with direct visualization near the proximal LAD (Figure 3). Mapping with a nonirrigated tip catheter (Blazer II XP, Boston Scientific, Natick, MA) was performed near the region of the prior ablation lesions with the aid of robotic hands (Figure 3; online-only Data Supplement Video II). Once mapping was complete, a small anterior thoracotomy (Figure 4) was performed directly above the region of the best activation and pace-mapping site. The epicardial fat was dissected; the LAD was slightly displaced laterally, and pace mapping was performed directly below the LAD in the interventricular septum. Pacing at this location produced a 99% pace-map match (Figure 5). Cryoablation was performed at this location with a CryoICE ablation system (AtriCure Inc, West Chester, OH) positioned directly below the LAD coronary artery. After 5 cryo applications (−60°C), each of 3-minute duration with a 10-cm malleable aluminum CryoICE probe (Atricure Inc West Chester, OH), no further ectopy was noted on high-dose isoproterenol (20 μg/min). The patient had an uneventful postoperative course and was discharged home. No further PVCs were noted on a 24-hour Holter monitor, and no VT or ischemia was seen on repeat exercise stress test at 3 months without any antiarrhythmic medications.

Discussion

The epicardial portion of the LV bound in between the LAD and left circumflex artery superior to the aortic valve is termed as the LV summit.3 The great cardiac vein (GCV) while continuing as the anterior interventricular vein bisects the LV summit into 2 functional regions: accessible (superior region) and inaccessible (inferior) regions for mapping.
and ablation. The superior region that extends from the arc between LAD (proximal to the first septal perforator), left circumflex, and great cardiac vein/anterior interventricular vein continuity is thought to be the inaccessible region of the LV. The epicardial fat in this region prevents energy delivery to the arrhythmogenic myocardial tissue, with additional risk of damage to the major coronary blood vessels. ECG features suggestive of site of origin in the inaccessible region of LV summit include ratio of R-wave amplitudes in lead II/III <1.3, ratio of QS-wave amplitudes in aVL/aVR <1.2, absence of s waves in V5/V6, and higher amplitude of QRS complexes in the inferior leads during the arrhythmias than that achievable during distal GVC pacing.

Cryoablation for ventricular arrhythmias not amenable to percutaneous radiofrequency ablation has been described in patients with nonischemic cardiomyopathy under cardiopulmonary bypass using cold cardioplegia. In this report, we describe a novel minimally invasive procedure using robotic surgery for mapping, followed by minithoracotomy and beating heart cryoablation of the site of origin of ventricular arrhythmias from the inaccessible region of the LV summit. Direct visualization and manipulation of the major blood vessels, combined with lesions created below these vessels in the myocardium, may account for a successful outcome. This novel technique may offer cure to ventricular arrhythmias otherwise inaccessible by percutaneous catheter ablation and with faster postoperative recovery than median sternotomy.

Disclosures

None.

References


Key Words: surgery ♦ ventricular tachycardia ♦ cryoablation ♦ LV summit
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