Retrograde coronary venous ethanol ablation of ventricular tachycardia in a patient after aortic valve replacement and failed both radiofrequency ablation and stereotactic radiotherapy

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Introduction

Radiofrequency (RF) ablation is a well-established and frequently used treatment modality for drug-refractory ventricular tachycardias (VT).[1] The left ventricular (LV) summit represents a common site of origin of focal idiopathic VT. Less frequently, it can host the complex arrhythmogenic substrate in patients with structural heart disease such as dilated cardiomyopathy or aortic valve disease. Such scenario may require repeated ablation procedures with an uncertain outcome. In the case of failed RF ablation, several unconventional treatment modalities, including bipolar RF ablation, stereotactic body radiation therapy (SBRT), and ethanol ablation, have been proposed.[2–5] We report a case of successful retrograde coronary venous ethanol ablation (RCVEA) of VT in a patient after aortic valve replacement and previously failed both bipolar RF ablation and SBRT.

KEY TEACHING POINTS

- Management of ventricular arrhythmias arising from the left ventricular (LV) summit may be challenging.
- We present a case of complex substrate-related ventricular tachycardia originating from the LV summit in a patient after aortic valve replacement that was successfully treated by retrograde coronary venous ethanol ablation after previously failed both bipolar radiofrequency ablation and stereotactic body radiation therapy
- Ethanol ablation can be safely performed in experienced centers as a bail-out strategy for otherwise intractable ventricular tachycardia.

Case report

A 69-year-old male patient after aortic valve replacement using a mechanical prosthesis (No 29; St. Jude Medical Inc, St. Paul, MN) with systolic dysfunction (LV ejection fraction of 30%) and prior implantable cardioverter-defibrillator implant with cardiac resynchronization therapy was admitted for incessant episodes of VT requiring multiple shocks. He previously underwent 2 ablation procedures in another hospital when 3 similar VT morphologies were induced with cycle length ranging from 240 to 420 ms (Figure 1, VT 1–3). All 3 VT exhibited wide QRS complexes with a pseudo-delta wave, inferior axis, and positive concordance in precordial leads with pattern break in lead V_2, suggesting epicardial origin. In addition, the pace map was suboptimal both on the LV endocardium and epicardially via the great cardiac vein (GCV). At that time, the bipolar endocardial LV map was normal, with the discrete unipolar low-voltage zone at the anterobasal LV region that was targeted by both unipolar and bipolar RF ablation between distal electrodes of 2 catheters positioned contralaterally in the LV and GCV (Figure 2A and 2B). Ablation was extended to the supravalvular aortic root that was mapped retrogradely. Although no VT was inducible at the end of the second procedure, the patient experienced an early recurrence of arrhythmia. The percutaneous epicardial access and ablation were not feasible owing to the previous cardiac surgery. Therefore, the patient was referred for SBRT. A 25 Gy

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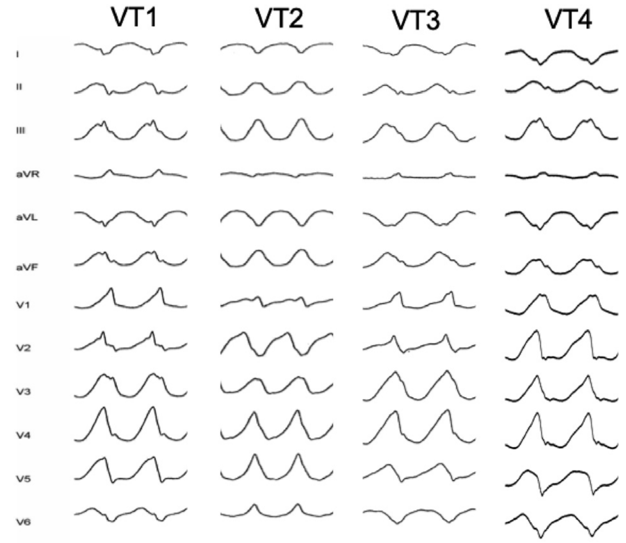

Figure 1 The 12-lead electrocardiogram of all documented ventricular tachycardia (VT) morphologies showed wide QRS complexes with a pseudo-delta wave, inferior axis, and positive concordance in precordial leads with pattern break in lead V_2 (VT1–VT3), suggesting epicardial origin. During the last procedure, only VT4 was induced before ablation.

dose was applied using the Cyberknife radiosurgery system (Accuray Inc, Sunnyvale, CA) to the anterobasal LV region, which was delineated by electroanatomical mapping (Figure 2C) and co-registered with planning computed tomography scan, as described earlier.[6] Three months after SBRT, the patient continued to present with recurrent episodes of VT. Owing to the VT recurrences fulfilling the definition of an electrical storm, ineffective antiarrhythmic therapy, and previously failed ablation procedures, the patient was brought to the electrophysiology lab for a bail-out RCVEA. The procedure was performed under conscious sedation, and it was facilitated by intracardiac echocardiography (AcuNav; Siemens Medical Solutions, Malvern). At the beginning of the procedure, VT was easily inducible (VT4, cycle length 410 ms, Figure 1) by programmed ventricular stimulation. After transseptal access was obtained, a long steerable sheath (Agilis NxT; Abbott, Chicago) was advanced into the left atrium. An LV endocardial voltage map (Figure 2) was created using the 3-D mapping system CARTO 3 (Biosense Webster, Irvine) and a 3.5 mm irrigated-tip catheter (NaviStar Thermo-Cool, Biosense Webster, Irvine). The electroanatomical voltage map of the left ventricle in a unipolar setting showed a local extension of noncompact scar in the anterobasal LV region because of previous procedures. However, the pace mapping in this region (either endocardially or inside the GCV) did not match the clinical VT morphology. In addition, during the VT (VT4, Figure 1), no prematurity was demonstrated here, suggesting a deep myocardial substrate. Retrograde mapping of supravalvular aortic root showed a dense scar with

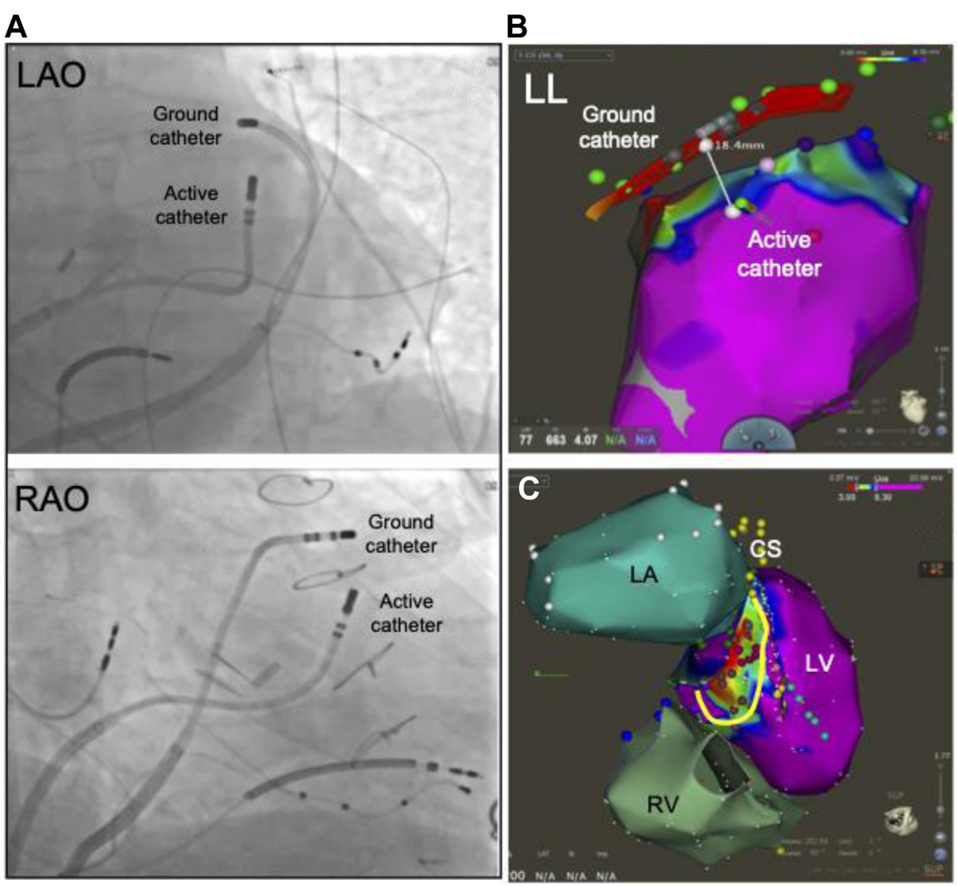

Figure 2 Bipolar radiofrequency (RF) ablation setting and substrate delineation before stereotactic body radiation therapy (SBRT). **A:** Fluoroscopic images of catheter position during bipolar RF energy application in left anterior oblique (LAO) and right anterior oblique (RAO) projection. **B:** Distance between active (left ventricle) and ground catheter (great cardiac vein) in left lateral (LL) projection is depicted. **C:** Endocardial 3-dimensional unipolar map displaying anterobasal low-voltage zone (*yellow line*) that was targeted by SBRT. CS = coronary sinus; LA = left atrium; LV = left ventricle; RV = right ventricle.

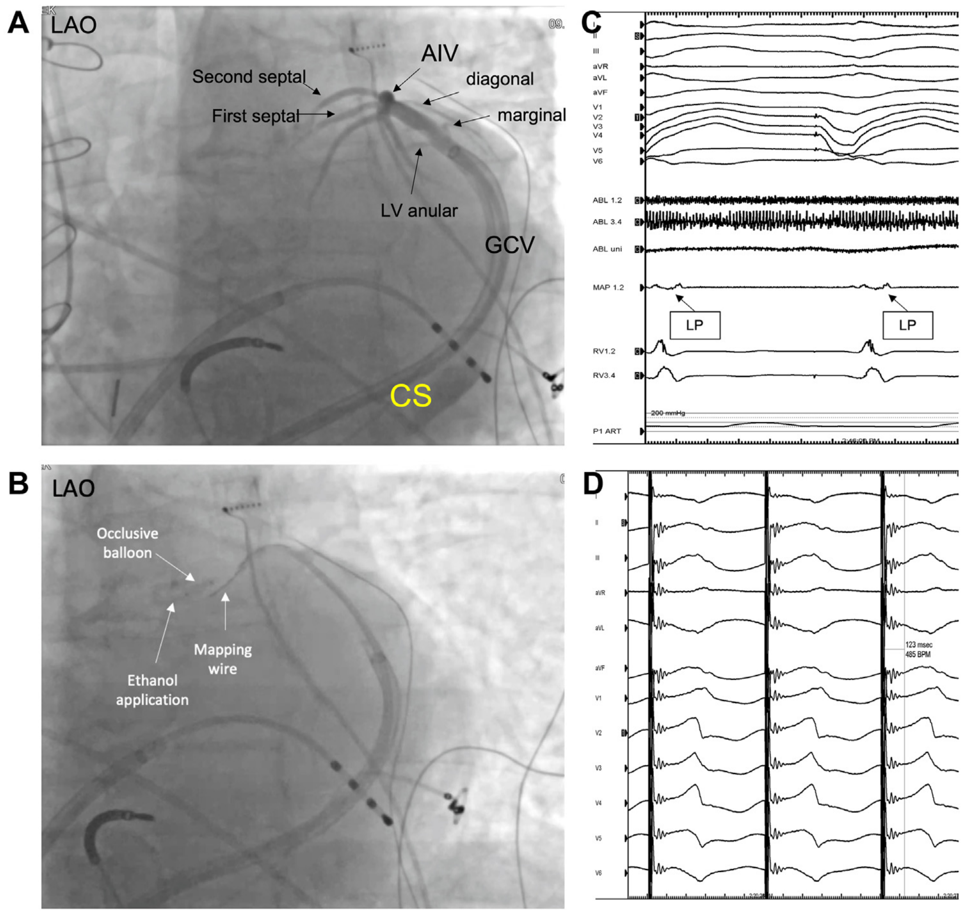

Figure 3 Retrograde coronary venous ethanol ablation. **A:** The coronary sinus (CS) angiogram shows 2 septal branches at the angulation between the great cardiac vein (GCV) and anterior interventricular vein (AIV). **B:** Micro–balloon catheter cannulation of the second septal branch with ethanol injection; mapping wire introduced in the first septal branch. **C:** Late potentials (LP) were recorded by mapping wire during right ventricular pacing. **D:** Pace mapping in the first septal branch produced similar morphology to VT4 with a long stimulus-to-QRS interval. LAO = left anterior oblique; LV = left ventricle.

noncapture by high-output pacing. Next, the steerable transseptal sheath was withdrawn to the right atrium and introduced into the coronary sinus and GCV over the mapping catheter. Selective angiography of the GCV and anterior interventricular vein branches was performed using an internal mammary artery guiding catheter (Figure 3A). Two septal branches were identified at the angulation between the GCV and anterior interventricular vein and mapped using a 0.014-inch guidewire (VisionWire, Biotronik, Berlin, Germany) that was connected in a unipolar configuration to an "alligator" clip with a needle inserted subcutaneously as a reference electrode (Figure 3A and 3B). Pace mapping at the first septal branch exhibited an acceptable morphological match to VT4 with a long stimulus-to-QRS interval (Figure 3D). Both septal branches were consecutively canulated by an over-the-wire balloon angioplasty catheter. Once in place, the balloon was inflated, and 96% ethanol was injected in the total amount of 1.5 mL of 96% ethanol per vein branch. After this, no VT was inducible. No procedure-related complication occurred. Since the patient was pacing-dependent, arrhythmia detection zones were set from 100 beats per minute. During the 6-month follow-up, the patient was free from implantable cardioverter-defibrillator shocks. Only short runs of nonsustained VT were documented, and 2 asymptomatic episodes of sustained VT were terminated by the first antitachycardia pacing.

Discussion

We report for the first time a case of successful RCVEA of VT associated with complex LV summit substrate in a patient with aortic valve replacement and multiple prior ablation attempts, comprising bipolar RF ablation and SBRT.

Catheter ablation of ventricular arrhythmias arising from the LV summit may be challenging for many reasons, including the complex intramural substrate, epicardial fat, and surrounding vessels preventing appropriate and safe energy delivery.[5] In the case of the inaccessible substrate, several alternative treatment strategies have been proposed, such as bipolar ablation with normal or half-normal saline irrigation, SBRT, and alcohol ablation of vessels supplying the targeted substrate.[2–7] SBRT has emerged as a promising noninvasive strategy in cases of failed RF ablation. The main limitation of SBRT is predominantly delayed and unpredictable clinical effects with substantial recurrence rates. Transarterial coronary ethanol ablation was reported to be effective in post–myocardial infarction VT even before the development of the RF ablation.[8] However, severe complications of this method have been also reported, including pericarditis, complete heart block, and inadvertent myocardial necrosis owing to the ethanol leakage.[9] To overcome these limitations, RCVEA was proposed as a feasible and safe alternative to transarterial coronary ethanol ablation with a reasonably good efficacy.[10,11] The main advantage of this method is a minimal risk of collateral myocardial damage, since eventual ethanol leakage is diluted by epicardial coronary vein backflow. However, some limitations should be taken into consideration. First, RCVEA might be challenging in some patients. An understanding of the complex venous anatomy of the LV summit and its terminology is critical for the reproducibility and feasibility of RCVEA.[12] In addition, future studies comparing the RCVEA with other bail-out approaches could be useful. Finally, the applicability of the RCVEA is limited to the arrhythmias originating from the substrate supplied by the appropriate venous branch.

Conclusion

Management of ventricular arrhythmias arising from the region of the LV summit may be challenging. RCVEA can be safely performed in experienced centers as a bail-out strategy for otherwise intractable VT.

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