Incessant intraseptal ventricular tachycardia ablated utilizing extracorporeal membrane oxygenation and bipolar ablation

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Introduction

Radiofrequency (RF) ablation of ventricular tachycardia (VT) poses numerous challenges that can limit acute and long-term success. A large percentage of clinical and induced VTs are not hemodynamically tolerated.[1] Various techniques for hemodynamic support have been utilized, including intra-aortic balloon pumps and percutaneous left ventricular (LV) assist devices. However, venoarterial extracorporeal membrane oxygenation (VA-ECMO) is gaining interest in the field, as it provides superior hemodynamic support during mapping and ablation of VT.[2]

Midmyocardial substrates are a major limitation of currently available RF ablation technology. These substrates are frequently seen in the interventricular septum and LV summit. Catheter-based technology continues to advance, but a major limitation is the depth of lesions that can be produced, which has led to an interest in bipolar ablation. Bipolar ablation delivers energy between 2 catheters placed across from each other, as opposed to between the ablation catheter and a grounding pad in standard unipolar ablation. This method allows for a targeted energy delivery with a larger lesion size.[3]

We present a case of a patient with incessant VT and recurrent cardiac arrest in the setting of cardiomyopathy, who required ECMO support and in whom the clinical VT remained easily inducible until bipolar ablation was performed across the interventricular septum. To the best of our knowledge, this is the first reported case of successful bipolar ablation of intraseptal recurrent ventricular VT in a patient with ECMO support.

Case report

A 52-year-old man with ischemic cardiomyopathy (ejection fraction 30%) and an implantable cardioverter-defibrillator device (ICD) was transferred from an outside hospital for drug-refractory monomorphic VT (Figure 1). Attempts were made to perform VT ablation at the other hospital, but he repeatedly became pulseless and required cardiopulmonary resuscitation.

The heart transplant service deemed the patient not to be a transplant candidate or a candidate for destination LV assist device support if VT ablation failed. Given his continued incessant VT and worsening hemodynamic compromise, it was felt that VT ablation was the only viable option. The initial plan was to obtain epicardial access in case epicardial circuits were found, and this would be done prior to ECMO cannulation owing to the need for heparin infusion after cannulation. However, immediately upon anesthetic induction, the patient became pulseless and chest compression was performed for 2 minutes, whereupon circulation returned.

He was immediately placed on femoral–femoral VA-ECMO support. Comprehensive 3-dimensional mapping was undertaken (Figure 1) in the right and left ventricles using NavX (St. Jude, Minneapolis, MN). Mapping of the clinical arrhythmia was predominantly obtained during VT, given the incessant nature of the arrhythmia and the clinical stability provided by ECMO support.

Using standard unipolar ablation with an externally irrigated ablation catheter, sites demonstrating late potentials while not in VT and diastolic potentials in VT (Figure 1) were targeted along the inferior LV septum and inferior LV wall. Catheter contact, as measured by electrogram morphology and impedance drop, was adequate during unipolar ablation. Transient VT termination occurred with unipolar ablation, although VT remained easily inducible.

KEYWORDS Bipolar ablation; Extracorporeal membrane oxygenation; Intraseptal; Nonischemic cardiomyopathy; Ventricular tachycardia
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KEY TEACHING POINTS

- Intraseptal ventricular tachycardia can be difficult to ablate using conventional unipolar ablation methods.
- Bipolar ablation can produce successful intraseptal lesions by delivering energy between catheters positioned in the left and right ventricle.
- Venoarterial extracorporeal membrane oxygenation can safely provide hemodynamic support in high-risk patients.

Given the failure of extensive unipolar ablation and demonstration of a septal substrate, coronary angiography was performed to identify possible septal targets for alcohol ablation or coil embolization; however, no clear targets were found. At this time, the decision was made to perform limited bipolar ablation across the interventricular septum. The irrigated ablation catheter was positioned in the mid LV septum while the nonirrigated catheter, positioned in the mid right ventricular septum, was used as ground (Figure 1). Power was titrated up from 10 W to 40 W with a duration of up to 60 seconds for each lesion. RF energy was delivered in sinus rhythm. Following bipolar ablation, VT was no longer spontaneously present, nor was it inducible with extrastimuli testing.

The patient was decannulated from VA-ECMO 24 hours after ablation and all antiarrhythmic drugs were discontinued. A repeat transthoracic echocardiogram demonstrated dramatic changes in the septal wall, with thinning and dyskinetic motion after ablation, but overall ejection fraction remained stable (Figure 2, Videos 1 and 2). The patient was discharged 12 days after ablation off all antiarrhythmic drugs. He remains free of VT and ICD therapies 8 months postablation.

Discussion

VA-ECMO is typically utilized to provide hemodynamic stabilization in the context of cardiogenic shock. However, this technique is being increasingly used for periprocedural stabilization in experienced VT centers. Nevertheless, studies of VT ablation on ECMO remain limited.[2,4,5] A recent study reporting the largest series of ablation outcomes for unstable VT requiring ECMO support demonstrated an overall survival rate of 88% with low procedure mortality over a 5-year period, suggesting that unstable VTs can be safely supported by ECMO to facilitate mapping and ablation.[2] There has been a movement in the field toward "substrate-based" ablation targeting abnormal potentials as

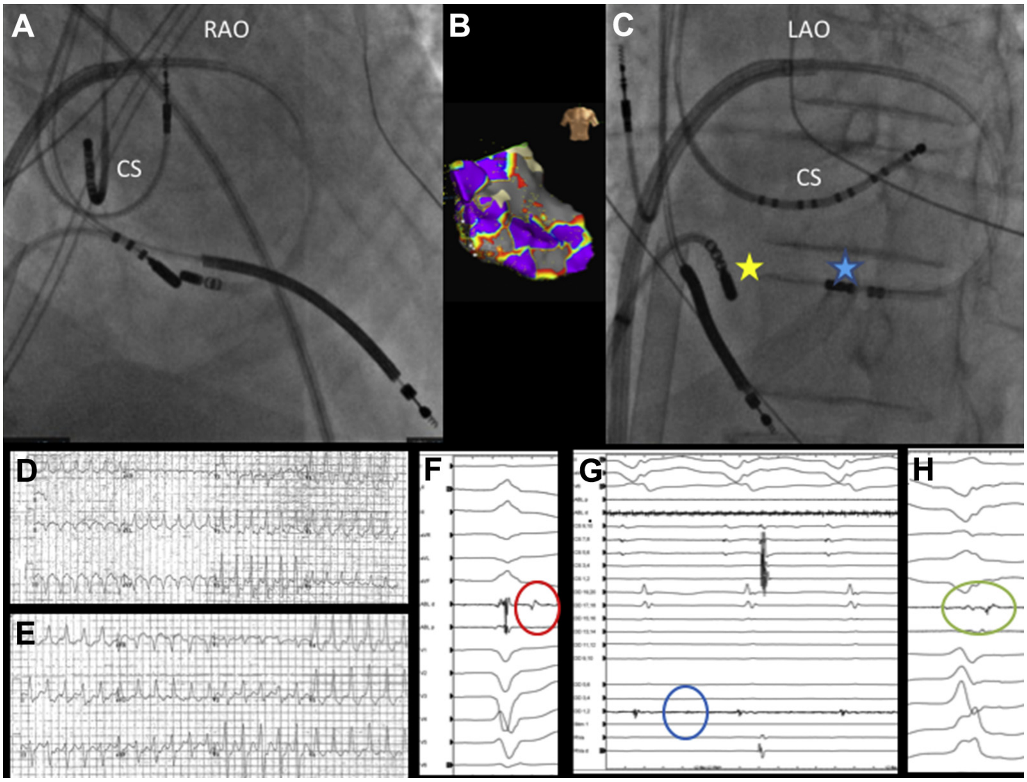

Figure 1 **A:** Right anterior oblique (RAO) fluoroscopy of catheter position at the time of bipolar ablation delivery. **B:** A 3-dimensional electroanatomic map of the septum. **C:** Left anterior oblique (LAO) fluoroscopy of catheter position at the time of bipolar ablation delivery. *Blue star* indicates left ventricular ablation catheter; *yellow star* indicates 8 mm nonirrigated catheter utilized for bipolar ablation across septum. **D, E:** The 2 clinical ventricular tachycardias (VTs) seen. **F:** Late potentials during sinus rhythm. *Red circle* indicates late potential. **G:** Mid-diastolic potentials during VT are shown; however, entrainment mapping demonstrated this site was a bystander. *Blue circle* indicates diastolic potential during VT. **H:** Early diastolic sites; bipolar ablation was delivered at this site and terminated the VT. *Green circle* indicates early diastolic potential during VT at successful bipolar ablation site. CS = coronary sinus.

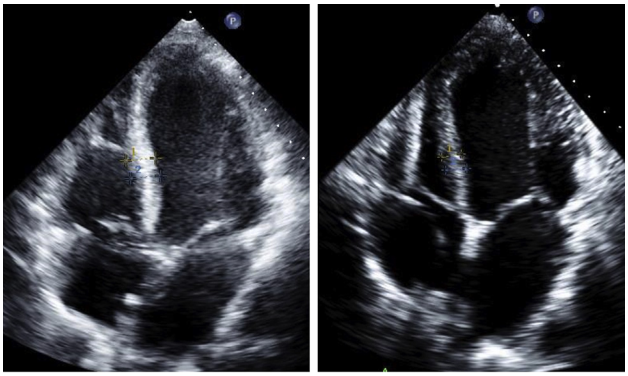

Figure 2 Four-chamber echocardiogram images before and after bipolar ablation demonstrating thinning of the interventricular septum (IVS) on repeat echocardiogram 1 year after ablation.

a way to avoid VT induction, with similar outcomes.[6] However, there is still utility to VT induction in many instances, and patients with severe cardiomyopathy may decompensate during a long procedure regardless of whether VT was induced or not. Therefore, ECMO support has potential benefits even in patients that do not have incessant VT. At our institution, we have moved toward using VA-ECMO to provide full hemodynamic support for patients with severely reduced LV systolic function and for those with previous evidence of hemodynamic intolerance to anesthesia, severely reduced cardiac output, or incessant and hemodynamically unstable VT when undergoing ablation.

Intraseptal VT is a particularly challenging scenario that is not uncommon in cases of ischemic cardiomyopathy. Indeed, 45% of patients with recurrent postinfarction VT showed critical involvement of the interventricular septum in 1 study.[7] Furthermore, patients with nonischemic VT are also prone to septal foci and circuits. Intraseptal VT can necessitate a transmural ablation lesion for effective treatment of the arrhythmia,[3] which unipolar ablation cannot produce in most cases. Extensive unipolar ablation delivered on each side of the interventricular septum can be exceedingly time-consuming and may still fail to control the arrhythmia if there is a critical midmyocardial component. Bipolar ablation may be one viable solution to this problem, as it not only has the ability to produce larger lesions, but it also decreases the time to deliver the required lesion set.[3]

In vitro models of bipolar ablation reported more successful transmural interventricular septal lesions compared to conventional unipolar ablation.[3,8,9] In addition, bipolar ablation required less ablation time.[3] Despite its effectiveness, the use of bipolar ablation has garnered interest only in recent years. A few clinical cases have reported the use of bipolar ablations for VT,[8,10,11] which all showed success in treating septal VT resistant to unipolar ablation. However, a key disadvantage of bipolar ablations on the proximal septum is the risk of consequent atrioventricular block.[11] This risk often limits the enthusiasm for delivering proximal septal lesions sets, particularly in patients that do not have a biventricular ICD in place. In this case, the patient only had a dual-chamber ICD, but bipolar ablation was undertaken despite the risks, given the likely mortality associated with a failed procedure. Interestingly, despite the aggressive septal bipolar ablation and associated septal wall motion changes in this patient, atrioventricular conduction remained intact.

VT ablation has modest overall success rates owing to the complexity of the substrate.[12] For many patients, alternative options exist if VT ablation fails, including additional antiarrhythmic drugs, autonomic modulation, ventricular assist devices, and heart transplant. However, in some cases, such as the one presented, the patient has no options and aggressive measures must be considered.

Conclusion

This case demonstrates the successful use of 2 relatively new techniques in the ablation of scar-related VT: VA-ECMO support and bipolar ablation. Both techniques are likely to see increasing utilization, alone or in combination, in the future as more centers become comfortable with their use.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2018.01.014.

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