

Successful ablation of ventricular tachycardia arising from a midmyocardial septal outflow tract site utilizing a simplified bipolar ablation setup



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Introduction

Bipolar radiofrequency (Bi-RF) ablation has been utilized to treat atrial and ventricular arrhythmias refractory to standard unipolar RF (Uni-RF) ablation.^{1–6} In order to perform Bi-RF, the configuration of an existing Uni-RF circuit is altered, such that another catheter is designated as the grounding connection for the active RF-delivering ablation catheter, instead of an impedance patch. This arrangement has usually required use of nonmanufactured, custom-made cables.^{1–5} Despite its utility in achieving deeper RF lesions compared to standard Uni-RF ablation, particularly in intramural substrate cases, several limitations exist with this construct: (1) connection of the custom-made cable to the grounding port can be tenuous and prone to malfunction; (2) construction and use of the cable requires technical expertise and is not industry standard, which limits availability; (3) active and ground catheters cannot be simultaneously visualized on the electroanatomic mapping (EAM) system, during mapping or ablation; and (4) other surrogates for confirming contact and stability of the catheters, including visualization of local electrograms (EGMs) and contact force, are absent, thus necessitating greater use of fluoroscopy and intracardiac echocardiography (ICE).⁴ An investigational device exemption (IDE) trial ([ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT02374476) Identifier: NCT02374476), in which Bi-RF is specifically configured within CARTO (Biosense Webster, Diamond Bar, CA), is underway to assess safety and efficacy, and through which both active and ground

catheters can be simultaneously visualized, with inter-catheter distances and active catheter force registered. However, this technology is not available to institutions not participating in the IDE trial.

In this case report, we describe a novel method for configuring a Bi-RF ablation setup without need for investigational or modified equipment.

Case report

A 57-year-old man with nonischemic cardiomyopathy and implantable cardioverter-defibrillator (ICD) presented with syncope and frequent ICD therapies owing to recurrent ventricular tachycardia (VT). He had undergone catheter ablation 2 years previously, during which a limited region of the left ventricle (LV) endocardial substrate was identified and targeted at the anterolateral mitral annulus. He had only self-limited recurrences on sotalol until presentation with ICD storm, which continued despite multiple antiarrhythmic drugs. He was then transferred to our facility for repeated ablation.

At baseline, the patient had frequent premature ventricular complexes (PVCs) ([Figure 1](#)). Notably, recorded PVCs and VT were of differing morphologies, but were similar in overall axis (left or right bundle with right and inferiorly directed axes), suggesting intramural arrhythmogenic source with varying exits from the outflow tract (OT) region.⁷ Recognizing that a potentially midmyocardial arrhythmogenic source was present, we planned to utilize techniques to augment RF energy delivery if necessary, including Bi-RF ablation and cooling irrigant with decreased ionic charge (ie, half-normal saline [HNS])^{3,8}; techniques and associated risks were discussed with the patient in informed consent before the procedure. Detailed EAM was performed in sinus rhythm of the right ventricle (RV) and LV using EnSite Precision EAM (Abbott, Saint Paul, MN). Normal bipolar endocardial voltage was observed throughout the RV and most of the LV ([Figure 2A](#)), except for the LVOT, above and below the level of the aortic valve, extending from the middle of the right sinus of Valsalva, anterolaterally to the aortomitral continuity (AMC). Three predominant PVCs were mapped to discrete locations within

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KEY TEACHING POINTS

- Bipolar ablation is sometimes necessary for targeting deep intramural arrhythmia sources, but its availability to date has been limited by restricted access to investigational equipment or custom-made equipment.
- Bipolar ablation can be safely and effectively performed without use of custom-made, modified, or investigational equipment, and with a widely available electroanatomic mapping system.
- In this case, bipolar ablation utilizing a simplified configuration was able to be performed to effectively control refractory ventricular tachycardia originating from the interventricular septum.

the LV ostium, in regions of bipolar voltage abnormality. In addition, 2 different sustained VTs (Figure 1), of similar but different morphologies compared to the PVCs, were able to be mapped, with earliest exit sites along the septal LVOT for VT1, near where the spontaneous PVCs were targeted, and the AMC for VT2 (Figure 2A). Using a strategy of substrate modification guided by pace mapping in sinus rhythm, we successfully eliminated the spontaneous PVCs and VT2 with ablation. However, VT1 was still inducible. High-power Uni-RF applied to LV and RV sides of the superior septum at earliest activation sites failed to eliminate VT1. Additionally, a steam pop (SP) occurred with 50-watt application, the depth of which did not penetrate to the mid-myocardial region of interest (Figure 2B). Although HNS irrigant was considered, we ultimately did not use it in this case, given previous observations of increased SP risk compared to ablation with standard irrigant and the fact that we had already observed an SP with standard irrigant.^{8,9} We decided to proceed with Bi-RF, theorizing that, by changing the vector of RF delivery and also inducing “antenna effect” heating from the ground electrode, the midmyocardial source could be more effectively targeted.^{1,5}

We positioned the FlexAbility SE catheter (Abbott) that had been used for Uni-RF on the RVOT at the site of earliest activation. Another FlexAbility SE catheter was positioned in the LVOT, opposite the RVOT catheter. The LV catheter was designated as the ground catheter by first connecting it to an older-generation T-type cable (IBI GenConnect, Abbott; Figure 3A), previously used to refine signals recorded from an ablation catheter connected to the EnSite recording system and to an older RF-IBI generator. The T-cable includes an RF-generator connector, which was left unplugged in this scenario, as well as pins through which mapping electrodes from the ablation catheter could be directly pinned into a recording system. Three of 4 proximal pins were connected to the recording-system (CardioLab IT Prucka, GE Healthcare, Chicago, IL) pin block, which allowed EGMs from

the ground catheter to be visualized, and for it to be simultaneously visualized along with the active ablation catheter on the EnSite EAM during mapping and ablation. The distal pin was connected to the RF generator (AmpereRF, Abbott) ground-pad plug using a jumper cable (Abbott; Figure 3). Using this Bi-RF setup, a series of septal ablations were delivered (Figures 2B and 3C). Powers of 30 W were initiated and titrated to 50 W, aiming for ≥ 10 -ohm impedance drops, active-catheter temperatures $\leq 40^{\circ}\text{C}$, and durations ranging from 30 seconds to 2 minutes. ICE was utilized to assess SP risk during ablation.¹⁰ Six Bi-RF lesions were delivered, alternating ground and active catheters, and without any SPs. Inter-catheter distances could be actively measured during mapping and ablation, and we aimed for 10- to 15-mm distances, which have most consistently produced transmural lesions.¹ Active and ground catheters were easily interchanged by switching catheter-handle cable connections.

At procedure end, lack of pace capture at Bi-RF sites and VT noninducibility were achieved. Frequent PVCs preablation were no longer observed postablation throughout a >1 -hour waiting period. The patient was discharged the following day and has had no recurrent ventricular arrhythmias in 6-month follow-up, indicating at least short-term ablation success.

Discussion

Our case demonstrates the feasibility of bipolar ablation delivered across the interventricular OT, a site known to be refractory to unipolar ablation.^{1,6} Importantly, we were able to carry out Bi-RF using a widely available mapping system (EnSite Precision, Abbott) and preexisting, noninvestigational, non-custom-made equipment, in distinction from prior reports.¹⁻⁴ The configuration described provides additional advantages of being able to visualize active and ground ablation catheters simultaneously within the EAM, as well as associated EGMs. We were able to make alternative use of an existing T-cable, which was originally designed to refine recordings from an ablation catheter when used with an

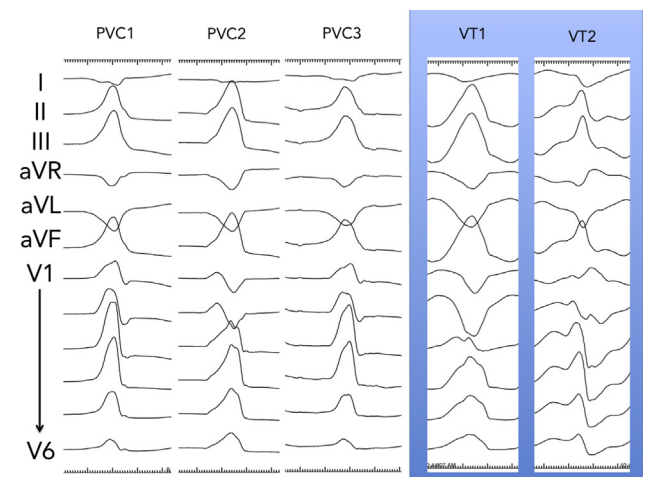


Figure 1 Twelve-lead electrocardiogram morphologies of 3 predominant premature ventricular complexes (PVC1–3) at baseline (white panels) and induced monomorphic ventricular tachycardias (VT1, VT2, blue panels).

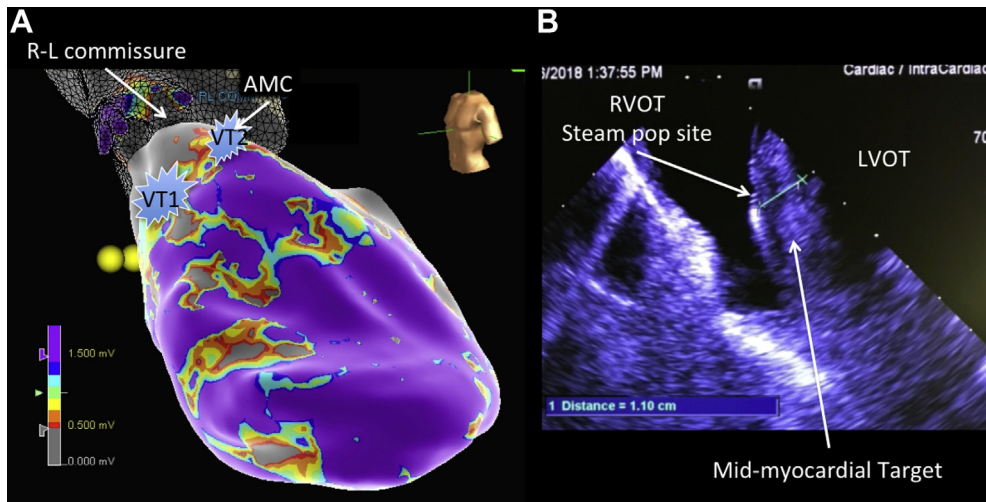


Figure 2 **A:** Electroanatomic bipolar voltage map of the left ventricle (LV), demonstrating normal bipolar voltage except in the outflow tract, just above and below the level of the aortic valve, extending from the septum anteriorly and laterally to the aortomitral continuity (AMC). Sites of earliest activation for ventricular tachycardia (VT) 1 and 2 are highlighted within regions of abnormal bipolar voltage (blue stars). **B:** Intracardiac echocardiography (ICE) depicts the location of midmyocardial substrate between the right ventricular outflow tract (RVOT) and the left ventricular outflow tract (LVOT). A residual steam pop lesion resulting from unipolar ablation using 50 watts on the right ventricle side of the septum (after high-power unipolar lesions applied to the LV side of the septum failed to render VT noninducible) is also shown. Note that the depth of the lesion does not appear to penetrate to the target of greatest interest. The interventricular septal distance measured at this location was 1.1 cm.

older-generation RF generator and the NavX system. Such cables exist for use with the IBI (Abbott), which was what was used for this case, and the Stockert generators (Biosense Webster, Diamond Bar, CA). Both could be used with non-SE FlexAbility as well as TactiCath catheters (Abbott).

When using the T-cable for Bi-RF, the generator connection was unnecessary; however, the pins were essential in allowing visualization of the ground catheter and its recorded EGMs, just as any other “standard” catheter could be. The terminal pin, which has housing that fits over one of the receiving

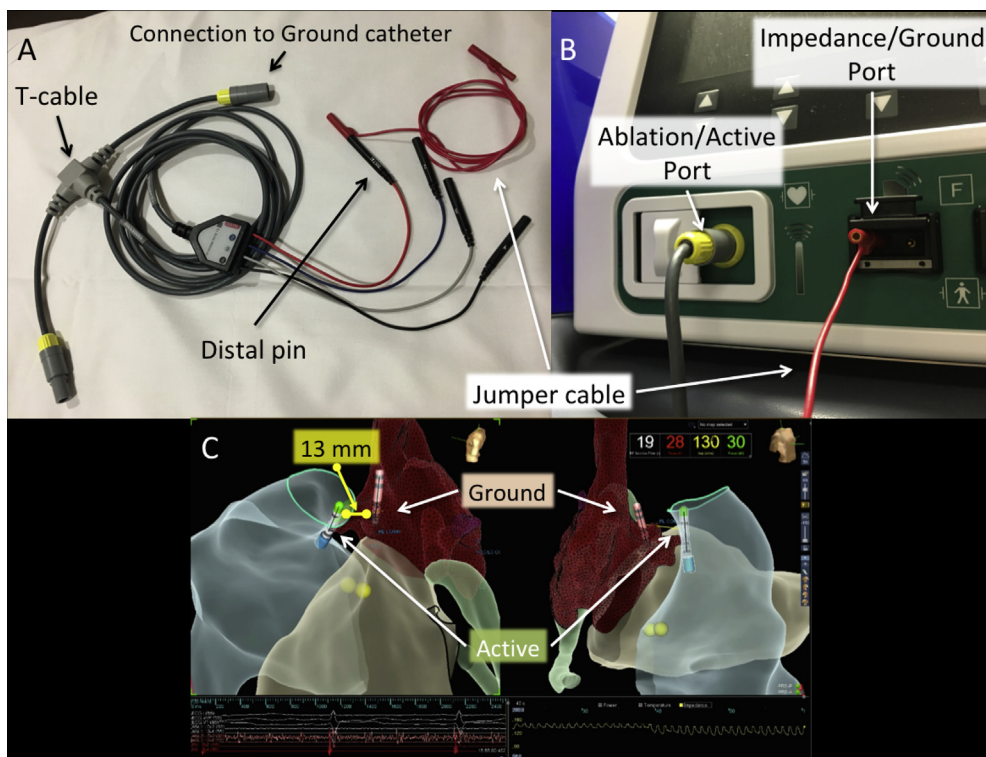


Figure 3 **A, B:** The T-cable and associated connections utilized to create a bipolar radiofrequency ablation circuit using standard unipolar ablation equipment. (See text for details.) **C:** The active and ground catheters as displayed on the electroanatomic mapping system, with associated intracardiac electrograms (lower left), and the impedance trend (lower right) during bipolar ablation; 3-dimensional reconstructions of the right ventricular outflow tract (light blue), the left ventricular outflow tract and aortic arch (red), and left ventricle (tan) are displayed in left lateral (left) and cranial right anterior oblique (right) projections.

pins designed for an impedance-patch plug for Uni-RF, could be connected directly, thus reducing potential equipment failures that could result from custom-made cables.

Intramyocardial substrate is particularly challenging because of difficulty achieving durable lesions at sufficient depth. Among patients with recurrent VT despite prior ablation, 30%–42% may involve midmyocardial targets.^{3,11} Clinical strategies to deliver deeper lesions to target these sites include the infusion of coronary arterial or venous ethanol, needle ablation, and use of HNS.⁸ Bi-RF has also emerged as a technique to focus RF energy to midmyocardial sites.^{1,2,4,5} To our knowledge, this is the first reported case of Bi-RF using unmodified cables and equipment. Most operators who may wish to perform Bi-RF may feel uncomfortable utilizing Bi-RF configurations described to date. Bi-RF technology integrated into CARTO, while also appealing in the lack of need to modify cables, is also investigational and is not widely available. The ability to achieve tasks described above using a widely available EAM technology and tools, without need for investigational technology or equipment, makes it particularly appealing and increases its accessibility.

Limitations to our approach include off-label use of unmodified equipment, necessitating specific consent of patients. It is unclear whether there are increased risks to patients using a Bi-RF even with existing equipment. During Bi-RF, there are only temperature and impedance data from the active catheter; thus there may be increased risk of SP or char formation at the site of the second, unmonitored catheter. We utilized ICE, with direct real-time visualization of catheters during ablation, to monitor for possible SPs. Finally, Bi-RF may not be feasible for all patients. Thickness of tissue targeted may preclude effective lesions even with Bi-RF, and therefore additional techniques for deeper lesion formation should be considered.

Conclusion

We present a unique case of Bi-RF effectively controlling VT storm arising from an intramyocardial septal circuit.

Notably, in this case, Bi-RF did not require use of investigational or modified equipment and could be carried out using premanufactured cables and a widely available EAM. In this case, there were no adverse events, and the procedure was effective. Further research is needed to assess this and other methods of Bi-RF for treatment of ventricular arrhythmias.

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