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CASE REPORT

ADVANCED

CLINICAL CASE

Bipolar Radiofrequency Ablation of Septal Ventricular Tachycardia Facilitated by an Intramural Catheter

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ABSTRACT

Intramural septal substrate presents a challenge in patients undergoing ventricular tachycardia ablation, in terms of both accurate mapping and ablation with unipolar radiofrequency energy. We present the first use of the novel 2-F octapolar catheter in accurately defining intramural septal scar and facilitating bipolar ablation. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2021;3:1119–24) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 79-year-old woman presented with recurrent episodes of sustained monomorphic ventricular tachycardia (VT) despite beta-blocker therapy.

PAST MEDICAL HISTORY

The patient had idiopathic dilated cardiomyopathy (ejection fraction 25%) and a cardiac resynchronization therapy-defibrillator (CRT-D) in situ. Two years previously, she underwent radiofrequency (RF) ablation for high-burden monomorphic ventricular ectopy of basal-septal origin that was causing low-percentage biventricular pacing. This procedure used unipolar RF ablation, delivered from both sides of the septum. This was partially successful, leading to reduction in, but not abolition of, her ectopy.

LEARNING OBJECTIVES

- To appreciate the challenges in mapping and treating VT with intramural septal substrate.
- To consider the advantages of bipolar RF ablation in such cases.
- To appreciate the utility of positioning a multipolar catheter within the summit communicating vein.

INVESTIGATIONS

A recent cardiac magnetic resonance scan demonstrated a midwall septal scar with a basal septal wall thickness of 9 mm (**Figures 1A and 1B**). CRT-D interrogation revealed several episodes of monomorphic VT that had been reliably terminated by antitachycardia pacing (**Figure 1C**), but it resulted in disabling symptoms.

MANAGEMENT

The patient declined additional antiarrhythmic therapy and elected to undergo VT ablation.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

CRT-D = cardiac resynchronization therapy-defibrillator

EGM = electrogram

LV = left ventricle

NSVT = nonsustained ventricular tachycardia

RF = radiofrequency

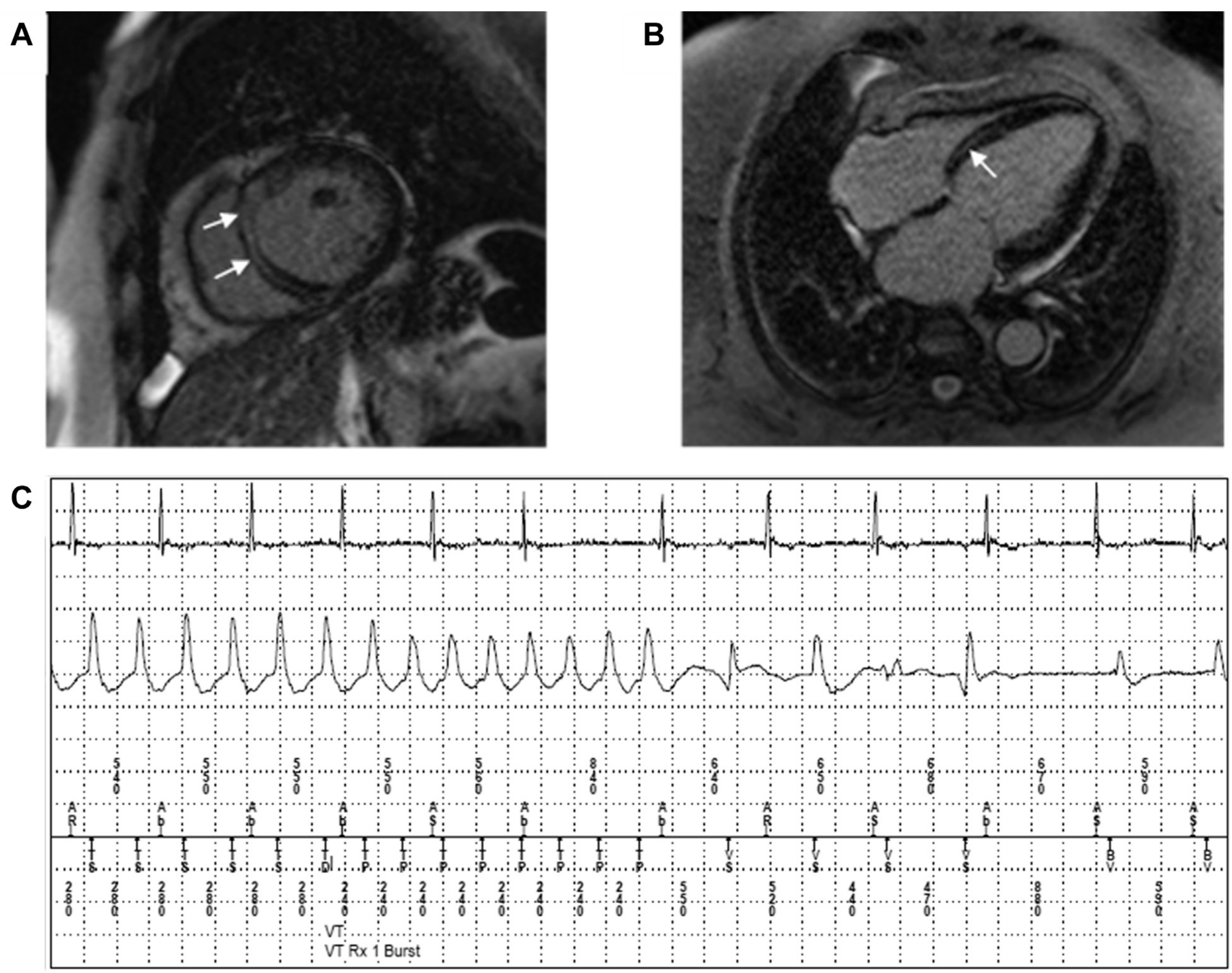
RV = right ventricle

VT = ventricular tachycardia

Endocardial electroanatomical mapping of both the left ventricle (LV) and the right ventricle (RV) was performed using the multipolar HD Grid and EnSite Precision mapping system (Abbott Laboratories) (Figures 2A and 2B). Bipolar and unipolar maps of the RV identified no areas of low voltage. In the LV, low-voltage bipolar and unipolar electrograms (EGMs) were observed in the basal septum and extended in a patchy distribution throughout the septum (Figure 2C).

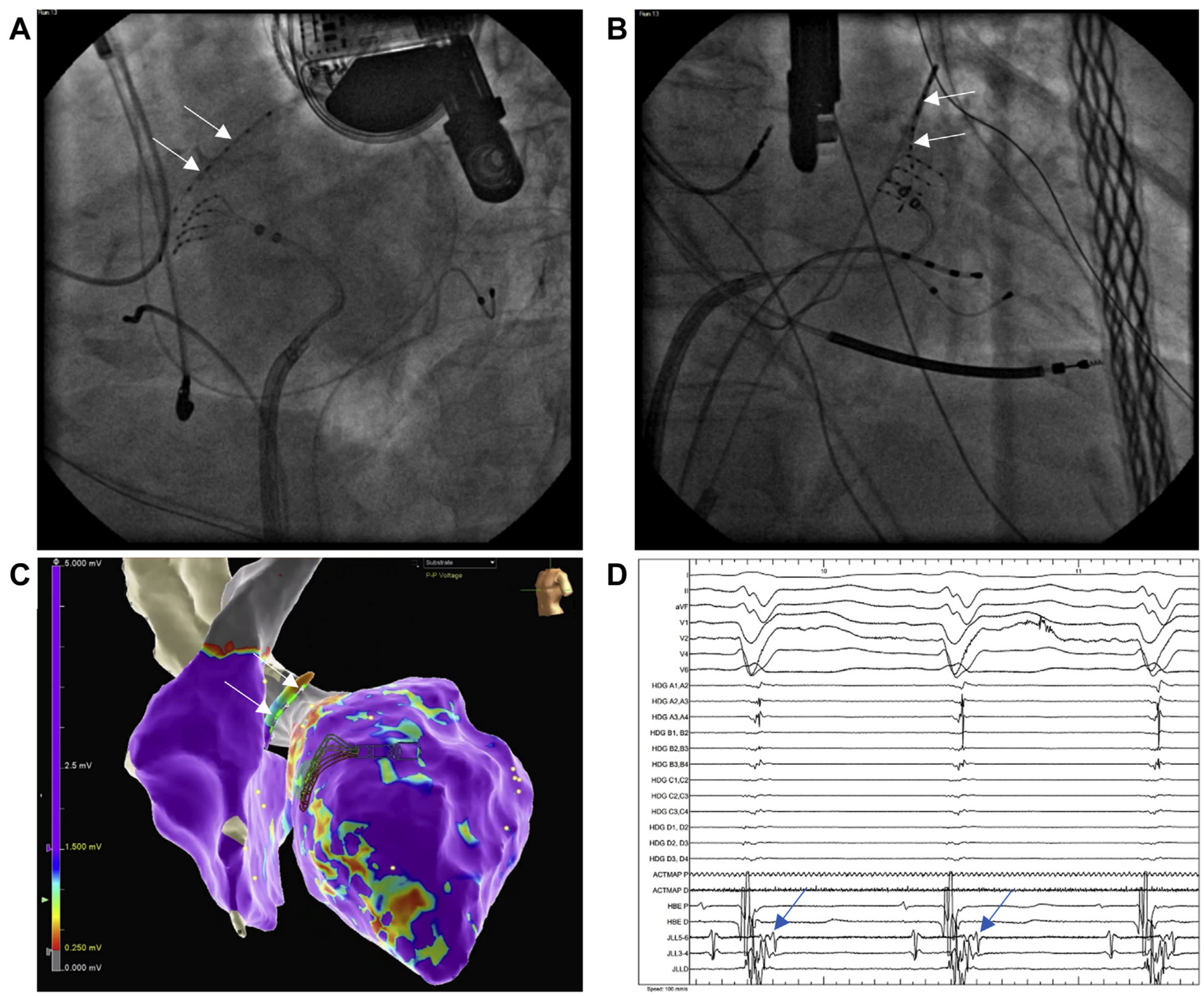
Using a steerable Agilis sheath (Abbott Laboratories) a 6-F multipurpose catheter was advanced to the junction of the great cardiac vein and the anterior interventricular vein to facilitate a venogram of the distal coronary sinus. A 2-F octapolar catheter (Japan Lifeline Co./Baylis Medical, Inc.) was then advanced into the summit communicating vein, in the region of the basal septal scar. Fractionated and delayed potentials were observed on the 2-F octapolar catheter in this location during sinus rhythm (Figure 2D).

FIGURE 1 **Cardiac Magnetic Resonance Imaging Scan and Implantable Cardioverter-Defibrillator Interrogation**



Cardiac magnetic resonance performed before cardiac resynchronization therapy-defibrillator implantation demonstrating midmyocardial scarring **(white arrows)** in the basal septum to midseptum seen in **(A)** short-axis and **(B)** apical 4-chamber views. **(C)** Sustained monomorphic ventricular tachycardia (cycle length 280 ms) treated by antitachycardia pacing. Note the similarity of the far-field electrograms of the clinical ventricular tachycardia to those produced during antitachycardia pacing delivered from the septal implantable cardioverter-defibrillator lead: **(top)** atrial electrogram, **(middle)** ventricular electrogram, **(bottom)** cardiac resynchronization therapy-defibrillator marker channel.

FIGURE 2 **Intra-Procedural Imaging and Electrogram Analysis**



Fluoroscopic images in the **(A)** left anterior oblique and **(B)** right anterior oblique projection showing catheter locations during the case. The 2-F octapolar catheter **(white arrows in A and B)** is positioned in the summit communicating vein. The HD Grid (Abbott Laboratories) is on the adjacent septal surface of the left ventricular cavity. **(C)** Bipolar voltage map of the left ventricular and left ventricular endocardium in the left anterior oblique projection. Areas of low voltage (<1.5 mV) are seen at the basal-septal left ventricular and periaortic regions, extending toward the apex. The HD Grid is seen within the left ventricular cavity abutting the septum. The 2-F octapolar catheter **(white arrows)** is also observed in the summit communicating vein extending intraseptally. **(D)** Fractionated and delayed electrograms **(blue arrows)** recorded by the 2-F octapolar catheter during sinus rhythm are significantly more prominent than those on the HD Grid situated on the adjacent left ventricular septal surface.

Programmed electrical stimulation was performed using triple extrastimuli and intravenous isoproterenol. Monomorphic nonsustained VT (NSVT) was induced, with a left bundle branch block-left inferior axis configuration with V_3 transition, consistent with a high septal exit, and with far-field EGMs on her CRT-D similar to those of the clinical VT. During NSVT, diastolic potentials were identified on the intraseptal 2-F octapolar catheter (Figure 3A), whereas pacing from the distal bipole of the 2-F octapolar catheter produced a >10/12 pace-match to the induced NSVT. No mapping maneuvers could be performed because of the brevity of the VT.

As a result of the diastolic potentials seen on the intraseptal catheter, as well as a history of failed unipolar ablation from both sides of the septum, the decision was made to proceed directly to bipolar RF ablation. Bipolar RF energy was delivered to this

JACC: CASE REPORTS, VOL. 3, NO. 8, 2021
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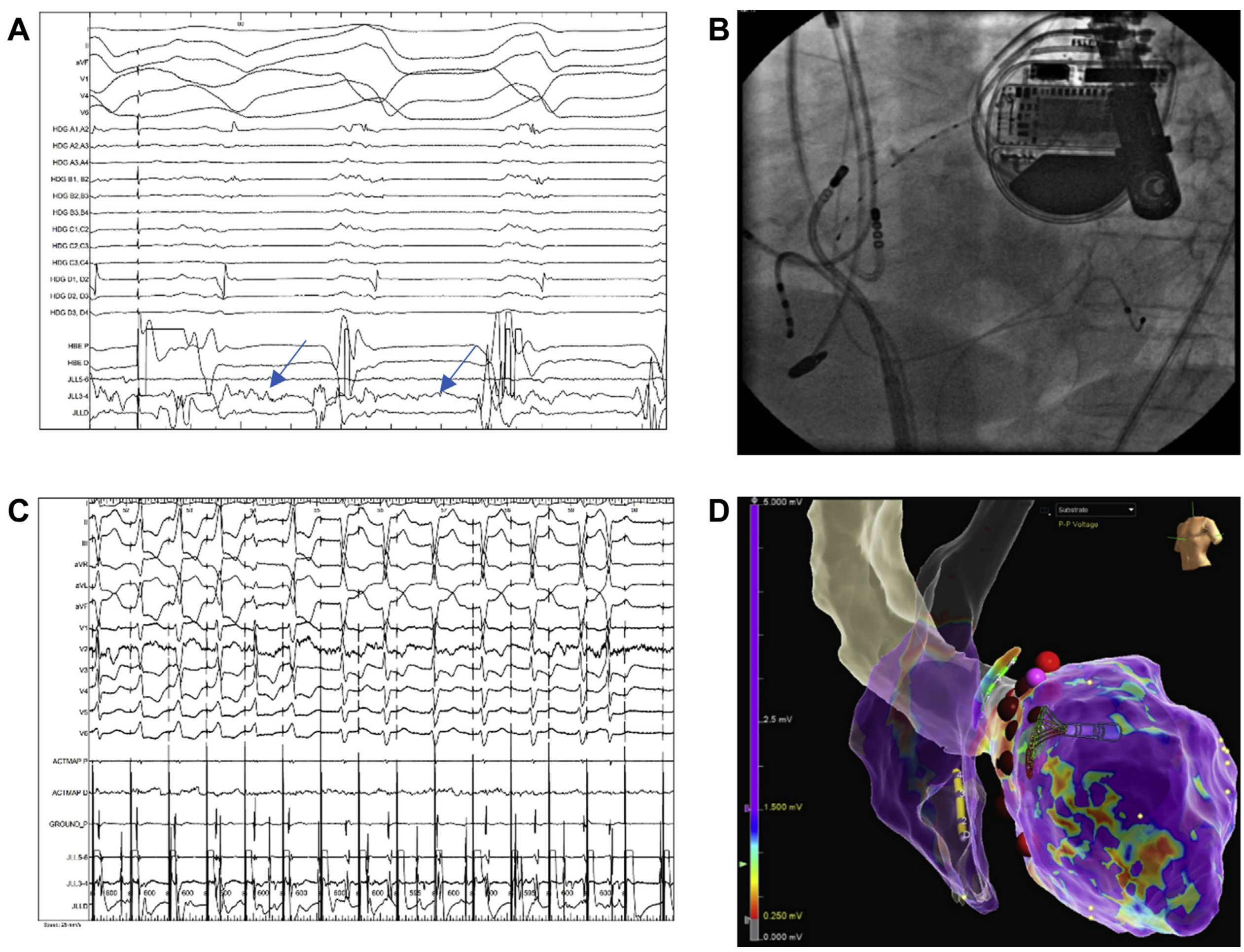
FIGURE 3 **Catheter Ablation of Intramural Septal Substrate**



(A) Brief nonsustained ventricular tachycardia with a left bundle branch block–left inferior axis configuration induced by programmed stimulation. Diastolic potentials **(blue arrows)** are observed on the 2-F octapolar electrodes. **(B)** Fluoroscopic image in the left anterior oblique projection showing catheter locations immediately before bipolar ablation. Note the 2-F octapolar catheter immediately between the active ablation catheter (on septal left ventricular endocardium) and the ground electrode (on septal right ventricular endocardium). **(C)** Pacing from the intraseptal 2-F octapolar catheter, at 10 mA/2ms, during ablation. Initially there is capture, but after the sixth beat, loss of capture is seen. **(D)** Final ablation lesion set.

region between a TactiCath SE catheter (Abbott Laboratories) sited at the basal septum of the LV and a Thermocool SF catheter (Biosense Webster, Inc.) placed on the opposing RV septal surface, serving as the ground electrode with an interelectrode distance of 9 mm (Figure 3B). Energy was delivered at 20 W, with gradual up-titration to a maximum of 45 W for up to 90 seconds, achieving an impedance drop of 27 ohms. Ablation was performed while pacing from the 2-F octapolar catheter at high output (10 mA, 2 ms), with loss of capture denoting successful ablation of the target site (Figure 3C). The bipolar RF time to achieve loss of capture during intraseptal pacing was 5 minutes and 49 seconds. Total RF time to address all substrate was 19 minutes 20 seconds (Figure 3D). Repeat programmed electrical stimulation failed to induce any further tachycardia.

DISCUSSION

Intramural septal scar is a common finding in patients with nonischemic cardiomyopathy who are undergoing catheter ablation for VT (1). This is important to recognize because midwall substrate may be difficult to identify accurately from either ventricle, and standard unipolar ablation may fail to create lesions of sufficient depth to abolish the substrate. In a recent series of patients with nonischemic cardiomyopathy and VT who were undergoing bipolar RF ablation, the presence of septal scar was associated with better outcomes compared with extraseptal scar, and the only anatomical limitation to bipolar RF ablation was septal thinning, with an intercatheter distance of <5 mm (2). Our patient had a significant septal scar, and the septal thickness was sufficient for bipolar ablation at 9 mm.

Uniquely, in this case we used a novel 2-F octapolar catheter to sample mid-wall EGMs directly. This technique allowed accurate localization of the substrate, in conjunction with bipolar RF ablation, which has been shown to be effective in controlling septal VT where unipolar ablation has failed (3). In a redo ablation for septal scar, it is reasonable to offer bipolar RF as first-line therapy because it avoids the potential for edema after multiple unipolar RF lesions that can inhibit subsequent bipolar RF delivery. One must acknowledge the possibility of causing complete atrioventricular block while performing bipolar ablation across the septum; however this risk can be minimized by gradual up-titration of power and tracking any junctional activity during ablation, which did not occur in this case. Moreover, the patient had a CRT-D in situ.

The utility of accessing the summit communicating vein in this case was severalfold: the direct recording of abnormal potentials in sinus rhythm; the recording of diastolic activity during brief NSVT that would otherwise have been missed; and the ability to pace intraseptally, leading to a good match to the NSVT, and to use the loss of intraseptal capture as a surrogate for sufficient lesion depth, thus confirming abolition of the substrate.

This strategy, targeting failure to capture the ventricle within the boundaries of a lesion set, has been used as an endpoint for VT ablation (4). Furthermore, it has been demonstrated that a metallic object, such as a mapping catheter, located in close proximity to the site of RF energy delivery, can amplify current density and lead to increased heating and tissue injury around the metallic object (5). Therefore, placing the 2-F octapolar catheter intraseptally, in the region of the likely substrate, may have focused the ablation on the intraseptal substrate and augmented the transmural effect of bipolar RF delivery. The loss of capture from the 2-F octapolar catheter seen after 5 minutes 49 seconds of bipolar RF ablation compares favorably to a published mean of 10 ± 5 minutes (2), thereby supporting this "antenna effect" theory. However, this mechanism requires further validation in clinical studies. The total procedure time (235 minutes) was not unduly prolonged by using the 2-F octapolar catheter compared with a reported mean bipolar VT ablation procedure time of 224 minutes (2).

Finally, although this 2-F octapolar catheter has been used previously in the vein of Marshall (6) and epicardial veins (7), we believe this is its first documented use in treating scar-dependent septal VT.

FOLLOW-UP

The patient has had no recurrence of VT at 120 days of follow-up.

CONCLUSIONS

Bipolar RF ablation across the septum is useful in patients with intramural scar, particularly if previous unipolar ablation has failed. Positioning a multipolar catheter in the summit communicating vein can facilitate the identification and ablation of critical substrate in cases of VT with intramural basal-septal scar.

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KEY WORDS bipolar ablation, intramural substrate, summit communicating vein, ventricular tachycardia