Successful simultaneous unipolar radiofrequency ablation of septal ventricular tachycardia using 2 ablation catheters

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Case report

A 56-year-old man was transferred to our institution with incessant ventricular tachycardia (VT). He had been diagnosed with nonischemic cardiomyopathy and New York Heart Association class I congestive heart failure 15 years previously, and he had a single-chamber implantable cardioverter-defibrillator (ICD) placed for primary prevention. He had been maintained on sotalol 80 mg twice a day for several episodes of VT in the previous 2 years. One month before admission, he suffered an ICD shock for polymorphic VT/ventricular fibrillation, and amiodarone was added. At that time, an echocardiogram showed a left ventricular ejection fraction of 0.20 with global hypokinesis and an end-diastolic diameter of 7.2 cm and an interventricular septum thickness of 1.0 cm. One week before the transfer, he presented to the hospital after suffering 3 ICD shocks for VT at 188–194 beats/min that was unresponsive to antitachycardia pacing, in the setting of an argument with his brother. Intravenous amiodarone and lidocaine were administered in addition to sotalol, but he continued to experience VT episodes, resulting in 7 more shocks for VT. He was transferred to our hospital for further management.

On arrival to our intensive care unit, the patient's rhythm was sinus with a left bundle branch block pattern, but multiple sustained episodes of monomorphic VT occurred with a rate of 140–150 beats/min. The VT was not tolerated hemodynamically, frequently accelerated with antitachycardia pacing, and resulted in more ICD shocks. A representative 12-lead electrocardiogram tracing recorded during VT is shown in Figure 1, revealing that the VT had left bundle branch mimicry with inferior axis (a markedly different frontal axis from the QRS complex during sinus rhythm). Despite anesthesia with dexmedetomidine, endotracheal intubation, and placement of an intra-aortic balloon pump, his VT burden was not improved, and he received 18 shocks in a 24-hour period in our intensive care unit.

On the first attempt at catheter ablation, a combined endocardial/epicardial procedure was performed. Voltage mapping of the left ventricle during sinus rhythm showed a moderate-sized area of scar (defined as a bipolar voltage of <0.5 mV) along the interventricular septum from the base to the mid-ventricle; the epicardium was largely free of scar. Sustained VT was easily induced, and the earliest sites of activation during VT were identified along the left ventricular basal septum. Repeated unipolar radiofrequency (RF) energy delivery using 40 W, titrated up to 45 W, of duration 50 seconds, with an 3.5-mm open-irrigated ablation catheter (ThermoCool SF, Biosense Webster, Diamond Bar, CA) on both sides of the septum led to transient slowing of VT but never terminated the tachycardia during ablation. In addition, after RF application in the right ventricle, sustained complete heart block during sinus was noted with continued episodes of VT. Despite the extensive ablation performed in this region (>15 full lesions), on the night of the procedure 3 additional episodes of VT occurred that each required cardioversion. Several options were entertained at this point, including a repeat RF ablation attempt or an alcohol septal ablation (although no suitable candidate vessel was identified on coronary angiogram supplying the putative origin of VT). Also, expedited heart transplant evaluation was initiated by our heart failure colleagues and bridging to transplant with extracorporeal membrane oxygenation or a biventricular assist device was considered.

We reasoned that the VT most likely originated in an intramural site within the septum and the initial catheter ablation provided incomplete penetration into the mechanism, resulting in slowing but not elimination of the VT. We decided to perform

KEYWORDS Ventricular tachycardia; Radiofrequency ablation; Biophysics of ablation

ABBREVIATIONS **ICD** = implantable cardioverter-defibrillator; **RF** = radiofrequency; **SURF** = simultaneous unipolar radiofrequency; **VT** = ventricular tachycardia (Heart Rhythm 2014;11:710–713)

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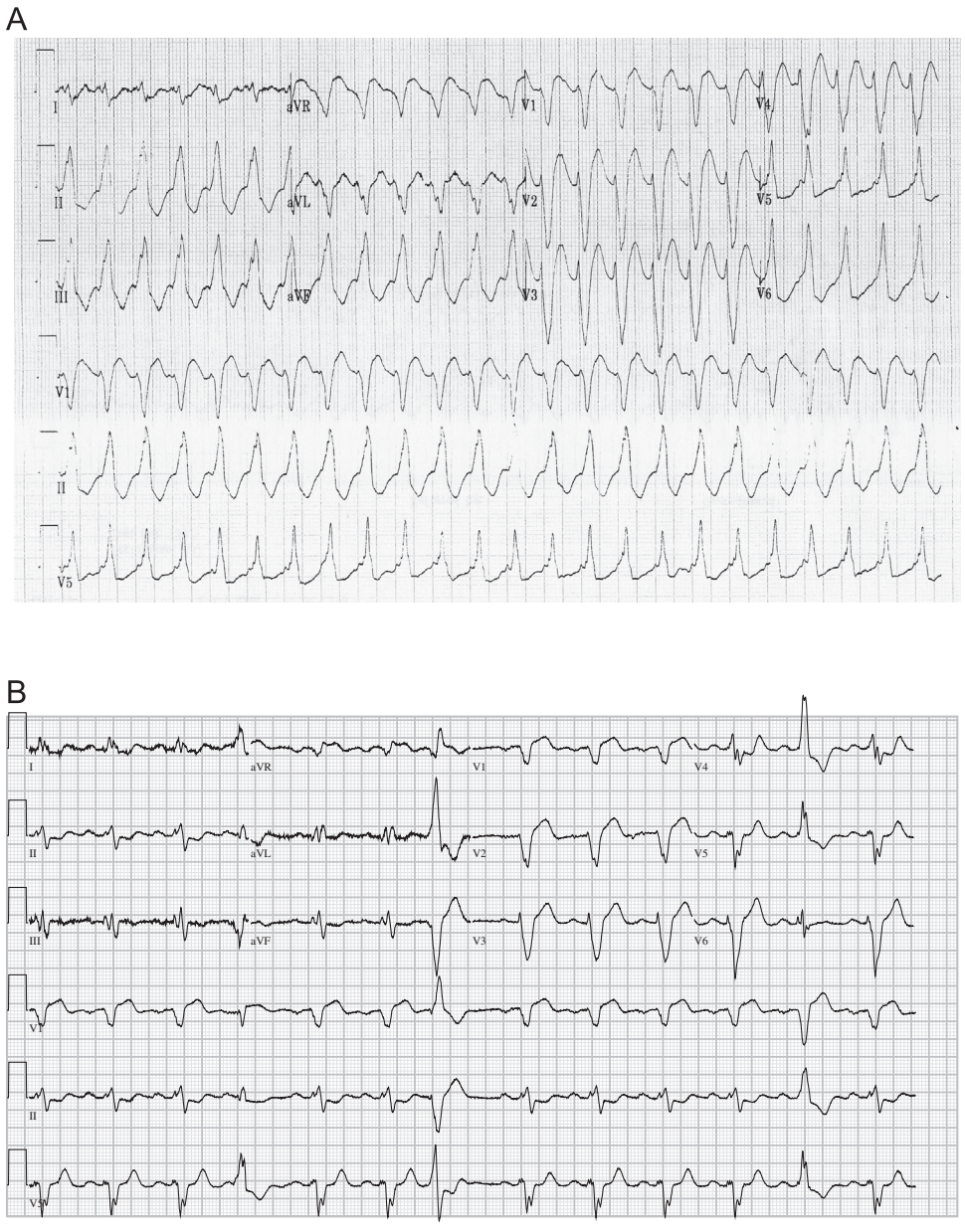

Figure 1 Twelve-lead electrocardiograms recorded during (**A**) ventricular tachycardia and (**B**) sinus rhythm before ablation.

a second attempt at catheter ablation, with the aim of producing lesions of greater depth. Venous and retrograde aortic access was obtained, and 2 separate ablation catheters were positioned on the left and the right side of the ventricular septum, respectively. The right-sided ablation catheter was an 8-mm catheter (Blazer II XP, Boston Scientific, Natick, MA), and the left-sided ablation catheter was a 3.5-mm open-irrigated catheter Diamond Bar, CA. Electroanatomic mapping was performed with CARTO 3 (ThermoCool SF, Biosense Webster, Diamond Bar, CA). Two separate dispersive patches were used as ground, with 2 separate generators in temperature (8 mm) and power (3.5 mm) controlled modes for the delivery of simultaneous unipolar radiofrequency (SURF) energy in a parallel configuration. This configuration allowed for independent temperature control and power control and, with separate return electrodes, did not require synchronization of RF current phases; essentially, this amounts to performing 2 simultaneous conventional RF ablations. A spontaneous initiation of VT was noted, and the earliest site of ventricular activation was once again mapped to the basal septum as identified on the previous procedure. Entrainment mapping was nondiagnostic, as it repeatedly transformed and accelerated the VT into a hemodynamically unstable rhythm that required cardioversion. The catheter positions in the left anterior oblique and right anterior oblique projections are shown in Figures 2A and 2B, alongside signals recorded from ablation catheters on the right ventricular septum and the left ventricular septum (Figure 2C). A diastolic potential was recorded preceding QRS onset by 51 ms on the left side of the septum and 25 ms on the right side of the septum, with a tachycardia cycle length of 400 ms. RF was applied at this site, using 55 W of energy via the 8-mm catheter (temperature controlled to 60ºC)