Successful elimination of ventricular arrhythmias by radiofrequency ablation within the left ventricular summit communicating vein using a 5F ablation catheter

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Introduction

Some idiopathic ventricular arrhythmias (VAs) originate from the left ventricular (LV) summit in the vicinity of the right and left ventricular outflow tracts.[1–3] LV summit-VAs often have the earliest activation during the VAs in the LV summit communicating vein (summit-CV).[4,5] Those LV summit-VAs have been reported to be successfully eliminated by radiofrequency (RF) ablation on the aortic cusps, LV endocardium, and right ventricular outflow tract.[1,5–9] However, it often is difficult to eliminate LV summit-VAs by RF ablation targeting the earliest activation during the VAs within the summit-CV because commonly used 8F RF ablation catheters usually cannot be advanced into the summit-CV due to its small vessel size, and sufficient RF power output cannot be delivered due to high generator impedance. A 5F nonirrigated ablation catheter is the smallest-sized ablation catheter available in current clinical practice. We present a case of successful catheter ablation of LV summit-VAs by RF applications within the summit-CV using a 5F nonirrigated ablation catheter.

KEY TEACHING POINTS

- Ventricular arrhythmias (VAs) originating from the left ventricular (LV) summit sometimes can be ablated on the aortic cusps, LV endocardium, and right ventricular outflow tract.
- Radiofrequency (RF) ablation directly targeting the earliest activation within the LV summit communicating vein (summit-CV) often is difficult because the commonly used 8F RF ablation catheters usually cannot be advanced into the summit-CV due to its small vessel size, and sufficient RF energy cannot be delivered due to high generator impedance.
- This case report demonstrates that use of a 5F nonirrigated ablation catheter, which is the smallest-sized ablation catheter available in current clinical practice, was effective for directly ablating within the summit-CV and successfully eliminating LV summit-VAs.

Case report

A 35-year-old man without any structural heart disease underwent RF catheter ablation of symptomatic ventricular premature contractions (VPCs). A total of 32,350 VPCs per day was recorded by 24-Holter electrocardiographic (ECG) monitoring before the ablation procedure. A 12-lead ECG recorded during the clinical VPCs exhibited an inferior axis and right bundle branch block morphology (Figure 1A). Multielectrode catheters were placed in the His-bundle electrogram recording area and right ventricular apex, and from the great cardiac vein (GCV) to the anterior interventricular vein (AIV). Activation mapping during the clinical VPCs using the EnSite Precision system (Abbott, Minneapolis, MN) identified the earliest activation in the AIV (AIV 5-6 in Figure 1B), and the local bipolar electrogram at that site during the VPCs preceded the QRS onset of the VPCs by 35 ms. Pacemapping at that site exhibited a good pacemap, and the pacemap score on the EnSite Precision system was 95% (Figure 1B). However, the local bipolar electrograms during the VPCs at the left coronary cusp (LCC) and aorto-mitral continuity (AMC) preceded the VPC-QRS onset by 7–15

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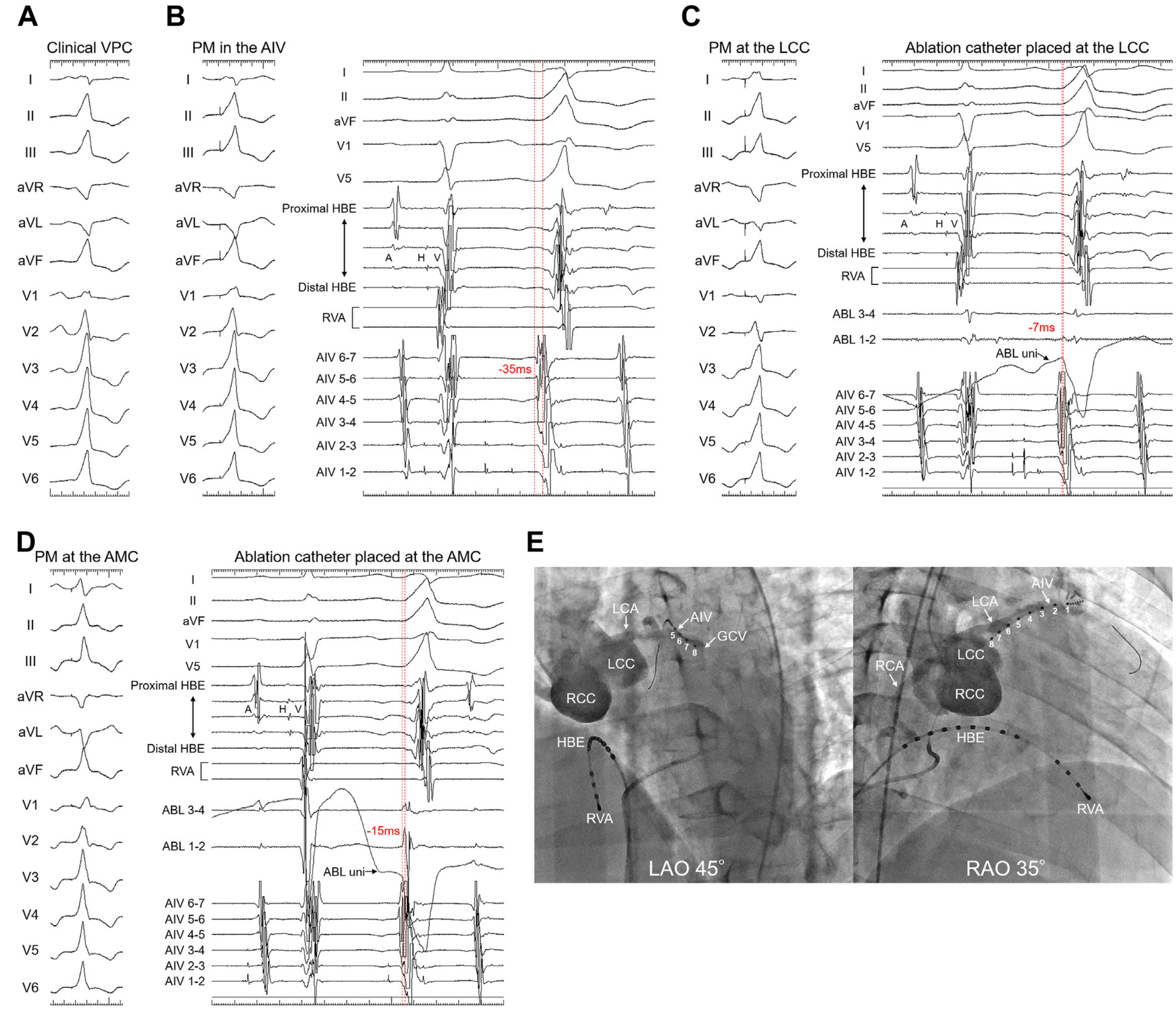

Figure 1 **A:** Twelve-lead electrocardiogram (ECG) recorded during clinical ventricular premature contractions (VPCs). **B:** Twelve-lead ECG of the pacemap (PM) in the anterior interventricular vein (AIV) **(left)** and body surface and intracardiac ECG recordings during the VPC demonstrating that the local electrogram preceded the VPC-QRS onset by 35 ms in the AIV (AIV 5-6; **right**). **C:** Twelve-lead ECG of the PM at the left coronary cusp (LCC) **(left)** and body surface and intracardiac ECG recordings during the VPC demonstrating that the local electrogram preceded the VPC-QRS onset by 7 ms at the LCC (ABL1-2; **right**). **D:** Twelve-lead ECG of the PM at the aorto-mitral continuity (AMC) **(left)** and body surface and intracardiac ECG recordings during the VPC demonstrating that the local electrogram preceded the VPC-QRS onset by 15 ms at the AMC (ABL1-2; **right**). **E:** Aortography and position of the multielectrode catheters on fluoroscopic images in the left anterior oblique (LAO) **(left)** and right anterior oblique **(right)** views. A = atrial electrogram; ABL 1-2 and ABL 3-4 = distal and proximal recordings by the 8F ablation catheter; ABL-uni = unipolar recording by the 8F ablation catheter; H = His-bundle electrogram; HBE = His-bundle electrogram recording area; GCV = great cardiac vein; LCA = left coronary artery; RCA = right coronary artery; RCC = right coronary cusp; RVA = right ventricular apex; V = ventricular electrogram.

ms, and pacemapping at those sites exhibited poor pacemaps with pacemap scores of 79%–91% (Figures 1C and 1D).

RF applications at the LCC and AMC, which were anatomically adjacent to the earliest activation site in the AIV, transiently eliminated the VPCs during ongoing ablation, with a maximum power output of 40 W and mean contact force of 11–30*g* using an 8F contact force–sensing irrigated ablation catheter (TactiCath SE, Abbott) and the Ampere RF generator (Abbott) (Supplemental Table 1). After retrograde coronary sinus venography (Figure 2A and Supplemental Video 1), the ablation catheter was introduced into the coronary sinus through a deflectable sheath (Agilis NxT, Abbott). The tip of the ablation catheter could be advanced to the distal GCV but could not be further advanced into the summit-CV. Thus, the 8F irrigated ablation catheter was changed to a 5F nonirrigated ablation catheter with a 5-mm tip (Ablaze Fantasista 5F, Japan Lifeline Co., Tokyo, Japan). The 5F ablation catheter could be advanced into the summit-CV (Figure 2B). The local electrogram during the VPCs recorded by the ablation catheter within the summit-CV preceded the VPC-QRS onset by 45 ms and was the earliest among all the mapping

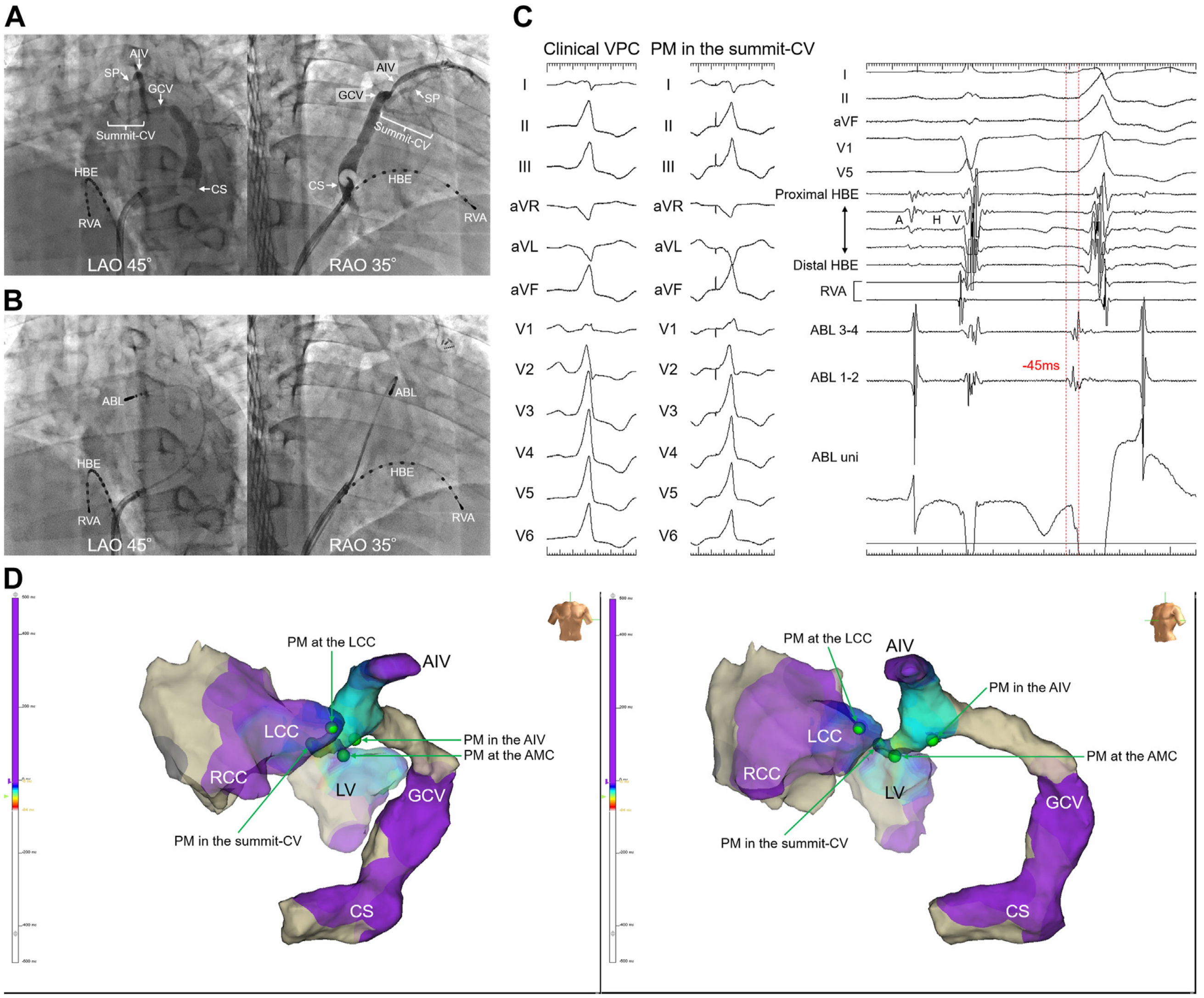

Figure 2 **A:** Retrograde coronary sinus venography showing the course of the GCV, AIV, summit-CV, and septal perforator in the LAO **(left)** and RAO **(right)** views (Supplemental Video 1). **B:** Fluoroscopic images showing the position of the tip of the 5F ablation catheter placed at the successful ablation site within the summit-CV in the LAO **(left)** and RAO **(right)** views. **C:** Twelve-lead ECGs of the clinical VPC **(left)** and PM in the summit-CV **(middle)** and body surface and intracardiac ECG recordings during the VPC demonstrating that the local electrogram recorded by the ablation catheter within the summit-CV preceded the VPC-QRS onset by 45 ms. **D:** Activation maps during the VPCs exhibiting the earliest activation within the summit-CV in the anteroposterior **(left)** and LAO **(right)** views (Supplemental Video 2). *Green tags* on the maps represent the PM sites. CS = coronary sinus; LV = left ventricle; SP = septal perforator; summit-CV, LV summit communicating vein; other abbreviations as in Figure 1.

electrograms (Figures 2C and 2D, and Supplemental Video 2). Pacemapping in the summit-CV exhibited the best pacemap, with a pacemap score of 97% (Figure 2C). During unipolar RF ablation between the 5F ablation catheter tip and 1 dispersive electrode pad attached to the patient's back using the CABL-IT RF generator (Japan Lifeline Co.), a temperature-controlled mode was applied with a maximum temperature of 65°C. The VPCs disappeared 21 seconds after commencement of RF application targeting the earliest activation within the summit-CV. During the RF application with successful elimination of VPCs, mean and maximum power output delivered were 8 W and 18 W, respectively; RF application duration was 26 seconds; and generator impedance dropped from 153 to 127 Ω (Figure 3 and Supplemental Table 1). Additional RF applications were performed around the successful ablation site within the summit-CV, with mean and maximum power output of 7–14 W and 11–26 W, respectively; RF duration of 31–70 seconds; and generator impedance drop of 21–29 Ω (Figure 3). Those RF applications within the summit-CV had a momentary overshoot of temperature up to 69°–80°C, although a maximum temperature was set at 65°C with the temperature-controlled mode. No char formation on the ablation catheter tip, audible steam pops, or ST-T changes on ECG monitoring occurred during or after the ablation. Thereafter, no VAs could further be induced by intravenous injection of isoproterenol and edrophonium chloride, and any programmed or rapid ventricular stimulation. The patient had no VA recurrences without any antiarrhythmic drugs during a 7-month follow-up period.

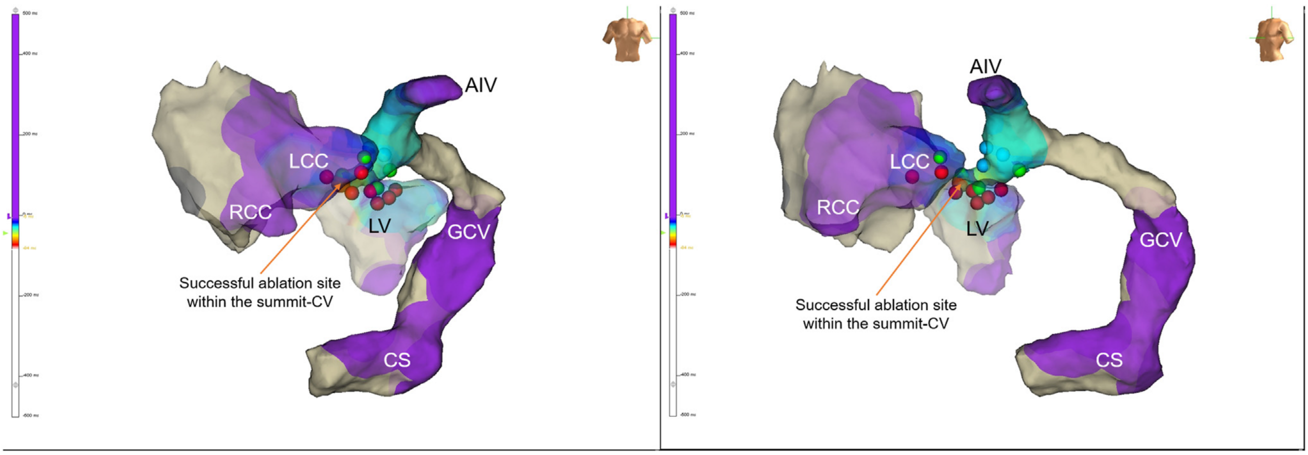

Figure 3 Final radiofrequency ablation sites on the VPC activation maps in the anteroposterior **(left)** and LAO **(right)** views. *Green, orange, light blue,* and *red tags* represent the PM sites, successful ablation site, ablation sites, within the summit-CV, and ablation sites at the AMC and LCC, respectively. Abbreviations as in Figures 1 and 2.

Discussion

This case report demonstrates that use of a 5F nonirrigated ablation catheter, instead of a commonly used 8F irrigated ablation catheter, was effective for directly ablating within the summit-CV and successfully eliminating LV summit-VAs.

LV summit-VAs can be ablated on the aortic cusps, LV endocardium, right ventricular outflow tract, and coronary venous system.[1,5–9] To the best of our knowledge, few studies have reported successful elimination of summit-VAs by RF ablation within the summit-CV using a 5F ablation catheter. Kaseno et al[2] used a 5F ablation catheter during ablation of VAs originating from the GCV, and the VAs were successfully eliminated by RF ablation within the GCV, with a maximum power output of 17 W, maximum temperature of 55°C, RF duration of 60 seconds, and generator impedance drop from 150 to 130 Ω. Hachiya et al[3] reported that a 5F ablation catheter was used during ablation within the distal GCV, but the details of the ablation sites and settings of RF power, temperature, and duration were not described in their report.

LV summit-VAs often have the earliest activation during the VPCs within the summit-CV. RF ablation directly targeting the earliest activation within the summit-CV often is difficult for the following reasons. (1) Thick ablation catheters, such as 8F irrigated ablation catheters, cannot be advanced into the summit-CV because of the small vessel size of the summit-CV. (2) Even if an ablation catheter can be advanced into the summit-CV, sufficient RF energy cannot be delivered because of high generator impedance >200–250 Ω or high contact force. A 5F ablation catheter has the smallest catheter tip in current clinical practice and the potential to be advanced more distally into the summit-CV. However, sufficient RF power output sometimes cannot be delivered as a result of a temperature rise because the ablation catheter does not have an externally irrigated catheter tip. The present case also had a relatively low-power output delivered during the successful ablation and required a relatively long RF duration to eliminate the VPCs because a temperature-controlled mode was applied with a maximum temperature of 65°C. Thus, RF applications were added around the successful ablation site. However, the present case seemed to have a relatively large summit-CV, which may have made possible the delivery of as much RF energy as needed. A 5F nonirrigated ablation catheter is one of therapeutic tools for treating summit-VAs originating from the vicinity of the summit-CV.

To the best of our knowledge, no previous reports have described coronary artery injury associated with RF ablation within the summit-CV using a 5F ablation catheter. However, the potential risk of coronary artery injury should be fully noted when delivering RF energy within the summit-CV. In the present case, aortography before ablation at the LCC and AMC demonstrated that the left anterior descending artery coursed parallel to the AIV, where a multielectrode catheter was placed (Figure 1E). In addition, retrograde coronary sinus venography demonstrated that the summit-CV coursed slightly downward in front of the LCC after diverging from the AIV (Figure 2A). Therefore, we considered that the summit-CV was located far from the left coronary artery. Furthermore, the presence or absence of ST-T changes on ECG was carefully monitored during and after RF applications within the summit-CV. Consequently, no RF applications caused any ST-T changes.

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Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2022.08.006.

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