Successful ethanol injection into the anterior interventricular cardiac vein for ventricular premature contractions arising from the left ventricular summit

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Introduction

Ventricular premature contractions (VPCs) without structural heart disease arising from an outflow tract are amenable to treatment with radiofrequency (RF) catheter ablation, but may not always be cured successfully because of the characteristic structure. Most of them may not be life threatening but can sometimes annoy patients. Recently, retrograde coronary venous ethanol infusions have been reported as an alternative method in patients with refractory ventricular arrhythmias (VAs) to RF ablation originating from various sites.[1,2] In those papers, all experienced ventricular tachycardias and had comorbidities or structural heart disease with a reduced ejection fraction.

This report describes the first case without structural heart disease to undergo an ethanol injection into the anterior interventricular cardiac vein (EIAIV) via the great cardiac vein (GCV) for VPCs arising from the left ventricular (LV) summit region that all other RF approaches could not eliminate.

Case report

A 52-year-old obese woman (body mass index: 33.5) without any structural heart disease and an ejection fraction of 75.8% was referred to our institute for a second catheter ablation with symptomatic VPCs exhibiting a left bundle branch block and inferior axis QRS morphology. The first session was performed 9 months prior to this session using a 7F, 3.5-mm 6-hole irrigated-tip ablation catheter, but the VPCs recurred after 1 month.

This procedure was performed after informed consent was obtained for all procedures, including the chemical ablation using ethanol that was approved by the review board of this institute. During this session, her electrocardiogram (ECG) exhibited an R ratio in leads III/II, Q ratio in leads aVL/aVR, peak deflection index, and maximum deflection index of 1.03, 1.03, 0.68, and 0.63, respectively (Figure 1A).[3,4] Coronary sinus mapping using a duodecapolar catheter inserted into the anterior interventricular cardiac vein (AIV) via the distal GCV through the superior vena cava revealed the earliest ventricular activation preceding the QRS onset by 52 ms during the VPCs (Figure 1B and C). The focus was mapped using a 7.5F, 4-mm irrigated-tip ablation catheter (FlexAbility, Abbott, St Paul, MN) in the AIV, aortic and pulmonary sinus cusps, and outflow tract endocardium of both ventricles, but none of those approaches exhibited an earlier ventricular activation than that within the AIV, nor could they reach anywhere fluoroscopically close to the earliest electrode pair. We tried to deliver RF energy at each of those sites, and all could successfully transiently eliminate the VPCs, but the VPCs recurred soon after without any change in the QRS morphology (Figure 2). Finally, we tried to perform an EIAIV in the same manner as an ethanol injection into the Marshall vein, as follows (Figure 3).[5] An angiographic catheter for the left internal mammary artery (6F IM, Asahi Intec, Tokyo, Japan) was inserted into the GCV via the superior vena cava close to the AIV. Through that catheter, a guidewire (0.014-inch Cruise for peripheral angioplasty, Asahi Intec) and balloon catheter (8-mm length Apex OTW with a 2-mm nominal diameter for angioplasty, Boston Scientific, Boston, MA) were advanced and inserted into the branch neighboring the culprit site. Then only a 0.2- to 0.3-mL injection of radiographic contrast medium through the lumen of the angioplasty balloon to confirm engaging the vessel eliminated all VPCs, and then 2.0 mL of dehydrated ethanol was uninterruptedly injected over 4 minutes (0.5 mL/min). No further VPCs appeared even under an infusion of isoproterenol and burst pacing. We added an injection of 1.0 mL of dehydrated ethanol at that site over 2 minutes. Then the procedure was finished after confirming there were no remarkable abnormalities observed on the coronary angiography, nor any changes in her ECG, including changes of the ST-T segment.

Discussion

Chemical ablation using an ethanol infusion into the culprit coronary artery was first applied clinically to treat VAs,[6]

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KEY TEACHING POINTS

- There is the so-called inaccessible area for treating ventricular premature contractions (VPCs) located in the left ventricular (LV) summit area, and considerable failed or recurrent cases have been reported in this series of patients. We experienced cases in which we attempted to deliver radiofrequency (RF) energy in the anterior interventricular cardiac vein (AIV), aortic and pulmonary sinus cusps, and outflow tract endocardium of both ventricles, and all could successfully transiently eliminate the VPCs, but the VPCs recurred soon after without any change in the QRS morphology.
- VPCs sufficiently preceded the QRS, especially in the AIV, where a drastic impedance change precluded a continuous energy delivery and no further RF deliveries could be applied at the same site because of a high impedance.
- Ethanol injection into the AIV may be one of the therapeutic options for treating VPCs arising from the LV summit, especially in the inaccessible area, that all other approaches could not eliminate.

and also experimentally for VAs with injections into the coronary veins.[7] Recently, ethanol infusion into the Marshall vein, which branches from the coronary sinus, has been reported to be one of the options for atrial arrhythmias and is widely accepted clinically. The procedure has been subsequently adopted for ventricular tachycardias refractory to RF ablation associated with structural heart disease that were all initially successfully eliminated.[1,2] However, more than half of the cases included in those papers had experienced a recurrence of their VAs and required additional RF ablation. To the best of our knowledge, this is the first case report describing the successful EIAIV of VPCs arising from the LV summit in a patient without any structural heart disease and a preserved ejection fraction.

One limitation of this study was that we did not evaluate the local electrogram from the guidewire inserted into the vein, nor did we perform pace mapping in order to confirm the culprit target. The guidewire we used in this case was a hydrophilic polymer jacket wire that was coated with urethane, which might have acted as an electric isolator, which may have interfered with recording the local electrograms, and the manufacturer prohibits delivering current through it because of the risk of tearing the urethane coat. First of all, from the local electrograms obtained by the mapping catheter, we determined that the target site was in the proximal AIV, which was located very close to the proximal septal branch that bifurcated very acutely. Further, we chose this guidewire for its better lubricity and crossability. We could

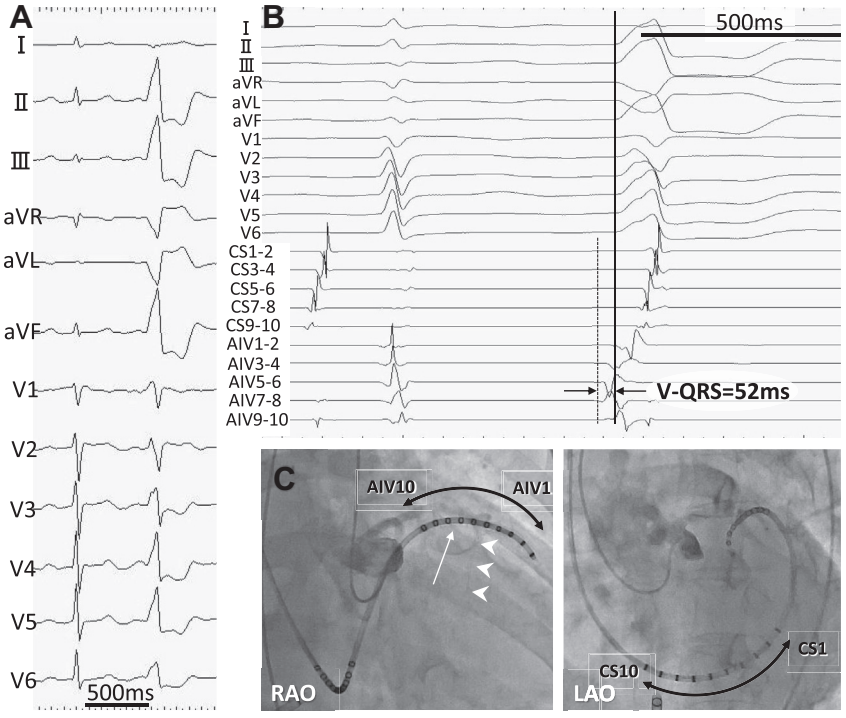

Figure 1 Twelve-lead electrocardiogram (**A**), intracardiac electrograms obtained by a duodecapolar electrode catheter inserted into the anterior interventricular cardiac vein (AIV) (**B**), and the catheter position with a contrast injection into the left coronary cusp (**C**). The earliest activation (indicated at AIV7-8) without a pre-potential precedes the QRS onset by 52 ms in the proximal AIV (*arrow*). The arrowheads indicate the first septal branch. CS = coronary sinus; LAO = left anterior oblique; RAO = right anterior oblique.

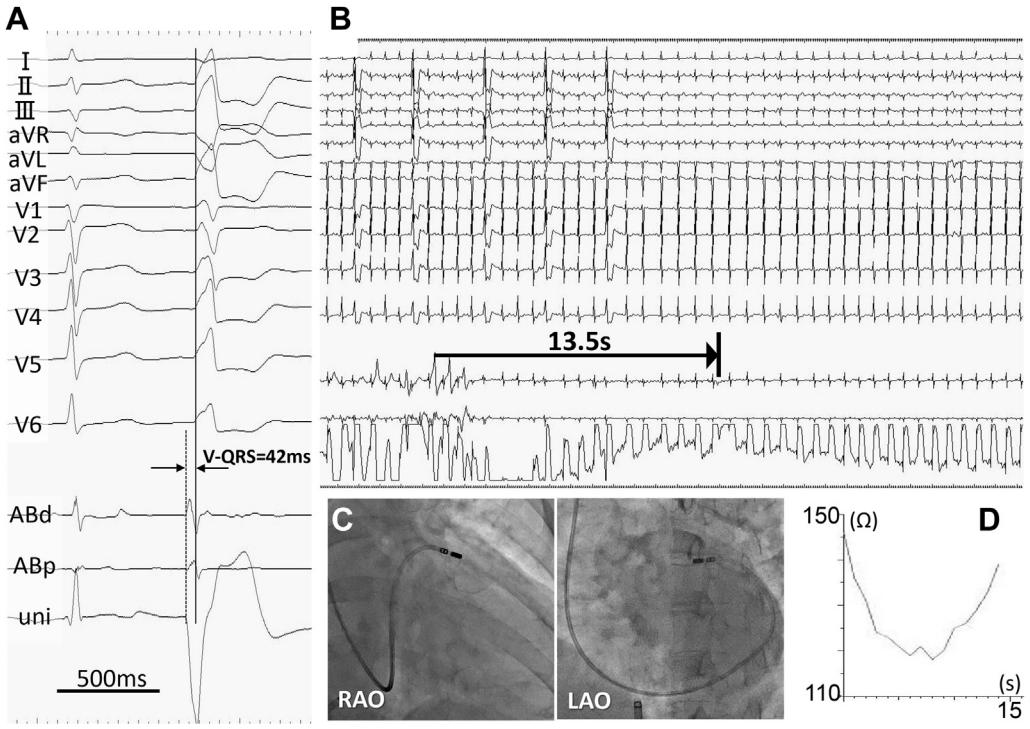

Figure 2 Representative transient successful radiofrequency (RF) application and catheter positions (**A–D**). Note that the ventricular arrhythmias were eliminated after starting the RF application (**B**), but a drastic impedance change precluded a continuous energy delivery for only 13.5 s (**B**, **D**). We could not perform another RF delivery at the same site because of a higher impedance (>250 Ω), and the ventricular premature contractions soon reappeared (not shown). The order of the electrograms in panel B is the same as that in panel A. ABd, ABp, and uni indicate the distal, proximal, and unipolar electrograms of the ablation catheter, respectively. Other abbreviations as in Figure 1.

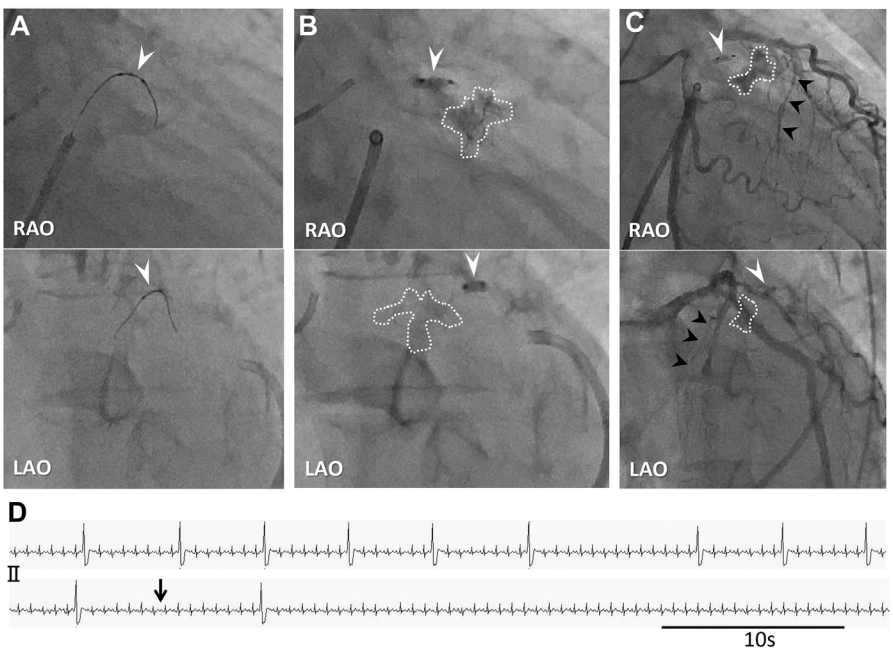

Figure 3 Procedural series of the ethanol injections into the anterior interventricular cardiac vein (AIV). **A:** Cannulation of an angioplasty wire and balloon (*white arrowhead*) into the AIV close to the culprit site. **B:** An ethanol infusion of 2 mL following a contrast medium injection through a wire lumen. The area surrounded by the dotted lines indicates the area stained by the contrast medium injection. **C:** Left coronary angiography following the ethanol injection into the AIV (EIAIV). The contrast stain (*dotted line*) lies close to the left anterior descending artery between the distal left main trunk and first septal branch (*black arrowheads*). **D:** Electrocardiogram tracing during the EIAIV. Frequent ventricular premature contractions reappeared constantly before the injection (upper), which disappeared soon after a test injection of a small amount of contrast medium (lower, *arrow*). LAO = left anterior oblique; RAO = right anterior oblique.

have obtained the electrograms from this guidewire or performed pace mapping; however, it would have been difficult to confirm if the local electrical information was reliable using the insulated guidewire.

Although the above reasons persuaded us not to collect the local electrograms using the guidewire, the local electrogram where we injected the ethanol, obtained by a conventional catheter, preceded the QRS by 42–52 ms, suggested that that site could have been the origin of this VPC.

Another limitation was that we did not attempt a pericardial approach. Further, it was unclear whether the EIAIV was the only method suitable for this case. However, this case met none of the criteria that would have suggested being treated with a pericardial approach,[8] although the obese physical constitution (body mass index: 33.5) could have affected the ECG criteria. Most importantly in this case, none of the approaches, other than the EIAIV, could result in a change in the QRS morphology, nor could they abolish the VPCs, which would explain that the origin in this case may have been the so-called inaccessible area.[3,8]

Further follow-up in this case and more experience will be required to warrant this approach, and the EIAIV may be one of the options for treating LV summit VPCs in patients without structural heart disease.

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