Guidewire ablation of epicardial ventricular arrhythmia within the coronary venous system: A case report

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Introduction

The ablation success rate of ventricular arrhythmia (VA) varies and is associated with the origin of arrhythmia. For some patients with focal ectopies arising from epicardial or intramural locations, neither endocardial nor epicardial ablation is always helpful, as a result of the inadequate power delivery to the VA origin and its proximity to the coronary arteries.[1,2] The least invasive access to target those foci is obtained via the coronary venous system (CVS). However, the ablation catheter may not be easily maneuvered when advancing it to the distal segment of the great cardiac vein (GCV) or their branches. Moreover, energy delivery may be limited owing to high impedance and inadequate irrigation flow.[3] We herein present a case wherein frequent symptomatic premature ventricular complexes (PVCs) originating from the left ventricular summit were successfully ablated from the distal part of the GCV using a guidewire.

Case report

A 48-year-old woman with 1-month history of palpitation and chest discomfort and invalid for medical therapy was referred for catheter ablation of frequent PVCs. The clinical electrocardiogram (ECG) showed that the PVC had a right bundle branch block morphology; positive R waves were in leads II, III, and aVF; and pseudo delta wave was in precordial QRS complex, indicating an epicardial origin in the left ventricular (LV) outflow tract (LV summit region) (Figure 1A). A 24-hour ambulatory Holter ECG showed that the number of PVCs was 34,475, accounting for 31.1% of all cardiac beats in 24 hours, and transthoracic echocardiography revealed no obvious structural heart abnormalities.

After the informed consent of this patient was obtained, a baseline electrophysiological study was performed. Venous and arterial access was gained via the right femoral artery and vein, as well as jugular vein, and a 10-pole diagnostic catheter (Webster®; Biosense-Webster, Irvine, CA) was positioned in the coronary sinus. Then LV mapping was performed with a 3.5 mm mapping ablation catheter (ThermoCool NaviStar®; Biosense-Webster) and a 3-dimensional electroanatomical mapping system (CARTO 3 System; Biosense-Webster) was used for activation mapping. In the areas of left Valsalva sinus, no satisfactory origin foci were detected, either under or above the aortic valve. Then, an attempt was made to map aortomitral continuity, but no near-field potential was detected.

Considering that CS1-2 potential was 26 ms ahead of the QRS onset (Figure 1B), the earlier activation site might be located at the distal part of the GCV. First, mapping of the endocardial site opposite to the CS1-2 was performed, but no ideal target was detected. Subsequently, the ablation catheter was advanced into the CVS, but unfortunately we ultimately failed to advance the catheter further despite many attempts. To conquer this technical difficulty, we decided to switch the conventional ablation catheter to a guidewire. After the patient signed informed consent, a 0.014-inch angioplasty guidewire (BMW; Abbott, Santa Clara, CA) was advanced into the coronary sinus via a guiding catheter, then a microcatheter (Fincross; Terumo, Tokyo, Japan) was advanced over the wire to expose only the distal 5 mm of the tip for mapping. We connected the proximal end of the guidewire to the lead V_1 electrode for the recording of the unipolar signal, and a near-field potential by wire that preceded the QRS by 26 ms at the distal part of the GCV was identified (Figure 1B and 1C). We advanced the guidewire and withdrew the microcatheter, leaving approximately 25

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KEY TEACHING POINTS

- Ventricular arrhythmia (VA) originating from epicardial or intramural locations poses a clinical challenge for catheter ablation, and the coronary venous system may provide routes for mapping and ablation of these arrhythmias, but inability to deliver sufficient radiofrequency energy owing to anatomical constraints, high impedance, and inadequate irrigation flow may limit the efficacy of ablation.
- As a novel technique, guidewire ablation through the coronary venous system is feasible and effective for treating epicardial or intramural VA. This approach overcomes the inability to advance the traditional ablation catheter in small-diameter vessels; and compared with ethanol infusion, it is more predictable to use guidewire ablation because of accurate targeting and limited myocardial injury.
- The innovation of this technique outlined in our case is the usage of a microcatheter. A guidewire covered with a microcatheter can be effectively used as an "ablation electrode" for unipolar mapping and ablation; by moving the microcatheter, length variability of the wire tip is available, as well as the possibility of performing saline infusion.

mm of wire tip exposed for ablation. Before ablation, coronary angiography was performed to avoid potential risk of artery injury. Figure 2 shows that the exposed wire tip was located at a safe position away from the adjacent coronary arteries (more than 4 mm). Subsequently, the end part of the wire was connected to the radiofrequency (RF) generator so that the uncovered part could deliver RF energy (Figure 3A illustrates the basic theory of guidewire ablation). Meanwhile, we linked the end of the microcatheter to the irrigation pump for saline injection. During the ablation procedure, RF energy was delivered with a starting output of 10 W for 30 seconds; Figure 3B shows that PVCs disappeared immediately 3 seconds later. The impedance decreased from 192 Ω to 175 Ω within 10 seconds, then it kept steady around 175 Ω. Then increased RF energy was delivered to enhance the ablation effect. When energy power increased to 20 W, a sharply increased impedance occurred at 15 seconds and the ablation was immediately terminated. A careful examination of the wire tip was performed after ablation, and no char formation was detected. During the procedure, the saline irrigation rate was at 2 mL/min, and the total ablation time was 75 seconds. It was impossible to induce PVCs immediately after 30 minutes of observation. ECG monitoring 2 hours after RF showed no ischemic ST-T change (Figure 3C), and no complication occurred during the mapping or ablation procedure. During the 6-month follow-up, the patient remained free of PVCs without any antiarrhythmic drugs.

Discussion

Catheter ablation failure poses a clinical challenge for patients with epicardial or intramural VA. The efficacy of retrograde coronary venous ethanol infusion to treat prior failed ventricular tachycardia (VT) has been reported,[4] but there are potential risk of off-target myocardial injury attributable to ethanol leak. Bipolar ablation is also an alternative for deeply originated arrhythmia: when targeting the LV summit, bipolar energy was delivered between the GCV / anterior interventricular *vein* and opposite endocardium; however, this approach requires optimal anatomic conditions.[5] Other bailout approaches, including half normal saline ablation and needle ablation, have also been reported,[6] but the relative merits of these are yet to be established.[2,4,7]

Guidewire, commonly used in coronary intervention, has been first described as a novel technique for intracoronary mapping to help guide VA ablation in electrophysiology, and it offers an alternative epicardial mapping strategy in targeting VT in those in whom a previous endocardial ablative approach has been unsuccessful.[8,9] Romero and colleagues[10] described a novel technique of intramyocardial guidewire ablation through a system used to treat coronary artery chronic total occlusions; a stiff Stingray guidewire was advanced through the first septal perforator into the interventricular septal myocardium for both mapping and ablation in the treatment of intramural LV summit VA, but several potential complications may occur owing to the stiff tip of the Stingray guidewire, such as coronary artery injury and intramural hematoma. A case report by Efremidis and colleagues[11] provided a guidewire ablation technique through the coronary venous system for epicardial LV summit VAs, and a distal 15 mm uninsulated VisionWire guidewire was used for both unipolar mapping and ablation at the distal GCV / anterior interventricular *vein* junction site. The vascular complication and thromboembolic events related to intracoronary ablation could probably be avoided when compared to Romero's research.

Unlike previous published research, a distal 30 mm uninsulated guidewire covered with a microcatheter was applied in our study for intravenous mapping and subsequent ablation via CVS, with the advantages of adjusting the length of the uncovered part of the wire tip and performing saline infusion. By linking the end of the microcatheter with the irrigation pump, saline infusion during ablation is available. In the distal segment of the GCV or branches, high impedance and limited cooling from surrounding blood flow are likely to limit sufficient RF energy delivery; saline infusion was useful for ensuring efficacy of ablation, because it can reduce intravenous impedance and temperature. Considering that

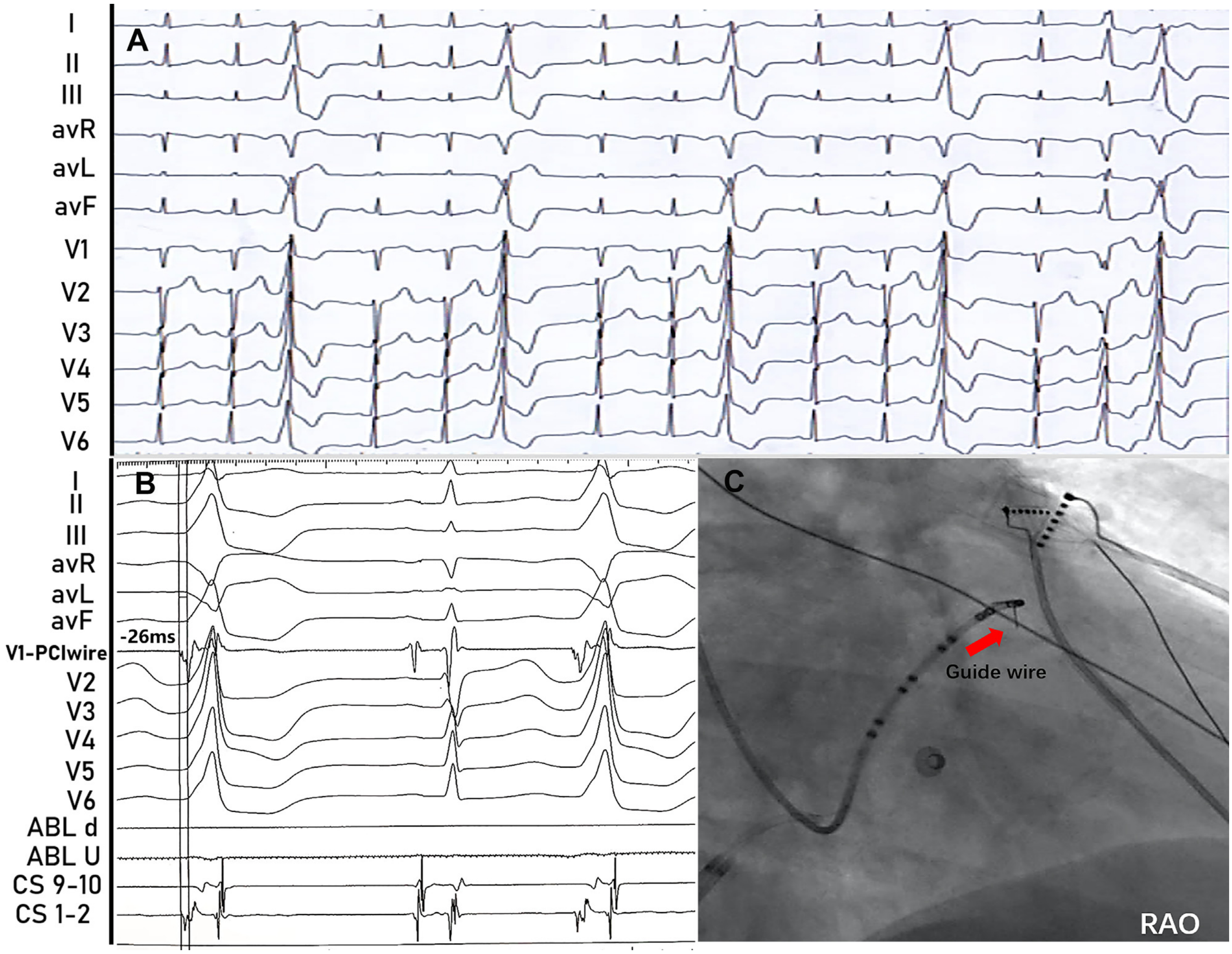

Figure 1 **A:** Standard 12-lead electrocardiogram (ECG, 25 mm/second) morphology of the premature ventricular complexes (PVCs). **B:** Activation mapping (100 mm/second) of PVCs by guidewire shows the earliest site of activation preceded the QRS onset by 26 ms, which is equal to the earliest activation time in CS1-2 (-26 ms). **C:** Angiographic image depicts that the guidewire was located within the great cardiac vein for mapping.

saline infusion had a negative correlation with ablation lesion, a lower speed at 2 mL/min was chosen in our operation, which allowed to maximize lesion size with a reduced baseline impedance and a relatively low risk of tissue overheating. On the other hand, length variability of the wire tip, which ensures precise mapping and complete ablation, is another superiority. For mapping purposes, a shorter exposed length is achievable for recording a more accurate unipolar signal, whereas for ablation purposes, a longer exposed length of guidewire can produce a wider lesion, with distal and proximal segments around the target site being totally covered, which increases the effectiveness of ablation; however, excessively prolonging the exposed wire tip might increase the risk of collateral injury. So an optimial exposed length for ablation is associated with efficacy and safety of this approach, which needs further exploration.

Based on previous published cases and our present research, we can demonstrate that guidewire ablation within the distal GCV is both feasible and safe and might be considered as an alternative approach for treating epicardial or intramural VAs inaccessible to conventional ablation catheter. Compared to ethanol infusion, lesion formation by wire is more predictable on account of its accurate targeting and limited myocardial injure. For bipolar ablation, some PVC/VT sources cannot be accessed owing to anatomic obstacles or due to being out of ablation range; in this setting, guidewire ablation might be considered as an alternative approach. This study, however, has several limitations. Firstly, the applicability of this technique is highly dependent on whether branches of the coronary sinus represent the origin of VAs or not, as previous reports showed only 9% of idiopathic VAs with earliest activation inside the CVS.[12] Secondly, without temperature monitoring, there were potential risks of char formation around the exposed tip of the wire, so an examination of the wire tip after ablation is required. Moreover, from this study, we recognized that the process of RF energy delivery through the guidewire is not yet well understood, and many factors, including caliber of target vessel, contact area of wire and tissue, and presence of epicardial fat, could

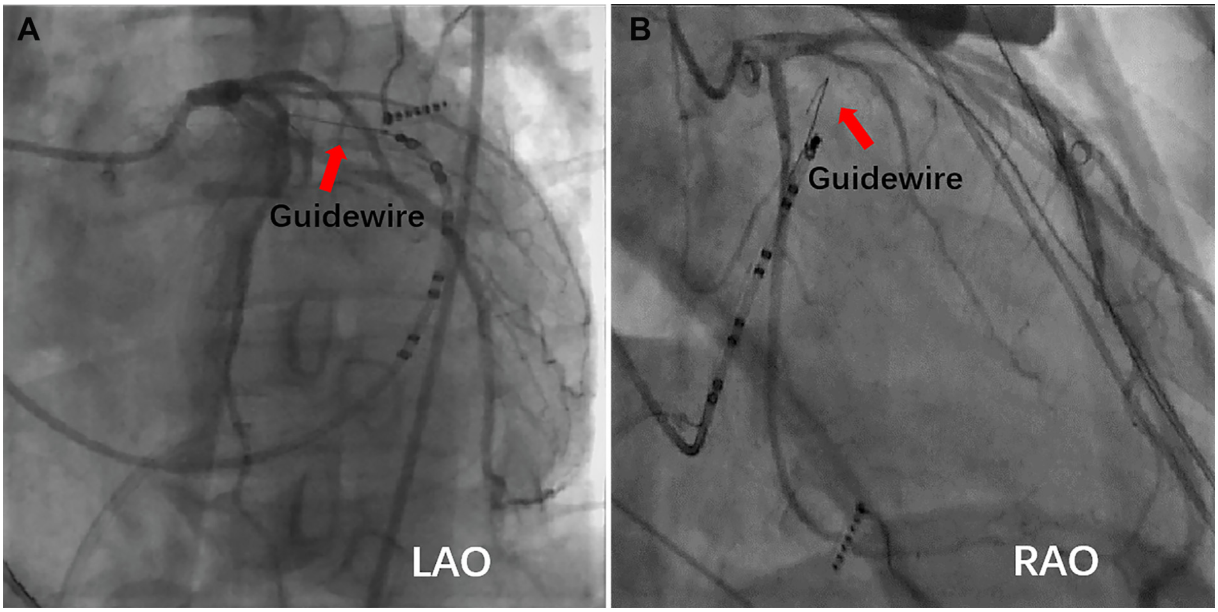

Figure 2 Angiographic images of left anterior oblique (LAO 35°, **A**) and right anterior oblique (RAO 35°, **B**) projections depicted the location between the guidewire tip and the left coronary artery (LCA). Noticeably, the exposed wire tip was located at a safe position away from the LCA.

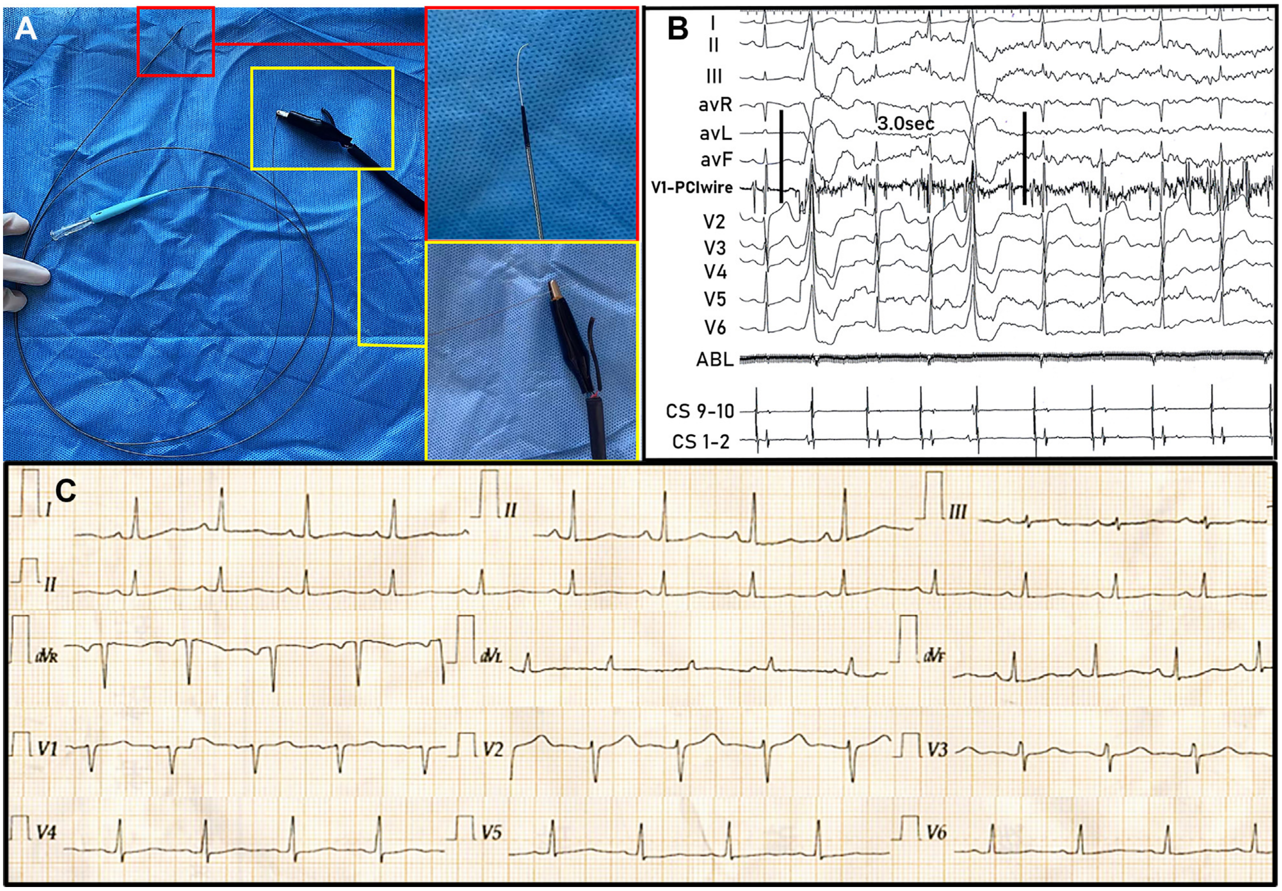

Figure 3 **A:** Illustration of ablation technique using guidewire. A 0.014-inch guidewire covered with a microcatheter was advanced into the coronary venous system, and the length of the uncovered part could be changed according to mapping or ablation purposes. The end part of the guidewire was connected to the radiofrequency (RF) generator via alligator clip to produce RF energy. **B:** Cardiac tracings exhibited the effective ablation, which was achieved by a guidewire at distal great cardiac vein with an output power of 10 W for 3 seconds. After additional application was delivered to enhance the ablation effect, premature ventricular complexes were terminated completely. **C:** Electrocardiogram morphology 2 hours after ablation (25 mm/second).

influence lesion dimension caused by guidewire ablation, so technical advancement and more clinical studies are needed to achieve better outcomes.

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