Frequent Premature Ventricular Complexes Originating from the Left Ventricular Summit Successfully Ablated from the Proximal Great Cardiac Vein Using an Impedance-based Electroanatomical Mapping System

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Abstract

We herein report a 58-year-old woman with frequent premature ventricular complexes (PVCs) originating from the left ventricular summit. The earliest ventricular activation of spontaneous PVCs was recorded in the proximal site of the great cardiac vein, which was simultaneously mapped and conducted using an impedance-based electroanatomical mapping system. Irrigated radiofrequency with a starting power output of 20 W and maximal temperature set at 40°C was applied with 10 Ω impedance fall, resulting in total disappearance of the frequent PVCs. The patient has remained free from PVCs for 18 months without requiring antiarrhythmic drug therapy.

Key words: premature ventricular complexes, great cardiac vein, irrigated ablation catheter, impedance-based electroanatomical mapping system, left ventricular summit

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Introduction

In clinical practice, idiopathic premature ventricular complexes (PVCs) are often encountered in the general population, and the frequent occurrence of PVCs chronically induces left ventricular (LV) dysfunction in patients with or without structural heart disease. Successful catheter ablation for frequent PVCs is effective for an improvement in the cardiac function (1-3). The LV epicardium is known to be susceptible to idiopathic ventricular arrhythmias (4). However, catheter ablation may be difficult to perform due to the small vessel diameter of the coronary sinus, proximity to the coronary artery, and limited access to the PVC focus. We herein present a case wherein the frequent occurrence of symptomatic PVCs, originating from the LV summit, was successfully ablated from the proximal great cardiac vein (GCV) using an irrigated ablation catheter and an impedance-based electroanatomical mapping system.

Case Report

A 58-year-old woman was referred to our hospital for catheter ablation of frequent PVCs. The patient had complained of palpitation and chest discomfort for several years during medical therapy with a regular follow-up at our hospital due to diabetes mellitus and essential hypertension. A resting 12-lead electrocardiogram (ECG) revealed PVCs with sinus rhythm with normal QRS configuration without ST-T segment abnormalities. The PVCs exhibited a right bundle branch block and an inferior axis pattern with slurring of the R wave in the precordial leads. The maximum deflection index was 0.6. A 24-h ambulatory Holter ECG showed 39,423 PVCs/day, including three consecutive beats of nonsustained ventricular tachycardia, representing 36.9% of all cardiac beats in one day. No obvious abnormalities were observed on a physical examination, and transthoracic echocardiography revealed no structural heart abnormalities.

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After obtaining the patient’s written informed consent, an electrophysiological analysis and catheter ablation were performed using an impedance-based electroanatomical mapping system (EnSite NavX, St. Jude Medical, St Paul, USA; Nihon Kohden, Tokyo, Japan). Multipolar electrode catheters were percutaneously inserted into the right jugular vein and femoral vein and positioned in the right atrium and coronary sinus, His bundle region, and right ventricular apex. After confirming that the electrode potential at the proximal GCV in the coronary sinus was approximately 20 ms earlier than the QRS onset of spontaneous PVC and removing the multipolar electrodes catheter from within the coronary sinus, a conventional radiofrequency ablation catheter with a 4 mm tip was introduced through the right jugular vein to the proximal GCV. We delivered radiofrequency energy (15 W, 55°C) from the earliest ventricular activation that preceded the QRS onset by 33 ms; pace mapping at the earliest site was an excellent match for the QRS complex of spontaneous PVCs (Fig. 1). However, this attempt failed to deliver sufficient radiofrequency energy due to increasing impedance. The conventional ablation catheter was therefore switched with a flexible-tip irrigated ablation catheter (Cool Flex, St. Jude Medical). The flexible-tip irrigated ablation catheter was navigated into the reference point (Fig. 2, red arrow and white dot) in the proximal GCV using the impedance-based electroanatomical mapping system. Irrigated radiofrequency energy was applied with a starting output power of 20 W and a maximal temperature of 40°C. The impedance decreased from 123 Ω to 113 Ω during energy application. Then, the PVCs completely disappeared and additional applications were delivered distally and proximally from the site of the first application point. The patient has remained free of PVCs for 18 months after treatment without requiring antiarrhythmic drug therapy.

**Discussion**

The LV summit, which is the most superior portion of the LV, is the site most susceptible to epicardial idiopathic PVCs. Baman et al. (4) reported that almost 15% of idiopathic ventricular tachyarrhythmias have an epicardial origin; however, treatment by catheter ablation within the coronary sinus is not possible in approximately 30% of patients. Yamada et al. (5) also reported that catheter ablation had to be abandoned in one-third of patients with ventricular tachyarrhythmias originating from the LV summit due to the inability of the catheter to access the myocardium, high impedance to radiofrequency application within the GCV, or close proximity to the coronary artery. Anatomical issues, including the venous structure, location, proximity to the coronary artery, and epicardial fat pad, present some difficulties in using a transvenous and/or transpericardial approach for catheter ablation treatment. Furthermore, although the PVC foci within the coronary venous system are accessible sites for an ablation catheter, the risk of complications, such as venous occlusion and rupture/injury to the adjacent coronary arteries, should be considered. In the present case, spontaneous PVCs in the 12-lead ECG exhibited a right bundle branch block and an inferior axis pattern with slurring of the R wave, a transition zone earlier than V1, an aVL/aVR amplitude ratio of 2.2, a precordial maximum deflection index of 0.6, and the existence of an S wave in V5 and V6, as shown in Fig. 1. These ECG characteristics indicated that the PVCs originated from the LV summit, which may be an appropriate candidate for catheter ablation by the percutaneous epicardial approach (4-6), and we were able to
identify and confirm that the earliest PVC activation site was accessible for catheter ablation from the proximal GCV. Therefore, these findings led us to attempt to deliver radiofrequency energy to the precise point identified, and we subsequently successfully ablated the PVCs from the proximal GCV. Similar to previous studies that used magnet-based electroanatomical mapping systems (4-6), the impedance-based system was helpful in identifying the accurate location of the PVCs within the venous lumen in sagittal and coronal planes. Moreover, any electrode catheter can be applied to increase the accuracy of mapping in this impedance-based electroanatomical mapping system. Thus, the irrigation catheter system and impedance-based electroanatomical mapping system can be effectively and safely used for treating PVCs originating from the LV summit.

Author's disclosure of potential Conflicts of Interest (COI).

References

Figure 2. Fluoroscopic images (A, B) and impedance-based electroanatomical mapping images (C, D). Red arrows indicate the distal site of the ablation catheter and white dots indicate the earliest site of PVC. RAO: right anterior oblique 30°, LAO: left anterior oblique 45°