INNOVATIVE COLLECTIONS

COMPLEX CASE STUDY

Idiopathic Ventricular Tachycardia Originating from a Myocardial Extension into the Non-coronary Aortic Cusp: the Significance of Unipolar Electrograms

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ABSTRACT. We present a 25-year-old woman with highly symptomatic premature ventricular complexes originating from a myocardial extension into the non-coronary aortic cusp and highlight the significance of unipolar electrograms in selecting the ablation target.

KEYWORDS. ablation, unipolar electrogram, premature ventricular complexes.

Introduction

Ventricular tachycardia or premature ventricular complexes (PVCs) originating from the right ventricular outflow tract (RVOT) usually occur in patients without structural heart disease, and radiofrequency ablation is the treatment of choice for drug-refractory PVCs.1,2 PVCs originating from the left ventricular outflow tract or aortic cusps have been previously described and often represent a challenge for ablation.3 Moreover, ventricular tachycardia or PVCs originating from the non-coronary aortic cusp are extremely rare. Precise localization of the origin of these arrhythmias can be greatly facilitated by analyzing both bipolar and unipolar electrograms.

Case report

A 25-year-old woman was referred for catheter ablation to treat highly symptomatic frequent PVCs. PVCs were monomorphic with the morphology shown in Figure 1. PVCs constituted 27% of her ventricular beats on a Holter monitor. She did not tolerate metoprolol because of fatigue. Her past medical history was otherwise unremarkable.

Electrophysiological study was performed without sedation or anesthesia to maximize the inducibility. Multipolar catheters were advanced to the His bundle, right ventricular apex, right atrial appendage, and coronary sinus. In addition, a 20-pole circular catheter (LASSO, Biosense Webster Inc., Diamond Bar, CA) was positioned at the RVOT through a long sheath. Both activation mapping and electroanatomical mapping (CARTO XP, Biosense Webster Inc.) of the RVOT were used to identify the origin of the PVCs. A 3.5 mm externally irrigated catheter (Navistar ThermoCool, Biosense Webster Inc.) was used for mapping. Activation mapping of PVCs in the right ventricle and pulmonary artery revealed that the site of earliest activation was located in the posterior aspect of the RVOT (60 ms earlier than the onset of QRS). However, close examination of the unipolar electrogram morphology revealed that the initial electrogram deflection (15–20 ms) represented a far-field component (Figure 2). In addition, multiple sites in the RVOT showed the same earliest activation timing, but the unipolar electrograms consistently demonstrated an initial far-field component of 15–20 ms (Figure 3). These findings indicated that the...
origin of the PVCs was not in the RVOT. No ablation was performed in the RVOT.

We then proceeded with mapping the coronary cusps using the retrograde transaortic approach. Detailed mapping of all the coronary cusps revealed a small, discrete potential 70 ms before the onset of the QRS (Figure 4). Of note, both the unipolar and bipolar electrograms recorded from the non-coronary cusp exhibited no far-field potential, indicating that the small potential was the origin of the symptomatic PVCs. In a subsequent sinus beat, this discrete potential was very late and buried in the ventricular activation (Figure 4, right panel), suggesting that this discrete potential represents a myocardial extension into the non-coronary cusp. Pace mapping at this site demonstrated identical morphology with clinical PVCs (12/12). Radiofrequency ablation at this site with 25 W abolished the PVCs immediately. The location of the ablation catheter in the non-coronary aortic cusp was confirmed by aortic root angiography (Figure 5).

Discussion

Idiopathic ventricular tachycardias arising from the non-coronary aortic cusp are rare, constituting only approximately 2% of aortic root ventricular arrhythmias. Moreover, a variant of idiopathic ventricular tachycardia originating from myocardial extensions into the non-coronary cusp has only been recently described for the first time. In this report, we describe a case of such a rare variant. The fact that the unipolar electrogram revealed an initial far-field component at the site of earliest activation in the RVOT, led us to search for an alternative site in the aortic cusps. Had we not utilized the information from the unipolar electrograms (Figures 2 and 3), we would have located the earliest activation in the RVOT, based on bipolar electrograms, which preceded the QRS by 50 ms during PVCs, and would otherwise be considered a good target. Multiple RF applications would have been delivered to the RVOT area without success. Nonetheless, unipolar electrograms indicated that this site could not be the site of origin because the initial component was far-field. Another interesting finding in our patient is that of an early sharp potential preceding the onset of QRS during the PVCs. The same potential was seen late after the QRS during sinus rhythm at the site of the successful ablation. This potential likely represents the depolarization of a myocardial connection between the non-coronary aortic cusp and the left ventricle and is the equivalent of an
Figure 2: Intracardiac electrograms at the site of earliest activation (60 ms before the onset of QRS) in the right ventricle based on bipolar recording. Of note, multiple sites at the right ventricular outflow tract (RVOT) showed similar “early” timing. The unipolar electrograms indicate that the local activation timing, represented by the sharpest slope during the local ventricular activation complex, was 15–20 ms after the onset of the bipolar electrogram, indicating that the first 15–20 ms of the local ventricular activation timing was far field. MAPD: the distal pair electrodes of the mapping catheter. Uni-D and Uni-P: the distal and proximal electrode of MAPD. RVOT: Lasso catheter positioned at the RVOT.

Figure 3: CARTO map based on bipolar electrograms (a) and unipolar electrograms (b).
accessory atrioventricular pathway potential. Similar potentials originating from ectopic myocardial tissue connecting the pulmonary artery to the right ventricle have been previously described. The origin of the muscular connections between the outflow tracts or the aortic cusps and the ventricles is postulated to result from abnormal embryonic development, where the myocardium surrounding the distal outflow tracts or the aortic cusps during the early stages of embryonic development fails to disappear completely, giving rise to an ectopic myocardial tissue. This remnant of myocardial tissue may provide the substrate for outflow tract ventricular tachycardias.

The utilization of unfiltered unipolar electrogram (1–500 or 600 Hz) during mapping and ablation has been greatly underappreciated. Our case highlights the importance of using the information from the unipolar electrograms in localizing the site of earliest activation during RVOT-like PVCs or ventricular tachycardias. Even though electroanatomical mapping systems have improved our ability to more precisely identify the source of such arrhythmias, it should be emphasized that electroanatomical mapping based only on bipolar electrograms may still be deceiving. Although electrocardiographic characteristics have been proposed for localization of a ventricular tachycardia in the non-coronary aortic cusp, our case did not demonstrate these features. Therefore, it was only based on detailed mapping using the available information from both unipolar and bipolar electrograms that we were able to successfully localize and ablate this arrhythmia. Our case exemplifies the results of a previous study, which indicated that when mapping in the right ventricle reveals early ventricular activation in the His bundle region, mapping in the right and non-coronary aortic cusps should be performed before ablation to identify the origin of the arrhythmia. During cases where the initial mapping does not localize the arrhythmia in the RVOT, or when ablation in the RVOT fails to eliminate the arrhythmia, meticulous mapping of the adjacent structures, including the aortic cusps, using the information from both bipolar and unipolar electrograms, should be performed.

Figure 4: Intracardiac electrograms at the site of earliest activation (70 ms before the onset of QRS) in the non-coronary aortic cusp. (a) Arrows indicate an early sharp potential with the same timing at both the unipolar and bipolar electrograms. (b) Pace mapping showed nearly 12/12 match with V4 being slightly off. A: atrial electrogram.

Figure 5: Right anterior oblique (upper panels) and left anterior oblique (lower panels) projections showing catheter position at the site of successful ablation. An aortic root angiogram is shown on the right panels. The site of successful ablation is located in the non-coronary aortic cusp.
References


