Reasons for failed ablation for idiopathic right ventricular outflow tract-like ventricular arrhythmias

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BACKGROUND The right ventricular outflow tract (RVOT) is the most common site of origin of ventricular arrhythmias (VAs) in patients with idiopathic VAs. A left bundle branch block, inferior axis morphology arrhythmia is the hallmark of RVOT arrhythmias. VAs from other sites of origin can mimic RVOT VAs, and ablation in the RVOT typically fails for these VAs.

OBJECTIVE To analyze reasons for failed ablations of RVOT-like VAs.

METHODS Among a consecutive series of 197 patients with an RVOT-like electrocardiographic (ECG) morphology who were referred for ablation, 38 patients (13 men; age 46 ± 14 years; left ventricular ejection fraction 47% ± 14%) in whom a prior procedure failed within the RVOT underwent a second ablation procedure. ECG characteristics of the VA were compared to a consecutive series of 50 patients with RVOT VAs.

RESULTS The origin of the VA was identified in 95% of the patients. In 28 of 38 (74%) patients, the arrhythmia origin was not in the RVOT. The VA originated from intramural sites (n = 8, 21%), the pulmonary arteries (n = 7, 18%), the aortic cusps (n = 6, 16%), and the epicardium (n = 5, 13%). The origin was within the RVOT in 10 (26%) patients. In 2 (5%) patients, the origin could not be identified despite biventricular, aortic, and epicardial mapping. The VA was eliminated in 34 of 38 (89%) patients with repeat procedures. The ECG features of patients with failed RVOT-like arrhythmias were different from the characteristics of RVOT arrhythmias.

CONCLUSIONS In patients in whom ablation of a VA with an RVOT-like appearance fails, mapping of the pulmonary artery, the aortic cusps, the epicardium, the left ventricular outflow tract, and the aortic cusps will help identify the correct site of origin. The 12-lead ECG is helpful in differentiating these VAs from RVOT VAs.

KEYWORDS Mapping; Radiofrequency ablation; Idiopathic ventricular arrhythmia; Failed ablation

ABBREVIATIONS **ECG** = electrocardiographic; **MRI** = magnetic resonance imaging; **RVOT** = right ventricular outflow tract; **VA** = ventricular arrhythmia; **VT** = ventricular tachycardia

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Introduction

A left bundle branch block, inferior axis morphology is the hallmark for outflow tract ventricular arrhythmias (VAs), especially for arrhythmias originating from the right ventricular outflow tract (RVOT).[1,2] RVOT arrhythmias are the most common VAs in patients without structural heart disease. Neighboring anatomic structures can result in electrocardiographic (ECG) characteristics that may be similar to arrhythmias originating from the RVOT.[2–6] The purpose of this study was to assess the reasons for the failure of ablation of arrhythmias with a left bundle branch block, inferior axis morphology.

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Methods

Patient characteristics

This was a consecutive series of 38 patients (13 men; age 46 ± 14 years; left ventricular ejection fraction 47% ± 14%) who had undergone 1 failed procedure in which a VA with a left bundle branch block, inferior axis morphology was targeted and who were referred for another ablation procedure. The patients in this study were selected from a series of 197 consecutive patients with idiopathic left bundle branch block, inferior axis VA. Among the 38 study patients, 29 had a history of palpitations, 2 came to medical attention because of congestive heart failure, and 4 had syncope. Two patients were asymptomatic. Left ventricular function was impaired in 19 (50%) patients. Six (16%) patients had sustained ventricular tachycardia (VT), 13 (34%) had nonsustained VT, and 19 (50%) had frequent premature ventricular complexes. A control group of 50 consecutive patients with left bundle branch block, inferior axis VA was used to compare ECG characteristics of the targeted VAs (Table 1).

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Table 1 Patient characteristics

Variables	Failed RVOT VA	Control group	*P*
Patient	38	50	
Age (y)	46 ± 14	45 ± 14	.70
Sex: male	13 (34)	18 (36)	.73
PVC/nonsustained VT/sustained VT	18/14/6	38/12/0	
PVC burden (%)	25 ± 15	15 ± 13	.002
Therapy			
Beta-blockers	23 (61)	38 (76)	.12
Calcium channel blockers	15 (39)	6 (12)	.003
Angiotensin-converting enzyme inhibitors/angiotensin receptor blockers	8 (21)	6 (12)	.25
Antiarrhythmic drug therapy including amiodarone	16 (42)	8 (16)	.007
Left ventricular ejection fraction (%)	47 ± 15	56 ± 10	.001
Abnormal left ventricular ejection fraction	19 (50)	14 (28)	.035

Values are represented as mean ± SD and n (%).
PVC = premature ventricular complex; RVOT = right ventricular outflow tract; VA = ventricular arrhythmia; VT = ventricular tachycardia.

Patients had echocardiographies and cardiac magnetic resonance imaging (MRI) to assess for the presence of structural heart disease.

Electrophysiologic study and mapping

After informed consent was obtained, several multipolar electrode catheters were introduced into the right ventricle, the right atrium and the His position. Programmed right ventricular stimulation was performed with up to 4 extrastimuli to assess for inducible VT. Programmed stimulation was repeated during the infusion of isoproterenol at 2–20 μg/min. The intracardiac electrograms were filtered at 50–500 Hz. The intracardiac electrograms and leads V_1, I, II, and III were displayed on an oscilloscope and displayed at a speed of 100 mm/s. The recordings were stored on an optical disc (EPMed Systems, West Berlin, NJ). An electroanatomical mapping system (CARTO, Biosense Webster, Diamond Bar, CA) was used to guide mapping. Activation mapping was performed during ventricular ectopy or VT. In the setting of infrequent ventricular ectopy, pace mapping was used to identify the site of origin. At the site of origin of a particular arrhythmia, pace mapping was performed and a matching pace map was defined as ≥10/12 matching leads compared to the targeted VA (Figures 1 and 2). Mapping was always started in the RVOT. At the earliest site of activation mapping, pace mapping was performed. This was followed by mapping of the pulmonary artery, the coronary venous system (Figure 2), the aortic cusps (Figure 1), and the left ventricular outflow tract. An intramural focus was considered if mapping on either wall of the ventricular cavity showed early activation yet the pace mapping did not

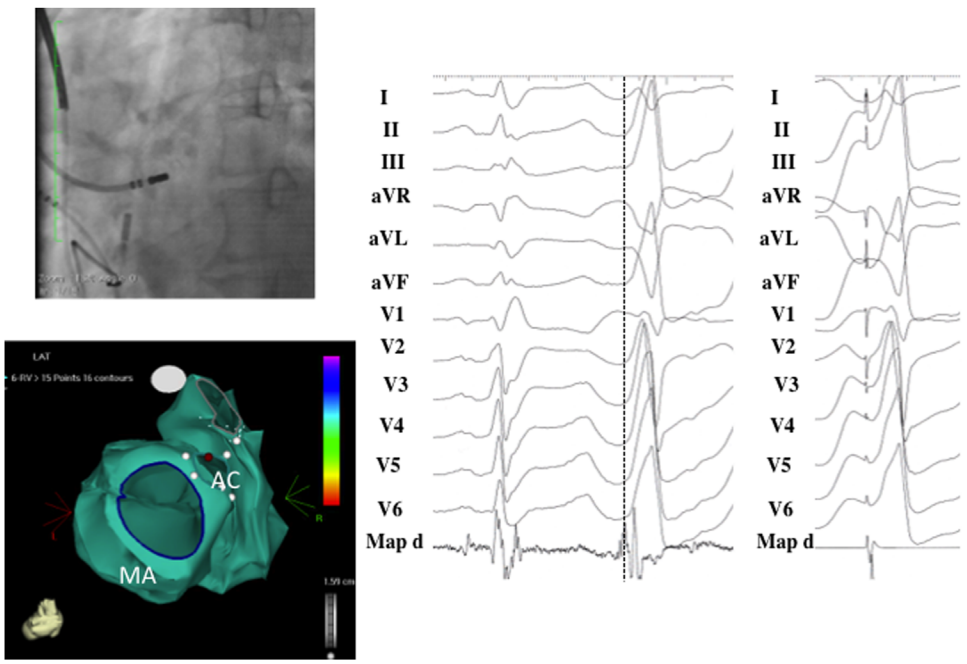

Figure 1 A premature ventricular complex (PVC) originating from the left coronary cusp. Top left insert shows the position of the mapping catheter in the left anterior oblique view within the left cusp. The insert below illustrates the 3-dimensional map of the echocardiographic contours of both right and left ventricles seen from a posterolateral view. Shown is the mitral annulus (MA) and the aortic cusps (AC). The brown tag indicates the successful ablation site within the left aortic cusp. To the right is the 12-lead electrocardiographic morphology of the targeted PVC and the intracardiac tracings of the activation map, indicating an activation time of −27 ms. The pace map on the right shows a match with the targeted PVC.

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