Ablation of ventricular arrhythmias arising near the anterior epicardial veins from the left sinus of Valsalva region: ECG features, anatomic distance, and outcome

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BACKGROUND Left ventricular outflow tract tachycardia/premature depolarizations (VT/VPDs) arising near the anterior epicardial veins may be difficult to eliminate through the coronary venous system.

OBJECTIVE To describe the characteristics of an alternative successful ablation strategy targeting the left sinus of Valsalva (LSV) and/or the adjacent left ventricular (LV) endocardium.

METHODS Of 276 patients undergoing mapping/ablation for outflow tract VT/VPDs, 16 consecutive patients (8 men; mean age 52 ± 17 years) had an ablation attempt from the LSV and/or the adjacent LV endocardium for VT/VPDs mapped marginally closer to the distal great cardiac vein (GCV) or anterior interventricular vein (AIV).

RESULTS Successful ablation was achieved in 9 of the 16 patients (56%) targeting the LSV (5 patients), adjacent LV endocardium (2 patients), or both (2 patients). The R-wave amplitude ratio in lead III/II and the Q-wave amplitude ratio in aVL/aVR were smaller in the successful group (1.05 ± 0.13 vs 1.34 ± 0.37 and 1.24 ± 0.42 vs 2.15 ± 1.05, respectively; $P = .043$ for both). The anatomical distance from the earliest GCV/AIV site to the closest point in the LSV region was shorter for the successful group (11.0 ± 6.5 mm vs 20.4 ± 12.1 mm; $P = .048$). A Q-wave ratio of <1.45 in aVL/aVR and an anatomical distance of <13.5 mm had sensitivity and specificity of 89%, 75% and 78%, 64%, respectively, for the identification of successful ablation.

CONCLUSIONS VT/VPDs originating near the GCV/AIV can be ablated from the LSV/adjacent LV endocardium. A Q-wave ratio of <1.45 in aVL/aVR and a close anatomical distance of <13.5 mm help identify appropriate candidates.

KEYWORDS Ventricular tachycardia ablation; Left sinus of Valsalva; Coronary venous system; Left ventricular outflow tract

ABBREVIATIONS **AIV** = anterior interventricular vein; **AMC** = aortomitral continuity; **ECG** = electrocardiographic; **GCV** = great cardiac vein; **ICE** = intracardiac echocardiography; **LSV** = left sinus of Valsalva; **LV** = left ventricle/left ventricular; **LVOT** = left ventricular outflow tract; **MDI** = maximum deflection index; **RF** = radiofrequency; **RSV** = right sinus of Valsalva; **RVOT** = right ventricular outflow tract; **VPD** = ventricular premature depolarization; **VT** = ventricular tachycardia

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Introduction

Idiopathic ventricular arrhythmias including ventricular tachycardia (VT) and frequent ventricular premature depolarizations (VPDs) commonly arise from the outflow tract region in both ventricles. An ablation procedure may be warranted to eliminate symptoms or for suspected VPD-induced cardiomyopathy.[1]

The most common site of the origin of outflow tract VT/VPDs is the right ventricular outflow tract (RVOT) endocardium, but in some cases, they may arise from the epicardium of the left ventricle (LV) in a region known as the LV summit.[2,3] When the site of origin is near the great cardiac vein (GCV) or anterior interventricular vein (AIV), radiofrequency (RF) energy can be delivered directly in veins[3–5] or to adjacent epicardial sites via a percutaneous pericardial puncture.[3,6] However, an ablation approach through the coronary venous system may be limited owing

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to difficulty in passing the ablation catheter to the site of interest, inability to achieve adequate power because of impedance/temperature rise, and proximity to coronary arteries. Limitations with the direct epicardial approach include the risks associated with epicardial access, catheter stability, proximity to coronary vessels, and presence of dense fat. Furthermore, this LV summit area can be difficult to map completely and recordings from GCV/AIV, although early, may reflect activation from an adjacent source. Because of these limitations and concerns, adjacent sites including the left sinus of Valsalva (LSV) or LV endocardium (immediately below the aortic valve) have been suggested as alternative sites of ablation.[7]

The objectives of this study were to define the ventricular arrhythmia electrophysiologic and electrocardiographic (ECG) characteristics and to determine the anatomic distance between the LSV region and the GCV/AIV when successful elimination occurs from the LSV region despite evidence suggesting a modestly earlier or equivalent activation time from the distal GCV/AIV.

Methods

Study population

Between January 2007 and March 2011, 306 outflow tract ablation procedures were performed at our center in 276 consecutive patients (including 23 epicardial approaches). Of these, 16 consecutive patients (8 men; mean age 52 ± 17 years) with the site of origin and/or exit site of the ventricular arrhythmia mapped to the distal GCV/proximal AIV as indexed by both the earliest or equally early activation time and the best pace-map match from the veins underwent an ablation attempt of 17 different VPDs or VT from the LSV and/or the endocardium immediately below and adjacent (within 10 mm) to the aortic valve. This strategy was deployed for 3 reasons: (1) proximity of the venous ablation site to the left coronary artery (<10 mm); (2) desire to avoid the potential risks of the transvenous and/or the direct transcutaneous epicardial approach and/or energy delivery; (3) the potential for higher power delivery from the LSV region and the adjacent LV endocardium compared with that from the venous system.

In cases where the LSV and/or LV endocardium ablation approach was unsuccessful and a safe distance (>10 mm) was confirmed by coronary angiography and/or intracardiac echocardiography (ICE) from the selected ablation site to the left coronary artery, a transvenous or epicardial approach was attempted (Figure 1).

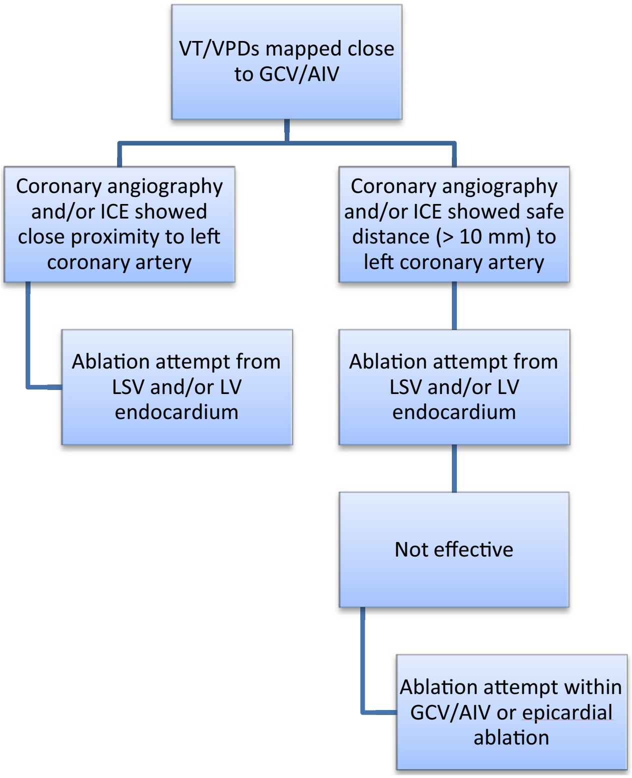

Figure 1 Branch diagram displaying ablation strategy. GCV/AIV = great cardiac/anterior interventricular vein; ICE = intracardiac echocardiography; LSV = left sinus of Valsalva; LV = left ventricle.

Electrophysiology study and ablation

Antiarrhythmic drugs were withheld prior to the procedure, except for amiodarone in 2 patients. All patients signed a written informed consent according to institutional guidelines of the University of Pennsylvania Health System. Catheters were placed into the heart under fluoroscopy through the femoral vessels accessed with the modified Seldinger technique. In selected patients, epicardial access was obtained, if needed, by using the transthoracic subxyphoid puncture approach, as previously described.[6]

Mapping and ablation was performed routinely by using a 3.5-mm open-irrigated-tip catheter (ThermoCool, Biosense Webster, Diamond Bar, CA) after the initial clinical experience with a 4-mm non–irrigated-tip catheter (Navistar, Biosense Webster) demonstrated limited energy delivery in certain areas. A smaller (4-F or 6-F) multielectrode catheter was used to map the GCV/AIV if the ablation catheter could not be advanced sufficiently. During mapping in the LV or aortic sinuses of Valsalva, intravenous heparin was used to achieve an activated clotting time of ≥250 seconds. ICE (AcuNav, Siemens, Medical, Mountain View, CA) was used in all procedures to visualize the position of the mapping catheter in the cusp region and, whenever possible, estimate the distance from the ostium of the left main coronary artery. ICE was also used to evaluate the aortic valve, monitor lesion formation, and assess for the detection of complications such as pericardial effusion.[8]

The activation time was measured from the onset of the bipolar electrogram (earliest positive or negative deflection) of the distal bipole of the mapping catheter to the earliest onset of the QRS complex in any of the 12 ECG leads. Activation times and pace-map match were measured/judged visually by 2 independent observers, with each of the 12 ECG leads assessed for the QRS vector and major notching or deflections from baseline for the pace-map assessment.