Catheter Ablation of Idiopathic Ventricular Tachycardia

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Idiopathic ventricular arrhythmias can originate from either the endocardial, midmyocardial, or epicardial regions of the heart. The outflow tracts and basal regions of the ventricle tend to be common locations of origin of these tachycardias. The anatomy of this region of the heart is both fascinating and, at times, challenging from a procedural standpoint. The orientation of the outflow tracts and basal regions allows mapping of ventricular tachycardias (VTs) using multiple anatomic approaches, such as through the coronary vasculature, directly through a percutaneous pericardial approach (transverse sinus), and through the atrial appendages. The intricate relationship of the outflow and basal regions of the ventricles to the coronary vasculature (arteries and veins) provides useful avenues for epicardial mapping and catheter ablation (Figure). Coronary veins provide endovascular access to the epicardial regions of the ventricles, especially the crucial area between the junction of the great cardiac vein and the anterior interventricular vein (Figure).

Coronary sinus venography was first described in the 1960s. Using occlusive venography, the middle cardiac vein, the great cardiac vein (GCV), and the anterior interventricular vein (AIV) usually can be visualized. The GCV, which runs in the posterior interventricular septum, and the AIV, which runs parallel to the left anterior descending coronary artery, allow epicardial access to the anterior basal ventricular surface. Coronary venous mapping has been an attractive option to identify epicardial circuits in structural heart disease ever since surgical studies demonstrated that about 20% of VTs related to posterior and inferior myocardial infarctions had a critical reentrant circuit in the epicardium. In patients with anterior myocardial infarction, access through the GCV and AIV allows mapping of late diastolic potentials over a wide area of the anterior wall without having to access the epicardium percutaneously. Coronary sinus and venous mapping were described by Arruda et al in 1996, and radiofrequency ablation of idiopathic ventricular tachycardia through this approach was described by Stellbrink et al in 1997.

The alternative (complementary) approach—percutaneous epicardial access—has certain limitations, especially pericardial bleeding and tamponade. Another limitation is the presence of epicardial fat that can mimic areas of scar due to the registration of low voltage, can introduce an error in the delineation of scar, and may limit lesion formation if the epicardial fat lies between the ablation catheter and the targeted area. With the use of coronary venous mapping, these limitations can be avoided.

Idiopathic VTs and ventricular ectopy originate from the basal aspect of the ventricles, which include the left ventricular outflow tract, right ventricular outflow tract (RVOT), pulmonary artery, aortic cusps, aortomitral continuity, and mitral annulus. Recently, ECG analysis of the location of the tachycardia, particularly outflow tachycardias with transition in V3, and their ablation have been subject of extensive study. In general, outflow tract tachycardias inscribe a sharp negative QRS complex in leads aVL and aVR, with tall monophasic R waves in the inferior leads. RVOT sites tend to have a left bundle branch block pattern in V1. RVOT tachycardias that are immediately anterior to the aorta have a precordial transition in V3 or later, whereas free wall sites have a transition at V4 or later. Medial LV basal sites have a narrower QRS than lateral sites with initial negative forces in lead V1 and predominantly positive forces in lead I. Left ventricular outflow tract tachycardias frequently have a right bundle branch block morphology or early transition in the preordial leads. The right aortic cusp sites show a predominantly negative vector in lead V1 with a late transition and small broad R wave in V2, whereas left cusp sites can show an M or a W configuration in V1 with early transition <V2.

The Present Study

In this issue of Circulation: Arrhythmia and Electrophysiology, Babam et al demonstrate that the transvenous approach is indeed safe and can be successful in 70% of idiopathic VTs when the earliest site of activation is in the coronary venous system. Of note, this success rate is similar to the transcutaneous epicardial approach. Further, 14% of idiopathic VTs (27 of 180 patients with idiopathic premature ventricular contractions or VTs) were found to have their earliest site of activation epicardially. Epicardial arrhythmias in the proximal GCV had left bundle branch block, whereas those in the distal GCV had right bundle branch block. The majority of these VTs (16 of 27), however, were of left bundle branch block morphology and inferior axis, similar to aortic cusp and RVOT VTs, but could be distinguished from the latter due to their wide R wave of >75 milliseconds in V1. This finding is in line with previous ECG criteria of epicardial VT and premature ventricular contractions, which have shown that these arrhythmias have a pseudodelta wave and a wider QRS given the greater distance from the epicardial sites of origin to
the His-Purkinje system. This study highlights several other important points. First, mapping and ablation within the GCV may be as successful as percutaneous epicardial ablation and can be carried out using open-irrigated ablation catheters. The success rate in this study was 74%. However, it should be noted that mapping through the coronary veins limits epicardial sampling because one is limited to areas of the myocardium that are subtended by a coronary vein. Therefore, percutaneous epicardial mapping should definitely be offered to patients who fail transvenous mapping and ablation. Second, coronary arterial anatomy needs to be defined. Surprisingly, proximity to a coronary artery leading to failure of ablation was seen in only one patient, although clearly, coronary angiography should be done routinely in every patient before ablation within the coronary venous system is attempted (see Figure). Third, as expected, sites of origin in the more distal GCV are more difficult to reach with standard ablation catheters and, hence, carry a lower success rate. Finally, regardless of the ECG pattern (left or right bundle branch block), mapping in the GCV can be useful if initial mapping in the RVOT or left ventricular outflow tract, respectively, does not yield the earliest site of origin. Of note, certain idiopathic tachycardias do not have a clear right or left bundle branch block morphology (equal R and S in V1) and, therefore, may not follow a predetermined road map and require more detailed and extensive mapping.

Implications
This study adds to the literature supporting the efficacy of ablation through the coronary veins.12 Idiopathic VTs can be approached by stepwise mapping of the outflow tracts, aortic sinuses, coronary arteries, and veins. Ablation can be performed safely from within the coronary venous system. Percutaneous epicardial mapping and ablation should be considered when coronary venous ablation fails. Both approaches need to take into account the proximity of coronary arteries, necessitating performance of coronary angiography pre- and postablation and assessment of phrenic nerve capture testing prior to ablation. Epicardial techniques, such as balloon protection, can be effective in protecting the phrenic nerve.13–15 However, coronary artery injury is an ever-present risk (especially near the proximal part of the AIV) (Figure), and surgery is still necessary in some cases for VTs originating in this region.16 Cryoablation and potential experimental approaches such as cold saline irrigation are likely to aid these approaches to catheter ablation.12,17,18

Support
Dr Shivkumar is supported by National Heart, Lung, and Blood Institute grant R01HL084261. The University of California, Los Angeles, has intellectual property relating to epicardial mapping and ablation.

Disclosures
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References

KEY WORDS: ablation ■ editorial