Ventricular Tachycardia Originating from Unusual Sites

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KEYWORDS

• Ventricular tachycardia • Ablation • Electrocardiography • Electrogram • Papillary muscle

KEY POINTS

- Recognition of typical electrocardiogram patterns and careful mapping are critical for localizing ventricular arrhythmia (VAs) of unusual origin.
- VAs from the right parahisian region can be differentiated from typical right ventricle outflow tract VAs by more positive R wave in lead I and flat or w pattern in lead aVL.
- Right ventricular moderator band VAs are rare and have a left bundle branch block (LBBB) pattern with late precordial transition (>V5).
- Left ventricular posterior papillary muscle premature ventricular complexes (PVCs) have a right bundle branch (RBB)/left axis that can be differentiated from posterior fascicular PVCs by a qR pattern in lead V1 and wider QRS.
- Mitral annular PVCs have a RBB pattern with positive precordial concordance.
- VAs from the great cardiac vein/anterior interventricular vein have LBBB/inferior axes with early precordial transition (by V2) and QS patterns in lead I.
- VAs from the basal cardiac crux have left bundle branch/superior axes with delayed intrinsicoid deflection.

INTRODUCTION

Ventricular arrhythmias (VAs) in the absence of structural heart disease (idiopathic) can present as premature ventricular contractions (PVCs) or sustained ventricular tachycardia (VT) and account for approximately 10% of patients with VAs. Although most of these arrhythmias originate from the right ventricular outflow tract (RVOT) or left ventricular outflow tract (LVOT), VT can also arise from other locations.[1,2] Distinct electrocardiographic and electrophysiologic features can help localize these arrhythmias. In the appropriate patients, radiofrequency (RF) catheter ablation is an effective treatment of patients with idiopathic VT.[3,4] This article discusses the electrocardiographic features of the more unusual origins of idiopathic VT. In addition, it discusses some electrophysiologic parameters and catheter-based ablation techniques used in the treatment of these arrhythmias.

RIGHT VENTRICLE

Tricuspid Annulus

The tricuspid annular region includes arrhythmias with origins from the parahisian region, midseptum, inferior tricuspid annulus, and the annular free wall. In a study of 454 consecutive patients with symptomatic VAs who underwent RF catheter

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ablation, Tada and colleagues[5] identified 38 patients (8%) with VAs originating from the tricuspid annulus. In 74% of patients VAs arose from the septal portion of the annulus, and in 26% VAs arose from the free-wall portion of the annulus. Of those that originated from the septal portion of the annulus, nearly three-quarters originated from the anteroseptum, above the His bundle, and the remaining from the midseptum or posteroseptum. The mean QRS duration was 149 ± 20 milliseconds. All VAs originating from the tricuspid annulus showed a left bundle branch morphology (QS in V1 for anteroseptal and rS for anterior and posterolateral origins). Because the tricuspid annulus is positioned inferiorly and posteriorly to the RVOT (Fig. 1), the QRS axis is typically leftward and less inferiorly or superiorly directed. The precordial lead transition depends on the site of origin, with free-wall VT/PVCs all having a later transition to R>S (typically >V3); however, this was also noted in about 50% of septal VT/PVCs. In addition, VT/PVCs originating from the free wall were more likely to have QRS notching (78% vs 11%) and a longer QRS duration (167 vs 143 milliseconds). When VAs originated from the annular septum, both ventricles were activated simultaneously, resulting in a shorter QRS duration and absence of QRS notching, whereas late activation of the left ventricular free wall accounted for the notching in free-wall VTs.

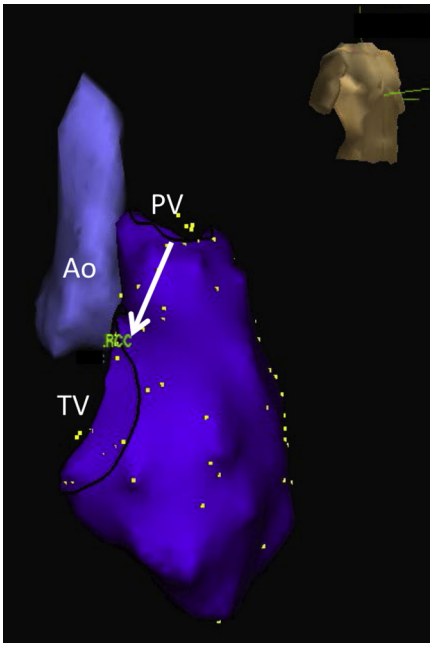

Fig. 1. Electroanatomic map of the right ventricle and aortic root in the right anterior oblique (RAO) projection. Note that the tricuspid annulus is inferior and posterior to the RVOT, which explains why PVCs/VT originating from the tricuspid annulus are less inferiorly directed and more positive in lead I compared with typical RVOT PVCs. Ao, aorta; PV, pulmonic valve; RCC, right coronary cusp; TV, tricuspid valve.

Parahisian VAs are commonly encountered and warrant special consideration. Yamauchi and colleagues[6] evaluated the electrocardiogram (ECG) characteristics of VAs originating from the His bundle in 10 patients and compared these ECG characteristics with 81 patients with RVOT VAs.

There were several ECG characteristics that could be used to differentiate VAs that originate from the His bundle from the RVOT (Fig. 2). Patterns that favored a His bundle origin over the RVOT included a QS pattern in lead V1 (80% vs 17%), an early precordial transition by V2/V3 (80% vs 22%), and the presence of an R wave in lead aVL (60% vs 9%). In our experience, when an RSR′ (w) pattern is present in lead aVL in an inferiorly directed LBBB morphology VA, it is a valuable ECG finding suggesting a parahisian origin.[7] In addition, a significantly narrower QRS complex (113 vs 131 milliseconds) and a lower R-wave voltage ratio index (lead III/II) favored the His bundle group (65% vs 97%), meaning that lead III<II was typically present in His the bundle group. Furthermore, significantly taller R-wave amplitudes in leads V5 (2.10 vs 1.37 mV) and V6 (2.08 vs 1.36 mV) were seen the His bundle group compared with the RVOT group. The His bundle is located more inferiorly and posteriorly to the RVOT, explaining the taller, monophasic R wave in lead I, flat or w-pattern in aVL, and lower QRS amplitude in lead III. Parahisian VAs also depolarize the His-Purkinje system resulting in a shorter QRS duration and taller QRS complexes in V5 and V6.

The His bundle region is also in close proximity to the right and noncoronary aortic cusps, and thus can show similar electrocardiographic features to aortic cusp VAs.[8,9] In a study of 13 patients, Yamada and colleagues[8] identified 7 patients with ventricular arrhythmias originating from the His bundle and compared these features with those originating from the right and noncoronary cusps (6 patients). A later precordial transition (V4 vs V2) was specific for distinguishing VAs from the His bundle region from the aortic sinus cusps, but the sensitivity was low because of significant overlap among the groups. Both sites show R waves in lead I, but a QS in lead aVL was more commonly seen with VAs originating from the aortic sinus cusps.

During mapping of parahisian VAs, the presence of a QS pattern on the unipolar recording at the ablation site can be helpful to identify local activation; mapping of the aortic right and noncoronary cusps and left parahisian sites is recommended to identify the earliest site of activation.[8]