Unusual Outflow Tract Ventricular Tachycardia

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KEYWORDS

• Ventricular tachycardia • Outflow tract • Ventricular arrhythmia • Heart

KEY POINTS

- Distinguishing premature ventricular contractions/ventricular tachycardia from the right ventricular outflow tract (RVOT) versus the left ventricular outflow tract (LVOT) can be difficult by electrocardiogram (ECG) findings alone, particularly when the origin is above the aortic valve, because of their close anatomic relationships.
- When the ECG shows a left bundle branch block morphology with an inferior axis and an R-wave transition at or later than V3 to V4, mapping first in the RVOT is reasonable.
- When ablation in the RVOT is unsuccessful despite early activation signals, mapping of the LVOT in the aortic cusps should be considered.
- A thorough understanding of the outflow tract anatomy as well as a systematic and meticulous approach to mapping of the ventricular outflow regions and great vessels increases the success rate and decreases the risk of damage to adjacent structures and the conduction system.
- The use of multimodality imaging, particularly real-time intracardiac echocardiographic guidance, is essential for defining anatomy, ensuring adequate catheter contact, and minimizing risks.

INTRODUCTION

The right ventricular outflow tract (RVOT) and left ventricular outflow tract (LVOT) are the most common sites of origin for ventricular arrhythmias in structurally normal hearts. These arrhythmias often arise from endocardial sites in the ventricles and can be successfully treated with radiofrequency catheter ablation.[1] They are generally focal with automatic/triggered activity and not related to scar-based reentry mechanisms.[2] However, ventricular outflow tract arrhythmias can arise from adjacent structures such as the proximal pulmonary artery and coronary cusps. It is important to understand the relationship between the relevant cardiac structures in this area for successful mapping and ablation. This article discusses unusual outflow tract ventricular tachycardias (VTs) using a clinical case presentation to highlight the key anatomic features as well as mapping and ablation techniques for this region.

ANATOMY OF THE OUTFLOW TRACTS

In a structurally normal heart, the RVOT and LVOT cross over each other with the RVOT located anteriorly and leftward relative to the aortic root and ventricular septum, whereas the LVOT is posterior and rightward. The RVOT wraps anteriorly around the aortic root and is in close proximity to the right coronary cusp (RCC) (**Fig. 1**). The pulmonary valve is anterior and superior to the aortic valve with a 90° orientation to the aortic valve in the horizontal plane (see **Fig. 1**). The pulmonary trunk is adjacent to the left coronary cusp (LCC). The noncoronary cusp (NCC) is located over the anterior atrial

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Card Electrophysiol Clin 8 (2016) 79–88
http://dx.doi.org/10.1016/j.ccep.2015.10.032

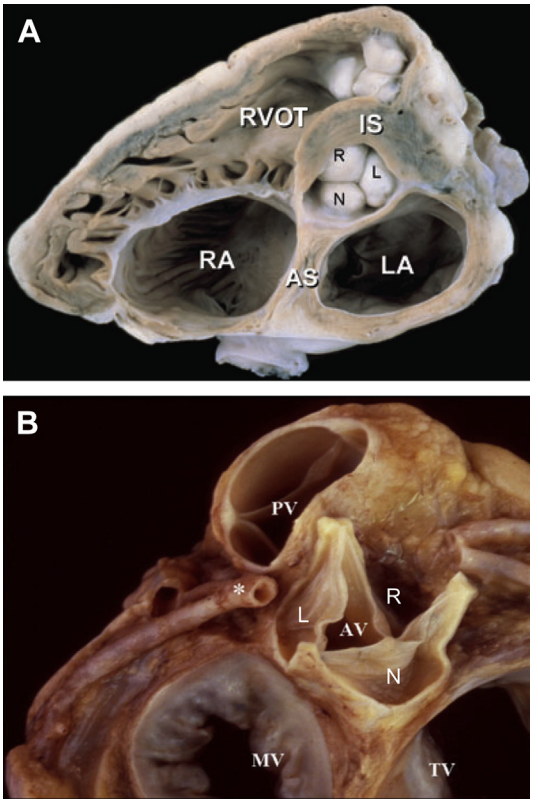

Fig. 1. Anatomic specimens demonstrating the outflow tract anatomy. (*A*) Cross section at the base of the heart showing the relationship of the aortic cusps to the atria and right ventricular outflow tract (RVOT). The RVOT wraps anteriorly around the aortic root with the right coronary cusp (R) adjacent to the thick interventricular septum (IS) in the posterior RVOT. The left coronary cusp (L) lies adjacent to the left atrium (LA) and the proximal pulmonary trunk. The noncoronary cusp (N) lies adjacent to the interatrial septum (AS) and the LA and right atria (LA). (*B*) The pulmonary valve (PV) is anterior and approximately 1-2 cm superior to the aortic valve (AV) with a 90° orientation in the horizontal plane. The posterior PV cusp is adjacent to the left main coronary artery in the epicardial space (*asterisk*) and the L cusp. The N cusp is the most inferior and posterior of all three cusps with its position adjacent to the AS. MV, mitral valve; TV, tricuspid valve. ([*A*] *From* Madhavan M, Asirvatham SJ. What are we ablating above the semilunar valves? Insights from electrical navigation. J Cardiovasc Electrophysiol 2011;22:530–33, with permission and [*B, C*] *From* Gami AS, Noheria A, Lachman N, et al. Anatomical correlates relevant to ablation above the semilunar valves for the cardiac electrophysiologist: a study of 603 hearts. J Interv Card Electrophysiol 2011;30:5–15; with permission).

septum in continuity with the anterior leaflet of the mitral valve (MV) (Fig. 2). The His bundle is a right atrial structure that goes across to the left ventricle (LV) via the membranous septum just under RCC-NCC commissure.

The superior RVOT is considered an epicardial structure because it is located above the LV with the pulmonary valve cusps adjacent to the epicardial coronary vasculature within the LV summit (see Fig. 1B). The pulmonary trunk is a completely infundibular muscular structure. The muscular fibers can extend into the interleaflet triangles and even above the sinotubular junction of the pulmonary valve along the entire circumference of the pulmonary trunk[3] (Fig. 3).

The LVOT is located posteriorly and rightward to the RVOT with the RCC positioned above the ventricular septum. Unlike the RVOT, the LVOT only has ventricular muscular extensions into the aortic valves under the RCC and LCC[3,4] (see Fig. 2). The NCC usually does not have any muscular connections because it has fibrous connections to the anterior leaflet of the MV and the membranous septum.

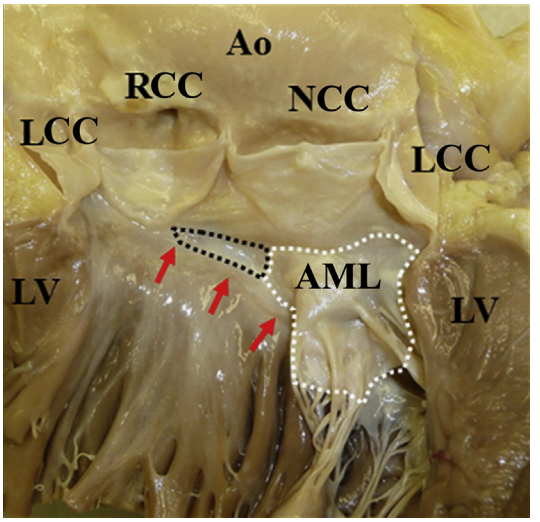

Fig. 2. Heart specimen demonstrating anatomy of the non-coronary cusp (NCC) which is in fibrous continuity with the anterior mitral valve leaflet (AML, *white dotted circle*) and the membranous septum (*black dotted circle*) which sits beneath the NCC-right coronary cusp (RCC) commissure. Therefore, the NCC is usually separated from the left ventricular (LV) myocardium by fibrous tissue (*red arrows*). (*From* Yamada T, Lau YR, Litovsky SH, et al. Prevalence and clinical, electrocardiographic, and electrophysiologic characteristics of ventricular arrhythmias originating from the noncoronary sinus of Valsalva. Heart Rhythm 2013;10:1605–12; with permission.)