HANDS ON

Ablation above the semilunar valves: When, why, and how? Part II

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In this two-part series on arrhythmias occurring above the semilunar valve, we discuss the relevant underlying anatomy and the technique for mapping and ablation above the aortic and pulmonic valve. In part I, we focused on ventricular arrhythmias, and in this paper (part II), we discuss the anatomy and present knowledge of the substrate mapped and ablated above the aortic valve for atrial tachycardia in certain unusual accessory pathways. The background anatomy of the aortic valve has been discussed in part I of this series, to which the reader is referred. Here we discuss the detailed anatomy of the aortic cusps relevant for atrial tachycardia and atrioventricular bypass tracts. Representative cases of these supravalvar arrhythmias are presented, and an approach for safe and effective ablation above the aortic valve to eliminate atrial tachycardia and bypass tracts in this location is then outlined.

Atrial tachycardia ablated above the aortic valve

The aortic valve is related anatomically to atrial tissue at specific sites. The noncoronary cusp (NCC) is immediately adjacent to the interatrial septum, whereas the right atrial appendage and the superior vena cava (SVC)/right atrial junction may overlie portions of the right coronary cusp (RCC). The most likely site for ablating atrial tachycardias above the aortic valve is in the NCC, and understanding the exact anatomy of this cusp is important when approaching supravalvar atrial tachycardia ablation. The NCC is the most posterior of the three aortic cusps. The most anterior portion of this cusp is the commissure with the RCC. As noted, this is the location of the membranous septum at which the His bundle is located. Thus, mapping or ablation in the NCC is unlikely to record a His bundle electrogram or ablate this structure. However, as the fast pathway and anteroseptal atrial myocardium are posterior to the His bundle, a catheter placed in the rightward portion of the NCC will map and potentially ablate these structures. Posteriorly, as well as to the left, portions of the NCC and the anterior portion of the interatrial septum lie in close proximity. Successful mapping and ablation of supravalvar atrial tachycardias require an accurate understanding of the anatomy, interpretation of aortography, intracardiac ultrasound images, and appreciation of the nuances of normal and abnormal electrograms found in the coronary cusps to safely ablate these tachycardias without damage to the nearby conduction system.

KEYWORDS Atrial tachycardia; Anatomy; Radiofrequency ablation; Electrophysiology; Coronary arteries; Accessory pathway; WPW (Heart Rhythm 2008;5:1625–1630)

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Salient electrophysiological issues with supravalvar atrial tachycardia ablation

Electrograms in the NCC

Because of the fairly thick and immediately adjacent atrial myocardium of the atrial septum, large atrial electrograms that appear to be relatively near field (thin valve tissue) are routinely found when mapping the NCC. In patients with atrial tachycardia arising from this region, however, often fractionated (but near-field) electrograms that precede the larger atrial electrograms are found.[1,2] The possible basis for these electrograms includes atrial myocardium being found in the NCC, abnormal adjacent atrial septal myocardium, or electrograms related to the valve tissue itself. Although the exact nature of these electrograms is unknown, their recognition during mapping and understanding the need to target these electrograms are essential when ablating NCC atrial tachycardia. If, when mapping, a large ventricular electrogram or His bundle recording is found, it is likely that the catheter is in the RCC. However, variable anatomy in which the NCC is somewhat rightward of its usual location may be responsible. Conversely, large atrial electrograms may sometimes be found when mapping the RCC. On first observation, this appears counterintuitive since the RCC is displaced much more anteriorly and in relation to the right ventricular outflow tract (RVOT), and thus one would not expect an atrial electrogram. However, atrial electrograms may be found in this location because of the overlying right atrial appendage. When mapping the RCC more distally (cephalad), the medial aspect of the SVC is also immediately adjacent.[3] Thus, as a generalization, one expects to find a large atrial electrogram when the catheter is located in the NCC and little or no atrial electrograms

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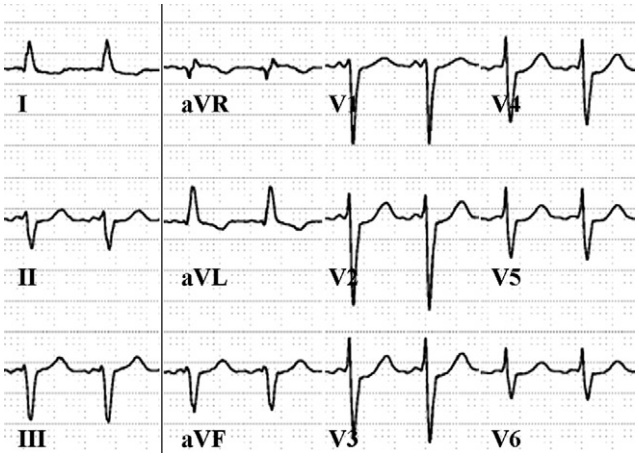

Figure 1 The 12-lead ECG of atrial tachycardia that was eventually ablated in the NCC of the aortic valve. Note the terminal positive P wave in lead V_1 and the narrow but positive/isoelectric P wave in the inferior lead. The apparently short P-R interval is sometimes noted with atrial tachycardia arising in supravalvar locations.

with large ventricular electrograms when mapping the RCC, but the electrophysiologist should be aware of the nuances resulting from variation in anatomy and the overlying adjacent structures.

Clues for atrial tachycardia origin above the valve

Since the number of cases reported in the literature is fairly few, clinically distinct features of cuspal atrial tachycardias are unknown. Both automatic tachycardia in structurally normal hearts and tachycardia associated with atrial fibrillation have been described as arising from this location. The electrocardiogram (ECG; Figure 1) typically shows fairly narrow P waves that tend to be positive in V_1 (whereas anterior tricuspid valve and right atrial appendage tachycardias are typically all negative in V_1).[4]

When mapping (Figures 2–4), relatively simultaneous activation of the His bundle, fast pathway, septal mitral annulus, and superior ostial coronary sinus regions is seen. With these anatomically disparate sites being activated at the same time, consideration of a deep myocardial focus in the anterior portion of the interatrial septum is often made. If the potential for successful ablation in the NCC is not appreciated, then either high-energy ablation on the right septum with risk of atrioventricular (AV) block or abortion of the procedure is often done. When the catheter is placed in the RCC, fractionated but near-field electrograms that precede the previously earliest but simultaneously activated areas by ≥20 ms and often ≥40 ms are seen. Ablation in the NCC as long as the catheter is positioned and directed in a straight posterior manner or leftward manner will not damage the conduction system. Ablation near the commissure with the RCC may injure the fast pathway, and thus cryoablation should be considered. Another important clue is the finding of far-field electrograms on the right interatrial septum just behind the superior portion of the tendon of Todaro that precede local activation (the near-field electrogram) by 20–40 ms. This should also alert the operator to the presence of either an NCC atrial tachycardia or a septal mitral annular tachycardia.

Left coronary cusp (LCC)/mitral annular tachycardia

Because of the aortic mitral continuity, the LCC does not usually have an immediate anatomic relation to atrial or ventricular myocardium. However, some patients have atrial tachycardia (with or without atrial fibrillation) for

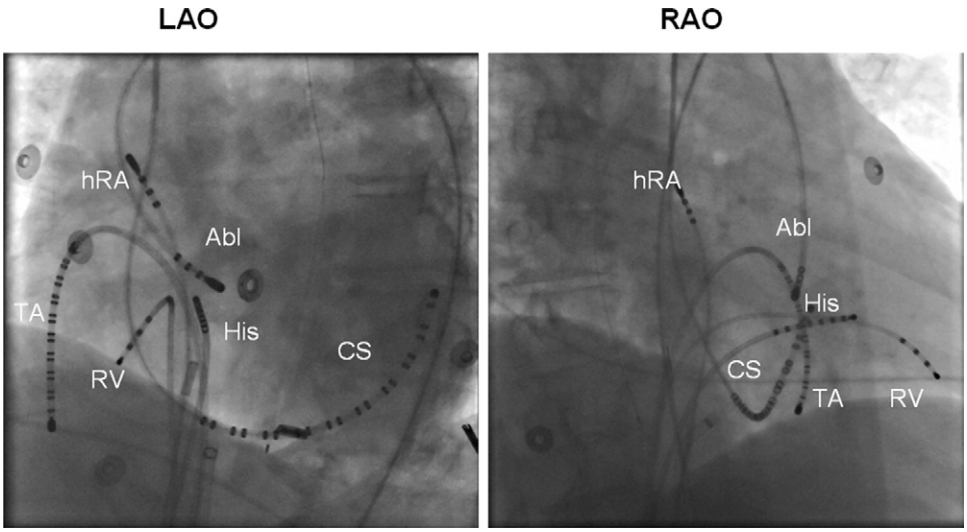

Figure 2 Fluoroscopic images (*left panel:* left anterior oblique; *right panel:* right anterior oblique) of catheter positions for ablation of the tachycardia shown in Figure 1. The ablation catheter (Abl) is shown to be leftward of the His bundle catheter in the left anterior oblique projection and is posterior (near the proximal electrodes) to the His bundle catheter in the right anterior oblique projection. This is the typical fluoroscopic location of the NCC. The electrograms obtained when mapping in such a location will typically show a large atrial electrogram with or without a fractionated component and a relatively small ventricular electrogram (see text for details). TA = tricuspid annulus; RV = right ventricle; His = His bundle recording catheter; CS = coronary sinus; hRA = high right atrial mapping catheter; Abl = ablation catheter retrograde access.