Repeat accessory pathway ablation: Challenges, surprises, and lessons learned

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Introduction

Atrioventricular (AV) reciprocating tachycardia is the second-most common supraventricular tachycardia in practice, with greater than 95% catheter ablation success rate and 1% risk of complete heart block, most commonly after ablation of septal and posteroseptal accessory pathways.[1] Mapping of the accessory pathway (AP) is utilized by the coronary sinus (CS) catheter, and difficulties may arise if there is an occluded CS. In this report we showcase using an endocardial mitral annular catheter in lieu of a CS catheter owing to occlusion and complete heart block as a result of left lateral AP ablation.

Case report

A 43-year-old man with 6 prior ablation attempts for an AP presented to clinic for intermittent palpitations. Previous ablation records were not available owing to multiple operators performing ablation in 3 different institutions prior to 15 years ago. The initial electrocardiogram (ECG) obtained in clinic revealed alternating beats with preexcitation (Figure 1A), with a similar PR interval of 160 ms between preexcited and nonpreexcited beats. The AP was believed to be left posteroseptal in location. The notched and negative preexcited ventricular complex in lead II was suggestive of an epicardial ventricular insertion and the intermittent preexcitation during sinus rhythm suggested the patient was at low risk for rapid AP conduction. Anterograde AV nodal conduction was apparently present. As such, he was asked to follow up after undergoing an event recorder to identify the etiology of his palpitations.

However, he presented to the emergency department 6 weeks later with a narrow QRS supraventricular tachycardia (SVT) at a rate of 177 beats per minute (cycle length 340 ms, Figure 1B), which was terminated by intravenous adenosine administration. After a shared decision, he was scheduled to return for an electrophysiology study and ablation.

KEY TEACHING POINTS

- Using a duodecapolar catheter placed along the endocardial mitral annulus is a feasible way for accessory pathway mapping in lieu of a coronary sinus catheter in patients with an occluded or absent coronary sinus.
- Rapid narrow QRS supraventricular tachycardia due to orthodromic reciprocating tachycardia is not a complete measure of normal atrioventricular conduction.
- Complete heart block can occur in nonseptal accessory pathway ablation.

At the onset of electrophysiology study, 3 operators could not place a catheter in the CS both from the femoral vein and from the internal jugular vein; thus a duodecapolar catheter was placed along mitral annulus (MA) after transseptal puncture (Figure 2).

At baseline, retrograde conduction was eccentric during ventricular pacing. Retrograde AV nodal conduction could not be determined. During atrial programmed stimulation, the shortest 1:1 AP conduction was less than 210 ms. The AP effective refractory period was less than 220 ms at the pacing cycle length of 400 ms. Anterograde AV nodal conduction and refractory properties could not be determined. Preexcited SVT was initiated by spontaneous premature atrial contractions (Figure 3A) tachycardia cycle length 468 ms). During tachycardia, the atrial activation sequence was high to low. His refractory premature ventricular beat did not advance the tachycardia and the concealed His refractory premature ventricular beat conduction blocked the anterograde AP conduction without changing the tachycardia cycle length (Figure 3A). These observations confirmed the diagnosis of atrial tachycardia (AT) and excluded antidromic reentrant tachycardia and ventricular tachycardia, and rendered AV nodal reentrant tachycardia with a bystander AP unlikely. However, this was not the patient's clinical tachycardia. Additional maneuvers were not performed owing to AT degenerating to atrial fibrillation (AF) requiring

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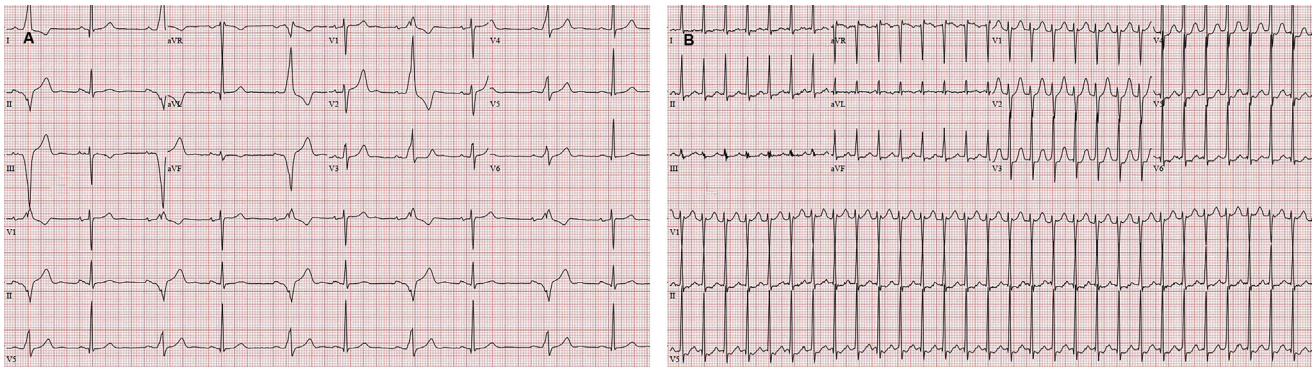

Figure 1 **A:** Electrocardiogram at baseline showing intermittent preexcitation. **B:** Clinical supraventricular tachycardia with a cycle length of 340 ms (177 beats/min).

cardioversion. The shortest preexcited R-R interval during AF was 208 ms (not shown).

To avoid further induction of AF, we proceeded to map and ablate the AP, as the patient had documented SVT consistent with an orthodromic reciprocating tachycardia (ORT). The irrigated bidirectional ThermoCool STSF (Biosense Webster, Inc. Irvine, CA) ablation catheter was placed in the left atrium via a second transseptal puncture. Ventricular pacing at a cycle length of 500 ms from RV showed an eccentric atrial activation sequence with the earliest A in the posterolateral, 4 o'clock position along the MA (Figure 2A). A nonsustained run of narrow QRS SVT was inducible during ventricular pacing. Ventricular overdrive pacing of this SVT showed a VAHV response, consistent with ORT (Figure 3B). This tachycardia was inducible only once and spontaneously terminated. Ventricular insertion of the AP was also mapped during sinus rhythm by advancing the ablation catheter into the left ventricle. The earliest ventricular activation during preexcited conduction was mapped to the posteroseptal location immediately below the MA at the 6 o'clock position (Figure 2B). In this location, the earliest local ventricular electrogram was preceding the onset of surface QRS by 0 to -5 ms (Figure 3C), suggesting the ventricular insertion of the AP was epicardial; furthermore, a pathway potential was seen. Thus, we subsequently targeted the atrial insertion site during ventricular pacing after concurrent confirmation of high-density mapping utilizing the CARTO (Biosense Webster, Inc) mapping system.

After verification of catheter stability using fluoroscopy, radiofrequency ablation was administered with a power output of 35 watts at the MA 4 o'clock position (Figure 3E) and after 8 seconds, VA block occurred and ablation was immediately turned off. Ventricular pacing was discontinued and he was noted to be in complete heart block (Figure 3D).

Further attempts of ablation were not performed owing to persistent AV block. AV conduction was restored by isoproterenol administration (0.08 mcg/kg/min), and a temporary pacemaker lead was placed at the end of the procedure. However, because of recurrent complete heart block, a permanent dual-chamber pacemaker was implanted on the second day of the procedure prior to discharge.

At 3-month follow-up, he had no further palpitations or recurrent SVT. Pacemaker interrogation revealed ventricular pacing 96% of the time. There was no AT. A 12-lead ECG showed P-synchronous pacing with occasional AV conduction without preexcitation. A venous phase-contrast cardiac computed tomography was obtained revealing an occluded CS os and reconstitution at the level of marginal vein (Supplemental Figure S1).

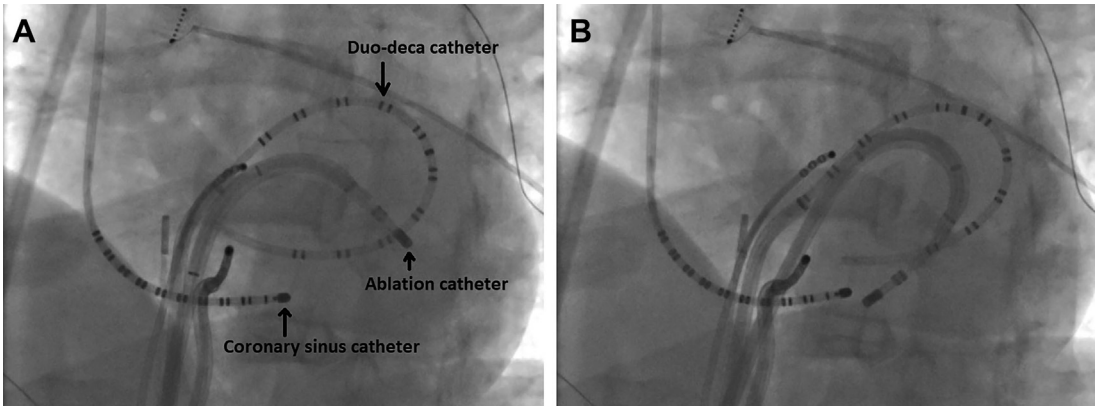

Figure 2 **A:** Left anterior oblique (LAO) view of the duodecapolar catheter placed along the mitral annulus and the earliest atrial activation during ventricular pacing at the posterolateral, 4 o'clock mitral annular position. Coronary sinus catheter tip is hooked at the os, unable to be advanced. **B:** LAO view of the earliest ventricular activation during preexcited sinus conduction at the posteroseptal, 6 o'clock mitral annular position.

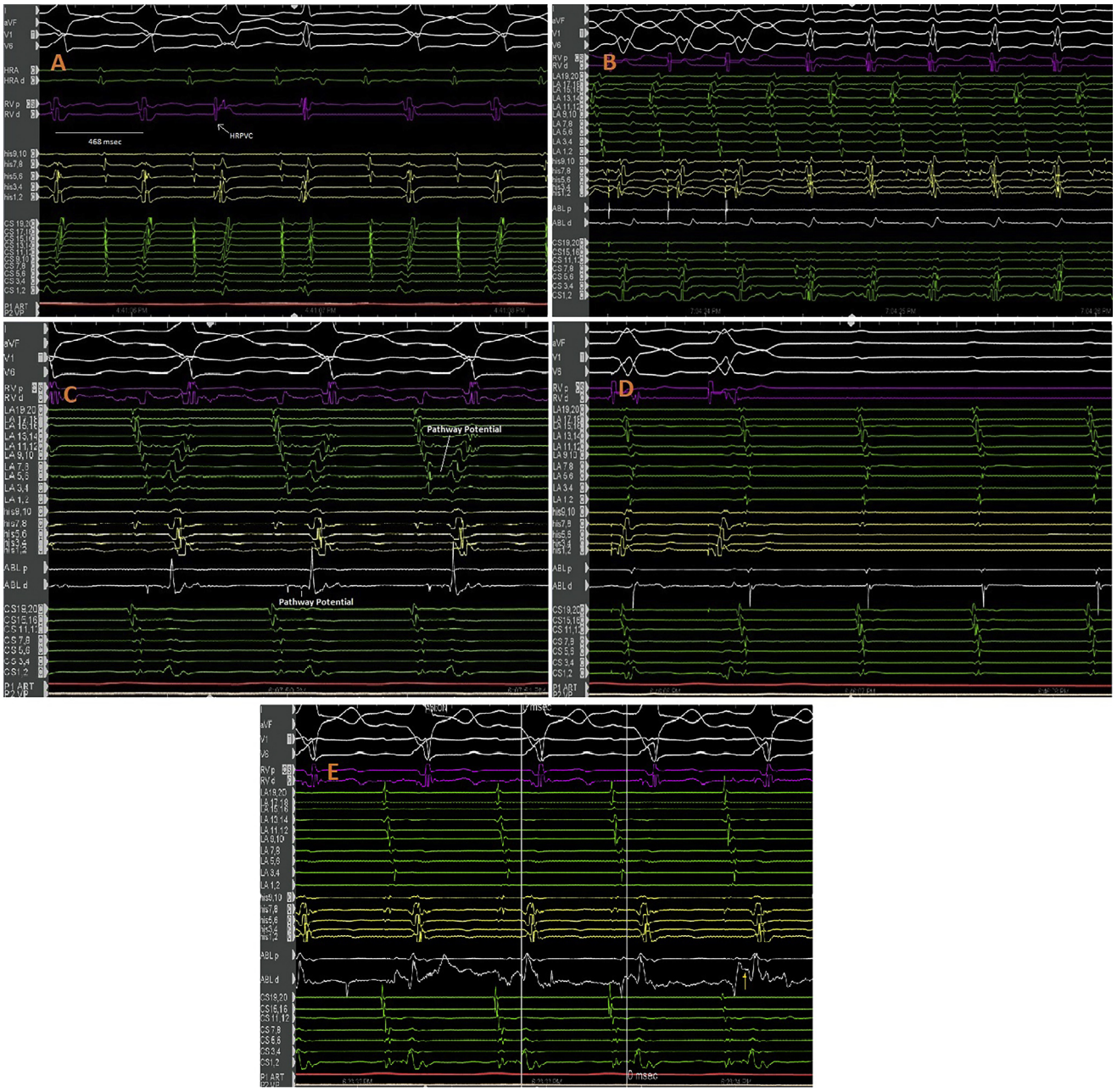

Figure 3 All images are at a sweep speed of 100 ms. **A:** Preexcited supraventricular tachycardia (SVT) cycle length: 468 ms. A His-refractory premature ventricular contraction does not alter SVT cycle length, and causes a narrow QRS owing to concealment in the pathway while the SVT continues without a change in cycle length. **B:** Clinical SVT with mitral annular catheter showing VAHV response suggestive of orthodromic reciprocating tachycardia. **C:** The earliest local ventricular electrogram preceding the onset of surface QRS by 0 to -5 ms, and pathway potential seen during anterograde conduction. **D:** Complete heart block after ablation of pathway atrial insertion site at the 4 o'clock mitral annulus. **E:** Electrograms seen with pathway potential (*arrow*) at the 4 o'clock mitral annulus prior to ablation. First vertical line coincides with onset of surface preexcited QRS. Second vertical line coincides with pathway potential on distal ablation catheter.

Discussion

This case illustrates several unusual features and therapeutic challenges. First, mapping left-sided APs without a CS catheter and utilizing a MA endocardial catheter as an alternative is effective for the most part, with some challenges. This endocardial catheter is not as stable staying in a fixed location as a CS catheter. The endocardial catheter is more atrial than the CS. Yet, it is still a useful adjunct, as shown in this case, and has not been described before, to the best of our knowledge. Furthermore, one may use a high-density mapping catheter such as the PentaRay (Biosense Webster, Inc), but individual electrogram annotation has to be consistent and precise. High-density mapping leads to high resolution and it is feasible with the smaller electrode diameter of a multipolar catheter. Nevertheless, panoramic mapping utilizing a multipolar catheter with quick regional recognition has its advantages.

Second, the complete heart block following ablation of the AP at its atrial insertion was unexpected. The ablation site

was approximately 3–4 cm from the CS os. Baseline ECG during sinus rhythm with intermittent narrow QRS complexes and the clinically documented ORT led to the assumption that anterograde AV conduction was intact. The intermittent and abnormal anterograde AV conduction is likely related to the patient's previous ablation procedures.

Third, intermittent preexcitation suggestive of poor anterograde AP conduction was proven to be an incorrect assumption, as this patient had very short R-R intervals during AF, suggestive of sympathetic influence on AP conduction properties.[2,3] It is also plausible that the apparent discrepancy between baseline intermittent AP conduction and rapid AP conduction during AF could be related to an "injured" AP from previous ablation attempts.

Fourth, the observation of CS occlusion warrants caution when multiple ablations are performed in the area of the CS os or in the lumen of the proximal CS, presumably where the AP was mapped to its ventricular insertion.[4]

Finally, atrial and ventricular insertion spatial disparity is significant in this patient.[5] Ventricular insertion was mapped to the posterior septal location, whereas the atrial insertion was mapped to the posterior lateral location, with an estimated distance of 27 mm. Our report highlights the important considerations and challenges involved in AP ablation in patients who have had multiple prior ablations.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2021.01.021.

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