Bradycardia-Dependent Conduction Block Into Pulmonary Vein After Isolation

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Pulmonary vein (PV) isolation is the cornerstone of ablation for the treatment of paroxysmal atrial fibrillation. Once PV isolation is achieved, multiple maneuvers may be used to assure durable effect, including pacing along the ablation line,1 adenosine challenge2 to uncover dormant PV conduction, and an appropriate waiting period after successful isolation.3 We describe a novel finding of transient PV reconnection by rapid pacing of the coronary sinus.

A 69-year-old man with symptomatic, drug-refractory, paroxysmal atrial fibrillation was referred for PV isolation. Echocardiography displayed a normal left ventricular ejection fraction with mild left atrial enlargement.

Antral isolation was performed in atrial fibrillation, first around the left PVs, followed by the right PVs. Ablation was performed with an open-irrigated ablation catheter (Thermocool SF, Biosense Webster, Diamond Bar, CA), guided by a 10-pole circular mapping catheter (Lasso, Biosense Webster, Diamond Bar, CA). During the right-sided lesion set, sinus rhythm resumed at a cycle length of 970 ms. Additional ablation was required to isolate the right PVs. Entrance block was noted, as was exit block, manifest by local PV capture while pacing from the circular mapping catheter and isolated PV firing (Figure 1). Pacing along the lesion sets (10 mA, 2 ms) identified areas that required additional ablation. A total of 21 mg adenosine failed to uncover dormant conduction 16 minutes after successful right PV isolation.

With the circular mapping catheter in the right superior PV, coronary sinus extrastimulus testing (S1S2) was performed with a basic drivetrain of 500 ms, starting 27 minutes after right PV isolation. Isolated right superior pulmonary vein firing persisted. After 3 minutes, PV conduction was noted during pacing, but entrance and exit block during sinus rhythm were noted immediately before (Figure 2A) and after (Figure 2B) subsequent rounds of electric stimulation. After another 2 minutes, persistent reconnection of the right PVs occurred. Additional ablation reisolated the right PVs.

To our knowledge, this is the first description of (relative) bradycardia-dependent PV block. As entrance and exit block were seen during sinus rhythm at a slower rate immediately pre- and post pacing, the most probable explanation for this finding is phase 4 block into the PV. It has been shown that ablation depolarizes the resting membrane potential of PV myocardium, preventing action potential generation.2 Progressive repolarization of resting membrane potential likely occurred during the many minutes between successful isolation and persistent recovery of PV conduction. At some point, partial depolarization likely caused a voltage-dependent inactivation of sodium channels in a gradual fashion, making them unavailable for action potential generation during slower rates. As resting membrane potential approached normal values, rapid pacing allowed for transient conduction into the PV by simultaneously recruiting enough available sodium channels to produce an action potential, whereas eventual return of normal resting membrane potential allowed for persistent reconnection at slower rates. A recent review by El-Sherif and Jalife4 suggests other possible mechanisms for bradycardia-dependent block in the setting of AV conduction disturbances: rapid pacing may produce an electrotonic effect across the ablation line that allows for generation of an action potential in the isolated PV tissue (because of rate-related changes in slow inward current), or a decrease in action potential amplitude can occur at slower rates leading to failure of propagation.

This case also illustrates that the use of adenosine response immediately after PV isolation is achieved, in lieu of an adequate waiting period, may provide false assurance that durable PV isolation has been achieved.

Disclosures

Dr Jacobson receives research grant from Biosense Webster. The other authors report no conflicts.

References


KEY WORDS: ablation techniques | adenosine | atrial fibrillation

**Figure 1.** Isolated firing from right superior pulmonary vein (RSPV) after isolation. Displayed are surface leads I and II (ECG), RSPV circular mapping catheter (CMC), and the distal coronary sinus (CS). Note the stable sinus rhythm cycle length on the ECG and CS recordings with dissociated potentials (arrows) from the RSPV with variable delays during atrial diastole.

**Figure 2.** A. Onset of pacing from coronary sinus. Isolated firing continues in right superior pulmonary vein (RSPV; arrows) before coronary sinus (CS) pacing. After the fourth paced beat, conduction into the RSPV is noted (asterisks). Format identical to Figure 1. B. Offset of pacing from coronary sinus. The last 4 paced beats conduct into the RSPV (asterisks). On resumption of sinus rhythm, isolated firing from the RSPV (arrows) resumes. The last dissociated potential (star) occurs 35 ms before the sinus P wave. No change in CS activation or P wave morphology was seen in response to the late-coupled pulmonary vein (PV) activation, consistent with exit block as well. LSPV indicates left superior pulmonary vein.
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Circ Arrhythm Electrophysiol. 2014;7:762-763
doi: 10.1161/CIRCEP.113.001304

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