Fibrillation in the Superior Vena Cava Mimicking Atrial Tachycardia

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A 49-year-old male was referred for catheter ablation for paroxysmal atrial fibrillation (PAF). PAF had recurred after each of 2 prior left atrial ablation procedures. He had a structurally normal heart with a left atrial diameter of 43 mm. The patient presented to the electrophysiology laboratory in AF with an average AF cycle length (CL) of 150 ms and reconnected pulmonary veins. After electric disconnection of all 4 veins using an antral circumferential approach, AF organized to an atrial tachycardia (AT), which was successfully converted into right atrial common type atrial flutter after ablation in the mid coronary sinus (CS). Ablation of the cavo-tricuspid isthmus was performed and converted the rhythm to a slightly irregular atrial tachycardia at a CL of approximately 430 ms and a P-wave morphology (inferior axis, positive/negative P wave in V1), suggesting an origin in the vicinity of the sinus node. Mapping in this region revealed a focal tachycardia located in the superior vena cava (SVC) with a CL of approximately 215 ms and predominantly 2:1 veno-atrial conduction. Radiofrequency (RF) ablation at the SVC-RA junction terminated this focal tachycardia and restored sinus rhythm in the right atrium. Subsequent mapping of the SVC during the course of the procedure using a circumferential mapping catheter, however, revealed a rapid tachycardia (CL 150 ms) with the right atrium (RA) remaining in sinus rhythm, indicating exit block from the SVC to the RA (Figures 1 and 2). RF ablation of the SVC focus first slowed the SVC tachycardia and subsequently terminated it. Surprisingly, despite the presence of complete exit block from SVC to RA during SVC tachycardia, immediately after termination conduction from RA to SVC was observed, as indicated by SVC potentials preceding by an atrial farfield signal recorded in the circumferential mapping catheter positioned in the SVC (Figure 3). Further mapping and ablation of the “entrance-connection” of the SVC resulted in complete isolation of the SVC, proving unidirectional conduction properties of the SVC (Figure 4). After ablation AF was not inducible despite isoproterenol infusion and rapid burst pacing.

Discussion

The SVC has been reported to play a role in arrhythmia initiation and maintenance in 6% to 12% of patients with PAF.1,2 Unidirectional conduction properties of myocardial sleeves in the SVC but not of RA connections to the SVC have previously been shown using a multipolar basket catheter.3 In the left atrium, potential unidirectional conduction from PV to atrium has been shown, based on PV pacing with conduction to the LA despite absent PV potentials during sinus rhythm, although far-field capture of the left atrium could not be completely excluded.4 In the present case it is possible that unidirectional block from SVC to RA was frequency-dependent. However, even slowing of the SVC tachycardia to a cycle length of 280 ms did not result in any SVC to RA conduction (Figure 3). It is also possible that block was a manifestation of concealed conduction of impulses into the SVC–RA junction.

It is interesting that 2 tachycardias with very different rates were observed within the SVC. The mechanism is uncertain, but multiple potential reentry paths or 2 simultaneously circulating wavefronts along 1 reentry path could theoretically cause these findings.

This case also demonstrates that a SVC tachycardia can be a source for apparent irregular atrial tachycardia that can potentially mimic sinus tachycardia.

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References


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Figure 2. Fluoroscopic image demonstrating a left anterior oblique view with coronary sinus catheter, mapping catheter, and circumferential catheter positioned in the SVC.
Figure 3. Tracing demonstrating termination of the focal SVC tachycardia with increased CL without affecting the atrial CL (860 ms), indicating exit block, even after the SVC tachycardia had slowed to a cycle length of 280 ms (surface EKG leads I, II, III, V1, and V5). Immediately after termination of the SVC tachycardia, conduction from the atrium to SVC is present, indicating unidirectional conduction from the RA to the SVC. LS indicates circumferential mapping catheter. *SVC activation preceded by the RA far-field potential.

Figure 4. The tracing demonstrates conduction from the RA to the SVC during RF ablation of the connection. Conduction into the SVC delays (asterisk) then blocks. L1–L20 were recorded from the circular catheter in the SVC, indicating complete SVC isolation.
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