Successful Catheter Ablation of a Focal Atrial Tachycardia From the Ascending Aorta
A Novel Location and Approach

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Focal atrial tachycardias (ATs) can originate anywhere in either atria and their appendages and the aortic root. However, to our knowledge, there has been no report of an AT having been successfully treated by catheter ablation in the trunk of the ascending aorta.

Patient Characteristics and Electrophysiological Study
A 56-year-old diabetic woman who had a history of frequent palpitations associated with syncope resistant to both amiodarone and propafenone was referred for catheter ablation after a failed ablation for a focal AT in the right atrium (RA). At the initial procedure, the earliest atrial activation was located at the ostium of the superior vena cava (SVC), but this preceded the onset of the surface P wave by only 10 ms (Figure 1, A and B). The SVC was isolated, but this did not result in termination of the tachycardia (Figure 1C). The earliest activation slightly shifted down to the medial wall of the RA at the junction with the SVC. Radiofrequency energy delivery at this particular area failed to terminate the tachycardia.

At the repeat procedure, a sustained AT with 1:1 atrioventricular conduction was observed and with 2:1 atrioventricular conduction during verapamil infusion. Electroanatomic mapping of both the right and the left atria demonstrated earliest atrial activation at the high septal wall of the right atrium, which was almost at the same timing as the surface P-wave onset (Figure 2A). The SVC and its surrounding tissue presented very low voltage due to previous ablation (Figure 2B). Persistent AT remained with a transient AV block during intravenous administration of 20 mg of adenosine triphosphate. The P-wave morphology was clearly shown by 12-lead ECG (Figure 2A). Radiofrequency energy delivery at and around this earliest point failed to terminate the tachycardia. During mapping of the aortic root, a low amplitude signal was surreptitiously found in the right posterolateral wall of the ascending aorta 2.5 cm away from the noncoronary aortic cusp (Figures 2C and 3C) that preceded the onset of the surface P wave by 56 ms (Figure 3A). This was 1.5 cm away from the earliest right atrial activation on the 3D electroanatomic map. Interestingly, activation did not conduct progressively along the aortic wall down to the noncoronary cusp (Figure 2C). Entrainment pacing was attempted at the earliest site but failed due to lack of capture at 28 mA × 9.9 ms. Radiofrequency ablation was performed, titrating the energy from 5 W to 20 W, and the tachycardia terminated within 5 seconds of radiofrequency application at 10 W (Figure 3B). After a total radiofrequency delivery of 120 seconds of 20 W, the tachycardia was no longer inducible with either atrial programmed stimulation or burst pacing, both with and without isoproterenol infusion. The detailed spatial anatomic relation of both atria, the aortic cusp, and the ascending aorta is shown in Figure 3D. The patient has been free of symptoms off all antiarrhythmic drug therapy in the 10 months after the procedure. Twenty-hour Holter monitoring at 4 and 8 weeks after the procedure only showed 2 and 10 premature atrial contractions, respectively.

Discussion
In the present case, the patient had a focal atrial tachycardia originating from the ascending aorta. Anatomically, the SVC and the medial wall of the upper right atrium are adjacent to the posterolateral wall of the ascending aorta (Figure 3D). Based on the mapping data of the 2 procedures, the earliest activation point was shifting down from the SVC to the high medial wall of the RA after local ablation. This indicated that the origin was not ablated, and radiofrequency delivery only touched its breakout point in the SVC and the RA. The above phenomenon was consistent with the final mapping result. In this particular case, the earliest activation point within the aorta was 1.5 cm above the corresponding earliest activation point recorded from the right atrium. Because the AT was...
terminated in less than 4 seconds with relatively low radio-frequency energy delivery, this suggests that this focal AT most probably arise from the wall of the ascending aorta, with an electric connection to the right atrium. An early study on the mechastructure of the pericardium demonstrated that although it was mainly composed of fibrous fibers, remnants of muscular fibers were observed. Such fibers could act as a myocardial bridge between the aorta and the right atrium in the present case, although direct evidence is lacking.

Clinical Implications
Recent advances in both mapping and catheter ablation techniques now permit procedures to successfully locate and ablate focal ATs. However, difficult cases are frequently encountered, and a detailed understanding of the spatial relationships between the cardiac chambers and great vessels is required.

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Disclosures
None.

References

Key Words: aorta | arrhythmia | catheter ablation | electrophysiology
Figure 1. Surface and endocardial ECG recordings, electroanatomic mapping, and catheter ablation results of the tachycardia in the first procedure. A, Surface ECG leads I, aVF, V2, and intracardiac electrograms recorded from the circular catheter placed inside the SVC (SVC9-10/H11015 SVCD-2), the coronary sinus from proximal to distal (CS9-10/H11015 CSD-2), and the ablation catheter during tachycardia. The earliest activation was found to be inside the SVC but only precedes the onset of the surface P wave by 10 ms (paper speed, 100 mm/s). B, Three-dimensional activation map also indicated the earliest activation from the SVC. C, SVC isolation did not terminate the tachycardia.
Figure 1 (Continued).
Figure 2. Surface and endocardial ECG recordings and electroanatomic mapping results of the tachycardia in the second procedure. A, left, Surface ECG leads I, aVF, V1, and intracardiac electrograms recorded from high right atrium (HRA), proximal and distal area of HIS bundle region (HISp and HISd), and coronary sinus from proximal to distal (CS9-10−CS1-2) during tachycardia; 1:1 atrioventricular conduction is noted with the leading atrial activation in HRA, HISp, and HISd area, occurring almost simultaneously (paper speed=100 mm/s). Right, Transient atrioventricular block occurred after adenosine triphosphate injection during tachycardia. The P-wave morphology is clearly seen with flat P waves in leads I and aVL, negative in lead aVR, biphasic in the inferior leads and all precordial leads, but being more positive and less negative in lead V1 (paper speed, 25 mm/s). B, Electroanatomic activation map of both atria using CS7-8 as the reference in a left anterior oblique view. The earliest activation point was located in the upper medial wall of the right atrium between superior vena cava and the HIS recording area. C, Activation map of the ascending aorta and the right atrium from a posterior view. The earliest activation was shown to be in the posterolateral wall of the ascending aorta. Notice that the low-amplitude signal seen in the distal electrode pair of the mapping catheter is leading the reference by 151 ms. D, Electroanatomic activation map of mesh showed the spatial distance between the earliest site in the ascending aorta (A) and the earliest site in the right atrium (B) was 15 mm away.
Figure 2 (Continued).
Figure 3. Target electrogram and catheter ablation results of the patient. A, Electrogram recorded from the distal ablation catheter at the target site shows a small signal preceding the onset of P wave by 56 ms (paper speed, 100 mm/s). Tracings are the same as those shown in Figure 1, but the HIS catheter is dislocated. B, Termination of the tachycardia within 5 seconds by radiofrequency delivery of 10 W (paper speed=50 mm/s). C, Aortic angiogram both in right anterior oblique 30° (left) and left anterior oblique 45° views (right) show that the target site was located at the posterolateral wall 2.5 cm away from the bottom of the noncoronary aortic cusp. The HIS catheter was replaced through the “redundant” long sheath for a stable position. D, Computed tomography image showed the anatomic relation of the ascending aorta and both atria from both left anterior oblique 45° and the posterior view. Notice the probable target site in the ascending aorta and its close proximity to the right atrium. SVC indicates superior vena cava; RAA, right atrial appendage; RA, right atrium; LA, left atrium.
Figure 3 (Continued).
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