A pseudo-sinus rhythm due to bigeminal ectopy with the focus in the right superior pulmonary vein

Marina Arai, MD,* Seiji Fukamizu, MD, PhD,* Rintaro Hojo, MD,* Masayasu Hiraoka, MD, PhD, FHRS†

From the *Department of Cardiology, Tokyo Metropolitan Hiroo Hospital, Tokyo, Japan, and †Department of Cardiovascular Disease, Tokyo Medical and Dental University, Tokyo, Japan.

Introduction
It has been reported that pulmonary vein ectopy is a common origin of focal atrial tachycardia; however, only a few cases of pulmonary vein rhythm treated by pulmonary vein isolation (PVI) have been reported. We present the rare case of a patient who presented with a “pseudo-sinus rhythm” even though he had undergone PVI and was ultimately found to have bigeminal ectopy from the reconnected right superior pulmonary vein (RSPV).

Case report
A 40-year-old man experienced frequent atrial premature complexes after PVI for persistent atrial fibrillation. The P-wave morphology of the dominant rhythm on the 12-lead electrocardiogram (ECG) was flat in lead I; positive in leads II, III, and aVF; and negative in lead aVR. Electrophysiological study confirmed reconnection of the RSPV, and the intracardiac electrogram (EGM) indicated the presence of reproducible bigeminal ectopy from the RSPV preceding the right atrial potentials. Although the first heartbeat had atrioventricular conduction, the second heartbeat was blocked (Figure 1A). We applied radiofrequency energy to the earliest activation site at the roof of the RSPV (Figure 2A), and the RSPV was reisolated. After reisolation of the RSPV, the sinus rhythm resumed, and a far-field pulmonary vein potential was recorded in the right atrial catheter (Figure 1B). The results indicated that the patient’s RSPV rhythm apparently simulated the sinus P wave; we call the former the “pseudo-sinus rhythm.”

The surface ECG showed few apparent changes in P-wave morphology before and after reisolation of the RSPV. However, comparison of each EGM showed that the cycle length of the sinus rhythm was 1200 ms and that of the RSPV ectopy was 1000 ms (Figure 1B). Because the rhythms had different cycle lengths, the sinus impulses were suppressed by the RSPV ectopy, thereby allowing maintenance of the pseudo-sinus rhythm.

Discussion
Because the sinus node and RSPV are located in close anatomic proximity, the P-wave morphologies of the 2 rhythms are often indistinguishable from one another. The 12-lead ECG (Figure 2B) indicated the presence of the pseudo-sinus rhythm in the first half of the examination, and the true sinus rhythm appeared right after 2 beats of atrial premature complexes with aberrant conduction. EGMs could reveal the presence of a pseudo-sinus rhythm. To prove that the bigeminal ectopy originated from the RSPV in our patient, we should have created an activation map of the pseudo-sinus rhythm before reisolation of the RSPV. However, we can exclude the possibility of superior vena cava (SVC) ectopy because in Figure 1A, the SVC1-2 clearly activated after the RSPV. Similarly, we should have

KEYTEACHING POINTS
• Apparent sinus rhythm on the surface electrocardiogram can be revealed to be a pseudo-sinus rhythm that originates from the pulmonary vein (PV) only by performance of an electrophysiological study.
• A reconnected PV can be the cause of a pseudo-sinus rhythm, so it should not be overlooked even if PV isolation has already been performed.
• The PV is one of the common origins of focal atrial tachycardia, so it should be considered a possible origin of a pseudo-sinus rhythm.

KEYWORDS
Atrial premature complex; Ectopy; Pseudo-sinus rhythm; Pulmonary vein isolation; Pulmonary vein rhythm; Right superior pulmonary vein

Address reprint requests and correspondence: Dr Marina Arai, Department of Cardiology, Tokyo Metropolitan Hiroo Hospital, 2-34-10 Ebisu, Shibuya-ku, Tokyo, 1500013, Japan. E-mail address: marina7arai@yahoo.co.jp.
Figure 1  
A: Electrophysiological study confirms reconnection of the right superior pulmonary vein (RSPV), whereas the intracardiac electrogram indicates the presence of a reproducible bigeminal ectopy from the RSPV preceding the right atrial potentials. Although the first heartbeat (solid-line circle) is associated with atrioventricular conduction, the second heartbeat (dotted-line circle) is blocked. 
B: After reisolation of the RSPV, sinus rhythm has resumed, and a far-field potential of the RSPV is recorded in the right atrial catheter (*). CS = distal electrode pair of the coronary sinus catheter; RA = right atrium; SVC = superior vena cava.

Figure 2  
A: Catheter positions during reisolation of the right superior pulmonary vein (RSPV). A ring catheter in the RSPV is shown. Radiofrequency energy is applied at the site of earliest activation, that is, the roof of the RSPV. 
B: Twelve-lead electrocardiogram shows the presence of the pseudo-sinus rhythm in the first half of the examination; the true sinus rhythm appears right after 2 beats of atrial premature complexes with aberrant conduction. ABL = ablation catheter; CS = distal electrode pair of the coronary sinus catheter; RA = right atrium; SVC = superior vena cava.
distinguished right atrial ectopy from RSPV ectopy. Specifically, we should have paced the right atrial potential and RSPV potential to confirm which is the near-field potential and which is the far-field potential. However, after reisolation of the RSPV, the right atrial potential turned out to be the far-field potential of the RSPV.

**Conclusion**

We present an interesting case of a patient whose RSPV rhythm mimicked the sinus rhythm on a 12-lead ECG, and an EGM was required to reveal it was a pseudo-sinus rhythm.

**References**

1. Tao S, Yamauchi Y, Okada H, Maeda S, Naito T, Kagiya N, Yamagushi T, Hara N, Komishi Y, Umemoto T, Miyamoto T, Ohayashi T. Pulmonary vein rhythm with prominent change in heart rate. Shinzo 2012; 44(Suppl 3):S3_197–S3_202.
2. Yamane T, Shah DC, Jais P, Haïssaguerre M. Pseudo sinus rhythm originating from the left superior pulmonary vein in a patient with paroxysmal atrial fibrillation. J Cardiovasc Electrophysiol 2001;12:1190–1191.
3. Yamada T, Murakami Y, Toyama J, Murohara T. Bigeminal pulmonary vein ectopy suppressed by pulmonary vein isolation. Int Heart J 2008; 49:129–132.
4. Kistler PM, Roberts-Thomson KC, Haqqani HM, Fynn SP, Singarayar S, Vohra JK, Morton JB, Sparks PB, Kalman JM. P-wave morphology in focal atrial tachycardia development of an algorithm to predict the anatomic site of origin. J Am Coll Cardiol 2006;48:1010–1017.