

Effect of the interatrial connection on the isolation line of the right pulmonary vein



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Introduction

Pulmonary vein (PV) isolation is the primary therapy for ablation of atrial fibrillation (AF); however, the isolation of PV occasionally fails and additional radiofrequency (RF) ablation inside the isolation line is required in some patients. In an autopsy study, muscular connections between the left atrium (LA) and right atrium (RA) are frequently observed. In addition to the Bachmann bundle, the study recognized the connection between the right pulmonary vein (RPV) antrum and RA (RPVA connection).¹ It is possible that these connections make the RPV antrum isolation difficult, but their clinical significance in AF ablation has not been elucidated. In addition, autopsy studies have reported that the RPVA connection is frequent, whereas electrophysiological studies have reported that the electrical conduction via this connection is infrequent.^{1,2} In an animal study, it was observed that the posterior–inferior septum of the LA frequently appeared as the earliest breakthrough during pacing from the posterior septum of the RA, whereas the Bachmann bundle was the preferential interatrial connection during pacing from the superior septum.³ In this study, we describe how the RPVA connection affects RPV isolation using pacing from the posteroinferior RA wall.

Case report

Case 1

A 64-year-old man with paroxysmal AF was referred for catheter ablation. He had a medical history of hypertension and diabetes mellitus. His echocardiography trace demonstrated normal cardiac function except for LA enlargement and a minor amount of pericardial effusion.

KEYWORDS Activation map; Atrial fibrillation; Interatrial connection; Isolation line; Radiofrequency ablation (Heart Rhythm Case Reports 2020;6:583–587)

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors have no conflicts to disclose. **Address reprint requests and correspondence:** Dr Yuichiro Miyazaki, Department of Cardiology, Akashi Medical Center, 33-743 Yagi, Okubo, Akashi, Hyogo, 674-0063, Japan. E-mail address: qoom.kaim@gmail.com.

KEY TEACHING POINTS

- There are electrical connections between the right pulmonary vein (RPV) antrum and the right atrium, which may disturb antral pulmonary vein isolation.
- Pacing from the posteroinferior site of the right atrium emphasizes the connection.
- The spatial relationship between the connection and the RPV isolation line could affect the success rate of RPV first-pass isolation.

The ablation procedure was performed under general anesthesia. Transseptal puncture was performed and 3 long sheaths were inserted into the LA. Before PV isolation, LA mapping was performed using a multispline electrode catheter and a 3-dimensional mapping system (PentaRay, CARTO3; Biosense-Webster Inc, Diamond Bar, CA) during pacing from the posteroinferior RA wall with a 6F 20-pole electrode catheter (2-10-2 mm spacing center to center) (Figure 1A, Supplementary Figure). Points were acquired using the CARTO CONFIDENSE module in continuous mapping mode if the local activation time stability (<3 ms), position stability criteria (<2 mm), and cycle length range (<±30 ms) were met. The earliest activation sites inside the LA were determined to be the connections between the LA and RA. The LA map was displayed as a voltage map during mapping and initial PV isolation. Circumferential PV antrum isolation was performed using an open-irrigated contact-force catheter (THERMOCOOL SMARTTOUCH SF, Biosense-Webster) with a deflectable sheath. The ablation index was used to isolate the PV and RF energy in power control mode at 25–40 W was delivered to target an ablation index of >500 (except for the posterior wall of the left PV). After the application of circumferential RF energy, the left PV was isolated. However, electrical RPV isolation was not achieved. Residual potential on the initial isolation line of the RPV decreased to <0.2 mV. The LA activation map performed before PV isolation was checked and showed the 3 LA breakthrough sites: 2

at the anterior wall region of the RPV antrum and 1 at the anterior septum. It is suspected that 2 RPVA connections were within the RPV isolation line (Figure 1B, C, D). The ablation catheter was positioned at the LA breakthrough site of the RPV antrum. The potential at the LA breakthrough site of the RPV antrum was earlier than the potential recorded at most parts of the RA (except for the area near the sinus node) and coronary sinus during sinus rhythm (Figure 1B). Additional RF ablation at the LA

breakthrough sites helped to electrically isolate the RPV (Figure 1E). After PV isolation, LA was remapped during pacing from the posteroinferior RA wall and only the anterior septum breakthrough site remained (Figure 1F).

Case 2

An 81-year-old man with paroxysmal AF was referred for catheter ablation. He had a medical history of hypertension and congestive heart failure. His echocardiography trace

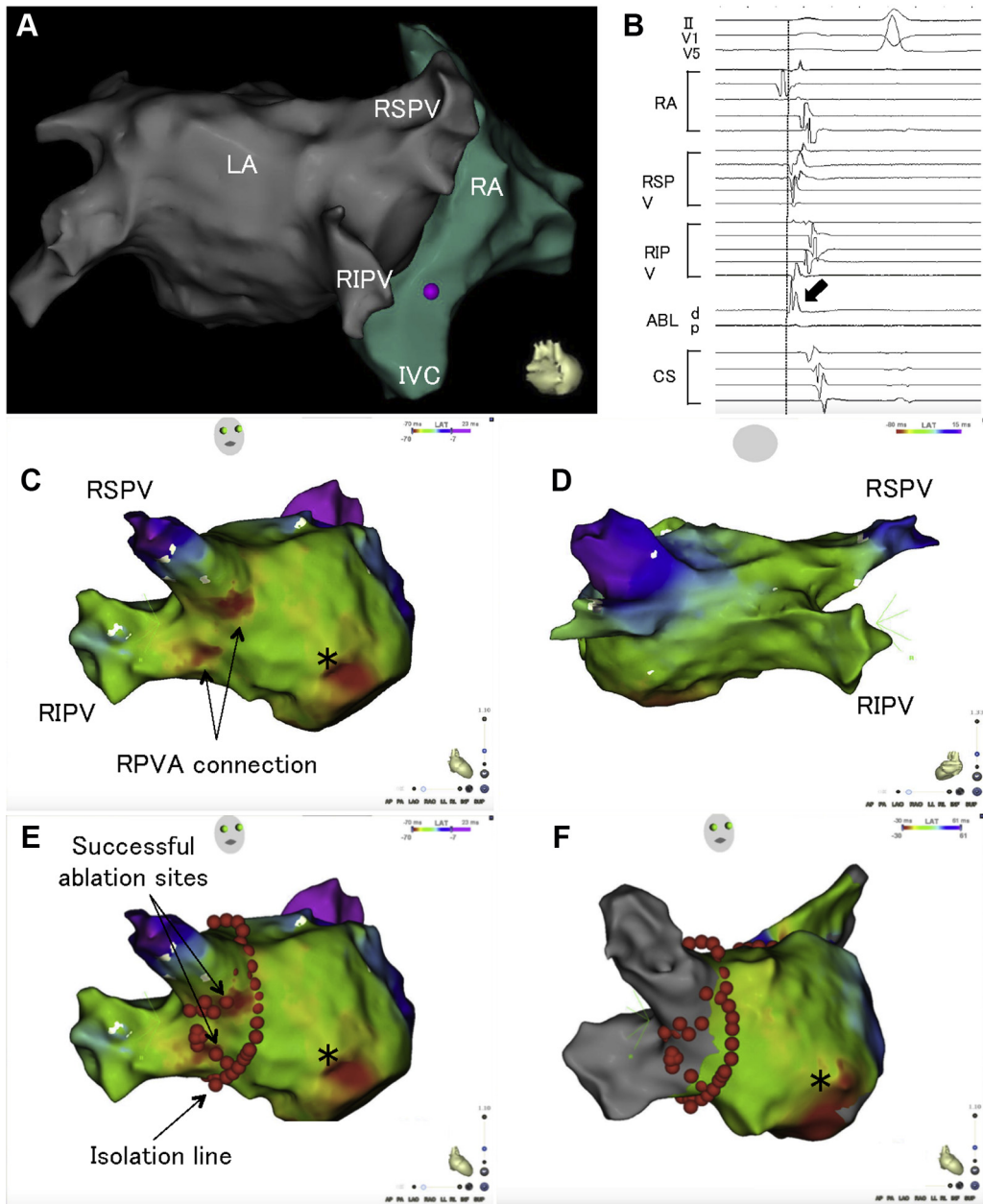


Figure 1 A: A pink tag demonstrates the pacing site at the posteroinferior wall of the RA. B: The ablation catheter was positioned at the LA breakthrough site of the RPV antrum. The potential at the LA breakthrough site of the RPV antrum (arrow) was earlier than the potential recorded at most parts of the RA (except for the area near the sinus node) and CS during sinus rhythm. C, D: LA activation map during pacing from the posteroinferior wall of the RA demonstrates 3 breakthrough sites, which are the anterior parts of the RPV antrum, and the anterior septum (*). E: Isolation line of the anterior wall of the RPV antrum passes through the LA side of the LA breakthrough site. Additional application of radiofrequency energy to the breakthrough sites led to successful isolation of the RPV. F: LA mapping during pacing from the posteroinferior wall of the RA after pulmonary vein isolation showed only the anterior septum breakthrough site. ABL = ablation catheter; CS, coronary sinus; IVC = inferior vena cava; LA = left atrium; RA = right atrium; RIPV = right inferior pulmonary vein; RPV = right pulmonary vein; RSPV = right superior pulmonary vein.

demonstrated normal cardiac function except for LA enlargement.

LA mapping and RF ablations were performed using the same methods as outlined in case 1. The RPV was isolated in 1 round and additional RF ablation was not needed in this case. After isolation of the RPV, we checked the LA activation map, which indicated LA breakthrough sites at the anterior wall region of the RPV antrum, the Bachmann bundle, and the anterior septum (Figure 2A and B). The isolation line of the anterior wall of the RPV antrum passed through the PV side of the RPVA connection (Figure 2C). After PV isolation, LA was remapped during pacing from the posteroinferior RA wall and the breakthrough sites remained (Figure 2D).

Case 3

A 49-year-old man with paroxysmal AF was referred for catheter ablation. He had no medical history except AF. His echocardiography trace demonstrated normal cardiac function.

LA mapping and RF ablations were performed using the same methods as outlined in case 1. After the application of circumferential RF energy, electrical RPV isolation was not achieved. Residual potential on the initial isolation line

of the RPV decreased to <0.2 mV. The LA activation map obtained before PV isolation showed the 1 LA breakthrough site at the anterior wall region of the RPV antrum, which was within the RPV isolation line (Figure 3A and B). Additional RF ablation at the LA breakthrough sites aided in the isolation of RPV (Figure 3C). After PV isolation, LA was remapped during pacing from the posteroinferior RA wall. The Bachmann bundle and the anterior septum conduction became apparent (Figure 3D).

Discussion

Previous studies have reported that wide antral PV isolation is superior to ostial PV isolation.⁴ However, in some patients, the additional application of RF inside the isolation line is required according to the position of the connection between the LA and RA.² Another study recognized the electrical conduction between the RPV and RA and reported that PV isolation required additional ablation in the RA.⁵ Anatomical studies have revealed that muscular bridges between the RPV antrum and RA were observed in almost all patients, whereas it is difficult to detect the conduction of these connections during the sinus rhythm.^{1,6}

In our case, interatrial connections, including the RPVA connection, were detected by pacing from the posteroinferior

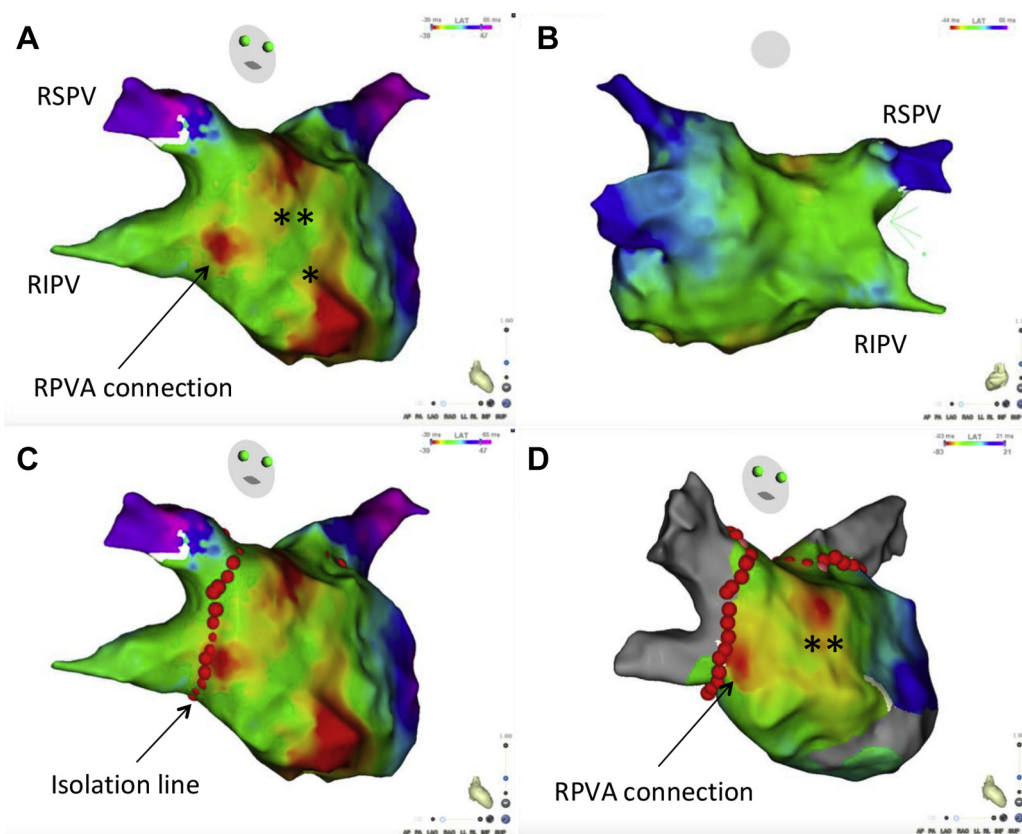


Figure 2 A, B: LA activation map during pacing from the posteroinferior wall of RA demonstrates 3 breakthrough sites, which are the anterior wall of the RIPV antrum, Bachmann bundle (**), and anterior septum (*). C: The isolation line of the anterior wall of the RPV antrum passed through the pulmonary vein (PV) side of the LA breakthrough site. D: LA mapping during pacing from the posteroinferior wall of the RA after PV isolation showed that the breakthrough sites at the anterior wall of the RIPV and Bachmann bundle remained (the area of the anterior septum was not mapped). Abbreviations as in Figure 1.

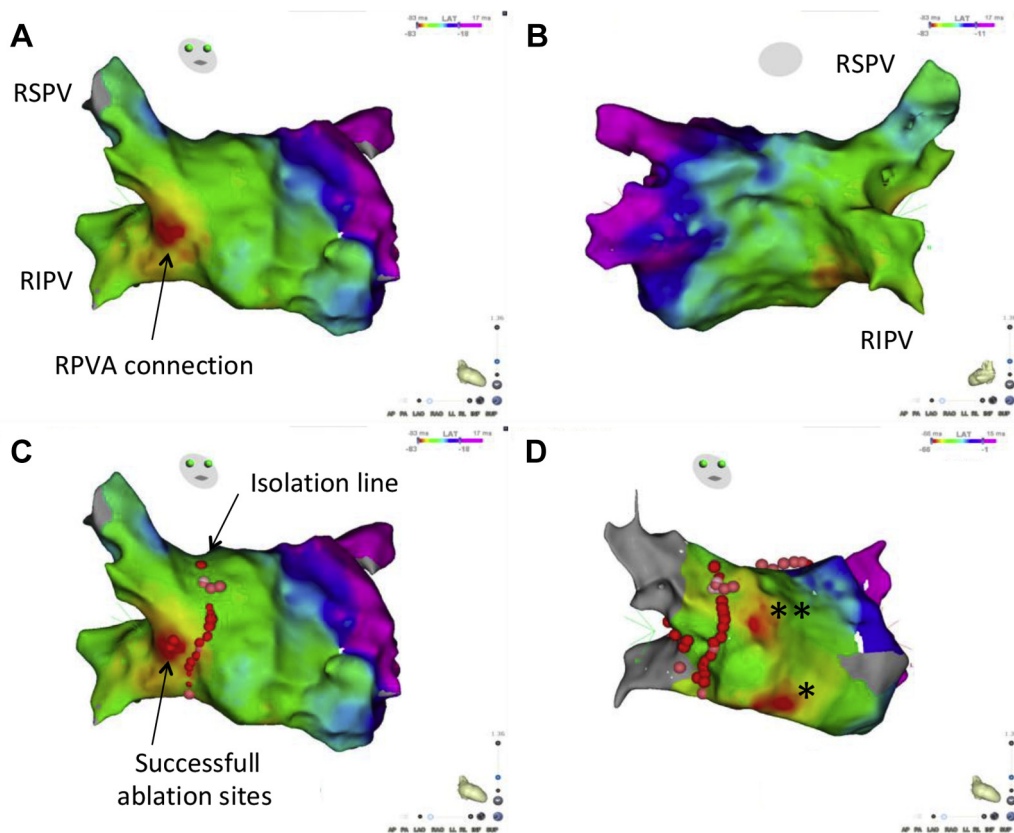


Figure 3 **A, B:** LA activation map during pacing from the posteroinferior wall of the RA demonstrates 1 breakthrough site at the anterior wall of the RPV antrum. **C:** The isolation line of the anterior wall of the RPV antrum passed through the LA side of the LA breakthrough site. Additional application of radiofrequency energy to the breakthrough site led to the successful isolation of the RPV. **D:** LA mapping during pacing from the posteroinferior wall of the RA after pulmonary vein isolation showed that the breakthrough sites at the Bachmann bundle (***) and anterior septum (*) became apparent. Abbreviations as in Figure 1.

RA wall. In cases 1 and 3, the RPV isolation line passed through the LA side of the RPVA connection. In case 2, the RPV isolation line passed through the PV side of the RPVA connection. From these cases, it is expected that the spatial relationship between the RPVA connection and RPV isolation line will affect the success rate of RPV isolation without ablation inside the isolation line (like carina ablation).

Recently, there has been an improvement in the first-pass PV isolation ratio using ablation index.⁷ However, a longer distance from the isolation line to PV ostium leads to incomplete PV isolation after the initial circumferential isolation.⁸ Because the RPVA connection might be associated with failure of the first-pass RPV isolation, specifying the RPVA connection location before PV isolation can help determine the ablation method. However, if the RPVA connection is quite close to the RPV carina, additional carina ablation may be inevitable.

Conclusions

The spatial relationship between the RPV isolation line and RPVA connection could be associated with the need for additional ablation inside the isolation line. It is expected that the

pacing from the posteroinferior site of the RA makes the RPVA connection stand out and contributes to the decision of ablation method.

Appendix Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2020.05.022>.

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