Spiral slow conduction associated with a box isolation in the posterior left atrium unmasking a pulmonary vein reconnection

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Introduction

The endpoint of pulmonary vein (PV) isolation of atrial fibrillation (AF) is to achieve bidirectional conduction block between the PVs and left atrium (LA), which is indicated both by the elimination or dissociation of the PV potentials during sinus rhythm or atrial pacing (entrance block) and failure to capture the atria by pacing from the PVs (exit block).[1] We present a case with a unidirectional reconnection from the LA to the right-sided PVs (RPVs), which was unmasked during a box isolation (BOXI) of the posterior LA, even though both entrance and exit block of the RPVs were confirmed before the BOXI, in a patient undergoing a second ablation procedure for recurrent AF. The manifestation of the LA-to-RPV reconnection in this case was suggested to be associated with (1) a change in the conduction pattern of the posterior LA by the BOXI during the second ablation procedure and (2) failure to create transmural ablation lesions along the posterior PV isolation line of the RPVs during the first ablation procedure, which resulted in counterclockwise spiral slow conduction in the posterior LA and the subsequent occurrence of epicardial conduction from the posterior LA to the right inferior PV (RIPV).

Case report

A 72-year-old woman underwent a second radiofrequency (RF) catheter ablation of persistent AF, guided by the Rhythmia system (Boston Scientific, Marlborough, MA). Bidirectional conduction block between the PVs and LA on both sides was initially confirmed during coronary sinus (CS) and PV pacing, and activation mapping during CS pacing using a mini-basket catheter (Orion; Boston Scientific) exhibited no remarkable fractionated potentials in the posterior LA (Figure 1A and the Online Video). After both a superior and inferior linear ablation of the posterior LA during a BOXI, RPV potentials were unmasked while RPV pacing still failed to capture the atria, which suggested the occurrence of a unidirectional reconnection from the LA to the RPVs (Figure 1B). Activation mapping during CS pacing demonstrated complete conduction block along the superior line of the BOXI, partial conduction block along the left-sided inferior line, and the presence of a conduction gap on the right-sided inferior line. Further, the activation pattern exhibited counterclockwise spiral slow conduction in the posterior LA with suspected epicardial conduction from the posterior LA to the RIPV as follows: (1) conducted from the inferior LA to the right side of the posterior LA through the conduction gap on the inferior BOXI line, (2) conducted inferior-to-superior on the right side of the posterior LA, (3) turned around from the right to left side at the center of the posterior LA, (4) exhibited superior-to-inferior slow

KEY TEACHING POINTS

- The present case had a unidirectional reconnection from the left atrium (LA) to the right-sided pulmonary veins (RPVs) during a second ablation procedure of atrial fibrillation, which was unmasked during a box isolation (BOXI) in the posterior LA, even though bidirectional LA–RPV conduction block was confirmed before the BOXI.
- Both counterclockwise spiral slow conduction in the posterior LA caused by the BOXI procedure and nontransmural ablation lesions along the posterior RPV isolation line during the first ablation procedure were suggested to have contributed to the occurrence of the epicardial reconnection from the posterior LA to the RPVs.
- High-resolution mapping with a mini-basket catheter may facilitate the identification of the activation sequence in the posterior LA changed by the BOXI and the epicardial reconnections between the posterior LA and PVs over the initial PV isolation lines.

KEYWORDS Atrial fibrillation; Box isolation; Epicardial conduction; High-resolution mapping; Pulmonary vein reconnection; Slow conduction
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conduction with a maximum continuous fractionation interval of 103 ms on the left side of the posterior LA, and (5) conducted from the left side of the posterior LA to the RIPV with activation blanking (Figure 1C–H and the Online Video). The connection between the left side of the posterior LA and RIPV was transiently eliminated with an RF application between these areas, corresponding to the border area between the right side of the posterior LA and RIPV, but recovered when the RF application was interrupted (Figure 2A and C). Finally, an RF application at the conduction gap on the inferior BOXI line successfully completed the BOXI (Figure 2B and C). After completing the BOXI, the conduction from the posterior LA to the RIPV still persisted during pacing from the posterior LA.

Discussion

This was a case report describing a unidirectional PV reconnection from the LA to the RPVs, which was unmasked during the BOXI in a patient undergoing a second RF ablation procedure of AF. The possible mechanism for the PV reconnection in this case may be both a change in the conduction pattern of the posterior LA during the BOXI procedure and nontransmural ablation lesions along the posterior RPV

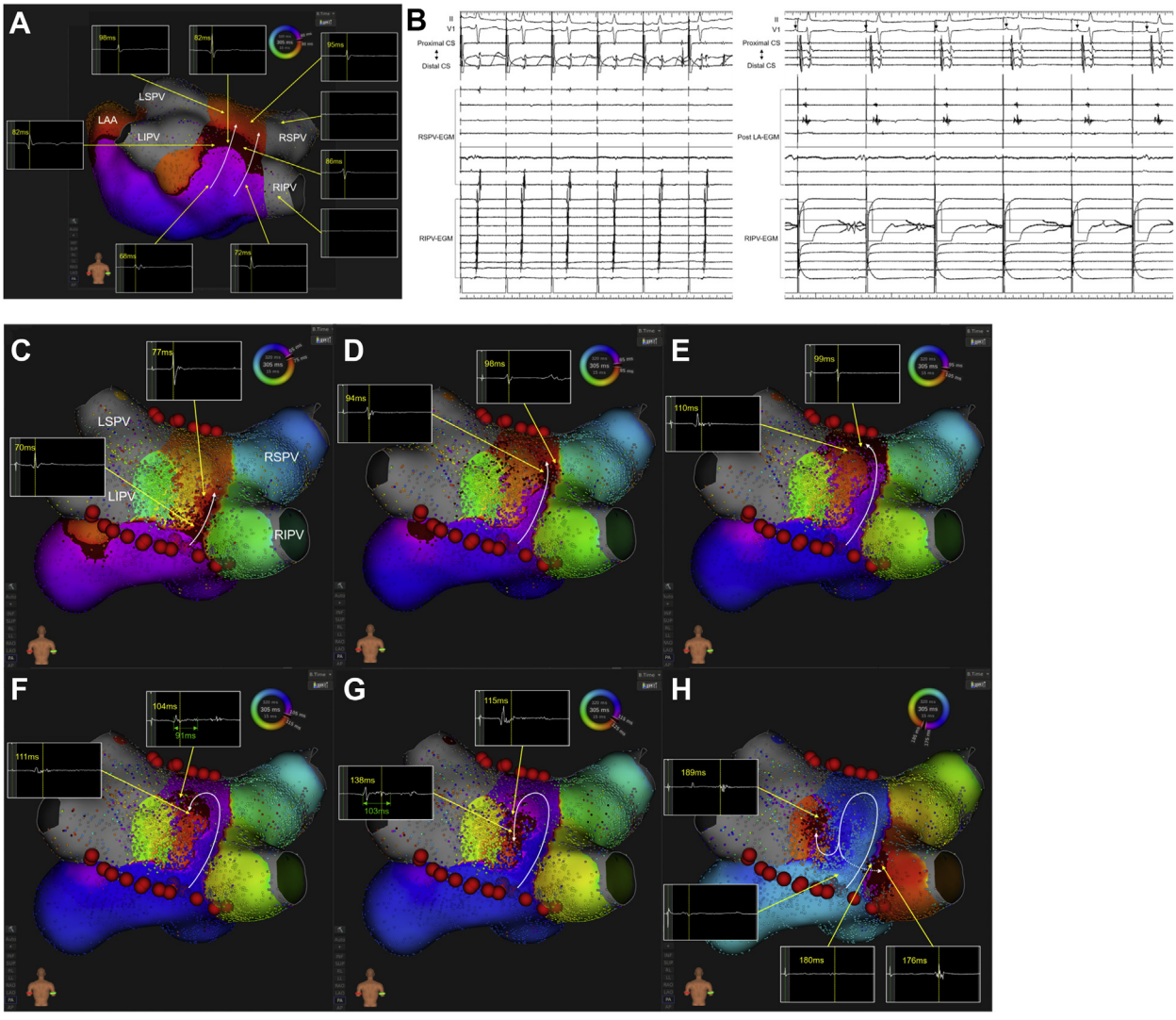

Figure 1 **A:** An activation map during coronary sinus (CS) pacing before the box isolation (BOXI). **B:** A unidirectional reconnection from the left atrium (LA) to the right-sided pulmonary veins (RPVs; left panel) and exit block from the right inferior pulmonary vein (RIPV) to the posterior LA (right panel) during the BOXI. Activation maps during CS pacing after the BOXI demonstrated **C:** conduction from the inferior LA to the right side of the posterior LA through the conduction gap on the inferior BOXI line; **D:** inferior-to-superior conduction on the right side of the posterior LA; **E, F:** turning around from the right to left side of the posterior LA; **G:** superior-to-inferior slow conduction on the left side of the posterior LA; and **H:** suspected epicardial conduction from the left side of the posterior LA to the RIPV. The red tags and dark red on the maps represent the radiofrequency application sites and activation wavefront, respectively. The white solid and dotted arrows on the maps and black arrows on the electrocardiograms indicate the endocardial and epicardial activation propagation and P waves during sinus rhythm, respectively. All activation maps and the online video were created using the mini-basket catheter, and the confidence mask for the maps and online video was set at 0.03 mV. CS = coronary sinus recordings; LAA = left atrial appendage; LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; Post LA-EGM = posterior LA mapping catheter recordings; RIPV-EGM = RIPV mapping catheter recordings; RSPV = right superior pulmonary vein; RSPV-EGM = RSPV mapping catheter recordings.

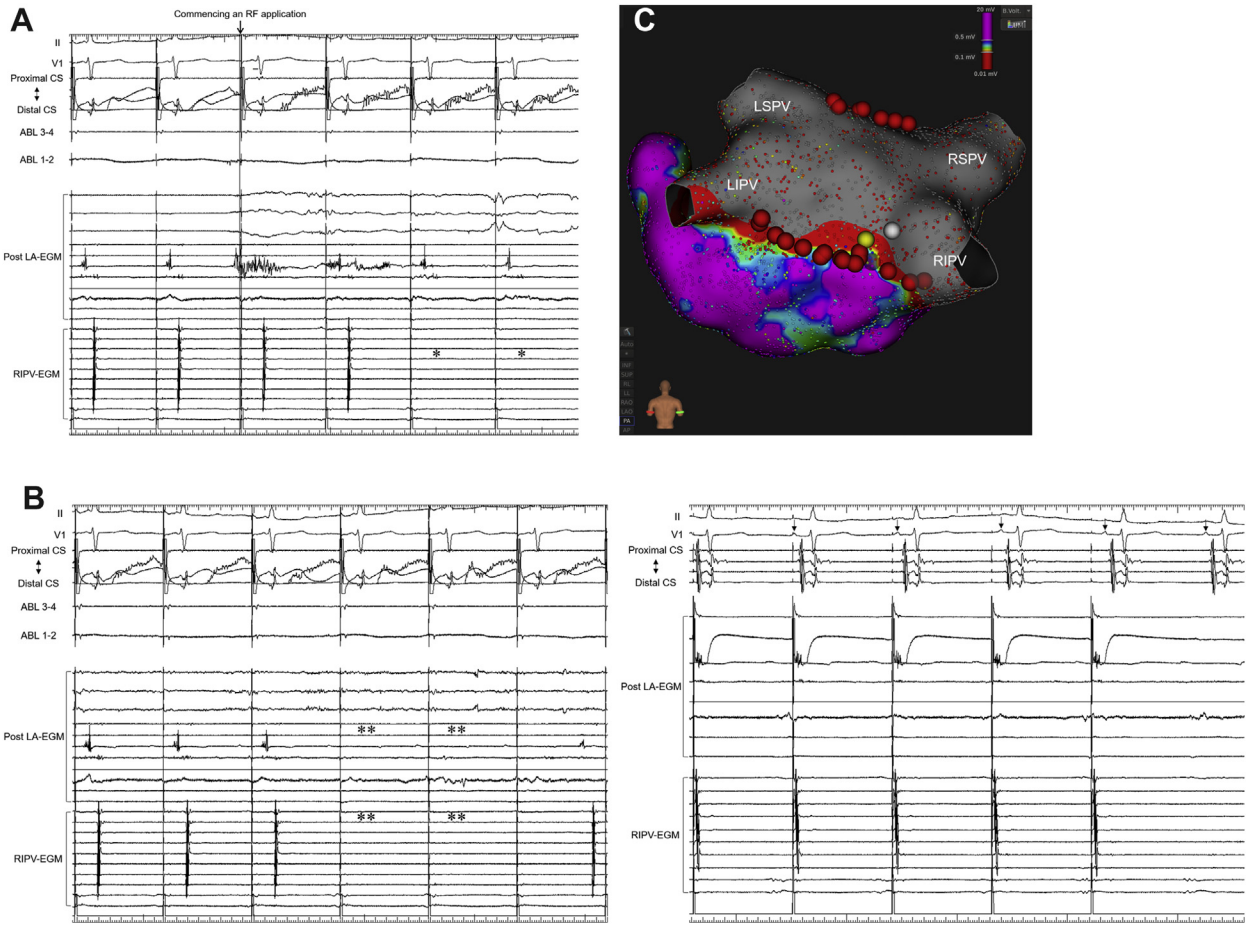

Figure 2 **A:** Transient elimination of the connection between the left side of the posterior left atrium (LA) and right inferior pulmonary vein (RIPV) during ongoing ablation (*). **B:** Completion of the box isolation (BOXI) with a radiofrequency (RF) application at the conduction gap on the inferior BOXI line (**). Coronary sinus (left panel) and posterior LA (right panel) pacing demonstrated entrance and exit block of the BOXI, respectively, and the conduction from the posterior LA to the RIPV still persisted after completing the BOXI. **C:** Final RF ablation sites on the postablation voltage map. The yellow and white tags represent the RF ablation sites with completion of the BOXI and transient conduction block between the posterior LA and RIPV, respectively. ABL 1-2 and 3-4 = distal and proximal ablation catheter recordings. Abbreviations are as in Figure 1.

isolation line during the first ablation procedure. Wong and colleagues[2] demonstrated that a different pacing cycle length and direction of the wavefront propagation during LA substrate mapping in AF resulted in significant changes in the voltage, conduction velocity, and complex fractionation. In the present case, both the pacing cycle length of 600 ms and pacing site of the CS during activation mapping were the same before and after the BOXI. Thus, remarkable slow conduction from the superior to inferior direction on the left side of the posterior LA appeared to have resulted from conduction block from the inferior to superior direction along the left-sided inferior BOXI line. Further, the change in the wavefront direction and occurrence of slow conduction in the posterior LA may have facilitated the PV reconnection. To the best of our knowledge, there have been no previous studies reporting the impact of the change in the conduction pattern of the posterior LA on the occurrence of PV reconnections in PVs, which had already acquired bidirectional PV–LA conduction block.

The origin and course of the connection between the left side of the posterior LA and RIPV remain unclear. No local potentials were recorded between these areas during an activation blanking period from the left side of the posterior LA to the RIPV, but the RF application on the right side of the posterior LA transiently eliminated the LA–RPV connection. These findings suggested the presence of epicardial conduction from the left side of the posterior LA to the RIPV.[3–5] Epicardial sparing by insufficient RF applications during the first PV isolation procedure also appeared to have contributed to the LA-to-RPV reconnection.

Appendix
Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2020.04.018.

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