

CASE REPORT

ADVANCED

CLINICAL CASE

Epicardial Connections as Intra-Atrial Conduction Routes in a Patient With Advanced Atrial Remodeling



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ABSTRACT

In a patient with long-standing persistent atrial fibrillation, elimination of an epicardial connection between the right-sided pulmonary venous carina and the right atrium during catheter ablation resulted in intra-atrial conduction injuries in the presence of advanced atrial remodeling. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2021;3:1774-1779)
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Pulmonary vein (PV) isolation is widely applicable as an effective treatment for atrial fibrillation (AF). Electrophysiologists occasionally encounter right-sided PVs (RtPVs) that are difficult to isolate without ablation in the PV carinal area, thus suggesting the presence of an epicardial connection (EC) between the RtPV carina and the right atrium (RA) (1-7).

HISTORY OF PRESENTATION

A 51-year-old woman was referred to our institution (Ibaraki Prefectural Central Hospital, Kasama, Japan) for catheter ablation of symptomatic

LEARNING OBJECTIVES

- To recognize IAC injuries in patients with atrial remodeling associated with AF.
- To realize that IAC injuries can occur following standard RtPV isolation if ECs attach inside the circumferential ablation line in the remodeled atrium.

persistent AF. Echocardiography revealed normal left ventricular function and an enlarged left atrium (LA) (48 mL/m²).

PAST MEDICAL HISTORY

She had a history of takotsubo cardiomyopathy.

INVESTIGATIONS

Sinus rhythm (SR) was restored by electrical cardioversion followed by left atrial mapping using a PENTARAY catheter under CARTO guidance (Biosense Webster, Inc.). The earliest activation site (breakthrough) in the LA was solely observed on the anterior wall near the right superior PV antrum (**Figure 1A**), thus suggesting a disturbance of intra-atrial conduction (IAC) through the Bachmann's bundle and the presence of an EC (1). In addition, because the conduction from the sinus node to the left atrial breakthrough site was rapid (39 milliseconds), this conduction was considered more preferential and dominant than other possible conduction routes through the fossa ovalis and coronary sinus (CS).

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the [Author Center](#).

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MANAGEMENT

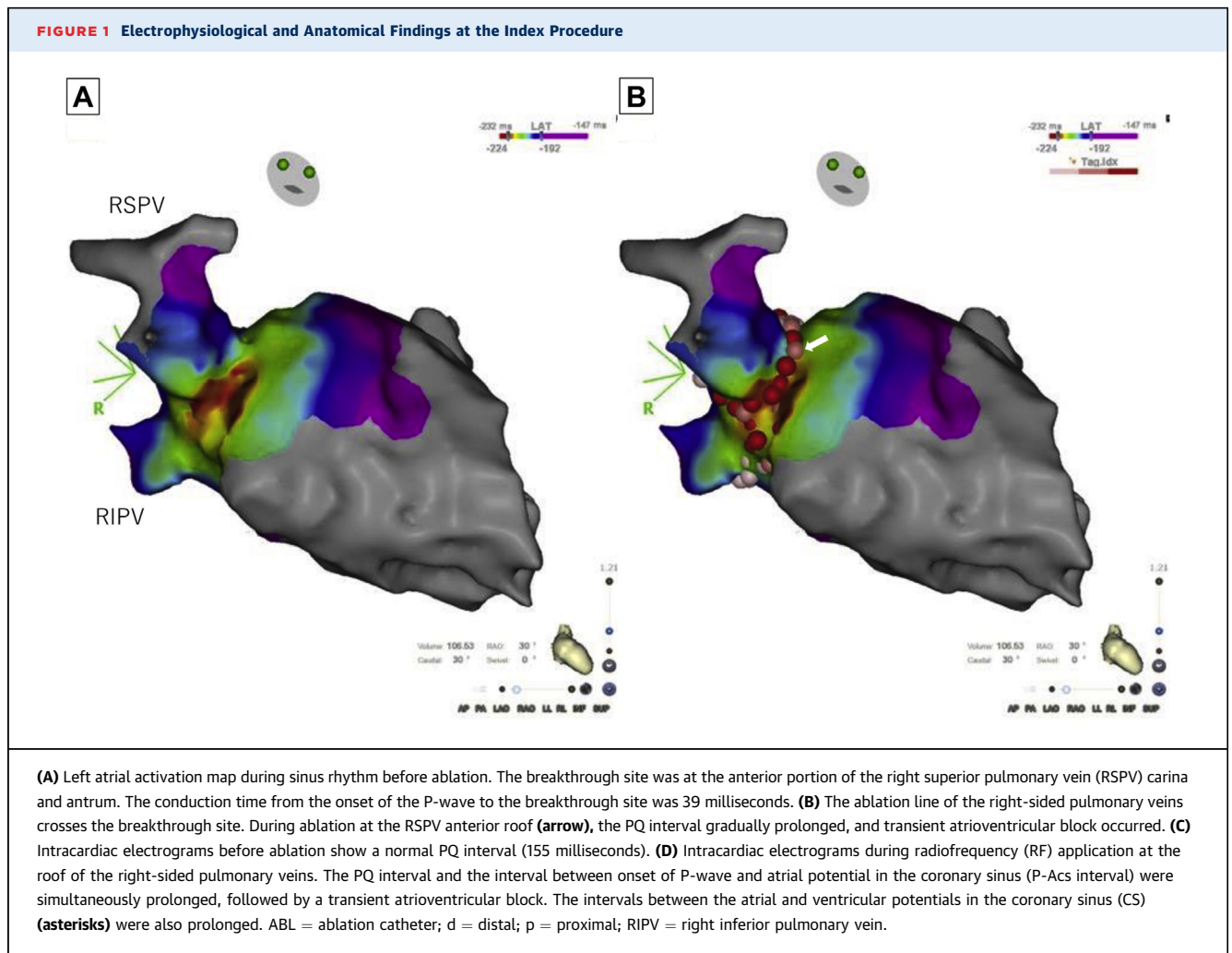
After successful isolation of the left-sided PVs, RtPV ablation was performed in which antral linear applications crossed the earliest activation site of the LA (Figure 1B). During ablation at the RtPVs (white arrow, Figure 1B), the PQ interval gradually prolonged from 155 to 312 milliseconds, followed by transient 2:1 atrioventricular (AV) block. Of note, this prolongation partially derived from the prolongation of the interval between the onset of the P-wave and the atrial potential in the CS (P-Acs) (Figures 1C and 1D), indicating the presence of an IAC delay. Although ablation of the RtPV carina was added, isolation failed. This PQ interval prolongation persisted even at the patient's discharge 3 days after the procedure (210 milliseconds).

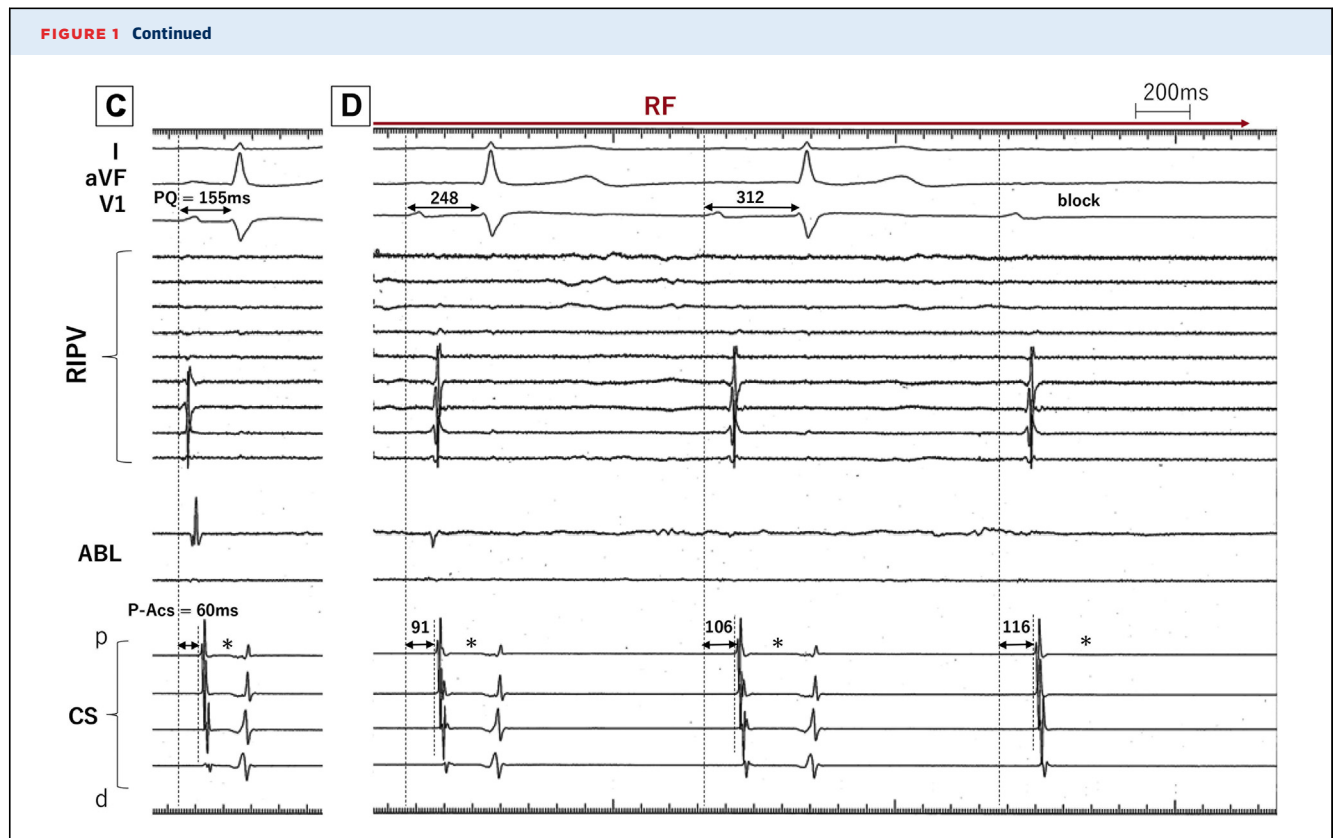
AF recurred and persisted early after the procedure, and a redo procedure was performed 6 months later. Spontaneous recovery of the PQ

interval was noted after cardioversion. Although PV potentials were found in the RtPV carina, gap conduction was unlikely, on the basis of careful PV antral mapping and the pacing study (8). Thus, we decided to create an activation map of the RA during pacing from a LASSO catheter (Biosense Webster, Inc.) placed in the right superior PV (5,8). The earliest activation site was found in the right atrial posteroseptal wall (Figure 2A), and ablation of that site achieved RtPV isolation (Figure 2B). Notably, during this application, the P-Acs interval was prolonged again (Figure 2B). Right atrial mapping during SR revealed a broad low-voltage area (Figure 2C), and the sinus impulse propagated unidirectionally only toward the anterior wall (Figure 2D, Video 1). The PQ interval remained prolonged postoperatively (240 milliseconds).

ABBREVIATIONS AND ACRONYMS

- AF** = atrial fibrillation
- AV** = atrioventricular
- CS** = coronary sinus
- EC** = epicardial connection
- IAC** = intra-atrial conduction
- LA** = left atrium
- P-Acs** = interval between onset of the P-wave and atrial potential in the coronary sinus
- PV** = pulmonary vein
- RA** = right atrium
- RtPV** = right-sided pulmonary vein
- SR** = sinus rhythm





DIFFERENTIAL DIAGNOSIS

Stimulation of ganglionated plexuses (GPs) by ablation can induce PQ prolongation and AV block.

DISCUSSION

Although the presence of an EC can predict technical difficulty in isolation and a worse outcome after catheter ablation,⁽²⁾ its physiological function and electrophysiological role are unclear.⁽⁵⁾

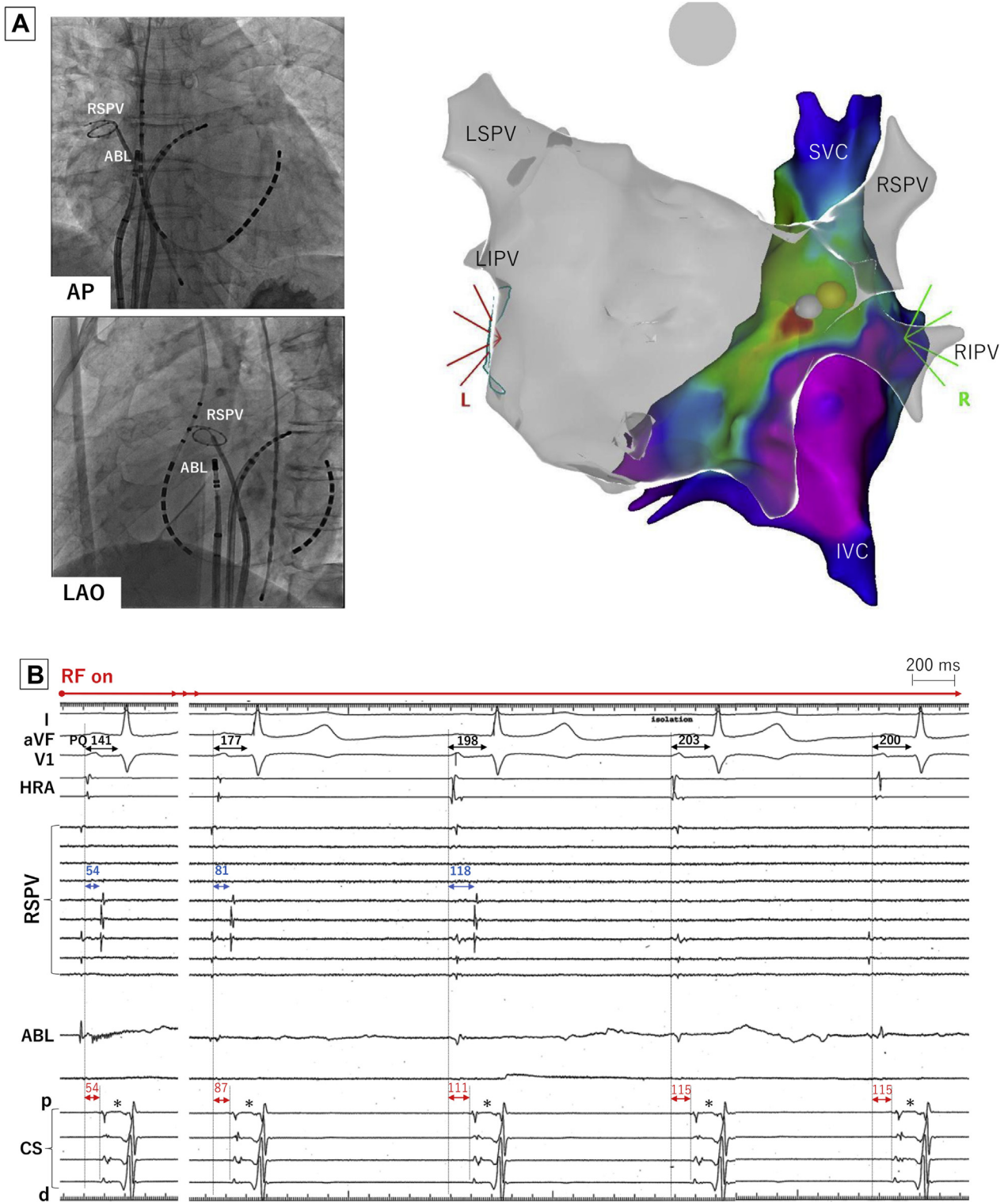
During SR, the largest, most common, and preferential anatomical route for IAC is through the Bachmann's bundle^(9,10). In the present patient, left atrial mapping revealed that a sinus impulse broke through solely to the RtPV carinal region, and this finding was considered to suggest the presence of an EC connecting the RtPVs and the RA⁽¹⁾. This EC precluded isolation of the RtPVs by circumferential lesion sets in the index procedure, and ablation at the posterior wall of the RA in the redo procedure achieved successful isolation^(1,3). Because the antral ablation line actually crossed this breakthrough area^(Figure 1B), the right-to-left conduction through the EC may have partially remained even after complete encirclement of the RtPVs (tag No. 1, [Figure 3](#)). We thought that ablation (tag No. 2, [Figure 3](#)) not only

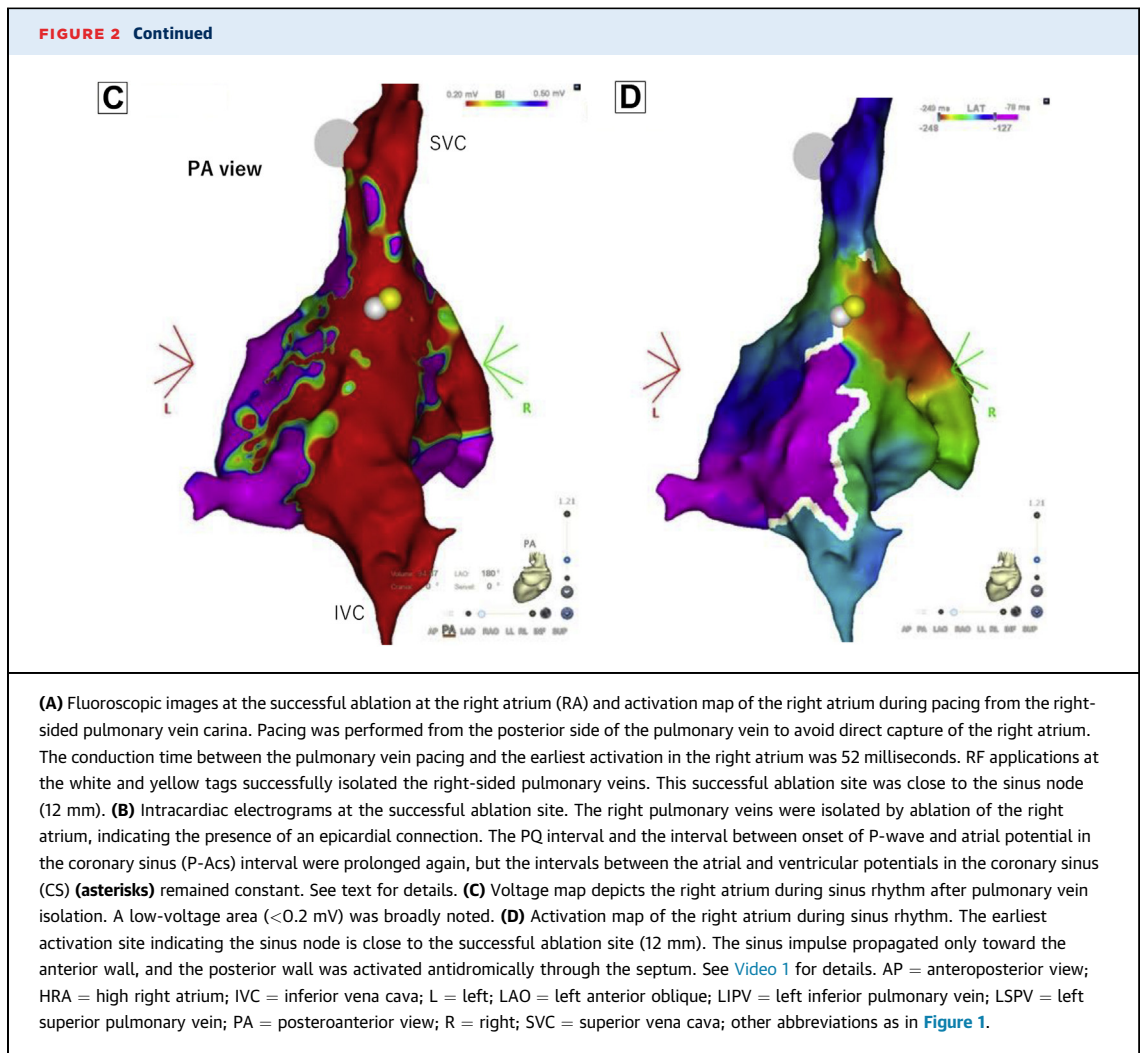
eliminated the EC attaching inside the RtPVs but also injured conduction by the EC attaching outside the PVs, thus accounting for the prolonged P-Acs interval during this ablation. We hypothesized that ablation tag No. 2 in [Figure 3](#) further promoted the IAC disorder and caused a block such that the sinus impulse passed only through the impaired right atrial anterior wall ([Figure 3, Video 1](#)). Because the P-wave configuration did not change significantly, delayed conduction through the Bachmann's bundle may have persisted after ablation.

During the redo procedure, the PQ interval and P-Acs interval were prolonged to almost the same degree ([Figure 2B](#)), thereby indicating IAC injuries. Stimulation of GPs was unlikely because the sinus rate and arterial blood pressure did not decrease during ablation, and the PQ interval prolongation persisted after ablation. However, in the index procedure, not only the P-Acs interval but also those between the atrial and ventricular potentials in the CS were prolonged (asterisks, [Figures 1C and 1D](#)), possibly indicating that both IAC impairment and GP response contributed to the PQ interval prolongation.

Recent investigations have provided additional evidence to link IAC disturbance with AF. Kanemaru et al⁽¹¹⁾ measured conduction time between the high

FIGURE 2 Electrophysiological and Anatomical Findings at the Second Procedure





RA and the CS during SR as a surrogate of IAC time, and it was a predictor of AF recurrence after catheter ablation. Spies et al (10) focused on mechanisms of PQ interval prolongation in patients with atrial arrhythmias, and right IAC delay estimated by His bundle recording was a underlying cause in patients with AF and atrial flutter compared with the control group. In this regard, His bundle recording during AF ablation is helpful in detecting and preventing the occurrence of IAC disturbance, and we must consider the possibility that extensive ablation beyond PVs can lead to atrial dyssynchrony and negatively affect the prevention and suppression of AF.

FOLLOW-UP

Amiodarone, 100 mg daily, was prescribed after ablation, and the PQ interval remained prolonged (210 milliseconds) 6 months after the second procedure.

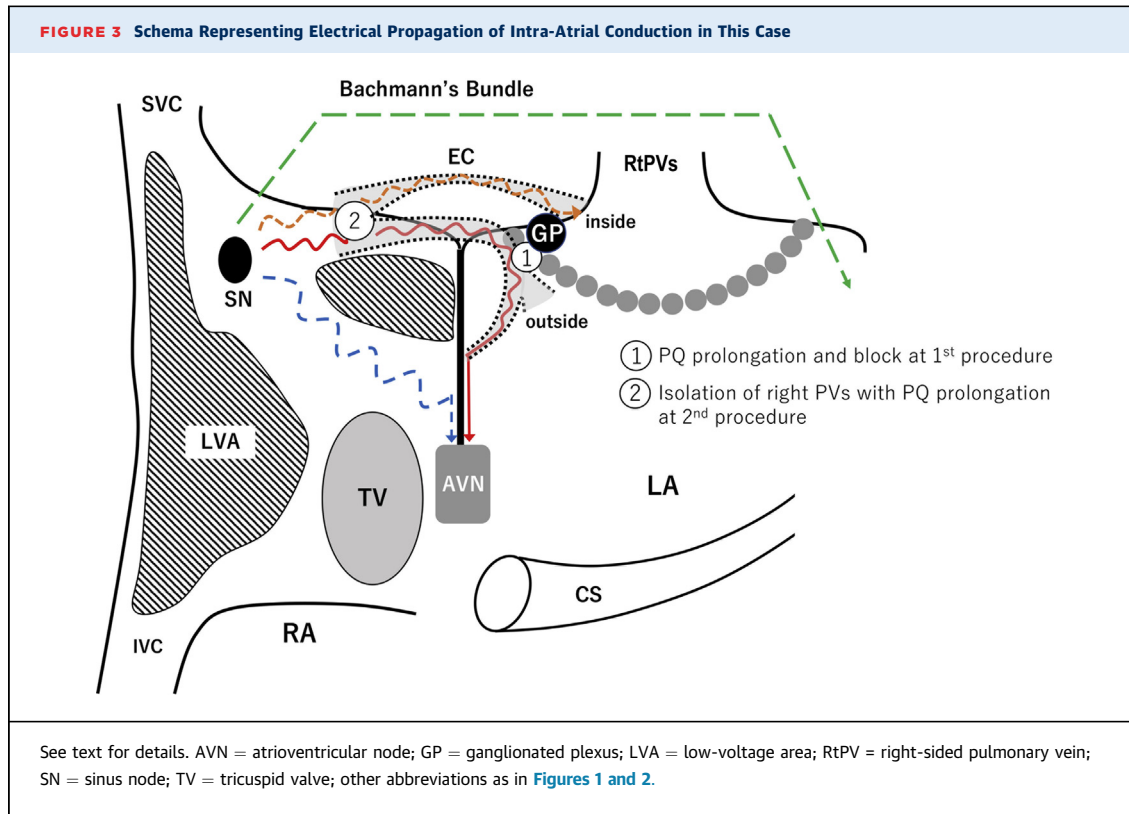
CONCLUSIONS

Although it was difficult to delineate the overall course of atrial conduction within this ablation procedure, this report showed that even in patients without a history of previous open heart surgery, IAC injuries can occur following standard RtPV isolation if ECs attach inside the circumferential ablation line.

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KEY WORDS ablation, atrial fibrillation, Bachmann's bundle, pulmonary vein isolation

APPENDIX For a supplemental video, please see the online version of this paper.