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【 CASE REPORT 】

Gap-related Pulmonary Vein and Left Atrial Flutter Mimicking Cavotricuspid Isthmus-dependent Atrial Flutter

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Abstract:
We herein report a 79-year-old man with recurrent atrial flutter (AFL) following catheter ablation for pulmonary vein (PV) isolation and block line of the cavotricuspid isthmus. An electrophysiological study and three-dimensional mapping results revealed left atrium (LA)-PV macroreentrant flutter caused by a conduction gap, possibly correlated to prior application, which mimicked cavotricuspid isthmus-dependent AFL. This LA-PV flutter was terminated after applying radiofrequency to the gap at the antrum near the bottom left inferior PV in the posterior LA wall. During follow-up, the patient did not present with atrial tachyarrhythmias; antiarrhythmic drugs were therefore not administered.

Key words: conduction gap, entrainment mapping, pulmonary vein isolation, three-dimensional mapping, typical atrial flutter

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Introduction

Atrial tachyarrhythmias occasionally recur following catheter ablation for atrial fibrillation (AF). Regular atrial tachyarrhythmias are usually caused by left atrium (LA)-pulmonary vein (PV) macroreentrant flutter, which may be associated with an iatrogenic conduction gap in a prior application line (1).

We herein report a patient with PV-LA flutter that developed after catheter ablation and mimicked cavotricuspid isthmus-dependent AFL.

Case Report

A 79-year-old man was referred to our hospital for the evaluation and treatment of narrow QRS tachycardia. He had undergone catheter ablation for PV isolation for paroxysmal AF and linear ablation for cavotricuspid isthmus with counterclockwise rotation of the tricuspid annulus for typical atrial flutter (AFL). The patient's symptoms included palpitation and exertional dyspnea. The 12-lead electrocardiogram (ECG) obtained during palpitation revealed the presence of AFL, which was believed to be recurrence of the counterclockwise rotation of typical AFL.

As shown in Fig. 1A, dominant negative deflections in the inferior leads were visible on the 12-lead ECG obtained at admission; these results usually indicate a counterclockwise rotation of the reentrant circuit around the tricuspid annulus. The upright flutter waves were observed in the precordial leads. Although the patient had undergone PV isolation for AF and linear ablation for cavotricuspid isthmus, these results indicated the risk of recurrent typical AFL.

An electrophysiological study was conducted to assess the persistent narrow QRS tachycardia. As shown in Fig. 2, the cycle length of AFL in this tachycardia was 190 ms, and the sequence of atrial activation during tachycardia was as follows: high right atrial septum, high lateral right atrium (RA), and low lateral RA. The potentials of the RA appendage, coronary sinus, and bundle electrode were nearly consistent during tachycardia. Entrainment mapping was performed from the low lateral RA and distal coronary sinus with a pacing cycle length of 175 ms during tachycardia and an atrial cycle length of 190 ms. The postpacing intervals

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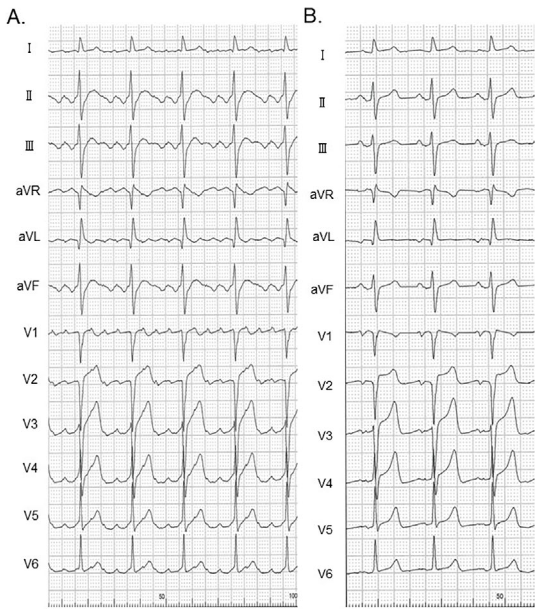

Figure 1. (A) The 12-lead ECG at rest revealed dominant negative deflections in the inferior leads, with a low amplitude flat to biphasic flutter wave in leads I and aVL and an upright flutter wave in the precordial leads. (B) The 12-lead ECG at rest revealed a sinus rhythm (78 bpm) after treatment. ECG: electrocardiogram

were 426 ms (Fig. 2A) and 270 ms (Fig. 2B) for tachycardia, respectively. We therefore believed that the reentrant circuit had exited via the LA.

Based on this, using the transseptal approach, we performed high-density mapping of the LA and PV during tachycardia using a three-dimensional mapping system (CARTO® PENTARAY® catheter and CARTO® 3 system; Biosense Webster, Irvine, USA). An iatrogenic conduction gap-related LA-PV macroreentrant circuit in the posterior LA wall, which entered from the antrum near the bottom of the left inferior PV and exited via the LA roof at the antrum of the left superior PV on the prior ablation line, was identified using an isochronal map (Fig. 3A) and propagation map (Fig. 3B) from a posteroanterior view.

In addition, we performed entrainment mapping from the left superior PV ostium (burst pacing with a cycle length of 175 ms and a postpacing interval of 195 ms, as shown in Fig. 4A). Based on these findings, as shown in Fig. 4B-D, we inserted a radiofrequency application-irrigated ablation catheter (CARTO THERMOCOOL SMARTTOUCH® SF, Biosense Webster) to fill in the gap at the antrum near the bottom of the left inferior PV, and tachycardia was terminated 3.4 s after initiating the application. Subsequently, additional radiofrequency applications were delivered to the reconnected points in the antrum of both the left and right PVs and completed circumferential PV disconnection.

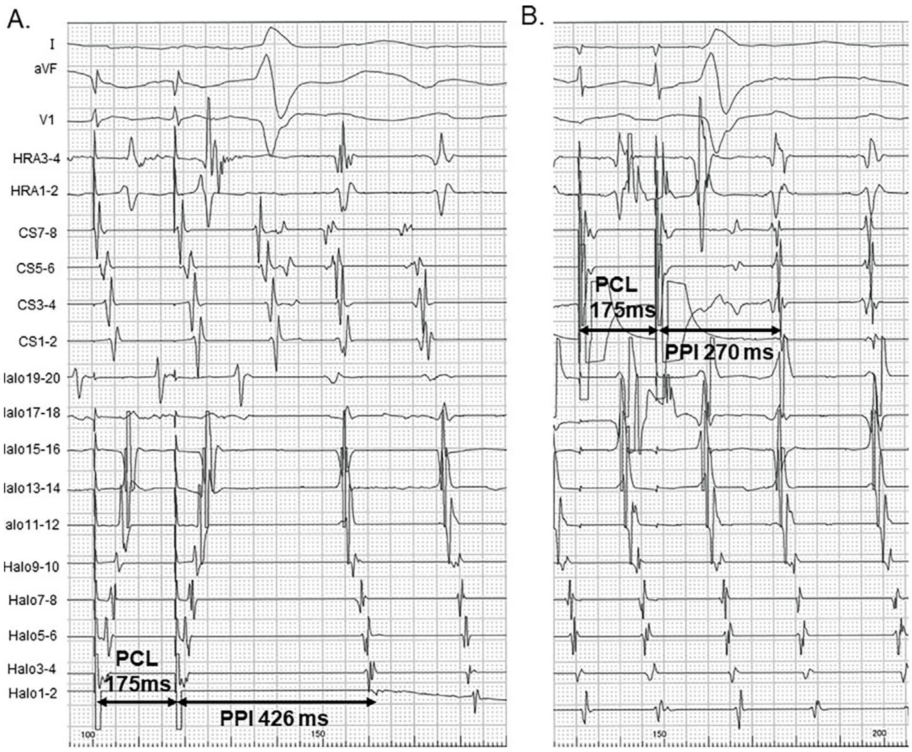

Figure 2. (A) Entrainment mapping from the lower lateral RA during tachycardia, with a pacing cycle length of 175 ms, revealed a postpacing interval of 426 ms. (B) Entrainment mapping from the distal coronary sinus during tachycardia, with a pacing cycle length of 175 ms, indicated a postpacing interval of 270 ms. CS: coronary sinus, Halo1-2: low lateral right atrium, Halo19-20: high septal right atrium, HRA: high right atrium, LSPV: left superior pulmonary vein, RA: right atrium, RV: right ventricle

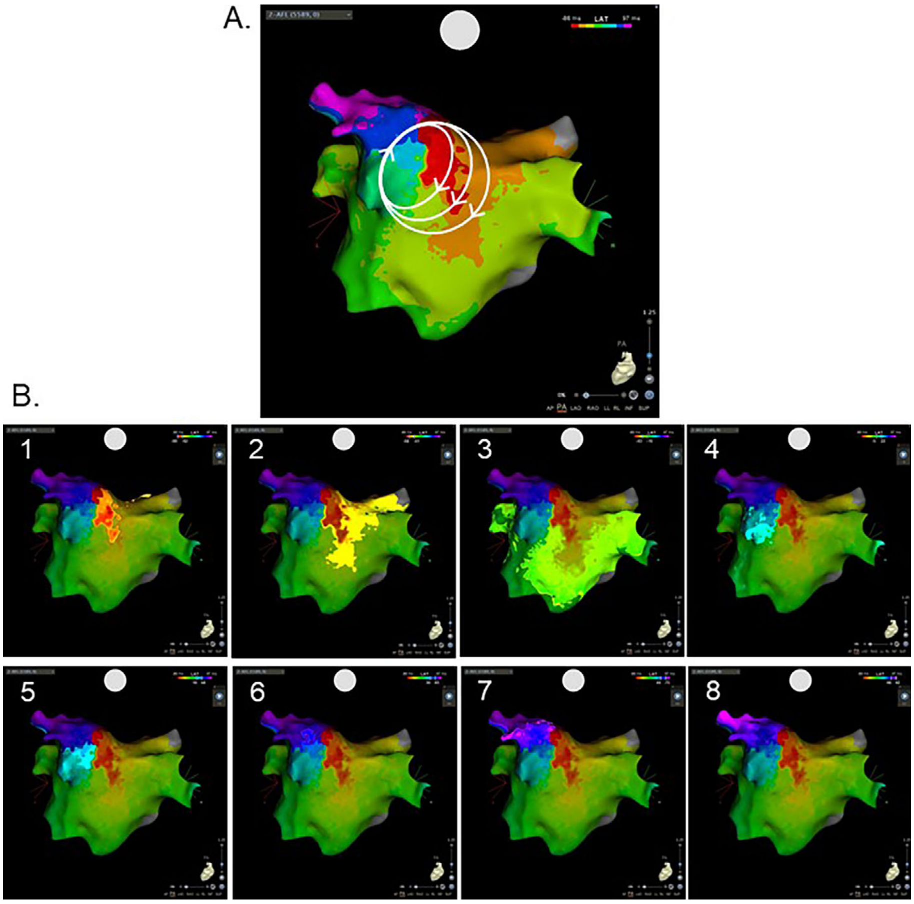

Figure 3. **Isochronal map (A) and propagation map (B) using the three-dimensional mapping system revealed LA-PV macroreentrant flutter that exited via the LA roof of the left superior PV antrum ablation line and entered from the antrum near the bottom of the left inferior PV. LA: left atrium, PV: pulmonary vein**

Thereafter, the patient's symptoms were relieved, and no recurrence was noted during the subsequent 10-month follow-up period (Fig. 1B).

Discussion

Satomi et al. (1) reported eight patients who presented with recurrent regular atrial tachycardia after the initial circumferential PV isolation, including two with an LA-PV macroreentrant pattern. Furthermore, the authors identified concealed entrainment within the PVs and performed three-dimensional mapping to confirm the presence of a LA-PV macroreentrant circuit.

In our patient, high-density LA-PV mapping and entrainment mapping during tachycardia clearly showed a conduction gap-related LA-PV flutter that entered from the antrum near the bottom of the left inferior PV and exited via the roof of the antrum of the left superior PV at the prior ablation line in the posterior LA wall.

Using a three-dimensional mapping system, Rodriguez et al. (2) investigated the biatrial activation pattern in the cavotricuspid isthmus-dependent AFL and confirmed that the posterior LA was activated in an inferior-to-superior direction in all patients with counterclockwise rotation of AFL. Conversely, the posterior LA was activated in a superior-to-inferior direction in our patient. Synchronous inferosuperior activation in the septal RA and posterior LA can elucidate the negative polarity of the AFL wave in the inferior leads.

In a 12-lead ECG showing a cavotricuspid isthmus-dependent AFL, an inverted sawtooth flutter wave pattern is usually observed in the inferior leads, with a low-amplitude flat to biphasic flutter wave in leads I and aVL, an upright flutter wave in the right precordial leads, and an inverted flutter wave in V_6 (3). The 12-lead ECG findings obtained during tachycardia in our patient, which mimicked those of a cavotricuspid isthmus-dependent typical AFL, can be attributed to the completed bidirectional block line along the cavotricuspid isthmus established during the earlier ablation that helped create a pattern of counterclockwise propagation in the RA. Possible causes of the upright flutter waves in the precordial leads in our patient include the following: the posterior LA activation pattern of the LA-PV flutter might have been in contrast to that of the cavotricuspid isthmus-dependent typical AFL; alternatively, the reentrant circuit might have originated from the posterior LA wall, which is located in the farthest posterior part of the heart, unlike in a cavotricuspid isthmus-dependent typical AFL, where it is located in a relatively anterior part of the heart.

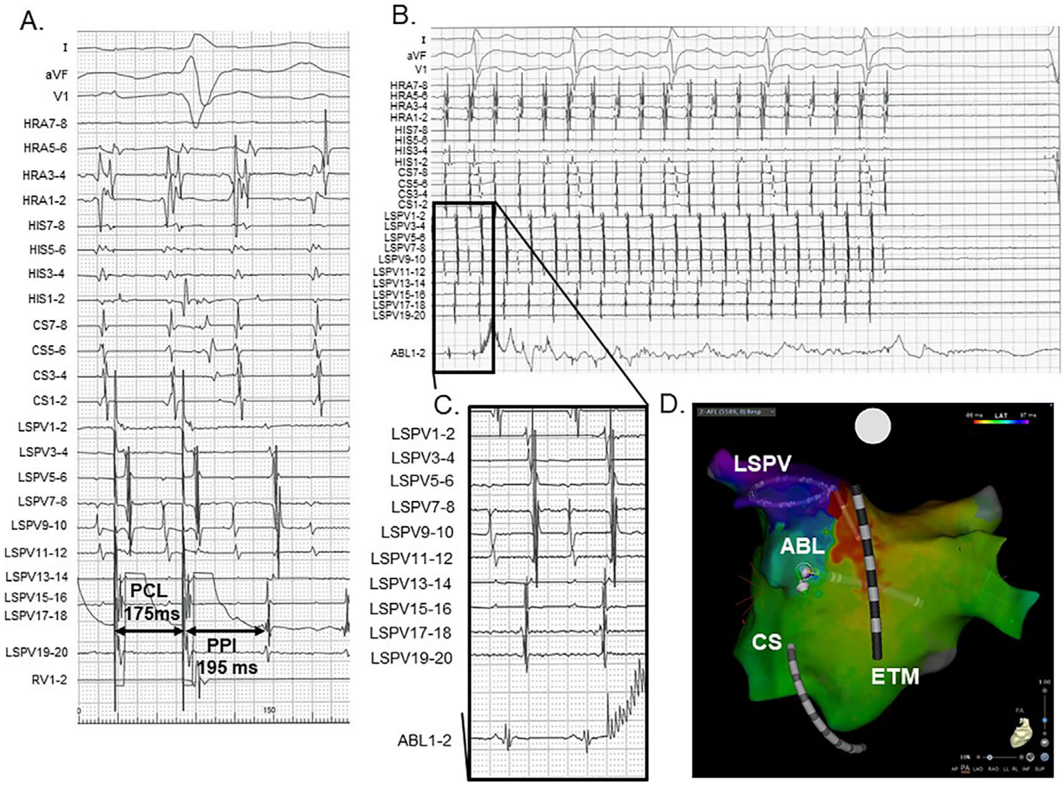

Figure 4. **(A) Entrainment mapping from the LSPV ostium during tachycardia, with a pacing cycle length of 175 ms, revealed a postpacing interval of 195 ms (B and C). During tachycardia, radiofrequency energy was delivered to the antrum near the bottom of the left inferior pulmonary vein (PV) in the posterior LA wall. Tachycardia was terminated 3.4 s after initiating radiofrequency. (D) The three-dimensional mapping system revealed the catheters in the isochronal map. The ablation catheter indicated the application point with a green arrow in a contact force direction from a posteroanterior view. CS: coronary sinus, Halo1-2: low lateral right atrium, Halo19-20: high septal right atrium, HRA: high right atrium, LSPV: left superior pulmonary vein, RV: right ventricle, ABL: ablation catheter, LSPV: left superior pulmonary vein, ETM: esophageal temperature monitor**

The authors state that they have no Conflict of Interest (COI).

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