What are the post-ablation insular residual electrograms in the posterior left pulmonary veins electrically connected to?

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A B S T R A C T

A 67-year-old man underwent a third ablation procedure for a recurrent atrial tachycardia (AT) after an extensive pulmonary vein (PV) isolation, linear ablation along the left atrial (LA) roof and posterolateral mitral isthmus (MI), and defragmentation of persistent atrial fibrillation and an induced perimitral AT. High-resolution mapping during the clinical AT using the Rhythmia system (Boston Scientific) suggested that the AT was a ridge-related reentrant AT and exhibited a reconnection of the left PVs (LPVs). The residual electrograms in the posterior LPVs were surrounded by endocardial scar, which was like an island consisting of residual LPV electrograms. Retrograde venography of the vein of Marshall (VOM) demonstrated that the VOM reached the posterior left superior PV through the ridge between the LA appendage and left inferior PV and then the LPV carina. An ethanol infusion into the VOM resulted in a simultaneous AT termination and complete electrical isolation of the LPVs, that is, the disappearance of the residual LPV electrograms. The insular residual LPV electrograms in the present case did not appear to be endocardially connected to the LA, because the LPV electrograms were surrounded by endocardial scar and there was a large time gap between the earliest activation in the posterior LPVs and activation in the surrounding area. The VOM course on the venography and the elimination of the residual LPV electrograms with an ethanol infusion into the VOM suggested that the insular residual LPV electrograms were electrically connected to the posterolateral LA via the VOM and its branches.

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1. Introduction

Some residual connections between the left pulmonary veins (LPVs) and left atrium (LA) during an extensive PV isolation of atrial fibrillation (AF) are associated with epicardial conduction via the vein of Marshall (VOM) or subepicardial myocardial strands [1–5]. Those epicardial connections are sometimes difficult to eliminate with touch-up radiofrequency ablation on the initial PV isolation lines, and require additional radiofrequency applications inside the initial PV isolation lines, such as at the carina region, to complete the electrical isolation of the PVs. We present a case with the insular residual electrograms in the posterior LPVs after an extensive PV isolation, which did not appear to be endocardially connected to the LA on high-resolution mapping. The VOM course on venography and the elimination of the residual LPV electrograms with an ethanol infusion into the VOM suggested that the insular residual LPV electrograms were electrically connected to the posterolateral LA via the VOM and its branches.

2. Case report

A 67-year-old man underwent a third ablation procedure for a recurrent atrial tachycardia (AT) with a tachycardia cycle length of 260 ms. The first procedure for persistent AF consisted of an extensive PV isolation, linear ablation along the left atrial (LA) roof, and defragmentation. The second procedure consisted of a re-isolation of the left inferior PV (LIPV) and linear ablation along the posterolateral mitral isthmus (MI) for an induced perimitral AT. During the third procedure, high-resolution mapping during the clinical AT using the Rhythmia system (Boston Scientific, Marlborough, MA) and a mini-basket catheter (IntellaMap Orion, Boston Scientific) suggested that the AT was a ridge-related reentrant AT...
Fig. 1. (A) Activation maps during the AT suggesting a ridge-related reentrant AT (Online Video 1). The numbers in the local electrograms indicate the intervals from the reference electrogram recorded in the coronary sinus to the local electrogram. The white solid and dotted arrows represent the endocardial activation propagation and possible epicardial conduction pathway via the VOM and its branches, respectively. (B) Bipolar voltage maps during the AT exhibiting insular residual LPV electrograms surrounded by endocardial scar (yellow arrows). The low voltage and scar areas were defined as areas with bipolar electrogram amplitudes of <0.5 mV and <0.1 mV, respectively. Abbreviations: LAA, left atrial appendage; LIPV, left inferior pulmonary vein (PV); LSPV, left superior PV; MA, mitral annulus; RIPV, right inferior PV; RSPV, right superior PV.

Fig. 2. Fluoroscopic images showing the course of the VOM and its branches (black and white arrowheads) (Online Video 2). The mini-basket catheter and circular mapping catheter are placed in the LAA and LIPV, respectively. Abbreviations: CS, coronary sinus. The other abbreviations are as in Fig. 1.

3. Discussion

This was a case report describing the complete elimination of the post-ablation insular residual electrograms in the posterior region of the LPVs (Fig. 1A, Online Video 1), and exhibited an LPV reconnection. The residual electrograms in the posterior region of the LPVs were surrounded by endocardial scar, which was like an island consisting of residual LPV electrograms (Fig. 1B). Retrograde venography of the VOM demonstrated that the VOM reached the posterior left superior PV (LSPV) through the ridge between the LA appendage (LAA) and LIPV and then the carina between the LPVs (Fig. 2, Online Video 2). An ethanol infusion into the VOM terminated the AT after a gradual prolongation of the tachycardia cycle length from 260 ms to 310 ms and concurrently electrically isolated the LPVs (Fig. 3). After the ethanol infusion with a total of 5 mL, voltage mapping exhibited the complete elimination of the insular residual LPV electrograms (Fig. 4).

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ipej.2021.04.008
LPVs with an ethanol infusion into the VOM. The VOM course on venography and the elimination of the LPVs electrograms with the VOM ethanol infusion suggested that the insular residual LPV electrograms were electrically connected to the posterolateral LA via the VOM and its branches. The residual LPV electrograms were surrounded by endocardial scar on the voltage map. Further, the activation map during the clinical AT revealed a large time gap between the earliest activation of the residual LPV electrograms and activation in the surrounding area, including the posterior and posterolateral LA and ridge, as in Fig. 1A. Those findings may indicate the absence of endocardial electrical connections between the LA and residual electrograms in the posterior LPVs.

The VOM usually arises from the coronary sinus in the posterolateral region of the LA and courses epicardially between the LAA and LPVs. Since the VOM has various venous branches [6,7], the extent of the ablation lesion obtained by an ethanol infusion into the VOM varies according to the extent of the VOM branches. A VOM ethanol infusion can create an ablation lesion along the MI area and ridge between the LAA and LPVs, which sometimes extends to the LA posterior wall and roof [7–12]. The VOM in the present case reached the posterior LSPV, which corresponded to the area with the insular residual electrograms. Therefore, the Marshall bundles along the VOM appeared to constitute an epicardial bypass between the insular residual LPV electrograms and posterolateral LA.

A VOM ethanol infusion can be useful for not only the PV isolation but also ablation of ATs and atrial flutters refractory to conventional radiofrequency-based ablation procedures, and can facilitate the creation of conduction block along the MI and eliminate Marshall bundle-related or ridge-related ATs [3,10,11,13–15]. Also in the present study, the VOM ethanol infusion was effective in both the treatment of the AT and the LPV isolation.

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Declaration of competing interest

No author has a real or perceived conflict of interest.

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