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Recurrent Perimitral Flutter due to Vein of Marshall Epicardial Connections Bypassing the Mitral Isthmus: Response to Ethanol Infusion

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Keywords

atrial tachyarrhythmia; perimitral flutter; vein of Marshall; epicardial connections; mitral isthmus; ethanol infusion

Case Presentation

A 68-year-old man with hypertension, dyslipidemia, obstructive sleep apnea, chronic obstructive pulmonary disease, sick sinus syndrome status post dual chamber pacemaker, and a history of two pulmonary vein isolation ablations for persistent atrial fibrillation, was evaluated in our institution for recurrent atrial flutter.

He underwent complete electrophysiology study. A duodecapolar catheter was used, so that the distal 10 poles were inside the coronary sinus (CS) and the proximal were in the right atrium (RA). The underlying rhythm was atrial flutter with a cycle length of 350 ms, and ostial-to-distal activations in the CS. Responses to entrainment were consistent with a left atrial origin. After a trans-septal puncture, a 3D map of the left atrium was performed using the NavX system (St. Jude Medical, St Paul, MN) and a circular duodecapolar catheter, which was consistent with counterclockwise perimitral flutter (PMF). However, the entire cycle length was not present in the mitral annulus (Figure 1A, 1B). An extensive scar was present in the previously ablated mitral isthmus, where no endocardial signals were detectable. Sites neighboring the scar (1–5 in Figure 1C, 1D) were either early (1–2) or late (3–4–5) relative to a reference (Ref) signal (Figure 1D).

In order to ascertain the role of the vein of Marshall (VOM) in providing with epicardial connections bypassing the endocardial mitral isthmus scar, we cannulated the VOM via the CS. A sheath was inserted in the CS through the right internal jugular vein. A LIMA angioplasty guide catheter was inserted in the CS with its tip facing posteriorly and superiorly in the right anterior oblique projection (Figure 1E). Contrast injection identified

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the VOM, which was subsequently cannulated with a 0.014" angioplasty wire and 2x6 mm angioplasty balloon (Medtronic, Minneapolis, MN) (Figure 1E, 1F). VOM signals were obtained by connecting the angioplasty wire in a unipolar fashion using alligator clips with the indifferent electrode clamped to the skin. By slightly exposing the wire beyond the balloon, only the exposed wire tip (~3 mm) would serve as an electrode, which could be located by the NavX system, and from which unipolar signals could be sequentially recorded at different depths of the VOM. Local activation times from different levels of the VOM were added to the NavX map (Figure 1C, 1D), and were shown to complete the reentrant activation sequence with the portion of the cycle length that was missing in the endocardial map.

Up to 4 injections of 98% ethanol were injected via the angioplasty balloon at different depths of the VOM. The first injection led to termination of the PMF (Figure 1G, H). Bidirectional perimitral block was subsequently proven by differential pacing. No radiofrequency ablation was required.

Discussion

PMF is a macro-reentrant tachycardia that typically occurs after left atrial ablation for atrial fibrillation. PMF is commonly treated by ablation in the so-called mitral isthmus, although this has been consistently reported as suboptimal. Failures can occur due to poor catheter contact, motion, or the thickness of the lateral ridge of the left atrium, as well as epicardial cooling of coronary sinus or VOM flow.^{1,2} It has also been hypothesized to occur due to remaining epicardial connections that bypass the endocardially ablated line,³ however definitive proof of such connections and their anatomical substrate has been lacking.

We have previously demonstrated that the VOM is part of the PMF circuit and that ethanol infusion in this vein assists in achieving mitral isthmus bidirectional block.⁴ Herein, we report the first proof a mechanistic role of VOM in recurrent PMF, by showing epicardial signals from the VOM in areas endocardially ablated, and the successful treatment by ethanol infusion.

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Figure 1.

Vein of Marshall (VOM) and perimitral flutter. **A–B**, 3D map of the left atrium illustrating counterclockwise perimitral flutter with extensive scar in the previously ablated mitral isthmus. The full reentrant cycle length is complete only after adding VOM activation times in **C**, **D**; Sites neighboring the scar (1–5) were either early (1–2) or late (3–4–5) relative to a reference (Ref) signal. Local activation times from different levels of the VOM were shown to complete the reentrant activation sequence with the portion of the cycle length that was missing in the endocardial map (VOMp and VOMd). **E–G**, Contrast injection identified the VOM, which was subsequently cannulated with a 0.014" angioplasty wire and 2x6 mm angioplasty balloon. **H**, Perimitral flutter terminates with VOM ethanol infusion.