# Ablation of perimitral flutter in a patient with a partially inaccessible left atrium

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## Introduction

Mitral valve disease and mitral valve surgery are important risk factors for the development of atrial arrhythmias.[1] Atrial tachycardias (AT) and atrial fibrillation are common in patients undergoing mitral valve surgery and are associated with increased morbidity and mortality.[2] Catheter ablation is a safe and effective approach when managing these arrhythmias and provides the opportunity to avoid lifelong antiarrhythmic therapy. The presence of a mitral valve prosthesis can make mapping and ablation of left AT more challenging. We describe a mapping and ablation strategy for a case of atypical flutter in a patient in whom a mechanical mitral valve was implanted in a supra-annular position, rendering a portion of the left atrial endocardium inaccessible via a traditional transseptal approach.

**KEY TEACHING POINTS**

- Mitral valve surgery creates left atrial scar, which can manifest as atrial tachycardias and atypical flutter.
- Traditional left atrial anatomy may be dramatically altered following mitral valve surgery. Supra-annular implantation of a mitral valve prosthesis may render portions of the left atrium inaccessible by a traditional transseptal approach.
- The lateral left atrial component of perimitral macroreentrant flutter can be targeted successfully with ethanol ablation of the vein of Marshall when arrhythmia substrate is not accessible from the endocardium.

## Case report

A 33-year-old woman with a past medical history of rheumatic heart disease and associated mitral valve stenosis underwent balloon valvuloplasty in 2013, followed by mitral valve repair in 2014. She subsequently developed *Mycobacterium chimaera* mitral valve endocarditis in 2016 requiring mechanical mitral valve replacement. In 2020 she was found to have a severe paravalvular leak requiring a repeat mechanical mitral valve surgery that necessitated implanting the prosthesis in an atrialized position (Figure 1B). She developed postoperative atrial fibrillation that required cardioversion and was discharged home in good condition.

The patient did well until early 2021, when she began to note recurrent episodes of palpitations and shortness of breath. She underwent successful ablation of cavotricuspid isthmus–dependent flutter but presented shortly thereafter in recurrent atrial flutter. She was taken for a second electrophysiological study, where she was found to be in a left atrial flutter, but transseptal puncture and left atrial ablation were not attempted owing to the atrialized position of the mechanical mitral prosthesis. She was cardioverted, with arrhythmia reoccurrence 3 days later, resulting in referral to our institution for further arrhythmia care.

In our clinic, the patient was noted to be in atrial flutter with positive flutter waves in the inferior leads as well as $V_1$–$V_3$ and isoelectric flutter waves in $V_4$–$V_6$ (Figure 1A). The ventricular rate was well controlled at 89 beats per minute. A transthoracic echocardiogram demonstrated a preserved left ventricular ejection fraction with a moderately dilated left atrium. Evaluation of the mitral prosthesis demonstrated normal function and gradients but implantation in a supra-annular position (Figure 1B). As the patient was very symptomatic from her arrhythmia, the decision was made to attempt catheter ablation.

The patient presented to the electrophysiology laboratory in her clinical flutter. The coronary sinus (CS) catheter showed a cycle length of 300 ms with proximal-to-distal activation. Entrainment maneuvers demonstrated the distal CS

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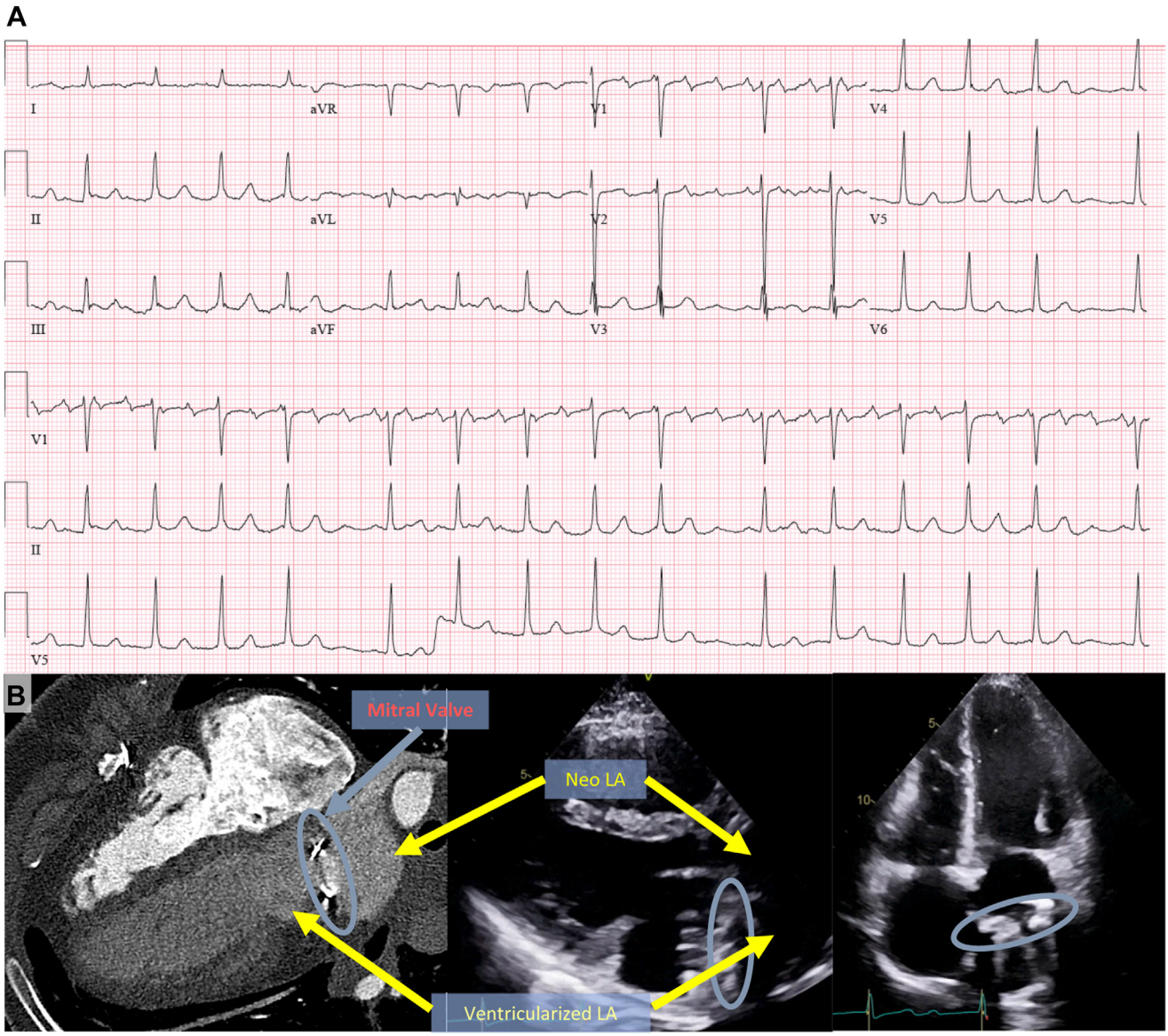


**Figure 1** Atypical flutter in a patient with a supra-annular mitral valve prosthesis. **A:** Electrocardiogram demonstrating an atypical flutter with variable atrioventricular block. **B:** Computed tomography and transthoracic echocardiography images demonstrating supra-annular implantation of the mitral valve prosthesis. LA = left atrium.

catheter was nearest the circuit with a postpacing interval minus tachycardia cycle length (PPI-TCL) of 30 ms with the proximal CS and right atrium out.

Intracardiac echocardiography was used to identify a safe window for transseptal puncture into the neo-atrium along the posterior fossa (Figure 2A). A left atrial (LA) 3D electroanatomical map revealed normal pulmonary vein anatomy with low-voltage regions (<0.2 mV) along the LA septum and prosthetic annular ring (Figure 2B). Activation mapping of the clinical flutter revealed only 45% of the cycle length (137/300 ms) within the neo–left atrium with breakout and best endocardial entrainment (PPI-TCL = 30 ms) along the roof near the left superior pulmonary vein (LSPV) and left atrial appendage (LAA). The posterior wall and LA septum were out while the lateral wall and coumadin ridge could not be mapped well owing to the catheter shaft interacting with the leaflets of the mechanical valve. Mapping of the CS was attempted, but the ablation catheter could not be advanced owing to a proximal CS stenosis.

Given her history of postoperative atrial fibrillation, the pulmonary veins were isolated and entrance and exit block were demonstrated while she remained in clinical flutter. As the best endocardial entrainment was along the roof near the LSPV and LAA, a roof line from LSPV to right superior pulmonary vein was created, with no effect on the tachycardia. Consideration was given to retroaortic mapping of the subvalvular component of the mechanical mitral valve, but femoral artery arteriogram demonstrated a small-caliber artery precluding introduction of a large sheath owing to increased risk of lower leg ischemia.

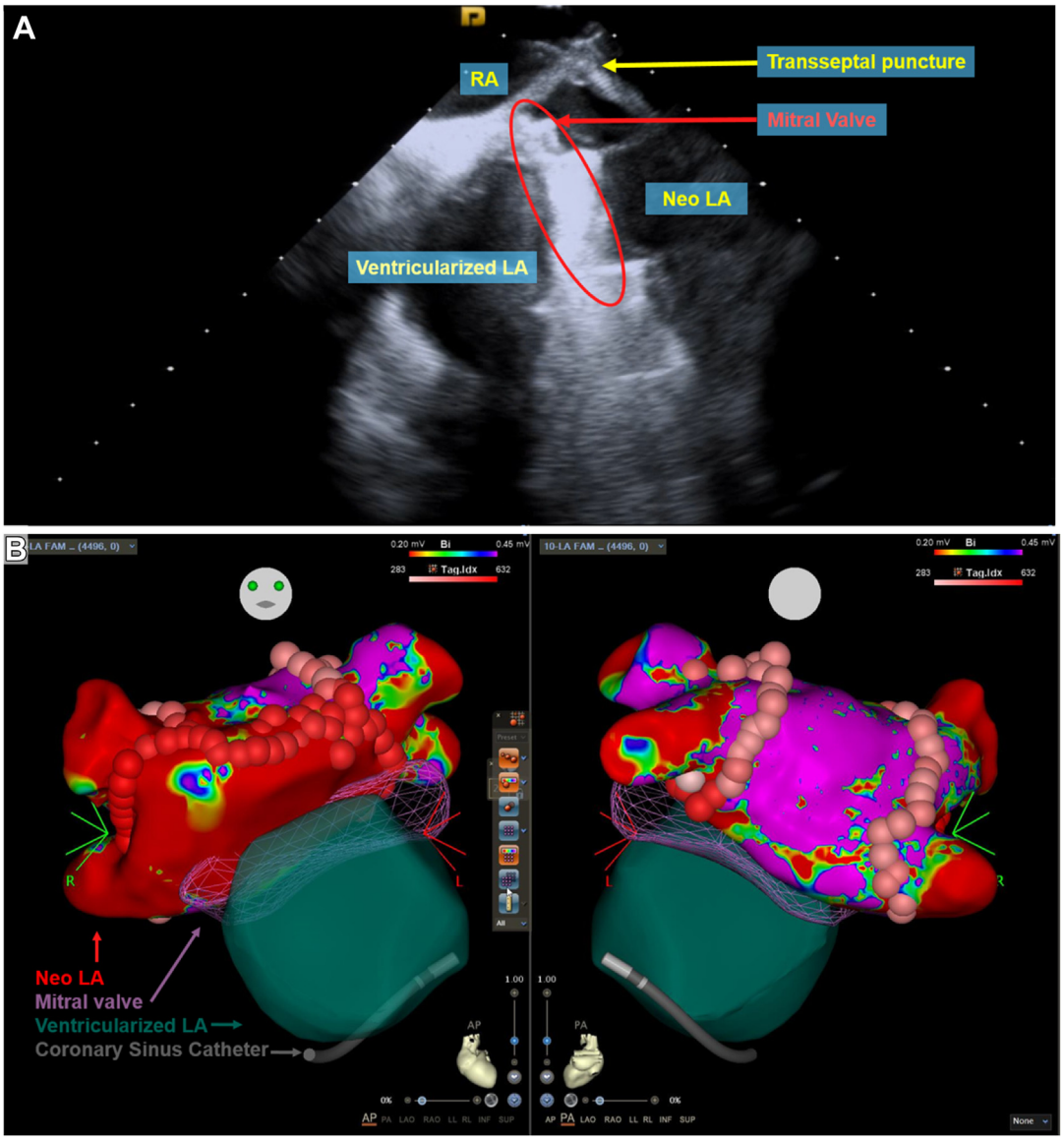


**Figure 2** Left atrial catheter ablation with a supra-annular mitral valve prosthesis. **A:** Intracardiac echocardiographic image of the transseptal puncture and left atrium (LA). RA = right atrium. **B:** Endocardial LA voltage map and lesion set with Cartosound reconstruction of the ventricularized LA and mitral valve.

As the 2 best entrainments were near the LSPV/LAA and distal CS, it was felt that the clinical flutter involved some combination of the lateral left atrium and/or vein of Marshall (VOM) that was protected by the mitral valve prosthesis. The CS and subsequently the VOM were identified using a 6F internal mammary artery catheter and a VisionWire (Biotronik, Berlin, Germany) (Figure 3). Entrainment from the wire within the VOM demonstrated a PPI-TCL = 10 ms (Figure 3). The decision was made to proceed with ethanol ablation of the VOM using a 2 mm coronary balloon, as has been previously described.[3] The first injection was performed distally near the LSPV/LAA and resulted in slowing the tachycardia from 300 ms to 350 ms. The balloon was withdrawn more proximally to the os of the VOM, where additional alcohol injection resulted in further slowing and termination of the clinical flutter. Atrial burst pacing was performed at this point and no further clinical arrhythmias were induced. The patient was awoken without complications and the patient was discharged home the next day off antiarrhythmic medications.

## Discussion

We present a unique case of a patient with an atypical atrial flutter that was not accessible to standard ablation catheters owing to interference from a mechanical mitral prosthesis implanted in a supra-annular position. Despite the steric limitations created by the prosthesis, mapping of the coronary venous system and the VOM identified a critical portion of the circuit that could be ablated successfully with local alcohol injection.

Supra-annular implantation of a mitral prosthesis is usually performed in children, in patients with extensive mitral annular calcifications, or in the setting of infective mitral

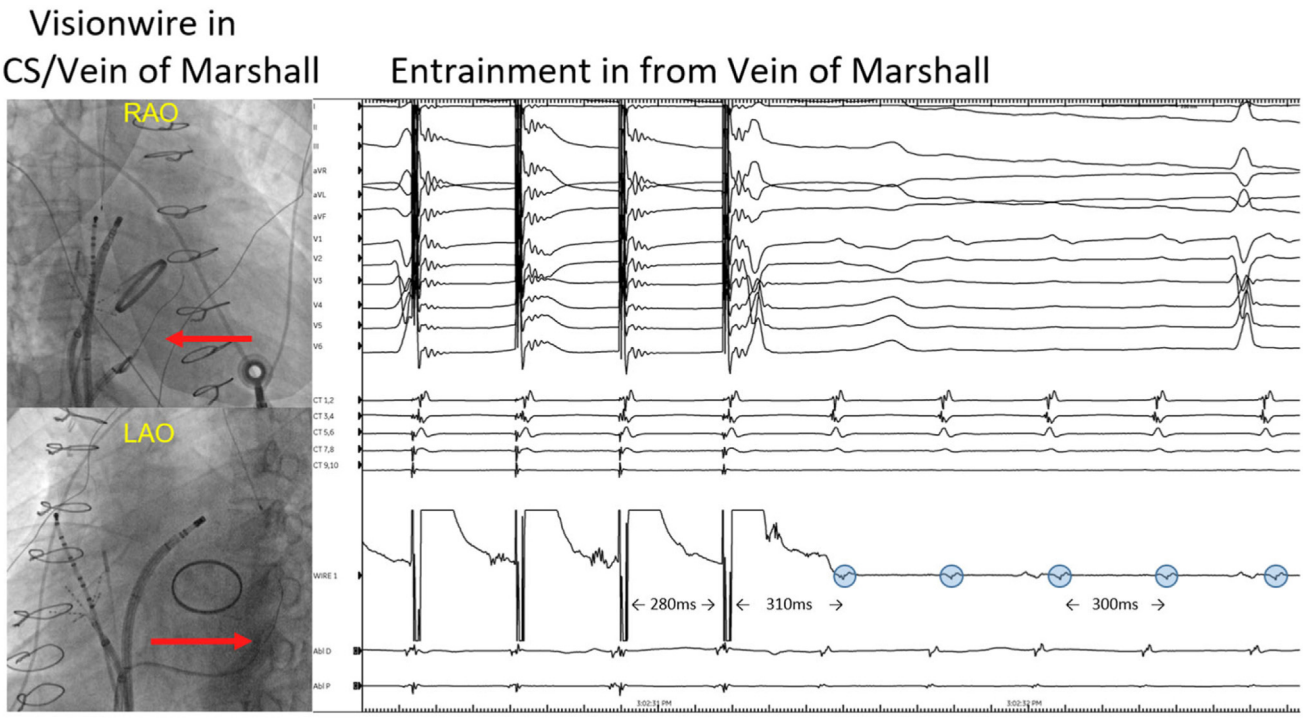


**Figure 3** Vein of Marshall cannulation with a VisionWire (Biotronik) with entrainment. Fluoroscopic images demonstrate VisionWire cannulation of the vein of Marshall (*red arrow*). Entrainment from the VisionWire demonstrates the vein of Marshall is within the atrial flutter circuit. CS = coronary sinus.

valve endocarditis. Although it is unknown if this valve location has any relationship to proarrhythmia, it is well recognized that mitral valve surgery can lead to macroreentrant AT.[4] Consistent with this, our patient presented with a flutter that involved the VOM/lateral LA, as demonstrated by entrainment and activation mapping. In most circumstances, mechanical mitral valve prosthesis–associated flutters can be safely and successfully ablated using standard transseptal techniques and catheters.[5,6] This was not true in this case, as the supra-annular site of valve implantation prevented access to a critical part of the circuit in the subvalvular LA and required mapping and ablation of the VOM.

The VOM is formed as a remnant of the embryonic left anterior cardinal vein providing electrical connections between the CS and LA. The VOM often plays a role in perimitral flutter, as 11% of perimitral flutters post pulmonary vein isolation or valve surgery have epicardial extensions involving the ligament of Marshall.[7] In many cases, ablation of this anatomic structure is essential to curing clinical arrhythmias by achieving bidirectional block across the mitral isthmus.[8] The VOM runs within the lateral ridge approximately 3 mm from the endocardial surface, rendering it susceptible to transmural lesions either epicardially through ethanol injection or endocardially with catheter ablation.[9] To this end, mitral annular thickness greater than 8.3 mm is predictive of failure to achieve block with endocardial ablation alone. This has led some groups to adopt a combined approach of radiofrequency catheter ablation and with VOM ablation for all patients.[10,11]

Although VOM ablation did eliminate the clinical flutter in the case reported here, the lateral left atrium remained unmappable with traditional catheter-based techniques. Consequently, we were unable to define the final pattern of ablation generated by the alcohol injection. It should be noted that a previous report suggests that alcohol injection of the VOM alone is sufficient to create transmural lines of block.[12]

In 18 months of follow-up, the patient is antiarrhythmic therapy free with a single arrhythmia episode occurring 1 month postablation involving a different atrial tachycardia (different cycle length, morphology, and axis).

## Conclusion

We describe a unique case of mechanical mitral prosthesis–associated flutter where a supra-annular surgical implantation rendered large portions of the left atrium inaccessible to catheter mapping and ablation. In these situations, the VOM can be explored, as it may be a critical component of perimitral flutter. Further, VOM ablation with ethanol can be performed safely and effectively in patients with inaccessible portions of the lateral left atrium.

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