

# Mitral annular flutter with epicardial coronary sinus conduit following mitral valve surgery



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## Introduction

The Society of Thoracic Surgeons recommends that maze procedure IV to treat persistent atrial fibrillation (AF) in patients undergoing concurrent mitral valve repair. Despite positive outcomes in most patients, macroreentrant atrial arrhythmia is commonly encountered following maze procedure and is associated with an increased risk of mortality and morbidity.<sup>1,2</sup> Often refractory to conservative management, these recurrent arrhythmias necessitate catheter ablation for treatment. Although the perimitral scar from mitral valve surgery or prior ablation facilitates slow conduction around the mitral annulus, the musculature of the coronary sinus (CS) also serves as a critical component of the reentry circuit in a significant number of patients with atypical flutter. We present a case of mitral annular flutter with the CS integral for reentry.

## Case report

A 64-year-old male patient with recurrent atypical atrial flutter (AFL) (Figure 1) with shortness of breath underwent an electrophysiological study. He has a history of successful mitral valve surgery with an Edwards Lifesciences bovine pericardial prosthesis. Owing to a history of paroxysmal AF, he underwent a maze procedure and left atrial appendage excision.

The flutter was induced with burst pacing from 280 to 220 ms in the CS, which had a chevron pattern (Figure 2A). Entrainment from the right atrial free wall and cavotricuspid isthmus had long return cycle lengths with manifest fusion.

**KEYWORDS** Atrial flutter; Coronary sinus; Maze procedure; Radiofrequency ablation; Mitral valve repair  
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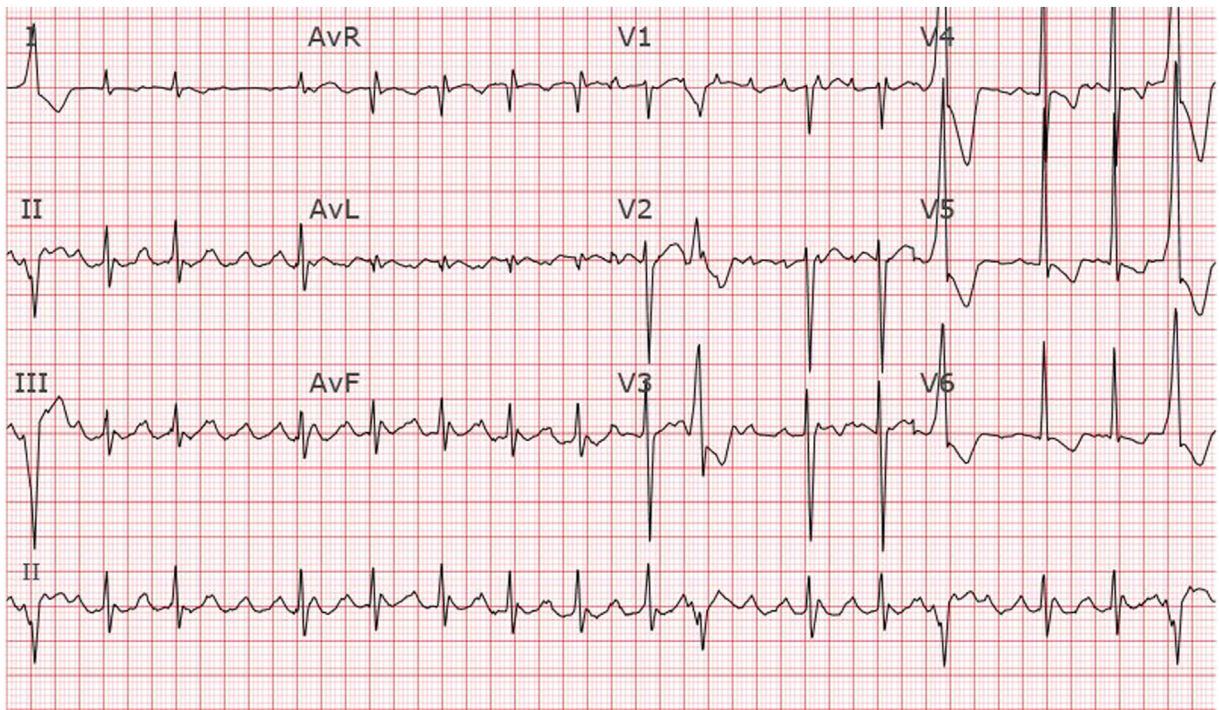
## KEY TEACHING POINTS

- Mitral annular flutter may frequently involve the coronary sinus owing to spatial proximity.
- High-density mapping of the entire cycle length of macroreentry may not offer sequential activation if a portion of the activation is missing.
- Integration of a nonmapping catheter may allow complete visualization of the activation sequence.

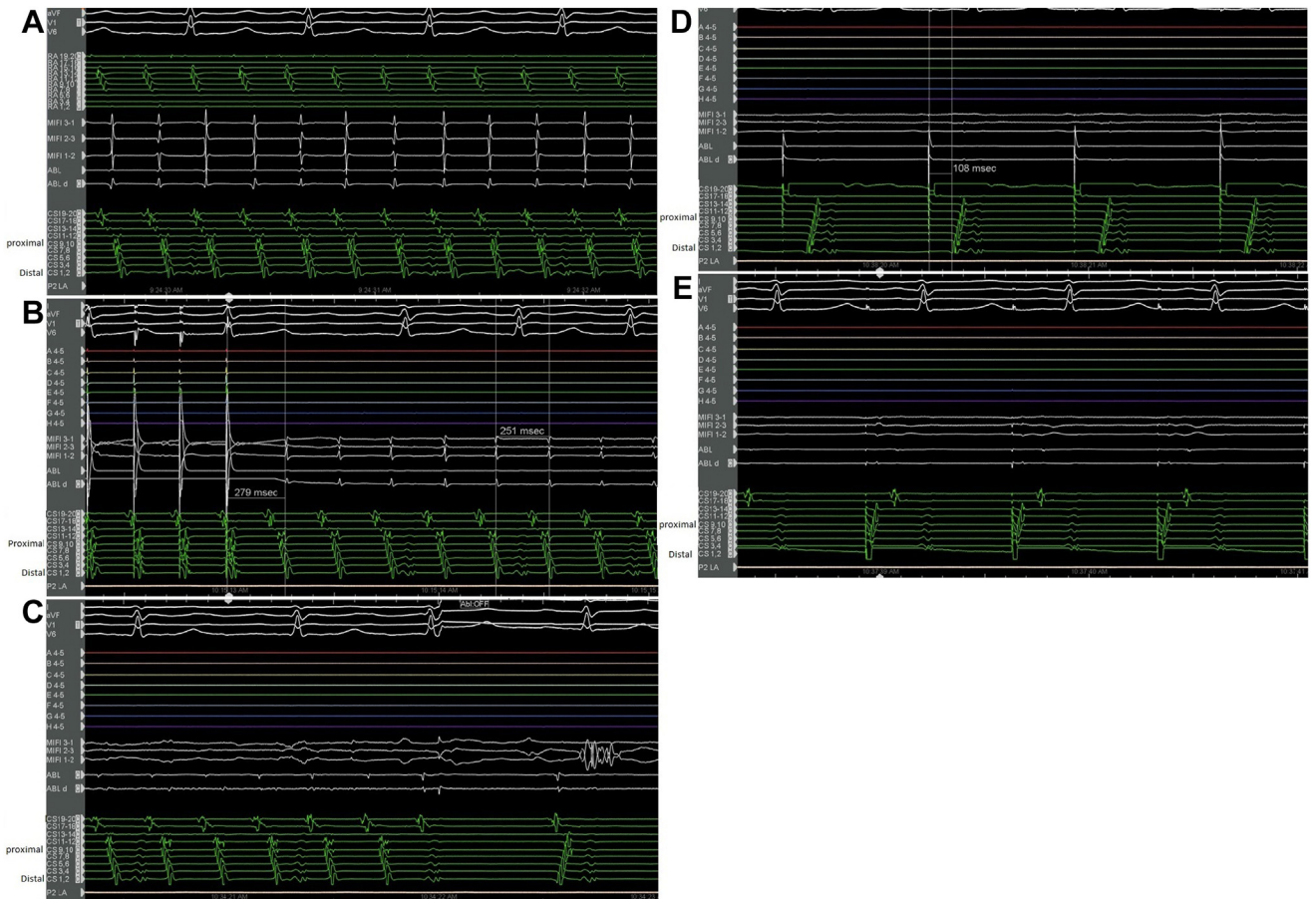
Entrainment from CS 1,2 near the 1-o'clock mitral annulus had a slightly longer return of 30 ms than the mitral annulus at a 3-o'clock position of 18 seconds with manifest fusion (Figure 2B). CS 9,10 more on the posterior aspect produced a return cycle length identical to the tachycardia cycle length. However, there was evidence of manifest fusion. Overdrive pacing from the CS os had 35 ms postpacing interval minus tachycardia cycle length.

Using the Orion catheter and Rhythmia HDX (Boston Scientific, Natick, MA), activation mapping was done, which showed mitral annular flutter with entire cycle length.<sup>3</sup> However, mitral annulus, endocardially from 3-o'clock to 5-o'clock position, had no discernible electrogram. Interestingly, when the coronary sinus electrogram was integrated into the mitral annular map, it explained the lack of continuity within the left atrium (LA). The impulse circumvented the LA using the CS as a conduit (Supplemental Video). From the LA, in a counterclockwise direction, around poles 9,10 the impulse used the CS musculature, and around poles 1,2 of the CS catheter entered back into the LA (Figure 3A and 3B).

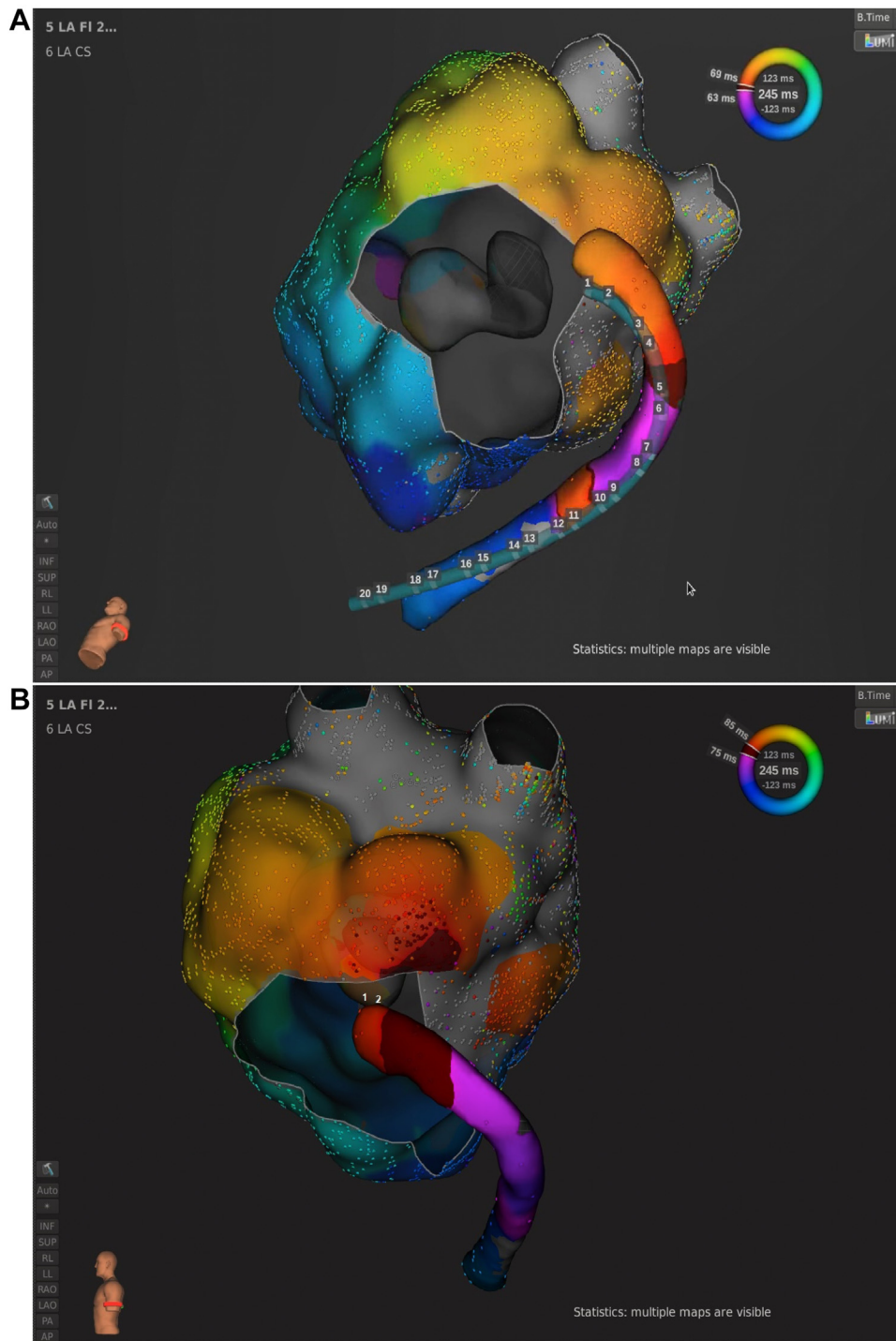
At a recommended irrigation rate for 30 W ablation, lesions in the CS conduit portion terminated the flutter (Figure 2C). Kissing lesions were delivered endocardially as insurance lesions at 45 W.<sup>4</sup> Subsequently, pacing in either direction showed a bidirectional block at the mitral annulus, which persisted until the end of the procedure (Figure 2D and 2E).



**Figure 1** A 12-lead electrocardiogram showing atrial flutter.



**Figure 2** **A:** Clinical flutter circuit. **B:** Entrainment from ablation catheter at 3 o'clock on the mitral annulus. **C:** Termination of flutter during ablation with distal ablation catheter showing double potentials owing to slowed conduction. **D:** Block demonstrated across the mitral annulus when pacing from proximal coronary sinus (CS). **E:** Block demonstrated along the mitral annulus when pacing from the distal CS.



**Figure 3** A, B: Atypical flutter circumventing the left atrium using the coronary sinus (CS) as a conduit. From the left atrium, in a counterclockwise direction, around poles 9,10 the impulse used the CS musculature, and around poles 1,2 of the CS catheter entered back into the left atrium.

### Discussion

The most important predictors for developing postoperative AFL after the maze procedure are the patient's age and cross-clamp time. Postsurgical scarred myocardium, inadequate lesions, and gaps provide the substrate for developing postsurgical arrhythmias. Owing to the anatomical proximity of the mitral isthmus ablation line (as part of the maze procedure) to the CS, radiofrequency ablation at the inferoposterior

LA can slow down the conduction in the LA endocardium and adjacent CS muscle, facilitating macroreentry.

The physiology of this flutter is considered to involve conduction properties between the LA and the CS musculature caused by both the maze procedure and mitral valve surgery. Alteration of conduction velocity and refractory periods of the LA myocardium, the connecting tissue between LA/CS, and the intervening CS muscle coat provide the substrate

for this type of flutter. The flutter can use the CS as a conduit, even if the endocardium is entirely blocked.

Localization of the critical components of the mitral annular flutter circuit poses a significant challenge in patients with this type of postsurgical AFL. The CS is not routinely mapped (generally used as a fixed reference catheter), and integration of nonmapping catheters into the global activation map is not available in all mapping systems.

In most patients, high power settings are required for endocardial radiofrequency ablation of the mitral annulus owing to heat sink, mainly due to the coronary sinus blood flow and, to some extent, the circumflex artery.

The CS/LA connections on either side of the endocardial lesions play a role in perimitral reentry of this nature. They should be the ablation target if the endocardium shows no discernible voltage.

The approach to this type of macroreentry with CS acting as a conduit with the endocardial block is different from achieving mitral annular block for persistent AF or perimitral macroreentry post AF ablation.

Ablating within the CS has challenges, including reaching impedance limits owing to poor blood flow within the CS or inadvertent ablation of a neighboring structure, the circumflex coronary artery. Continuous 12-lead monitoring, intracardiac echo imaging, and careful up-titration of energy

output while monitoring impedance may significantly provide safety. Routine angiography to define spatial proximity to the circumflex artery may not be needed unless prior coronary angiography defines the close relationship of a dominant circumflex artery.

Besides termination flutter, the bidirectional block is critical for the long-term resolution of this arrhythmia.

## Appendix Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcre.2022.05.015>.

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