

A novel mapping and ablation strategy of the mitral isthmus using intracardiac echocardiography in the left atrium



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Introduction

Intracardiac echocardiography (ICE) has recently become the standard imaging modality for many cardiac electrophysiology procedures. This technique has been almost exclusively utilized in right-sided cardiac chambers, either as direct visualization of right-sided structures or as a way to achieve improved resolution of left-sided structures such as the pulmonary veins (PV).^{1,2} While there have been reports of using ICE in the left atrium (LA) and coronary sinus (CS),^{3,4} we report a case using ICE for guidance in CS ablation of a mitral isthmus (MI) atrial flutter.

Case report

A 73-year-old man with paroxysmal atrial fibrillation underwent catheter ablation. After the 4 PVs were completely isolated, the rhythm converted to persistent flutter with a cycle length of 334 ms. Activation mapping and entrainment confirmed the rhythm as a macroreentrant flutter around the mitral annulus. An ablation line beginning at the 5 o'clock region from the CS was made to the anterior ridge of the left inferior PV. The rhythm terminated during ablation on the MI, but conduction block could not be demonstrated after multiple endocardial ablation attempts. To better understand the local anatomy, we decided to insert a 64-element vector phased-array ICE into the LA for enhanced visualization of the MI. An 8F catheter (CARTO SoundStar; Biosense Webster, Irvine, CA) was advanced from the right femoral vein through a 15F FlexCath steerable sheath into the LA. The ICE and sheath were carefully manipulated to obtain both vertical and horizontal views of the posterior and lateral mitral annulus.

Using the guidance of an electroanatomic mapping system (CARTO; Biosense Webster), we carefully reconstructed the geometry of the MI. We scanned from the left PVs to the

KEY TEACHING POINTS

- Intracardiac echocardiography (ICE) can safely be used in the left atrium.
- ICE in the left atrium in conjunction with mapping software can give the electrophysiologist better anatomical views of vital structures.
- If conduction block cannot be demonstrated via the endocardial approach, ICE in the left atrium may assist in visualization of thickened tissue, requiring an epicardial approach.

mitral valve. One of the vertical views clearly displayed the LA posterior wall, the adjacent body of the CS, and the thickness of the LA posterior wall, ranging from 3.5 to 8 mm (Figure 1). The thickest portion, 8 mm, appeared to be at the intersection of the CS and MI ablation line (Figure 2). We felt the 8 mm thickened tissue was the culprit for our

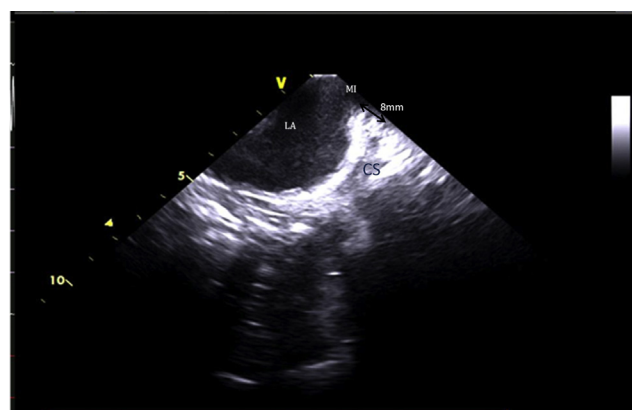


Figure 1 Intracardiac echocardiography image in the left atrium (LA) revealing a thickened mitral isthmus (MI) of 8 mm (arrow measuring from the endocardial surface of the mitral isthmus to the coronary sinus [CS] during diastole).

KEYWORDS Ablation; Coronary sinus; ICE; Intracardiac echocardiography; Left atrium; Mitral isthmus
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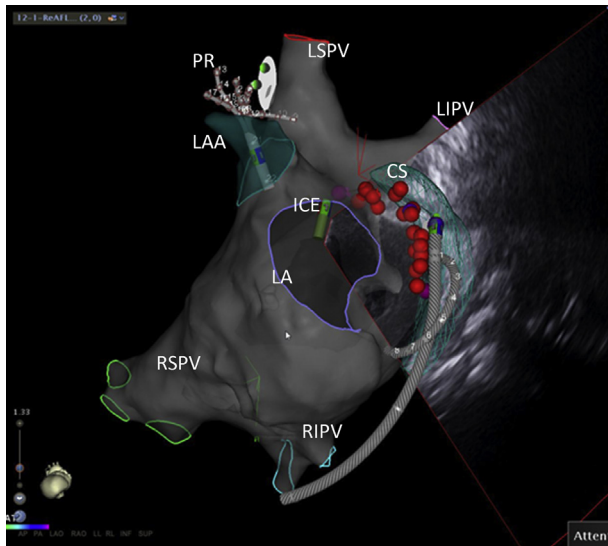


Figure 2 A left anterior oblique caudal view of the left atrium (LA). This is an inferior and anterolateral view of the LA looking superiorly. The mitral isthmus endocardial ablation line can be appreciated (red dots). The intracardiac echocardiography catheter (ICE) in the LA can be seen projecting a second image of the mitral isthmus and coronary sinus (CS). Also, a CS and ablation catheter can be seen in the CS and a CARTO PentaRay (Biosense Webster, Irvine, CA) catheter (PR) can be visualized in the left atrial appendage (LAA). LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

lack of conduction block. Again, multiple endocardial ablations were attempted at this location; however, conduction block was not appreciated. We decided an epicardial approach at this thickened area was warranted. A 3.5 mm irrigation-tip catheter (ThermoCool NaviStar, Biosense Webster) was

advanced into the CS and was positioned at the area of greatest thickness (Figure 2). For monitoring conduction along the MI, the ablation was done during pacing from the LA appendage using a CARTO PentaRay catheter (Biosense Webster). A single lesion at 20 watts was performed in the CS, and after only 9 seconds conduction block was suggested by the changed CS activation (Figure 3).⁵ Bidirectional block was proven using activation mapping. There was no recovery of conduction when reassessed after 30 minutes.

Discussion

We believe this is the first case reporting the use of ICE in the LA to guide MI ablation. The technique has been reported in the assistance of PV isolation but not widely applied in routine practice.³ Limited by the depth of ICE, the conventional application of ICE in the right atrium may not be enough to visualize the precise anatomy of the MI. In our case, we also used a steerable sheath, which allowed us to create both vertical and horizontal views. Obtaining a horizontal view allowed us to obtain an anatomical relationship among the mitral valve, the MI, the left PVs, and, most importantly, the CS and left circumflex artery (LCx) (Supplemental Figure 1). The vertical view provided the depth needed to visualize the lateral aspect of the mitral annulus and lateral wall of the LA as well as the attached CS (Figure 1). Also, the atrio-ventricular groove, including the CS and LCx, was viewed in cross-section.

Successful ablation of the MI can be challenging owing to several factors: thickened tissue at the junction of the PV and mitral annulus, variable depth of the pouch adjacent to the MI, and vital nearby anatomy of the CS and LCx.^{6,7}

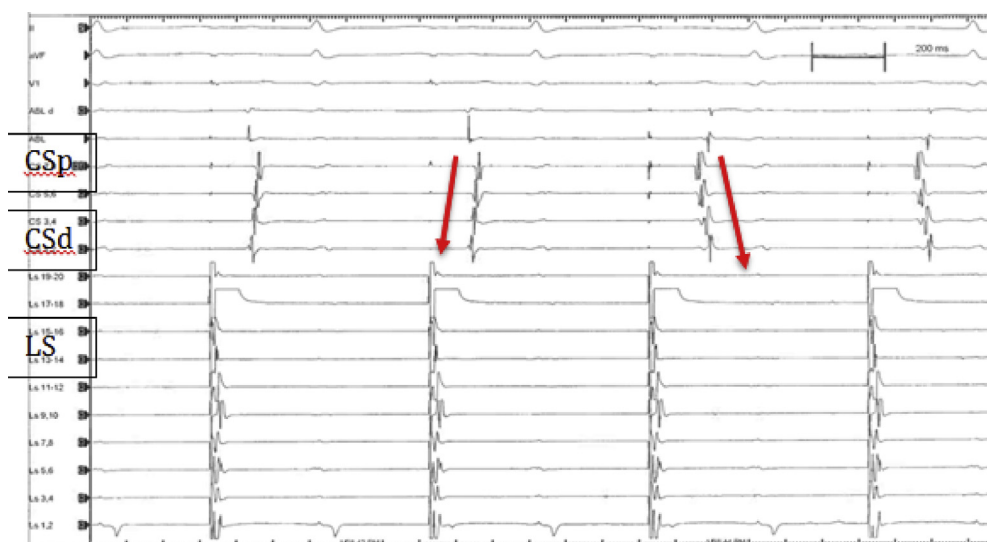


Figure 3 Electrogram revealing change in coronary sinus (CS) activation (red arrows) during ablation in the CS. Pacing is from the left atrial appendage. Ablation distal (ABL d) is located in the CS at the thickest (8 mm) portion of the mitral isthmus. CSd = coronary sinus distal; CSp = coronary sinus proximal; LS = PentaRay catheter located in the left atrial appendage.

Conclusion

To achieve complete block along the MI, ablation within the CS is frequently required.⁸ Ablation within the CS carries risks of perforation and injury to the LCx. Our case may provide a new option to precisely pinpoint the site for limited ablation within the CS. We suggest using ICE in the LA to better visualize and measure thickened MI and CS tissue. If there is difficulty in obtaining bidirectional block with an endocardial approach, ICE in the LA may assist in identifying thickened tissue for which an epicardial ablation via the CS is needed. In an attempt to minimize collateral injury, the technique described may be useful to design an ablation line that avoids a lengthy endocardial ablation of thickened tissue or the LCx.

Appendix Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2018.10.010>.

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