Balloon occlusion of the distal coronary sinus facilitates mitral isthmus ablation

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BACKGROUND Mitral isthmus ablation is challenging. Blood flow in the coronary sinus (CS) may act as a heat sink and reduce the efficacy of radiofrequency ablation.

OBJECTIVE This study investigates whether balloon occlusion of CS facilitates mitral isthmus ablation.

METHODS This single-center, prospective, randomized controlled trial included patients undergoing ablation for atrial fibrillation. After circumferential pulmonary vein isolation and roof line ablation, mitral isthmus ablation was performed during left atrial appendage pacing using an irrigated ablation catheter (endocardium: maximum power: 40/50 W, maximum temperature: 48°C; CS: maximum power: 25/30 W, maximum temperature: 48°C). An air-filled 40 × 10-mm percutaneous transluminal angioplasty balloon (Opta Pro, Cordis Europa, LJ Roden, The Netherlands) was used to occlude the CS on the epicardial aspect of the ablation line. Left coronary and CS angiography were performed before and after the procedure.

RESULTS Forty-six patients were studied. The balloon was successfully positioned in the distal CS in 20 of 23 patients (87%). Mitral isthmus block was achieved in 41 of 46 patients (91%). According to intention-to-treat analysis, there was significant reduction in the need for epicardial CS ablation (48% vs. 83%, $P = .01$) in the CS occlusion group but no difference in acute success rate. Secondary analysis showed reduction in mean total ablation time (9.4 ± 5.5 vs. 13.3 ± 4.6 minutes, $P < .02$) and mean CS ablation time (1.5 ± 2.8 vs. 3.4 ± 2.7 minutes, $P < .05$) in patients who had CS occlusion.

CONCLUSION Balloon occlusion of the CS during mitral isthmus ablation is feasible and safe. It significantly reduces ablation time and the need for CS ablation to achieve mitral isthmus block. The results support the hypothesis that heat sink is one of the obstacles to successful mitral isthmus ablation.

KEYWORDS Radiofrequency ablation; Atrial fibrillation; Mitral isthmus; Coronary sinus; Heat sink

ABBREVIATIONS **AP** = anteroposterior; **AF** = atrial fibrillation; **CS** = coronary sinus; **LAA** = left atrial appendage; **LAO** = left anterior oblique; **PVI** = pulmonary vein isolation; **QCA** = quantitative coronary angiography; **RAO** = right anterior oblique

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Introduction

Mitral isthmus ablation is commonly performed as an adjunct to pulmonary vein isolation (PVI) in the treatment of persistent atrial fibrillation (AF).[1-5] When performing mitral isthmus ablation, it is important to achieve complete block because an incomplete line may be proarrhythmic, leading to the development of gap-related macroreentrant tachycardia.[6–8] It is recognized that mitral isthmus block is technically challenging to achieve, requiring epicardial ablation from within the coronary sinus (CS) in the majority of patients.[1,2]

It is not entirely clear why it is difficult to achieve mitral isthmus block with endocardial ablation alone. One explanation may be that blood flow in the CS acts as a heat sink, removing heat from the ablation site and reducing the efficacy of radiofrequency ablation.[9] In an animal model, eliminating this heat sink effect by temporary balloon occlusion in the CS resulted in the creation of transmural lesions using endocardial ablation alone.[10] Our study is a randomized controlled trial to investigate whether temporary distal CS occlusion to remove this heat sink effect facilitates mitral isthmus ablation.

Methods

Study population

This was a prospective, single-center, randomized controlled trial. Due to the nature of the procedure, patients but not operators were blinded to the randomization. Patients who were scheduled for catheter ablation procedures for persistent or long-duration paroxysmal (episodes lasting >48 hours) AF were recruited. Patients who had attempts at previous mitral isthmus ablation or had a left ventricular pacing lead in the CS were excluded. Written, informed

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consent was obtained. The study protocol was approved by the Oxford Research Ethics Committee. Recruitment took place over a 7-month period.

Catheter ablation procedure

The procedures were performed with the patients in the postabsorptive state under general anesthesia or conscious sedation. All antiarrhythmic drugs except amiodarone were discontinued for at least 5 half-lives prior to the procedure. All patients were anticoagulated for at least 1 month and had transesophageal echocardiography to exclude LA thrombus on the day of the procedure. A steerable decapolar catheter (Dynamic XT, Bard, Lowell, MA, USA) was positioned within the CS. A quadripolar catheter (Josephson, Bard) was positioned in the aortic root as a positional reference catheter. Double transseptal punctures were performed for introduction of an F-curve 3.5-mm irrigated-tip catheter (Thermocool, Biosense Webster, Lowell, MA, USA) through a steerable sheath (Agilis, St. Jude Medical, St. Paul, MN, USA) and a pulmonary vein mapping catheter (Optima, St. Jude Medical) through a fixed-curve sheath (SL(0), St. Jude Medical). A heparin bolus and infusion was used to maintain the Activated Clotting Time (ACT) between 300 and 350 seconds throughout the procedure. The electroanatomical geometry of the LA chamber was created (EnSite NavX or Velocity, St. Jude Medical) and circumferential PVI was initially performed as described before.[11,12] Roof line ablation was performed by creation of a contiguous line of ablation lesions from the left to right superior pulmonary veins over the most cranial portion of the LA roof. Radiofrequency energy was delivered with powers of 30 W, temperature limited to 48°C, and irrigation rates of 17 to 30 ml/min. Roof line block was confirmed with activation mapping and differential pacing.

Mitral isthmus ablation

Where patients remained in AF, electrical cardioversion was performed to restore sinus rhythm, and PVI and roof line block were confirmed. Mitral isthmus ablation was then performed during left atrial appendage (LAA) pacing. Initial endocardial ablation settings were: maximum powers of 40 W at the annular end and 30 W at the venous end of the line; maximum temperature: 48°C; irrigation rate: 17 to 30 ml/min. This was performed by drag ablation starting from a lateral position (3 to 4 o'clock) on the mitral valve annulus to the isolated left-sided pulmonary veins. Ablation was guided by a >85% reduction of local electrogram amplitude. After the initial line, the ablation catheter was moved along the line to look for sharp atrial electrograms earlier than that recorded in the distal CS. If isthmus block was not achieved after at least 10 minutes of endocardial ablation time and no further atrial electrograms were identified along

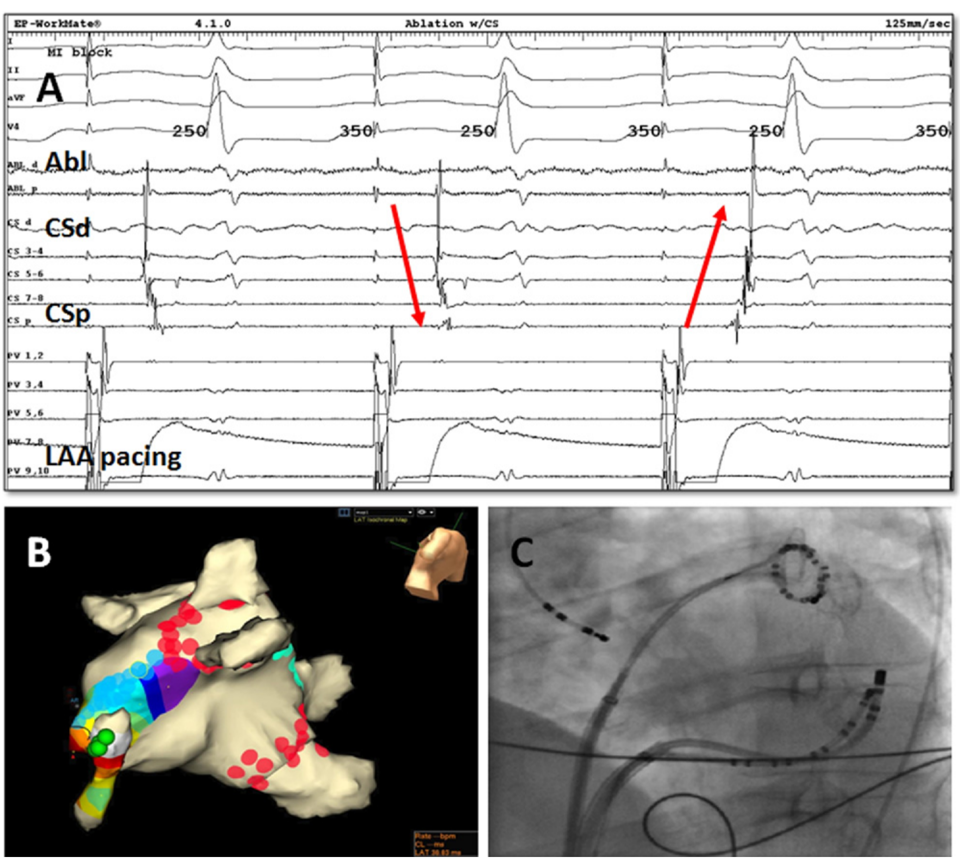

Figure 1 **A:** Electrograms showing sudden reversal in coronary sinus (CS) activation (red arrows), indicating mitral isthmus block during left atrial appendage (LAA) pacing. Abl indicates ablation catheter's electrograms. **B:** Activation map during LAA pacing showing breakthrough point in distal CS (represented by the earliest activation, white color). **C:** Fluoroscopy showing catheter position in distal CS which achieved mitral isthmus block.