

Intracardiac echocardiography–guided simultaneous pulmonary vein isolation and percutaneous transvenous mitral commissurotomy



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Introduction

Percutaneous transvenous mitral commissurotomy (PTMC) has been established as an effective and minimally invasive treatment for symptomatic mitral stenosis (MS).^{1,2} Rhythm control in atrial fibrillation (AF) associated with MS is often difficult using antiarrhythmic drugs and cardioversion, even after PTMC.^{3–5} Several studies have reported the efficacy of a maze procedure combined with mitral valve surgery for rhythm control in patients with AF and MS,^{6,7} including intracardiac echocardiography (ICE)-guided pulmonary vein isolation (PVI) or PTMC.^{8,9} However, no studies have reported the efficacy of ICE-guided simultaneous PVI and PTMC in patients with MS and AF. Here we describe 2 cases in which this procedure was successfully performed.

Case report

Case 1

A 54-year-old woman had moderate rheumatic MS. At the age of 17 years, she was found to have asymptomatic MS based on detection of a diastolic murmur at the cardiac apex. The patient experienced acute heart failure and frequent palpitation due to the onset of paroxysmal AF. An electrocardiogram (ECG) and chest radiograph showed signs of left atrium (LA) enlargement. The coronary angiogram showed no significant stenosis. Transthoracic and transesophageal echocardiography showed LA dilation (56 mm) and normal left ventricular ejection fraction (77%). Moderate MS (1.12 cm²) and mild mitral regurgitation were also confirmed. The Wilkins echocardiography score was 7 (thickening, 2;

mobility, 2; subvalvular apparatus, 1; and calcification, 2). Given that the patient experienced acute heart failure due to paroxysmal AF despite moderate MS, we decided to perform PVI and PTMC in the same session.

Case 2

A 49-year-old woman had moderate rheumatic MS. Although she was found to have a diastolic murmur at the cardiac apex as a child, she had never had a hospital follow-up. The patient experienced acute heart failure with persistent AF and was found to have MS after receiving treatment for acute heart failure. The ECG showed AF with a heart rate of 84 beats per minute and LA enlargement; the latter was also confirmed by chest radiograph. The coronary angiogram showed no significant stenosis. Transthoracic and transesophageal echocardiography showed LA dilation (47 mm), normal left ventricular ejection fraction (56%), and no LA appendage thrombus. Moderate MS (1.18 cm²) and trivial mitral regurgitation were also observed. The Wilkins echocardiography score was 6 (thickening, 2; mobility, 2; subvalvular apparatus, 1; and calcification, 1). Given that the patient had symptomatic MS with persistent AF, we decided to perform PVI and PTMC in the same session.

PVI and PTMC procedure

In both cases, PVI was performed as the first step. Intravenous heparin was administered to maintain an activated clotting time of 300–350 seconds during the entire procedure. A 10F SoundStar ultrasound catheter (Biosense Webster, Diamond Bar, CA) for ICE imaging was inserted into the right atrium via the right femoral vein and the left side of the atrial septum was evaluated to determine whether it was free of thrombi. Anatomical mapping of the LA was performed with the CartoSound module of the CARTO3 system (Biosense Webster). Transseptal puncture was performed with ICE guidance and the catheter was advanced into the LA, where the ICE probe was retroflexed and rotated counterclockwise to allow clear visualization of the LA appendage

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KEY TEACHING POINTS

- Rhythm control in atrial fibrillation (AF) associated with mitral stenosis (MS) is often difficult using antiarrhythmic drugs and cardioversion, even after percutaneous transvenous mitral commissurotomy (PTMC).
- PTMC and pulmonary vein isolation (PVI) in separate sessions improved the AF-free survival rate compared to non-ablation therapy.
- Intracardiac echocardiography-guided PVI and PTMC in a single session showed similar effectiveness, cost reduction, and shortening of hospitalization time compared to separate procedures.

and confirm the absence of thrombi.⁹ Two long sheaths were then inserted into the LA and circumferential PVI was performed using a ThermoCool SmartTouch catheter (Biosense Webster) (Figure 1A, B). An electroanatomical image was constructed by ICE and catheter. Circumferential PVI was performed guided by electroanatomical image integrated with computed tomographic image of the LA. The endpoint of PVI was elimination of all PV potentials recorded by a ring catheter placed at the ostium of the PV and PV-to-LA conduction block during pacing from the ring catheter.¹⁰ Immediately after hemodynamic data was obtained, PTMC was performed via the antegrade transvenous approach using an Inoue balloon. In both procedures, ICE was useful for determining the ballooning position at the mitral valve (Figure 1C, D). In case 1, we started with a 24 mm balloon that was expanded to 28 mm. Mitral valve area (MVA) increased from 1.12 cm² to 2.16 cm² and mean pulmonary capillary wedge pressure decreased from 16 mm Hg to 14 mm Hg after PTMC. In case 2, a 24 mm balloon was expanded to 26 mm and finally to 28 mm. MVA increased from 1.36 cm² to 1.70 cm² and mean pulmonary capillary wedge pressure decreased from 19 mm Hg to 14 mm Hg after PTMC. The procedure lasted 160 minutes for case 1 and 150 minutes for case 2, and the fluoroscopy time was 54 minutes for case 1 and 25 minutes for case 2. Thus, we successfully performed simultaneous PVI and PTMC in both patients without any complications. The patients remained stable and were discharged within several days of the surgery.

Follow-up

After discharge, patients were seen in our hospital at the outpatient clinic monthly thereafter. At each hospital visit, the patients underwent 12-lead ECG and intensive questioning regarding any arrhythmia-related symptoms. Holter electrocardiography and echocardiography were performed every 6 months for 2 years. Follow-up echocardiography showed preserved MVA (>1.5 cm²) and decreased LA volume in both

cases for 2 years. There was no recurrence of AF, even without antiarrhythmic drugs, and no rehospitalization for acute heart failure during the 2-year follow-up period (Table 1).

Discussion

We successfully performed ICE-guided simultaneous PVI and PTMC without any complications in patients with MS and AF. There was no decompensated heart failure, AF recurrence, or mitral valve restenosis in the 2-year follow-up period. The maze procedure combined with a mitral valve replacement has been established as a surgical method for rhythm control in patients with mitral valve disease and AF; 80% of patients were free of AF 5 years after this combined approach.^{6,7} Compared with the combined catheter procedure of PVI and PTMC, mitral valve replacement with the maze procedure has a longer hospitalization time and various complications related to the prosthetic valve, but is also associated with delayed mortality.¹¹ In another study, hybrid PTMC and PVI therapy maintained sinus rhythm in 80% of patients during a follow-up period of 4.0 ± 2.7 years and improved the AF-free survival rate compared to direct cardioversion following PTMC.¹² Although these investigators performed PTMC and PVI in separate sessions, the catheter procedures were as effective as in combined surgery. Considering the relatively young age and low Wilkins echocardiography scores of the patients in the present study, we decided that the hybrid catheter procedure was more appropriate than mitral valve surgery with the maze procedure. We successfully and safely performed the procedures in a single session and demonstrated that the results persisted for 2 years. Cost reduction and shortening of hospitalization time are also advantages of the simultaneous procedure. The transseptal puncture approach is technically demanding and requires a sound understanding of atrial anatomy, even for skilled electrophysiologists. ICE is useful in patients who have previously undergone septal repair, have poorly defined fossa ovalis anatomy, or exhibit LA enlargement due to MS.¹³ Cardiac tamponade and iatrogenic atrial septal defects caused by repetitive puncture, an excessively large sheath crossing the septum, or longer procedure time are the most frequent complications associated with transseptal puncture.^{9,13} ST-segment elevation and ventricular fibrillation are rare and may be accompanied by a pronounced vagal response. The atrial septum harbors a high density of parasympathetic fibers that preferentially innervate the right coronary artery, leaving it vulnerable to cholinergic vasospasm.¹⁴ ICE-guided simultaneous PVI and PTMC avoids these complications by reducing the number of transseptal punctures, and is thus an ideal strategy in patients with MS and AF. Compared with transesophageal echocardiography, ICE during PTMC is a less invasive treatment that minimizes the risks of complications due to deep sedation or general anesthesia, such as postprocedural hypotension, delirium, and aspiration pneumonia.⁹ Saji and colleagues also demonstrated that an ICE-guided procedure reduces the fluoroscopy time and the number of personnel required for anesthesia and

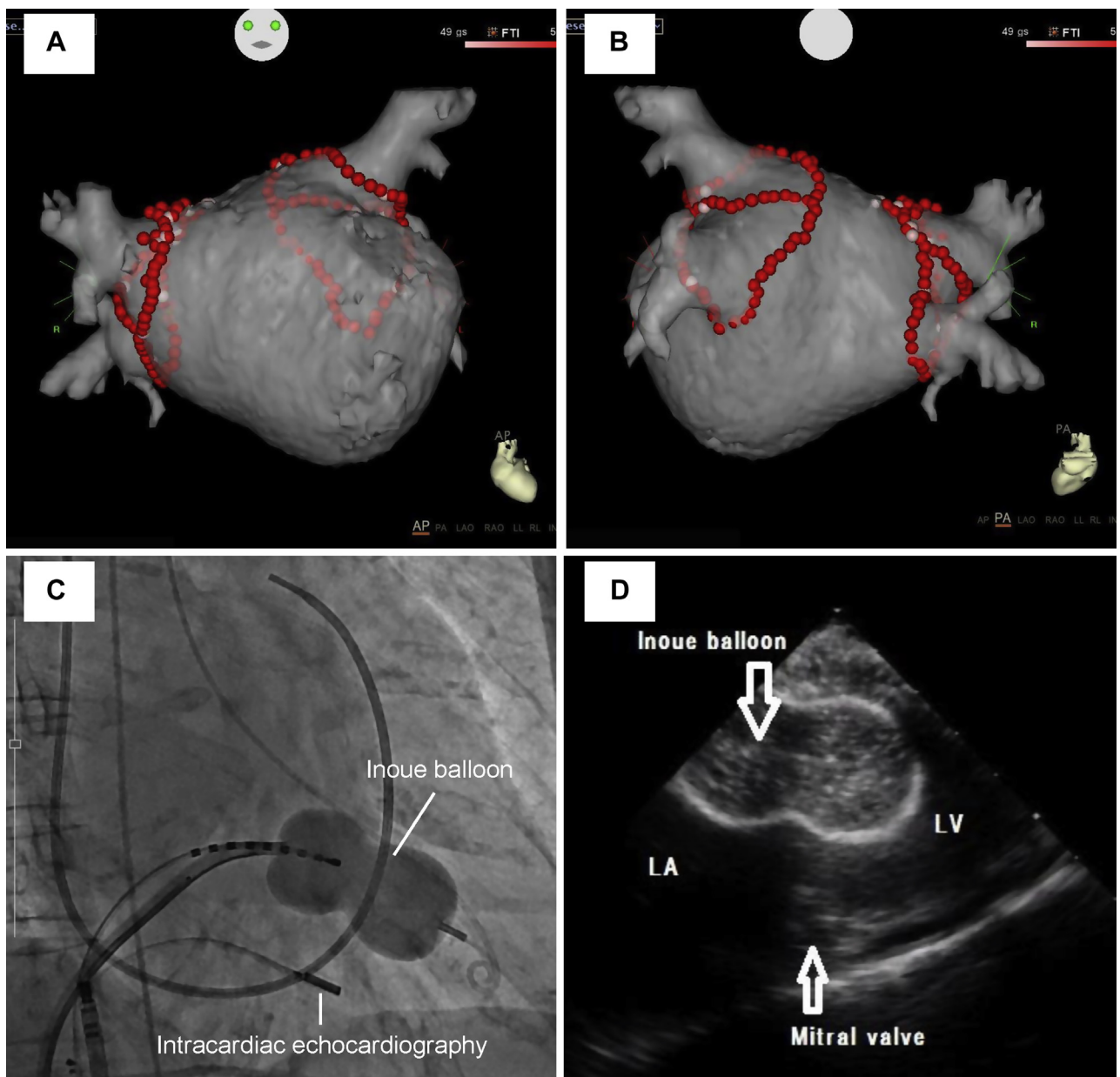


Figure 1 Intracardiac echocardiography (ICE) images acquired during simultaneous pulmonary vein isolation (PVI) and percutaneous transvenous mitral commissurotomy. **A, B:** Anterior-posterior (**A**) and posterior-anterior (**B**) views of 3-dimensional left atrial anatomical images acquired with the CARTO system (Biosense Webster, Diamond Bar, CA) after circumferential PVI. Red dots indicate the sites of radiofrequency ablation. **C, D:** Fluoroscopic image from the right anterior oblique view (**C**) and ICE (**D**) for visualization of the optimal ballooning site of the mitral valve. LA = left atrium; LV = left ventricle.

Table 1 Patient characteristics before, and 2 years after, the procedure

	Case 1 (54 years old, female)		Case 2 (49 years old, female)	
	Before	After	Before	After
Left atrial diameter, mm	56	48	47	40
Left ventricular ejection fraction, %	77	71	56	71
Mitral valve area, cm ²	1.12	1.57	1.18	1.78
Mitral regurgitation (grade)	mild	mild	trivial	mild
B-type natriuretic peptide, pg/mL	174	47	120	20
Atrial fibrillation	2 episodes per month	None	Persistent	None

echocardiography. Currently, ICE imaging is possible only in a single plane; however, the next generation of 3-dimensional ICE probes may provide better support during PTMC.

Conclusion

ICE-guided simultaneous PVI and PTMC is a safe and minimally invasive procedure for patients with MS and AF, although the effectiveness of this approach requires validation in additional studies with a large number of patients and longer follow-up period.

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