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**Cryoballoon pulmonary vein isolation and left atrial appendage occlusion prior to atrial septal defect closure: A case report**

Wu YC *et al.* Cryoballoon PVI, LAA and ASD occlusion

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**Abstract**

BACKGROUND

In patients who suffer from both atrial fibrillation (AF) and atrial septal defect (ASD), cryoballoon pulmonary vein isolation (PVI), sequential left atrial appendage (LAA) occlusion and ASD closure could be a strategy for effective prevention of stroke and right heart failure.

CASE SUMMARY

A 65-year-old man was admitted to our institution due to recurrent episodes of palpitations and shortness of breath for 2 years, which had been worsening over the last 48 h. He had a history of AF, ASD, coronary heart disease with stent implantation and diabetes. Physical and laboratory examinations showed no abnormalities. The score of CHA2DS2VASc was 3, and HAS-BLED was 1. Echocardiography revealed a 25-mm secundum ASD. Pulmonary vein (PV) and LAA anatomy were assessed by cardiac computed tomography. PV mapping with 10-pole Lasso catheter was performed following ablation of all four PVs with complete PVI. Following the cryoballoon PVI, the patient underwent LAA occlusionunder transesophageal echocardiographic monitoring. Lastly, a 34-mm JIYI ASD occlude device was implanted. A follow-up transesophageal echocardiography at 3 mo showed proper position of both devices and neither thrombi nor leakage was found.

CONCLUSION

Sequential cryoballoon PVI and LAA occlusion prior to ASD closure can be performed safely in AF patients with ASD.

**Key Words:** Atrial fibrillation; Atrial septal defect; Cryoballoon; Pulmonary vein isolation; Left atrial appendage occlusion; Case report

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**Core Tip:** Patients who suffer from atrial septal defect (ASD) with atrial fibrillation are prone to right heart dysfunction and embolism. We report the first case treated with a 3-in-1 procedure (cryoballoon pulmonary vein isolation and left atrial appendage occlusion prior to ASD closure), which may not be performed routinely. However, for ASD patients complicated with poorly controlled atrial fibrillation and unable to tolerate long-term oral anticoagulants, this 3-in-1 procedure can be considered.

**INTRODUCTION**

Pulmonary vein isolation (PVI) has been established as a treatment for patients with atrial fibrillation (AF)[1]. Cryoballoon PVI has become a relatively simple alternative for radiofrequency ablation[2]. Left atrial appendage (LAA) occlusion is performed as an alternative treatment to oral anticoagulation in patients with non-valvular AF[3]. Atrial septal defect (ASD), as the most common congenital heart disease, may lead to right heart dysfunction and paradoxical embolism[4]. In patients who suffer from both AF and ASD, cryoballoon PVI combined with ASD closure and the LAA occlusion combined with ASD closure have been reported[5-7]. However, there has been no report on the 3-in-1 procedure (cryoballoon PVI, LAA occlusion and ASD closure), which may be effective for preventing stroke and right heart failure. Here, we report a patient who underwent sequential cryoballoon PVI, LAA occlusion and ASD closure during the same operation.

**CASE PRESENTATION**

***Chief complaints***

A 65-year-old man was admitted to our hospital due to recurrent episodes of palpitations and shortness of breath for 2 years.

***History of present illness***

His symptoms started 2 years ago with recurrent episodes of palpitations and shortness of breath, which had worsened over the last 48 h.

***History of past illness***

His past illness included AF, ASD, coronary heart disease with stent implantation and diabetes.

***Personal and family history***

None.

***Physical examination***

The patient’s temperature was 36.6 °C, heart rate was 74 bpm, respiratory rate was 16 breaths *per* minute, blood pressure was 120/70 mmHg and oxygen saturation in room air was 98%. There was no filling of jugular vein; cardiac auscultation showed arrhythmia and no cardiac murmur in each valve area; and no edema was found in both lower limbs.

***Laboratory examinations***

On admission, his blood tests including routine blood test, renal function, liver function, thyroid function and coagulation function showed no abnormalities.

***Imaging examinations***

Pulmonary vein (PV) anatomy was assessed in detail by cardiac computed tomography (CT) (Figure 1A). Reconstruction and measurement of LAA and selection of suitable implantation angle and position were also completed by cardiac CT (Figure 1B-C). Electrocardiography showed AF with a ventricular rate of 76 bpm. Echocardiography showed normal left ventricular ejection fraction, moderate dilatation of the left atrium (50 mm), severe enlarged right atrium and right ventricle and moderate tricuspid regurgitation (estimated pulmonary arterial systolic pressure was 47 mmHg). Abnormal flow from the left to right atrium through the interatrial septum was found by color Doppler image. Echocardiography revealed a 25-mm secundum ASD with adequate margins for ASD closure. There were no obvious abnormalities on chest CT and abdominal color Doppler ultrasound.

***Further diagnostic work-up: AF embolism and bleeding score***

CHA2DS2VASc score was 3 (diabetes mellitus, vascular disease, age 65 years to 74 years) and HAS-BLED was 1 (age ≥ 65 years). He refused a long-term anti-coagulation treatment.

**FINAL DIAGNOSIS**

AF, ASD, coronary heart disease and diabetes.

**TREATMENT**

***Cryoballoon PVI***

The patient had recurrent AF, which was poorly controlled with antiarrhythmic drugs, so PVI was attempted. Under general anesthesia, a 12F FlexCath steerable sheath (Medtronic Inc., Minneapolis, MN, United States) was advanced into the left atrium without transseptal puncture. A cryoballoon catheter (Medtronic Inc.) was introduced inside the 12F sheath. Following good balloon occlusion, we applied two ablation freezes for 120-180 s (Figure 2A-D). PV mapping was performed following ablation of all four PVs with a 10-pole Lasso catheter (Biosense-Webster Inc., Diamond Bar, CA, United States). We used bidirectional conduction block between the left atrium and PVs[8] to conform the complete elimination of PV electrical activity. Preoperative and postoperative electrocardiograms are shown in Figure 2E-F.

***LAA occlusion***

Anticoagulant therapy was recommended, but the patient refused to take long-term oral anticoagulants, so LAA occlusion was selected. Following the cryoballoon PVI, the patient underwent LAA occlusionunder transesophageal echocardiographic (TEE) monitoring[9]. A special sheathing canal was placed to perform LAA angiography, and a pigtail angiographic catheter was directed to the LAA with the following positions: Right anterior oblique 30° + cranial 20° and right anterior oblique 30° + caudal 20°. Suitable LAA occluder (Watchman, 3.0 cm) was selected following measurement of LAA orifice width and depth. The LAA occluder was introduced into the LAA along the sheathing canal. The position of the occluder was monitored by TEE. A pull test was conducted to determine the stability of the occluder. After suitable position of the occluder and good plugging effect were confirmed, the occluder was released (Figure 1D).

***ASD closure***

The indications and benefits of atrial septal occlusion are clear. Figure 3A shows a secundum ASD by echocardiography. After cryoballoon PVI and LAA occlusion, the diameter of the interatrial defect was measured on TEE images in various planes, and a 34-mm JIYI ASD occluder device (Shanghai Shape Memory Co., Ltd, Shanghai, China) was implanted[10]. Secured and stable positioning of the occluder was confirmed through a push-pull test (Figure 3B). After unscrewing the occluder from the cable, good positioning of the device was demonstrated by a final TEE examination.

**OUTCOME AND FOLLOW-UP**

The patient was subsequently treated with propafenone 150 mg three times a day for 3 mo. Antiplatelet and anticoagulation therapy (clopidogrel and rivaroxaban) was administered following the doctor's advice. Before discharge, correct device positions were confirmed by echocardiography (Figure 3C). A follow-up TEE was performed to confirm proper seating of the devices and to identify thrombi or residual leak at 3 mo (Figure 3D). Both devices were located in proper position, and neither thrombi nor leakage was present. Subsequently, the patient discontinued rivaroxaban and changed to aspirin and clopidogrel.

**DISCUSSION**

We report an ASD patient with AF who underwent the cryoballoon PVI and LAA occlusion prior to ASD closure, which indicates that this 3-in-1 operation is feasible, but it is not recommended as a routine procedure. For patients with ASD complicated with poorly controlled AF and unable to tolerate long-term oral anticoagulants, this 3-in-1 procedure can be considered.

AF is the most common cardiac arrhythmia, which occurs in 1%-2% of the general population[11]. Since PVs were demonstrated as major sources of ectopic beats, PVI has been considered as the cornerstone for AF procedures[12]. Cryoballoon AF ablation has been established as a useful and safe method in treating paroxysmal and persistent AF, providing an alternative approach to radiofrequency ablation[13]. The incidence of AF is strikingly high in patients with ASD, even after surgical closure[14]. Furthermore, compared with the general population, patients with ASD suffer earlier from atrial arrhythmia[15]. Closure of the ASD could decrease the volume overload and reverse remodeling of the atrium[16]. In the present case, we performed cryoballoon ablation followed by closure of LAA and ASD, which we thought could maintain sinus rhythm, reverse atrium remodeling and prevent embolism.

Koermendy *et al*[17] reported that LAA occlusion through ASD or patent foramen ovale was a feasible access. Cardiac tamponade and perforation of adjacent organs could be obviated by avoiding a transseptal puncture[18]. Another advantage is not to create an iatrogenic septal defect. It is not easy to perform LAA occlusion after ASD occlusion, as the ASD occluder makes it difficult to transseptal puncture[19]. Thus, before ASD occlusion, it is necessary to evaluate the indication for LAA occlusion carefully. According to the reported guidelines, a CHA2DS2VASc score of ≥ 2 point is considered as an indication for LAA occlusion[20]. Our case strictly followed this standard, and as this patient refused to take long-term anti-coagulants, LAA occlusion was conducted before ASD closure.

Invasive and surgical procedures are becoming less frequent because of the improvement in percutaneous techniques, especially in cardiac interventions[21]. The present case report indicates that cryoballoon PVI and LAA occlusion prior to percutaneous ASD closure can be performed safely and can prevent several difficulties and complications. In addition, this 3-in-1 procedure was beneficial simultaneously to maintain sinus rhythm, reverse atrium remodeling and prevent embolism.

**CONCLUSION**

Cryoballoon PVI and LAA occlusion prior to ASD closure can be performed sequentially in ASD patients with AF, which may not be performed routinely. However, for ASD patients complicated with poorly controlled AF and unable to tolerate long-term oral anticoagulants, this 3-in-1 procedure can be considered.

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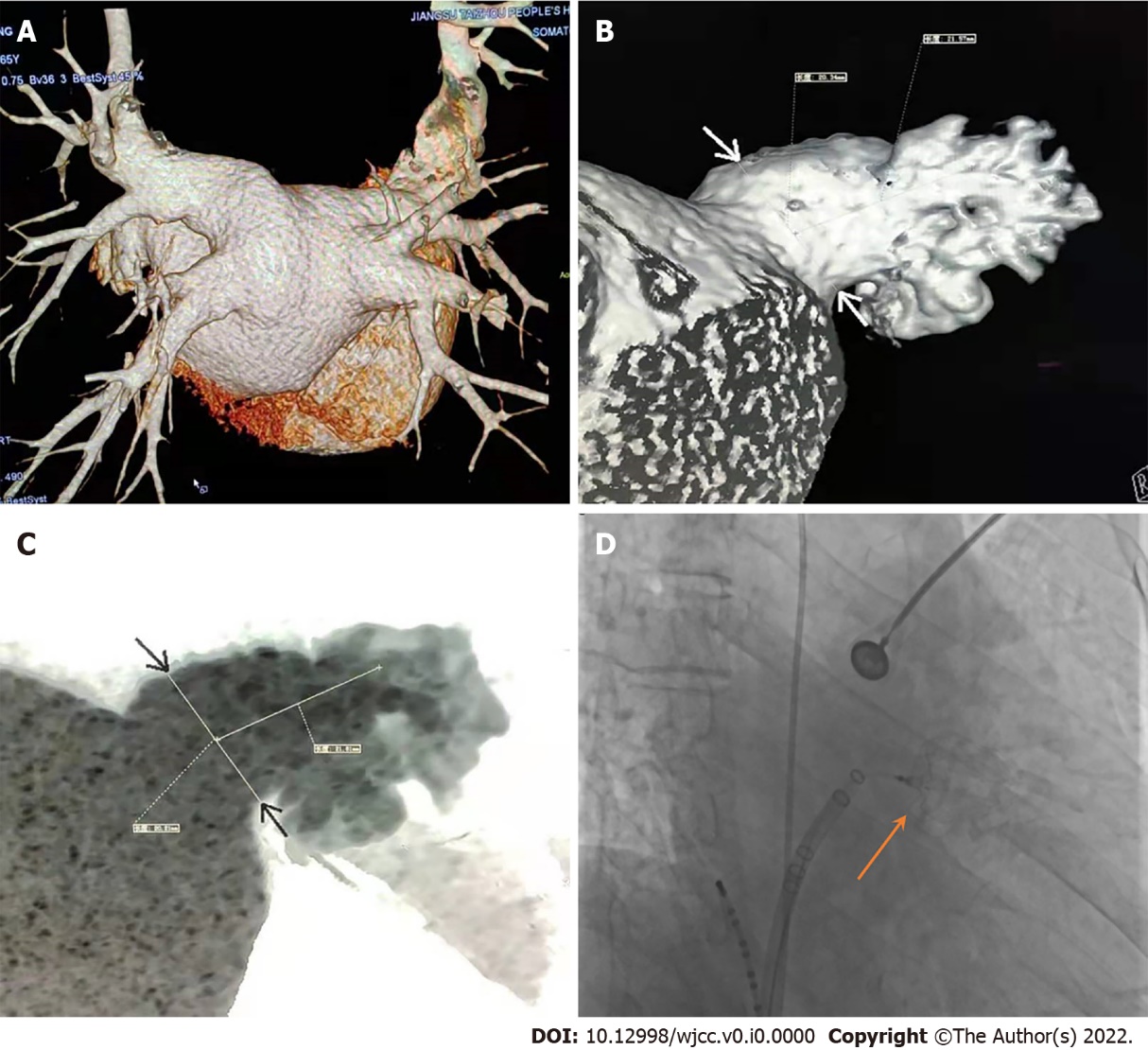
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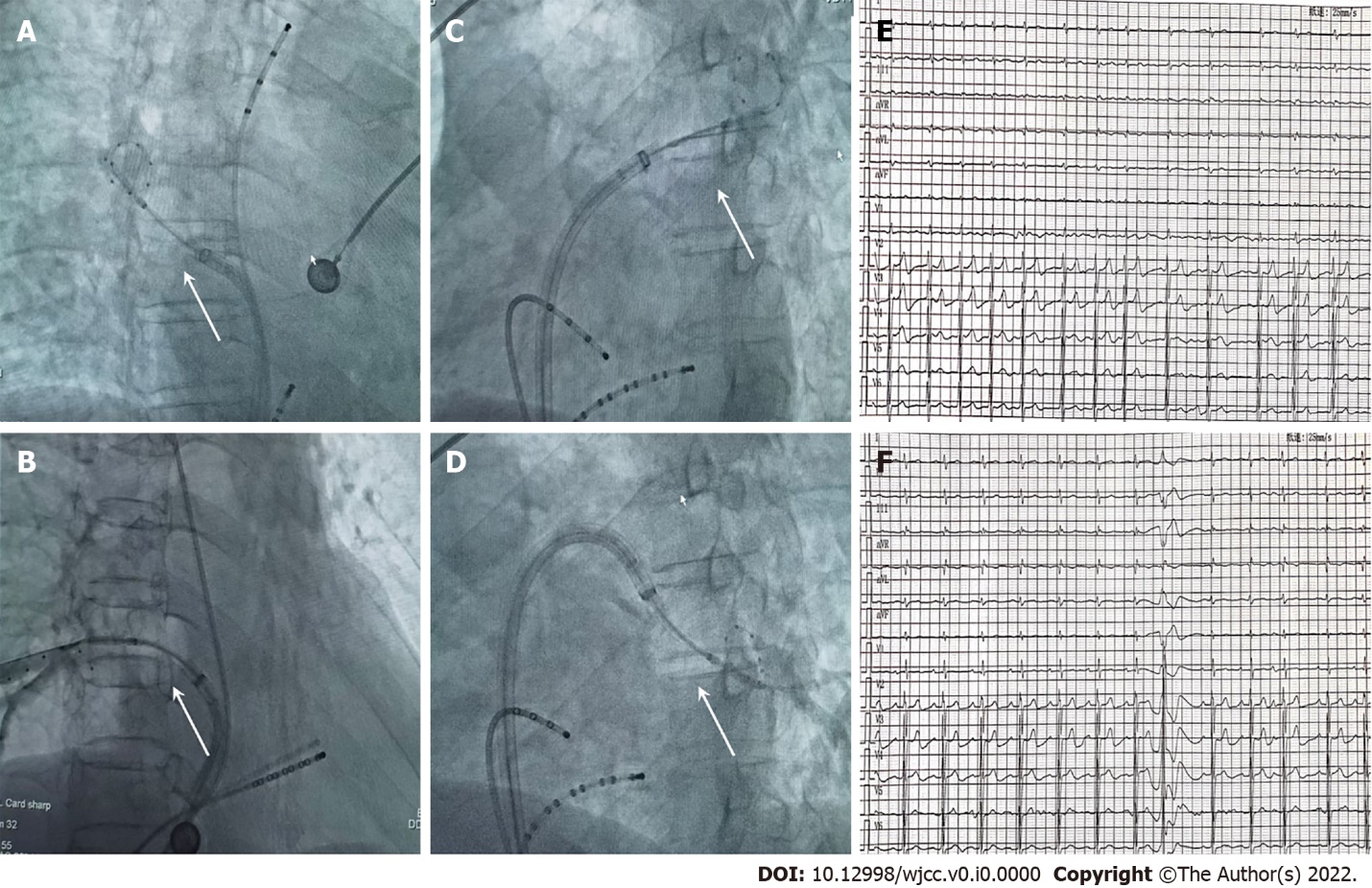
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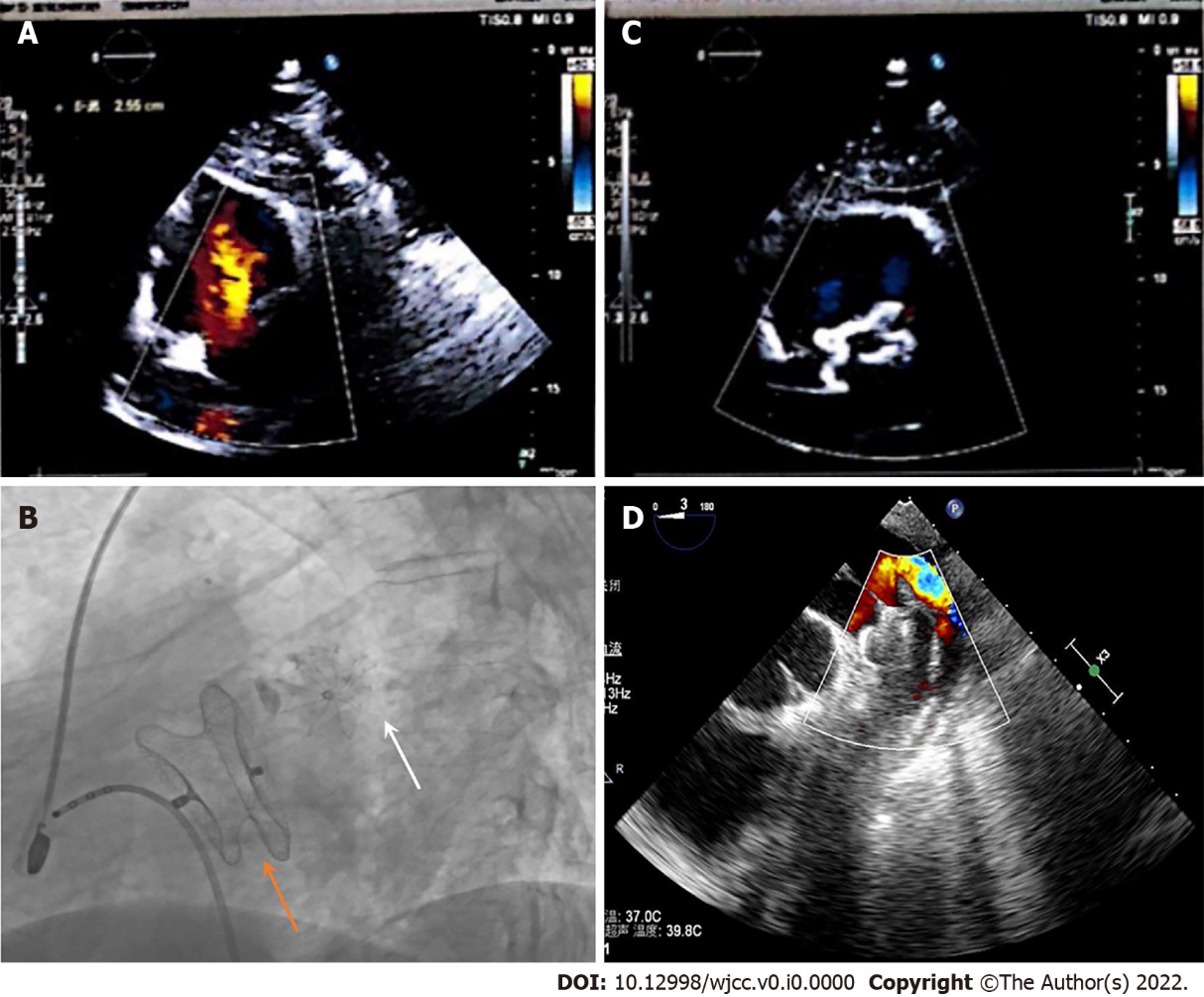
**Figure Legends**



**Figure 1 Reconstruction of pulmonary vein and left atrial appendage by cardiac computed tomography.** A: Reconstruction of pulmonary vein; B-C: Reconstruction and measurement of left atrial appendage (LAA); D: LAA occluder was released. Orange arrow shows LAA occluder.



**Figure 2 Cryoballoon ablation.** A-D: Cryoballoon ablation of all four pulmonary veins with good balloon occlusion; E-F: Preoperative and postoperative electrocardiogram. White arrows show balloon occlusion.



**Figure 3 Outcome and follow-up.** A: Preoperative echocardiography for atrial septal defect (ASD); B: Final X-ray image after left atrial appendage occlusion and ASD occlusion; C: Postoperative echocardiography for ASD; D: Follow-up at 3 mo by transesophageal echocardiography. Orange arrow shows ASD occluder; white arrow shows left atrial appendage occluder.