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Minimally Invasive Correction of Failed Percutaneous Atrial Septal Closure with Device Embolization

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Abstract

We present the case of a minimally invasive surgical correction for failed percutaneous atrial septal defect (ASD) closure in a 57-year-old female patient with residual ASD, tricuspid regurgitation, atrial fibrillation, and embolization of one of two occluders to the superior mesenteric artery. Our surgical approach consisted of anterolateral minithoracotomy, aortic and femoral vein cannulation, cryoablation, cardiac device removal, closure of ASD with autologous pericardium, and tricuspid repair. The procedure was uneventful and patient was discharged home on postoperative day 4.

Keywords
- cardiovascular surgery
- heart disease
- minimally invasive surgery (includes port access minithoracotomy)

Introduction

Atrial septal defects (ASDs) are the most common congenital heart defect diagnosed in adulthood. Despite being considered a simple defect, challenges in optimal diagnostic and treatment options exist, specifically if the defects are large. ASDs are associated with arrhythmias, right heart failure, tricuspid valve regurgitation, thromboembolism, and have even been linked to migraine.[1]

Percutaneous device closure of ASDs has emerged as a safe alternative to traditional surgical closure many years ago due to its minimal invasiveness and resultant shorter hospital stays. King and Mills reported the first successful transcatheter closure on an ASD in 1974. Although the transcatheter closure procedure is safe and effective, complications include occluder malpositioning and migration, arrhythmia, air embolism, and perforation of the aorta. Device dislodgement is one of the most common complications,[2] which can be associated with stroke and sudden death. Here, we describe a case of minimally invasive surgical treatment of a failed percutaneous atrial septal closure complicated by device embolization.

Case Description

A 57-year-old female presented with progressive dyspnea and recurrent episodes of atrial fibrillation. She underwent a

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transesophageal echocardiogram that diagnosed a 4-cm diameter ASD with a left to right shunt, and a moderately enlarged right atrium.

Due to the size of the ASD, two occluder devices (Occlutech Figulla 24 and 12 mm) were implanted with a small residual shunt.

Three years later, however, she was admitted to the hospital with palpitations and dyspnea on exertion, in keeping with New York Heart Association Class III. An electrocardiogram showed persistent atrial fibrillation. Transesophageal echocardiogram demonstrated left to right residual shunt with a shunt fraction of 43%, right atrium enlargement, moderate to severe tricuspid regurgitation, and left ventricle ejection fraction of 52%. Surprisingly, only one interatrial septum occluder was visualized (►**Fig. 1**).

Chest and abdomen computed tomography (CT) showed dislodgement of the occluder and embolization to the superior mesenteric artery causing its total occlusion, but with important collateralization process and no signs of organ ischemia or symptoms (►**Fig. 2**). The patient consulted our center for a minimally invasive surgical approach. A classic minimally invasive approach with groin cannulation for cardiopulmonary bypass (CPB) was challenged by the risk of redislocation of the device after establishing retrograde CPB flow through the femoral artery. We therefore decided to perform an anterior minithoracotomy with central arterial cannulation and peripheral venous drainage.

CPB was initiated after femoral vein cannulation using a 25-Fr two-stage (Edwards Lifesciences) cannula for superior and inferior cavae drainage. A 4-cm skin incision was performed in the 4th intercostal space just lateral to the right internal mammary. The aortic cannula (Edwards Lifesciences) was then placed in the ascending aorta using Seldinger technique. After start of CPB, the heart was arrested after cross-clamping with Bretschneider cardioplegia. In total bypass, the right atrium was opened and the occluder was extracted. The large ASD allowed access to the left atrium. The left atrial appendage was closed by direct suture closure from the inside and a box lesion cryoablation was performed. The ASD was closed with 4×3 cm patch of autologous pericardium (►**Fig. 3A**). Bypass time was 136 minutes and aortic cross-clamping was 71 minutes. Tricuspid valve was repaired after removal of the aortic cross-clamp in a beating heart approach with a 28-mm SimuPlus annuloplasty band (►**Fig. 3B**). The dislodged occluder was left in place. Total operating time was 213 minutes.

Intraoperative transesophageal echocardiogram showed a corrected ASD with no residual shunt and no tricuspid regurgitation (►**Fig. 3C**). The patient had an excellent clinical postoperative outcome with no complications, allowing for her discharge home 4 days after the surgery.

Discussion

We present the case of a minimally invasive surgical correction for failed percutaneous ASD closure in a 57-year-old female patient with residual ASD, tricuspid regurgitation, atrial fibrillation, and embolization of one of two occluders to the superior mesenteric artery. Our surgical approach consisted of anterolateral minithoracotomy, aortic and femoral vein cannulation, cryoablation, cardiac device removal, closure of ASD with autologous pericardium, and tricuspid repair. The procedure was uneventful and patient was discharged home on postoperative day 4.

Patients with ASDs have become a rare commodity in classic cardiac surgery with the advent of atrial occluders. However, if the defects are too large, occluders may not be able to eliminate the entire ASD and more than one occluder is not advisable due to the high risk of dislocation and embolization.

Here, surgical correction is still an option, but in most cases classic sternotomy has been used as approach. In our case, the ASD was large and the interventionalist initially decided to apply two occluders at the same time. While the initial result was acceptable, the workup for a planned atrial ablation procedure a few years later revealed a recurrence of the ASD caused by dislodgment and embolization of one of the two occluders. CT imaging localized the occluder that had

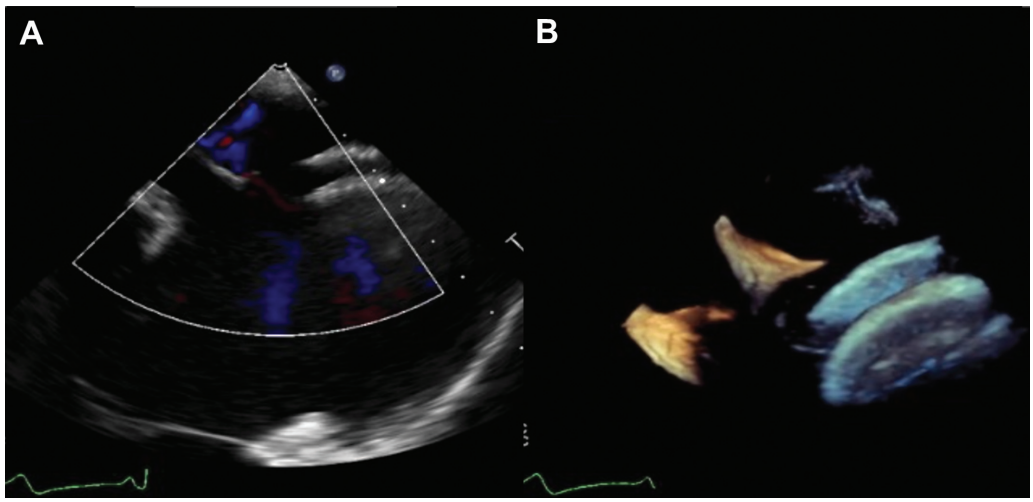

Fig. 1 Preoperative echocardiographic images showing a significant interatrial shunt (**A**) and the presence of a single occluder (**B**).

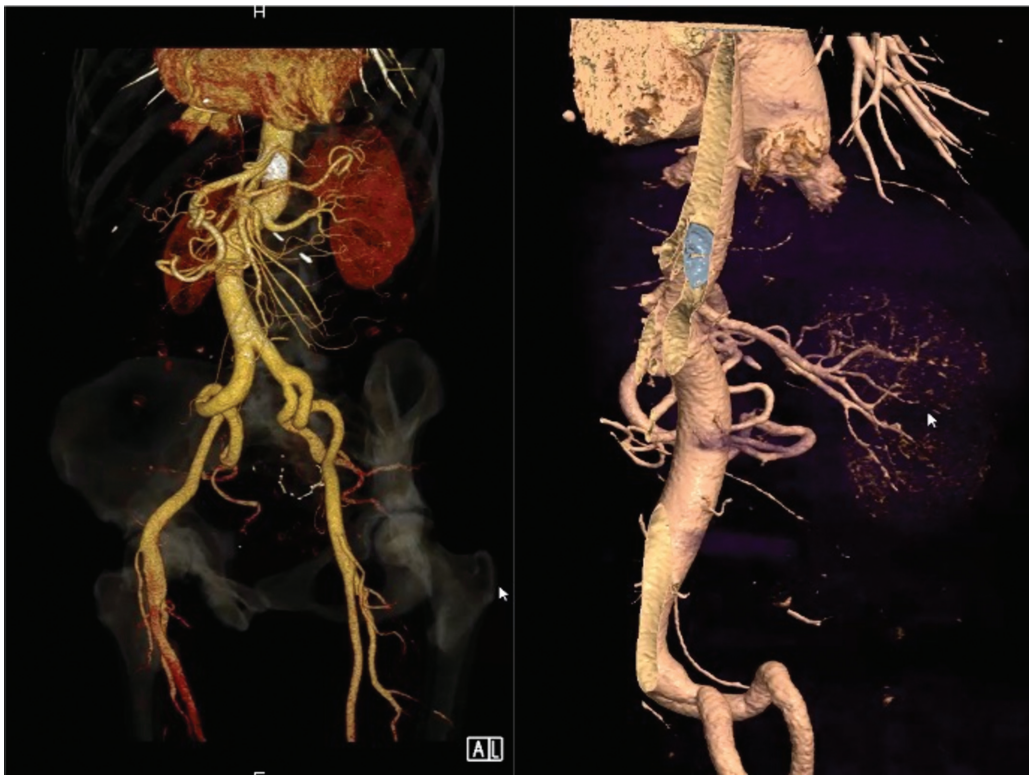

Fig. 2 Digital reconstructions of computed tomography showing an important process of collateralization of the abdominal vessels after total occlusion of the superior mesenteric artery (the occluder is shown in white).

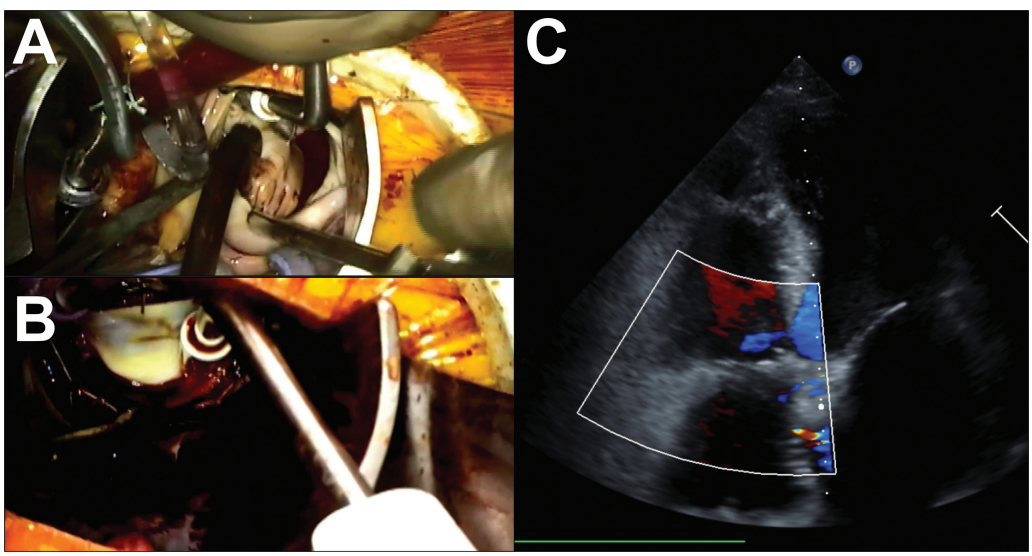

Fig. 3 Intraoperative images showing the surgical access with central arterial cannulation and wide exposure of the atria (**A**), final result of tricuspid repair in beating heart approach (**B**), and absence of tricuspid regurgitation (**C**).

been dislodged to the abdominal aorta causing total mesenteric superior artery occlusion. Fortunately, the occlusion did not result in clinical symptoms.

Since minimally invasive access mainly requires groin cannulation, the flow reversal in the descending aorta posed the risk of reembolization of the device back into the aortic arch. In order to circumvent that risk, we decided to use central cannulation for the arterial perfusion line. With single lung ventilation, we opened the right chest, opened the pericardium, and placed the aortic cannula through two purse-string sutures into the distal ascending aorta using Seldinger's technique. After CPB was successfully established, the procedure was routinely performed by clamping the aorta, opening the right atrium in total bypass, removing the one remaining device, and performing cryoablation left atrial appendage occlusion, ASD patch closure, and tricuspid repair.

Performing this procedure through minimally invasive access has become routine in our center and poses no

significant surgical challenge. Autologous pericardium can be harvested at the beginning of the procedure and exposure of the ASD from the side is fully adequate for control of the entire procedure. The specific challenge from the embolized occluder was addressed by central cannulation which required single lung ventilation as the only additional change from our daily routine.

ASD patients often present with atrial fibrillation and discussions on additional ablation procedures were held at the time of surgical closure of ASDs.[3] In this case, we closed the left atrial appendage from the inside using an inversion mattress suture placement and re-eversion technique with the over-and-over second-layer closure. At the end of the case, there was no evidence of residual left atrial appendage, the patient was in sinus rhythm, and the tricuspid valve was competent.

This case demonstrates that surgical correction of large ASDs and associated cardiac problems is possible through minimally invasive access, obviating the need for sternotomy for these cases.

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Conflict of Interest

None declared.

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References

1 Brida M, Chessa M, Celermajer D, et al. Atrial septal defect in adulthood: a new paradigm for congenital heart disease. Eur Heart J 2022;43(28):2660–2671

2 Lee WC, Fang CY, Huang CF, Lin YJ, Wu CJ, Fang HY. Predictors of atrial septal defect occluder dislodgement. Int Heart J 2015;56 (04):428–431

3 Refaat MM, Ballout J, Mansour M. Ablation of atrial fibrillation in patients with congenital heart disease. Arrhythm Electrophysiol Rev 2017;6(04):191–194

