Percutaneous closure of patent foramen ovale and atrial septal defect: A case report

Perkutano zapiranje odprtega ovalnega okna in okvare medpreddvornega pretina: Prikaz primera

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Abstract

A 67-year old man with a haemodynamically significant type secundum atrial septal defect (ASD), large patent foramen ovale (PFO) and a significant septal aneurism presented with shortness of breath and limited exercise tolerance. There was no evidence of additional structural abnormalities or significant coronary artery disease. Simultaneous percutaneous closure of both defects was planned. Since the wire could only be passed through PFO while the second wire could not be passed through the ASD, only PFO was closed with a 35 mm Amplatz PFO occluder. After 3 months, which served for tissue ingrowth of Amplatz PFO occluder and aneurism stabilization, ASD located in the posterior-inferior part of the fossa ovalis documented by three-dimensional transesophageal echocardiography (3D-TEE) was easily crossed and successfully closed with a 12 mm Amplatz ASD occluder. Stable position without unwanted interference between the devices was obtained. There was no residual shunting on colour Doppler and no bubble shunting during Valsalva maneuver. Within 6 months after the procedure, symptoms significantly improved and the right heart chambers decreased. 3D-TEE revealed both devices in good position with only trivial shunting through the PFO occluder documented by colour Doppler.

Izvleček

67-letnega moškega s pomembno hemodinamsko okvaro medpreddvornega pretina (ASD) tipa secundum v kombinaciji z velikim odprtim ovalnim oknom (PFO) in anevrizmo medpreddvornega pretina smo obravnavali zaradi težkega dihanja med naporom in omejene telesne zmogljivosti. Dodatnih strukturnih nepravilnosti ali pomembne koronarne bolezni nismo potrdili. Načrtovali smo sočasno perkutano zapiranje obeh okvar. Z žico smo prečkali PFO, z drugo žico pa preko ASD nismo uspeli priti. Zato smo zaprli PFO s 35-milimetrskim zapiralom Amplatz PFO. Po 3 mesecih, ki so služili za vraščanje zapirala in stabiliziranje anevrizme pretina, smo s tridimenzionalnim transezofagealnim ultrazvokom (3D-TEE) jasno umestili ASD, ki je bil v postero-inferiornem delu t. i. fosse ovalis. Uspešno smo ga prečkali in zaprli z 12-milimetrskim zapiralom Amplatz ASD. Obe zapirali sta bili v stabilni legi, preostalega pretoka pri barvni Dopplerjevi ultrazvočni preiskavi ali prehoda mehurčkov med Valsalvo pa ni bilo. V 6 mesecih so se simptomi pomembno izboljšali, desne srčne votline pa zmanjšale. 3D-TEE je pokazal dobro lego obeh zapiral in minimalen preostali pretok skozi PFO zapiralo.

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1 Introduction

Atrial septal defect (ASD) accounts for up to 30 % of all congenital heart abnormalities. There are four types including type primum, secundum, sinus venosus superior/inferior and sinus coronarius (1). Most of the patients with ASD are asymptomatic until their forties and early fifties (2) when shortness of breath and limited exercise tolerance gradually develops due to increasing left to right shunting (3). Only ASD type secundum is amenable for percutaneous closure which is the preferred treatment in case of appropriate anatomic characteristics.

Patent foramen ovale (PFO), on the other hand, is present in about 30 % of population and may be the culprit for paradoxical embolization resulting in ischemic stroke, myocardial infarction or peripheral ischemic event (4). Percutaneous closure may reduce the incidence of repeat paradoxical embolization and represents an effective and safe alternative to lifelong antiaggregation or/and anticoagulation therapy in these predominantly younger patients (5-7). Large ASD or PFO is frequently associated with interatrial septal aneurism (ISA) which may make percutaneous closure more challenging and increases the risk of device embolization. We herein report a patient in whom large PFO and ASD accompanied with significant ISA were successfully closed using two Amplatz occluders implanted in sequential procedures.

2 Case report

A 67-year-old man with arterial hypertension and paroxysmal atrial fibrillation presented with shortness of breath and limited exercise tolerance. Several years earlier, a 7 mm ASD estimated to be hemodynamically insignificant, was documented. No additional cardiac abnormality including PFO or ISA has been documented at that time.

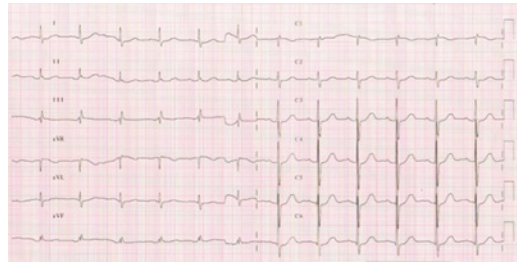

Figure 1: 12-lead electrocardiogram recorded on admission.

A 12-lead electrocardiogram recorded at our institution revealed sinus rhythm with borderline first-degree AV block and signs of left ventricular hypertrophy without evidence of right bundle branch block (Figure 1). Transthoracic echocardiography (TTE) showed moderately enlarged right ventricle (end-diastolic area 29 cm^2) and right atrium (area 36 cm^2). Left ventricle showed concentric hypertrophy, normal ejection fraction and transmitral Doppler flow pattern suggestive of mild diastolic dysfunction. Also left atrium was moderately dilated (area

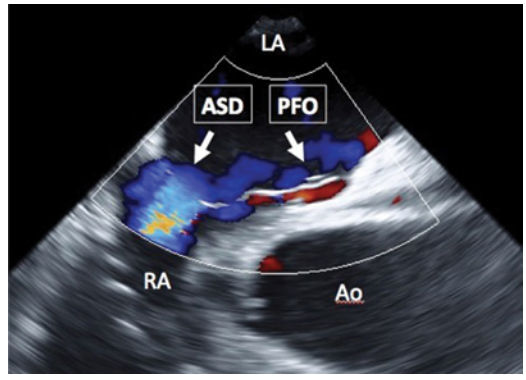

Figure 2: Two-dimensional transesophageal echocardiographic view (90 degrees) on interatrial septum showing significant left to right color Doppler flow through atrial septal defect (ASD) and very long patent foramen ovale (PFO) with some in-tunnel color Doppler flow. LA = left atrium; RA = right atrium; Ao = aorta.

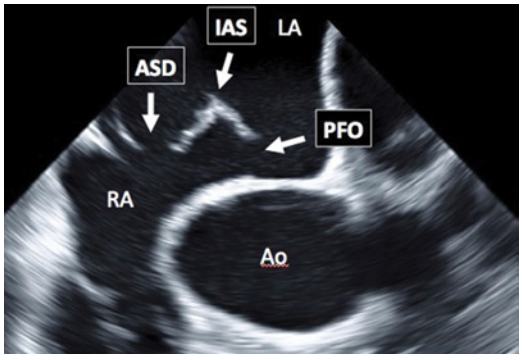

Figure 3: Two-dimensional transesophageal echocardiographic view (90 degrees) on interatrial septum during Valsalva maneuver showing atrial septal defect (ASD), very large patent foramen ovale (PFO) and significant aneurism of interatrial septum with large amount of abundant tissue. LA = left atrium; RA = right atrium; Ao = aorta.

of 36 cm^2). Transesophageal echocardiography (TEE) revealed PFO with a very long tunnel which widely opened during Valsalva maneuver and was associated with immediate massive bubble appearance in left atrium. Additionally, large ISA with oval ASD (12 × 7 mm) with significant left to right shunting (Qp/Qs 2.6:1.0) was demonstrated (Figure 2 and Figure 3).

Cardiac MRI did not show additional abnormalities. Coronary angiography revealed mild nonobstructive disease. Right atrial pressure was 8/7 mm Hg (mean 5 mm), pulmonary artery pressure 38/9 mm Hg (mean 22 mm) and left atrial pressure measured by passage of the catheter through the PFO was 9/7 mm Hg (mean 6 mm Hg). Calculated Qp/Qs based on oximetry performed on room air was 1.9:1.0.

Simultaneous percutaneous closure of both defects was planned. We routinely use fluoroscopy and TEE guidance under conscious sedation without endotracheal intubation (9-11). A J-tipped wire was easily passed through the PFO. The second wire, nor J-tipped not hydrophilic, could not have been passed through the ASD even when PFO was completely occluded with the sizing

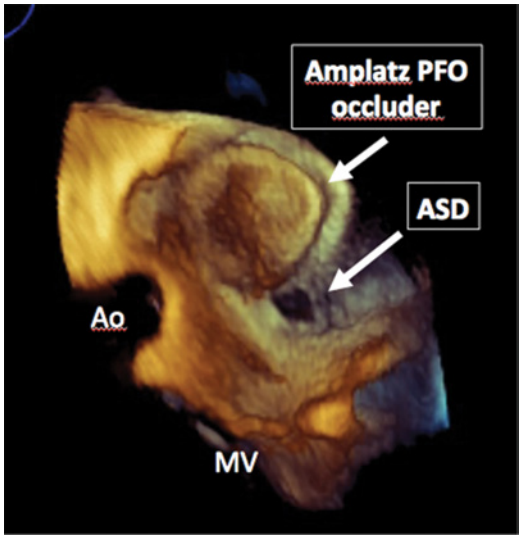

Figure 4: Three dimensional transesophageal echocardiographic view from left atrium showing the left disk of Amplatz PFO occluder and atrial septal defect (ASD) at the infero-posterior part of fossa ovalis. Ao = aorta; MV = mitral valve.

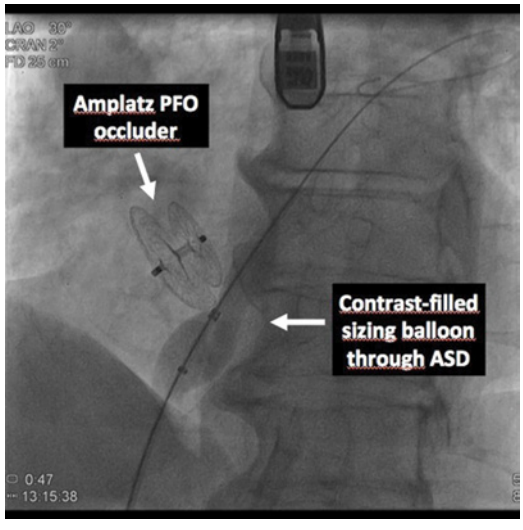

Figure 5: Fluoroscopic view (LAO 30/2 degrees) showing Amplatz PFO occluder and wire with contrast-filled sizing balloon through the atrial septal defect (ASD).

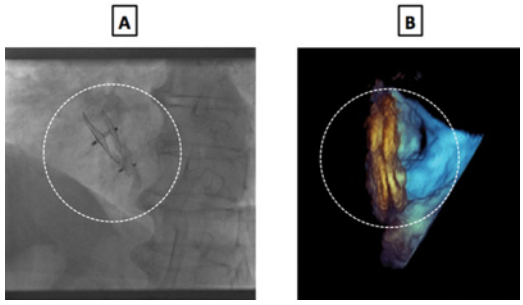

Figure 6: Fluoroscopic (A) and three-dimensional transesophageal echocardiographic side view (B) showing both implanted Amplatz occluders in appropriate position. LA = left atrium; RA = right atrium.

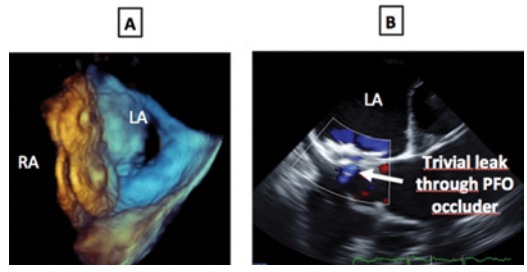

Figure 7: Three-dimensional transesophageal echocardiographic view from left atrium showing both implanted Amplatz occluders (A) and two dimensional echocardiographic view (90 degrees) of interatrial septum showing trivial color flow through the Amplatz PFO occluder (B) 6 months after the procedure.

balloon. At that point, the decision was made to close PFO using 35 mm Amplatz PFO occluder and perform ASD closure in a staged procedure after ingrowth of the device and ISA stabilization. After 3 months, the patient was brought again to the catheterization laboratory. Three- dimensional (3-D) TEE revealed a 10 mm ASD located at infero-posterior border of fossa ovalis just below the previously implanted Amplatz PFO occluder which was in a good position (Figure 4). A standard J-tipped wire was this time easily passed through the ASD and following balloon sizing (Figure 5), a 12 mm Amplatz ASD occluder was successfully deployed. Complete closure without unwanted interference between the both devices assessed by fluoroscopy (Figure 6a) and 3-D TEE (Figure 6b) was documented. There was no residual color Doppler flow through any device or interatrial septum. The patient was discharged next morning without any complications.

At 6 months follow up, he reported significantly decreased shortness of breath and improved exercise tolerance. He roughly estimated improvement of symptoms for about 70 % from the baseline and reported only two brief episodes of, most likely, paroxysmal atrial fibrillation.

TTE showed that right ventricular area significantly decreased from 29 cm^2 to 15 cm^2 and right atrium area from 36 cm^2 to 28 cm^2. 3-D TEE showed both closure devices in adequate position with persisting small overlap (Figure 7A) and trivial color flow through the Amplatz PFO occluder (Figure 7B).

3 Discussion

We described a patient with a complex pathology of aneurismatic interatrial septum with large PFO and ASD which were successfully closed in a staged procedure using two Amplatz occluders. This case nicely illustrates the important role of TEE in such complex procedures and in particular the added value of 3-D TEE which served to accurately locate ASD and its relation to PFO occluder which stabilized ISA. Such clear imaging was essential for easy wire crossing of ASD during the staged procedure. With good cooperation between interventional cardiologist and echocardiographist, even such complex procedure becomes more predictable, safer and requires less fluoroscopy. Instead of TEE, intracardiac echocardiography (ICE) using percutaneous probe introduced via femoral vein could also have been used. We have pre-

viously described successful closure of ASD in several patients (10). This technology is undoubtedly more comfortable for a patient but it does not provide a 3-D image and is unfortunately associated with significant additional cost.

We have developed considerable experience in PFO (9,11) and ASD closure (10) which has been as we write, successfully performed in 213 patients using different closure devices (Table 1). In PFO patients, who had concomitant ISA in 33 %, a 6- month closure rate assessed by TEE was in excess of 90 % without device embolization/thrombosis/pericardial effusion (9). In ASD patients, successful closure was achieved in all patients of whom 3 (13 %) had multiple defects requiring two

Amplatz occluders. Only 3 of 140 PFO patients (2.1 %) presented with combined PFO/ASD defects. In one patient, both defect were successfully closed using only one, but larger device resulting in complete closure also at 6 month TEE. In a second patient, FlatStent for PFO and Amplatz for ASD were used. Despite complete initial closure, follow up TEE after 6 months demonstrated residual shunting through the PFO tunnel for which antiaggregation therapy without additional closure attempt has been advised. Also herein reported patient with only trivial shunt at 6 months will be further followed to document eventual increase in shunting. These observations indicate importance of systematic TEE follow up to document possible remodeling of the tunnel and septum after closure device(s) over time with reoccurrence of shunts. We recently demonstrated such dynamic changes after in--tunnel PFO closure using FlatStent (11).

Table 1: Percutaneous structural interventions at MC Medicor between October 2006 and end of December 2017.

	Number of patients
PFO closure	181
ASD closure-single defect	26
ASD closure-multiple defects	3
PFO + ASD closure	3
VSD closure	1
Left atrial appendage closure	29
TAVI	11
Percutaneous paravalvular leak closure	1
Alcohol septal ablation for HOCM	8
All percutaneous structural interventions	**262**

Legend: PFO = patent foramen ovale; ASD = atrial septal defect type secundum; VSD = ventricular septal defect; TAVI = transcatheter aortic valve implantation; HOCM = hypertrophic obstructive cardiomyopathy

In conclusion, our patient illustrates the capability of current percutaneous closure procedures to achieve optimal defect closure even in complex anatomies thereby avoiding open heart surgery. It also emphasizes the need for close intraprocedural cooperation between interventional cardiologist and echocardiographist who now, with 3-D TEE, has a very valuable tool to guide percutaneous structural interventions.

The patient gives his consent to the publication.

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