Case Report/Series

Percutaneous atrial septal defect closure using transesophageal echocardiography without fluoroscopy in a pregnant woman: a case report

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ABSTRACT

Transcatheter closure is the treatment of choice for atrial septal defect (ASD); it has good efficacy and minimal complications. However, this approach in a pregnant woman is limited due to the risk of radiation exposure. A novel fluoroscopy-free technique has been introduced to reduce x-ray exposure. This case reported the experience of an ASD transcatheter closure in a pregnant woman without fluoroscopy guidance. To the best of our knowledge, this is the first successful fluoroscopy-free technique for transcatheter closure in Indonesia. The case is a 26-year-old primigravida at 26 weeks' gestational age with secundum ASD and pulmonary hypertension. Transcatheter closure was successfully performed with a Cera ASD occluder (Lifetech Scientific Corporation) no. 28 mm guided by transesophageal echocardiography. During the procedure, transient supraventricular tachycardia was developed. There were no other major or minor periprocedural complications. ASD transcatheter closure in a pregnant woman without fluoroscopy is feasible, safe, and effective.

KEYWORDS atrial septal defect, catheterization, pregnant woman, transesophageal echocardiography

Transcatheter closure of atrial septal defect (ASD) is a well-established procedure. Good efficacy, low morbidity, prevention of sternotomy, reduced length of stay, and lower cost have led the transcatheter ASD closure to be the preferred method over surgery.[1,2] However, in some groups of patients, concern over radiation exposure might limit the use of this method, such as for a pregnant woman, since radiation exposure might cause harm to the fetus.[2] To avoid radiation exposure, a fluoroscopy-free technique for ASD transcatheter closure has been developed.[2] To the best of our knowledge, this report described the first experience of an ASD transcatheter closure in a pregnant woman without fluoroscopy in Indonesia.

Case illustration

A 26-year-old primigravida at 26 weeks' gestational age was admitted to the outpatient clinic with worsening dyspnea since the first trimester of pregnancy in July 2018. She also had a history of supraventricular tachycardia (SVT). On examination, she was well compensated. She was afebrile; her pulse rate was 88 bpm, blood pressure was 90/60 mmHg, respiratory rate was 20 breaths per min, and peripheral

oxygen saturation was 99%. She had a normal first heart sound, a wide fixed split in the second heart sound, and accentuated P2 without murmur or gallop. There was no sign of clubbed fingers. Other physical examinations were unremarkable. Her electrocardiography (ECG) was suggestive of right ventricular hypertrophy. Transthoracic echocardiography (TTE) revealed secundum ASD with a bidirectional shunt, pulmonary hypertension, severe tricuspid regurgitation, and a tricuspid valve gradient of 130 mmHg.

She was diagnosed with chronic heart failure functional class III, secundum ASD, and pulmonary hypertension. Although the optimal therapy for heart failure had been given, the symptoms persisted. Thus, closing the defect was mandatory for both mother and fetus. Cardiac catheterization followed by transcatheter closure of ASD was scheduled. We planned to attempt a fluoroscopy-free technique only using transesophageal echocardiography (TEE). Informed consent was obtained from the patient. Before the procedure, the patient was consulted to obstetrician and received a tocolytic agent (duvadilan 10 mg b.i.d).

Procedure

A diagnostic procedure of right heart catheterization was performed under general anesthesia only with TEE and without fluoroscopy. A wire was positioned at the inferior vena cava (IVC), superior vena cava, right atrium (RA), left atrium, right ventricle, and main pulmonary artery (PA) under watchful monitoring of the echo from the mid-esophageal bicaval view and mid-esophageal aortic valve short axis view (Figure 1).

The hemodynamic data revealed that the systolic pressure of the pulmonary arteries was high (more than 2/3 of systemic pressure) with pulmonary (Qp) and systemic (Qs) blood flow ratio (Qp:Qs) was 1.6, pulmonary vascular resistance index 10 WU.m^2, and pulmonary vascular resistance (PVR)/systemic vascular resistance (SVR) 0.44. Oxygen vasoreactivity test was performed for 10 min and the Qp:Qs was 5.4, pulmonary arteriolar resistance index 2.2 WU.m^2, and PVR/SVR 0.13 (Table 1).

Considering the value of PVR/SVR was <0.33, transcatheter closure of ASD without a fenestrated device was planned. TEE was performed intra-procedural and the diameter of ASD is 18–22 mm with favorable rims for device closure. Closure with a Cera ASD occluder (Lifetech Scientific Corporation, China) no. 28 mm was planned with guidance of TEE (Figure 2).

Due to high pulmonary artery pressure (PAP), a 4F multipurpose (MP) catheter was placed from the left femoral vein into the left PA to monitor the

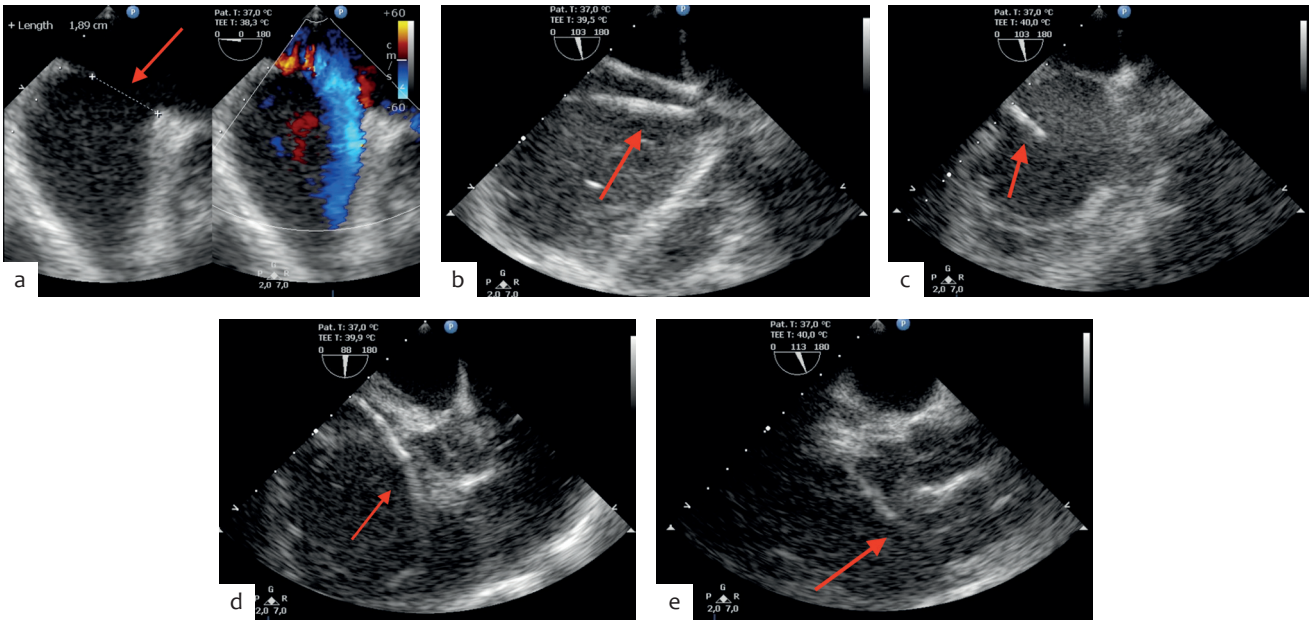

Figure 1. Diagnostic catheterization under TEE guidance (red arrow). (a) Pre-procedural TEE showed the diameter of the secundum ASD; (b) visualization of MP catheter at SVC; (c) visualization of MP catheter at RA; (d) MP catheter was placed at RVOT; (e) visualization of MP catheter at MPA. TEE=transesophageal echocardiography; ASD=atrial septal defect; MP=multipurpose; SVC=superior vena cava; RA=right atrium; RVOT=right ventricular outflow tract; MPA=main pulmonary artery

Table 1. Hemodynamic data before and after the procedure

Parameter	Pre-closure				Post-closure	
	Pre-oxygen vasoreactivity test		Post-oxygen vasoreactivity test			
	Pressure (mmHg)	Oxygen saturation (%)	Pressure (mmHg)	Oxygen saturation (%)	Pressure (mmHg)	Oxygen saturation (%)
Inferior vena cava		77		87		
Superior vena cava		66		74		
Right atrium, (a/v/mean)	10/9/8			10/10/9		
Right ventricle (systolic/end-diastolic)	85/12					
Main pulmonary artery (systolic/diastolic/mean)	84/43/58	80 (step up)	79/41/55	94 (step up)	74/39/52	
Left atrium, (a/v/mean)	14/12/12	98	12/11/10	99		
Descending aorta (systolic/diastolic/mean)	97/60/74	97	97/59/74	99 (step up)	104/60/76	100 (peripheral)

a=atrial kick; v=passive filling of the atrial during ventricular systole

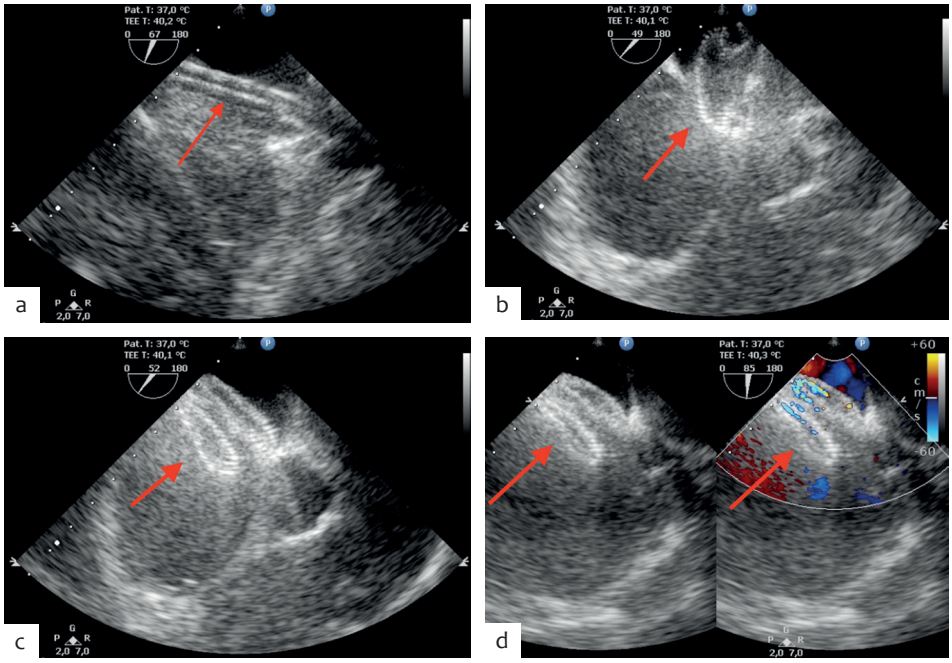

Figure 2. Transcatheter closure of ASD using TEE guidance (red arrow). (a) The delivery sheath was advanced to the LUPV; (b) the device was not fully occluding the defect, need repositioning; (c) after repositioning, the device was positioned correctly (no residual leak or impingement on adjacent structures); (d) TEE after the procedure showed the device stowed in place; no peripheral residual shunt was present (red arrow). ASD=atrial septal defect; TEE=transesophageal echocardiography; LUPV=left upper pulmonary vein

PAP continuously and a 6F MP catheter was inserted through a 6F sheath in the right femoral vein to the IVC and right atrium (RA). Subsequently, a 0.035-inch guidewire was advanced into the RA through a 6F MP catheter guided by TEE using a bicaval view. Clockwise torque on the catheter may be needed to obtain the correct direction while advancing through the defect toward the left atrium and was positioned in the left upper pulmonary vein (LUPV). Once the catheter in the LUPV, the guidewire was extracted. Next, a 0.035-inch stiff wire was advanced to the LUPV guided by the placed catheter. The sheath and a 6F MP catheter were pulled out. Tracked by TEE, the 12F delivery sheath was inserted along with the stiff wire into the LUPV. The Cera ASD occluder (Lifetech Scientific Corporation) no. 28 mm entered the 12F delivery

sheath into the LUPV. Under TEE guidance, the sheath was then gently withdrawn to deploy left atrium side disc of device in left atrium, and then the device was pulled into the RA until the RA side disc was inflated maximally in RA. Manipulation of the device was needed to correct its position to the proper location. During device deployment, stable SVT occurred with heart rate of 145 bpm. Adenosine triphosphate 10 mg was given to the patient intravenously, and the ECG converted to sinus rhythm, with a heart rate of 101 bpm. Final evaluation with TEE showed that the device was in a good position without residual ASD. After the device was proven to be in a stable position with the wiggle test, we decided to detach the device. We obtained the descending aorta (AoD) pressure and PAP once again simultaneously. The result was good, with increased AoD pressure and decreased PAP (Table 1).

After the procedure, TEE documented the device stowed in place without residual ASD or any impingement on adjacent structures (Figure 2). The procedural time in this patient is approximately 120 min. No major complications have been observed in this patient.

At the outpatient clinic, the patient reported an improvement in her symptoms and exercise ability (New York Heart Association functional class II) after one month of the procedure. The TTE showed a well-seated device without evidence of residual interatrial shunting. Three months after the procedure, the patient gave birth to a 2,400 g newborn (spontaneously crying) via cesarean section at 37 weeks of gestation due to oligohydramnios.

DISCUSSION

For the last decade, transcatheter closure has been the treatment of choice for secundum ASD. The gold standard for transcatheter placement is a fluoroscopy-guided procedure. Each patient undergoing this procedure may be exposed to radiation, where a median radiation dose might reach 5 (0.16–14.4) or 6.5 (0.24–22) millisieverts.[1] The risk of radiation exposure has been an issue, especially in young patients and during pregnancy because there might be an implication for the development of malignancy and a teratogenic effect on fetal development. Our patient is a primigravida at 26 weeks' gestational age with symptoms of heart failure despite adequate therapy. Closure of ASD is critical to ensuring the safety of the mother and fetus.

Recently, to reduce radiation exposure, Ewert et al[2] successfully performed diagnostic catheterization and transcatheter closure of ASD under the guidance of echocardiography alone in 19 out of 22 patients. Their study reported that procedural times were similar (88 *versus* 100 min; $p = 0.09$). However, the fluoroscopy-free group received significantly higher doses of propofol for sedation. Since then, several studies have reported the safety and feasibility of this technique, but it has not been widely accepted for routine use.[1,3–5]

This study reported the first successful transcatheter closure of secundum ASD without fluoroscopy in Indonesia. The biggest issue in this procedure is the operator's performance view to track the guidewire and sheath in 2D view of TEE.[3] Visualization of tip of the catheter and deployment of the device is critical for the safety and efficacy of device closure of ASD. Thus, an operator skilled in transcatheter intervention and experienced echocardiographer are mandatory.[3–5]

Moreover, the hemodynamic parameters after closure, especially the PAP, had correspondingly decreased significantly compared to pre-closure data. Patients with an uncorrected left-to-right shunt, such as ASD, are at risk for developing pulmonary arterial hypertension (PAH).[6–8] Although the exact pathogenesis of PAH in ASD is not clearly defined, it has been postulated that persistent exposure to increased pulmonary blood flow leads to vascular remodeling and dysfunction, resulting in a progressive rise in PVR and eventually, PAP.[8–10] Pulmonary flow is determined by the size of the ASD. Larger ASDs are associated with a greater risk of developing PAH. Thus, closing the defect will reduce the amount of pulmonary flow and consequently reduce PAP.[8] In this patient, the reduction of PAP after closure shows that increased PAP is caused by flow. Also, a rise in systemic pressure after closure in this patient indicates the presence of a significant left-to-right shunt. However, in some of patients with PAH who undergo ASD transcatheter closure, the elevated PAP persists, despite a reduction from baseline values. This suggests some degree of associated irreversible changes in the pulmonary vasculature.[8] Recent studies showed that factors associated with a reduction in PAP after ASD closure were a higher degree of PAH, younger age, and smaller size (body surface area).[8–11]

The procedural time in this patient is approximately 120 min, including sedation. Other studies reported a procedure of shorter duration. However, most of them were not included in the duration of diagnostic catheterization without fluoroscopy guidance. Yang et al[3] reported a total of 114 children with secundum ASD who underwent transcatheter device closure under the guidance of TEE without fluoroscopy with a procedural time in the range from 8 to 42 min (median 18 min), while Schubert et al[1] reported a procedural time ranging from 20 to 170 min. Since this is our first experience, we strongly believed that with increasing operator experience, the mean procedure time will be shorter and comparable to the time needed for our standard practice.

During the procedure, the patient experienced an SVT due to device deployment in the atrial chamber but immediately converted to sinus rhythm after adenosine administration. Transient heart rhythm disturbances and device embolization are the most common intraprocedural complication reported by several studies.[1–5,11] Fortunately, there were no other major complications related to the procedure, including embolization of the device, residual shunt, malignant arrhythmias, cardiac tamponade, cardiac chamber rupture, or thrombosis-related conditions in this patient.

In conclusion, the transcatheter closure of an ASD without fluoroscopy is feasible, safe, and effective. However, our experience is still limited, and a longer follow-up is needed in the future.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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