

Feasibility and Safety of Transcatheter Device Closure for a Large Atrial Septal Defect with Moderate Tricuspid Regurgitation

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ABSTRACT

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Background: Atrial septal defect (ASD) is the most common congenital heart disease (CHD) with a slow progression, often remaining undiagnosed during youth. This can result in a late diagnosis in adulthood when the defect has already become large, which may be associated with increased morbidity and mortality due to the progression of symptoms. **Case summary:** A 38-year-old woman presented with a 2-month history of cough, dyspnea, and hoarseness. Transthoracic echocardiography (TTE) revealed right atrial and ventricular dilation from right-sided volume overload, normal left ventricular function (LVEF 72%, EDD 39 mm, ESD 23 mm), normal RV systolic function (TAPSE 33 mm), atrial septal aneurysm (ASA+), and moderate-to-severe tricuspid regurgitation (TR, VC 0.5 cm). Peak TR velocity was 2.4 m/s, yielding an estimated RV systolic pressure of 26–31 mmHg (IVC collapse >40%), indicating functional TR secondary to RV/annular dilation. TEE confirmed ASD with left-to-right shunt, measuring 22.6 mm (2D) and 19.7 × 15.6 mm (3D). Rim dimensions showed aortic rim minimal (thin and floppy) and posterior rim 14.3 mm (thin/floppy). Transcatheter closure was successfully performed using a 24-mm Memocarna ASD Occluder (Revass Systems). **Discussion:** Transcatheter closure was successfully performed, resulting in a significant reduction of respiratory symptoms and complete resolution of hoarseness. This confirmed the mechanical relief of left recurrent laryngeal nerve compression (Ortner's syndrome) following defect closure. **Conclusion:** Transcatheter closure of a large ASD in an adult with large ASA was successfully performed, resulting in significant improvement in the patient's pre-existing respiratory symptoms and hoarseness.

BACKGROUND

ASD is the most common congenital heart disease diagnosed in adulthood approximately 25–30% of cases, with secundum ostium being the most frequently affected type and often asymptomatic during childhood.^{1,2} Over time, the condition may progress and manifest with various symptoms, influenced by the size of the defect and the presence of associated hemodynamic changes.¹

CASE PRESENTATION

A 38-year-old female presented with a persistent cough for 2 months, occasionally accompanied by dyspnea and voice changes. The patient had taken multiple medications

for her cough, but the symptoms persisted.

Investigations

Physical examination revealed elevated blood pressure (140/80 mmHg) and a cardiac murmur, while the pulmonary examination remained normal. Electrocardiogram (ECG) demonstrated T-wave inversions in leads V1–V2 and broad QRS complex (0.10 s), suggested to incomplete RBBB. Chest X-ray showed features of bronchitis with a normal cardiothoracic ratio (CTR <50%). Evaluation by transthoracic echocardiography (TTE) demonstrated significant right-sided volume overload, characterized by a dilated right atrium and ventricle with preserved RV systolic function (TAPSE 33 mm) and normal left ventricular ejection fraction

(LVEF 73%, EDD 39 mm, ESD 23 mm). Moderate tricuspid regurgitation (TR) and mild mitral regurgitation were noted.

Transesophageal echocardiography (TEE) confirmed a secundum atrial septal defect (ASD) with a left-to-right shunt, measuring 22.6 mm on 2D imaging and 19.7×15.6 mm on 3D view. Rim assessment demonstrated minimal aortic rim (thin and floppy) and posterior rim 14.3 mm (thin and floppy), while SVC; IVC; and mitral rims were adequate at 19.0 mm, 20.5 mm, and 9.0 mm, respectively. The presence of ASA (+) in TTE anatomically explains the thin and floppy nature of the aortic and posterior rims on TEE. Recognizing this structural flexibility was crucial in selecting an occluder to achieve stable device positioning.

Hemodynamic evaluation via color Doppler imaging revealed a peak TR velocity of 2.4 m/s. Using the modified Bernoulli equation and assuming a right atrial pressure of 3–5 mmHg (based on an IVC diameter <2.1 cm with $>40\%$ collapse), the estimated pulmonary artery systolic pressure (PASP) / RV systolic pressure (RVSP) was 26–31 mmHg. This indicates functional moderate-to-severe TR secondary to RV annular dilation in the setting of normal-to-borderline pulmonary pressures.

Invasive hemodynamic measurement revealed a normal mean pulmonary artery pressure (mPAP) of 15.5 mmHg. Although a formal Qp/Qs ratio was not calculated, a hemodynamically significant left-to-right shunt was clearly evidenced by marked right-sided chamber enlargement on echocardiography.

Differential Diagnosis

The patient's persistent cough and intermittent dyspnea initially suggested a primary pulmonary etiology, such as chronic bronchitis, asthma, pulmonary tuberculosis, or chronic obstructive pulmonary disease, also the absence of cardiomegaly on chest radiography (CTR $<50\%$) in this patient may have further reduced the initial suspicion of cardiac disease. However, the presence of a cardiac murmur despite an otherwise unremarkable pulmonary examination prompted consideration of an underlying cardiac cause. In adults, secundum atrial septal defects may remain clinically silent for years and can present with nonspecific respiratory symptoms, including chronic cough and dyspnea, which may mimic primary pulmonary disease.

Echocardiographic evaluation was therefore important in establishing the underlying diagnosis, revealing right atrial and right ventricular dilation and a secundum ASD with a left-to-right shunt.

Management

The patient underwent transcatheter closure of the ASD under general anesthesia. After induction and endotracheal intubation, TEE demonstrated an oval-shaped secundum ASD measuring approximately 15×20 mm, with adequate rims for device closure. The right groin area was prepared and draped in a sterile manner. Right femoral venous puncture was performed, and a 6F sheath was inserted. An MPA2 catheter was advanced through the inferior vena cava into the right atrium, across the ASD, and into the left atrium. A guidewire was then positioned in the left upper pulmonary vein to provide stable support. A 12F delivery sheath was advanced over the guidewire into the left atrium. Through this sheath, a 24-mm Memocarna ASD Occluder (Revass Medical, Engineering Co., China) was introduced. Under continuous TEE and fluoroscopic guidance, the left atrial disc was deployed first and gently pulled against the interatrial septum, followed by deployment of the right atrial disc to secure the device in position. A stability (tug) test confirmed that the device was well seated on the interatrial septum. After confirmation of satisfactory device position and minimal residual shunt on TEE, the device was released from the delivery cable. The total procedural time was 45 minutes, and the procedure was completed successfully without complication.

Follow Up

During hospitalization, the patient reported no post-procedure complaints and was discharged on single antiplatelet therapy with Ascardia (Aspirin) 80 mg daily planned for 6 months to prevent device-related thromboembolism; no prior heart failure medical therapy or diuretics were required. At the 1-month clinical follow-up, the patient remained completely asymptomatic with no reported cardiovascular or neurological complaints. Although a formal 1-month post-procedure follow-up TTE was not documented due to logistical constraints, clinical evaluation confirmed stable functional status without signs of heart failure or thromboembolic events.

DISCUSSION

Atrial septal defect is often asymptomatic during childhood, which lead to a late diagnosis.² ASD creates a direct communication between the atrial chambers, allowing blood to shunt between the systemic and pulmonary circulation. The direction and volume of blood flow through the interatrial septum are determined by the size of the defect and the relative atrial pressures, which depend on the compliance of the left and right ventricles. Due to lower pulmonary vascular resistance and the high compliance of the right ventricle, the shunt usually flows from left to right.³ In this case, the patient presented with a large defect, resulting in increased left-to-right atrial blood flow, leading to volume and pressure overload in the right atrium and subsequent atrial enlargement.^{4,5}

Hoarseness in this patient suggested the presence of Ortner's syndrome (cardiovocal syndrome). The left recurrent laryngeal nerve arises from the ipsilateral vagus nerve at the level of the aortic arch, loops beneath it through the aortopulmonary window, and ascends along the tracheoesophageal groove to innervate the intrinsic laryngeal muscles involved in phonation. In this case, massive right atrial and right ventricular dilation, combined with pulmonary artery enlargement secondary to the large secundum ASD, caused extrinsic mechanical compression of the left recurrent laryngeal nerve within the narrow aortopulmonary window, leading to hoarseness.⁶ Excessive pulmonary blood flow may cause structural abnormalities and impair local cellular immunity, likely contributing to the patient's recurrent respiratory infections.^{4,5} Elevated right-sided filling volumes additionally stretch the atrial myocardium, predisposing it to conduction abnormalities and electrical remodeling. Secundum defects present with incomplete right bundle branch block, as shown in this case.⁷

Although there is no lower age limit for defect closure, referral for surgery before school age is common practice. Chronic right-sided volume loading secondary to a left-to-right shunt causes RA and RV enlargement, which frequently leads to functional tricuspid regurgitation (TR). Increased right ventricular volume leads to tricuspid annular dilation and impaired leaflet coaptation, resulting in secondary rather than primary valvular regurgitation.^{8,9,10,11} The presence

of an ASA alongside a deficient aortic rim necessitates device upsizing relative to the static defect dimensions to ensure optimal tissue coverage, stable device anchoring, and complete defect apposition.¹² In this patient, transcatheter closure was successfully performed without complications.

The greater amount of blood flow through the right heart causes volume overload and the enlargement of the right ventricle, which lead to the decrease of diastolic volume of the left ventricle develops with age and intensifies clinical manifestations. In this case, patient didn't show any criteria of left ventricle diastolic dysfunction.¹³

The major concern with delayed ASD closure in adulthood is the progressive development of pulmonary vascular disease and in advanced cases, irreversible pulmonary arterial hypertension (PAH) and Eisenmenger. A sustained increase in blood flow through the pulmonary circulation caused by a chronic left-to-right shunt leads to pulmonary vascular remodeling. These pathological changes in the walls of the pulmonary arteries increase pulmonary vascular resistance (PVR). As PVR increases, pulmonary artery pressure rises to overcome this resistance and maintain pulmonary blood flow.¹³ When PVR exceeds systemic vascular resistance, the shunt direction reverses to right-to-left, resulting in cyanosis and Eisenmenger syndrome, indicating irreversible pulmonary vascular disease that strictly contraindicates defect closure.^{13,14} In this patient, the absence of pulmonary hypertension was directly supported by a normal mean pulmonary artery pressure (mPAP of 15.5 mmHg) and a non-elevated RVSP.

CONCLUSION

Transcatheter closure of a large ASD in an adult with large ASA was successfully performed, resulting in significant improvement in the patient's pre-existing respiratory symptoms and hoarseness. This case underscores the technical feasibility of device closure in complex septal anatomies with hypermobile, minimal aortic rims, while highlighting Ortner's syndrome as a rare yet important clinical presentation of adult congenital heart disease.

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TAKE HOME MESSAGES

- Adult ASDs can present deceptively with atypical extra-cardiac manifestations, such as respiratory symptoms or hoarseness (Ortner's syndrome), rather than overt heart failure, emphasizing the need to maintain a high index of suspicion in young adults with unexplained cardiopulmonary complaints.
- The co-existence of ASA rendered the aortic rim minimal and floppy; detailed 2D/3D TEE characterization of rim mobility rather than size alone is essential for selecting an appropriately oversized occluder to guarantee stable deployment.
- Preserved IVC collapse (>40%) and normal right atrial pressure (3–5 mmHg) can coexist with significant right-sided volume overload, confirming that functional tricuspid regurgitation may remain reversible prior to the onset of severe pulmonary arterial hypertension.

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