CLINICAL VIGNETTE

Refractory Hypoxia Post Catheter Ablation for Atrial Fibrillation

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Clinical Presentation

An 84-year-old male presented to electrophysiology for management of atrial fibrillation. Past medical history included persistent atrial fibrillation, nonischemic dilated cardiomyopathy, hypertension, hypercholesterolemia, and sleep apnea. His long-standing shortness of breath, dyspnea on exertion and low energy were attributed to his atrial fibrillation. Prior attempts to manage his atrial fibrillation with antiarrhythmics and cardioversion failed to convert him into sinus rhythm. There was no history of chest pain, dizziness, fever, chills, cough, strokes, or sick contacts. Baseline Echo revealed an ejection fraction of 45%, a normal sized right ventricular (RV) with mild reduction in function. Physical examination included temperature of 98.2° F, blood pressure 123/77 mmHg, heart rate of 93 beats/minute, respiratory rate of 18, and oxygen saturation of 99% on room air. Cardiovascular examination revealed no precordial lifts or thrills with irregularly irregular rhythm with normal S1 and S2. No gallops, murmurs, or rubs appreciated. Radial, femoral, and dorsalis pedis pulses were 2+ bilaterally. There were lower extremity edema and no jugular venous distension. The remaining of his physical examination was unremarkable. Due to his significant symptom's catheter ablation of his persistent atrial fibrillation was scheduled and was successful in converting the patient back to sinus rhythm. Following extubation, the patient developed acute hypoxic respiratory failure with decrease in SpO2 to low 80s, mean arterial pressures to low 60s, and heart rate to low 50s, concerning for right to left shunt due to elevated right-sided filling pressures noted during the ablation procedure. He appeared fluid overloaded on exam with elevated jugular vein pressure and required diuretics. Postoperative TTE revealed moderate tricuspid regurgitation, moderately enlarged RV with moderate reduction in function, with pulmonary artery pressure of 27mmHg. Bubble study confirmed the right to lift shunt likely related to iatrogenic ASD (iASD) during ablation.

Discussion

Hypoxia is a common clinical presentation caused by inadequate simply of oxygen at the tissue level, that is usually attributable to pulmonary conditions such as inadequate ventilation, dysfunction of the lung parenchyma or pulmonary embolism. A very specific cause in adults is represented by right to left interatrial shunting.[1] iASD is a known but underrecognized complication of left atrial procedures including pulmonary vein isolation, which happens when the interatrial septum is punctured to gain access to the left atrium. Over 80% of patients undergoing catheter ablation develop iASD, and over 95% of those patients have spontaneous resolution of their iASD within the following year, highlighting the benign nature of iASD. However, a small percentage of patients can have persistent ASD with long term sequelae including hypoxia and dyspnea.[2] The defect usually presents with left-to-right shunt with the relatively higher left atrial pressure compared to the right atrial pressure but can also present with right-to-left shunt when there is underlying right heart dysfunction, which can lead to an elevated right heart pressures.[3] Obstructive sleep apnea is another significant cause of right to left shunt predominance, due to recurrent transient episodes of hypoxemia during apneic spells inducing pulmonary vasoconstriction and eventually pulmonary hypertension.[4] Echocardiograph evaluates ASDs by demonstrating shunting across the interatrial septum. Two-dimensional transthoracic echocardiography (2D TTE) is often done first, providing the necessary imaging information to establish the diagnosis of ASD and make informed clinical decisions.[5] Transesophageal echocardiogram (TEE) provides higher definition visualization of the interatrial septum. This is usually done when findings on transthoracic imaging are unsatisfactory or technically limited. TEE is also particularly helpful in visualizing sinus venosus ASDs and, therefore, is indicated to rule out a sinus venosus ASD in the setting of right ventricular enlargement and volume overload of unknown etiology.[5] Indications for closure are the same as with congenital ASD. These include symptoms such as an embolic event, hypoxemia due to right-to-left shunting, or right heart enlargement/failure due to left-to-right shunt.[6] Special care in management should be given to patients with concomitant pulmonary hypertension or RV dysfunction, because the ASD functions as a "pop-off" right-to-left shunt to accommodate cardiac output during periods of increased physical activity, and closure of the ASD is contraindicated and could send the patients into RV failure.[7] Clinicians can utilize a tool known as the pulmonary artery pulsatility index (PAPi), comprised of hemodynamic indices defined as (systolic PAP − diastolic PAP) / Central venous pressure (CVP), that can serve as a predictor of RV failure.[8] A common surgical strategy to improve outcomes consists of leaving behind a small interatrial communication to provide a "pop-off" during periods of elevated right-sided pressures when the resultant right-to-left shunt through

the interatrial communication prevents acute right ventricular failure at the cost of systemic desaturation.[9] In symptomatic patients with no contraindications, percutaneous closure of iASDs can be safely performed. The procedure results in immediate arterial saturation improvement and reduced right-to-left shunting.[10] The most common devices used in the U.S for ASD closure include the Amplatzer and CARDIOFORM Septal Occluders.[11] Device choice depends on the underlying medical condition of the patient, with the Amplatzer being favored in patients with pulmonary hypertension or RV dysfunction due to its fenestrated properties.[12] Clinicians have the option to modify the degree and number of fenestrations, a decision that is driven by the hemodynamic findings and pressure changes during transient balloon occlusion during the procedure.[12]

Clinical Course

Following optimal diuresis, the patient condition improved and he was discharged. Over the following year, he had progressive shortness of breath and a reduction in physical capacity, which required oxygen supplementation. Repeat Echo showed an ejection fraction of 55%, a moderately dilated RV with moderate dysfunction. Given his increasing symptoms, the decision was made to close his ASD. After optimization of CVP with diuretics right heart catheterization revealed elevated right atrial pressure, mildly elevated pulmonary capillary wedge pressure at 15 mmHg, and a mean PA pressure in the low 20s with a PAPi score of 0.94, indicating a low probability of developing RV failure with ASD closure. A TEE to better visualize the interatrial septum, revealed a 7mm x 8mm ASD (Figure A). In the procedure room baseline hemodynamics revealed a right atrial pressure of 16 mmHg, RV pressure of 31/15, and a PA pressure of 30/15 mmHg. Balloon occlusion test was done and repeat hemodynamics revealed a right atrial pressure of 17 mmHg, RV pressure of 30/15, and a PA pressure of 25/12 mmHg. An 8 mm Amplatzer septal occluder was deployed under transesophageal guidance using percutaneous catheter closure, Echo evaluation showed the occluder in optimal position with no evidence of shunting (Figure B), and arterial blood gas monitoring showed an improvement of oxygen saturation from 88% to 94%. After the procedure, the patient had rapid resolution of his symptoms, and was discharged home the following day. At a one-month follow-up visit he reported a significant improvement in his energy and activity level and echocardiography demonstrated no evidence of an intracardiac shunt. He was without hypoxia or need for oxygen supplementation and continues to do well.

Learning Points

1- Although rare, some patients can have persistence of their ASD following catheter ablation, leading to long term sequelae like hypoxia.
2- Echo assessment is the mainstay to evaluate ASDs by demonstrating the shunting across the interatrial septum.
3- A special care should be given for patients with pulmonary hypertension or RV dysfunction, as sudden increase in the right heart pressures after ASD closure can push the patients into RV failure. PAPi indices can serve as a predictor of RV failure in those patients.
4- In patients with no contraindication, ASD closure may significantly improve hypoxia and functional capacity.

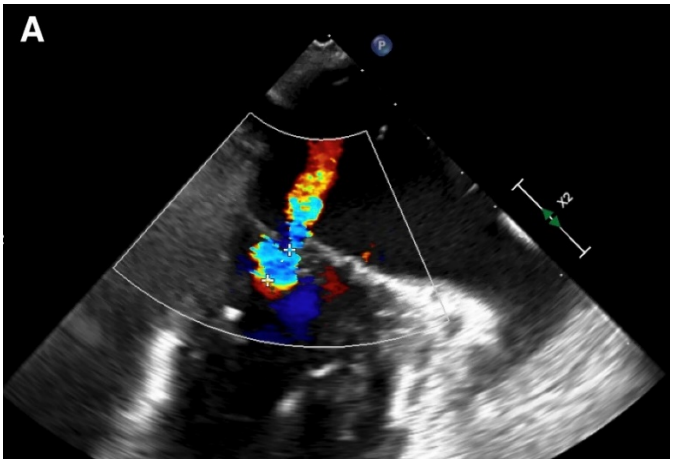

Figure A: A preprocedural TEE demonstrating the shunt across the interatrial septum

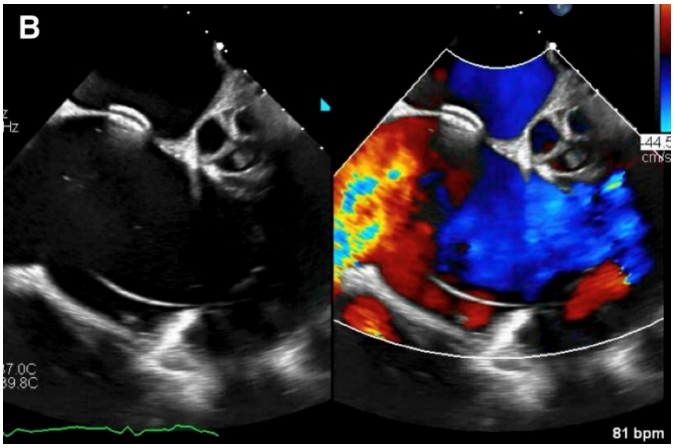

Figure B: Post implant TEE showing optimal positioning of the occluder with resolution of the shunt

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