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Journal

The Annals of Thoracic Surgery, 94(1)

ISSN

0003-4975

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Publication Date

2012-07-01

DOI

10.1016/j.athoracsur.2011.12.093

Unusual Effect of an Atrial Septal Aneurysm on Venous Drainage During Cardiopulmonary Bypass

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Atrial septal aneurysm is an uncommon cardiac anomaly that is usually asymptomatic or occasionally associated with cardioembolic events. We present the unusual impeding effect of an atrial septal aneurysm on venous drainage during cardiopulmonary bypass in a 70-year-old man who underwent aortic valve replacement and coronary artery bypass graft surgery.

(Ann Thorac Surg 2012;94:e11–2)

An atrial septal aneurysm (ASA) is a localized saccular deformity of the interatrial septum (IAS), generally seen as a bulge into the right or left atrium with a protrusion greater than 15 mm. It is commonly noted as an incidental finding in echocardiographic studies. Earlier ASA was thought to be a rare congenital abnormality. However, with the recent widespread use of two-dimensional echocardiography, especially transesophageal echocardiography (TEE), it has been more frequently identified in patients. As an isolated anomaly of the atrial septum ASA is usually asymptomatic and is not of any clinical significance to warrant surgical therapy. However, symptomatic ASA may be associated with cardioembolic events, especially in the presence of interatrial shunts, usually in the form of patent foramen ovale (PFO), and may need interventional therapy. Rarely it may cause right atrial inflow obstruction.

A 70-year-old man with known history of aortic stenosis presented with progressive dyspnea on exertion. Transthoracic echocardiography (TTE) revealed a calcified and severely stenotic aortic valve with a calculated valve area of 0.97 cm^2 resulting in a peak gradient of 75 mm Hg and a mean gradient of 40 mm Hg. There was trivial aortic valvular regurgitation. There was a reduced E/A wave ratio of 0.7, indicative of left ventricular diastolic dysfunction. Cardiac catheterization demonstrated a calculated aortic valve area of 1 cm^2 with a mean gradient of 39 mm Hg, severe triple vessel coronary artery disease, and 60% stenosis of the left main coronary artery. Left ventricular ejection fraction was estimated to be 0.60. Left ventricular end diastolic pressure was 16 mm Hg. Other hemodynamic parameters were within normal limits. He underwent aortic valve replacement using a size 25 St Jude Epic stented tissue valve (St Jude Medical Inc, St Paul, MN) and 3 vessel coronary artery bypass grafting with pedicled left internal thoracic artery graft to the left anterior descending artery, reversed saphenous vein grafts from the ascending aorta to the second circumflex obtuse marginal artery and the posterior descending artery under cardiopulmonary bypass (CPB), and moderate systemic hypothermia. The CPB was established by cannulating the ascending aorta with a 20 Fr Medtronic cannula (Medtronic Inc, Minneapolis, MN) for arterial flow and the right atrium for venous drainage using a size 29 × 37 Edwards 2-stage cannula (Edwards Lifesciences LLC, Irvine, CA). Transesophageal echocardiography performed at the beginning of the procedure confirmed the findings of TTE. It was also remarkable for the finding of a large ASA (Fig 1). There was no atrial septal defect (ASD) or PFO. During the CPB run the perfusionist could not achieve full desired systemic flow of 5 L/min due to inadequate venous return. Attempts to address this problem with vacuum-assisted venous drainage worsened the problem. Increasing the amount of vacuum suction on venous drainage further reduced the venous return and the flow dropped to as low as 3 L/min. The position of the venous cannula was assessed, and confirmed to be in good position. This was doubly confirmed by repositioning the venous cannula. The TEE revealed the large ASA had developed a 22-mm protrusion of the aneurysm into the right atrium from the plane of the atrial septum. No other atrial or venous anomaly such as an abnormally large Eustachian valve or Chiari malformation was present. The inferior vena cava was normal and of average size. After repeated trials and various maneuvers it was found that the best CPB flow was achieved with gravity-assisted venous drainage that enabled a flow of about 3.6 L/min initially that improved to 4.5L/min later. Moderate hypothermia was achieved by cooling the patient to 26°C. Surgery was completed uneventfully. The patient recovered well and was discharged home after 7 days postoperatively.

Comment

Atrial septal aneurysm is a localized saccular deformity of the IAS, generally at the level of the fossa ovalis, which bulges into the right or left atrium or both with a protrusion of greater than 15 mm beyond the plane of the atrial septum as measured by echocardiography. Prior to the widespread use of two-dimensional echocardiography, ASA was considered to be a rare congenital abnormality; subsequently, however, and especially after implementation of TEE, it has become more frequently identified [1–5]. Its prevalence varies between 0.08% and 1.2% in TTE studies, while recent studies using TEE report a prevalence of 2% to 10%. Only about 100 cases of ASA were reported before 1985 but since then a considerable number of cases have been published and the lesion morphologically described and categorized [1, 4]. Recently, ASA has been classified based on echocardiographic motion into the following 5 types [5]. Type 1R, the ASA protrudes from the midline of the IAS to the right atrium throughout the cardiorespiratory cycle. Type 2L, the ASA protrudes from the midline of the IAS to the left atrium throughout the cardiorespiratory cycle. Type 3RL, the maximal excursion of the ASA is toward the right atrium with a lesser excursion toward the left atrium. Type 4LR, the maximal excursion of the ASA is toward the left atrium with a lesser excursion toward the right atrium. Type 5, the ASA movement is bidirectional and equidistant to the right as well as to the left atrium during the cardiorespiratory cycle.

Atrial septal aneurysm has been associated with congenital heart diseases such as ASD, PFO, ventricular septal

Accepted for publication Dec 1, 2011.

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0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2011.12.093

defects, patent ductus arteriosus, Ebstein anomaly, tricuspid atresia and pulmonary atresia as well as acquired heart diseases, including valvular disease, cardiomyopathy, systemic and pulmonary hypertension, ischemic heart disease, arrhythmias, and thrombus formation. An ASA commonly presents as an incidental echocardiographic finding with no symptoms attributable to it. More recently a number of studies demonstrated an association between ASA and cerebrovascular events of embolic origin, including transient ischemic attacks and cerebrovascular accidents [1, 4, 6]. An ASA in the presence of a PFO has been associated with an increased risk of cerebrovascular events. Rarely it may mimic an atrial tumor in either the right or left atrium [7] or present with atrial arrhythmias [1, 3, 5]. Walpot and colleagues [8] reported right atrial inflow obstruction of the inferior vena cava due to ASA and an elongated Eustachian valve. There is no report in the literature of ASA limiting or impeding the venous drainage during CPB. We report a case of ASA that manifested in this fashion.

In our patient the TTE imaging did not demonstrate the presence of ASA, although an impressive type 5 ASA, with protrusion of the thin aneurysmal IAS into the right and the left atrium during various periods of cardiorespiratory cycle by about 22 mm, was detected with intraoperative TEE without any interatrial communication. The size and mobility of the ASA, along with its behavior like a type 1R ASA, as seen in the TEE during CPB, prompted us to realize that it impeded the venous drainage by obstructing the proximal ports of the venous cannula, especially when vacuum-assisted venous drainage was attempted. When full flow could not be achieved due to decreased venous return, additional fluid volume and moderate systemic hypothermia were used to aid adequate CPB run. Adequacy of CPB flow was assessed by continuous monitoring of venous line oximetry and near-infrared spectroscopy to measure regional oxygen saturation of cerebral tissue using the INVOS system (Somanetics, Troy, MI). These values and trends were found to be in the normal acceptable range throughout the surgery; hence, no attempt was made to change the cannulation strategy. If an ASA is associated with persistent limitation of venous drainage causing significant or unacceptable compromise of CPB arterial return, then alternative venous cannulation strategies should be considered. For example, separately cannulating the superior vena cava and the inferior vena cava or alternatively by insertion of additional cannula into either the right atrium or into the cavae, and if necessary, excision of the ASA. As the risk of cerebrovascular events or embolic strokes in patients with incidental ASA was low, we did not contemplate surgical treatment for ASA. The patient was placed on aspirin after coronary artery bypass grafting, which appears to be effective therapy to prevent cardioembolic events associated with ASA [6]. Eight months postoperatively our patient is asymptomatic and doing well with improved exercise tolerance. (Fig 2).

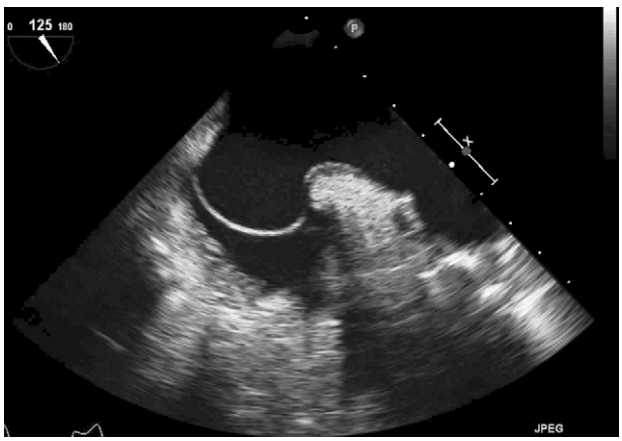

Fig 1. A transesophageal echocardiography image showing the large atrial septal aneurysm protruding into the right atrium.

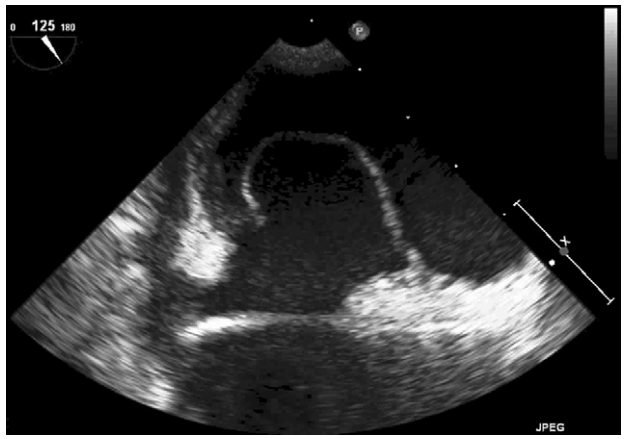

Fig 2. A transesophageal echocardiography image showing the large atrial septal aneurysm protruding into the left atrium.

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