Case Reports

Ruptured Sinus of Valsalva Aneurysm

Associated with Situs Ambiguus, Isolated Levocardia, and Polysplenia

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Aneurysm of the sinus of Valsalva, a rare cardiac condition, results from dilation of an aortic sinus. Sudden aneurysm rupture can trigger rapidly progressive heart failure.

We discuss the case of a 57-year-old woman with situs ambiguus, isolated levocardia, and polysplenia who presented with acute-onset heart failure. Transesophageal echocardiograms revealed an aneurysm of the right coronary sinus of Valsalva that had ruptured into the right atrial cavity. The patient underwent successful surgical repair.

To our knowledge, this is the first report of a sinus of Valsalva aneurysm in a patient with this combination of congenital abnormalities. We briefly review the association between congenital heart disease, situs ambiguus, and ciliary dysfunction. ***(Tex Heart Inst J 2017;44(6):416-9)***

Key words: *Abnormalities, multiple/diagnosis/pathology; aortic aneurysm/diagnosis; body patterning/genetics; cilia/pathology; coronary vessel anomalies/complications; heart failure/complications; heterotaxy syndrome/complications; sinus of Valsalva/diagnostic imaging/pathology/surgery; treatment outcome*

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Sinus of Valsalva aneurysm (SVA) is a dilation of one of the 3 aortic sinuses between the aortic valve (AV) annulus and the sinotubular junction or supra-aortic ridge.[1,2] This condition (prevalence, 0.09%–3.5%) arises from a congenital or acquired anomaly.[2,3] A ruptured SVA causes rapidly progressive heart failure. Genetic mutations (such as that in Marfan syndrome) and embryologic developmental defects underlie congenital presentations.[1-4] Acquired conditions (such as infection, atherosclerosis, or trauma) can exacerbate the destruction of connective tissue and lead to aneurysm formation.[1-4]

Developmental biological explanations for congenital heart disease (CHD) and its relationship with situs ambiguus and SVA formation are complex. In murine models, CHD has resulted from errors in left–right patterning during early embryonic development.[5] Among the major participants in left–right patterning are cilia, which are structural components involved in the rudimentary navigation of tissue formation and organ siting.[6,7] Defective ciliary function is associated with CHD and, possibly, SVA formation.

We report the case of a ruptured SVA in a woman who had situs ambiguus, isolated levocardia, and polysplenia. We discuss SVA and the possible role of ciliary dysfunction as its genetic cause.

Case Report

A 57-year-old woman with situs ambiguus, isolated levocardia, and polysplenia was transferred to our center for evaluation of new-onset decompensated congestive heart failure. She had presented at another hospital with sudden dyspnea and transient neck pain, followed by 5 days of progressive dyspnea and orthopnea.

Our physical findings included a bifid uvula; a loud, harsh, continuous murmur (heard best during systole and early diastole) at the right upper sternal border; jugular venous distention up to the mandibular angle; and bibasilar crackles. An electrocardiogram showed sinus rhythm with right bundle branch block. Chest radiographs showed mild cardiomegaly, mild congestion of the pulmonary vasculature, and small bilateral pleural effusions. Computed tomograms of the chest and upper abdomen revealed isolated levocardia, bilateral anatomic left (bi-lobed) lungs, a right-sided stomach, a horizontally configured liver, and right-sided polysplenia (Fig. 1).

Transthoracic echocardiograms showed normal ventricular dimensions and function. Color-flow Doppler echocardiograms showed abnormal flow into the right atrium, suggesting a ruptured SVA. Transesophageal echocardiograms confirmed

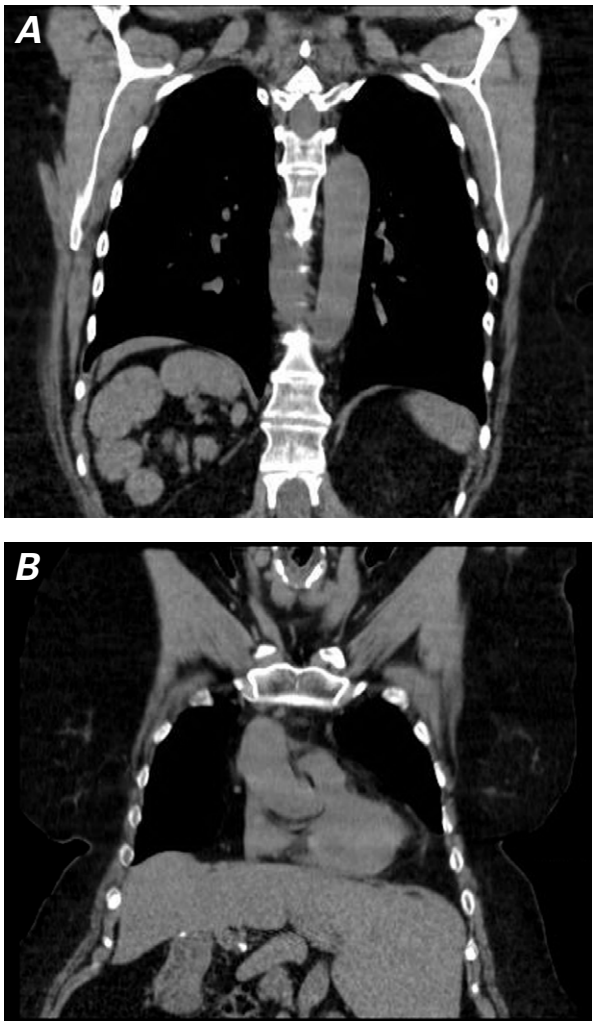

Fig. 1 *Computed tomograms show **A**) right-sided polysplenia and **B**) horizontal configuration of the liver.*

a ruptured SVA from the right coronary sinus into the right atrial cavity during systole and diastole (Fig. 2). Three-dimensional–guided planimetry revealed a regurgitant orifice with an estimated area of 0.42 cm^2. No significant gradient across the AV was noted. Additional findings were a bicuspid AV, a patent foramen ovale, and a well-developed right atrial appendage that was morphologically like a left atrial appendage (left isomerism) (Fig. 3). A left-sided aortogram showed a tubular, ruptured SVA and a long shunt (Fig. 4), and coronary angiograms showed normal coronary arteries.

The patient underwent composite aortic root replacement with insertion of a mechanical AV. As of November 2017, she was doing well.

Discussion

Our patient had a seemingly unique combination of anatomic abnormalities, including SVA, situs ambiguus, isolated levocardia, and polysplenia.

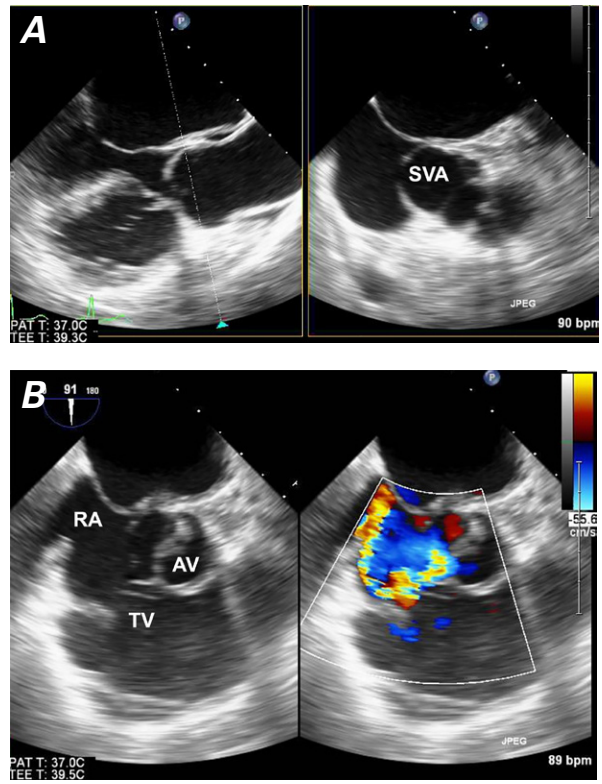

Fig. 2 *Transesophageal echocardiograms. **A**) X-plane images show a ruptured aneurysm of the right coronary sinus of Valsalva. **B**) X-plane image and color-flow Doppler mode reveal the ruptured aneurysm and left-to-right shunting into the right atrium.*

AV = aortic valve; RA = right atrium; SVA = sinus of Valsalva aneurysm; TV = tricuspid valve

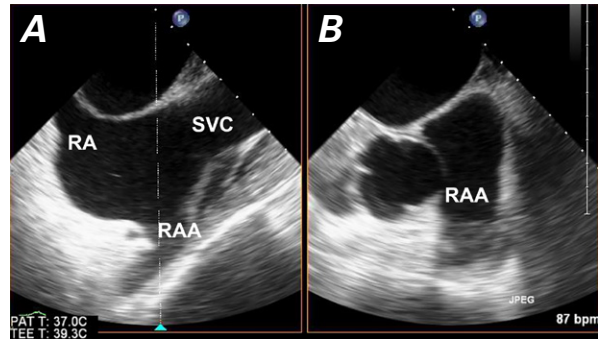

Fig. 3 *Transesophageal echocardiograms in **A**) midesophageal bicaval view and **B**) X-plane image of that view show a right atrial appendage that morphologically resembles a left atrial appendage.*

RA = right atrium; RAA = right atrial appendage; SVC = superior vena cava

Sinus of Valsalva Aneurysms. Aneurysms of the sinus of Valsalva differ markedly from the typical causes of acute heart failure. After an SVA has been identified, the treatment is surgery. According to one report,[8] surgical repair of a ruptured SVA had a 10-year survival

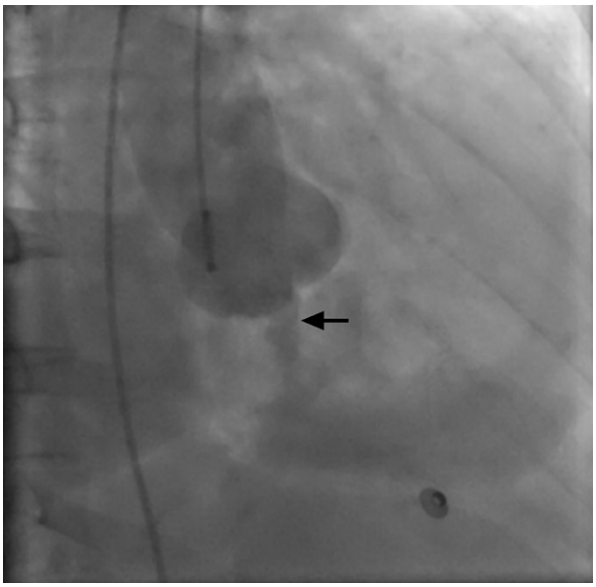

Fig. 4 *Aortogram shows a tubular, ruptured sinus of Valsalva aneurysm and a long shunt (arrow).*

rate of 90%. However, the challenge is to establish an early and accurate diagnosis; these aneurysms are typically clinically silent until they rupture.[3] Rarely, SVAs can lead to myocardial ischemia, either by directly compressing a coronary artery or by thrombotic embolization.[1,2,8,9] Ruptured SVAs typically present in the 3rd or 4th decade of life with nonspecific symptoms, including chest pain, dyspnea, and fatigue.[8] However, presentation and hemodynamic stability depend on the involved sinus and the vector of the consequent shunt within the associated cardiac chamber.[3,4] Regardless, heart failure will occur within hours or weeks.[2,9]

Many authors have reported single sinus aneurysms. Most originate in the right coronary sinus (65%–85%), followed by the noncoronary sinus (10%–30%) and the left coronary sinus (1%–5%). The first 2 SVA types rupture into the right ventricle (in 70%–80% of cases), right atrium (19%), left atrium or ventricle (6%), or pulmonary trunk (<1%).[2,4,9] Aneurysms of the left coronary sinus usually rupture into the left ventricle or atrium.[1] Congenital causes of SVAs can coexist with additional cardiac abnormalities, such as ventricular septal defect (30%–60%) or bicuspid AV (10%–17%).[2,8,10] Of note, bicuspid AVs are also associated with thoracic aortic aneurysms, which affect the clinical presentation and surgical management of SVAs.[11,12]

Situs Ambiguus. Situs ambiguus occurs in approximately 1 in 10,000 births. Whereas situs inversus is a mirrored reversal of normally arranged abdominal or thoracic organs, situs ambiguus is a nonmirrored arrangement of those organs across the left and right axis of the body. Patients with situs ambiguus can have asplenia or polysplenia, conditions with clinically important implications and markedly different mortality rates.

In one study,[13] 59% of patients with situs ambiguus were asplenic. Asplenia is characterized by bilateral right-sidedness: bilateral anatomic right lungs and atria, and a midline liver. All patients have pulmonary stenosis and ventricular septal defects, resulting in cyanosis.[14] Lacking a spleen and its ability to fight infections, 90% of patients die before one year of age.[15] Conversely, polysplenia is characterized by bilateral left-sidedness: bilateral anatomic left lungs, bronchi, and atria. The liver may also be midline, and patients have 2 to 9 small spleens that form the collective mass of one normal spleen.[14,15] Polysplenic patients rarely have pulmonic stenosis or cyanosis, which can render difficult the clinical diagnosis of situs ambiguus in the young.[16] Furthermore, cardiac disease is not always present in polysplenia, so pinpointing mortality rates is challenging.[15] Polysplenic patients have no heightened susceptibility to bacterial infections and have survived to 70 years of age.[15]

Embryology of Situs Ambiguus, Polysplenia, and SVA. An elaborate embryonic developmental mechanism underlies the formation of tissue and siting of organs. A cluster of motile ciliary cells at the Hensen node generates a gradient that establishes a left–right axis.[6,17,18] Defects in these cilia result in abnormal left–right patterning that can present as situs ambiguus or situs inversus.[6,17,18,19] Left–right patterning is crucial in the siting of the great cardiac vessels and in atrial morphology.[6,19] Accordingly, the atrial appendages are used to denote isomerism, as in our patient with left isomerism (2 morphologic left atrial appendages).[6]

Primary cilia malfunction can lead to cardiac defects, polycystic kidney disease, and primary ciliary dyskinesia (Kartagener syndrome).[7,20] Our patient's SVA and situs ambiguus suggest that SVA might also be a phenotypic presentation of ciliary dysfunction.

In the presence of known congenital abnormalities, the early diagnosis of SVA can prompt surgical treatment that has a high success rate.

References

1. Weinreich M, Yu PJ, Trost B. Sinus of Valsalva aneurysms: review of the literature and an update on management. Clin Cardiol 2015;38(3):185-9.
2. Feldman DN, Roman MJ. Aneurysms of the sinuses of Valsalva. Cardiology 2006;106(2):73-81.
3. Arikan E, Karagoz A, Bayata S, Yilik L, Unluer EE. A rare cause of dyspnea: sudden rupture of aortic Valsalva sinus aneurysm. Case Rep Med 2013;2013:909302.
4. Feldman DN, Gade CL, Roman MJ. Ruptured aneurysm of the right sinus of Valsalva associated with a ventricular septal defect and an anomalous coronary artery. Tex Heart Inst J 2005;32(4):555-9.
5. Bruneau BG. Signaling and transcriptional networks in heart development and regeneration. Cold Spring Harb Perspect Biol 2013;5(3):a008292.

6. Dykes IM. Left right patterning, evolution and cardiac development. J Cardiovasc Dev Dis 2014;1(1):52-72. Available at: http://www.mdpi.com/2308-3425/1/1/52.
7. Ware SM, Aygun MG, Hildebrandt F. Spectrum of clinical diseases caused by disorders of primary cilia. Proc Am Thorac Soc 2011;8(5):444-50.
8. Post MC, Braam RL, Groenemeijer BE, Nicastia D, Rensing BJ, Schepens MA. Rupture of right coronary sinus of Valsalva aneurysm into right ventricle. Neth Heart J 2010;18(4):209-11.
9. Lakoumentas JA, Bonou MS, Brili S, Theocharis CS, Benroubis AD, Perpinia AS, Harbis PK. Ruptured aneurysm of the right sinus of Valsalva into the right ventricle. Hellenic J Cardiol 2002;43(6):242-5. Available at: http://www.hellenicjcardiol.org/archive/full_text/2002/6/2002_6_242.pdf.
10. Del Campo C, Weinberg DM. Sinus of Valsalva aneurysm of the non-coronary cusp: repaired in the adult with a Freestyle bioprosthesis. Tex Heart Inst J 2003;30(3):202-4.
11. Ziganshin BA, Elefteriades JA. Guilt by association: a paradigm for detection of silent aortic disease. Ann Cardiothorac Surg 2016;5(3):174-87.
12. Kuriakose EM, Bhatla P, McElhinney DB. Comparison of reported outcomes with percutaneous versus surgical closure of ruptured sinus of Valsalva aneurysm. Am J Cardiol 2015;115(3):392-8.
13. Ferdman B, States L, Gaynor JW, Hedrick HL, Rychik J. Abnormalities of intestinal rotation in patients with congenital heart disease and the heterotaxy syndrome. Congenit Heart Dis 2007;2(1):12-8.
14. Moller JH, Nakib A, Anderson RC, Edwards JE. Congenital cardiac disease associated with polysplenia. A developmental complex of bilateral "left-sidedness". Circulation 1967;36(5):789-99.
15. Peoples WM, Moller JH, Edwards JE. Polysplenia: a review of 146 cases. Pediatr Cardiol 1983;4(2):129-37.
16. Stanger P, Rudolph AM, Edwards JE. Cardiac malpositions. An overview based on study of sixty-five necropsy specimens. Circulation 1977;56(2):159-72.
17. Francis RJ, Christopher A, Devine WA, Ostrowski L, Lo C. Congenital heart disease and the specification of left-right asymmetry. Am J Physiol Heart Circ Physiol 2012;302(10):H2102-11.
18. Nakamura T, Hamada H. Left-right patterning: conserved and divergent mechanisms. Development 2012;139(18):3257-62.
19. Karp N, Grosse-Wortmann L, Bowdin S. Severe aortic stenosis, bicuspid aortic valve and atrial septal defect in a child with Joubert Syndrome and Related Disorders (JSRD) - a case report and review of congenital heart defects reported in the human ciliopathies. Eur J Med Genet 2012;55(11):605-10.
20. Seeger-Nukpezah T, Golemis EA. The extracellular matrix and ciliary signaling. Curr Opin Cell Biol 2012;24(5):652-61.