

Role of Echocardiography in the Diagnosis of Aorto-Right Ventricular Fistula: A Rare Complication of Surgical Aortic Valve Replacement Successfully Closed by Bovine Pericardial Patch



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INTRODUCTION

Aortic stenosis is associated with considerable mortality and morbidity for which no pharmacologic therapy is yet available. Aortic valve replacement is the mainstay of treatment and can be done either via the transcatheter approach or surgically. Aortocardiac shunt is a complication rarely associated with surgical aortic valve replacement (SAVR). We report a case of aorto-right ventricular (AoRV) fistula diagnosed on echocardiography and computed tomographic (CT) angiography after SAVR.

CASE PRESENTATION

A 60-year-old white man presented to our institution with exertional dyspnea, light-headedness, and intermittent palpitations. His cardiac history was remarkable for calcific bicuspid aortic valve with stenosis and third-degree heart block, for which he had undergone implantation of a dual-chamber permanent pacemaker 2 years before the current presentation. Physical examination detected a grade 4/6 harsh systolic murmur that was heard best at the right upper sternal border. His lungs were clear. Transthoracic echocardiography (TTE) revealed severe aortic valve stenosis, with a mean gradient of 30 mm Hg, dimensionless index of 0.23, and calculated valve area of 0.79 cm². Also noted was a decreased left ventricular ejection fraction of 42%. Transesophageal echocardiography (TEE) confirmed severe aortic valve stenosis and mild ascending aortic dilation. A preprocedural CT scan revealed a heavily calcified aortic valve (Figure 1). Cardiac catheterization did not reveal hemodynamically significant coronary artery disease. SAVR was done using a 23-mm Mosaic bioprosthesis (Medtronic, Minneapolis, MN). To properly implant the valve, extensive intraoperative debridement around the annular cusps was required. Intraoperative TEE was

felt to show a possible small subaortic ventricular septal defect, which at the time was felt to be insignificant. One day after the procedure, the patient had worsening shortness of breath and a dramatic increase in oxygen requirement. On physical examination, a continuous murmur was heard throughout the precordium and distended neck veins. Diffuse lung crackles were heard on auscultation. Chest radiography showed bilateral pulmonary opacities consistent with congestive heart failure. On TTE, a shunt with continuous flow between the right sinus of Valsalva and the right ventricle was seen, and the right atrium and right ventricle were more dilated than they had been on intraoperative TEE. Given these new findings, bedside TEE was repeated (Figure 2, Videos 1 and 2). Results of TEE confirmed the findings on TTE, showing continuous color and spectral Doppler flow originating from the aorta to the right ventricle (Figure 3). Pulmonary artery pressure was elevated, and left ventricular ejection fraction had decreased even further to 25%. The prosthetic valve itself appeared normal and well seated, with no paravalvular or central leaks. Retrospective review of intraoperative transesophageal echocardiographic images showed continuous flow from the aortic root to the right ventricle along the interventricular septum rather than through it. This shunt visually appeared much smaller than that visualized on postoperative TTE and TEE, which were performed as a result of the patient being decompensated. CT scanning was performed using gating, retrospective, using a dual-source cardiac CT scanner to rule out additional anatomic abnormalities. Heart rate at the time of scan was 60 beats/min. It was 86 beats/min at the time of initial noncontrast scanning, but the patient received an intravenous β -blocker to reduce heart rate before the contrast portion of the CT examination. It showed a 5.0- to 5.5-mm defect between the right sinus of Valsalva and the right ventricle (Figure 4). Also noted was mild dilation of the right atrium, the right ventricle, and the pulmonary artery.

Surgical exploration revealed a slitlike area that originated 1 mm superior to the sewing ring of the prosthesis, about 1 cm from the right coronary ostium, toward the pulmonary artery. The slit was closed by anchoring a bovine pericardial patch over the proximal portion of the valve's sewing ring, after which intraoperative TEE revealed no further evidence of the intracardiac shunt. The patient was discharged home in stable condition. Six days after discharge, he developed paroxysmal atrial flutter. Heart rate was controlled, and the patient was started on warfarin. Follow-up TTE at 1, 4, and 8 months showed no intracardiac shunting, with normal prosthetic valve function.

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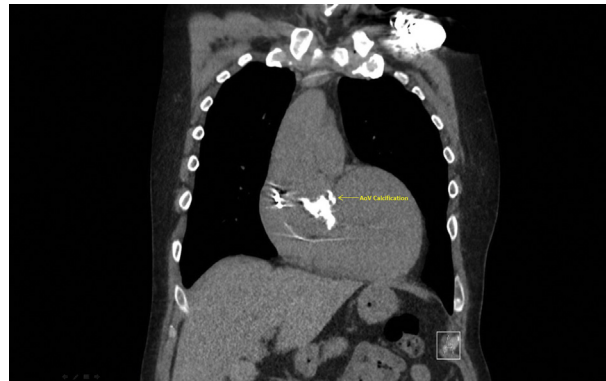


Figure 1 Pre-SAVR CT image showing aortic valve (AoV) calcifications.

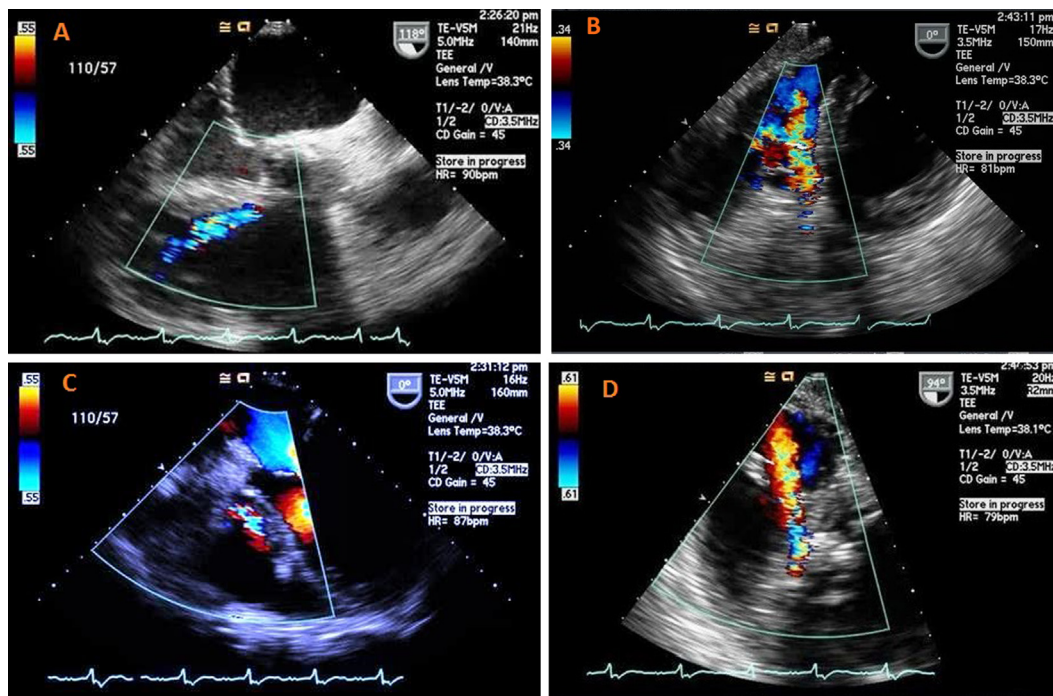


Figure 2 Color flow Doppler showing continuous flow through AoRV fistula. (A) Modified midesophageal, three-chamber view; (B,D) deep transgastric views; and (C) right ventricular-focused four-chamber views.

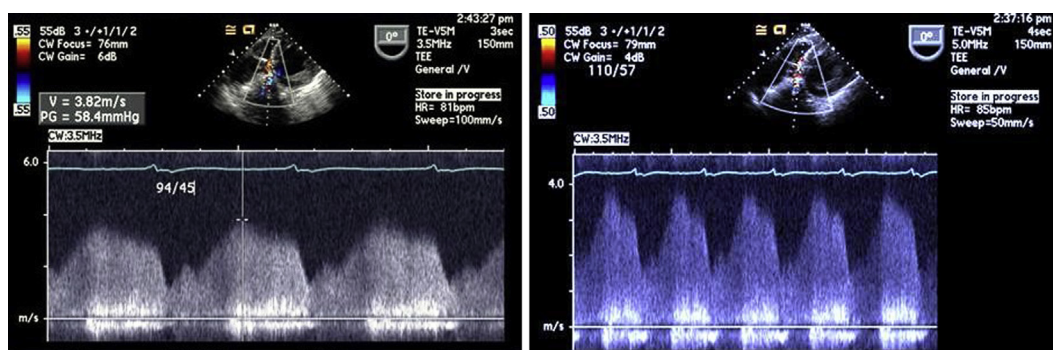


Figure 3 TEE showing a high-velocity, unidirectional left-to-right shunt on transgastric transesophageal views.

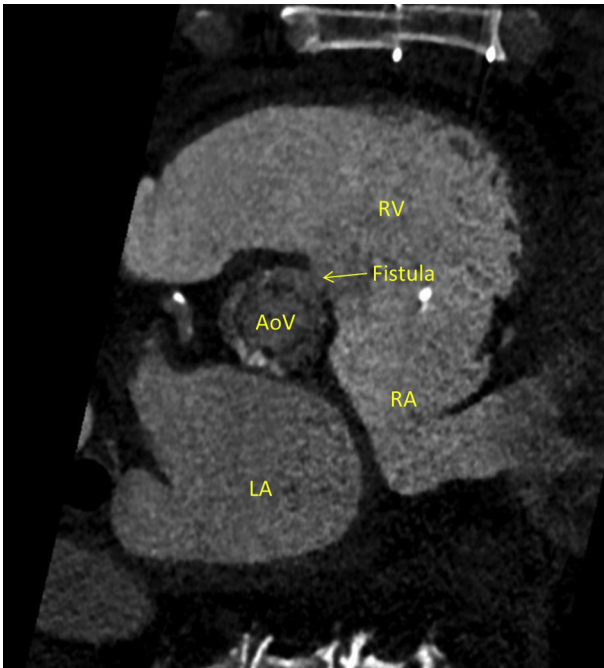


Figure 4 Retrospectively gated, dual-source cardiac CT scan showing fistulous communication between the right sinus of Valsalva and the right ventricle. AoV, Aortic valve; LA, left atrium; RA, right atrium; RV, right ventricle.

DISCUSSION

AoRV fistulas develop at an area of surface contact between the aorta above the right coronary cusp and right ventricular outflow tract.¹ They have been reported with penetrating chest injury,¹ blunt cardiac injury,² infective endocarditis,³ aortic dissection,⁴ and rupture of congenital sinus of Valsalva aneurysms.⁵ The incidence of AoRV fistula is difficult to estimate, but was reported to be <0.5% in a series of 310 patients.⁶ Proposed mechanisms include formation of a pseudoaneurysm at the aortotomy suture line that eventually ruptures into the right ventricle,⁷ excessive dilatation of a prosthetic valve on a heavily calcified annulus, injury to the membranous septum during dissection below the noncoronary cusp, and aggressive debulking of heavily calcified aortic annulus.^{8,9} Ischemic necrosis of the membranous portion of the ventricular septum because of its involvement in prosthetic valve suture has also been suggested.⁹

Clinical presentation depends primarily on the size of the shunt and on chronicity, whether early or delayed. A small shunt may be asymptomatic and be identified on a follow-up visit as a murmur only.^{9,10} Larger shunts may cause dyspnea and decreased exercise tolerance by congestive heart failure. Shunts are often refractory to medical management.¹¹ Surgical or percutaneous closure of the fistulous tract is necessary because spontaneous closure has not been observed.^{12,13} Data regarding the natural history of fistulas associated with prosthetic valve replacement are scarce, but in a review of 40 patients with traumatic AoRV fistulas, 38 were repaired surgically with satisfactory outcomes.¹³

Echocardiography, preferably with color mapping, is the preferred diagnostic tool to evaluate and define cardiac fistulas.¹⁴ TEE is considered superior to two-dimensional TTE because of its close proximity to the aortic root and enhanced image quality.¹⁴ CT scanning can

also be used for identifying and providing supplemental information for procedure planning.

Our patient had an early complication after SAVR. We suspect that the need for extensive debridement of the heavily calcified bicuspid aortic valve might have resulted in an aortic tear into the right ventricle. The fistula was identified fairly quickly with TTE and confirmed with TEE. Changes in right-sided chamber size and pulmonary artery were important as collateral evidence in favor of a left-to-right shunt. The fistulation was further defined by using multiplanar CT imaging, which also provided additional information for precise surgical closure. The SAVR fistula was successfully closed surgically using a bovine pericardial patch. Outpatient follow-up with multiple repeat echocardiographic examinations documented the patient's uneventful recovery. Many reports have cited similar complications with transcatheter aortic valve replacement, making this an important complication of which to be mindful in order to diagnose it early.¹⁵ In addition, the case points toward the pivotal role of echocardiography in identifying and successfully managing this problem.

CONCLUSION

AoRV fistula is a rare complication of SAVR. Development of a new murmur after procedure should raise suspicion for fistulous communications. High index of suspicion, however, is required for delayed shunts. Echocardiography with color flow Doppler is the investigation of choice for correct diagnosis by paying close attention to right-sided dimensions and pulmonary artery pressure. Careful postprocedural follow-up with imaging is recommended for timely identification and prompt treatment.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.case.2017.06.008>.

REFERENCES

1. Rustad DG, Hopeman AR, Murr PC, Van Way CW III. Aortocardiac fistula with aortic valve injury from penetrating trauma. *J Trauma* 1986;26:266-70.
2. Siavelis HA, Marsan R, Marshall WJ, Maull K. Aortoventricular fistula secondary to blunt trauma: a case report and review of the literature. *J Trauma* 1997;43:713-5.
3. Baumgartner FJ, Omari BO, Robertson JM, Nelson RJ, Pandya A, Pandya A, et al. Annular abscesses in surgical endocarditis: anatomic, clinical, and operative features. *Ann Thorac Surg* 2000;70:442-7.
4. Fonseca P, Dias A, Bettencourt N, Ferreira N, Fonseca C, Gama V. Acute aortic dissection complicated by aorto-right ventricular fistula. *Rev Port Cardiol* 2014;33:813-5.
5. Norwicki ER, Aberdeen E, Friedman S, Rashkind WJ. Congenital left aortic sinus-left ventricle fistula and review of aortocardiac fistulas. *Ann Thorac Surg* 1977;23:378-88.
6. Jackson DH Jr, Murphy GW, Stewart S, DeWeese JA, Schreiner BF. Delayed appearance of left-to-right shunt following aortic valvular replacement: report of two cases. *Chest* 1979;75:184-6.
7. Roy D, Saba S, Grinberg I, Zughuib M, Sakwa M, Clancy P, et al. Aorto-right ventricular fistula: a late complication of aortic valve replacement. *Tex Heart Inst J* 1999;26:140-2.
8. Muñoz-García AJ, Rodríguez-Bailón I, Alonso Briales JH, Jiménez Navarro M, Hernández García JM, de Teresa-Galván E. Aorto-right

- ventricular fistula after percutaneous aortic valve implantation of a Core-Valve prosthesis. *Texas Heart Inst J* 2011;38:728-9.
9. Lorenz J, Reddy CV, Khan R, Hoover E, Hsu HK, El-Sherif N. Aortico-right ventricular shunt following aortic valve replacement. *Chest* 1983;83:922-5.
 10. Chow WH, Lee PK, Cheung KL, Mok CK. Two-dimensional and pulsed Doppler echocardiographic diagnosis of an acquired aortic right ventricular fistula. *Clin Cardiol* 1989;12:544-5.
 11. Pate GE, Al Zubaidi A, Chandavimol M, Thompson CR, Munt BI, Webb JG. Percutaneous closure of prosthetic paravalvular leaks: case series and review. *Catheter Cardiovasc Interv* 2006;68:528-33.
 12. Lu TL, Beregi JP, Rey C, Midulla M, Lions C. Percutaneous closure of an aorto-right ventricular fistula with an Amplatzer plug. *J Vasc Interv Radiol* 2011;22:100-1.
 13. Samuels LE, Kaufman MS, Rodriguez-Vega J, Morris RJ, Brockman SK. Diagnosis and management of traumatic aorto-right ventricular fistulas. *Ann Thorac Surg* 1998;65:288-92.
 14. Ananthasubramaniam K. Clinical and echocardiographic features of aorto-atrial fistulas. *Cardiovasc Ultrasound* 2005;3:1.
 15. Hagiwara K, Saito N, Yamazaki K, Kimura T. Aorto-right ventricular fistula following transcatheter aortic valve implantation using a 29 mm SAPIEN XT valve. *BMJ Case Rep* 2017;2017 <http://dx.doi.org/10.1136/bcr-2017-219247>.