Case Report

Transcatheter Correction of Aortic-Right Ventricular Shunt Following Aortic Valve Replacement: A Case Report

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Abstract

We describe the first case in the literature of transcatheter correction of aortic-right ventricular (Ao-RV) shunt after aortic valve replacement (AVR) with an Intuity® prosthesis (Edwards Lifesciences). A 79-year-old patient with a history of coronary artery bypass grafting and aortic regurgitation underwent AVR using a rapid-release 25-mm Intuity® prosthesis. After 45 days, he presented with severe heart failure, and an Ao-RV shunt was identified on transthoracic echocardiography. Given his history of previous cardiac surgeries, percutaneous correction was attempted. Initially, an attempt was made to catheterize the defect via the transapical approach, which was unsuccessful. The right femoral artery was punctured, and the shunt was catheterized via the aorta, with the implantation of a MemoPart ventricular septal defects (VSD) occluder, resulting in a significant reduction of the shunt. The patient was then transferred to the intensive care unit. However, there was no satisfactory clinical improvement, and transthoracic echocardiography revealed persistent Ao-RV shunt. Therefore, the surgical team opted for a new approach through the femoral artery and a second MemoPart VSD occluder was implanted. A transesophageal echocardiogram showed no leak, and the patient progressed satisfactorily and was discharged from the hospital. Shunts after AVR are rare. In these conditions, percutaneous management is a safe and feasible technical option. This is the first case reported in the literature of this type of complication after Intuity prosthesis implantation.

Introduction

The presence of an aortic-right ventricular (Ao-RV) fistula is a rare phenomenon, mostly resulting from a sinus of Valsalva aneurysm rupture. Other causes include sequelae of infective endocarditis, aortic dissection, trauma, or, more rarely, complications after aortic valve replacement (AVR). It is known that the presence of previous thoracic surgeries is directly associated with higher mortality and worse clinical outcomes, making percutaneous correction of this defect a promising technique in this context when intervention is necessary.[1-4]

Here, we report the case of a patient who underwent transcatheter correction of an Ao-RV fistula following AVR with an Intuity prosthesis (Table 1).

Case report

We report the case of a 79-year-old male patient, who had undergone two cardiac surgeries in the past, namely myocardial revascularization in 2010 and biological AVR in 2015 due to aortic regurgitation. The patient also had a history of dyslipidemia, nutritional anemia, and atrial flutter. He recently presented with prosthetic dysfunction and underwent another biological AVR using a rapid implant 25-mm Intuity® prosthesis (Edwards Lifesciences).

A transthoracic echocardiogram (TTE) performed immediately after surgery showed the bioprosthetic valve in an aortic position without a periprosthetic leak, with preserved opening and mobility, and minimal central regurgitation with a maximum left ventricular-aortic gradient of 15 mmHg. An Ao-RV shunt, initially confused with a perimembranous ventricular septal defect, was also observed, measuring 7 mm, with left-to-right flow and a maximum gradient of 30 mmHg.

Despite the echocardiographic findings, the patient had a good clinical outcome and was discharged from the hospital. However, he returned and was readmitted approximately

Table 1 – Events from the first coronary artery bypass (2010) to the definitive closure of the Ao-RV shunt.

Timepoint	Clinical description
2010	Coronary artery bypass grafting
2015	AVR with biologic prosthesis for aortic regurgitation
October 2022	Redo AVR using a 25-mm Intuity prosthesis
November 2022	Percutaneous closure of Ao-RV fistula
December 2022	Successful second attempt at closing Ao-RV fistula (second plug)

Ao-RV: aortic-right ventricular; AVR: aortic valve replacement

Keywords

Transcatheter Aortic Valve Replacement; Heart Ventricles; Aorta

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45 days after AVR surgery, with decompensated heart failure, New York Heart Association functional class IV. He presented with dyspnea at rest, lower limb and scrotal edema, and ascites. Brain natriuretic peptide levels were 2620 pg/ml. The patient was treated with diuretic therapy and measures for decompensated heart failure but showed no significant clinical improvement despite adequate treatment.

A repeat TTE showed no change in the previously observed findings immediately after surgery. Cardiac magnetic resonance imaging was then performed to further elucidate the case, showing a slight jet originating from the aortic valve plane towards the septal leaflet of the tricuspid valve, with a Qp/Qs ratio of 1.03. Given these findings and the lack of significant improvement in heart failure decompensation, intervention was deemed necessary. Percutaneous correction was the method of choice, given the patient's history of multiple cardiac surgeries.

During the first intervention, a left lateral thoracotomy was performed with pericardial opening, puncture of the left ventricular apex, and insertion of a 7F introducer for shunt catheterization. After unsuccessful catheterization, the introducer was removed and a purse-string suture was placed at the left ventricular apex. Subsequently, the right common femoral artery was punctured under ultrasound guidance, and a 6F introducer was installed. The Ao-RV shunt was successfully catheterized via the aortic route with a Vert catheter. A pigtail catheter and a Simon catheter were introduced with the aid of a 0.035 × 260 hydrophilic exchange guidewire and a 0.035 × 260 Teflon-coated exchange guidewire. The 6F femoral artery introducer was exchanged for a 9F introducer using an extra-stiff guidewire. After the guidewire was positioned in the right ventricle through the shunt, a MemoPart VSD occluder was delivered and deployed, guided by fluoroscopy, and transesophageal echocardiography contrast was injected for quality control when a significant reduction in left-to-right flow was observed (Figure 1). The femoral artery introducer was removed, and manual compression was performed. A rigorous hemostasis revision was performed on the previously performed left lateral thoracotomy for catheterization, and a reinforcement of the left ventricular apex was made, followed by closure of the planes.

A new follow-up TTE showed an intracardiac device of the "plug" type positioned more towards the aortic annulus, with the presence of a residual leak and a left-to-right shunt on color Doppler with a maximum systolic gradient of 99 mmHg.

Thus, the surgical team opted for a new approach. The new procedure began with an ultrasound-guided puncture of the left common femoral artery and the insertion of a 6F introducer. A 5F pigtail catheter was placed in the coronary sinus. Ultrasound-guided puncture of the right common femoral artery was performed, and an 8F introducer was placed. The Vert catheter was passed through the ascending thoracic aorta with the aid of a hydrophilic wire. The wire was replaced with a straight-tip Teflon-coated wire and passed through the shunt orifice. The wire was then replaced with an extra-stiff J-tip wire. The catheter and introducer were removed and replaced with the introducer of the prosthesis. The second MemoPart VSD occluder was placed in the appropriate location. Aortography and left ventriculography were performed for control, and no residual flow was visualized. A follow-up TTE also did not show any leak around the implanted device. The femoral artery introducers were removed, and manual compression was performed (Figure 2).

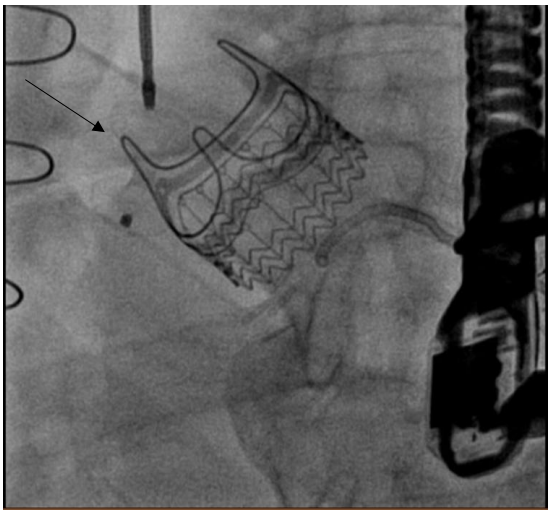

Figure 1 – *Normally positioned biologic aortic prosthesis associated with the presence of the plug, with significant reduction of the shunt through the fistula evaluated by in-room echocardiography.*

The patient progressed satisfactorily, with improved heart failure, and was discharged from the hospital.

Discussion

AVR with a prosthetic valve can result in complications such as infection, bleeding, embolic events, prosthesis dehiscence, and component fracture.[5-7] The occurrence of an aorto-ventricular fistula (AVF) after AVR is a rare complication. Jackson Jr. et al.[8] reviewed a series of 310 patients who underwent AVR over a 12-year period and found left-to-right intracavitary shunts in only 2 patients, suggesting a low incidence of this complication.

It is known that AVF is not limited to surgical AVR. Verdugo-Marchese et al.[3] reported the case of an elderly patient with a high EUROSCORE II score who underwent transcatheter aortic valve implantation and also developed this complication. Nine other cases have been reported in the literature, mostly involving the Edwards Sapien valve.

The mechanism underlying this complication remains unclear. It is believed that the degree of valve calcification, particularly of the valve annulus, as well as the need for aggressive surgical debridement, favors this complication. Other mechanisms include membranous septum injury during dissection below the noncoronary cusps, perivalvular injury secondary to inadequate retraction, and pseudoaneurysm formation at the aortotomy site with subsequent rupture into the right ventricle.[4-6]

Noninvasive methods such as TTE, computed tomography, and magnetic resonance imaging have been useful for

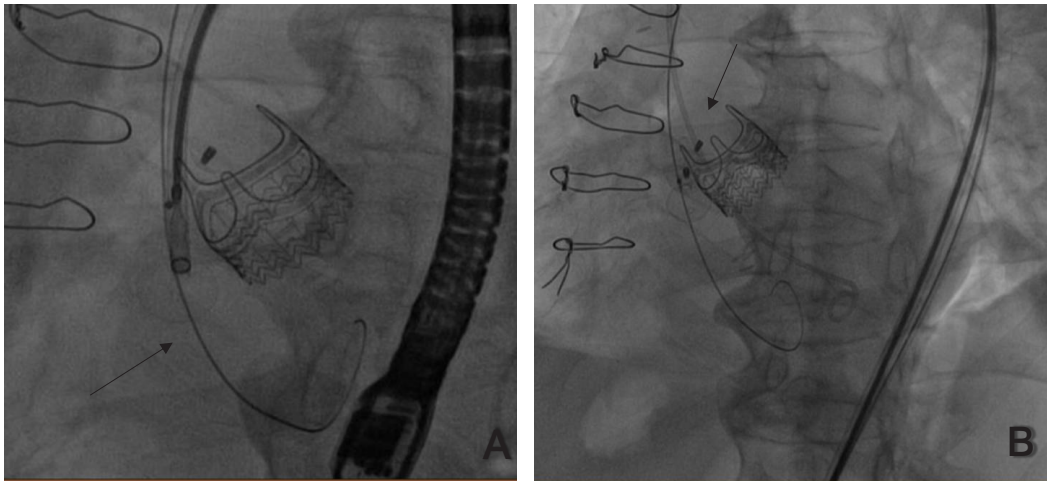

Figure 2 – *Fluoroscopy showing the passage of the guide wire through the fistula (A) and implantation of a second plug (B) without any leak, as evaluated by TEE.*

diagnostic and corrective planning purposes, although aortography represents the gold standard.[2]

If left untreated and depending on the degree of AVF shunting, this condition can result in right ventricular overload and heart failure, compromising patient survival.[7,8] Little is known about the natural history of this complication after AVR, but Samuels et al.,[9] in their review of 40 cases of traumatic AVF described in the English literature from 1958 to 1998, found satisfactory results with good clinical outcomes for the 38 patients who underwent surgical correction.

However, in cases of AVF related to AVR, correction is not always necessary. Najib et al.[6] reported the case of a 42-year-old patient with a bicuspid aortic valve and ascending aortic aneurysm who underwent AVR and ascending aorta replacement with a synthetic vascular graft and developed communication between the right coronary sinus of the aorta and the right ventricle. The patient had preserved ventricular function, normal cardiac chamber dimensions, and normal pulmonary artery systolic pressure values and chose to be managed conservatively. After a 9-month follow-up, the patient remained asymptomatic, with normal cardiac dimensions, function, and pulmonary artery systolic pressure.

When treatment is indicated, there is a clear preference for percutaneous closure of the fistulous tract, as most patients who develop this complication have undergone multiple previous thoracotomies, which increases their surgical risk.[2,4]

Ao-RV shunt is a rare complication in the context of postoperative AVR. Percutaneous closure is feasible, especially in patients with a history of multiple previous surgeries. Although relatively new, this treatment modality has shown satisfactory results with good clinical outcomes. To the authors' knowledge, this is the first reported case occurring after the implantation of the Intuity rapid deployment valve. Most of the reported cases have involved St. Jude Medical and Bjork-Shiley prostheses.

Author Contributions

Conception and design of the research, acquisition of data, analysis and interpretation of the data, statistical analysis and obtaining financing: Maia AS, Fonseca JHP; writing of the manuscript and critical revision of the manuscript for intellectual content: Maia AS, Perego AF, Mayer DH, Camacho MHB, Fonseca JHP.

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This article does not contain any studies with human participants or animals performed by any of the authors.

Use of Artificial Intelligence

The authors did not use any artificial intelligence tools in the development of this work.

Availability of Research Data and Other Materials

The underlying content of the research text is contained within the manuscript.

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