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Case Report

Transcatheter pulmonary valve implantation for re-intervention in recurrent right ventricular outflow tract obstruction

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ABSTRACT

Transcatheter pulmonary valve implantation (TPVI) has emerged as a less invasive alternative to surgical conduit replacement in patients with recurrent right ventricular outflow tract (RVOT) obstruction, particularly after repair of tetralogy of Fallot (TOF). We report a case of successful TPVI using a balloon-expandable MyVal transcatheter heart valve in a 58-year-old male with a complex cardiac history, including multiple prior surgeries and interventions for TOF and RVOT re-stenosis. The patient presented with severe symptoms, and multimodality imaging revealed severe right ventricle to pulmonary artery conduit stenosis, right-sided chamber dilation, and moderate biventricular dysfunction. Following thorough pre-procedural planning, TPVI was performed with conduit pre-dilation, deployment of a Cheatham platinum-covered stent to prevent conduit rupture, and implantation of a 23-mm MyVal valve. Post-procedural imaging confirmed optimal valve positioning, elimination of transconduit gradient, and resolution of pulmonary regurgitation. The patient was discharged on dual antiplatelet therapy with significant symptomatic improvement. This case highlights TPVI as a safe and effective re-intervention strategy in anatomically suitable high-risk patients with RVOT conduit dysfunction. While short-term outcomes are favourable, further data are warranted to assess long-term valve durability, particularly with newer valve technologies such as MyVal valve in the pulmonary position.

Learning objectives: This case report demonstrates that transcatheter pulmonary valve implantation using a balloon-expandable MyVal valve with covered-stent reinforcement provides a safe, effective, and minimally invasive re-intervention for recurrent right ventricular outflow tract conduit obstruction in complex post-tetralogy of Fallot patients. It underscores the value of meticulous preprocedural imaging, coronary compression testing, and tailored device selection to ensure optimal valve deployment, gradient elimination, and symptomatic improvement, offering a compelling alternative to high-risk redo surgical conduit replacement.

Introduction

Surgical repair for tetralogy of Fallot (TOF) may often necessitate subsequent interventions due to late complications, such as right ventricular outflow tract (RVOT) dysfunction resulting from stenosis and regurgitation [1]. Transcatheter pulmonary valve implantation (TPVI), also called transcatheter pulmonary valve replacement or percutaneous pulmonary valve implantation, is a minimally invasive alternative option that reduces morbidity and recovery time in these individuals [2]. We present a case of TPVI for re-intervention with recurrent RVOT obstruction using balloon-expandable transcatheter heart valve (THV) in a 58-year-old patient with multiple prior cardiac surgeries for TOF, demonstrating its role in managing RVOT conduit dysfunction.

Case report

At 24 years of age, this patient underwent intracardiac repair for TOF. After a few years, he developed RVOT re-stenosis and underwent a redo intra-cardiac repair surgery with a 21-mm aortic homograft. Later, he underwent percutaneous balloon angioplasty of the right ventricle to pulmonary artery (RV-PA) conduit. Subsequently, he underwent dual-chamber implantable cardioverter defibrillator implantation for

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recurrent syncope with intermittent complete heart block, wide QRS, and arrhythmias. Unfortunately, despite multiple invasive procedures, the patient remained symptomatic. Echocardiography showed an elevated pressure gradient (55–60 mmHg) across the RV-PA conduit, and normal ventricular function, for which he declined any active intervention. At age 58 years, he developed severe Class IV dyspnoea requiring hospitalisation. Transthoracic echocardiography revealed RV-PA conduit gradient of 34 mmHg with moderate pulmonary regurgitation (PR), severe tricuspid regurgitation, mild right ventricular dysfunction and left ventricular ejection fraction of 40 %. Catheterisation study confirmed these findings, and coronary angiography was normal. Cardiac computed tomography (CT) revealed severe circumferential calcification and stenosis of the RV-PA conduit (13.7 × 5.2 mm, area = 76.9 mm^2 at the annulus, Fig. 1; 29.2 × 20.0 mm, area = 530 mm^2 at mid-conduit; 27.0 × 22.0 mm, area = 789 mm^2 at PA bifurcation) with the conduit length of 41 mm. The heart valve team decided on TPVI.

TPVI procedure was performed under general anaesthesia with intravenous heparin, antibiotic prophylaxis and ultrasound-guided vascular access. A 5F pigtail catheter was tracked into the PA across the stenosed RV-PA conduit using a 150 cm, 0.035″ Terumo guidewire via the right femoral vein (Fig. 2) and the gradient measured was 37 mmHg. Another 5F pigtail catheter was placed in the aortic root using a 150 cm, 0.035″ Terumo guidewire via the right femoral artery. PA angiogram performed in right anterior oblique (RAO) 30/cranial 30 and left anterior oblique (LAO) 90 views showed severely calcified stenosed RV-PA conduit with moderate PR. Aortic root injection in LAO 90 and RAO 30/cranial 30 views showed good flow in the right and left coronaries. The pigtail catheter was not providing support for tracking the Lunderquist wire. Hence, pigtail catheter was placed into the distal left PA with the support of 0.035″ 260 cm Amplatz super-stiff wire. Then the pigtail catheter was removed. A 7F JR guide catheter was taken over the Amplatz wire and then exchanged into 0.035″ 260 cm Lunderquist extra stiff wire. Another 0.035″ 260 cm Lunderquist extra stiff wire was also taken through the JR catheter and parked in the distal left PA for additional support. Then JR guide catheter was removed. The right femoral vein access site was dilated with 18F dilator. A 14F Python sheath was passed through right femoral vein until RV over the two Lunderquist wires. The stenosed RV-PA conduit was sequentially dilated using Zmed balloon (18 × 40 mm at 6 atm) and Atlas gold balloon (20 × 40 mm at 14 atm). Simultaneously performed aortogram showed patent flow in right and left coronary arteries. A balloon test to exclude potential coronary artery compression was performed prior to TPVI. One of the Lunderquist wires was removed. Then 39-mm Cheatham platinum (CP) covered stent was tracked over the other Lunderquist wire using 22 × 50 mm BIB balloon and optimally positioned across the stenosed conduit. RV angiogram performed through 5F pigtail catheter via left femoral vein also confirmed the optimal position, and then the CP stent was deployed with sequential inflations of the inner (at 5 atm) and outer balloon (at 3 atm). It was post-dilated using Atlas gold balloon (22 mm × 20 mm at 14 atm). Then, 23-mm MyVal valve was crimped and using the Navigator delivery system negotiated through the expandable Python sheath and carefully deployed inside the CP-covered stent. Post-valve implantation,

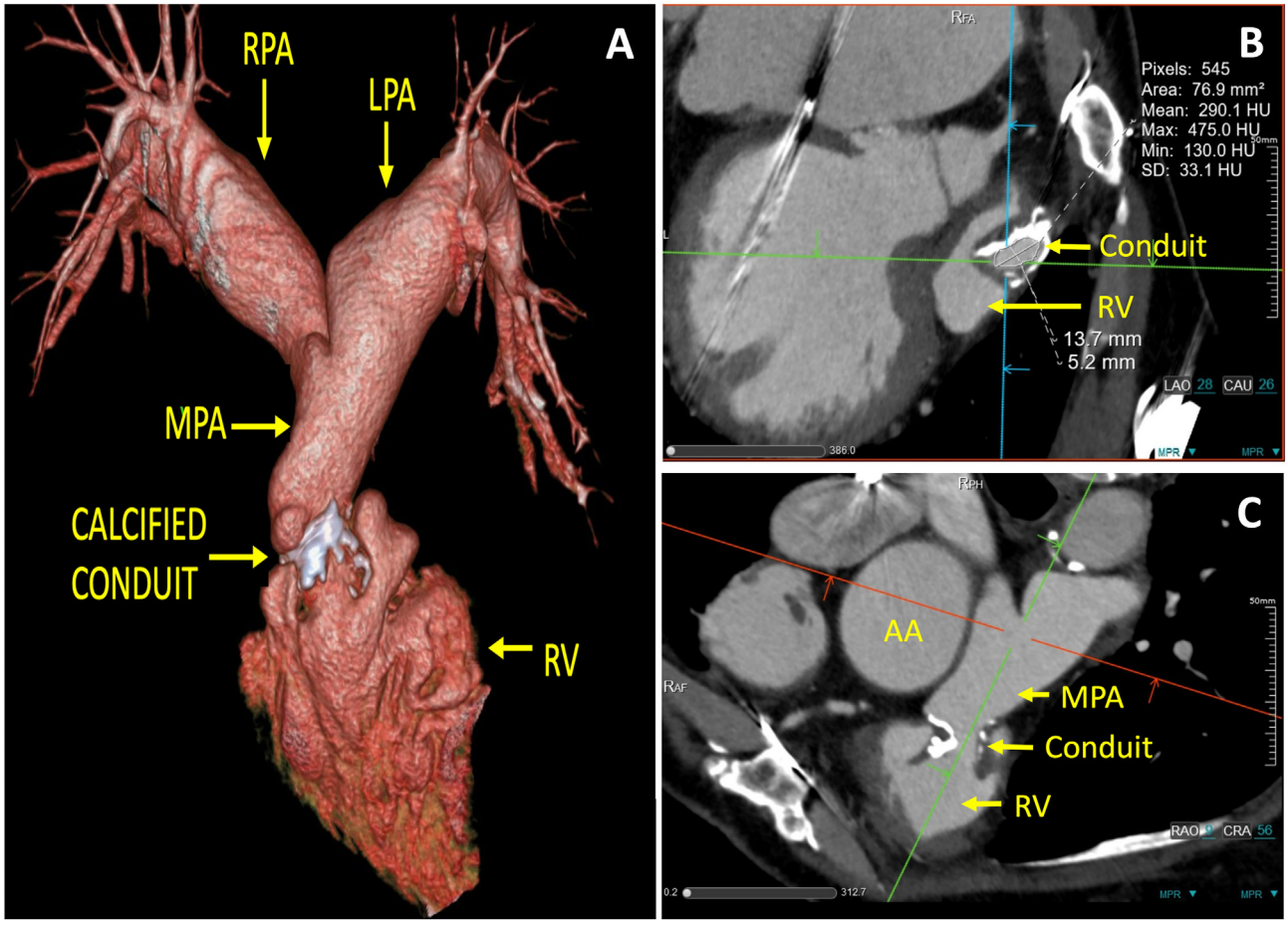

Fig. 1. Cardiac computed tomography showing severe circumferential calcification and stenosis of the right ventricle to pulmonary artery conduit.
AA, ascending aorta; LPA, left pulmonary artery; MPA, main pulmonary artery; RPA, right pulmonary artery; RV, right ventricle.

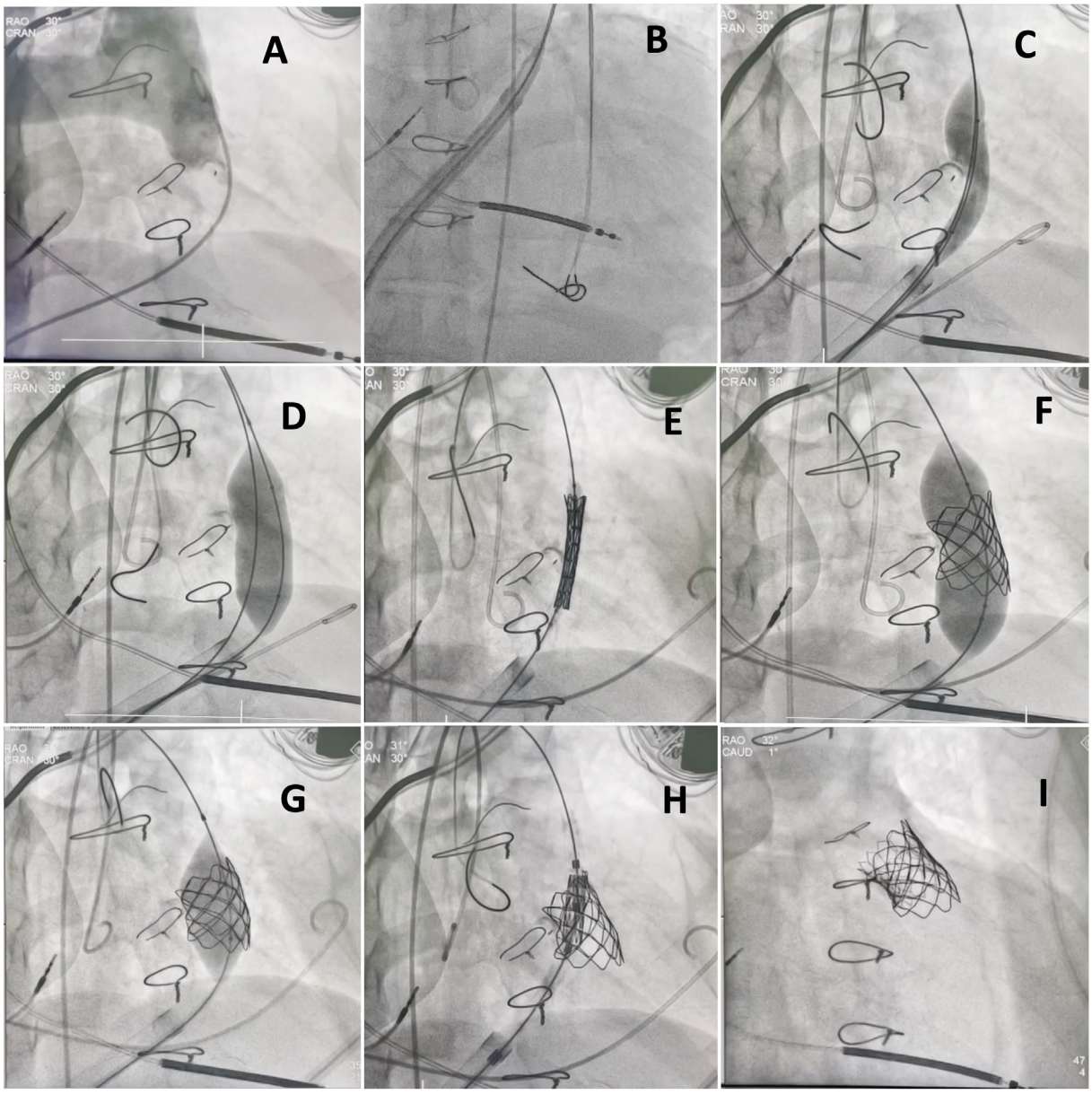

Fig. 2. Transcatheter pulmonary valve implantation procedure.
(A) Pulmonary artery angiography showing right ventricular outflow tract conduit calcific stenosis; (B) 14F Python sheath was passed over two Lunderquist wires; (C) balloon dilatation with 18 × 40 mm Zmed balloon at 6 atm; (D) further balloon dilatation with 20 × 40 mm Atlas gold at 14 atm; (E) 39-mm CP stent positioned; (F) CP stent deployed; (G) CP stent postdilated with 22 × 50 mm BIB balloon; (H) 23-mm Myval transcatheter heart valve positioned; (I) Final result after deploying Myval valve.

aortogram showed patent coronary flow and PA angiogram showed a well-positioned PA valve with no paravalvular leak (PVL) and there was no gradient across RV to PA. Vascular access site in the groin was secured with a figure-of-eight haemostatic suture. The patient had rapid symptom relief and improvement in RV function. At discharge, he was advised 6 months of dual antiplatelet therapy (aspirin 75 mg and clopidogrel 75 mg) followed by single antiplatelet therapy.

Discussion

Recurrent RVOT obstruction is a common issue following TOF repair. Traditional redo surgical replacement of the RV-PA conduit remains a standard therapy, especially in anatomically complex cases or severe calcification, but this approach carries higher morbidity and longer recovery times. The use of TPVI for the treatment of recurrent RVOT obstruction in patients with prior cardiac surgery is a minimally invasive alternative to high-risk repeat open-heart surgery.

European Society of Cardiology (2020) guidelines recommend PV replacement (surgical or catheter) after TOF repair in symptomatic patients with severe PR and/or at least moderate RVOT obstruction (Class IC). Whenever anatomically feasible, TPVI is preferable in those without native outflow tract (Class I) and, in those with symptomatic RV-PA conduit stenosis (RV systolic pressure > 60 mmHg or lower with reduced flow) and/or severe PR (Class IC) [3,4]. Hence, TPVI has become the treatment of choice for RVOT reintervention when anatomically feasible. The key advantages of TPVI over open surgical replacement include reduced procedural risk, lower morbidity, shorter hospital stay, and immediate haemodynamic improvement.

Various THV options are available for TPVI (Table 1). A multicenter study with the Melody TPVI demonstrated high procedural success,

Table 1
Comparison of transcatheter heart valves used for TPVI.

Valve	Manufacturer	Type	Frame material	Leaflet material	Sealing skirt	Delivery system	Valve Sizes	Suitable anatomy
Melody	Medtronic Inc., Minneapolis, MN, USA	Balloon-expandable	Platinum–iridium closed-cell stent	Bovine jugular vein	–	22 Fr Ensemble II Balloon-in-Balloon delivery system	18 mm, 20 mm and 22 mm diameter	Conduit, bioprosthetic valve
Sapien 3	Edwards Lifesciences, Irvine, CA, USA	Balloon-expandable	Cobalt-chromium frame	Bovine pericardium	Textured PET sealing skirt	Edwards Commander delivery system; 14 Fr/16 Fr dynamic expandable eSheath+ introducer	20 mm, 23 mm, 26 mm & 29 mm	Conduit, bioprosthetic valve, native RVOT
MyVal	Meril Life Sciences, Vapi, Gujarat, India	Balloon-expandable	Nickel-cobalt alloy with hybrid honeycomb frame	Bovine pericardium	External PET lined sealing-cuff	Navigator delivery system; 14 Fr expandable Python sheath	From 20 mm to 32 mm (1.5-mm increments)	Conduit, bioprosthetic valve; native RVOT
Venus P-valve	Venus Medtech, Hangzhou, China	Self-expanding	Nitinol frame with 6 radiopaque markers	Porcine pericardium	–	22 Fr & 24 Fr delivery system	From 28 m to 36 mm (2-mm increments)	Native RVOT
Harmony	Medtronic Inc., Minneapolis, MN, USA	Self-expanding	Nitinol wire-strut frame conforming to native RVOT	Porcine pericardium	–	25 Fr delivery catheter system	22 mm and 25 mm	Native RVOT
Med-Zenith PT	Beijing Med-Zenith, Beijing, China	Self-expanding	Laser cut nitinol wire	Porcine pericardium	–	21 Fr delivery system	20 mm, 23 mm, 26 mm	Native RVOT
Pulsta	TaeWoong Medical Co, Gyeonggi-do, South Korea	Self-expanding	Knitted nitinol wire stent	Porcine pericardium	–	18 Fr delivery system	18 mm to 32 mm in 2-mm increments	Native RVOT

PET, polyethylene terephthalate; RVOT, right ventricular outflow tract; TPVI, transcatheter pulmonary valve implantation.

excellent short-term valve function, and low rates of reintervention at one year [5]. Another 10-year study on the durability of transcatheter aortic valves provides some insight into their long-term performance [4,5]. The MyVal valve used in this case is the CE-marked indigenous valve of India, which has demonstrated promising outcomes in the aortic position and has recently been used for RVOT re-intervention [6–8]. In MyVal valve, the crimped balloon-expandable bovine pericardial valve is mounted on a nickel-cobalt alloy hybrid honeycomb frame (higher percentage of closed cells at the ventricular end for increased radial force and open cells at the aortic end) with an external polyethylene terephthalate (PET) lined sealing-cuff to minimise PVL (Table 1) [6–8]. The 14 Fr Navigator delivery system of the MyVal valve allows greater flexion and trackability in tortuous RVOT. The MyVal valve is available in multiple sizes. These characteristics of the MyVal valve offer technical and practical advantages, making it a suitable for RVOT re-interventions, particularly in anatomically challenging or high-risk patients.

The case presented here demonstrates that TPVI is a viable alternative for managing recurrent RVOT obstruction, especially in patients with complex surgical histories who are at high risk for redo open-heart surgery. The patient's heavily calcified conduit required a valve with high radial force and minimal PVL risk; these are the qualities of MyVal valve's nickel-cobalt frame and PET cuff. THV size can be determined in two ways: (i) pre-procedural, electrocardiogram-gated (end-systole) cardiac CT assessment (preferred method) and (ii) intra-procedural, after deployment of CP-covered stent, inflating semi-compliant balloon in RVOT and watching for the occurrence of waist or contrast regurgitation. If any ellipticity remains, the next larger THV size is chosen to ensure complete leaflet expansion. RAO cranial view (CT oriented) is preferred for true en-face, coaxial alignment; additionally, lateral view may be used as an orthogonal check for ovality and PVL risk. Neither view replaces CT sizing; they only confirm coaxiality of deployment and reveal asymmetric expansion. Considering the CT measurements in our patient with a history of intracardiac repair using a 21-mm aortic homograft, a 23-mm MyVal valve was selected.

Careful patient selection, meticulous planning, comprehensive pre-procedural imaging (echocardiography, cardiac CT) and invasive hemodynamic assessment are essential to guide TPVI procedure. The intervention involves securing vascular access, performing sequential conduit dilation, conducting a balloon test to exclude coronary compression, and deploying a covered stent to create a stable landing zone, minimising rupture risk and ensuring valve stability. However, potential complications such as coronary compression, conduit rupture, stent fracture, and PVL highlight that not every anatomical configuration is suitable for TPVI.

Although TPVI holds significant promise, its long-term durability, especially for newer devices such as MyVal, is yet to be proven. Success rates and outcomes depend on the operator's skill and institutional experience. Early results are encouraging, but comprehensive follow-up data on valve longevity and reintervention rates are essential. Furthermore, underlying pathology, individual anatomy, and specific valve design will all critically influence long-term performance [9].

Conclusion

TPVI, when anatomically suitable, offers a safe, effective re-intervention for recurrent RVOT obstruction in high-risk patients, with high procedural success and excellent short-term outcomes. However, its long-term durability remains to be determined.

Consent statement

Written informed consent was obtained from the patient for publication of this case report, including accompanying images.

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Declaration of competing interest

None to be declared for all the authors of this study.

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