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CASE REPORT
Structural intervention

Management of life-threatening deformation of obstructive transcatheter mitral valve replacement bioprosthesis with balloon inflation in left ventricular outflow tract: a case report

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Background Left ventricular outflow track (LVOT) obstruction (LVOTO) is a severe complication of transcatheter mitral valve replacement (TMVR) procedures, with an uncertain prognosis and only few strategies available to prevent its occurrence. TMVR is thus contra-indicated in some patients because of a high risk of LVOTO onset. We demonstrate how LVOTO can be managed with a balloon inflation in the LVOT and a D-shaped deformation of the bioprosthetic valve.

Case summary A 64-year-old female presented with acute pulmonary oedema 2 weeks following aortic valve replacement and aorto-coronary bypass surgeries. A concomitant mitral stenosis, secondary to significant calcifications of the mitral annulus, was not treated during the procedure. After surgery, the mitral valvulopathy caused an acute heart failure and TMVR was performed by the heart team. The procedure was complicated by a cardiac arrest secondary to the onset of LVOTO which was managed by a balloon inflation in the LVOT and an alcohol septal ablation. Two-year follow-up shows a favourable outcome of the patient and good function of the prosthetic valve despite its deformation.

Discussion This case highlights the successful management of a LVOTO following valve-in-mitral annular calcification TMVR by balloon inflation in the LVOT. It is strongly recommended to place a 'rescue' guidewire in transaortic position during TMVR in order to manage the potential onset of acute LVOTO.

Keywords Case report • Transcatheter mitral valve replacement • Mitral stenosis • Left ventricular outflow tract • Valve-in-MAC • Balloon dilatation

ESC Curriculum 4.4 Mitral stenosis • 4.10 Prosthetic valves • 7.1 Haemodynamic instability • 7.4 Percutaneous cardiovascular post-procedure

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Learning points

- Balloon inflation in left ventricular outflow tract (LVOT) helps to manage a LVOT obstruction (LVOTO) during valve-in-mitral annular calcification transcatheter mitral valve replacement (TMVR).
- In patients at high risk of LVOTO post TMVR, inserting a provisional transaortic rescue guidewire facilitates LVOT balloon inflation in complication management procedure.

Introduction

The percutaneous treatment of stenotic or regurgitating mitral valvulopathy by implanting a bioprosthesis—transcatheter mitral valve replacement (TMVR)—has shown its feasibility and safety compared with high-risk conventional surgical procedures. Initially developed for treating surgical mitral bioprosthesis degeneration and valvular degeneration after mitral annuloplasty—valve-in-ring—the technique was later applied to treat calcified mitral stenosis (MS)—valve-in-mitral annular calcification (ViMAC). Balloon expandable bioprosthetic valves are generally used in these procedures. Procedural complications can be very severe: prosthesis embolization, annular rupture, left ventricular outflow tract (LVOT) obstruction (LVOTO).[1] LVOTO can occur when the implanted valve results in the displacement of the anterior mitral leaflet towards the LVOT, particularly in case of concentric left ventricular hypertrophy (LVH) and small mitro-aortic angle.[2] In this clinical case, we present the management of post-TMVR LVOTO by balloon dilatation of the LVOT, which resulted in prosthesis deformation and regression of the LVOTO.

Timeline

2 weeks prior to transcatheter mitral valve replacement (TMVR)	Surgical aortic valve replacement and coronary artery bypass
2 days prior to TMVR	Acute pulmonary oedema
Day 0	TMVR Cardiac arrest after valve implantation Resuscitation after LVOT balloon inflation Alcohol septal ablation
Day 2	Discharge from intensive care unit
Day 15	Discharge from hospital
2 years after TMVR	Last follow-up: good clinical and haemodynamic condition

Case presentation

We present the case of a 64-year-old female with a history of chronic renal failure, on dialysis since she was 16 years old, who underwent 3 renal transplantations. The patient's history also included peripheral arteriopathy, stenting of the common right iliac artery and previous thoracic irradiation for breast cancer. The patient presented with Class III NYHA dyspnoea secondary to a double stenotic valvulopathy: a calcified aortic stenosis and a calcified MS. The society of thoracic surgeons (STS) score was 15.1% and the Euroscore 2 was 10.5%. Initial heart surgery consisted in aortic valve replacement with a 23 mm Edwards Carpentier Magna Ease and two coronary artery bypass graft surgery with left internal mammary artery at the left anterior descending artery and right internal mammary artery on the obtuse marginal. No surgical intervention could be performed as a treatment of the MS, as the mitral annulus and the subvalvular apparatus were highly calcified. After surgery, the patient presented with a massive acute pulmonary oedema requiring prolonged non-invasive ventilation sessions and intravenous diuretics dependence. Patient was sent to rehabilitation 2 weeks following cardiac surgery.

A transoesophageal echocardiography (TEE) performed during hospital stay showed a much calcified stenotic mitral valve (mean gradient 15 mmHg and valve area at 1.01 cm^2), a normally functioning aortic bioprosthesis and preserved left ventricular ejection fraction (LVEF) at 71% associated with a moderate circumferential LVH. The heart team decided to perform a ViMAC, as mitral surgery was not feasible and the patient's valvular anatomy was incompatible with balloon valvuloplasty (severely calcified valve, absence of commissural fusion). A preliminary feasibility assessment was carried out and included a cardiac computed tomography (CT) scan (*Figure 1*). The valvular area measurement was 642 mm^2, leading to the choice of a 29 mm Sapien 3 bioprosthesis (Edwards Lifesciences, Irvine, CA, USA). The calcifications required for prosthesis anchoring, and in particular, the large and continuous calcifications of the posterior leaflet were clearly visible on the CT scan (*Figure 1A*) and were associated with a long and redundant anterior mitral leaflet (*Figure 1B*). The mitro-aortic angle measured 117.3° and the neo-LVOT area measurement (3mensio software) was 175.4 mm^2 (*Figure 1C*). The left ventricular cavity was small, 73.9 mm by CT scan, and associated with a concentric LVH. Despite the high risk of LVOTO (neo-LVOT at 175 mm^2), we decided to perform a TMVR because of the refractory symptomatology under optimal medical treatment.

The procedure was performed under general anaesthesia using TEE, via a right femoral venous route. After an echo-guided transseptal puncture, the mitral valve was crossed anterogradely with the help of an AGILIS L catheter. A Safari XS guidewire (Boston Scientific) was inserted in the left ventricle, the inter-atrial septum was predilated with a 14 mm balloon, and an Edwards 14 French sheath was inserted into the inferior vena cava. A 29 mm Edwards Sapien 3 balloon expandable prosthesis was then implanted under rapid pacing at 160 b.p.m. over the guidewire (see Supplementary material online, *Video S1*). Major low cardiac output occurred after the implantation, followed by a pulseless electrical activity which required cardiopulmonary resuscitation, chest compressions, and IV injection of 1 mg of adrenaline, repeated three times. TEE revealed a complete obstruction of the LVOT by the device and the anterior mitral leaflet, preventing the ventricular ejection, with still aortic leaflets (see Supplementary material online, *Video S2*).

In a situation of extreme emergency, we decided to insert a 10 French introducer (Terumo) in the left femoral artery and to place a second Safari XS guidewire in the left ventricle. A 23 mm balloon (Edwards Lifesciences) was introduced in the LVOT. We observed a deformation of the Edwards Sapien 3 prosthesis (Edwards Lifesciences) during balloon inflation (see Supplementary material online, *Video S3*), without any mobilization or embolization. The aortic balloon was sized according to the surgical aortic prosthesis dimension (23 mm).

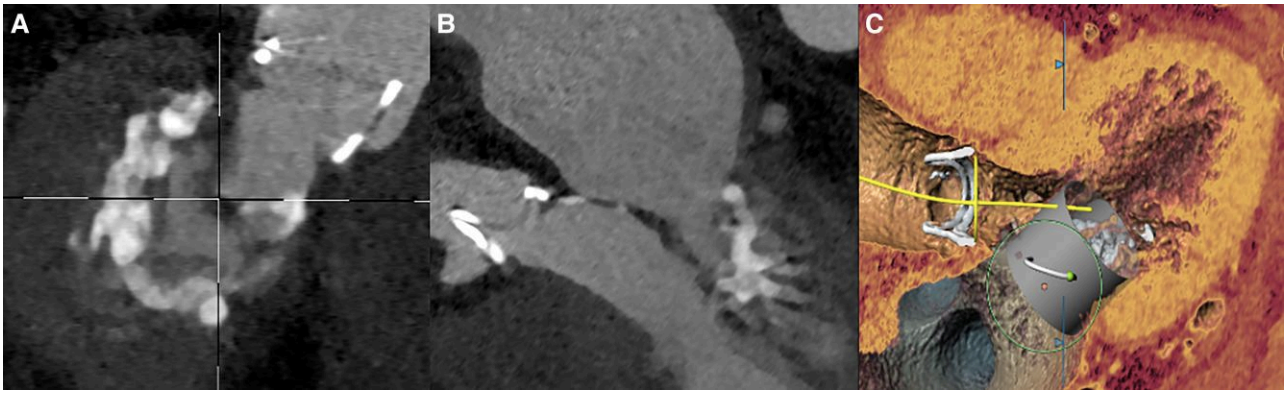

Figure 1 Pre-procedural computed tomography scan assessment of mitral valve. (*A*) Important calcification of mitral annulus and posterior mitral leaflet visible in two cavities view. (*B*) Large and redundant anterior mitral leaflet in left ventricular outflow tract view. (*C*) Computed tomography scan reconstruction of predictive neo-left ventricular outflow tract with Sapien 3, 29 mm prosthesis.

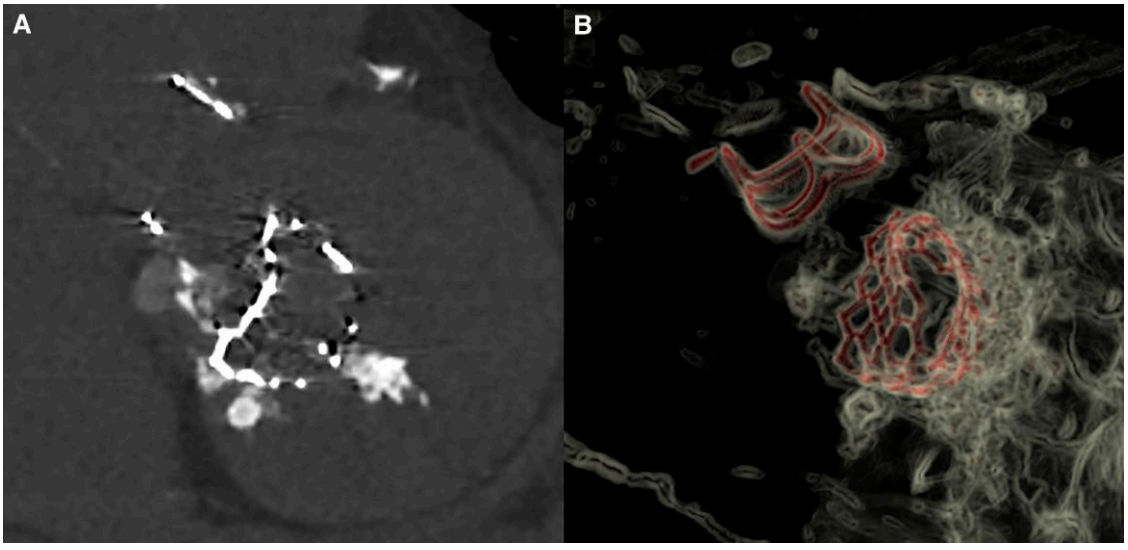

Figure 2 Computed tomography scan of mitral prosthesis after dilatation of left ventricular outflow tract. (*A*) Two-dimensional mitral prosthesis with D-shape deformation. (*B*) Three-dimensional mitral prosthesis with D-shape deformation.

The patient immediately recovered normal haemodynamic parameters and a correct systolic function. Echography images showed the aortic valve opening again and a non-obstructed LVOT.

Considering the initial LVH, and its intensification following the cardiac arrest, we decided to carry out an alcohol septal ablation via the second septal at the end of the procedure.

Post-procedural course was uneventful both neurologically and haemodynamically, despite a 10 min low flow. The patient was discharged 13 days after the intervention. The echocardiographic assessment at discharge showed a normal biplane LVEF at 80%, normally functioning mitral bioprosthesis with a 3 mmHg mean gradient, only minimal paravalvular leak and an absence of significant LVOT obstruction with a 10 mmHg gradient.

The 2-year post-procedural follow-up is satisfactory with a significant symptomatic improvement: NYHA Class I dyspnoea. Two-year post-procedure trans-thoracic echocardiography showed a 68% LVEF with mild stenosis of prosthetic mitral valve (mean transprosthetic gradient 4 mmHg) with no significant leak and no significant LVOTO (16 mmHg gradient; see Supplementary material online, *Video S4*), associated with septal thinning of the ablated zone.

A CT scan without contrast medium showed an obvious, D-shaped deformation of the Sapien 3 valve (Edwards Lifesciences) caused by the inflated balloon used to treat the obstruction (*Figure 2A*). This deformation was also visible on the 3D reconstruction of the CT scan images (*Figure 2B*).

Discussion

The present case illustrates a management strategy of LVOTO, as a complication of TVMR. The balloon inflation performed in the LVOT causes a

D-shaped deformation of the Edwards Sapien 3 prosthetic valve (initially of circular shape), similar to the shape of the anatomical mitral annulus and prevents the occurrence of LVOTO. The 2-year follow-up showed an absence of haemodynamic complications and no functional alterations of the bioprosthesis after its deformation. Alcohol septal ablation in the context of LVH further reduces the risk of LVOTO onset. Ideally, it should be performed 1 month prior TMVR in stable patients identified early as being at high risk of obstruction.[3]

A 'kissing-balloon' case in a valve-in-valve TVMR was described recently,[4] and another report showed that prophylactic midline laceration of the anterior leaflet (LAMPOON technique) could be performed prior to TMVR.[5] However, no mid-term follow-up data are available to date regarding these procedures.

In a situation of TMVR with high-risk criteria for LVOT obstruction, the systematic retrograde insertion of a guidewire in the LVOT allows the rapid inflation of a 'rescue' balloon, resulting in the obstruction clearance. The case presented herein shows, for the first time, the use of this technique in a ViMAC procedure with a 2-year follow-up.

Lead author biography

Dr Hugo Cavalerie graduated from the Toulouse medical university in France in 2021. Now he is fellow in interventional cardiology at Clinique Saint Augustin in Bordeaux, France. He has ongoing interest in interventional cardiology including coronary artery disease and structural heart disease.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports*.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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