Transcatheter ,,valve-in-valve“ mitral valve replacement for patient-prosthesis mismatch: Chronicle of a death foretold

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Abstract

Severe mitral annular calcification (MAC) may represent a challenging issue which can lead to poor outcomes and serious issues such as patient-prosthesis mismatch (PPM). The potential harmful effect of PPM must be prevented through the use of alternative techniques that allow mitral valve replacement with adequately sized bioprostheses in patients with MAC. PPM should be recognized as a contraindication for transcatheter valve-in-valve replacement as it leads to poor outcomes and early prosthetic degeneration.

Introduction

MV replacement in patients with severe mitral annular calcification (MAC) can lead to poor outcomes and serious issues such as patient-prosthesis mismatch (PPM). PPM in patients with MAC must be prevented as it is associated with harmful effects and its future correction is extremely challenging and related to adverse results. The current case report describes a poor outcome of transcatheter mitral valve-in-valve (ViV) replacement for the treatment of mitral PPM. Approval by the Institutional Review Board (IRB) and informed consent were waived according to our institutional policies for anonymized case reports.

Case report

A 74 year-old male patient was referred to our department due to decompensated heart failure. He weighed 83 kg and his height was 178 cm, with a corresponding body surface area (BSA) of 2,01 m^2. Relevant comorbidities included arterial hypertension, hyperlipidemia, severe pulmonary hypertension, atrial fibrillation and a previous ischemic stroke. The patient underwent a biological mitral valve (MV) replacement (Hancock, size 25 mm; Medtronic, Minneapolis, MN) 4 years prior to presentation for the treatment of symptomatic severe mixed mitral stenosis with regurgitation in another cardiac surgery department. At the time, the surgeon noted severe MAC that prevented insertion of a larger MV prosthesis. The geometric effective orifice area (EOA) of the Hancock valve prosthesis size 25mm is 1.46cm^2 (1). This led to a severe PPM (EOA-index 0,72 cm^2/m^2) immediately after that initial operation. Two years later, the patient presented with rapid degeneration and stenosis of the MV prosthesis with severe symptoms (New York Heart Association (NYHA) class III). A transapical mitral ViV procedure (Sapien S3, size 23 mm; Edwards Lifesciences, Irvine, CA) was performed in the same cardiac surgery service, as a “last stage” measure to relieve symptoms. However, this led to a higher degree of PPM. Consequently, the patient re-presented to our department 2 years after transcatheter ViV replacement with severe dyspnea (NYHA IV) and peripheral edema. Transthoracic echocardiography revealed recurrent severe mitral stenosis (Pmax / Pmean 37/15 mmHg) and severe PPM (EOA-Index 0.32 cm^2/m^2), as well as markedly decreased right ventricular function and pulmonary hypertension (systolic PA pressure 45 mmHg). CT-scan revealed extensive mitral annular calcification (**Figure 1 A - C**). Due to the ineffectiveness of conservative medical therapy and the patient’s wishes, we decided to perform a high-risk redo surgical MV replacement.

Surgery was performed through median sternotomy and with standard cannulation for cardiopulmonary bypass (CPB). Intraoperatively, both highly degenerated MV prostheses could be extracted (**Figure 2 A - C**). Extensive annular decalcification was required to ensure implantation of an adequately sized MV prosthesis (**Figure 2 D**). In order to prevent atrio-ventricular rupture as a result of the extensive decalcification, mitral annular reconstruction with a bovine pericardial patch was performed (**Figure 3**). A mechanical MV prosthesis (SJM Mitral Modell MJ-501, size 29 mm; Abbott, Chicago, IL) was thereafter implanted. Weaning from cardiopulmonary bypass (CPB) was not possible due to severe hypokinesia of the anterior left ventricular wall as evidenced in the intraoperative transesophageal echocardiography. It was hypothesized that a piece of calcium had embolized into the left coronary tree, since the preoperative cardiac catheterization ruled out significant coronary artery disease. Therefore, an aortocoronary bypass in beating heart technique (with CPB support) was performed to the left anterior descendent artery (LAD) using a saphenous vein graft. Thereafter, CPB could be successfully weaned. However, the thorax was left open due to a very dilated right ventricle as well as persistent hemodynamical instability. Cardiac catheterization was performed immediately after the operation, confirming calcium embolization with significant main left coronary occlusion. Proper function of the venous bypass to LAD could be observed, and the circumflex artery was stented. The patient developed low cardiac output syndrome thereafter, and an intra-aortic balloon pump was implanted. The patient developed progressive right heart failure thereafter with increasing catecholamine doses. Cardiac arrest subsequently occurred and a percutaneous arterio-venous extracorporeal life support (ECLS) was emergently implanted under mechanical cardiopulmonary resuscitation. One day later, the patient developed fixed and dilated pupils. CT scan revealed generalized cerebral edema with signs of brain herniation. Supportive measures were withdrawn shortly thereafter.

Comments

MAC is among the most challenging problems in cardiac surgery. It can lead to poor outcomes and serious issues such as PPM. Patients with severe circumferential MAC are frequently not suitable for transcatheter MV replacement and outcomes after percutaneous valve in MAC (ViMAC) are disappointing (2). Additionally, these patients are often judged to have no surgical alternative. Hence, decision making in those high-risk patients could be tremendously difficult. Therefore, MV procedures in those patients should always be discussed by a “Heart Team” and should be preferably performed in high-volume “Heart Valve Centers”.

Several alternative techniques offer the possibility of implanting accurately sized MV bioprostheses in patients with MAC, thus avoiding the negative effects of PPM. Surgical ViMAC through direct open atrial access is an option with excellent outcomes (3). It allows removal of the anterior mitral leaflet under direct view in order to minimize the risk of left ventricular outflow tract obstruction (3). Alternatively, based on the same concept, the LAMPOON transcatheter technique splits the anterior mitral leaflet percutaneously prior to transcatheter ViMAC (4).

Transcatheter mitral ViV procedures have excellent outcomes in high-risk patients with degenerated mitral bioprostheses (2,5). Nevertheless, transcatheter methods are only possible if anatomy is deemed to be favorable (2,5,6).This is not the case in this patient, who presented with severe prosthetic MV stenosis of a very rapidly degenerating mitral prosthesis, which originally resulted in mitral PPM. Accelerated structural valve deterioration is known to occur in patients with PPM due to turbulent blood flow through the bioprosthesis (7). Hence, PPM can only be addressed by implanting a new MV prosthesis with a greater effective opening area. Therefore, transcatheter mitral ViV replacement was in this case only a palliative strategy to ephemerally improve quality of life in a highly symptomatic patient, whose structural heart disease further worsened due to persistent severe PPM.

In conclusion, PPM must be prevented through the use of alternative techniques that allow implantation of adequately sized MV prostheses in patients with MAC. PPM should be recognized as a contraindication for transcatheter mitral ViV replacement.

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Figure legends:

Figure 1 A-C. Preoperative thorax CT-scan showing the previously implanted prosthetic mitral valves (red arrows) and the surrounding extensive annular calcification (yellow arrows). **A**transversal view, **B** coronal view, **C** sagittal view.**Ao** Aorta, **LA** left atrium, **LV** left ventricle,**PA** pulmonary artery, **RA** right atrium, **RV**right ventricle, **SVC** superior vena cava.

Figure 2 A–C Degenerated mitral "valve-in-valve" prostheses. Note the severe stenosis demonstrated by the inability of the leaflets to sufficiently open (yellow arrow). **A** lateral view, **B**view from ventricular aspect, **C** view from atrial aspect.**Figure 2D** Calcified tissue removed during operation.

Figure 3. Mechanical valve (yellow arrow), bovine pericardial patch for reconstruction of the posterior aspect of the mitral annulus (blue arrow).