Transcatheter Valve Unable to Cure Patient–Prosthesis Mismatch of Mosaic Bioprosthesis

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Abstract

Transcatheter aortic valve implantation (TAVI) has been recently established as a less invasive alternative to conventional aortic valve replacement (CAVR) in patients presenting with expected high procedural risk. The rapid technologic advances and the recent improvement of clinical outcomes with TAVI have made it possible to treat degenerated bioprosthesis using the valve-in-valve implantation concept (Walther T, Simon P, Dewey T, et al. Transapical minimally invasive aortic valve implantation: multicenter experience. Circulation 2007;116(11, Suppl):I240–I245; Webb JG, Pasupati S, Humphries K, et al. Percutaneous transarterial aortic valve replacement in selected high-risk patients with aortic stenosis. Circulation 2007;116(7):755–763). Recently, concerns were raised regarding the appropriate sizing of transcatheter valve prosthesis and its effect on residual stenosis (Klaaborg KE, Egeblad H, Jakobsen CJ, et al. Transapical transcatheter treatment of a stenosed aortic valve bioprosthesis using the Edwards SAPIEN Transcatheter Heart Valve. Ann Thorac Surg 2009;87(6):1943–1946; Zedig R, Achouh P, Berrebi A, et al. Valve- in- a- valve implantation: a word of caution. Ann Thorac Surg 2009;87:1943–1946), eventually resulting in a patient–prosthesis mismatch (PPM). We report a case with severe PPM after inserting a 23-mm Sapien (Edwards Lifesciences, Irvine, United States) valve into degenerated 23-mm Medtronic Mosaic prosthesis (Medtronic, Minneapolis, Minnesota, United States).

Keywords

- aortic valve and root
- surgery
- heart valve
- transapical
- TAVI

Case Report

A 73-year-old man (80 kg, 171 cm, body surface area (BSA) 1.97 m^2) underwent conventional aortic valve replacement (CAVR) and bypass surgery in October 2008. A 23-mm Medtronic Mosaic bioprosthesis (Medtronic, Minneapolis, Minnesota, United States) was used to replace the stenotic native aortic valve. The intermediate branch was also revascularized. In January 2009, the perioperative echocardiography showed a mean gradient 38 mm Hg. Two years later, the patient was admitted to our unit with severe signs of left heart failure. An echocardiogram showed malfunctioning aortic bioprosthesis with calcified leaflets and relevant stenosis (mean gradient 34 mm Hg).

Next to his deteriorated cardiac condition, he presented several comorbidities such as arterial hypertension, chronic renal insufficiency, and peripheral arterial disease. The calculated logistic EuroSCORE (European System for Cardiac Operative Risk Evaluation) was 16.6%. After discussion of the case in "heart team", the patient was planned for a transapical transcatheter aortic valve implantation (TAVI)–valve-in-valve implantation (VinV) procedure. The operation was done in general anesthesia.

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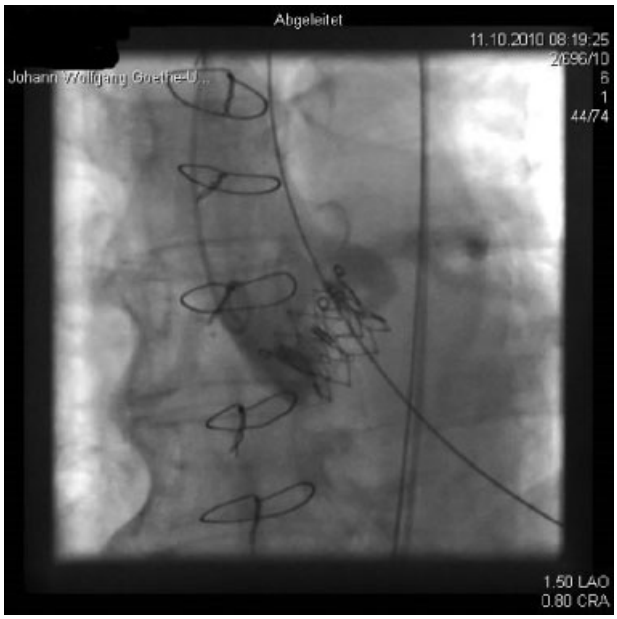

Fig. 1 The 23-mm Sapien valve was implanted by transapical procedure in the degenerated 23-mm Medtronic Mosaic valve.

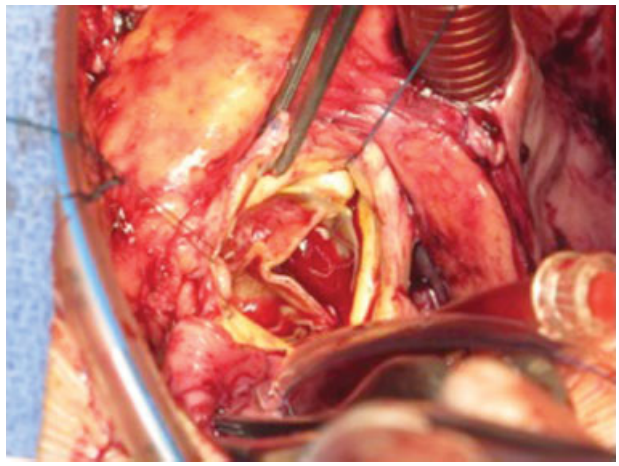

Fig. 2 View on the aortic valve: The right leaflet shows a thrombus and a rotation of one of the commissure of the Sapien valve in relation to the stents of the Mosaic prosthesis.

A 23-mm Sapien valve (Edwards Lifesciences, Irvine, United States) was implanted within the degenerated 23-mm Medtronic Mosaic valve (►**Fig. 1**). The postoperative echocardiogram confirmed a good VinV results, and the transvalvular peak and mean gradient were 14 and 10.7 mm Hg, respectively. No regurgitation was present. After 2 months, the mean gradient increased to 37 mm Hg.

Two years later, the patient was admitted with progressive dyspnea. An echocardiography assessment revealed a mean gradient of 41 mm Hg over a visually normal valve. Insufficiency was not present. To treat the patient-prosthesis mismatch (PPM) the patient underwent a balloon dilatation of the prosthesis and the mean gradient was reduced from 41 to 29 mm Hg. The control echocardiography performed 1 month later showed again severe aortic valve stenosis with a mean gradient of 58 mm Hg and a calculated indexed effective orifice area of 0.45 cm^2/m^2, definitely a severe PPM. To solve the problem, conventional aortic valve re-replacement was planned.

The operative treatment included replacement of the prosthetic valves by a 25-mm Carpentier-Edwards Perimount prosthesis (Edwards Lifesciences Corp, Irvine, California, United States). In addition, the aortic root was enlarged using the Rittenhouse–Manouguian technique using a native autologous pericardial patch. In addition, the left ventricular outflow tract was opened with a subaortic myectomy as described by Morrow. The right leaflet of the explanted valve showed a thrombus and a rotation of one of the commissure of the Sapien valve in relation to the stents of the Medtronic Mosaic prosthesis (►**Fig. 2**). The operative and early postoperative course was unremarkable. After 7 days, the patient was discharged. The control echocardiogram showed a good result with a mean gradient of 11 mm Hg. The patient did not complain of dyspnea afterward.

At 1 year follow-up, the patient was asymptomatic with a mean gradient of 18 mm Hg at echocardiography.

Discussion

The VinV therapy may be an effective and less invasive method to treat high-risk patients presenting with degenerated and stenotic aortic valve prosthesis, as recently published.[1–5] Hemodynamic performance of the catheter valve prosthesis is dependent on its full expansion during the implantation. In case of VinV scenario, a full expansion may be constrained by the internal diameter of the original bioprosthetic prosthesis and lead to incomplete cage expansion with residual stenosis or leakage.[6,7] Sizing consideration must take into account the internal diameter of the implanted xenograft instead of the labeled size and the nature of valve failure with possible increase of material within the original stent.[7] The geometric internal diameter of the stented bioprosthetic heart valve prosthesis is most relevant for VinV therapy and varies for a given labeled size.[7] The labeled size of stented prosthesis refers to the stent outer diameter. The internal diameter of most stented valves is significantly smaller. The Medtronic Mosaic prosthesis implanted at initial surgery had a labled size and orifice diameter (OD) of 23 mm. The inner diameter published in technical descriptions is 20.5 mm.[6] However, this is the inner diameter of the stent and does not represent the geometric inner diameter of the valve. The original porcine aortic wall, the septal muscle shelf, and the remnants of the leaflets further reduce this diameter, although implant instructions allow to implant a 23 mm.

When Sapien valve was inserted into aortic annulus down to a diameter of 18 mm a problem arise because this diameter is completely fixed by a prosthetic stent. Therefore, in contrast to the implant instructions, the inner diameter of the Medtronic Mosaic valve was too small to allow a complete expansion of the Sapien valve prosthesis leading to severe aortic stenosis.

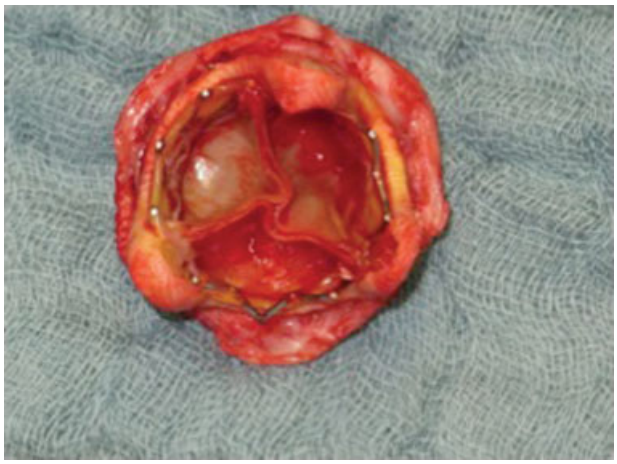

Fig. 3 The explanted Sapien valve shows an asymmetric expansion within the Mosaic stent.

At explant, the Sapien valve showed an asymmetric expansion within the Medtronic Mosaic stent. This most probably caused an asymmetric valve opening and creating a spin wheel phenomenon (►**Fig. 3**). Furthermore, the impaired movement of the right coronary leaflet led to a thrombus formation on the aortic aspect, creating further stenosis.

The question remains why transvalvular gradients were low and normal immediately after the VinV procedure. In severe hypertrophic ventricles the stroke volume and by this also the cardiac output may be low despite the calculated left ventricular ejection fraction is normal. This phenomenon is described as paradoxical low output and might be one explanation of the low periprocedural gradient. Leaflet mobility may have been shortly normalized after balloon valvuloplasty as indicated by the short success of the procedure. The obviously impaired leaflet mobility caused by the asymmetry and later thrombus formation was not visible at echocardiographic exams even after re-evaluation knowing the pathology. The patient was relieved from the stenosis after CAVR with root enlargement and subvalvular myectomy.

Overall, this patient had to undergo four interventions which does not only cause physical stress but also results in high treatment costs.

The case presented should alert physicians of the limiting sizing factor (true internal diameter) of a stented degenerative bioprosthesis. The decision for TAVI versus CAVR in high-risk patients should be based on clinical judgment taking individual patient characteristics as calculated risk not always correlates to the true clinical risk.

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