

## Trans-catheter Aortic Valve Implantation in Patients with Previous Mitral Valve Replacement: A Case Series

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### Abstract

**Introduction:** Transcatheter aortic valve implantation is a routine clinical method for patients with severe aortic stenosis at high surgical risk, such as previous cardiac surgery. The presence of mechanical mitral prosthesis might complicate trans-catheter aortic valve implantation because of possible interference between both prostheses. Some clinical reports have already demonstrated the feasibility of trans-catheter aortic valve implantation in such patients.

**Methods and results:** We report 4 patients with severe symptomatic aortic stenosis who had prior mitral valve replacement that successfully underwent trans-catheter aortic valve implantation with Sapien XT (Edwards Lifesciences, Irvine, USA) and CoreValve (Medtronic, Irvine, USA) aortic prosthesis. Multi-slice computed tomographic angiography was used for the assessment of the distance between both aortic and mitral prosthesis annuli. Trans-esophageal echocardiography was introduced for precise positioning of trans-catheter aortic valve. There were no special technical tips besides precise positioning and slow opening of the valve prosthesis. In case of CoreValve the goal was the positioning close to "zero point" and in case of Edwards Sapien valve higher as a "half-on-half" position according to natural aortic valve. We observed no deformation or dysfunction of aortic and mitral prosthesis in any of the patients. Balloon aortic valvuloplasty prior to implantation is not mandatory; however it helps to observe the mutual effect of the new aortic valve and pre-existent mitral prosthesis.

**Conclusions:** We conclude that trans-catheter aortic valve implantation can be safely and successfully performed in patients with mechanical mitral prosthesis. It is important to carefully evaluate the anatomical conditions with trans-esophageal echocardiography and computed tomographic angiography. Skillfulness and experience of the operators should not be neglected.

**Keywords:** Aortic valve stenosis; Trans-catheter aortic valve replacement; Mitral valve replacement; Aortic prosthesis; Mitral prosthesis

### Introduction

Aortic stenosis is the most common heart valve disease besides mitral valve regurgitation in the developed world. The only definitive treatment for severe symptomatic aortic stenosis is aortic valve replacement. Open-heart surgery is still gold standard for the treatment of low risk patients with aortic stenosis. In the last 15 years trans-catheter aortic valve implantation (TAVI) has been proved to be superior or at least non-inferior in cases of moderate or high operative risk patients [1-3]. Older patients with previous mechanical mitral valve replacement (MVR) are, however, considered high surgical risk due to a hostile thorax. The procedural risk can be considerably reduced using a percutaneous approach. Randomised-controlled trials of TAVI stipulated the presence of mitral valve prosthesis as an exclusion criterion for enrolment in the trial [1,3]. Functional interference between the non-compliant mechanical mitral prosthesis and trans-catheter aortic valve is possible and might have clinical consequences [4]. Therefore, in patients with MVR, TAVI should be

considered with caution. There might be at least three main concerns: 1. Possible aortic valve under-expansion in the presence of a noncompliant mechanical mitral prosthesis and postoperative scar; 2. The risk of aortic device embolization; 3. The risk of post-procedural dysfunction of the mitral prosthesis as a consequence of its damage during percutaneous manipulation or due to functional interference with aortic bioprosthesis [5]. Nevertheless, a number of authors have published successful cases of TAVI in the presence of mechanical valve prostheses [6-13]. In this paper we present four patients who underwent successful TAVI after previous mitral valve surgery.

### Patients, Materials and Methods

We searched our hospital registry for all the patients with severe aortic stenosis who underwent TAVI in University Medical Centre Ljubljana since the beginning of our TAVI program in October 2009 until August 2016 (n=301 pts). There were four patients with pre-existent mechanical mitral valve prosthesis who were considered high-risk surgical candidates following joint evaluation by cardiac surgeons and cardiologist and had undergone TAVI. The preoperative and postoperative examinations included collecting data regarding medical history, clinical and laboratory examination, electrocardiography, chest

radiography and transthoracic echocardiography before and after the procedure. Doppler ultrasound examination of the carotid arteries and coronary angiogram were performed to exclude hemodynamic significant carotid and coronary artery stenosis respectively. In addition, multi-slice computed tomographic angiography (MS-CTA) was performed in all four patients before TAVI, in order to carefully assess aortic root diameters, peripheral arterial axes and relationship between aortic annulus and mitral prosthetic valve or ring. The TAVI procedure was performed in hybrid operating room using fluoroscopic imaging and trans-esophageal echocardiography (TEE) to observe the correct position of the device.

TAVI program was approved by Slovenian Ethic Committee, Scientific Board of University Medical Centre of Ljubljana and Ministry of Health of the Republic of Slovenia in 2008.

## Results

Since the beginning of TAVI program in October 2009 four patients with previous mitral valve replacement underwent TAVI procedure in

University Medical Centre Ljubljana. The median patient age at the time of the procedure was 79 years (range 71-86 years). Three patients (75%) were female. They were all classified in functional classes III or IV according to New York Heart Classification (NYHA). Their median NT-proBNP level was 9194 ng/l (range 2015-22141 ng/l). In addition to dyspnea two patients (50%) reported having chest pain during vigorous physical activity. Three patients (75%) had atrial fibrillation. All of the patients had moderately to severely reduced renal function with median glomerular filtration rate of 57 ml/min/1.73 m<sup>2</sup> (range 38-71 ml/min/1.73 m<sup>2</sup>). One patient had undergone two previous surgical mitral valve replacements. The mean interval between most recent mitral valve replacement and TAVI procedure was 12.5 years (range 3-15 years). They were all considered high-risk patients for surgical aortic valve replacement with median logistic EuroSCORE 27.43% (range 16.13-50.66%), median EuroSCORE II 14.64% (range 7.08-26.40%) and median STS score 5.52% (range 3.93-7.28%, Table 1).

Pt	Gndr	Age (yrs)	Dyspnea status (NYHA)	NT-proBNP	Angina status (CCS scale)	ECG rhythm	GFR (ml/min/1.73 m <sup>2</sup> )	No. of previous MVR	Most recent MVR	logES (%)	ESII (%)	STS score (%)
				(ng/l)								
1	F	86	3	9194	2	AF	48	1	2000	50.66	26.4	7.28
2	F	77	3	NR	2	AF	38	2	2007	16.13	10.59	5.39
3	F	81	3	2015	0	SR	66	1	1998	20.07	7.08	3.93
4	M	71	4	22141	0	AF	71	1	2002	34.79	18.68	5.64

**Table 1:** Baseline preoperative patient characteristics; AF: Atrial Fibrillation; CCS: Canadian Cardiovascular Society; ESII: EuroSCORE II; F: Female; GFR: Glomerular Filtration Rate; Gndr: Gender; logES: logistic EuroSCORE; M: Male; MVR: Mitral Valve Replacement; NR: Not Reported; NYHA: New York Heart Classification; Pt: Patient; SR: Sinus Rhythm.

All the patients had severe degenerative aortic stenosis. Before TAVI procedure the median value of mean trans-aortic pressure gradient was 41 mmHg (range 25-50 mmHg), median value of peak blood flow velocity through aortic valve 4 m/s (range 3.1-4.3 m/s) and median calculated aortic valve area (AVA) 0.55 cm<sup>2</sup> (range 0.5-0.6). Reduced systolic left ventricular function was found in two cases and moderate or severe pulmonary hypertension in all of the patients with median value of systolic pulmonary artery pressure 51.5 mmHg (range 45-60 mmHg). Echocardiographic measures of the patients before TAVI are summarized in Table 2.

Pt	AVA (cm <sup>2</sup> )	AVAi	peak velocity (m/s)	Peak AoV gradient (mmHg)	Mean AoV gradient (mmHg)	EF (%)	sPAP (mmHg)
		(cm <sup>2</sup> /m <sup>2</sup> )					
1	0.5	0.34	4	64	42	35	48
2	0.6	0.33	3.1	40	25	60	45
3	0.6	0.36	4.3	75	50	60	55
4	0.5	0.27	NR	69	40	24	60

**Table 2:** Echocardiographic measures of patients before trans-catheter procedure; AoV: Aortic Valve; AVA: Aortic Valve Area; AVAi: indexed

Aortic Valve Area; EF: Ejection Fraction; NR: Not Reported; sPAP: systolic Pulmonary Artery Pressure.

Three out of four (75%) patients underwent TAVI procedure in deep sedation using trans-femoral approach, while one patient (25%) underwent trans-apical TAVI procedure which required general anaesthesia. In two out of three trans-femoral cases (66%) a surgical preparation of femoral artery was necessary, while in one patient ProStar closure device was used. In all patients brain protection device (Spiderwire) was inserted in right carotid artery. In two of the patients balloon aortic valvuloplasty (BAV) was required due to critical aortic stenosis as a part of acute pre-TAVI preparation. In three out of four (75%) patients a balloon-expandable Edwards Sapien XT bioprosthesis was implanted and in one trans-femoral patient (25%) a self-expandable Medtronic CoreValve was used (Table 3). Valves were implanted under RTG-diascopic guidance and angiography. Additional TEE guidance was used in all four patients for optimal valve positioning.

Pt	Access site	BAV before TAVI	Diameter of largest BAV balloon (mm)	Valve manufacturer	Valve size (mm)	Vascular closure technique
1						
2						
3						
4						

1	TA	N	/	Edwards Sapien XT	23	surgical
2	TF	Y	23	Edwards Sapien XT	23	surgical
3	TF	Y	22	Edwards Sapien XT	26	percutaneous device
4	TF	N	/	Medtronic CoreValve	31	surgical

**Table 3:** Trans-catheter aortic valve implantation (TAVI) procedure details; BAV: Balloon Aortic Valvuloplasty; N: No; Pt: Patient; TA: Trans-apical; TF: Trans-femoral; Y: Yes.

Valve was successfully deployed in all four cases without interference and damage of the existent mitral prosthesis, coronary obstruction or prosthesis embolization. Mild paravalvular regurgitation was found in three out of four patients (75%) and moderate paravalvular regurgitation in one patient (25%). After the procedure there were no embolic events such as periprocedural myocardial infarction, stroke or transitory ischemic attack. Only a small amount of embolic material was caught in the protection device net. Permanent pacing was required in one patient (25%) as a consequence of new-onset complete atrioventricular block. Acute renal failure with AKIN score 2 developed in one patient (25%). There were no cardiac tamponade, late vascular complications and infective endocarditis after the procedure. Median duration of hospital stay was 8 days (range 6-15 days).

### Discussion

Despite initial concerns, feasibility of TAVI in the presence of a mechanical prosthesis has been demonstrated. However, experience to date is limited. In addition to other possible complications after TAVI, such as prosthesis embolization, coronary artery obstruction, cardiac tamponade, embolic events, renal failure or heart block, there is a chance of mechanical valve dysfunction, either intra- or post-procedurally [14]. Special caution is needed to achieve a good position and proper expansion of the aortic valve without interference and damage of the existent mitral prosthesis. In order to properly assess the altered anatomical conditions in the presence of mechanical mitral prosthesis, precise pre- and intra-procedural imaging is necessary. MS-CTA should be the imaging technique of choice [8]. It might be of crucial to do step by step slow opening of prosthesis and proper (re)positioning to reach optimal device position. It seems that a three-dimensional TEE allows accurate assessment of anatomy [5]. TEE might be supportive in the final prosthesis positioning especially in case of severe calcifications and difficult aortic root and valve anatomy. It is difficult to recommend an optimum vascular approach and type of the artificial valve based on the limited experience to date. Some suggest the use of the self-expandable CoreValve prosthesis in this group of patients might be related to higher incidence of under-expansion or deformation of the prosthesis due to self-expanding support frame of the valve [7]. On the other hand in case of proper position of CoreValve the function of implanted valve might be better due to leaflets in supra-valvular position without important frame deformities and under-expansion. The selection of optimal non-femoral route should be anatomy driven. Trans-apical access may bear the risk of interference between delivery sheath and artificial mitral prosthesis [7,15]. On the other hand trans-apical approach offers the best manipulation and positioning control. Trans-aortic route may

offer the benefits of the control similar to trans-apical, however in some anatomical situations the positioning of the prosthesis might be quite challenging due to limited space, especially in case of horizontal aorta anatomy. In this case series, we presented four successful implantations of aortic valve prosthesis in patients with previous mitral valve replacement, balloon-expandable as well as self-expandable using trans-femoral as well as trans-apical approach. We observed no aortic valve under-expansion, device embolization or post-procedural mitral prosthesis dysfunction. Overall in TAVI, as well as in the case of special TAVI indications, it is reasonable to adopt the least invasive possible approach. There are no demanding implantation tips and tricks. However, precise positioning of the valve prosthesis and step-by-step slow opening might be reasonable. At this point operator skills and TAVI experiences are important.

### Conclusion

TAVI procedures in patients with previous MVR should be performed by experienced operators that might be able to cope with some specific technical challenges.

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