

# Aortic valve–sparing procedures in patients with aortic valve insufficiency: a single-center experience

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**Introduction** Valve replacement surgery has been the treatment of choice for both bicuspid (BAV) and tricuspid aortic valve (TAV) insufficiency. Aortic valve–sparing surgery remains an interesting therapeutic option, yet it is a major and highly complex procedure. Similarly to the modern valves resistant to structural deterioration,<sup>1</sup> it enables long-term outcomes that lower the risk of redo surgery, which is particularly important when treating young patients. The procedure helps avoid the need for anticoagulation, decrease the risk of infections and endocarditis, and optimize aortic valve hemodynamics.<sup>2</sup> Aortic insufficiency (AI) often results from a progressive connective tissue disorder of the aorta leading to dilation of the aortic annulus, aortic root, and ascending aorta. The pathogenesis of aortopathy involves congenital or acquired degenerative mechanisms.<sup>3,4</sup> The novel approach to aortic valve repair entails the restoration of normal hemodynamics accompanied by stabilization of the aortic annulus and ascending aorta.<sup>3,5</sup> The appropriate repair technique is selected based on the AI classification that corresponds with the specific AI pathogenesis.<sup>6</sup>

This study aimed to assess the extent of aortic valve repair, including the stabilization of the aortic root, and aortic interventions as well as to evaluate early clinical and hemodynamic outcomes of the repair.

**Methods** We retrospectively reviewed 59 patients who underwent aortic valve repair performed by an experienced aortic surgeon (MJ) at Wrocław University Hospital between January

2017 and July 2019. Demographic data and procedural details were collected from patients' medical records and the AVIATOR registry (<https://heartvalvesociety.org/AVIATOR/>). Patients with moderate to severe AI (grade 3 or 4) were considered eligible for valve repair.

According to the American Heart Association / American College of Cardiology and European Society of Cardiology / European Association for Cardio-Thoracic Surgery guidelines, the aortic root and ascending aorta repair is indicated when the ascending aorta has dilated over 45 mm in patients with a BAV and moderate to severe AI.<sup>7-9</sup> The novel concept of the earlier aortic root and ascending aorta repair is increasingly acknowledged, as is its fundamental role in stabilizing aortic valve repair. In a number of recent studies,<sup>5,6,10,11</sup> the threshold for aortic intervention has been even lowered to a range of 42 to 43 mm.

The preoperative patient evaluation included transthoracic echocardiography, transesophageal echocardiography (TEE), and computed tomography angiography. The appropriate technique was chosen based on the mechanism of AI assessed by intraoperative TEE and precise measurements of the aortic annulus performed with the Hegar dilator as well as leaflet effective height and coaptation length with the Schäfers caliper. After the repair, TEE was repeated to ensure that the procedure was successful.

**Statistical analysis** Data were analyzed using the Statistica 10.10 software (StatSoft, Inc., Kraków, Poland). The results were presented as mean (SD) and median.

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**TABLE 1** Aortic valve-sparing procedures in the study group (n = 59) and the findings of transesophageal echocardiography before and after the repair

Variable	Value	
Aortic valve-sparing procedures, n (%)		
External VAJ annuloplasty	20 (34)	
Internal annuloplasty <sup>a</sup>	8 (14)	
Internal VAJ annuloplasty <sup>b</sup>	9 (15)	
Subcommissural VAJ annuloplasty <sup>c</sup>	29 (49)	
Sinus remodeling	7 (12)	
Ascending aorta prosthesis	45 (78)	
STJ annuloplasty	49 (83)	
Central plicating suture	51 (86)	
Cusp resection	24 (41)	
Shaving	26 (44)	
Free-edge reinforcement	3 (5)	
Patch reconstruction	1 (2)	
TEE findings before and after the procedure, mean (SD); median		
LVEDD, mm	Before	57 (8.8); 57
	After	56 (7.6); 55
LVESD, mm	Before	38 (8.6); 38
	After	37 (7.8); 37
EF, %	Before	61 (4.6); 48
	After	60 (4.8); 47
VAJ, mm	Before	27 (3.4); 27
	After	24 (2.3); 24
Aortic root, mm	Before	40 (6.6); 40
	After	36 (4.5); 36
STJ, mm	Before	36 (7.8); 35
	After	30 (3.1); 30
Tubular aorta, mm	Before	44 (8.7); 45
	After	31 (3.1); 30
Peak gradient, mm Hg	Before	13 (3.9); 14
	After	16 (6.7); 14
Mean gradient, mm Hg	Before	7 (2.1); 6
	After	8.4 (4.3); 7
AI grade <sup>d</sup> , 0/1/2/3/4	Before	0/8/13/24/13
	After	0/2/0/0/0

- a Performed with the Goretx suture (W. L. Gore & Associates, Inc., Medical Products Division, Flagstaff, Arizona, United States) on the Hegar dilator
- b Performed with the HAART ring (BioStable Science & Engineering, Austin, Texas, United States)
- c Performed with the Cabrol stitches
- d Data are presented as number of cases diagnosed with each AI grade.

Abbreviations: AI, aortic insufficiency; EF, ejection fraction; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; STJ, sinotubular junction; TEE, transesophageal echocardiography; VAJ, ventriculoaortic junction

**Results and discussion** Between January 2017 and July 2019, a total of 59 patients (mean [SD] age, 46 [16.7] years; 52 men [88%]) with moderate to severe AI underwent aortic valve repair or valve-sparing aortic root replacement (VSRR). Our cohort included 41 patients (69%) with a BAV and 18 (31%) with a TAV. Among those with a BAV, the majority (88%) had type 1 BAV with right-left fusion, and 10 patients, type 0 BAV. Bicuspid aortic valves were usually associated with cusp prolapse (49 [83%]) and calcification of an unformed commissure (18 [44%]). Among all patients, 14 (24%) underwent aortic valve repair procedures only, whereas 45 (76%) had VSRR including aorta replacement accompanied by the aortic root or sinotubular junction remodeling (ie, the Yacoub or David 3 procedure) or reimplantation (David 1 procedure). According to the classification by El Khoury,<sup>6</sup> the most common type of AI was type 1 associated with ventriculoaortic junction dilation. The mean (SD) diameter at this level equaled 27 (3.4) mm on TEE. The most frequent procedure applied in those patients to restore valve function was annuloplasty, which reduces the diameter of the basal ring. The external, internal, or subcommissural annuloplasty was used, depending on the stabilization of the annulus' location. Prolapsing leaflets were managed by leaflet plication or free leaflet edge remodeling, whereas leaflet restriction was treated with triangular resections, a patch, or shaving. Detailed data on the types of procedures performed and TEE findings are presented in TABLE 1.

The durability of aortic valve repair can be predicted based on the reported consensus for hemodynamic parameters and valve morphology.<sup>11</sup> The transaortic peak pressure gradient should not exceed 20 to 25 mm Hg, and the aortic annulus should be smaller than 25 mm in diameter. The effective height should exceed 9 to 10 mm for a BAV, 8 to 9 mm for a TAV, or more than a half of the leaflet height. The surgery was considered successful when no regurgitation was observed or it was reduced to mild (grade 1). In our study group, the average reduction of the basal ring diameter was 10%, the mean (SD) effective height was 11 (2.2) mm, and the mean (SD) geometric height was 22.61 (1.7) mm. In the immediate postoperative period, 1 patient (1.7%) experienced third-degree atrioventricular block and 17 patients (28.8%) required the infusion of pressor amines. One patient (1.7%) presented with grade 3 AI and required valve replacement. No deaths were reported in our study group within 2 years of follow-up.

The undeniable advantages of aortic repair have recently been confirmed in long-term follow-up.<sup>2</sup> The latest state-of-the-art aortic repair (apart from aortic valve leaflet repairs) entails the complex stabilization of the aortic annulus and aortic root, which enhances the durability of the procedure.<sup>2,6,12</sup> Multicenter trials

tracked by the AVIATOR registry have confirmed the efficacy and durability of aortic repair with around 90% of patients free from repeat surgery during follow-up of 10 to 15 years. Nevertheless, the results of aortic valve repair still need further investigation and a comparison with replacement surgery.<sup>5</sup>

We report hemodynamic and anatomical advantages predisposing to the long-term durability of the aortic valve repair. In extensive studies on reconstructive procedures,<sup>2</sup> the ratio of the BAV to TAV patients is 40:60, while our database predominantly contains the BAV repairs (69%). In most of these patients, we observed aortic annulus and ascending aorta dilation at different levels. The inverse proportion of patients undergoing aortic valve repair (BAV > TAV) suggests that many patients with AI are still considered for aortic valve repair, except for young patients with a congenital BAV. They present with complex aortic valve and ascending aorta pathology and are considered much earlier for reconstructive surgery involving valve repair. Our observations confirm that young patients benefit from reconstructive surgery. Aortic valve repair or VSRR with annuloplasty can have more durable effects as it stabilizes the aortic annulus and improves its function, which prevents further dilation.

The latest predictors of repair durability are precise. Specific measurements are taken perioperatively, including effective height, coaptation length, and a ventriculoaortic junction diameter.<sup>2,13</sup> The most recent solid evidence indicates that reparative procedures should play an important role in aortic surgery. However, they should be conducted in cardiac surgery centers that collaborate with multidisciplinary teams with great expertise in surgery, diagnostics, and intensive care.

## ARTICLE INFORMATION

**CONFLICT OF INTEREST** None declared.

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