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# Matching the type of aortic valve-sparing to the aortic root pathology

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The development of aortic valve-sparing operations (AVS) was founded on the knowledge of functional anatomy of the aortic root, the pathophysiology of degenerative disorders of the aortic root and ascending aorta, and already established procedure to address aortic cusps abnormalities (1). We named these procedures AVS to differentiate them from aortic valve repair which implies repairing the aortic cusps, something that may or may not be necessary during AVS. We classified AVS in two basic types: remodeling of the aortic root and reimplantation of the aortic valve (2). Remodeling of the aortic root includes a variety of operative procedures that range from simple correction of the dilated sinotubular junction (STJ) to correct aortic insufficiency (AI) due to outward displacement of the aortic commissures, to more complex operations that involve replacement of one or more aortic sinuses, aortic cusp repair, aortic annuloplasty, and reimplantation of one or both coronary arteries (3). Reimplantation of the aortic valve describes an operation whereby the aortic sinuses and coronary arteries are detached from the aortic root, and the skeletonized aortic valve is sutured inside a tubular Dacron graft and the coronary arteries are reimplanted (3). We believe that each one of these various types of AVS has a place in the surgical armamentarium to treat patients with dilated ascending aorta and aortic root with or without AI.

Echocardiography is the best diagnostic tool to examine the aortic root and determine the feasibility of AVS. The aortic cusps are the most important component to the aortic root and must be carefully interrogated to assess their number, size, thickness, pliability, and excursion

during the cardiac cycle. Cusp prolapse can be seen by echocardiography. Plain computed tomography (CT) scan is probably more accurate than echocardiography to determine the extent of calcification in the aortic cusps. In our experience, even small specks of calcium predict future failure of AVS, particularly in patients with bicuspid aortic valve (BAV). The diameters of the aortic annulus, aortic sinuses, STJ and ascending aorta should be obtained in multiple views as part of preoperative assessment. The final decision as to whether to preserve or to replace the aortic valve is done after opening the aorta and visually inspecting the aortic cusps and other components of the aortic root. The quality of the tissues that make the aortic cusps are the most important component because unlike the aortic annulus, aortic sinuses and STJ, there are limitations on how they can be modified.

The diameter of the normal aortic annulus ranges from 19 to 25 mm in adults (4). Dilatation of the aortic annulus is common in patients with degenerative aneurysms, and probably the most important factor in deciding what type of AVS to use. Dilatation of the aortic annulus causes a mismatch between the area of the aortic orifice and the area that the cusps must seal during diastole. Reduction of the aortic annulus diameter is required to allow the cusps to coapt inside of the aortic root and completely seal the aortic orifice. This can be accomplished by various types of annuloplasty: an internal rigid ring (HAART Aortic Annuloplasty Technologies-BioStable Science & Engineering, Austin, TX, USA), an external annuloplasty band of polyester fabric such as the Extra-Aortic Ring

(Coroneo Inc., Montreal, Quebec, Canada), or by reimplantation of the aortic valve.

### Remodeling of the aortic root

Older patients with large ascending aortic aneurysm and AI frequently have normal aortic annulus diameter (e.g., <25 mm) and the aortic sinuses may only be dilated at the level of the STJ. Replacement of the ascending aorta with reduction in diameter of STJ often corrects AI unless there is concomitant cusp prolapse which can be easily corrected by plication along the nodule of Arantius. This is the simplest type of remodeling of the aortic root and useful in selected patients. The ideal diameter of the STJ can be estimated by pulling the three commissures upward and approximating them centrally until the cusps touch each other. The diameter of the imaginary circle that includes all three commissures is the diameter of graft used to be sutured at the STJ.

If one or more aortic sinuses are aneurysmal, they should be replaced by tailoring the Dacron graft to replace one, two or all three aortic sinuses.

If the aortic annulus is dilated (e.g., >25 mm) or the aortic cusps heights appear insufficient to seal the aortic orifice, an aortic annuloplasty is necessary. If an annuloplasty is deemed necessary, there is evidence that reimplantation of the aortic valve is the best AVS.

### Reimplantation of the aortic valve

Young patients (e.g., <50 years of age) and those with associated genetic syndromes are best treated with reimplantation of the aortic valve. This type of AVS has been the most commonly used and has the longest and most favorable long-term results (5). Patients with BAV and AI frequently have a large aortic annulus and are also best served with reimplantation of the aortic valve (6).

The size of graft used for reimplantation of the aortic valve can be estimated based on the height of the cusps, the diameter of an imaginary circle produced by pulling the three commissures upward as described for remodeling of the aortic root, or the height of the commissure between the left and the non-coronary cusps (which in our experience underestimates the diameter by 2 to 3 mm and is associated with a higher proportion of plication of free margin of the cusps). The type of graft used (straight tube or a graft with

sinuses) remains controversial. We continue to believe that reimplantation of the aortic valve into a tubular Dacron is technically simpler and more predictable than into a graft with preformed sinuses. If one believes that aortic sinuses are important for the durability of the AVS, then the use of a graft one size larger than needed and plication of the graft at the nadir of the cusps and in between commissures at the level of STJ produces correctly shaped neo-aortic sinuses. To date, there is no evidence that creation of aortic sinuses has a beneficial effect on the durability of the AVS (5).

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### Footnote

*Conflicts of Interest:* The author declares no conflicts of interest.

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