

Fate of nonreplaced sinuses of Valsalva in bicuspid aortic valve disease

Chan B. Park, MD,^{a,b} Kevin L. Greason, MD,^a Rakesh M. Suri, MD,^a Hector I. Michelena, MD,^c Hartzell V. Schaff, MD,^a and Thoralf M. Sundt III, MD^a

Objective: There is growing consensus that the ascending aorta should be replaced at the time of aortic valve replacement for bicuspid aortic valve even if it is only moderately dilated; the natural history of nonreplaced sinuses of Valsalva is less clear.

Methods: We identified patients without defined connective tissue disorder undergoing primary aortic valve replacement for bicuspid aortic valve and separate repair of the ascending aorta without root replacement at the Mayo Clinic between January 1, 1988, and December 31, 2007.

Results: Among 218 patients, 65 underwent ascending aortoplasty and 153 underwent separate graft replacement of the ascending aorta. Of the latter group, 15 also had graft replacement of the noncoronary sinus. The mean age at operation was 62 ± 13 years. Valvular dysfunction was predominantly stenosis in 151 patients (70%), regurgitation in 54 patients (25%), and mixed in 12 patients (5%). At a follow-up of up to 17 years (median, 3.3 years; range, 0–17 years), 10 patients (5%) had undergone late reoperation, of whom 1 had replacement of the ascending aorta and 1 had replacement of the root for significant dilatation of the sinuses. Both patients had originally undergone aortoplasty. No other patient required root surgery. One-, 5-, and 10-year freedom from reoperation for any cause were 97.6%, 94.9%, and 85.5%, respectively.

Conclusions: Although progressive ascending aortic dilatation after aortic valve replacement for bicuspid aortic valve is well documented, progressive dilatation of nonreplaced sinuses is not evident. Separate valve and graft repair remains a reasonable surgical option in the setting of aortic valve replacement for bicuspid aortic valve with ascending aortic dilatation provided the sinuses of Valsalva are not significantly enlarged. (*J Thorac Cardiovasc Surg* 2011;142:278-84)

Bicuspid aortic valve (BAV) is the most common congenital valvular heart disease, affecting 0.9% to 2.0% of the general population,¹ and the underlying pathology responsible for aortic valve replacement (AVR) in as many as one third of patients in the United States.² BAV is associated with ascending aortic dilatation and enlargement of the aortic valve annulus in as many as half of all individuals.³⁻⁸ Furthermore, ascending aortic dilatation may progress even after successful AVR.⁹ Because ascending aortic dilatation is a widely recognized risk factor for aortic dissection,¹⁰ and patients with BAV are overrepresented in autopsy series of aortic dissection,¹¹ a more aggressive posture toward replacement of the moderately enlarged ascend-

ing aorta has been advocated in the most recent American College of Cardiology/American Heart Association guidelines for the treatment of valvular heart disease.¹²

Although progressive dilatation of the ascending segment is well documented, the risk of progressive dilatation of the sinuses of Valsalva is less clear. The issue has practical significance because replacement of the sinuses either as part of a composite root replacement or as a full valve-sparing root mandates reimplantation of the coronary arteries. Although these procedures are reported to carry low operative risk by centers with large experience,¹³⁻¹⁵ data suggest that the risk is higher in the community at large. In a study from the Society of Thoracic Surgeons database, the incremental risk ratio associated with root replacement relative to isolated AVR was 2.78.¹⁶ Complications related to coronary artery reimplantation occur, even in experienced hands.¹⁷ The hazards of this approach can be expected to be higher if a particularly aggressive prophylactic approach is advocated in patients even when the sinuses are not particularly enlarged because mobilization and reimplantation of the nondisplaced coronary ostia will be more difficult. Furthermore, if subsequent reoperation is required either because a young patient opts for a bioprosthesis or a mechanical valve becomes infected or obstructed by pannus, reoperative root replacement can be expected to carry a higher risk than reoperative AVR.¹⁸

From the Divisions of Cardiovascular Surgery,^a Mayo Clinic, Rochester, Minn; Department of Thoracic and Cardiovascular Surgery,^b St Paul's Hospital, The Catholic University of Korea, Seoul, Korea; and Divisions of Cardiovascular Medicine,^c Mayo Clinic, Rochester, Minn.

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Address for reprints: Thoralf M. Sundt III, MD, Mayo Clinic, 200 1st St SW, Rochester MN, 55905 (E-mail: sundt.thoralf@mayo.edu).

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Abbreviations and Acronyms

AVR = aortic valve replacement
 BAV = bicuspid aortic valve
 HR = hazard ratio

The alternative procedure to root replacement, a separate valve and graft, obviates the risks associated with coronary reimplantation but leaves the patient at potential risk of subsequent sinus dilatation. A small series previously reported suggested that late complications associated with separate valve and graft were uncommon; however, follow-up was limited.¹⁹ In the interest of further exploring this question with a larger data set over a longer follow-up interval, we examined our institutional experience with the late dilation of nonreplaced sinuses of Valsalva after separate valve and aortic repair in the setting of BAV disease.

MATERIALS AND METHODS

This study was approved by institutional review board of the Mayo Clinic. All patients gave consent for inclusion in clinical research projects, and study specific consent was waived. Patients with BAV undergoing primary separate AVR and repair of the ascending aorta by graft replacement or aortoplasty between January 1, 1988, and December 31, 2007, were identified via search of our prospectively managed, Society of Thoracic Surgeons-compliant computerized clinical database. Patients with defined connective tissue disorders (Marfan syndrome or Ehlers–Danlos syndrome) were excluded, as were those with concomitant procedures on other valves. Perioperative data were collected from the database and retrospective review of medical records, including echocardiographic reports, pathology reports, and all operative records. When possible, aortic root and ascending aortic sizes were determined from preoperative and the most recent echocardiograms. There is no uniform policy at the Mayo Clinic regarding size criteria for replacement of the sinuses, and it is therefore likely that some mildly or even moderately enlarged sinuses were left intact. In more recent years the approach has been more aggressive, including replacement of the noncoronary sinus when enlarged with a tongue extension of graft material (Figure 1). Long-term follow-up information was obtained by postal survey.

Statistical Analysis

Descriptive statistics were presented as mean \pm standard deviation for continuous variables and frequency and percentage for categorical variables. Preoperative and postoperative aortic root sizes were compared by paired *t* test. Kaplan–Meier method was used to draw survival curves and calculate 5- and 10-year survival statistics and freedom from reoperation. Cox regression models were used to find the univariate and multivariate predictors of survival. Variables significant by univariate analysis ($P < .05$) were considered in the multivariable model, with model selection using the stepwise method (backward and forward methods resulted in the same model). All statistical tests were 2 sided with the alpha level set at 0.05 for statistical significance. Analysis were performed using SAS (SAS Institute Inc, Cary, NC).

RESULTS

The mean age at the time of surgery was 61.5 (\pm 13.0) years (Table 1). Male patients predominated (75%). Of note, 55% were smokers, 61% had hypertension, and

61% had hypercholesterolemia. Only 8 patients (3.7%) had a history of aortic coarctation. The dominant functional valvular disease was stenosis in 70% of patients and insufficiency in 25% of patients. The pattern of cusp fusion by echocardiography or observation at the time of operation was left and right cusp fusion in 132 patients (84%), right and noncoronary cusp fusion in 24 patients (15%), and left and noncoronary cusp fusion in 2 patients (1.3%). Eighty-eight percent of patients had an identifiable raphe, and 64% of patients had asymmetric cusps. Unfortunately, data were not collected prospectively with regard to root dimensions or phenotype.

Operative

As shown in Table 2, at surgery 153 patients underwent graft replacement of the ascending aorta and 65 patients underwent ascending aortoplasty. The choice between these procedures, as was the choice between separate valve and graft versus root replacement, was by the operating surgeon and not by strict diameter criteria. There is no uniform institutional policy with regard to the procedure performed, although aortoplasty is currently less common. Among patients with graft replacement of ascending aorta, the noncoronary cusp was replaced or repaired in 15 patients (6.9%) because of asymmetric enlargement. Concomitant hemi-arch or total aortic arch replacement was performed in 13 patients (6.0%). Mechanical and biological prostheses were used in equal numbers. The mean age was 67 \pm 13 years for those receiving biological prostheses and 56 \pm 10 years for those receiving a mechanical valve. During this same time interval, 147 patients with BAV underwent full root replacement.

Early Outcome

The operative mortality was 2.8% (6 patients). Fourteen patients underwent reoperation for bleeding (6.6%). Postoperative intraaortic balloon pump support was used in 8 patients (3.8%), and 19 patients required ventilation for more than 24 hours (9.0%). Three patients (1.4%) had transient ischemic attacks, and 5 patients (2.4%) had permanent stroke. Three patients had postoperative renal failure with an increase of serum creatinine to greater than 2.0 mg/dL or a doubling of the preoperative creatinine, or the institution of dialysis (1.4%). Two patients had postoperative sepsis (0.9%).

Late Outcomes

The follow-up was to a maximum of 17.2 years, with a median of 3.3 years. The completeness of follow-up by Clark's equation²⁰ was 79%. During follow-up, 10 patients underwent late reoperation for a variety of indications (Table 3). There were no late reoperations for aortic root dissection or rupture. A 67-year-old male patient who had undergone AVR for aortic stenosis and reduction aortoplasty, as well

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