Long-term prognosis of ascending aortic aneurysm after aortic valve replacement for bicuspid versus tricuspid aortic valve stenosis

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Objective: The bicuspid aorta is thought to have a higher risk of progressive dilation after aortic valve replacement with a subsequently increased risk of adverse aortic events. Our aim was to compare the risk of late aortic events after isolated aortic valve replacement surgery for bicuspid versus tricuspid aortic valve stenosis with concomitant mild to moderate dilatation of the proximal aorta.

Methods: A total of 325 consecutive patients (60% males; mean age, 59.5 ± 10 years) with aortic valve stenosis and concomitant ascending aortic dilatation of 40 to 50 mm underwent isolated aortic valve replacement from 1995 through 2000. A total of 153 patients (47%) were diagnosed with bicuspid aortic valve stenosis (bicuspid aortic valve group), whereas the remaining 172 patients (53%) had tricuspid aortic valve stenosis (tricuspid aortic valve group). Follow-up (3566 patient-years) was 100% complete. Adverse aortic events were defined as the need for proximal aortic surgery or the occurrence of aortic dissection/rupture or sudden death during follow-up.

Results: Overall survival was 78 ± 4% in the bicuspid aortic valve group versus 55 ± 6% in the tricuspid aortic valve group ($P = .006$) at 15 years postoperatively, but age-adjusted survival was not significantly different between groups ($P = .4$). A total of 5 patients (3%) in the bicuspid aortic valve group versus 9 patients (5%) in the tricuspid aortic valve group underwent proximal aortic surgery during follow-up. Aortic dissection occurred in 3 patients in the tricuspid aortic valve group and in no bicuspid aortic valve patients. Fifteen-year freedom from adverse aortic events was 93 ± 3% in the bicuspid aortic valve group versus 82 ± 6% in the tricuspid aortic valve group ($P = .2$).

Conclusions: Patients with bicuspid and tricuspid aortic valve stenosis with concomitant mild to moderate ascending aortic dilatation are at comparably low risk of adverse aortic events 15 years after isolated aortic valve replacement. (J Thorac Cardiovasc Surg 2014;147:276-82)

The bicuspid aorta has been proposed to dilate progressively after isolated aortic valve replacement (AVR) at an accelerated rate, a process that is followed by an increased risk of adverse aortic events.[1,2] The explanation for this phenomenon has been based predominantly on the genetic hypothesis of aortopathy in bicuspid aortic valve (BAV) disease.[2-4] The widespread popularity of the genetic theory, which considers BAV aortopathy a congenital disorder of vascular connective tissue, has led to more aggressive treatment recommendations of the proximal aorta in such patients, approaching aortic management recommendations of Marfan syndrome.[5,6] However, such an aggressive surgical treatment strategy of BAV aortopathy has been questioned by some investigators.[7]

Recent in vitro and in vivo studies brought major advances in the understanding of BAV function[8,9] and provided hemodynamic insight into the different clinical forms of BAV disease.[10,11] In the face of these recent important findings, the reevaluation of clinical data on bicuspid aortopathy is appropriate. Considering the heterogeneity of BAV disease,[12,13] clinical research should also take into account the distinct homogeneous patient subgroups. We therefore restricted our analysis to 1 clinically relevant subgroup of BAV patients—those with bicuspid valve stenosis and mild to moderate dilatation of the proximal aorta who underwent isolated AVR surgery.

Our aim was to compare the risk of late aortic events after isolated AVR for bicuspid versus tricuspid aortic valve stenosis with concomitant mild to moderate dilatation of the proximal aorta using long-term follow-up.

METHODS

We reviewed our institutional valve surgery database to identify all patients who underwent isolated AVR for predominant/pure aortic valve stenosis with concomitant ascending aortic dilatation of 40 to 50 mm between January 1995 and January 2001 at the Central Hospital Bad Berka. A total of 1095 patients underwent an isolated AVR surgery during the study period (255 BAV patients and 840 tricuspid aortic valve [TAV] patients). Concomitant replacement of the proximal aorta was required in 110 patients with dilatation of the ascending aorta >50 mm (53 BAV patients and 57 TAV patients). Patients with mixed aortic valve lesions were included only if valve stenosis was the predominant lesion (ie, patients with a severe stenosis and mild to moderate aortic valve insufficiency were assigned to

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Abbreviations and Acronyms
AVR = aortic valve replacement
BAV = bicuspid aortic valve
TAV = tricuspid aortic valve

the stenosis subgroup). Patients who underwent AVR surgery after 2001 were not included to have an adequate long-term follow-up (ie, at least 10 years post-AVR).

A total of 325 consecutive patients with predominant/pure aortic valve stenosis and concomitant ascending aortic dilatation of 40 to 50 mm underwent isolated AVR surgery during the study period. Patients with bicuspid aortic valve stenosis (BAV group, n = 153) were identified and compared with those with tricuspid valve stenosis (TAV group, n = 172). The valve was identified as bicuspid or tricuspid based principally on intraoperative direct inspection (discussed later). Study approval was obtained from the local ethics committee. Individual patient consent was waived.

The primary end point of our study was freedom from late adverse aortic events in the BAV group versus the TAV group. Adverse aortic events were defined as the need for proximal aortic surgery or the occurrence of aortic dissection/rupture or sudden cardiac death during long-term follow-up.

Definitions and Measurements

The morphology and function of the aortic valve was assessed by preoperative echocardiography in all patients. The BAV was suspected if 2-dimensional short-axis imaging of the aortic valve demonstrated the existence of only 2 commissures delimiting 2 aortic valve cusps. The final decision regarding the bicuspidality or tricuspidality of the aortic valve, however, was made based on the intraoperative description of valve morphology by the surgeon. Aortic valve stenosis was defined using the uniform and validated Doppler-based echocardiographic measurements.

The diameter of the proximal aorta was measured preoperatively by means of transthoracic 2-dimensional echocardiography and routine aortic angiography during cardiac catheterization. Multiple echocardiographic measurements of the maximal diameter of the ascending aorta were performed in systole using a parasternal long-axis view. Moreover, proximal aortic dimensions were measured at multiple sites on aortic angiography and the maximal aortic diameter was recorded. A proximal aortic diameter of 40 mm was our cutoff value for defining dilatation of the aorta. In the current study, we used the maximal diameter of the proximal aorta, which was the supracoronary portion in the vast majority of our study population. Therefore, this measure is restricted mostly to the ascending portion of the proximal aorta. All patients with a dilated proximal aorta, as diagnosed in these screening examinations, underwent subsequent preoperative computed tomography or magnetic resonance angiography of the thoracic aorta. Moreover, the maximal diameter of the proximal aorta was measured routinely intraoperatively (ie, using a caliper) before going on pump. The proximal aorta was defined as normal size only if all 3 measurements (ie, echocardiography, aortic angiography, and intraoperative measurement) described the aortic diameter consistently of <40 mm. If a proximal aortic aneurysm >50 mm in maximal diameter was observed, then simultaneous aortic surgery was performed. In all remaining patients with a proximal aortic diameter of 40 to 50 mm, isolated AVR was performed.

Arterial hypertension was defined as a systemic blood pressure of >140/90 mm Hg recorded at multiple measurements and/or evidence of long-standing systemic hypertension treated by medication before AVR. Systemic hypertension was treated by medication in 80% of the study patients.

Study Population

Demographics and intraoperative variables of both study groups are displayed in Table 1. Patients in the BAV group were significantly younger and less symptomatic compared with the TAV group. Moreover, there was a clear predominance of male patients in the BAV group. More important, no significant difference in the diameter of ascending aorta was found between the study groups at the time of AVR surgery.

All 325 patients underwent conventional isolated AVR surgery through a median sternotomy or partial upper L-ministernotomy using standard cardiopulmonary bypass and moderate systemic hypothermia. Intraoperative management was uniform without any major changes over time. The intraoperative variables of both study groups are presented in Table 2. Aortic crossclamp time and cardiopulmonary bypass time tended to be longer in the BAV group. Moreover, a mechanical valve prosthesis was implanted more frequently in the BAV group compared with the TAV group. There was a tendency toward an implantation of a larger prosthesis size in the BAV group.

Follow-up

Our follow-up protocol consisted of a telephone interview with the patients, their family members, and/or the patients' general practitioners. All imaging data obtained during the postoperative course (echocardiography reports, computed tomographic scans/magnetic resonance angiographic images) were obtained from patients' cardiologists or general practitioners and were entered into our database. There was no standard follow-up protocol for aortic imaging in the current study. Surgical notes were obtained on all patients who underwent redo cardiac surgery. A total of 62 patients (19%) were treated for noncardiac reasons in our hospital during the postoperative course and their medical records were obtained for follow-up. All medical records of patients who died in external hospitals were forwarded on request to our hospital. In all cases of out-of-hospital death, we aimed to confirm or exclude sudden cardiac death. In a total of 35 patients (11%) in whom no contact details were available, a telephone book-based search was performed.

Statistical Analysis

Standard definitions were used for patient variables and outcomes. Categorical variables are expressed as percentages, and continuous variables are expressed as mean ± standard deviation with range. All statistical analyses were performed with the IBM SPSS 19.0 software (IBM Corp, New York, NY). Survival analysis was performed according to the methods of Kaplan-Meier, and statistical differences were analyzed using the log-rank test. Age-adjusted survival was compared using the log-rank test. A multivariable analysis (ie, Cox regression) of risk factors for adverse aortic events was performed. All variables were screened initially in the univariate model and were considered for clinical relevance before including them in the multivariate model.

RESULTS

Perioperative Results

The in-hospital outcomes are summarized in Table 3. In-hospital mortality was comparable between the study groups (ie, 0.7% in the BAV group vs 2.3% in the TAV group, $P = .3$). Two patients (1 patient in the BAV group and 1 patient in the TAV group) died suddenly on the surgical ward, most probably as a result of a fatal arrhythmia. An autopsy examination was performed in both cases without evidence of aortic dissection or rupture. One patient in the TAV group died of major stroke 3 days after AVR surgery. Two additional patients in the TAV group