Valve-preserving root replacement in bicuspid aortic valves

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Objective: Bicuspid aortic valve anatomy is associated with aortic root aneurysm in a relevant proportion of patients. These patients require root replacement for prognostic reasons, and the valve may be preserved. The objective of this analysis is to analyze the early and late outcomes of root remodeling for bicuspid aortic valve.

Methods: Between November 1995 and December 2009, 153 patients (133 male) were treated by root remodeling in the presence of a bicuspid aortic valve. Acute dissection was present in 6 individuals. In 137 instances, additional correction of cusp pathology was achieved by plication (n = 119), triangular resection (n = 59), and implantation of a pericardial patch (n = 27). Follow-up ranges from 3 months to 14.5 years (mean, 4.9 ± 3.8 years; cumulative, 757 years) and is complete in 99.3%.

Results: One patient died of intracranial hemorrhage in the hospital (mortality 0.7%). Survival at 5 and 10 years was 99% and 91%, respectively. Seven patients required reoperation for stenosis (n = 1) or recurrent aortic insufficiency (n = 6) between 1 month and 11 years postoperatively. The aortic valve was re-repaired in 2 cases. Freedom from reoperation at 5 and 10 years was 95%; freedom from valve replacement was 97%. Freedom from valve-related complications was 91% at 5 and 10 years.

Conclusions: Root remodeling for aortic root aneurysm in the presence of a bicuspid aortic valve can be performed with a low morbidity and mortality. The long-term stability of the reconstructed aortic valve is excellent if normal valve configuration is achieved. The occurrence of late stenosis seems to be rare, and freedom from valve-related complications is high. (J Thorac Cardiovasc Surg 2010;140:S36-40)

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Concomitant cardiovascular disease was present in 44 individuals (29%), that is, coronary artery disease (n = 15), mitral regurgitation (n = 1), arch aneurysm (n = 25), or permanent atrial fibrillation (n = 4).

Operative Technique

The technique has been described in detail. In all operations, the chest was opened by a median sternotomy. In acute dissection, either the right femoral (n = 2) or right axillary artery (n = 4) was used for arterial inflow. The aorta was completely transected above the commissures and mobilized. Graft size was chosen smaller than the aorta-ventricular diameter, taking the body surface area (BSA) of the patient into consideration. Generally, a 26-mm graft was chosen for a BSA less than 2 m², and a 28-mm graft was chosen for larger patients. The graft was tailored to accommodate the asymmetry of the root, with a large tongue for the sinus of the nonfused cusp and 2 smaller tongues for the rudimentary sinuses. In the last 2 years, we have tended to create 2 almost symmetric tongues for a 170- to 180-degree orientation of the 2 normal commissures of the nonfused cusp tissue. If more extensive aortic replacement (ie, arch) was required, it was opened by a median sternotomy. In acute dissection, either the right femoral (n = 4) or total (n = 22) incision was used for arterial inflow.

For correction of cusp pathology, the large normal cusp (commonly the noncoronary) was used as reference. The edges of the normal and fused cusps were aligned before performing root remodeling, and prolapse of the fused cusps was corrected by placing central plicating sutures on the free margin. In June 2004, we realized that root replacement could induce prolapse by reducing intercommisural distance; we also recognized that preexisting prolapse of the noncoronary cusp could be present, and we therefore modified the procedure. Since then, root replacement has been performed first to create the final root configuration as a prerequisite for assessment of cusp configuration. After completion of remodeling, the graft was cut 10 to 20 mm above the commissures, and the aortic valve was inspected carefully. The effective height of the normal cusp was measured with radial and upward tension on the commissures; the effective height was increased to 10 mm by central plication sutures on the free margin. The free margins of the nonfused and the fused cusps were then aligned. Redundancy of the free margin of the fused cusps was eliminated by central plication (n = 119) or triangular resection, and readaptation (n = 59). If more extensive calcifications were present in the raphe, the tissue was excised and replaced by a patch of autologous pericardium if more extensive calcifications were present in the raphe, the tissue was excised and replaced by a patch of autologous pericardium. He underwent uneventful reoperation after 3 hours and a normal neurologic status.

During follow-up, 4 patients died between 8 months and 9 years postoperatively. All had shown stable valve function during scheduled follow-up visits, and the cause of death could not be determined. Survival was 99% and 91% at 5 and 10 years postoperatively, respectively.

Increasing aortic regurgitation developed in 10 patients during follow-up. Six patients required reoperation for clinical or echocardiographic signs of left ventricular volume overload. At reoperation, the cause of failure was symmetric prolapse (n = 2), suture line dehiscence after plication (n = 1), or partial cusp replacement (n = 3). The valve was re-repaired in 2 patients and replaced in the other 4 patients. The remaining 4 patients have remained stable and asymptomatic. Freedom from aortic regurgitation grade 2+ or higher is 95% at 5 years and 90% at 10 years. Aortic stenosis was observed in 1 patient 11 years after the initial procedure, which had included removal of a calcific plaque from the noncoronary cusp. He underwent uneventful reoperation and valve replacement.

Freedom from reoperation is 95% at both 5 and 10 years (Figure 2); freedom from valve replacement is 97% at 5 and 10 years postoperatively (Figure 3). Four thromboembolic events were observed between 3 weeks and 3 months postoperatively. In 2 events, this was apparently related to paroxysmal atrial fibrillation, and in the other 2 events, no additional disease could be found. There were no episodes of endocarditis throughout the follow-up period. Freedom from all valve-related

Abbreviations and Acronyms

BAV = bicuspid aortic valve
BSA = body surface area

RESULTS

Mean myocardial ischemic time was 75 ± 14 minutes, and duration of extracorporeal circulation was 100 ± 26 minutes. For isolated remodeling without a concomitant procedure, mean ischemic time was 70 ± 7 minutes.

One 38-year-old patient died in the hospital, for a mortality of 0.7%. He had undergone elective surgery with extubation after 3 hours and a normal neurologic status. On postoperative day 1, an intracranial hemorrhage developed from a previously undiagnosed cerebral aneurysm and he died the same day. Early morbidity included reexploration for bleeding (n = 4) and atrioventricular block requiring implantation of a pacemaker (n = 1).

Statistical Analysis

All data are presented as mean ± standard deviation. Kaplan–Meier curves were calculated for freedom of relevant regurgitation, freedom from reoperation, and freedom from valve replacement using a commercially available software package (Prism, GraphPad Inc, San Diego, CA).
THE OCCURRENCE OF AORTIC DILATATION IN CONJUNCTION WITH BICUSPID ANATOMY OF THE AORTIC VALVE HAS BEEN STUDIED MORE EXTENSIVELY IN THE PAST DECADE. AORTIC ANEURYSM HAS BEEN SHOWN TO OCCUR IN APPROXIMATELY 60% OF INDIVIDUALS WITH THIS ANATOMIC VARIANT IRRESPECTIVE OF THE PRESENCE OR TYPE OF HEMODYNAMIC DYSFUNCTION OF THE AORTIC VALVE.14,15 DIFFERENT PATTERNS OF AORTIC DILATATION HAVE BEEN DESCRIBED,3,16 AND THE PATTERNS HAVE BEEN LINKED TO THE FUSION TYPE OF THE AORTIC VALVE.4,17 NOTABLY, THE DISTRIBUTION OF FUSION PATTERN IN OUR PATIENTS WAS SIMILAR TO THAT PUBLISHED FOR BAVS IN GENERAL.18 Thus, we cannot confirm the proposed relationship between aortic dilatation and fusion pattern.4

The prognostic impact of aortic dilatation has been increasingly recognized19 and has resulted in the lowering of thresholds for prophylactic surgery compared with aneurysms and tricuspid aortic valves.20,21 It is, however, unclear whether the diameter of the root should be considered different from that of the tubular ascending aorta. We believe that replacement of a moderately enlarged root helps to stabilize the aortic valve if repair is performed. Thus, we consider a root diameter of more than 40 to 44 mm, depending on the BSA of the patient, as a cutoff in favor of root replacement. Further information will be necessary to guide surgical decision-making.

The conventional standard treatment for a diseased BAV and aortic dilatation has been composite replacement of the valve and root. A large series treated this way was published recently.22 Our current population seems generally comparable, with a similar mean age (51 vs 53 years) and similar follow-up (mean 4.9 vs 5.9 years). The current 10-year survival is similar to that reported. The authors described a stroke rate of 0.7% per patient year and hemorrhagic complications of 0.5% per patient year. Cumulative freedom from valve-related complications was not stated, and complete follow-up was available in only 88% of the patients.22
Our current data compare favorably with this large series. Even though a learning curve is included in our series, freedom from reoperation is also identical with that reported in another large series with 2 replacement strategies in a less selected patient population.

Both forms of valve-preserving aortic replacement have been used in the context of BAVs: root remodeling and valve reimplantation.7,11,24 At this time there is no specific published information regarding long-term results of valve reimplantation in the setting of bicuspid anatomy. We have consistently chosen root remodeling for this scenario,11 and the current results seem to support this approach. We cannot, however, determine the superiority of one approach over the other. We have not seen progressive dilatation of the aortoventricular junction as risk factor for valve failure or re-operation, indicating sufficient stabilization of that structure by remodeling. An important cause for failure was iatrogenic prolapse induced by reduction of root size,11 which has largely been avoided since the introduction of the effective height concept.12 Limited calcifications of the aortic cusps may be seen as another risk factor. Simple removal of the calcium may be associated with late development of stenosis, as seen in 1 of our patients. We have also observed the need for reoperation in 3 of 27 individuals in whom the calcified cusp tissue was replaced with a pericardial patch. Thus, with longer follow-up and more experience, we may have to reconsider our previous observations on the safety of patch implantation in the setting of BAV.11

The limitations of the current analysis are primarily due to the lack of a matched control group. Because most of our patients are referred for valve repair, generation of a prospective control, ideally in the form of randomization, has been and will be psychologically difficult. Despite the size of the patient cohort studied, the number of individuals is still small compared with large valve trials, and only a limited proportion of our patients have exceeded 10 years of follow-up. Finally, at this time there is no information on ‘‘very long’’ follow-up, that is, exceeding 20 years. This will be important to determine the true long-term role of preservation of BAVs.

CONCLUSIONS

Root remodeling for root aneurysm in the presence of a BAV can be performed with low morbidity and mortality. Long-term stability of the reconstructed aortic valve is excellent if normal valve configuration is achieved. The occurrence of late stenosis seems to be rare, and freedom from valve-related complications is high. Valve preservation for the combination of regurgitant BAV and root aneurysm seems to be at least equivalent to composite replacement.

References


