Predictors of early and medium-term outcome of 200 consecutive aortic valve and root repairs

Marek J. Jasinski, MD, PhD, Radoslaw Gocol, MD, Marcin Malinowski, MD, Damian Hudziak, MD, Piotr Duraj, MD, and Marek A. Deja, MD, PhD

Objectives: Advantages of aortic valve repair and root reconstruction include maintenance of natural valve hemodynamic parameters and avoidance of prosthetic valve-related complications. However, general acceptance of valve reconstruction may be limited by paucity of long-term follow-up data from only a few centers. This report is intended to supplement existing outcome information for aortic valve repair.

Methods: Between 2003 and 2013, 200 consecutive patients (149 men, 51 women; mean age, 52.1 years) with significant aortic regurgitation and aortic root enlargement underwent aortic valve repair and associated root reconstruction. The same prospective selection criteria and systematic valve repair approaches were followed throughout the study. Root management consisted of either root remodeling or reimplantation with Dacron prostheses. Kaplan-Meier techniques were used to assess major end points of all-cause mortality, reoperation, and repair failure. Univariable log-rank testing was used to identify associations between risk factors and major events.

Results: Early mortality was 2% (4 patients), and early repair failure was 3% (6 patients). New York Heart Association functional class was found to be a risk factor for early mortality and morbidity (odds ratio, 3.3; $P = .03$), whereas crossclamp time and cardiopulmonary time were risk factors for early mortality (odds ratio, 1.04; 95% confidence interval, 1-1.07; $P = .01$ and odds ratio, 1.02; 95% confidence interval, 1-1.03; $P = .02$), respectively. Survival at a mean follow-up of 48.6 $\pm$ 34.3 months (median follow-up, 43.6 months; range, 17.8-78 months) was 94%, with a freedom from reoperation of 91%. Univariable risk factors for mortality were preoperative New York Heart Association functional class and requirement for root replacement. Repair failure and reoperation were associated with bicuspid valve anatomy, subcommissural annuloplasty, and complex leaflet repair. Freedom from repair failure was associated with aortic reimplantation.

Conclusions: Data from a prospective cohort of patients undergoing aortic valve repair and root reconstruction reinforce the satisfactory medium-term results obtained with valve reconstruction. Further analysis of these patient outcomes is necessary to draw definitive conclusions on operative techniques. (J Thorac Cardiovasc Surg 2015;149:123-9)

See related commentary on pages 129-30.

Interest in aortic valve repair during aortic root reconstruction is increasing, and valve-sparing operations, as introduced by David and colleagues,[1,2] Yacoub and colleagues,[3] and others,[4] are being more commonly applied. Leaflet repair techniques, such as central leaflet plication, are becoming standardized[5-8] and have contributed significantly to improving results. Other important developments include a classification of aortic regurgitation (AR),[9,10] echocardiographic standardization,[11] and a better understanding of bicuspid valve anatomy.[12] Nonetheless, application of aortic valve repair is lagging. One potential cause of individual surgeon reluctance could be the still limited amount of long-term data that have been generated—and those data only in a few centers. The purpose of our study was to examine a single-center experience with aortic valve repair over 10 years to further clarify future application of aortic valve and root reconstruction.

METHODS

Patient Population

Two hundred consecutive patients undergoing aortic-valve-sparing surgery for chronic AR and/or associated root aneurysm from 2003 to 2013 were enrolled prospectively into the study. Only emergent patients were excluded. All patients without significant preoperative stenosis or poor leaflet tissue quality in the form of large areas of fibrosis, calcifications, and restriction as well as large fenestrations precluding aortic repair were preselected for repair/sparing procedure. They constitute one-third of all patients with root procedures. Preoperative transthoracic echocardiographic and transesophageal echocardiographic examinations

From the Department of Cardiac Surgery, Medical University of Silesia, School of Medicine, Katowice, Poland.

Disclosures: Authors have nothing to disclose with regard to commercial support.

Read at The American Association for Thoracic Surgery Aortic Symposium 2014, New York, New York, April 24-25, 2014.

Received for publication June 18, 2014; revisions received Aug 6, 2014; accepted for publication Aug 18, 2014; available ahead of print Oct 13, 2014.

Address for reprints: Marek J. Jasinski, MD, PhD, Department of Cardiac Surgery, Medical University of Silesia, Ziolowa 47, 40-635 Katowice, Poland (E-mail: marekjas@poczta.onet.pl).

0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2014.08.057

Abbreviations and Acronyms
AR = aortic regurgitation
NYHA = New York Heart Association
STJ = siontubular junction
STS = Society of Thoracic Surgeons
VAJ = ventriculoaortic junction

were performed according to a defined protocol. The type of AR was systematically described, patients suitable for repair were identified, and surgical procedures were performed according to a consistent approach. Operative characteristics, as well as early postoperative outcomes, were recorded prospectively using a preestablished data set.

Echocardiography and Patient Selection

Transthoracic echocardiograms were obtained preoperatively, and then at 1 month following surgery. Subsequently, transthoracic echocardiograms were performed at 1 year according to guidelines published by the American Society of Echocardiography, Society of Cardiovascular Anesthesiologists, and European Society of Echocardiography.[11] A thorough transesophageal echocardiographic examination was performed after induction of general anesthesia (before cardiopulmonary bypass), and then repeated at the end of the procedure. Required echocardiographic views (parasternal long axis and apical 4 and 5 chamber) with prespecified 2-dimensional cine loops were recorded, as were M-mode and Doppler data.

Patients were selected for aortic valve repair on the basis of echocardiographic findings, taking into account magnitude and character of AR, occurrence and location of leaflet prolapse, direction of the resulting AR jet, specific bicuspid anatomy, pliability/calcification of leaflets, annular size, sinotubular junction (STJ) dimensions, and aortic diameters. Aortic root dilatation was defined as significant at a sinus diameter in diastole measured above 4.5 cm in bicuspid and 5.0 cm in tricuspid anatomy, according to current recommendations.[13]

Surgical Management

All operations were performed through a median sternotomy, with standard cardiopulmonary bypass, in normothermia, with cannulation of the ascending or arch aorta and right atrium, and superior pulmonary vein venting. Myocardial protection was accomplished with anterograde cold blood cardioplegia and maintained with anterograde direct coronary reinfusion every 20 minutes. The ascending aorta was opened transversely, 1.5 cm above the tops of the commissures. For valve assessment, 3 stay sutures of 4-0 Prolene (Ethicon Inc, Somerville, NJ), were placed above the highest point of each commissure and positioned under tension. First, effective height of each leaflet was evaluated,[14,15] as were central leaflet coaptation and individual leaflet prolapse. Second, the relative lengths of leaflet free margins were assessed with the Frater technique[16]; that is, suturing 3 noduli arantii together and identifying leaflets with disparately stretched, elongated segments producing prolapse.[17-19]

Type of repair was defined by the functional classification of El Khoury and colleagues.[9] Morphologic criteria were added to specify groups of different surgical techniques. Sizes of aortic root in those groups are presented in Table 1.

Type 1: Functional Aortic Annulus Enlargement Causing Central AR

STJ and aortic enlargement. STJ remodeling was performed with the size of aortic prosthetic graft equal to ventriculoaortic junction (VAJ) diameter. The anastomosis between root and the Dacron graft involved equal spacing between commissures.

STJ and sinuses of valsalva enlargement. Root remodeling was performed with separate sinuses replacement. Aortic prosthetic graft size was selected to be equal to VAJ diameter, which per definition ought to be 28 mm or less.

VAJ enlargement. Subcommissural annuloplasty was performed with 2-0 braided sutures with pledgets, including the middle third of the subcommissural triangles.

STJ, aortic root, and VAJ enlargement. Initially, David I valve reimplantation was employed, with a straight Dacron graft sized 2-4 mm larger that the desired STJ, measured over a Freestyle sizer (Metronic, Minneapolis, Minn), to produce satisfactory leaflet apposition. Since 2009 a modified reimplantation technique was employed, with a Valsalva conduit (Gelweave Valsalva; Vascutek, Inchinnan, Scotland) reproducing different shape and size of aortic root. Dacron prosthesis size was based on the height of commissures being the same as diameter in Valsalva conduit, with the nonleft coronary commissure chosen as the point of reference. During the reimplantation procedures, 10 to 12 2-0 pledgeted horizontal mattress sutures formed a proximal suture line at the ventriculoaortic junction, and a second outflow line was created with 3 running 4-0 Prolene sutures, starting from nadirs of each neosinus up to the highest commissural fixation.

Type 2: Leaflet Prolapse and Eccentric AR

With leaflet prolapse, 2 techniques were chosen: 7-0 Gore-Tex (W. L. Gore & Associates, Inc, Flagstaff, Ariz) free edge stabilization and leaflet plication. The first technique began with suturing the Gore-Tex suture to the aorta at the commissure of the prolapsing leaflet, and then running a locking stitch along the free edge, referencing the length reduction required to the normal adjacent leaflet. Leaflet plication relied on free margin length assessment, and excess and prolapsing leaflet tissue was plicated centrally with 7-0 Prolene.[16] Complex repair was defined as application of >1 techniques for leaflet management.

Bicuspid Valve Disease

Usually subcommissural annuloplasty was performed combined with raphe excision and autologous pericardial patch reconstruction. Gore-Tex leaflet stabilization or leaflet plication was added as necessary to correct prolapse,[17] and additional root stabilization was performed with a remodeling straight aortic graft (Figure 1).

After aortic valve repair, the height of coaptation was considered acceptable if it was ≥4 mm on transesophageal echocardiography. Mild regurgitation (grade 1) was defined by vena contracta <3 mm, central jet with ratio to left ventricular outflow tract width of below 25%, and normal flow pattern in descending aorta. Moderate residual regurgitation (grade 2) was diagnosed in presence of vena contracta of 3 to 6 mm and jet to left ventricular outflow tract ratio between 25% and 65%. These could be accompanied by some degree of diastolic flow reversal in descending aorta but with end-diastolic velocity lower than 20 cm/sec. Higher values of the listed parameters would indicate severe residual regurgitation (grade 3). Finally, transvalvular gradients were determined with continuous wave Doppler.

Data Acquisition and Analysis

Baseline demographic, clinical, and echocardiographic data were recorded prospectively. Operative and follow-up data subsequently were collected directly and by review of patient records. As a part of the prospective study, all patients were scheduled for clinical and echocardiographic follow-up at 1 month and at 6 months to 1 year. All 200 patients operated between 2003 and 2013 were identified and included in the follow-up study. Follow-up data also were confirmed through the national registry, and 100% completeness of primary end point data could be