Long-term survival, valve durability, and reoperation for 4 aortic root procedures combined with ascending aorta replacement

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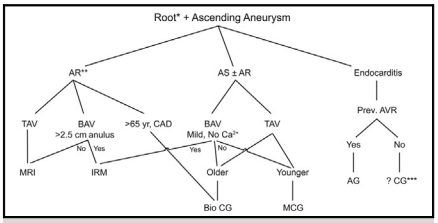
ABSTRACT

Objective: To evaluate long-term results of aortic root procedures combined with ascending aorta replacement for aneurysms, using 4 surgical strategies.

Methods: From January 1995 to January 2011, 957 patients underwent 1 of 4 aortic root procedures: valve preservation (remodeling or modified reimplantation, n = 261); composite biologic graft (n = 297); composite mechanical graft (n = 156); or allograft root (n = 243).

Results: Seven deaths occurred (0.73%), none after valve-preserving procedures, and 13 strokes (1.4%). Composite grafts exhibited higher gradients than allografts or valve preservation, but the latter 2 exhibited more aortic regurgitation (2.7% biologic and 0% mechanical composite grafts vs 24% valve-preserving and 19% allografts at 10 years). Within 2 to 5 years, valve preservation exhibited the least left ventricular hypertrophy, allograft replacement the greatest; however, valve preservation had the highest early risk of reoperation, allograft replacement the lowest. Patients receiving allografts had the highest risk of late reoperation ($P < .05$), and those receiving composite mechanical grafts and valve preservation had the lowest. Composite bioprosthesis patients had the highest risk of late death (57% at 15 years vs 14%-26% for the remaining procedures, $P < .0001$), because they were substantially older and had more comorbidities ($P < .0001$).

Conclusions: These 4 aortic root procedures, combined with ascending aorta replacement, provide excellent survival and good durability. Valve-preserving and allograft procedures have the lowest gradients and best ventricular remodeling, but they have more late regurgitation, and likely, less risk of valve-related complications, such as bleeding, hemorrhage, and endocarditis. Despite the early risk of reoperation, we recommend valve-preserving procedures for young patients when possible. Composite bioprostheses are preferable for the elderly. (J Thorac Cardiovasc Surg 2016;■:1-12)



Current Cleveland Clinic treatment algorithm for root and ascending aortic aneurysm.

Central Message

Aortic valve-preserving root procedures are recommended for young patients; composite bioprostheses are reasonable for the elderly.

Perspective

Four aortic root procedures combined with ascending aorta replacement—valve preservation, mechanical or biologic composite grafts, and allografts—provide excellent survival and good durability. Valve-preserving and allograft procedures have the lowest gradients, but more late regurgitation. We recommend valve-preserving procedures for young patients; composite bioprostheses are reasonable for the elderly.

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In the past, a Bentall operation, which incorporates an artificial aortic valve within an ascending aorta tube graft, was the standard treatment for various combined aortic root and ascending aorta pathologies.[1] Initially, the valve was mechanical (“composite grafts”), but bioprostheses were eventually introduced,[2] as were allografts,[3] for combined aortic root and ascending aorta replacement. Over the past 25 years, David and colleagues[4] have championed a variety of valve-preserving techniques. It remains uncertain, however, which of these techniques—older or newer—is the right one for the right patient at the right time.[5-7]

In a previous comparison of appropriate root procedures (modified reimplantation for tricuspid aortic valves and remodeling for bicuspid ones) versus a biologic composite valve, we showed that modified reimplantation exhibited superior durability after 9 to 10 years, compared with remodeling, which showed better durability after 10 to 12 years.[5] Furthermore, bicuspid valve repair—40% combined with aortic surgery—carried a 0.47% risk of hospital death and a 0.25% risk of stroke, and long-term durability improved over time with newer techniques, such as higher commissure implantation.[8] However, how reparative procedures compare with mechanical and biologic graft root replacement alternatives in the long term remains unclear.[6,9]

The present study goes beyond our previous reports, to examine our experience over the past 20 years with aortic root procedures combined with ascending aorta replacement. All of the patients in the study were managed with (1) valve preservation (remodeling or modified reimplantation); (2) biologic valve composite grafts; (3) mechanical valve composite grafts; or (4) allograft root and ascending aorta replacement with coronary reimplantation. On the basis of long-term outcomes and surveillance in an era that favors reparative techniques, do mechanical and biologic composite grafts and allografts still have a place? If so, in what kind of patient, at what time?

METHODS

Patients

From January 1995 to January 2011, 957 patients underwent 1 of 4 aortic root procedures for aneurysms of the root and ascending aorta: (1) valve preservation (n = 261; remodeling [n = 56] or reimplantation [n = 205]); (2) composite biologic graft (n = 297); (3) composite mechanical graft (n = 156); or (4) allograft root (n = 243). Patients who underwent emergency surgery, had endocarditis or acute aortic dissection, or did not have an ascending aorta replacement were excluded.

Operative Techniques

The operative techniques have been described before for the root part of the procedure, including a L.G.S.-modified valve reimplantation technique using pledgets, sizing to body surface area, and Hegar’s dilators[5,10]; an inclusion type of remodeling of the root[6]; composite mechanical valve implantation, including with a tube graft to the left main coronary artery (which we now use primarily for patients with acute dissection or who have undergone reoperation[11,12]); standard techniques for biologic implants with coronary buttons; and allograft root implantation by the inclusion or button technique. In 234 patients (24%), circulatory arrest was used for concomitant aortic arch replacement (Table 1).

Data

Data were collected prospectively and entered into our Cardiovascular Information Registry. Use of these data for research was approved by the Cleveland Clinic Institutional Review Board, with requirements for patient consent waived.

Endpoints

Study endpoints were (1) in-hospital postoperative morbidity and mortality; (2) time-related aortic valve function (assessed by gradients and regurgitation on longitudinal echocardiograms); (3) left ventricular reverse remodeling, assessed by left ventricular mass on longitudinal echocardiograms; (4) aortic valve and aorta-related reoperations; and (5) short- and long-term mortality.

Longitudinal echocardiographic data for aortic valve function and left ventricular reverse remodeling obtained at follow-up were extracted from our echocardiogram database to ascertain valve function. However, surveillance echocardiograms were available only in patients who were followed at Cleveland Clinic. Previously, we have shown that these patients constitute a representative sample, one not confounded by return of patients for aortic problems.[13] Few statistically significant differences were found between patients surveilled or not at Cleveland Clinic (data not shown).

A total of 1626 echocardiograms, performed on 718 patients (75%), were available for analysis in the postoperative period (Figure E1). Time-related survival and aortic-related reoperations were obtained from yearly follow-up questionnaires (with phone follow-up if questionnaires were not returned). Follow-up was available for 943 patients (98%). The median follow-up time was 5.3 years (mean, 5.6 ± 4.6 years), with 5351 patient-years of data available for analysis; 25% of patients were followed for >9 years, and 5% for >15 years.

Data Analysis

The following outline of our data analysis is presented in detail in Appendix E1. To reduce bias in comparing outcomes among groups, 4 propensity scores were generated for each patient and forced into models of outcome. The temporal patterns of follow-up echocardiographic measures were estimated using longitudinal data analysis, with risk-adjusted comparisons made by including propensity scores in the models. Risks of reoperation and death were estimated by the Kaplan-Meier method, and a nonproportional hazards model was used to identify risk-adjusted mortality differences.

Presentation

Continuous variables are summarized as mean ± standard deviation, or as equivalent 15th, 50th (median), and 85th percentiles when the distribution of values was skewed. Categoric data are summarized as frequencies and percentages. Uncertainty is expressed by confidence limits equivalent to ±1 standard error (68%). Comparison of groups was done with the Kruskal-Wallis nonparametric test for continuous variables and the χ^2 test for categoric data.

RESULTS

Patient Characteristics and Procedural Details

Patients in the valve-preserving and mechanical composite valve groups were the youngest, and those