Valve-sparing root replacement for freestanding pulmonary autograft aneurysm after the Ross procedure

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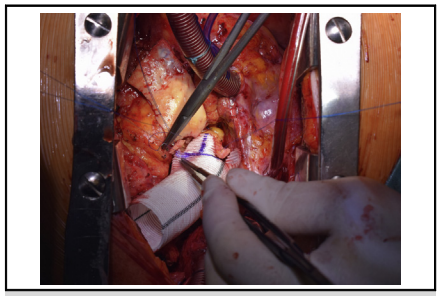
ABSTRACT

Objective: Autograft dilatation is the main long-term complication following the Ross procedure using the freestanding root replacement technique. We reviewed our 25-year experience with the Ross procedure with a special emphasis on valve-sparing reoperations.

Methods: From 1991 to 2016, 153 patients (29.6 ± 16.6 years; 29.4% pediatric) underwent a Ross operation at our institution with implantation of the autograft as freestanding root replacement. The follow-up is 98.7% complete with a mean of 12.2 ± 5.5 years.

Results: Mortality at 30-days was 2.0%. Echocardiography documented no or trivial aortic regurgitation in 99.3% of the patients at discharge. Survival probability at 20 years was 85.4%. No case of autograft endocarditis occurred. Autograft deterioration rate was 2.01% per patient-year, and freedom from autograft reoperation was 75.3% at 15 years. A reoperation for autograft aneurysm was required in 35 patients (22.9%) at a mean interval of 11.1 ± 4.6 years after the Ross procedure. A valve-sparing root replacement was performed in 77% of patients, including 10 David and 17 Yacoub procedures with no early mortality. Three patients required prosthetic valve replacement within 2 years after a Yacoub operation. At latest follow-up, 92% of all surviving patients still carry the pulmonary autograft valve. Freedom from autograft valve replacement was 92.1% at 15 years.

Conclusions: Using the David or Yacoub techniques, the autograft valve can be preserved in the majority of patients with root aneurysms after the Ross procedure. Reoperations can be performed with no early mortality, a good functional midterm result, and an acceptable reintervention rate. (J Thorac Cardiovasc Surg 2018;■:1-8)



Yacoub procedure for pulmonary autograft aneurysm after the Ross operation.

Central Message

The David and Yacoub procedures enable preservation of the autograft valve in the majority of patients with root aneurysm after the Ross procedure.

Perspective

Autograft dilatation is the main long-term complication following the Ross procedure using the freestanding root replacement technique, and accounts for most reoperations. The David and Yacoub procedures for preservation of the autograft valve carry a low operative risk and provide a good midterm functional result with an acceptable rate of reintervention.

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ADULT

The use of the pulmonary autograft as an aortic valve substitute, first proposed by Donald Ross in 1967,[1] provides a viable valve with excellent hemodynamics,[2] a high resistance to infection,[3,4] growth potential in children, low thrombogenicity, and therefore avoidance of anticoagulation. Compared with homograft implantation and prosthetic valve replacement, the Ross procedure improves long-term survival and quality of life in young adults by avoidance of early degeneration and valve-related complications.[5-7] Despite a low operative mortality,[8-10] concerns remain regarding the possibility of complex reoperations on both the autograft and homograft.[11] Progressive aortic root dilatation is increasingly recognized late after the Ross procedure, especially

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Abbreviations and Acronyms
CI = confidence interval
RVOT = right ventricular outflow tract

when the autograft was implanted as a freestanding root replacement.[12] Experience with valve-sparing reoperations to salvage the autograft valve and to prevent prosthetic valve replacement remains limited.[13-16] In this study, we reviewed our experience with the Ross procedure over 25 years with a special emphasis on valve-sparing reoperations.

METHODS

Patients

From January 1991 to December 2016, 153 patients (24.8% female; 29.4% pediatric) underwent Ross operations at our institution with implantation of the autograft as a freestanding root replacement. The operative indications were in line with the American College of Cardiology and American Heart Association guidelines.[17] The Ross operation was proposed to patients younger than 50 years and in select older patients if considered appropriate. Concomitant severe comorbidities, extensive coronary artery disease, severely depressed ventricular function, and structural defects of the pulmonary valve were considered contraindications for a Ross procedure.

In patients with a failing autograft, indications for surgery included neosinus dilatation of 50 mm or greater, a progressive increase in aortic diameter of greater than 5 mm/year, and severe valve regurgitation with symptoms of left ventricular dilatation or dysfunction. Calcifications, retraction, large fenestrations and severe prolapse of valve leaflets, valve stenosis, and informed patient refusal were considered contraindications for a valve-sparing reoperation. This retrospective investigation was approved by the Ethics Committee of the Kepler University Hospital (file number K-117-16) and patient consent was waived.

Follow-up

Follow-up was closed in December 2016, and it is 98.7% complete with a mean of 12.2 ± 5.5 years, yielding a cumulative total of 1845 patient-years. The mean echocardiographic follow-up was 10.5 ± 5.8 years. A retrospective review of prospectively collected data was performed using our institutional database. The clinical course and echocardiographic data were obtained from medical records, patient visits, telephone interviews, and communications with referring physicians. Patients were examined using transthoracic echocardiography before and after surgery and during regular follow-up visits. The severity of aortic regurgitation was classified as grades 0, I (trivial), II (mild), III (moderate), and IV (severe).

Operative Technique

Standard cardiopulmonary bypass with moderate hypothermia was conducted in all patients. The pulmonary valve was evaluated using thorough echocardiography and visual inspection at the beginning of the operation. The autograft was implanted as a freestanding (complete) root replacement in an intra-annular position with close interrupted or a running polypropylene suture. In adolescent and adult patients, the proximal suture line was reinforced with a strip of pericardium. The distal anastomosis was performed 2-3 mm above the commissures to keep the autograft short. The right ventricular outflow tract (RVOT) was reconstructed using a cryopreserved homograft. If one was not available, a Contegra or a Freestyle prosthesis (Medtronic, Minneapolis, Minn.) was used.

The techniques of valve-sparing root reconstruction have been described previously in detail.[18,19] If the aortoventricular junction was dilated, the reimplantation technique according to David[18] was favored to stabilize the annulus effectively. Additional measures included subcommissural annuloplasty, resuspension of commissures for cusp prolapse, and leaflet augmentation with autologous pericardium as required. Intraoperative transesophageal echocardiography was performed in all patients to assess valve function.

Statistics

Statistical analysis was performed using the R statistical software package, version 3.2.3. All data sets of continuous variables were checked for normal distribution (test of normality: Kolmogorov-Smirnov with Lilliefors significance correction, type I error = 10%). Data sets of continuous variables without normally distributed data sets and of variables measured on ordinal scales were compared using the exact Mann-Whitney *U* test, and data sets of categorical variables were compared using the Fisher exact test or chi-square test (with provision of adjusted residuals). Continuous variables are reported as means ± standard deviations. If the data are considerably skewed, medians and quartiles are given in brackets. Time-to-event variables, depicted by Kaplan-Meier plots, were compared using the log-rank test. For the comparative depiction of the survival times of the study population and the total population, a matched-pair approach with age- and sex-related estimations of total population survival times (source: Statistik Austria; available at: http://www.statistik-austria.at) censored at 25 years was used. Cox regression (including a forward method based on the likelihood ratio approach) was used to investigate the influence of the following covariates on the time to aneurysm occurrence: bicuspid aortic valve, sex, aortic regurgitation, and age at first operation. The type I error was not adjusted for multiple testing; therefore, the results of inferential statistics are descriptive only.

RESULTS

Patients

Clinical and operative data are summarized in Table 1. The mean age of the study population was 29.6 ± 16.6 years, including 50 patients (32.7%) older than 40 years. A cardiac operation had been performed previously in 39 patients (25.5%). Aortic regurgitation was the most frequent indication for surgery (56.2%). The study population included 34 patients (22.2%) with a bicuspid aortic valve and 19 patients (12.4%) with acute infective endocarditis.

Operative Date and Postoperative Course

The mean aortic cross-clamp time was 124 ± 22 minutes. Nineteen patients (12.4%) underwent a combined procedure. Permanent pacemaker implantation was required in 7 patients (4.6%) for atrioventricular block. However, 3 of those patients had undergone operations for endocarditis, and 2 procedures were redo operations. Echocardiography at discharge documented aortic valve regurgitation grade 0-I in 150 patients (99.3%) and grade II in 1 patient.

Mortality

All-cause mortality at 30 days was 2.0% (3 patients). One child with critical congenital aortic stenosis and endocardial fibroelastosis died from cardiac failure. Sudden