Valve repair improves the outcome of surgery for chronic severe aortic regurgitation: A propensity score analysis

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Background: For patients with aortic regurgitation (AR), aortic valve (AV) repair represents an attractive alternative to AV replacement (AVR), because it does not expose patients to the risk of prosthetic valve complications. Although the durability of AV repair has been documented, its prognosis has not yet been compared with prognosis of AVR.

Methods: We performed a propensity score analysis to match patients who underwent surgical correction of severe AR by either AVR or AV repair between 1995 and 2012. After matching, 44 pairs of patients were compared regarding baseline characteristics; overall survival; operative survival; cardiac events, including reoperations; recurrent AR; and New York Heart Association functional class at final follow-up.

Results: Operative mortality was similar in the AV repair and AVR groups (2% vs 5%; $P = .56$). Kaplan-Meier survival analysis indicated a significantly better overall 9-year survival after AV repair than after AVR (87% vs 60%; $P = .007$). Cox proportional survival analysis demonstrated that the choice of treatment was an independent predictor of postoperative survival. Finally, AV repair resulted in a slight increase, albeit not statistically significant, in reoperation rate (8% vs 2%; log rank $P = .35$).

Conclusions: AV repair significantly improves postoperative outcomes in patients with AR and whenever feasible should probably be the preferred mode of surgical correction. (J Thorac Cardiovasc Surg 2014;148:1913-20)

Aortic valve (AV) replacement (AVR) is an established treatment for patients with severe AV regurgitation (AR).[1,2] AVR improves prognosis and quality of life, but exposes patients to a variety of prosthesis-related complications.[3] Mechanical valves are associated with the risks of thromboembolism, valve thrombosis, and anticoagulation-related bleeding, whereas biological valve substitutes undergo structural degeneration and expose patients to the risk of reoperation.[4] The risk of prosthetic valve endocarditis also remains for both biological and mechanical substitutes. Taken together, the cumulative risk of valve-related complications has been estimated to be around 50% at 10 years in patients undergoing AVR for the treatment of AR.[4,5]

In recent years, repair techniques for diseased AVs have received increasing attention, with the perception that maintaining the normal architecture of the AV apparatus would be beneficial to the patient.[6-9] Thanks to innovations in operative techniques,[9] an improved understanding of the functional anatomy of the aortic valve and root,[10] as well as increased awareness of the mechanisms leading to AR,[11] AV repair has progressively evolved from an anecdotal approach to a plausible alternative to AVR. Several studies have indeed demonstrated that AV repair is feasible in a majority of patients with AR due to aortic root diseases or cusp prolapses and results in a low incidence of valve-related complications, including reoperations.[7-12] Despite these promising results, it is still uncertain if reconstruction of the AV provides survival advantages over AVR, as observed in mitral valve surgery.

We examined the outcome after AV repair or AVR in patients with severe AR, hypothesizing that AV repair would improve overall survival compared with AVR. Because comparison between these 2 operative approaches can be obscured by differences in baseline characteristics, the technique of propensity score matching was used to reduce selection bias and heterogeneity in the study population.

METHODS

Study Population

The study population consisted of 942 consecutive patients who underwent surgical correction of AR or for dilation of the ascending aorta between January 1, 1995, and December 31, 2012. Exclusion criteria (Figure 1) were missing preoperative data (n = 47), AV surgery without severe AR, primary surgery for dilation of the ascending aorta, coronary

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Abbreviations and Acronyms
AR = aortic regurgitation
AV = aortic valve
AVR = aortic valve replacement
NYHA = New York Heart Association

artery bypass graft surgery, mitral regurgitation, tricuspid regurgitation, or myxoma (n = 307).

Among 588 patients with severe AR, those aged <18 years (n = 24); severe acute AR due to endocarditis or aortic dissection (n = 81); concomitant severe mitral regurgitation or aortic stenosis (n = 42); a nondilated left ventricle, defined as a LV end-diastolic dimension <32 mm/m height (n = 49)[13]; prior valve surgery (n = 69); glomerular filtration rate <30 mL/min (n = 4); or a life expectancy <1 year in the absence of AR (n = 3) were secondarily excluded. Patients undergoing a Ross procedure were excluded as well (n = 31). Patients who had coronary artery disease or had previously undergone coronary artery bypass graft surgery were not excluded.

Group Selection

To reduce the effect of treatment selection bias, a propensity score analysis was performed.[14,15] The propensity score was estimated by use of a multiple logistic regression model where treatment was the dependent variable, and plausible correlates of either the therapeutic decision or survival acted as independent variables. The 5 covariables used to build the propensity score were age, New York Heart Association (NYHA) functional class I-II, presence of bicuspid AV, ejection fraction, and the mechanism of AR. The calculated propensity scores were then used to select pairs of patients with matched propensity scores in the 2 treatment groups (1:1 match) within a caliper of 0.15 standard deviations of the propensity score, using STATA 10.0 software (Stata Corporation, College Station, Tex) and the psmatch routine. The propensity score yielded 44 matched pairs of patients.

Information on postoperative events and functional class was obtained for all patients between January and April 2013. Cardiac events and causes of death were ascertained by contacting the patients' physicians, the patients themselves if alive or their family, and by reviewing death certificates. Follow-up was 97% complete.

Echocardiography

Preoperative and follow-up echocardiographic examinations were performed using commercially available ultrasound systems. All patients underwent a comprehensive examination, including M-mode and 2-dimensional echocardiography, as well as conventional and color Doppler examinations. All tests were conducted by experienced echocardiographers.

The severity of AR was assessed semiquantitatively on a scale of 1+ to 4+ by an integrated approach that included the size of the regurgitant jet in the left ventricular cavity; the proximal regurgitant jet width; the jet deceleration rate; the magnitude of the diastolic flow reversal in descending aorta; the size of the proximal convergence zone; and, when available, the regurgitant volume and the effective regurgitant orifice area. Severe AR was defined as grade 3+ AR or greater. The approach to semiquantification used in our study is in agreement with prevailing guidelines at the time of examination.[16]

Surgical Procedures

The choice of surgical technique was left at the discretion of the attending surgeon who took into account the referring physicians' and the patients' preferences. The choice between an attempt to valve repair, without any guarantee in terms of long-term results, and AVR was clearly presented to every patient and referring physician. Although the majority of patients accepted the risk and underwent AV repair, a few patients refused and preferred to undergo AVR.

Surgical repair of the AV involved a variety of techniques tailored to each individual dysfunction identified. These techniques have been extensively described elsewhere.[10] The prostheses used in AVR were mechanical in 15 patients and biological in 29 patients. The choice of prosthesis was discussed in detail among the informed patient, his or her cardiologist, and the surgeon, in accordance with prevailing guidelines. In general, bioprosthetic AVR was proposed to patients aged 65 years or older, whereas mechanical AVR was preferred in patients younger than age 60 years. Between the ages of 60 and 65 years, both substitutes were usually proposed and the final choice took into account possible contraindications and patients' preferences.

Statistical Analysis

All statistical analyses were performed using SPSS version 20.0 software (IBM-SPSS Inc, Armonk, NY). Continuous variables were expressed as mean ± 1 standard deviation, with categorical variables as counts and percentages. To compare groups, student paired *t* test or McNemar χ^2 tests were used when appropriate.

A Cox proportional-hazards survival model for matched data was built for determination of the factors independently associated with outcome. For the univariate analysis, all clinical, angiographic, and echocardiographic variables were proposed for inclusion. Variables with $P < .10$ were subsequently submitted to a multivariate Cox proportional-hazards survival model. For this purpose, a preliminary model was built from which the choice of treatment was excluded. The ability of the choice of treatment to improve the prediction of death by this preliminary model was then tested.

Cardiovascular events and reoperation-free survivals in the 2 treatment groups were computed using the Kaplan-Meier method and compared using the log-rank χ^2 test. For each patient included in the study, the corresponding average age- and gender-specific annual mortality rates of the Belgian general population were obtained and an expected survival curve was constructed.

The authors had full access to and take full responsibility for the integrity of the data. All authors read and agreed to the article as written.

RESULTS

The strategy of the analysis was to compare the matched AV repair group with the AVR group regarding baseline characteristics of the patients; overall survival; operative-free survival; and survival free of cardiac events, including reoperations, recurrent AR, and NYHA functional class at last follow-up.

Baseline Characteristics

Table 1 shows the baseline demographic and clinical characteristics of the study population. Baseline hemodynamic and echocardiographic characteristics are shown in Table 2. Operative data are shown in Tables 3 and 4.

Indications for surgery were presence of symptoms (n = 32, 8 for NYHA functional class II symptoms and 24 NYHA class III-IV symptoms), asymptomatic dilation of the ascending aorta (n = 15), asymptomatic left ventricular dysfunction (n = 6), and asymptomatic left ventricular dilation (n = 35).