Aortic valve replacement after previous heart surgery in high-risk patients: Transapical aortic valve implantation versus conventional aortic valve replacement—a risk-adjusted and propensity score-based analysis

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Objective: Cardiac reoperations have been associated with increased morbidity and mortality compared with first-time surgery. We analyzed our experience with reoperative aortic valve replacement (redo-AVR) and compared these results with those from patients who had undergone transapical aortic valve implantation (TA-AVI) as a second heart operation.

Methods: In the present retrospective observational comparative study, we analyzed the outcome of 136 patients with previous cardiac surgery who had undergone conventional redo-AVR (n = 59; since 2006) or TA-AVI (n = 77; since 2008) with respect to the 30-day outcomes (Valve Academic Research Consortium criteria), 1- and 3-year survival, and the risk factors for both approaches after previous heart surgery.

Results: Neither group differed significantly in their risk profile, leading to similar Society of Thoracic Surgeon score and EuroSCORE. The 30-day mortality was 3.39% (n = 2) in the redo-AVR group and 7.8% (n = 6) in the redo TA-AVI group ($P = .465$). The overall combined safety endpoint at 30 days was significantly lower for the TA-AVI patients (18.1% vs 33.9% in redo-AVR; $P = .036$). The unadjusted and adjusted 1-year survival showed no difference between the 2 groups. The unadjusted 3-year survival revealed a 2.1-fold greater mortality risk after TA-AVI ($P = .055$). Adjustment by multivariate Cox regression analysis (hazard ratio, 1.427; 95% confidence interval, 0.635-3.209; $P = .389$) and propensity score (hazard ratio, 1.571; 95% confidence interval, 0.575-4.291; $P = .378$) led to a >50% risk reduction, resulting in similar 3-year survival in the 2 groups.

Conclusions: Redo-AVR can be performed with acceptable results in high-risk patients and still serves as the reference standard. Reoperative valve surgery by TA-AVI is feasible and results in comparable short- and mid-term survival. (J Thorac Cardiovasc Surg 2014;148:90-7)

The increasing age in the western population and the advances with respect to medical treatment have led to an increasing incidence of aortic valve replacement (AVR) in patients who have undergone previous cardiac surgery.[1] If these procedures are performed using conventional techniques, this surgical approach features several technical challenges. The re-entry risk, including injuries to grafts, and the method of achieving sufficient myocardial protection are challenging.[1] Also, the advanced cardiovascular morbidity of most of the mostly elderly patients undergoing repeat surgery aggravates the perioperative risk. Therefore, cardiac reoperations have been associated with increased morbidity and mortality compared with first-time surgery.[2] The introduction of transcatheter aortic valve implantation (ie, transfemoral [TF-AVI], transapical [TA-AVI], transaortic, transsubclavian) represents a promising alternative for aortic valve interventions in high-risk patients. However, data on the outcome for TAVI after previous cardiac surgery compared with conventional redo-AVR are still limited. Moreover, previous studies have either focused on mixed treatment groups (TF-AVI and TA-AVI), have specifically compared the outcomes after previous coronary artery bypass grafting,[3,4] or have compared TA-AVI after previous cardiac surgery with TA-AVI as the first procedure.[5,6]

In this context, we retrospectively analyzed the outcome of redo-AVR and compared the results with the outcomes of patients who had undergone TA-AVI as a secondary cardiac

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

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Received for publication May 3, 2013; revisions received June 24, 2013; accepted for publication July 12, 2013; available ahead of print Oct 14, 2013.

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0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2013.07.046

Abbreviations and Acronyms

AI = aortic insufficiency
AVR = aortic valve replacement
CIs = confidence intervals
HRs = hazard ratios
TA-AVI = transapical aortic valve implantation
TF-AVI = transfemoral aortic valve implantation

operation (redo TA-AVI) with respect to the 30-day outcomes (Valve Academic Research Consortium [VARC] criteria), 1- and 3-year survival, and the risk factors for both approaches.

METHODS

Data Collection

We queried our institutional adult cardiac surgery database for all patients who had undergone isolated redo-AVR at our institution from January 2006 to May 2011. Reoperative surgery was defined as any previous cardiac operation using a thoracotomy or sternotomy approach. In addition, we scanned our database for all patients who had undergone TA-AVI (February 2008 to April 2012). Patients with endocarditis and emergency cases were excluded from the analysis. The review of our databases identified 136 patients with previous cardiac surgery who had undergone conventional redo-AVR (n = 59) or TA-AVI (n = 77). The patient demographics and preoperative characteristics are listed in Table 1. The previous cardiac operations are listed in Table 2. All patients underwent redo aortic valve surgery for either aortic stenosis or insufficiency. From January 2006 to February 2008, redo-AVR was the only available treatment option, because the TA treatment approach was first introduced at our institution in February 2008. All patients accepted for TA-AVI were selected by the heart team of our institution. TF-AVI was considered as the first option, and TA-AVI was used in the case of contraindications for TF-AVI. A total of 37 patients who had undergone redo-AVR underwent surgery before the start of our TA-AVI program, and 22 had undergone redo-AVR, despite the existing transcatheter treatment option.

The local ethics committee approved the present study.

Prosthetic Valve System and Procedure

Conventional redo-AVR. The specific details of the surgical technique, valve selection, and implantation were determined by the individual cardiac surgeon. In general, the patients had undergone redo median sternotomy and establishment of cardiopulmonary bypass by way of the ascending aorta and right atrium. The types of prosthesis used were the Carpentier-Perimount (Edwards LifeSciences, Irvine, Calif), Mitroflow, and Carbomedics (both Sorin, Milano, Italy).

Redo TA-AVI. TA-AVI was performed using the Edwards SAPIEN prosthesis (Edwards LifeSciences). The procedural steps were performed as previously described.[7]

Endpoints

The objective of the present study was (1) to analyze the potential differences between redo-AVR and TA-AVI regarding the 30-day outcomes (VARC criteria)[8]; (2) to estimate the effect of the type of surgical procedure on 1- and 3-year survival; and (3) to identify the potential risk factors for mortality for each surgical procedure.

Statistical Analysis

We used unpaired *t* tests for parametric variables, Mann-Whitney *U* tests for nonparametric variables, and Fisher's exact tests for categorical variables to perform pairwise comparisons for the pre-, peri-, and postoperative factors. The effect of the type of surgical procedure on 1- and 3-year survival was analyzed using 3 different methods. First, a univariate Cox regression model was fitted to estimate the unadjusted treatment effect of TA-AVI versus redo-AVR. Additionally, the survival curves were estimated using the Kaplan-Meier method and compared using the log-rank test. Second, an adjusted treatment effect was estimated within a Cox regression model that included the clinically relevant covariates with $P < .1$ on univariate Cox regression analysis and remaining in the model after backward, stepwise selection. The variables considered are listed in Tables 1 and 2, plus the log creatinine. Third, a propensity score-based analysis was performed to validate the estimated treatment effect. The propensity score was estimated using a logistic regression model, with the type of surgery as an outcome and the preoperative patient characteristics as covariates, and then included in a Cox regression model to evaluate the propensity score-adjusted treatment effect. Univariate Cox regression models were fitted for each surgical procedure to identify the predictors for 1- and 3-year mortality.

For Cox regression models, hazard ratios (HRs) for the comparison between TA-AVI and redo-AVR, the corresponding 95% confidence intervals (CIs), and the results of the Wald test of the hypothesis of a no-treatment effect are reported. All reported *P* values are 2-sided, and $P < .05$ was considered statistically significant. Statistical analysis was performed using Excel (Microsoft, Redmond, Wash) and SPSS (IBM, Somers, NY).

TABLE 1. Patient demographics and preoperative characteristics

Variable	Redo-AVR (n = 59)	TA-AVI (n = 77)	*P* value
Male gender	39 (66.1)	46 (59.7)	.479*
Age (y)	66.75 ± 16.95	79.51 ± 6.29	<.001†
BMI (kg/m^2)	26.86 ± 4.52	26.58 ± 4.79	.729†
STS score (%)	9.94 ± 3.25	11.23 ± 4.25	.216†
EuroSCORE, numeric	10.54 ± 2.91	11.49 ± 2.99	.068†
EuroSCORE, logistic			
Median	20.68	24.99	.134‡
IQR	12.35-35.55	14.55-41.65	
Preoperative LVEF (%)	53.69 ± 13.38	52.17 ± 14.11	.533†
AF	14 (23.7)	16 (20.8)	.683*
NYHA class III-IV	45 (76.3)	65 (86.7)	.173*
COPD	6 (10.2)	9 (11.7)	1*
CAD	33 (55.9)	70 (90.9)	<.001*
PAOD	9 (15.3)	25 (32.5)	.028*
Renal dysfunction	29 (49.2)	45 (58.4)	.302*
PH	20 (33.9)	27 (35.1)	1*
Preoperative creatinine (mg/dL)			
Mean	1.09	1.22	.106‡
Range	0.88-1.39	0.98-1.59	
Diabetes	17 (28.8)	31 (40.3)	.206*

Data presented as n (%) or mean ± standard deviation, unless otherwise noted. Renal dysfunction considered present if preoperative serum creatinine >1.1 mg/dL. *AVR,* Aortic valve replacement; *TA-AVI,* transapical aortic valve implantation; *BMI,* body mass index; *STS,* Society of Thoracic Surgeons; *IQR,* interquartile range; *LVEF,* left ventricular ejection fraction; *AF,* atrial fibrillation; *NYHA,* New York Heart Association; *COPD,* chronic obstructive pulmonary disease; *CAD,* coronary artery disease; *PAOD,* peripheral arterial occlusive disease; *PH,* pulmonary hypertension (>50 mm Hg systolic pressure). *Fisher's exact test. †Student's *t* test. ‡Wilcoxon rank sum test.

RESULTS

Preoperative Clinical Characteristics

Apart from age, coronary heart disease, and peripheral arterial occlusive disease, the compared groups did not differ