

Perioperative Risk of Redo Aortic Valve Replacement

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Background: To evaluate the perioperative risk of redo aortic valve replacement (AVR).

Materials and Methods: Sixty-three patients (53 males, 10 females) underwent redo AVR from 2001–2005. Forty-one bioprostheses had to be replaced for degeneration and/or paravalvular leakage, and 18 mechanical prostheses were changed because of thrombosis and/or paravalvular leakage. Four patients with a bicuspid aortic valve underwent a mechanical AVR after a primary reconstructive procedure. We compared the perioperative course of the redo AVR (group 2) with the primary procedure (group 1).

Results: Fifty-two patients received a mechanical prosthesis and eight a biological one. Three patients underwent a refixation of the prosthesis for a paravalvular leakage. The durations of surgery (261.7 ± 49.5 min vs. 191.7 ± 31.6 min), cardiopulmonary bypass (130.3 ± 37.1 min vs. 101.3 ± 28.4 min), and cross-clamping (80.4 ± 23.4 min vs. 66.4 ± 20.6 min) were significantly longer in group 2 than in group 1. Forty-three patients had an uneventful postoperative course. There were 28 (8) postoperative complications in group 2 (1): Need for pacemaker insertion: 8 vs. 2; reexploration for bleeding: 4 vs. 1; temporary renal insufficiency: 3 vs. 4; cerebral confusion: 5 vs. 0; low cardiac output syndrome: 4 vs. 0; wound infection: 2 vs. 1; intestinal ischemia: 1 vs. 0. Four patients expired after redo AVR: two resulting from multiorgan failure, one suffered from an intestinal ischemia requiring bowel resection, and one expired as a result of an aortic rupture during resuscitation.

Conclusion: Conventional reoperative AVR is associated with an enhanced perioperative risk. Therefore these patients should be referred early for reoperation to avoid high-risk emergency operations with a significantly increased mortality. (*Ann Thorac Cardiovasc Surg* 2009; 15: 105–110)

Key words: redo aortic valve replacement, reoperation, operative risk

Introduction

It is well-known that the operative risk for aortic valve replacement (AVR) after coronary artery bypass grafting

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and in patients requiring coronary artery bypass grafting concurrent with redo heart valve surgery has increased.^{1,2} Unfortunately, however, the contemporary risk of redo AVR is ill-defined.^{3,4} Usually it is supposed that the operative mortality associated with repeat heart valve surgery is higher than for the initial valve operation.^{2,5} But controversy exists, whether there is an incremental effect to mortality compared to the primary operation³ and what risk factors are contributing to that mortality.⁴

We reviewed our experiences with isolated redo AVR for 5 years and report on our results here, since under ideal circumstances a study on reoperative AVR would include only patients undergoing isolated AVR.³

Table 1. Preoperative data

	Group 1	Group 2	P value
Age at the time of surgery (years)	46.3 ± 17.8	56.4 ± 14.3	<0.0001
BMI	24.3 ± 2.8	26.2 ± 2.8	0.0002
Angina	19	15	0.37
Previous cardiac decompensation	8	15	0.09
Cardiac vertigo	11	4	0.052
Cardiac syncope	11	3	0.02
Arterial hypertension	19	30	0.008
Diabetes mellitus	3	8	0.025
Nicotine abuse	11	10	0.74
Peripheral arterial occlusive disease	3	6	0.26
Hyperlipemia	9	16	0.07
Previous myocardial infarction	1	3	0.16
Previous cerebral infarction	2	4	0.16
Endocarditis	14	11	0.47
History of rheumatic fever	11	6	0.059
Sinus rhythm	61	51	0.0016
Atrial fibrillation	2	11	0.0027
Permanent pacemaker stimulation	0	1	nc
Ejection fraction (%)	59.8 ± 8.8	57.2 ± 12.4	0.15
Pulmonary capillary wedge pressure (mmHg)	14.2 ± 6.1	18.7 ± 7.0	0.0006

BMI, body mass index (weight in kg/height in m²); nc, not calculated.

Materials and Methods

Sixty-three patients (53 males, 10 females) underwent isolated redo AVR in our department from 2001 to 2005. Only patients with an isolated primary (group 1) AVR in whom an isolated redo (group 2) AVR was performed were included in this retrospective study. This means that the patients of group 1 and group 2 are the same patients. Patients with additional procedures (e.g., bypass or mitral valve surgery) were excluded. Data were collected by reviewing the charts of the patients.

Statistical analysis

The statistical analysis was performed with the *t*-test for dependent variables for quantitative data and the McNemar test for qualitative data. A *p* value of less than 0.05 was considered significant. All values are given as mean values and standard deviation. The statistical calculation was done with the SAS software.

Results

The most important preoperative data are summarized in Table 1.

Table 2 presents an overview of the different reasons for AVR. Fourteen patients (22%) suffered from a bicuspid aortic valve. Eleven patients of group 2 suffered from

Table 2. Reasons for AVR

	Group 1	Group 2	P value
Isolated aortic stenosis	18	5	0.0046
Severity of stenosis	2.75	2.6	0.7
Isolated aortic insufficiency	20	27	0.2
Severity of insufficiency	3.1	3.0	0.7
Combined aortic valve vitium	25	28	0.61
Severity of stenosis	2.5	2.07	0.0076
Severity of insufficiency	1.9	2.4	0.028

a prosthetic endocarditis with no signs of stenosis or insufficiency. These patients were operated on because an antibiotic therapy for several weeks was not successful. Therefore a change of the prosthesis was the only therapeutic option. In 11 of the 27 patients of group 2 undergoing redo AVR for prosthetic incompetence, the insufficiency was caused by paravalvular leakages.

Table 3 gives the most important operative parameters. Mean duration from the primary to the redo procedure was 10.0 ± 6.5 years for all patients and 23.0 ± 11.3 years for patients after primary aortic valve reconstruction (4 patients), 6.2 ± 6.1 years for patients after mechanical AVR (18 patients), and 10.4 ± 4.0 years for patients after biological AVR (41 patients). The redo procedures consisted of 52 implantations of mechanical prostheses, 8 implantations of biological prostheses, and 3 treatments with a refixation of the primary implanted prosthesis

Table 3. Operative parameters

	Group 1	Group 2	<i>P</i> value
Elective surgery	57	48	0.049
Urgent surgery	1	13	0.0013
Emergent surgery	5	2	0.26
Operative duration (min)	191.7 ± 31.6	261.7 ± 49.5	0.0004
Duration of cardiopulmonary bypass (min)	101.3 ± 28.4	130.3 ± 37.1	0.0004
Cross-clamp time (min)	66.4 ± 20.6	80.4 ± 23.4	0.0008
Size of the implanted prosthesis (mm)	27.0 ± 2.6	26.2 ± 2.0	0.02

Table 4. Postoperative data

	Group 1	Group 2	<i>P</i> value
Duration of mechanical ventilation (hours)	14.2 ± 5.1	17.0 ± 13.8	0.09
Stay on the ICU (days)	2.3 ± 1.1	2.9 ± 2.1	0.07
Stay on the normal ward (days)	10.7 ± 4.7	10.3 ± 2.3	0.49

The data are presented for the surviving patients, since the expired patients had a very long stay in the intensive care unit, which would falsify the data.

ICU, intensive care unit.

Table 5. Postoperative complications

	Group 1	Group 2	<i>P</i> value
Need for permanent pacemaker insertion	2	8	0.03
Temporary renal insufficiency	4	3	0.7
Revision for bleeding	1	4	0.18
Postoperative confusion	0	5	nc
Need for intra-aortic balloon pump	0	4	nc
Wound-healing disturbance	1	2	0.56
Bowel necrosis	0	1	nc
Need for dialysis	0	1	nc

nc, not calculated.

because of a paravalvular leakage.

All patients underwent a complete re sternotomy using an oscillating saw. Preparation of the adhesions for the redo procedure did not lead to any injury of the heart or the great vessels. Cardiopulmonary bypass was instituted via cannulation of the right atrium and the ascending aorta. A left ventricular vent was routinely inserted via the right upper pulmonary vein. Crystalloid cardioplegia (Bretschneider's solution, 1,500–2,000 mL) was administered antegradely via the coronary ostia (group 1: 57 patients; group 2: 52 patients) or the ascending aorta (group 1: 3 patients; group 2: 4 patients). Isolated retrograde cardioplegia was used in 3 (group 1) and 2 (group 2) patients; combined administration of cardioplegia only in patients of group 2 (coronary ostia and retrograde application: 3 patients; ascending aorta and retrograde application: 2 patients).

Topical ice slush was used in each patient. All procedures were performed in mild hypothermia (28°C or 32°C). After primary or redo AVR, the heart was deaerated via the left ventricular apex and the ascending aorta. The postoperative data are presented in Tables 4 and 5.

Four patients died after redo AVR: 2 patients died because of a multiorgan failure, one suffered from an intestinal ischemia requiring bowel resection, and one expired as a result of an aortic rupture during resuscitation.

Discussion

Calcification leading to degeneration and primary tissue failure of bioprosthetic heart valves is the most frequent reason for bioprosthetic heart valve replacement and is less well understood than calcification of the native

aortic cusps.^{6,7)} The most important determinant of calcification is young age, which may be explained by immune-mediated reactions and increased adsorption of proteins.^{7,8)} Also, mechanical stress plays an important role in bioprosthetic valve durability with stent design being the most important factor for minimizing mechanical stress.^{7,8)} Other risk factors that are discussed for an accelerated bioprosthetic valve calcification are smoking, hyperlipidemia, female sex, renal insufficiency, hypertension, and diabetes, but until now their importance has remained controversial.^{7,8)} Unfortunately, there is no medical therapy that until now has been demonstrated to be effective in the prevention of the progression of bioprosthetic valve calcification.⁶⁾ For these reasons, structural dysfunction (76.6%) is the most frequent cause for reoperation in patients with bioprosthetic heart valves, followed by endocarditis (9.1%), perivalvular leakages (5.2%), and thrombosis or thromboembolism (3.9%).³⁾ In patients with mechanical heart valves, nonstructural dysfunction (pannus formation, 36.7%) is the most common reason for exchange of the prosthesis with perivalvular leakages (31.7%); endocarditis (18.3%) and thrombosis or thromboembolism (5.0%) are more infrequent.^{3,9)}

The perioperative mortality of reoperations for prosthetic heart valve failure is reported as 3%–11.5%^{2–4)} and is determined by preoperative and operative parameters: preoperative risk factors are gender (4.6% for males vs. 13.3% for females), advanced New York Heart Association (NYHA) class (odds ratio for class III, 1.7; for class IV, 7.8) with poor hemodynamics, advanced age, increased weight, renal insufficiency or failure, peripheral vascular disease, nonelective surgery, indication for operation (periprosthetic leakage, endocarditis, or a prosthetic valve thrombosis), type and size of the prosthetic heart valve, number of previous heart operations, tricuspid insufficiency, acute endocarditis of the natural valve at the previous operation, aortic root disease at the original operation, and timing of reoperation.^{2–5)} Operative factors are concomitant coronary artery bypass grafting, heart penetration during surgery (usually a result of mediastinal and pericardial adhesions leading to a death hazard ratio of 7.6), a double-valve procedure, repair of an ascending aortic aneurysm with a composite graft, concomitant left ventricular aneurysmorrhaphy, prolonged duration of surgery, cardiopulmonary bypass, and cross-clamping, as well as a need for intra-aortic balloon pump insertion.^{2–5)} Most postoperative deaths are due to cardiac causes, espe-

cially myocardial failure, indicating the severely compromised state of these patients.²⁾ Some authors report on a significantly increased risk of a redo prosthetic exchange of mechanical heart valves compared with the replacement of tissue valves.²⁾ This may be explained by a more frequent abrupt prosthetic valve dysfunction of mechanical prosthesis (for example, resulting from a thrombosis of the prosthesis or a leaflet escape) with a consequent decompensation and urgent operation.^{2,4,9,10)} The overall survival for reoperative heart valve surgery is reported as 65% at 5 years, 51% at 10 years, 47% at 15 years, and 42% at 20 years.⁵⁾ This means that surviving patients have a low risk of death (4%) per year.⁵⁾ Nevertheless, to lower the perioperative risk for redo AVR, reoperation at an earlier stage (immediately when the prosthetic dysfunction has been identified) before occurrence of numerous risk factors is desirable. This requires a closer and more accurate patient follow-up leading to an earlier and more optimal timing for reoperation.^{3,4)}

Furthermore, other operative strategies were described to reduce the operative risk of redo AVR. At first, minimally invasive procedures using an upper median hemisternotomy were proposed to reduce the risk of right ventricular injury and increased bleeding.¹¹⁾ The authors themselves report that the major problem of redo procedures arise from adhesions, which precluded repeat cannulation of the right atrial appendage requiring, in this case, a cannulation of the right femoral vein.¹¹⁾ This demonstrates that minimally invasive redo procedures are much more difficult than primary procedures, and a reduction of the operative risk for redo AVR cannot be derived from this case report, since adequate studies concerning this specific topic are lacking. If newer techniques for AVR (e.g., transapical or femoral transarterial aortic valve [AV] implantation) can also be performed as redo AVR remains to be seen, since these procedures are still in their infancy.¹²⁾ Another aspect is the kind of cardioplegia and the route of its administration. In patients with aortic valve disease, myocardial protection is regarded more difficult because of the myocardial hypertrophy. Various strategies (e.g., antegrade crystalloid cardioplegia, antegrade/retrograde cold blood cardioplegia, and continuous retrograde warm or cold blood cardioplegia) were studied.^{13–15)} Whereas Jin et al.¹³⁾ concluded that antegrade/retrograde cold blood cardioplegia offers the best preservation of myocardial physiological response in the hypertrophied myocardium, others were unable to demonstrate the superiority

of one of the tested strategies.^{14,15)} In summary, current techniques of myocardial protection are considered sub-optimal in high-risk patients, and further developments (e.g., pharmacological preconditioning, sodium-hydrogen exchange inhibition, and gene therapy) must be awaited.¹⁶⁾

Regarding all these aspects for reoperative AVR, which prosthesis is appropriate for a certain patient remains controversial. The present agreement is that mechanical heart valves are durable but thrombogenic, and that bioprosthetic valves are less thrombogenic, but they have limited durability.⁵⁾ Potter et al.³⁾ recommends to implant mechanical valves preferentially in patients who received a mechanical prosthesis at the primary procedure. In patients with previous xenografts, they implanted biologic and mechanical valves at nearly equal rates.³⁾ Nollert et al.⁸⁾ are of the opinion that bioprostheses can generally not be advocated in patients younger than 65 years because accelerated degeneration increases the risk of reoperation in younger patients. In patients with an endocarditis, Rizzoli et al.⁵⁾ recommend the use of unstented biological prostheses or homografts because they may partially neutralize the risk of recurrence. This opinion is supported by Sadowski et al.,¹⁷⁾ who reported on excellent results in 655 patients undergoing AVR with fresh homografts: The 30-day hospital mortality for reoperation was only 2.87% and markedly lower than for the primary procedure (4.31%). The mean durability for all homografts was reported with 12.4 years with cumulative rates for freedom from reoperation at 5-, 10-, 15-, and 20 years of 94.1%, 87.9%, 76.6%, and 49.6%, respectively. Major causes for reoperation were valve degeneration (79.8%) with AV insufficiency in 62.5% and AV stenosis in 17.26%; endocarditis occurred in only 15.1% of all patients. In the opinion of Sadowski et al.,¹⁷⁾ the advantages of human homografts are restoration of normal blood flow in the aortic root, sinuses, and coronary orifices; resistance to infection in patients with endocarditis; and low costs. The disadvantages are the more complicated operative technique, the limited availability, and a suboptimal durability, especially in young patients who are at an increased risk of early homograft degeneration.

Conclusions

Conventional reoperative AVR is associated with an enhanced perioperative risk. Therefore these patients should be referred early for reoperation to avoid high-risk emergency operations with a significantly increased

mortality.

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