Replacement of the aortic root for acute prosthetic valve endocarditis: Prosthetic composite versus aortic allograft root replacement

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Objective: Aortic root replacement for prosthetic aortic valve endocarditis with accompanying destruction of the aortic root is a well-established surgical intervention. However, there is still no consensus whether prosthetic material or allogeneic material should be used. Here we report on our experience with prosthetic composite and aortic allograft root replacement in such patients during a 10-year interval.

Methods: From 1991 through 2001, 29 patients with prosthetic aortic valve endocarditis combined with aortic root destruction underwent reoperation at our institution. Sixteen patients received aortic root replacement with a cryopreserved aortic root allograft (group A) and 13 with a prosthetic composite graft (group B). The interval between the initial operation and reoperation was 29 months (range, 5-168 months) in group A and 55 months (range, 7-248 months) in group B.

Results: Hospital mortality was 18.5% (n = 5 patients, 3 in group A and 2 in group B). Median follow-up was 21 months (range, 1-48 months) for group A and 34 months (range, 1-152 months) for group B ($P > .2$). Survival at 1 and 5 years was $81\% \pm 10\%$ and $81\% \pm 10\%$ in group A and $85\% \pm 10\%$ and $85\% \pm 10\%$ in group B, respectively. No patient underwent reoperation for recurrent prosthetic aortic valve endocarditis.

Conclusions: Our results indicate that excellent long-term results can be achieved regardless of the material used for aortic root replacement in patients with prosthetic aortic valve endocarditis.

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Prosthetic valve endocarditis (PVE) is an important complication after aortic valve replacement. Blumberg and associates¹ described infectious destruction of the aortic root in 56% to 100% of these patients. The associated hospital mortality for these patients can reach as high as 30%.²⁻⁴ Thorough debridement of infected prosthetic material and infected tissue, re-replacement of the entire aortic root, and prolonged antibiotic therapy are all accepted strategies for the treatment of PVE.⁵⁻¹⁰ However, there is still debate whether to use biologic material (homograft, autograft, or xenograft) or prosthetic material in these patients.^{2,5,6,8-16}

In this retrospective study we reviewed the clinical data and outcomes for 29 patients who underwent reoperation for PVE associated with infectious destruction of the aortic root with homograft or composite aortic root replacement from 1991 through 2001 to elucidate whether the material used for aortic root replacement in PVE has any influence on short-term and long-term outcome.

TABLE 1. Patient data and preoperative complications

Characteristic	Group A (n = 16)	Group B (n = 13)	P value
Men (n [%])	13 (81.2%)	10 (76.9%)	>.2
Mean age (y)*	61 (37-72)	48 (23-81)	>.2
Mean follow-up (mo)*	21 (1-48)	34 (1-152)	>.2
Time between initial operation and reoperation (mo)*	29 (5-168)	55 (7-248)	.54
Mean preoperative NYHA functional class	3.7 ± 0.49	3.8 ± 0.45	>.2
Cardiogenic shock (n [%])	2 (12.5%)	2 (15.3%)	>.2
Septic (n [%])	7 (43.8%)	6 (46.1%)	>.2
Septic embolism (n [%])	2 (12.5%)	1 (7.7%)	>.2
Acute renal failure (n [%])	3 (18.8%)	2 (15.3%)	>.2
Preoperative artificial ventilation (n [%])	3 (18.8%)	3 (23.1%)	>.2

NYHA, New York Heart Association.

*Data are expressed as medians with ranges. Note that some patients had more than one preoperative complication.

Material and Methods

In a 10-year period between 1991 and 2001, 29 patients underwent reoperation for PVE with infectious destruction of the aortic root after aortic valve or composite replacement in our institution (6 women and 23 men; mean age, 51 ± 14 years; range, 23-81 years). According to the surgeon's preference, either homograft aortic root replacement (group A, n = 16) or composite aortic root replacement (group B, n = 13) was performed. All patients were in New York Heart Association functional class III and IV preoperatively. Nine patients had severe preoperative complications, such as cardiogenic shock. Patient data, including information on the preoperative complications, are depicted in Table 1.

Sepsis was defined as a temperature of greater than 38°C, increased cardiac output, low systemic vascular resistance, and low oxygen extraction ratio. Acute renal failure was defined as a rapid decrease of glomerular filtration, with a subsequent progressive increase of serum creatinine, blood urea nitrogen, and electrolyte imbalance and the development of metabolic acidosis accompanied by oliguria (<500 mL of urine output in 24 hours) or anuria. Low cardiac output was defined as a mean arterial pressure of less than 60 mm Hg in the presence of a cardiac index of less than 2 L · min⁻¹ · m⁻², with a mean right atrial pressure of 18 mm Hg or greater and a mean left atrial pressure of 18 mm Hg or greater.

Detected Infectious Microorganisms Causing PVE

PVE was caused mainly by *Staphylococcus aureus* (n = 12 [41%]), and in 6 (21%) patients the infectious microorganism could not be detected (Table 2).

Surgical Technique

Operations were performed with moderate hypothermia in 24 (83%) patients. However, in 5 (17%) patients deep hypothermia was chosen for aortic arch surgery. For myocardial protection,

TABLE 2. Organism cultured from blood or intraoperative specimen

Organism	Group A (n = 16)	Group B (n = 13)	P value
<i>Enterococcus faecalis</i> (n [%])	4 (25%)	4 (30.8%)	>.2
<i>Staphylococcus aureus</i> (n [%])	6 (37.5%)	6 (46.1%)	>.2
<i>Candida albicans</i> (n [%])	2 (12.5%)	1 (7.7%)	>.2
Not known (n [%])	4 (25%)	2 (15.3%)	>.2

either cold crystalloid cardioplegia or cold blood cardioplegia was used. The infected prosthetic aortic valves or composite grafts were completely excised. Abscess cavities were opened, curetted, washed out with iodine solution, and filled with a gentamicin-saturated fibrin glue, as described by Karck and coworkers.¹⁷ Macroscopically infected or necrotic tissue was widely resected, regardless of the proximity of the conduction system. Reconstruction of the aortic annulus with autologous pericardium or glutaraldehyde-fixed bovine pericardium was performed in 4 patients (group A, n = 1; group B, n = 3). Homograft implantation into the aortic root was carried out with interrupted monofilament suture material (4-0 Prolene, Ethicon). Mechanical composite grafts (St Jude Medical, n = 3; Carbomedics n = 9; ATS, n = 1) were implanted with single Teflon-armed sutures. Coronary buttons were reimplemented with a continuous monofilament suture (5-0 Prolene, Ethicon). The distal anastomosis was carried out with a continuous monofilament suture (4-0 or 3-0 Prolene, Ethicon). Valve prostheses, Dacron prostheses, and Teflon patches were incubated in gentamicin solution before implantation for 5 minutes.

In addition, the sewing ring of the prosthesis was irrigated with a mixture of fibrin glue and gentamicin before implantation. In 12 (41%) patients additional surgical procedures were performed, as depicted in Table 3.

Postoperative Antibiotic Therapy

Patients received antibiotic therapy specifically directed against the detected microorganisms. If the microorganism could not be isolated, broad-spectrum antibiotic therapy was administered (vancomycin and broad-spectrum gram-negative coverage). In all patients intravenous antibiotic therapy was maintained for 6 weeks postoperatively.

Statistical Analysis

Data are expressed as medians with ranges or as the mean ± SD where appropriate. Demographic and baseline variables were analyzed by using the Student *t* test for continuous variables and the Fisher exact test for qualitative variables. Analysis of survival was performed by using the Kaplan-Meier method. Statistical differences in Kaplan-Meier survival estimates were determined by using the log-rank test. Statistical analyses were performed by using the SPSS for Windows software package (SPSS Inc).

Results

Five (18.5%) patients died during the hospital stay, 3 (18.7%) in group A and 2 (15.3%) in group B. One patient

TABLE 3. Intraoperative data

	Group A (n = 16)	Group B (n = 13)	P value
CPB time (min)*	203 (149-363)	172 (85-268)	.047
Crossclamp time (min)*	132 (97-177)	107 (54-127)	.034
Circulatory arrest (n [%])	3 (18.7%)	2 (15.4%)	>.2
Concomitant procedure			
MVS (n [%])	2 (12.5%)	1 (7.7%)	>.2
Aortic arch replacement (n [%])	2 (12.5%)	2 (15.4%)	>.2
CABG (n [%])	3 (18.7%)	1 (7.7%)	.04

CPB, Cardiopulmonary bypass; MVS, mitral valve surgery; CABG, coronary artery bypass grafting.

*Data are expressed as medians with ranges.

in group A died in the operating room as a result of therapy-refractory low cardiac output syndrome. Two patients in each group died of cardiac causes or multiorgan failure within the first 14 days after the operation. The majority of patients in both groups experienced a complicated postoperative course, and a significant number of postoperative complications were observed (Table 4). The most common postoperative complication in both groups was acute renal failure requiring temporary hemodialysis. The mean stay in the intensive care unit was prolonged in all patients (group A: 5 ± 3 days [range, 2-28 days]; group B: 6 ± 4 days [range, 3-36 days]; $P > .2$).

Median follow-up was 21 months (range, 1-48 months) for group A and 34 months (range, 1-152 months) for group B ($P > .2$). No patients were lost to follow-up. During follow-up, no recurrent prosthetic valve endocarditis was diagnosed, and no patient had to undergo reoperation. Survival at 1 and 5 years was $81\% \pm 10\%$ and $81\% \pm 10\%$ in group A and $85\% \pm 10\%$ and $85\% \pm 10\%$ in group B, respectively ($P > .2$, Figure 1).

Discussion

The results of this study indicate that the material (biologic vs prosthetic) used for aortic root replacement has no effect on hospital mortality, long-term mortality, and the incidence of recurrent PVE in patients requiring redo aortic root surgery for PVE associated with infectious destruction of the aortic root.

The surgical goal in the treatment of PVE combined with infectious destruction of the aortic root is a low rate of recurrent PVE. It has been argued that the use of homograft material as a valve substitute in the setting of PVE with infectious destruction of the aortic root is associated with a lower mortality and a lower incidence of recurrent PVE compared with prosthetic material.⁹⁻¹¹ We were not able to detect any differences regarding hospital mortality between the groups (group A, 18.7%; group B, 15.4%; $P > .2$). The

TABLE 4. Perioperative complications

Complication	Group A (n = 16)	Group B (n = 13)	P value
Hospital mortality (n [%])	3 (18.7%)	2 (15.3%)	>.2
Atrioventricular block III° (n [%])	4 (25%)	2 (15.4%)	.013
Stroke (n [%])	2 (12.4%)	1 (7.7%)	>.2
Acute renal failure (n [%])	7 (43.7%)	8 (61.5%)	>.2
Low cardiac output syndrome (n [%])	3 (18.7%)	4 (30.8%)	>.2
Prolonged artificial ventilation, >48 h (n [%])	6 (37.5%)	8 (61.5%)	>.2

Note that some patients had more than one postoperative complication.

overall mortality in our study cohort of 18.7% is comparable with what other investigators have previously reported. In the most recent studies, hospital mortality for PVE varied between 9.4% and 32%.^{2-4,8-10} Moreover, a meta-analysis from the United Kingdom heart valve registry showed a similar mortality rate averaging 20%.¹⁸ The second important issue in the treatment of PVE beside mortality is the incidence of recurrent PVE. Delay and coworkers¹⁹ demonstrated that surgical intervention for PVE can be performed with no hospital deaths; however, in this study freedom from reoperation was only 45% after 1 year.

We speculate that this might be the result of an intraoperative eradication failure of the underlying organism from the aortic root. In our patient population we had no recurrent PVE with a total follow-up of 47 ± 44 months (range, 1-152 months). Lytle and associates⁹ showed a recurrent rate of 3.8% within 1 year after surgical intervention for PVE by using homograft aortic root replacement as the second procedure. Hagl and colleagues¹⁰ demonstrated, with an almost identical patient cohort, a 4% recurrence rate for PVE after using prosthetic composite graft replacement for the treatment of PVE. In both series the entire aortic root was replaced either with homografts or prosthetic material. These findings might support the strategy of using aggressive surgical intervention to replace the aortic root in patients presenting with PVE. Data comparing the effect of biologic (homograft-autograft) material or prosthetic material on outcome in patients with PVE and infectious aortic root replacement are rare. Haydock and coworkers,¹¹ as well as McGiffin and associates,¹² underlined the advantage of homograft aortic root replacement for PVE associated with annular destruction in a comparative study comparing homograft versus prosthetic aortic replacement for PVE. However, none of these studies were randomized, and the number of patients involved was limited. Recent published studies dealing with the problem of PVE and infectious destruction of the aortic root showed excellent

Figure 1. Survival in patients after prosthetic composite (group A) and aortic allograft root (group B) replacement: replacement for acute prosthetic aortic valve endocarditis.

short-term and long-term results: one group used homograft material, and the other group used prosthetic material for aortic root replacement in the presence of PVE.^{9,10} The results from these studies did not differ in terms of short- and long-term survival or in the incidence of recurrent PVE. From these studies and our own results, we believe that other factors in addition to the material used for the treatment of PVE might influence the outcome. Delahaye and associates²⁰ showed that undue delay of operation for endocarditis is common and that the delay in surgical treatment might result in more severe infectious destruction of cardiac structures, with all resulting consequences. Furthermore, a more aggressive surgical approach to the treatment of PVE seems to influence the outcome.^{10,21} Hagl and associates¹⁰ stressed that patients presenting with PVE combined with infection beyond the valve annulus are best treated with aortic root replacement rather than aortic valve replacement and repair of annular destruction because of decreased hospital mortality after aortic root replacement. In our opinion a radical surgical approach with resection of all infectious and necrotic tissue regardless of the cardiac structures involved followed by complete aortic root replacement might be the clue to success in the treatment for PVE with infectious destruction of the aortic root.

Limitations

We wish to address several limitations. First, the number of patients in each group is too small to draw definite conclusions concerning the material that should be used in PVE with infectious destruction of the aortic root. However, in the most recent publications, the patient cohort with complicated PVE was almost similar to ours.^{6,9,10} Second, patients were not prospectively randomized, and the selection for either homograft or prosthetic aortic root replacement was dependent on the surgeon's preference only. Furthermore, the severity of the infection and the causative microorganism might vary between different patient cohorts.

Conclusions

Keeping all the aforementioned drawbacks of this study in mind, we believe that the material used for aortic root replacement in PVE with infectious destruction of the aortic root has no major effect on postoperative outcome. The strategy of early reoperation for PVE, thorough debridement, aggressive surgical technique, and prolonged antibiotic treatment might reduce mortality and the incidence of early and late recurrent PVE and improve long-term survival.

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