Comparison of Allografts and Prosthetic Valves When Used for Emergency Aortic Valve Replacement for Active Infective Endocarditis

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Aortic valve replacement (AVR) using allografts is an established method of treating aortic valve disease. It is uncertain, however, whether the increased technical demands of allograft AVR can be justified in emergency operations. This study reports 15 patients treated between 1987 and 1990 for acute bacterial or fungal endocarditis involving the aortic valve. Patients underwent emergency AVR because of severe congestive failure, overwhelming sepsis or cerebral emboli. Eight patients received prosthetic valves (group I: 4 mechanical, 4 porcine) and 7 received human allografts (group II: 5 aortic and 2 pulmonary). The groups were comparable in age (group I, 55 years; group II, 51 years), intravenous drug abuse (group I, 1; group II, 3), and previous AVR (group I, 3; group II, 2). One group I and 4 group II patients had septal abscesses. Additional procedures in group I included mitral valve replacement (2), tricuspid valve replacement (1) and aortic root replacement (1). Additional procedures in group II were mitral valve repair (1), root replacement (1), atrial septal defect closure (1) and aortocoronary bypass (1). Mean bypass times (group I, 189 minutes; group II, 204 minutes) and cross-clamp times (group I; 108 minutes; group II, 121 minutes) were similar. Operative deaths occurred in 4 of 8 group I and 1 of 7 group II patients. All surviving patients have been successfully followed (group I, 28 months; group II, 18 months). No group I patient has required reoperation. One group II patient required reoperation for recurrent infection affecting the allograft, and another group II patient died 10 months postoperatively from noncardiac causes. All other group II patients are alive and well with functioning allografts. AVR with allografts can be performed safely in this high-risk patient population.

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Orthotopic aortic valve replacement (AVR) using a human valve allograft was first performed by Ross in 1962.[1] Lau et al[2] and Manhas et al[3] extended this operation to the treatment of endocarditis. Since then, several groups have reported their experience with this technique.[4–6] Allografts may be the preferred substitute for acutely infected aortic valves because of their resistance to infection.[7–8] Despite the successes of allograft AVR for endocarditis, it is likely that most patients requiring emergency operation in this setting are treated with prosthetic valves. It is possible that some surgeons question the appropriateness of performing a more technically demanding procedure on a critically ill patient. In such a patient, the additional time required for proper insertion of an allograft may be thought to compromise the chances for a successful outcome. To evaluate these questions, we have reviewed our results with emergency AVR for endocarditis.

METHODS

Patients: The records of patients undergoing AVR for endocarditis between 1987 and 1990 at 1 institution were reviewed. Patients with valvar disease resulting from previous endocarditis that had resolved by the time of operation, patients treated for an extended period with antibiotics to permit AVR under better conditions, and patients with negative blood and valve cultures at operation were excluded from the study. All patients included in this series required emergency operation for 1 or more clinical criteria: intractable congestive failure, overwhelming sepsis, or documented cerebral emboli attributed to valvar vegetations. Records were examined for preoperative information including demographic data, predisposing factors to endocarditis, bacteriologic findings, and cardiac evaluation by echocardiography and cardiac catheterization. Operative

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TABLE I Patient Data: Allograft Versus Prosthetic Valves for Aortic Valve Replacement for Active Infective Endocarditis

Pt. No.	Age (yr) & Sex	Predisposing Factors	Blood Cultures	Indications for Operation	Operative Findings	Gram Stain of Valve
			Group I			
1	77 M	Aortic stenosis	S. aureus	Congestive failure	Vegetations	Not performed
2	69 F	Previous AVR	S. aureus	Congestive failure	Abscess	Gram + cocci
3	47 M	i.v. drug abuse	Str. sanguis	Sepsis	Vegetations	Gram + cocci
4	65 M	Aortic stenosis	Str. bovis	Congestive failure	Vegetations	Not performed
5	47 M	0	Str. hyacis	Congestive failure	Vegetations	Gram + cocci
6	69 F	Previous AVR	S. aureus	Congestive failure	Vegetations	Not performed
7	44 M	Previous AVR	S. aureus	Sepsis	Vegetations	Gram + cocci
8	25 F	i.v. drug abuse	S. aureus	Cerebral embolism	Vegetations	Gram + cocci
			Group II			
9	50 F	Aplastic anemia; Hickman catheter	Str. faecalis	Congestive failure	Abscess	Not performed
10	62 M	Previous AVR	C. albicans	Sepsis	Vegetations	Yeast forms
11	59 F	Aortic stenosis	Str. faecalis	Cerebral embolism	Vegetations	Gram + cocci
12	62 F	Atrial septal defect	S. aureus	Cerebral embolism	Abscess Atrial septal defect	Not performed
13	58 F	i.v. drug abuse	Str. faecalis	Congestive failure	Abscess	Gram + cocci
14	24 F	Previous AVR	S. aureus	Congestive failure	Abscess Aorta-RA fistula	Gram + cocci
15	42 M	i.v. drug abuse	S. aureus	Congestive failure	Vegetations	Gram + cocci

AVR = aortic valve replacement; C. = candida; i.v. = intravenous; RA = right atrial; S = staphylcoccus; Str. = streptococcus.

TABLE II Operative and Postoperative Data

Pt. No.	Replacement Valve	Bypass Duration (min)	Ischemia Duration (min)	Other Procedures	Operative Result	Long-Term Result
			Group I			
1	Porcine	137	100	0	Died	—
2	Porcine	220	145	0	Died	—
3	Porcine	109	60	0	Survived	Alive and well 25 mo. po
4	Mechanical	116	71	0	Survived	Alive and well 26 mo. po
5	Mechanical	211	156	Mitral valve replacement	Survived	Alive and well 26 mo. po
6	Mechanical	358	93	Aortic root replacement	Died	—
7	Mechanical	227	158	Mitral valve replacement	Survived	Alive and well 34 mo. po
8	Porcine	130	83	Tricuspid valve replacement	Died	—
			Group II			
9	Allograft PV	277	114	Mitral valve repair	Survived	Alive and well 21 mo. po
10	Allograft AV	216	135	0	Died	—
11	Allograft PV	190	137	Aortocoronary bypass X2	Survived	Alive and well 8 mo. po
12	Allograft AV	164	120	Atrial septal defect closure	Survived	Alive and well 13 mo. po
13	Allograft AV	214	125	0	Survived	Alive; late repeat AVR 24 mo. po
14	Allograft AV	228	127	Aortic root replacement	Survived	Died 10 mo. po of noncardiac causes
15	Allograft AV	140	87	0	Survived	Alive and well 18 mo. po

AV = aortic valve; AVR = aortic valve replacement, po = postoperatively; PV = pulmonary valve.

findings, techniques and results were noted. Pathologic and bacteriologic analyses of operative specimens were reviewed.

The choice of valve substitute was made by the surgeon before beginning the operation. The decision to use or not to use an allograft valve was based on the surgeon's experience with and confidence in these materials, and did not reflect any other patient selection factors such as age, cardiac function, hemodynamic instability or associated procedures required. In only 1 case was this decision altered. One patient for whom an allograft was intended had an aortic anulus that exceeded the size of any available allograft. This patient therefore received a porcine valve. For patients in whom an allograft valve was selected, an aortic valve allograft was used when possible. When no aortic allograft was available in the correct size, a pulmonary valve allograft was used instead. Mechanical or bioprosthetic valves were selected in non-allograft recipients based on criteria such as patient age, contraindications to anticoagulation, possible desire for pregnancy, and ability to comply with a medical regimen. Antibiot-

ic coverage was instituted at diagnosis and continued for 6 weeks postoperatively. Postoperative data were obtained by outpatient follow-up in our clinic, or by phone with the patient and the patient's personal physician. No patient was lost to follow-up.

RESULTS

Of 15 patients who met the criteria for emergency AVR for endocarditis, 12 underwent operation within 24 hours of diagnosis, all within 48 hours. Eleven patients were taken to the operating room immediately after cardiac catheterization, echocardiography or computerized tomography. Data are summarized in Tables I and II. Eight patients (group I) underwent AVR with a prosthetic valve (4 mechanical, 4 bioprosthetic valves) and 7 patients (group II) underwent AVR with a cryopreserved human aortic valve (5) or pulmonic valve (2).

Group I included 5 men and 3 women and group II included 2 men and 5 women. Groups I and II were similar in mean age (group I, 55 years; group II, 51 years), frequency of intravenous drug abuse (group I, 1 patient; group II, 3 patients), and history of previous AVR with a prosthetic valve (group I, 3 patients; group II, 2 patients). A comparison of patients with native valve endocarditis to those with prosthetic valve endocarditis is listed in Table III. Cardiopulmonary bypass times were significantly longer in patients with prosthetic valve endocarditis, but no other statistically significant differences were found. Additional operative findings were septal abscess in 1 group I and 4 group II patients, mitral valve endocarditis in 1 group I and 1 group II patient, atrial septal defect in 1 group II patient, and aorta-right atrium fistula in 1 group II patient. All patients had positive blood cultures at the time of operation. Cultures of valvar vegetations or blood, or both, in group I patients were positive for Staphylococcus aureus in 5 patients, and for Streptococcus sanguis, Streptococcus bovis, and Streptococcus hyacis in 1 patient each. Cultures in group II patients were positive for Staphylococcus aureus in 3 patients, Streptococcus faecalis in 3, and Candida albicans in 1. All staphylococcal species were sensitive to methicillin.

Additional procedures performed in group I patients included replacement of the mitral valve (2), tricuspid valve (1) and aortic root (1). Additional procedures in group II were mitral valve repair (1), aortic root replacement (1), atrial septal defect closure (1) and coronary artery bypass × 2 (1). Mean duration of cardiopulmonary bypass (group I, 189 minutes); group II, 204 minutes) and aortic cross-clamping (group I, 108 minutes; group II, 121 minutes) were not significantly different.

Perioperative deaths occurred in 4 of 8 group I patients and in 1 of 7 group II patients. Three group II patients with septal abscesses required insertion of permanent pacemakers for complete heart block. Two had documented heart block preoperatively. No other significant complications were encountered. All patients with focal neurologic injury attributed to preoperative emboli exhibited improvement after AVR, and no new neurologic problems were encountered.

TABLE III Comparison of Patients Undergoing Operation for Native Versus Prosthetic Valve Infections

	Native Valve Infection	Prosthetic Valve Infection
Number of patients	10	5
Age (years)	53 ± 4	54 ± 8
Indications for operation		
Congestive failure	6	3
Sepsis	1	2
Cerebral emboli	3	0
Patients requiring additional procedures	5	3
Cardiopulmonary bypass duration (min)	169 ± 17	250 ± 24*
Cardiac ischemic duration (min)	105 ± 10	132 ± 10
Operative results		
Survived	8	2
Died	2	3
Long-term results		
Well *without reoperation*	7	1
Well after reoperation	1	0
Late death	0	1

*p = 0.02. Values are mean ± standard error of the mean.

Mean duration of follow-up has been 28 months in group I and 18 months in group II. One group II patient, who continued to use intravenous drugs, developed recurrent endocarditis 6 months after allograft AVR. This patient was successfully treated medically, and cardiac catheterization demonstrated competence of her allograft valve. She presented to another hospital 18 months after allograft AVR with severe aortic insufficiency. At reoperation, she was found to have a perforation of 1 valve leaflet. Blood and valve cultures at operation were negative. Her allograft was replaced with a porcine valve in accordance with the preference of the surgeon treating her at that time. One group II patient died in a motor vehicle accident 10 months after AVR. All other group I and II patients are alive and well, without evidence of valve dysfunction.

DISCUSSION

The frequency of endocarditis may be increasing, perhaps due to nosocomial infections resulting from invasive procedures, immunosuppressed states and intravenous drug abuse, among other factors. In addition, a substantial percentage of all endocarditis is encountered among patients with previously inserted prosthetic valves. The bacteriologic characteristics of endocarditis are changing as well. Although the frequency of Streptococcus viridans endocarditis appears to be decreasing, this may actually reflect an increasing frequency of other organisms.[9] Thus, the need for operative intervention will likely increase as well. Most patients with endocar-

ditis are best treated nonoperatively unless there is a specific indication for operation. However, endocarditis associated with severe aortic insufficiency and congestive failure is fatal in 40 to 93% of patients without surgical treatment.[9] Endocarditis with septic emboli, overwhelming sepsis, intracardiac abscess, conduction disturbance, resistant organisms, suppurative pericarditis or clinical deterioration despite appropriate antibiotics are other indications for AVR.

When operation is indicated for endocarditis, it is preferred that antibiotics be used to control the infection, so that valve replacement may have the highest probability of success.[10,11] However, inappropriate delay to achieve bacteriologic "cure" may carry excessive risk.[12] The operative mortality of valve replacement for active endocarditis is 3 to 4 times that for controlled infection.[11,13] The patients in this series represent the extreme portion of the endocarditis spectrum. All of these patients required emergency operation because of specific clinical findings (hemodynamic collapse, cerebral emboli or septic shock) that were contraindications to even a brief trial of nonoperative therapy. Reports of surgical intervention for active endocarditis often have included patients who underwent operation after lengthy antibiotic therapy[14] as well as patients with moderate congestive heart failure as an indication for operation.[13] Nevertheless, reported operative mortality for valve replacement for endocarditis has been as high as 30%.[11,13-16]

Comparison of published series is made difficult by the wide differences in definitions. "Early" operations for endocarditis have included patients treated for 1 week to 2 months after diagnosis.[17-19] Most series describing emergency valve replacement for endocarditis report high frequencies of death and early reoperations.[13,20,21] However, there are reports of patients undergoing emergency valve replacement for endocarditis with survival of ≥90%.[22,23]

In such an emergency setting, the selection of valve replacement may be influenced by perceived difficulties related to the patient's condition and to technical problems. Considerations of long-term valve function, hemodynamic performance, resistance to reinfection and freedom from anticoagulant therapy may be subordinate to accomplishing an expeditious procedure and improving the patient's chances of operative survival. Although allografts are more resistant to infection, use of allografts requires greater ischemic time and more precise operative technique. As a result, the use of aortic valve allografts for AVR may be questioned.

The results of this series suggest allografts are acceptable replacements even in the most seriously ill patients with endocarditis. Bypass and ischemic times were not significantly greater in allograft recipients. Long-term results of allograft AVR in this setting remain unknown, although our only patient requiring late reoperation continued to use intravenous drugs after her AVR. The 1 operative death among allograft recipients occurred in a patient with fungal infection of a prosthetic valve, a condition that is fatal in 80 to 90% of cases.[24,25]

AVR for endocarditis was first described in 1965.[26] Allograft AVR for endocarditis was first reported in 1970.[3] In 1984, Ross's group described aortic root replacement with an allograft for prosthetic valve endocarditis.[2] Since then, others have established the efficacy of allografts for both freehand AVR and aortic root replacement in endocarditis.[4-6] The advantages of allografts in patients with endocarditis include resistance to reinfection, easier management of root abscesses, and success in severe endocarditis where prosthetic valves have failed.[27] These advantages are amplified by the excellent performance of allografts with respect to hemodynamics, durability and freedom from thromboembolism. Long-term follow-up after valve replacement for active endocarditis is important. The 5-year survival in these patients is 40 to 79%, with a reoperation rate as high as 13%.[16,19,28] Allografts may improve these long-term results. The use of pulmonary valve allografts for AVR has rarely been reported.[29] Pulmonary allografts require more precise technique because they are less rigid, and their long-term durability is uncertain. However, pulmonary allografts may calcify less than aortic allografts.[30]

In treating endocarditis surgically, the replacement material used is only one factor affecting the results. Prompt intervention, adequate debridement, obliteration of fistulas, resection of mycotic aneurysms, secure suture placement and antibiotic treatment are unquestionably of greater importance. The operative outcome is also heavily dependent on the patient's underlying condition and left ventricular function. We believe the results of this study support the use of allografts for emergency AVR for endocarditis. Further use and more long-term follow-up are needed to fully evaluate the benefits of this approach.

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