

Mitral valve replacement

Results 20 years after operation¹

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Records of the first 100 patients surviving operation for total mitral valve replacement at The Cleveland Clinic Foundation (1962–1964) were reviewed to determine long-term results. After 20 years, 15 patients were still alive, but 13 had sustained a major cardiac event. Complications related to lack of anticoagulant therapy for patients with mechanical prostheses were frequent. No patient-related variable examined appeared to preclude 20-year survival.

Index term: Mitral valve, surgery

Cleve Clin Q 52:369–373, Fall 1985

Mitral valve replacement is done to relieve the symptoms and alter the unfavorable natural history associated with severe mitral valve dysfunction. Total replacement of the mitral valve with a prosthesis was successfully accomplished by Starr in 1960,¹ and in 1962, it was used at The Cleveland Clinic Foundation. Therefore, we now have a vantage point of more than 20 postoperative years from which to view the results of mitral valve replacement. Profound changes in operative techniques have made the perioperative results of those early procedures inapplicable to current practice. Nor will the long-term results accurately predict the fate of current surgical candidates since operative techniques can influence late results and the prostheses implanted today are much different from earlier models. Extended follow-up of patients from an earlier surgical period, however, may provide perspective about the evolution of valve replacement and highlight the reasons that

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0009-8787/85/03/0369/05/\$2.25/0

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Table 1. Perioperative complications

	No. of patients
Myocardial infarction	4
Cardiovascular accident	
Permanent	4
Transient	10
Ventricular arrhythmias or fibrillation	20
Heart block	6
Respiratory failure	8
Low-output state	5
Re-exploration for bleeding	8

our attempts at palliation may fail. This study reviews the results 20 years after valve replacement for the first 100 patients who survived operation for mitral valve replacement at The Cleveland Clinic Foundation.

Materials and methods

By review of operative and patient records, the first 100 consecutive patients who underwent mitral valve replacement and survived the hospital course were surveyed. These patients underwent surgery between May 1962 and September 1964; an additional 14 patients undergoing mitral valve replacement during the same interval did not survive operative hospitalization. Patients undergoing concomitant operations on other valves were excluded.

Preoperative and operative data were obtained from hospital records. Follow-up of survivors was carried out by trained research assistants between January and August 1984. Data regarding non-survivors were obtained from family members, hospital records, and the records of the patients' personal physicians.

Definitions used in categorizing the cause of late death have been published previously for sudden death, myocardial infarction, congestive heart failure, and ventricular arrhythmias.² Patients who died of a clinical syndrome that appeared cardiac in nature but could not be categorized precisely due to unavailable data were classed into a group titled "undocumented probable cardiac death." Criteria used for definitions of late cardiac events have also been published previously.² With the exception of cardiac reoperation, only the first nonfatal cardiac event involving each patient was recorded in actuarial computations. Details of all operations were recorded.

Study group

The 100 patients in the study group were 15 to 63 years of age at operation (mean age, 45 years). There were 57 women (mean age, 45 years) and 43 men (mean age, 46 years). The preoperative New York Heart Association (NYHA) functional class was II in 19 patients, III in 69, and IV in 12. Thirty-one patients had undergone previous mitral valve surgery.

Preoperative cardiac catheterization was performed in 91 patients and coronary arteriography in 79. Six patients had at least one critical ($\geq 70\%$) coronary lesion: 4 had one-vessel disease, 1 two-vessel disease, and 1 three-vessel disease. Nine patients had noncritical coronary lesions. Mitral valve lesions determined clinically and angiographically included regurgitation in 28 patients, stenosis in 24, and mixed lesions in 48. Seventy-one patients had had atrial fibrillation preoperatively. The cause of mitral disease was rheumatic in 73 patients, myxoid degenerative in 25, ischemic in 1, and congenital in 1.

At operation, a Starr-Edwards 6000-type mitral valve prosthesis was used in 92 patients and a Starr-Edwards flange-type (disc) prosthesis in 8. In 10 patients, a left atrial thrombus was removed. One patient received a concomitant internal mammary artery implant (Vineberg procedure). Fifty-three patients suffered one or more perioperative complications (Table 1). Sixteen patients were receiving warfarin when discharged from the hospital, while the others were not taking anticoagulants.

Late results

Survival

All survivors were followed for 20 years (Fig 1). Forty-eight survived for five years, 29 for 10 years, and 15 for 20 years. Among the 20-year survivors, the mean age at operation was 38 (range, 25–52 years); the preoperative rhythm was atrial fibrillation in 8 patients and sinus rhythm in 7; the preoperative valve lesion was insufficiency in 4 patients, stenosis in 3, and mixed in 8; and 5 patients had undergone previous mitral valve commissurotomy. All survivors had received a Starr-Edwards 6000-model caged-ball valve and 2 had undergone left atrial thrombectomy. Of the 20 patients documented to have postoperative in-hospital ventricular arrhythmias (multiple premature ventricular contractions,

ventricular tachycardia, or ventricular fibrillation), 18 died, 6 within a year of operation.

Of the 9 patients with noncritical coronary artery disease, none were late survivors. Of the 6 patients with at least one critical coronary lesion, 2 are late survivors. Both patients had single-vessel disease; 1 had internal mammary artery implantation at the time of mitral valve replacement, and the other underwent reoperation for bypass grafting 128 months after valve replacement.

Causes of death are listed in *Table 2*. Postmortem examinations were performed in 29 cases. Six deaths were considered noncardiac. The 22 deaths occurring the first postoperative year were categorized as sudden death in 5, congestive heart failure in 4, paravalvular leak in 3, acute myocardial infarction in 2, undocumented probable cardiac death in 3, systemic embolism in 2, stroke in 1, endocarditis in 1, and cerebral hemorrhage in 1. The 14 deaths which occurred more than 10 years after operation were classified as noncardiac in 3; stroke in 3; congestive heart failure in 2; undocumented probable cardiac death in 2; and sudden death, endocarditis, valve thrombosis, and death at cardiac reoperation in 1 each.

Of the 16 patients taking anticoagulants at discharge, 6 discontinued warfarin and died shortly thereafter; 3 of the 10 patients who continued to take warfarin are 20-year survivors. Many patients who were not taking warfarin on discharge were subsequently given anticoagulants after the occurrence of nonfatal events. Fifty-one patients were taking warfarin when they died. Thirteen of the 20-year survivors are taking warfarin, but 2 take dipyridamole only.

Nonfatal events: event-free survival

Sixty-nine patients suffered major nonfatal events; the initial major nonfatal events are listed in *Table 3*. In addition, 31 patients suffered transient neurologic events prior to the occurrence of a major event. Transient neurologic events were excluded when determining event-free survival. Two patients survived 20 years without a major cardiac event, but both experienced transient neurologic events.

Nine patients underwent cardiac reoperation, 5 involving mitral valve procedures. Four patients were reoperated on for prosthetic mitral valve thrombosis at 7, 107, 214, and 222 months

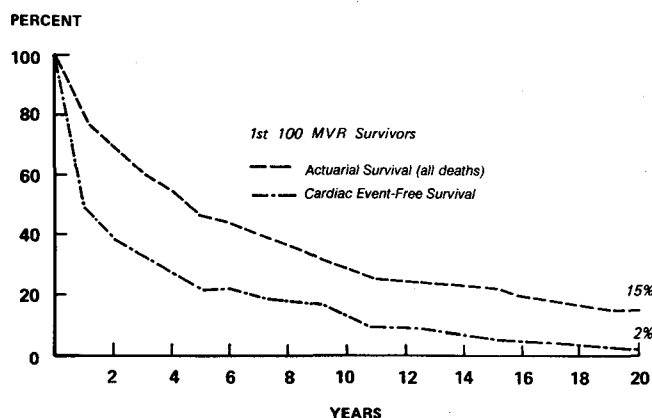


Fig. 1. Survival (Kaplan-Meier) and event-free survival for 100 consecutive in-hospital survivors (1962-1964).

Table 2. Causes of death

	No. of patients
Cardiac	
Undocumented probable cardiac death	21
Sudden death	15
Congestive heart failure	9
Myocardial infarction	7
Stroke	7
Prosthetic valve thrombosis	3
Prosthetic valve leak	6
Ventricular arrhythmias	3
Endocarditis	2
Cerebral hemorrhage	2
Noncerebral embolus	2
Death during cardiac reoperation	2
Noncardiac	
Trauma	3
Cancer	2
Hepatic failure	1

Table 3. Initial nonfatal cardiac events

	No. of patients	No. of patients on warfarin
Major neurological event (permanent stroke)	31	3
Noncardiac embolus	12	0
Myocardial infarction	7	3
Severe symptoms	11	4
Congestive heart failure	6	0
Reoperation	2	0

after surgery. Two died at reoperation, 1 died late after reoperation, and 1 is a 20-year survivor. One patient underwent reoperation for a mitral paravalvular leak at five postoperative months and is a 20-year survivor. Three repeat procedures were for operations on other valves (two

for aortic valve replacement and one for aortic and tricuspid replacement), and one was done for coronary bypass grafting. No deaths occurred during these reoperations, and 3 of the 4 patients are 20-year survivors.

Nine of the 15 survivors are asymptomatic; 4 have NYHA class II symptoms and 2 have class III symptoms. Of the 7 patients in sinus rhythm preoperatively, 5 are still in sinus rhythm 20 years later.

Discussion

Results of operations performed from 1962 to 1964 cannot be used to predict the outcome for patients undergoing valve replacement in 1985. The imperfect operative results from this early era of valve replacement contributed to late morbidity and mortality. Six patients who died without undergoing reoperation had paravalvular leakage which appeared to contribute significantly to the hemodynamic difficulties that caused their death (*Table 2*). The 1 patient who did undergo reoperation for closure of a paraprosthetic leak is a 20-year survivor.

Thromboembolic complications had a major impact on these patients. Early in the history of total prosthetic valve replacement, it was not clear that anticoagulation with warfarin would lower morbidity and mortality for patients with mechanical prostheses, and most patients in this series were given warfarin only after the occurrence of a nonfatal embolic event. Fourteen late deaths were clearly related to embolic or thrombotic phenomena. It is also important to remember that with or without autopsy data, it is not always possible at an interval of up to 20 years to accurately assign a pathologic cause of late death; some fatalities categorized as undocumented probable cardiac death, sudden death, acute myocardial infarction, and congestive heart failure were probably thromboembolic in nature. Other studies of patients receiving the Starr-Edwards 6000-type prosthesis have noted a lower late mortality than in our series up to 10 postoperative years, a difference most likely due to more consistent strategies of anticoagulation.^{3,4} The importance of anticoagulant therapy for patients with mechanical prostheses has been previously demonstrated for those with aortic valve prostheses.²

Between 10 and 20 years after operation, the mortality rate diminished. Fifty-one percent of

patients alive at 10 years survived to 20 years. Over that second postoperative decade, a smaller proportion of deaths were due to causes apparently valve-related, probably because by 10 postoperative years almost all survivors were taking anticoagulants.

Focus on the long-term survivors teaches us what can be achieved by mitral valve replacement. Of the 15 20-year survivors, 9 are asymptomatic, although all have experienced either a major cardiac event or a transient neurologic episode. The 20-year survivors had had a younger average age at operation than did the nonsurvivors, and more of them had had sinus rhythm preoperatively. Patient-related variables, such as previous valve surgery, atrial fibrillation, preoperative functional class IV, left atrial thrombus, hemodynamic valve lesions, ventricular arrhythmias, and coronary atherosclerosis have not precluded the possibility of 20-year survival in our series.

Of the 15 late survivors, 6 underwent interim reoperation (2 for mitral valve-related problems within a year of the primary operation). The other 4 patients underwent repeat surgery more than 10 years postoperatively, and only 1 for a mitral valve lesion. Thus, the value of cardiac reoperation is underscored.

Although by 20 postoperative years, the cumulative morbidity and mortality of these patients were high, many problems were due to complications related to the combination of mechanical valvular prostheses and suboptimal anticoagulation strategies—factors over which we have some control. Patients with mechanical prostheses should receive warfarin. The use of bioprostheses in the form of porcine and bovine heterografts represents an attempt to decrease prosthesis-related and anticoagulant-related complications. Current data suggest that that approach has had some benefit.^{5,6} Recent reviews of patients followed after valve replacement combined with coronary bypass grafting indicate that placement of bioprostheses in either the aortic or the mitral position increased late survival for at least five postoperative years, provided patients did not take warfarin on a permanent basis.^{2,5} There is a big difference between a five-year and a 20-year follow-up, and because of tissue degeneration in primary valve failure of bioprostheses, most patients may need reoperation by the 20-year mark. However, effective intraoperative myocardial protection has contributed to a recent

decrease in operative risk for many types of valve operations, and it is our opinion that a low risk of elective mitral valve reoperation can keep valve failure from heavily influencing late mortality. This review demonstrates that nothing about the intrinsic nature of mitral valve disease makes 20-year postoperative survival impossible, and with improved prostheses and a low risk of reoperation, we think it can be made probable.

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