Aortic valve replacement in elderly patients with aortic stenosis

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Abstract

***Objective*—To assess the risk of aortic valve replacement and long-term follow-up in elderly patients with dominant aortic stenosis.**

***Design*—Retrospective analysis of patients who had aortic valve replacement over a 10 year period and were routinely seen in an outpatient clinic.**

***Setting*—University hospital.**

***Patients*—93 patients aged ⩾ 60 and 47 patients ⩾ 70 years with symptomatic aortic stenosis undergoing aortic valve replacement.**

***Main outcome measures*—Early and late mortality in different age groups. Influence of preoperative signs and symptoms on overall outcome.**

***Results*—The proportion of patients older than 70 years increased from 11% in 1978 to 54% in 1986. Perioperative mortality was 3·6% and mortality after 2 and 5 years was 9% and 13% respectively. Survival was similar (85% and 83%, respectively) in patients aged 60–69 years (group 1, n = 93, mean age 64·5 (2·7) and patients aged ⩾ 70 years (group 2, n = 47, mean age 72·6 (2·5)). Additional coronary artery disease and coronary bypass grafting did not significantly affect survival. The cardiothoracic ratio was inversely related to survival (Cox regression, p < 0·05). Preoperative symptoms (syncope, angina pectoris, and dyspnoea) were similar in both patient groups. After a mean (SD) follow up of 51 (33) months 96% of surviving patients were in NYHA functional class I or II with no difference between the two age groups. Similarly, the cardiothoracic ratio and Sokolow index decreased to near normal values in both age groups.**

***Conclusion*—The risk of aortic valve replacement in patients with dominant aortic stenosis is low and not significantly influenced by age. Therefore replacement may be performed without increased risk in elderly patients and with a good long-term outcome.**

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In Europe and the United States aortic stenosis has become the most common valve disease in adults.[1] The clinical spectrum of aortic stenosis has shifted from post-inflammatory to degenerative lesions and aortic stenosis is most prevalent in older patients.[1 2] Aortic stenosis is a progressive disease[3 4] that progresses more rapidly in patients with degenerative calcifying aortic stenosis and in older patients.[2 5] Because valve replacement is the only effective treatment and because older patients are increasingly presenting with symptomatic aortic stenosis we assessed early and late mortality and improvement of symptoms in elderly patients with dominant aortic stenosis undergoing aortic valve replacement. We also evaluated the influence of preoperative signs and symptoms on overall outcome.

Patients and methods

PATIENTS

A total of 140 patients aged ⩾ 60 years (range 60–81 years, 96 men and 44 women) with dominant, symptomatic aortic stenosis underwent aortic valve replacement in our hospital between 1977 and 1986. All had angina pectoris or dyspnoea or both and 73% were in NYHA functional class III or IV. There was a history of syncope in 42% and concomitant aortic regurgitation in 87%. Operation was elective in 134 and urgent in six patients. All patients were operated on by the same surgical team using standard cardiopulmonary bypass and cold blood potassium cardioplegia in 108 patients for myocardial protection or coronary perfusion at the beginning of the study period in 32 patients. We used an interrupted suture technique. Mechanical prostheses were implanted in 119 (St Jude-Medical in 59, Björk-Shiley in 40, Omnicarbon in 13, Duromedics in six, and Starr-Edwards in one) and bioprostheses were used in 21 patients (Ionescu-Shiley in 17, and Carpentier-Edwards in four).

Bioprostheses were used only when long-term anticoagulation with warfarin was contraindicated or patients were not expected to outlive the tissue prostheses.

PREOPERATIVE INVESTIGATIONS

Left heart catheterisation was performed preoperatively in all patients for direct measurement of aortic pressure gradient (pull-back method) and assessment of concomitant coronary artery disease, aortic regurgitation, and left ventricular ejection fraction.

Coronary artery disease was defined as narrowing by 75% or more of the lumen of at least one vessel. Aortic regurgitation was graded angiographically: as grade I (just visible contrast regurgitation), grade II (contrast regurgitation to the apex, but fully washed out

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after each ejection), grade III (contrast accumulation), and grade IV (free aortic regurgitation).

FOLLOW UP

After discharge patients were routinely seen in our outpatient clinic 3 and 12 months after operation and usually every year thereafter. We reviewed their records for symptoms (syncope, angina pectoris, dyspnoea), clinical findings, cardiothoracic ratio on chest x rays and 12 lead surface ECG preoperatively, at discharge, 3 months postoperatively, and at the last available follow up (at a mean of 51 (33) months after operation).

The following perioperative complications were assessed: newly developed atrial fibrillation present at discharge, bradycardia requiring pacemaker implantation, ventricular arrhythmias (ventricular tachycardia and ventricular fibrillation), bleeding requiring reoperation, myocardial infarction, stroke, haemodynamically significant pericardial effusion, pneumonia, wound infections, and sternal wound revision.

Survival was assessed as time from operation to last follow up examination. For patients not reporting for the last, scheduled visit, the time of death was ascertained by asking the patient's private physician or relatives.

At the last follow up examination patients were also asked to judge their improvement in physical limitation after operation as excellent/good, satisfactory, or unsatisfactory.

STATISTICAL ANALYSIS

Values are given as mean (SD). Student's t test, Chi square test, and repeated measures analysis of variance (ANOVA) were used as appropriate. Survival rates were calculated according to the method of Kaplan-Meier. The influence of age, preoperative NYHA functional class, ejection fraction, calculated aortic valve area, left ventricular pressures, presence of coronary artery disease and concomitant bypass grafting on survival was estimated using the Cox proportional hazard model. All calculations were performed using the Systat statistical package. p Values of $< 0{\cdot}05$ were regarded as statistically significant.

Table 1 Preoperative signs and symptoms in 140 patients with dominant aortic stenosis

	Group 1 (60–69 yr)		Group 2 (≥ 70 yr)		
Variable	*n*	*Result*	*n*	*Result*	*p Value*
Age (years) (mean (SD))	93	64·5 ± 2·6	47	72·6 (2·5)	0·0001
Sex (M/F)	93	68/25	47	29/18	0·17
Syncope	93	37 (40%)	47	22 (47%)	0·62
Angina pectoris (NYHA III/IV)	93	38 (41%)	47	21 (45%)	0·83
Dyspnoea (NYHA III/IV)	93	60 (65%)	47	29 (62%)	0·85
Heart rate (bpm) (mean (SD))	93	76 (14)	47	75 (12)	0·76
Cardiothoracic ratio (mean (SD))	90	0·53 (0·06)	45	0·53 (0·06)	0·75
Sokolow index (mV) (mean (SD))	84	3·9 (1·2)	39	4·3 (1·8)	0·15

Numbers of patients available for evaluation are indicated.

Table 2 Preoperative haemodynamic findings in 140 patients with dominant aortic stenosis

	Group 1 (60–69 yr)		Group 2 (≥ 70 yr)		
Variable	*n*	*Result*	*n*	*Result*	*p Value*
PCWP (mm Hg)	65	17 (10)	33	18 (8)	0·62
EF ((%) RNA)	12	56 (19)	13	50 (15)	0·40
EF ((%) Cath)	34	53 (18)	16	55 (19)	0·80
Systolic BP (mm Hg)	83	138 (24)	44	142 (34)	0·41
Diastolic BP (mm Hg)	83	73 (12)	44	69 (14)	0·10
LVSP (mm Hg)	59	212 (32)	33	214 (42)	0·80
LVEDP (mm Hg)	55	31 (10)	30	26 (10)	0·04
Δ P syst (mm Hg)	58	74 (26)	31	72 (26)	0·95
AVA (cm^2)	41	0·48 (0·16)	25	0·45 (0·18)	0·54
CI ($l/min/m^2$)	79	2·90 (0·70)	35	2·80 (0·80)	0·48
Aortic regurgitation	92	83 (90%)	47	40 (85%)	0·62
CAD	93	31 (33%)	47	19 (40%)	0·74

Numbers of patients available for evaluation are indicated, PCWP, pulmonary capillary wedge pressure; EF, ejection fraction; RNA, radionuclide angiography; Cath, left heart catheterisation; BP, aortic blood pressure; LVSP, left ventricular peak systolic pressure; LVEDP, left ventricular end diastolic pressure; Δ P syst, systolic pressure gradient; AVA, aortic valve area; CI, cardiac index; CAD, coronary artery disease.

Results

The mean age of the study population was 67·2 (4·6) years. Ninety three patients were aged 60–69 (mean 64·5 (2·6)) years (group 1) and 47 patients were 70–81 (mean 72·6 (2·5)) years (group 2). The proportion of patients ≥ 70 years increased from 11% in 1978 to 54% in 1986.

PREOPERATIVE FINDINGS AND SYMPTOMS

Table 1 summarises the preoperative characteristics of the patients. There were no significant differences in sex distribution; incidence of syncope, severe angina pectoris, and dyspnoea; and heart rate between the age groups. The cardiothoracic ratio and Sokolow-index were increased in both groups, indicating similar degrees of left ventricular hypertrophy.

Preoperative haemodynamic findings (table 2) were also similar in both groups except for left ventricular end diastolic pressure which was slightly but significantly higher in group 1 patients ($p < 0{\cdot}05$). The peak-to peak pressure gradient over the aortic valve was similar in both age groups (table 2).

The ejection fraction measured by left ventriculography during left heart catheterisation (mean 54%, range 18–82%) and by radionuclide angiography (mean 52%, range 15–82%) was similar in both age groups and was < 40% in 28% of group 1 and 24% of group 2.

Concomitant aortic regurgitation was present in 87%. The frequency and severity of concomitant aortic regurgitation were similar in both groups: grade I, II, and III regurgitation was seen in 22%, 25%, and 40% of group 1 patients and in 21%, 32%, and 32% of group 2 patients respectively. Grade IV regurgitation was not seen. The cardiothoracic ratio was similar in patients with grade III (0·53 (0·67)) or lesser degrees of aortic regurgitation (0·52 (0·51) NS).

Coronary artery disease was present in 33% of group 1 patients (8% had three vessel disease), and in 40% of group 2 patients (13% had three vessel disease, NS). Revascularisation procedures were performed in 25 of 30 group 1 and in 12 of 19 group 2 patients ($p = 0{\cdot}11$, χ^2).

IN-HOSPITAL PERIOPERATIVE COMPLICATIONS

The length of hospital stay was similar in both groups (20·6 (5·8) days in group 1 and 22·5 (16·4) days in group 2). In total, there were

Table 3 In-hospital complications in 140 patients undergoing aortic valve replacement

Complications	*Events (n)*
New atrial fibrillation	12
Ventricular arrhythmias (VT/VF)	6 (1)
Bleeding requiring reoperation	5
Stroke	3 (1)
Reoperation because of subvalvar obstruction	2
Perioperative infarction	2 (1)
Pneumonia	2 (1)
Sternal wound revision/ wound infection	3
Aortic rupture	1 (1)
Persistent III degree AV block	1
Severe right heart failure	1
Pericardial effusion requiring pericardiocenteses	1
Total	39 (5)

Numbers in parentheses and deaths attributable to the respective complication. AV, atrioventricular; VF, ventricular fibrillation; VT, ventricular tachycardia.

39 perioperative complications (table 3). Complications were as common in the younger patients (n = 26, 28%) as in the older patients (n = 13, 28%).

FOLLOW UP

Six patients were lost to follow up. Follow up was somewhat shorter in group 2 patients because in recent years more elderly patients had operations (4·6 (2·9) years in group 1 and 3·5 (2·3) years in group 2 (p = 0·03)).

There were two (1·4%) operative deaths, both in group 1, and hospital mortality (all deaths within 30 days including operative deaths) was 3·6% (n = 5), with no significant difference between group 1 (n = 4, 4·3%) and group 2 (n = 1, 1·9%).

During long-term follow up 16 patients died. There was a total of 21 deaths, with cardiac deaths in seven patients (33%). Four patients (19%) died of major bleeding (two intracerebral haemorrhages (one early, one late), one trauma, and one from aortic rupture); three patients (14)% died of cancer; two (10%) died from pneumonia (one early, one late) and in five patients (24%) the mode of death was not known.

Thus the probability of survival 1, 5, and 8 years after operation was 92·6% (125 patients at risk), 84·1% (n = 55), and 75·5% (n = 20) respectively for all patients. Figure 1 shows that the probability of survival was not significantly different in the older and the younger patient groups.

Of all factors evaluated only the preoperative cardiothoracic ratio was an independent predictor for survival in the Cox regression analysis (p = 0·04). Age, preoperative NYHA classification of angina pectoris and dyspnoea, ejection fraction, calculated aortic valve area, preoperative systolic and end diastolic left ventricular pressure, coronary heart disease, and bypass grafting were not significant determinants.

Figure 2 shows the changes in functional NYHA class, cardiothoracic ratio, and Sokolow index. At discharge NYHA limitations caused by angina pectoris or dyspnoea

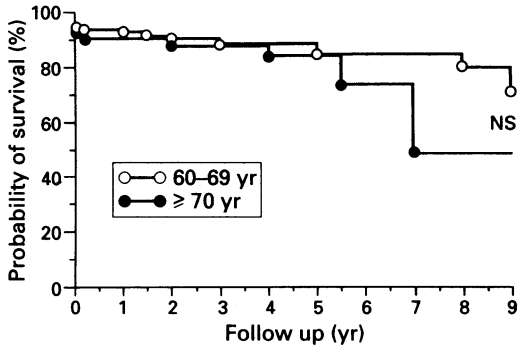

Figure 1 Probability of survival after aortic valve replacement was similar in patients aged 60–69 years or ⩾ 70 years.

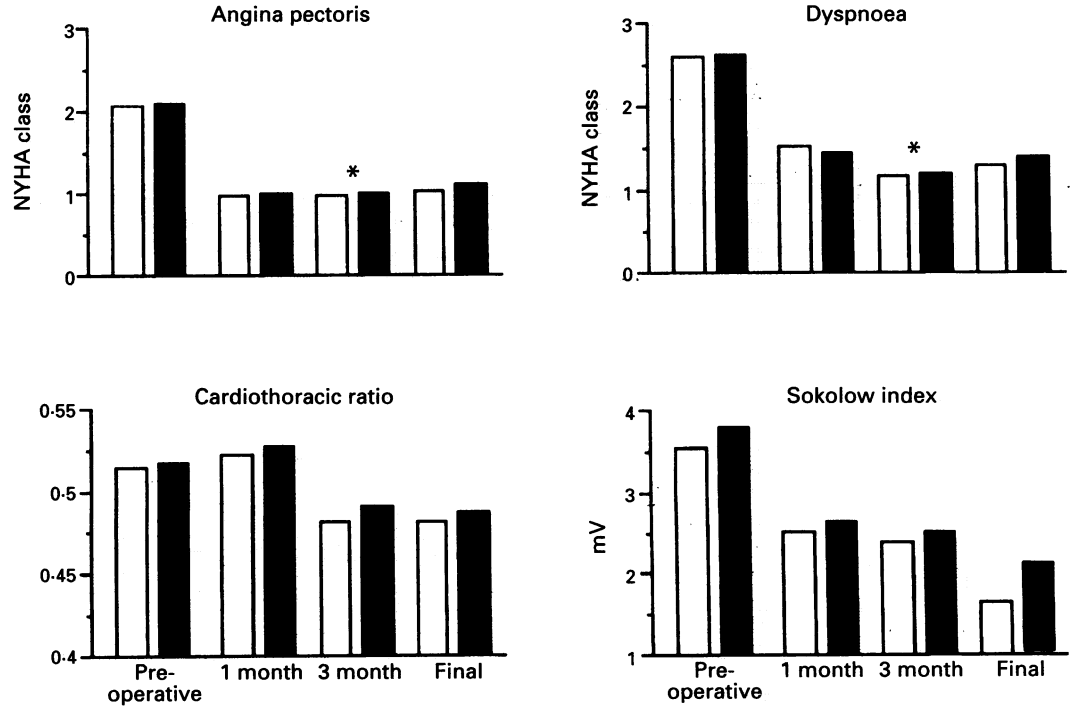

Figure 2 Preoperative and postoperative NYHA classification of angina pectoris, dyspnoea, cardiothoracic ratio, and Sokolow index in patients aged 60–69 years or ⩾ 70 years. Assessment was performed before operation, 1 and 3 months after surgery, and at final follow up examination. Both age groups showed persistent and similar decreases in signs and symptoms over time (p < 0·01, ANOVA).*

had already decreased similarly in both age groups and there were no significant differences after 3 months and at the last follow up examination (repeated measures ANOVA). Similarly the cardiothoracic ratio decreased in both age groups after discharge to normal or near normal values and then remained unchanged until the last examination. The Sokolow index decreased progressively up to the last examination in both groups, but remained slightly higher in the older patient group at the last examination (fig 2).

At last follow up examination 91% of surviving patients reported an excellent or good improvement in physical capacity, 8% judged it as satisfactory, and only one patient (group 2) judged it to be unsatisfactory (corresponding values for groups 1 and 2: 90·6%, 9·4%, 0% *v* 93%, 5·7%, 2·3%, NS).

Discussion

In the early days of aortic valve replacement, overall in-hospital mortality was 7–12%,[6–8] and in patients over 60 years of age it was as high as 20%.[6 9–15] Depending on age at operation, preoperative condition, and time of follow-up long-term mortality ranged from 4·6% to 10·4% per year.[13 16–23] Since then surgical outcome has improved substantially as the result of advances in anaesthesia, myocardial protection, and postoperative care.[24–27]

Our data in an elderly population with dominant aortic stenosis accord with these trends towards improved survival and show a low perioperative (3·6%) and long-term mortality (13% at 5 years, hospital deaths included) after aortic valve replacement, irrespective of age. The low perioperative mortality may be due in part to the low incidence of urgent operations, because the risk is higher with urgent surgery.[28–30] In terms of the severity of preoperative symptoms (NYHA class III and IV impairment in 73%) the overall outcome in our patients was particularly good, and compares well with recent reports in which patients were clearly younger.[24 25]

Aortic valve replacement has also been reported in patients considerably older than ours.[30–32] The early mortality (5·7%[32] and 30%[30]) suggested, not unexpectedly, that the risk in octogenarians was substantially higher than in our study group of patients aged between 70 and 80 years. However, late survival has also been reported to be excellent in such patients[31 32] and in one instance was found to be even better than that of an age and sex matched control group.[31]

Our data show also that quality of life and functional capacity improved substantially in all patients. Thus at the last follow up examination 91% of surviving patients reported good or excellent improvement in their physical capacity and 96% were in NYHA functional class I or II compared with NYHA III or IV in 73% before operation. The cardiothoracic ratio decreased to normal or near normal values within 3 months in both groups, whereas left ventricular hypertrophy seemed to regress progressively up to the last examination. This continuing reduction of left ventricular hypertrophy accords with a study in which angiographically assessed left ventricular muscle mass fell continuously during a follow up of up to 70 months after aortic valve replacement.[33 34]

Because there are no alternatives to valve replacement our results and those of others are particularly encouraging. The benefits of balloon dilatation of the aortic valve were short-lived: in a recent report restenosis occurred in over 50% of patients within one to two years. Furthermore, the best long-term results were obtained in patients who would have been expected to have excellent long-term results after aortic valve replacement.[35]

PREDICTORS OF MORTALITY AND LONG-TERM SURVIVAL

We found that the cardiothoracic ratio was the only independent predictor of survival in a Cox regression model that evaluated nine clinical and haemodynamic variables. Similar observations have been reported before,[16 24 25] but unlike others[21 24 25 30 36 37] we did not identify additional predictors such as preoperative ejection fraction, coronary artery disease, NYHA classification, or presence of atrial fibrillation.[38] On theoretical grounds significant concomitant aortic regurgitation might lead to a greater increase in cardiothoracic ratio that might explain the impact of cardiothoracic ratio in our study. However, the cardiothoracic ratio in our patients with grade III regurgitation was no different from that in patients with lesser degrees of regurgitation. The discrepancies between our findings and those of others may also be explained in part by the fact that many of the variables shown to be significant by univariate analysis may not be by the multivariate analysis that we used. Moreover, patients with either dominant aortic stenosis or dominant aortic regurgitation were sometimes assessed jointly[24] despite the fact, that the two lesions differ in many aspects. Furthermore, we measured preoperative ejection fraction only in 75 of our 140 patients. However, in a report on open chest cardiac surgery in octogenarians the ejection fraction was predictive of early mortality but not of late mortality.[31] We, like others,[39–41] found that concomitant coronary artery disease or coronary artery bypass grafting did not significantly affect survival. In contrast, others found that late mortality was higher in patients with aortic stenosis who had concomitant coronary artery disease than in those who had stenosis alone[42 43] and the Veterans Administration valve study identified the presence of three vessel disease as the most powerful independent predictor of hospital mortality after aortic valve replacement.[36] Similarly, operative risk was higher in combined aortic and coronary artery disease[44] and in patients undergoing additional coronary artery bypass grafting.[27 31 32 45] This discrepancy cannot readily be explained but it may arise because only 9% of our patients had three vessel disease. Furthermore, coronary artery bypass grafting was less likely to be

performed in those of our patients who were older than 70. This approach is supported by a recent review that questioned the evidence that coronary artery bypass grafting at the time of aortic valve replacement does indeed improve survival.[46]

Aortic stenosis is increasingly a disease of the elderly. Aortic valve replacement is the only successful treatment and it has become a safe procedure even in elderly patients with advanced functional impairment. Long-term survival and quality of life after aortic valve replacement in patients with dominant aortic stenosis are excellent, and advanced age alone should not be regarded a contraindication for aortic valve replacement in otherwise healthy patients.

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