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Aortic valve replacement in the octogenarians: perioperative outcome and clinical follow-up*

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Abstract

Objectives: To determine long-term results of aortic valve replacement (AVR) in patients 80 years old or older, and assess the factors influencing perioperative outcome. **Methods:** Data were reviewed on 83 consecutive octogenarians, undergoing aortic valve replacement between 1992 and 1997. There were 66 women and 17 men (mean age: 82.8 years). Fifty-seven patients (69%) were in New York Heart Association (NYHA) class III-IV and six had previous myocardial infarction. Three patients had previous percutaneous aortic valvuloplasty. There were 19 urgent procedures (23%). Coronary artery bypass grafting (CABG) was performed on 21 patients (25%). Possible influence of preoperative and operative variables on early and late mortality was performed with univariate and multivariate statistical analysis, and survival was estimated with the Kaplan-Meier method. **Results:** Operative mortality was 13% (9% for AVR, 24% for AVR-CABG). Postoperative complications were respiratory failure in 19 patients, atrial fibrillation in 19, hemodialysis in four, myocardial infarction in four and stroke in two patients. Five patients required pacemaker insertion for permanent atrioventricular block. Median hospital stay and intensive care unit stay were 19.8 ± 12.2 days and 7.9 ± 3.4 days, respectively. Multivariate predictors of hospital death ($P < 0.05$) were percutaneous aortic valvuloplasty, NYHA class IV, and urgent procedure. Mean follow-up was 26.5 months. Survival at 1,2, and 5 years was 98.5 ± 1.4% (63 patients at risk), 93.4 ± 3.2% (47 patients at risk), and 78.2 ± 6.9% (six patients at risk), respectively. Preoperative myocardial infarction and urgent procedure were independent predictors of late death. At most recent follow-up, 91% were angina free and 81% were in class I—II. **Conclusions:** Aortic valve replacement in octogenarians can be performed with acceptable mortality. These results stress the importance of early operation on elderly patients with aortic valve disease. Both long-term survival and functional recovery are excellent.

Keywords: Aortic valve ; cardiac surgery ; octogenarians ; quality of life

1. Introduction

The increase in life span of European and American populations over the past decades has resulted in a significant increase in the number of people aged over 80 years. Based on statistical data derived from population studies, life expectancy varies from an average of approximately 8.1 years at the age of 80 years to 6 years at the age of 89 years [1].

With this ageing of the population and the greater use of non-invasive diagnostic techniques, particularly echocar-diography with two-dimensional Doppler ultrasonography, the diagnosis of symptomatic aortic valve disease, particularly aortic stenosis, is becoming increasingly common [2].

Recent reports reveal that cardiac operations for selected elderly individuals who have otherwise good physical and mental health can improve mortality, morbidity and quality of life [3-6]. However, the outcomes remain not completely defined, especially for valve procedures.

To analyse these issues further, we have reviewed our early and long-term results in patients aged 80 years and over who underwent aortic valve replacement (AVR) at our institution, between January 1992 and November 1997.

2. Methods

2.1. Patients

Records of 83 patients who underwent AVR, with or without concomitant procedures, were reviewed. A total of 46 preoperative, operative and postoperative variables were recorded. Follow-up information was obtained from all hospital survivors through clinic visits and annual letters, and was 100% complete. Mean follow-up was 26.5 months, and cumulative follow-up was 206 patient-years. Between February and March 1998, all known

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survivors were questioned to determine general health status, presence or absence of chest pain, dyspnea or angina pectoris, postoperative New York Heart Association (NYHA) functional class and quality of life.

Table 1 *Patient clinical characteristics. MI, myocardial infarction; COPD, chronic obstructive pulmonary disease.*

Variable	**No. of patients (%)**
Men	17 (21)
Women	66 (79)
Age (years)	82.8 ± 2.2
Status - elective	64 (77)
Status - urgent	19 (23)
New York Heart Association - class III	31 (37)
New York Heart Association - class IV	26 (31)
Previous MI	6 (7)
Diabetes mellitus	9 (11)
Hypertension	33 (40)
Hypercholesterolemia	8 (10)
Smoking	7 (8)
COPD	3 (4)
Preoperative atrial fibrillation	13 (16)
Preoperative pacemaker	8 (10)
Renal insufficiency	3 (4)
Previous vascular surgery	6 (7)
Prior percutaneous aortic valvuloplasty	3 (4)

Coronary artery disease was defined as a reduction of vessel diameter by at least 50% in one view on coronary angiography. Stenosis to this degree in the left anterior descending system, circumflex system, or right coronary system was used for the criterion of single, double, or triple vessel disease. Urgent operations were defined as operative procedures performed in patients whose accelerated symptoms prompted urgent hospital admission for evaluation and who were judged to be too unstable for discharge before surgery. Operative mortality was any death occurring within 30 days of the operation or death during the same hospital admission as the operation. Postoperative course was followed up in terms of bleeding, cardiac and renal status, assisted ventilation duration and neurological events. Congestive heart failure was determined by the presence of pulmonary congestion or opacities consistent with oedema on chest roentgenograms. Perioperative myocardial infarction was defined as either a new Q wave or the elevation of the myocardial fraction of creatinine kinase in association with persistent ST segment changes or a new conduction abnormality. Stroke was defined as any neurologic deficit lasting longer than 24 h, even if the deficit resolved before hospital discharge.

Anaesthesiological protocol was the same throughout this period, extracorporeal circulation was performed with a membrane oxygenator, and myocardial protection used cold crystalloid cardioplegia solution added to topical cooling.

2.2. Statistical analysis

Distribution for all relevant variables was expressed either as percentages or as mean ± SD. The effects of nominal risk factors, such as the presence of angina, on early mortality were evaluated univariately with χ^2 test or Fisher's exact test. The effects of continuous variables, such as age, were univariately evaluated with two-sample *t*-tests or with Wilcoxon rank sum tests when necessary. Combinations of risk factors were multivariately evaluated with multiple logistic regression models. Survivorship to death, for all patients and for all hospital survivors, was estimated with the Kaplan-Meier method. To assess separately those risk factors related to late survival as distinct from operative deaths, we analysed only hospital survivors. Nominal risk factors for survival were assessed with log-rank tests. Continuous measurable risk factors, such as age, and combinations of risk factors, both nominal and continuous, were evaluated with Cox's proportional hazard models. A P value < 0.05 was considered statistically significant.

3. Results

3.1. Patient population

The population consisted of 83 consecutive patients ranging in age from 80 to 89 years who underwent AVR, either alone or in combination with other procedures. Clinical characteristics of these patients are listed in Table

1. Most common presenting symptoms were dyspnea on exertion in 70 patients (84%), congestive heart failure in 51 patients (61%), angina in 48 patients (58%), and syncope in 21 patients (25%).

Assessment of left ventricular function showed that six patients (7%) had poor function, defined as an ejection function of <35%. Mean ejection fraction was 58.8 ± 13.7%. Mean valve area was 0.52 ± 0.02 cm^2, mean valve gradient was 66.0 ± 17.7 mmHg. Mean LVEDP was 22.3 ± 7.8 mmHg. Twenty-one patients (25%) had significant coronary artery disease.

Aortic stenosis was the predominant valvular lesion in 64 patients (77%), followed by combined aortic stenosis and insufficiency in 18 patients (22%) and aortic insufficiency in one patient. Valvular disease involved calcified lesions in 80 patients (96%), bicuspid valve in 12 patients (14%), myxo-matous degeneration in seven patients (8%), rheumatic disease in two patients (2%), and endocarditis in one patient.

Stented bioprostheses were implanted in 74 patients (89%), stentless bioprostheses in seven patients (8%), and mechanical valves in two patients (2%). Average valve size was 21.1 mm. Additional CABG was performed in 21 patients (25%), respectively for one-vessel disease in 10 (11%), two vessels disease in eight (10%), and three vessels disease in three (4%). Mean cardiopulmonary bypass time was 103.5 ± 40.5 min, and mean aortic cross clamp time was 66.0 ± 21.4 min.

Table 2 *Operative results*

Variable	**No. of patients (%)**
Death	11 (13)
Stroke	2 (2.4)
Myocardial infarction	4 (5)
Pneumonia	13 (15)
Prolonged mechanical ventilation (>48 h)	19 (23)
Pacemaker	5 (6)
Dialysis	4 (5)
Arrhythmias	22 (26.5)
Re-exploration for bleeding	3 (3.6)
Sternal wound reoperation	1 (1.2)
Pericardial drainage	3 (3.6)
Length of stay (days)	19.8 ± 12.2
Prolonged stay (>14 days)	38 (46)

3.2. Postoperative complications

Early postoperative complications are listed in Table 2. Arrhythmias occurred in 22 patients (26.5%), of whom 19 had atrial fibrillation or supraventricular tachycardia, and three had ventricular tachycardia. Among 19 patients (23%) requiring prolonged (>2 days) mechanical ventilation, 13 (15%) had pneumonia. Two patients (2.4%) developed cerebrovascular accident, of which one completely recovered before hospital discharge. Thirty patients (36%) had no postoperative complications. Length of hospital stay averaged 19.8 ± 12.2 days, including two patients with stays longer than 50 days.

3.3. Hospital mortality

Hospital deaths occurred in 11 patients (13%), of which nine (10.8%) represent 30-day mortality. Of the 11 patients, three were men and eight were women. Five patients were operated on urgently and six were operated on electively. Six patients had aortic valve replacement alone, and five had combined AVR-CABG. Seven patients were NYHA class IV. Three patients with previous percutaneous aortic valvuloplasty died. Causes of hospital death were myocardial infarction in four patients, respiratory insufficiency in four, and multisystem organ failure in three patients. Univariate analysis of 46 perioperative variables showed four variables (Table 3) associated with operative mortality. Only three variables, NYHA functional class IV, urgent procedure, and previous percutaneous valvuloplasty remained statistically significant independent variables predicting early mortality on multivariate logistic regression analysis.

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Table 3 *Preoperative variables of operative mortality. MI, myocardial infarction; NYHA, New York Heart Association.*

Variable	Univariate analysis (*P* value)	Multivariate analysis (*P* value)
Previous percutaneous valvuloplasty	0.002	0.01
Preoperative MI	0.006	0.052
NYHA functional class	0.011	0.035
Urgent procedure	0.028	0.02

3.4. Late mortality

Seventy-two patients were discharged from hospital. A total of 11 patients had died at follow-up. Cardiac causes resulted in four deaths (36.5%), and non-cardiac causes resulted in seven deaths (63.5%). Long-term survival after aortic valve replacement is depicted in Fig. 1. For hospital survivors, survival at 1, 2 and 5 years was 98.5 ± 1.4% (63 patients at risk), 93.4 ± 3.2% (47 patients at risk), and 78.2 ± 6.9% (six patients at risk), respectively. Univariate analysis of 40 preoperative variables showed five variables associated with late mortality (Table 4). Two variables, urgent procedure and preoperative myocardial infarction, remained statistically significant as independent predictors of late mortality by multiple Cox-regression.

Fig. 1. *Survival curve of all 83 patients and of 72 hospital survivors aged 80 years and older undergoing AVR.*

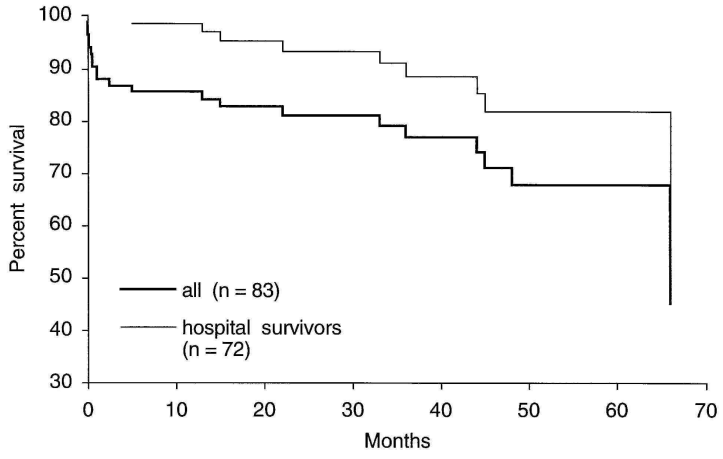

Table 4 *Perioperative variables of late mortality among hospital survivors. AS, aortic stenosis; AI, aortic insufficiency; MI, myocardial infarction; EF, ejection fraction.*

Variable	Univariate analysis (*P* value)	Multivariate analysis (*P* value)
Preoperative MI	0.009	0.003
Urgent procedure	0.012	0.035
Preoperative pacing	0.012	0.35
AS and AI	0.026	0.22
EF <35%	0.042	0.64
Stented bioprostheses	0.065	0.34

3.5. Quality of life assessment

We did not experience valve-related complications, such as thromboembolism, bleeding events, prosthetic valve endocarditis, structural failure or reoperation.

At the time of follow-up, NYHA functional class and activity level also were assessed. The majority of patients were in NYHA class I (41/61, 67%) and class II (15/61, 25%). Patient activity level was rated as heavy, defined as running or lifting heavy objects; moderate, defined as ability to do cleaning; light, defined as activities of daily living; and bedridden. Patients often rated their activity level as heavy (13/61, 21%), or moderate (29/61,

48%). Among the 61 long-term survivors, 92% believed that having heart surgery after age 80 years was a good choice, and similarly 88% felt as good as, or better than they had preoperatively.

4. Discussion

The elderly population continues to expand in western countries, and acquired heart disease is a leading cause of death among the elderly [7]. Because aortic valvular disease remains a common problem in the elderly, increasing numbers of elderly patients are presenting for surgical evaluation of symptomatic valve disease. Controversy continues to exist as to whether aortic valve replacement represents a prudent expenditure of health-care resources in this population [5,8,9].

The natural prognosis of severe aortic stenosis is ominous: 90% of patients with angina and syncope died within 3 years of the onset of symptoms and if heart failure was present, death occurred within 2 years [10]. Balloon aortic valvuloplasty has been proposed as an alternative to operation in the treatment of aortic valve stenosis [11]. Nevertheless, published hospital mortality ranged from 3 to 10% [12,13], and hospital morbidity from 10 to 25%. Furthermore, immediate restenosis (within 72 h) occurred in 25% of patients, and 66% had restenosis within 6 months [13]. Survival curves showed less than 80% survival at 1 year, and functional improvement did not occur in all patients [13].

Early reports of AVR in elderly patients showed high operative mortality rates; however, recent reports have shown mortality rates of 2-10% for isolated AVR [14,15]. In a recent study by Akins et al. [14], hospital mortality in 105 octogenarians who had isolated AVR was 7.6%. Similarly, Tseng et al. [16] reported a 6.1% operative mortality among 247 elderly patients (70-89 years old) who underwent isolated AVR.

Our hospital mortality for 62 patients who underwent isolated AVR was 9%. These results show that AVR can be performed with an acceptable risk in patients older than 80 years of age. Significant improvement in surgical outcome has been ascribed to advances in myocardial protection, anaesthesia and postoperative critical care.

We sought to define risk factors that would be predictors of early death in this elderly population. Multivariate logistic regression analysis showed that the only preoperative risk factors associated with operative mortality were NYHA functional class IV, previous percutaneous valvuloplasty, and urgent procedure. After surgery, myocardial infarction was harbinger of a poorer outcome. Poor left ventricular function was also predictive of hospital death in two series, respectively from the Texas Heart Institute [15] and from the John Hopkins Hospital [16]. Elayada et al. [15] also found hypertension and concomitant surgical procedures to be associated with early mortality. Galloway et al. [17] showed emergency operation, isolated aortic regurgitation and previous cardiac operation to be predictive of operative mortality. It is important to note that in our experience, previous aortic valvuloplasty was an independent factor predicting operative mortality. However, it is possible that those patients were initially felt to be poor surgical candidates.

In our series, age itself was not a predictor. Similarly, age was not a predictor in the recent study by Tseng et al. [16].

Our postoperative complication rate was somewhat high (64%). Pulmonary insufficiency or infection was one of the leading causes of postoperative morbidity. In these elderly patients, we are now having encouraging results with partial sternotomies, early extubation (less than 6 h postoperatively) and more vigorous pulmonary toilet. Among the 22 patients who developed postoperative arrhythmias, 19 had atrial fibrillation or supraventricular tachycardia that was rapidly treated with either intravenous antiarrhythmic agents or cardioversion. The incidence of other postoperative complications such as stroke, dialysis, myocardial infarction, or reoperation, was comparable with other recent reports [14,16].

For hospital survivors, survival at 1, 2, and 5 years was 98.5 ± 1.4%, 93.4 ± 3.2%, and 78.2 ± 6.9%, respectively. These survival rates are comparable with other studies and show good long-term survival despite advanced age [15,16,18].

In our study, previous myocardial infarction and urgent procedure were preoperative risk factors predictive of late mortality, by multivariate analysis. These results suggest that elderly patients should be referred for operation as early as possible to prevent urgent operations or advanced stage disease. Urgent operation also was predictive of late mortality in other recent studies [13,19]. When survival was stratified based on urgency of operation, our survival for elective surgery was 98.1 ± 1.9%, 96.0 ± 2.8% and 87.1 ± 6.5% at 1, 2, and 5 years, respectively, as compared with 92.8 ± 6.9%, 83.6 ± 10.8% and 42.7 ± 16.7% at 1, 2, and 5 years, respectively, for urgent operations. Clearly, referral of elderly patents before end-stage disease requiring urgent operations is paramount to long-term survival.

Of at least equal importance to the elderly as survival, is quality of life. In this study, 92% of long-term survivors believed in retrospect that having decided to have cardiac surgery after age 80 years had been a good choice. Furthermore, at a mean follow-up of 26.5 months postoperatively, 72% of survivors were still living at home or

with their families. Finally, we did not experience valve-related complications, such as bleeding events, thromboembolism, prosthetic valve endocarditis, structural failure or reoperation.

We currently believe the bioprosthetic valve is the safest cardiac valve substitute in the octogenarians. A report by Jamieson et al. [20] states that structural deterioration of tissue valves is limited in the elderly population. Because systemic anticoagulation is rarely required, bioprosthetic valves have a reduced incidence of haemorrhagic and thrombotic complications compared with mechanical valves [21]. Furthermore, the use of stentless valves allows for implantation of larger prostheses, which in our study has beneficial effects on long-term survival, however, without reaching statistical significance.

Aortic valve replacement combined with coronary artery bypass grafting resulted in a 24% early- and a 12.5% late-mortality. This is noticeably higher than the 6.3% early mortality recently reported by Akins et al. [14], but comparable to the 28% early and 40% late mortality reported by Fiore et al. [22], which, however, is a somewhat older series. Our higher operative mortality could, in part, be explained by the significant preponderance of women (4:1). In other reports, female sex has been an independent predictor of both early and late mortality in the elderly, both for isolated AVR [23], and for AVR with CABG [24].

Conventional practice suggests that revascularization should be performed at the time of aortic valve replacement if major coronary artery stenosis is present, regardless of the presence or absence of angina [25]. Reports [26] in younger patient populations indicate that myocardial revascularization does not increase the operative mortality of valve replacement, and the functional result may be improved by relieving the symptoms of angina and providing improved myocardial protection. This aggressive approach requires prolonged ischemic time and may not be appropriate in the octogenarians. We now tend to believe that in octogenarians, only those with critical (> 80%) coronary lesions or severe angina should undergo concomitant coronary bypass grafting. Less than complete revascularization may be an acceptable alternative in this elderly subset of patients when congestive heart failure is a primary indication for operation.

In summary, AVR can be performed in patients 80 years or older with acceptable mortality, good long-term results and good quality of life. Preoperative risk factors associated with early mortality involve previous percutaneous valvuloplasty and NYHA functional class IV, whereas myocardial infarction was a predictor of late mortality. Urgent procedure was an independent predictor of both early and late mortality.

We believe octogenarians with aortic valve disease should not be denied the benefits of surgery if they are reasonably good surgical candidates, are physiologically and mentally able to withstand the stress of surgery and have good motivation for an improved life style.

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