

Aortic Valve Replacement in Octogenarians With Severe Aortic Stenosis. Experience in a Series of Consecutive Patients at a Single Center

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Introduction and objectives. Greater life-expectancy has led to an increase in the incidence of severe aortic stenosis, which accounts for a significant proportion of the workload of cardiology departments. With the imminent arrival of percutaneous aortic valve prostheses, it is important to know how effective surgery currently is in octogenarians.

Methods. The study included all patients aged ≥ 80 years with severe aortic stenosis who underwent cardiac catheterization prior to aortic valve replacement between May 1996 and May 2006. The percentage of patients who underwent surgery, outcomes at 30 days, long-term survival, and predictors of mortality were analyzed.

Results. Of the 137 patients evaluated, 104 (75.9%) underwent surgery, while 33 did not due to a low ejection fraction or severe chronic bronchitis, or because the patient's family did not give consent. The patients' mean age was 81.7 (1.5) years, 61.5% were female, 18.4% had diabetes, 7.8% had had a previous infarction, and 32.7% had coronary disease. Three patients (2.9%) had a perioperative myocardial infarction, 6 (5.8%) had a stroke, and 6 (5.8%) had a permanent pacemaker. Four patients (3.8%) died during the first 30 days. The survival rates at 1, 2, 3, 4, 5, and 6 years were 90 (2.9), 81 (4.2), 78 (4.8), 75 (5.3), 65 (7.2), and 60 (8.2)%, respectively. The following predictors of long-term mortality were identified: creatinine level, emergency surgery, and reintervention because of bleeding. Some 76.3% of patients remained in New York Heart Association functional class I-IV.

Conclusions. Aortic valve replacement can be performed successfully in patients aged ≥ 80 years with severe aortic stenosis; the complication rate was low, and the survival rate and long-term results were good. Predictors of mortality in this series were the creatinine level, emergency surgery, and reintervention because of bleeding.

Key words: Aortic valve stenosis. Surgery. Prognosis. Survival.

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Cirugía de recambio valvular por estenosis aórtica severa en mayores de 80 años. Experiencia de un centro en una serie de pacientes consecutivos

Introducción y objetivos. El aumento de la expectativa de vida ha incrementado la incidencia de estenosis aórtica severa, que representa un volumen importante en la actividad de los servicios de cardiología. Con la inminente llegada de las prótesis aórticas percutáneas es necesario conocer los resultados actuales de la cirugía en octogenarios.

Métodos. Desde mayo de 1996 hasta mayo de 2006 se estudió a todos los pacientes ≥ 80 años con estenosis aórtica severa que fueron remitidos para la realización de un cateterismo cardíaco. Se analizaron el porcentaje de pacientes operados, la evolución a los 30 días y la supervivencia a largo plazo, así como los predictores de mortalidad.

Resultados. De 137 pacientes, 104 (75,9%) fueron operados y 33 rechazados por baja fracción de eyección, bronquitis crónica severa y negativa de la familia. La edad era de $81,7 \pm 1,5$ años, el 61,5% era mujer, el 18,4% tenía diabetes, el 7,8% infarto previo y el 32,7%, enfermedad coronaria. Hubo 3 (2,9%) casos de infarto perioperatorio, 6 (5,8%) accidentes cerebrovasculares y 6 (5,8%) marcapasos definitivos. Cuatro (3,8%) pacientes fallecieron en los 30 primeros días y la supervivencia a 1, 2, 3, 4, 5 y 6 años fue del $90 \pm 2,9$, $81 \pm 4,2$, $78 \pm 4,8$, $75 \pm 5,3$, $65 \pm 7,2$ y $60 \pm 8,2\%$, respectivamente. Los predictores de mortalidad a largo plazo fueron: concentración de creatinina, cirugía urgente y reexploración por sangrado. El 76,3% de los pacientes se mantuvo en grado funcional I-IV de la New York Heart Association.

Conclusiones. Los pacientes ≥ 80 años con estenosis aórtica severa pueden ser tratados con recambio valvular con una baja incidencia de complicaciones, buena supervivencia y resultados funcionales a largo plazo; los predictores de mortalidad en nuestra serie fueron las concentraciones de creatinina, la cirugía urgente y la reexploración por sangrado.

Palabras clave: Estenosis valvular aórtica. Cirugía. Pronóstico. Supervivencia.

ABBREVIATIONS

SAS: severe aortic stenosis
 NYHA: New York Heart Association
 AVR: aortic valve replacement

INTRODUCTION

The steady increase in life expectancy and improvements in the efficacy and usefulness of non-invasive diagnostic techniques has led to cardiology and heart surgery services witnessing a progressive increase in the number of octogenarian patients with surgically treatable heart disease. The number of patients >70 years accounts for more than 30% of the surgical activity in some heart surgery centers.¹ Although a difference between so-called chronological and biological age may often be found, the ability of the elderly patient to cope with a major physiological insult, such as heart surgery, is low due to existing comorbidity, limited functional reserve of vital organs and reduced defense and adaptation capacity.²

Coronary heart disease and valvular disease, alone or combination, are the most frequent reason for heart surgery in this population group as reported in several published series. Severe calcific aortic stenosis (SAS) is the most frequent valvular heart disease found in octogenarians and its prevalence steadily increases with age, from 2.5% at 75 years to 8.1% at 85 years.³ It accounts for 60%-70% of the interventions conducted in octogenarians,² but, despite the good results recently reported in heart surgery patients ≥80 years, the decision on whether to perform aortic valve replacement (AVR) remains difficult for the physician and patient.⁴ On the other hand, with the immanent arrival of percutaneous aortic valve prostheses,⁵ it is important to know the outcomes of AVR such that, as a reference standard, a comparative analysis can be made of the new techniques and their applicability in the elderly patient.

The aims of this study are: *a)* to analyze the long-term results of AVR due to SAS in a consecutive series of patients ≥80 years in a tertiary care center; and *b)* to identify the predictors of total mortality in this series.

METHODS

Patients

All patients ≥80 years with SAS who had undergone coronary catheterization prior to AVR between May 1996 and May 2006 were included in the study. Details of the

patients who did not finally undergo surgery were recorded and the reason for not proceeding with surgery analyzed. The remaining group, which underwent AVR with or without coronary revascularization, formed the study population.

The demographic and preoperative characteristics of the patients were obtained from the catheterization laboratory database, where they had been prospectively recorded. The remaining variables were collected by reviewing the clinical records in the clinical records and data archives unit. The variables selected for study were based on those included in the EuroSCORE and Parsonet scales for evaluating surgical risk,^{6,7} as well as other predictors mentioned in previous studies and those meeting the authors' criteria.

Follow-Up

The long-term follow-up of patients was carried out by telephone or, in those cases where telephone contact was not possible, by direct interview with the patient or their family in their health centers or in Spanish National Health Service (Instituto Nacional de la Seguridad Social) departments. The New York Heart Association (NYHA) functional class was obtained prior to surgery and at follow-up by telephone interview with the patient. The patients were classified in functional class I at follow-up if they were asymptomatic from the perspective of cardiovascular disease and were perceived as being able to lead a normal life for their age.

Definitions

- Coronary heart disease: >50% reduction in vessel diameter in at least 1 angiographic plane
- Systolic dysfunction: ejection fraction <50%. Severe systolic dysfunction: ejection fraction <35%
- Severe pulmonary hypertension: systolic pulmonary artery pressure (SPAP) >50 mm Hg
- Urgent surgery due to critical condition: need for hospital admission due to unstable clinical situation and/or life-threatening risk requiring early surgery
- Perioperative follow-up: conducted during hospital stay or 30 days after surgery if previously discharged. Perioperative morbidity and mortality was similarly defined
- Perioperative infarction: presenting with ST-segment elevation and/or identified at echocardiographic control between the first and second week post-surgery
- Perioperative stroke: neurological defect clinically compatible with this entity lasting for at least 24 h
- Early extubation: carried out in the first 24 h post-surgery
- Sudden cardiac death: occurring suddenly or having a direct cardiac cause
- Functional class: assessed according to the NYHA scale

Statistical Analysis

Continuous variables are expressed as mean (standard deviation) or as the median for skewed distributions, and discrete variables as absolute value and percentage. The Student *t* test was used to compare means and the χ^2 test to compare proportions. All the values were expressed as two-tailed probabilities where *P* values $\leq .05$ were considered significant. A Kaplan-Meier survival analysis was performed and a Cox analysis of the variables that could be clinically associated with worse prognosis during follow-up to determine the predictors of long-term mortality. The data were analyzed with SPSS software version 12.0 for Windows (SPSS Inc., Chicago, Ill, USA, 1999).

RESULTS

Between May 1996 and May 2006, 137 patients underwent cardiac catheterization prior to AVR due to SAS. In total, 33 (24.1%) patients did not undergo surgery due to severe deterioration of ventricular function, presence of severe chronic bronchitis or because the patient and/or family withheld consent. The remaining 104 patients formed the study sample. The mean age was 81.7 (1.5) years (range, 80-87 years) (Figure 1) and 61.5% were women. Of these, 18% were diabetic, 7.8% had a history of infarction, and 32.7% presented coronary heart disease. Mean ejection fraction was 63% (9.02), 9.6% of patients presented some degree of ventricular systolic dysfunction, and 1 patient presented severe systolic dysfunction. Table 1 shows the preoperative characteristics of the patients.

All patients underwent a standard surgical procedure by means of median sternotomy and cardiopulmonary bypass. Urgent surgery was performed in 2.9% of patients due to their critical condition. Stented tissue valves with supportive frames were implanted in 90.4% of patients. Mean diameter was 21.3 (1.64) mm. Revascularization was performed in 27.9% of patients using the saphenous vein in all cases. Mean times of aortic clamping and cardiopulmonary bypass were 66.9 (17.2) min and 89.2 (26.4) min, respectively. Table 2 shows the characteristics of the surgical procedure.

The median intensive care unit stay was 4 days and 88.3% of the patients underwent early extubation. Intraaortic balloon counterpulsation was required in 7.7% of patients and no cases of severe vascular complication were observed. The median hospital stay was 10 days. Table 3 shows the postoperative complications: 3 (2.9%) patients had perioperative myocardial infarction, 6 (5.8%) patients had a stroke, 11 (10.6%) had postprocedural permanent atrial fibrillation, and 6 (5.8%) had a permanent pacemaker. The association between stroke and permanent atrial fibrillation after the procedure barely reached statistical significance (*P* = .062).

All patients studied underwent perioperative and long-term clinical follow-up. Mean and median follow-up time

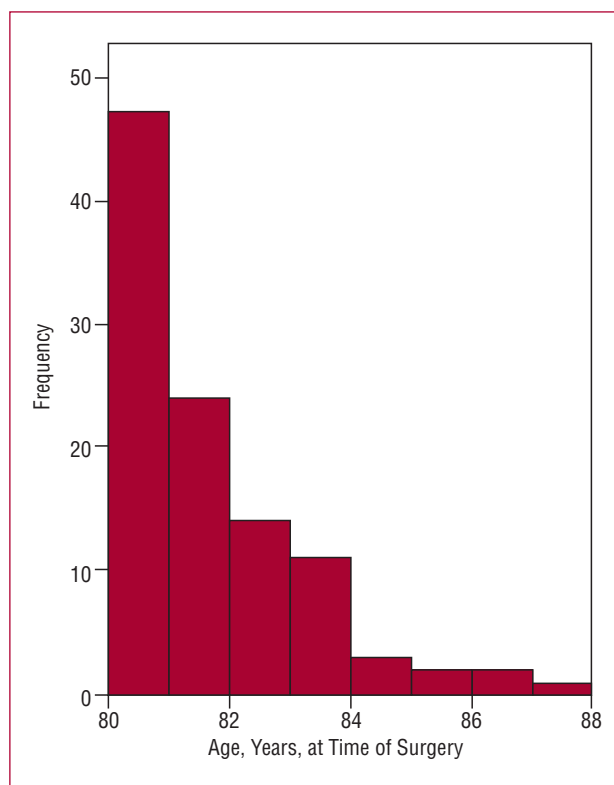


Figure 1. Age distribution at the time of surgery.

was 31.4 (25.12) months and 24.4 months, respectively. Perioperative mortality was 3.8% (4 patients), due to massive bleeding, cardiac arrest, pneumonia and multiorgan failure, and myocardial infarction complicated by cardiogenic shock. Survival rates at 1, 2, 3, 4, 5, and

TABLE 1. Preoperative Characteristics of the Study Sample

Age, mean (SD), y	81.7 (1.5)
Women	61.5%
Diabetes mellitus	18.4%
Arterial hypertension	59.2%
Dyslipidemia	61.5%
Smoking habit	25.2%
Extracardiac vascular disease	12.6%
Previous stroke	7.7%
Chronic bronchitis	11.7%
Previous surgery	1.9%
Previous atrial fibrillation	16.3%
Previous pacemaker	1.0%
Previous aortic valvuloplasty	0%
Ventricular systolic dysfunction	9.6%
Severe pulmonary hypertension	15.4%
Coronary heart disease	32.7%
Left main coronary artery disease >50%	3.8%
Previous myocardial infarction	7.8%
Critical condition prior to surgery	2.9%
Ejection fraction	63.2 (9.0)
Systolic pulmonary pressure, mean (SD), mm Hg	29.4 (11.3)

TABLE 2. Perioperative Characteristics

Tissue valve	90.4%
Associated coronary artery bypass graft surgery	27.9%
Associated mitral valve replacement	0%
Associated surgery of the ascending aorta	0.9%
Previous intraaortic balloon counterpulsation	0.9%
Need for urgent surgery due to critical condition	2.9%

TABLE 3. Postsurgical Complications

Myocardial infarction	3 (2.9%)
Stroke	6 (5.8%)
Dialysis	0
Reintervention due to bleeding	6 (5.8%)
Reoperation due to sternal dehiscence	3 (2.9%)
Pericardial drainage	2 (1.9%)
Permanent pacemaker	6 (5.8%)
Intraaortic balloon counterpulsation	8 (7.7%)
Permanent atrial fibrillation	11 (10.6%)
Pneumonia	2 (1.9%)
Prosthetic valve endocarditis	0

6 years was 90% (2.9), 81% (4.2), 78% (4.8), 75% (5.3), 65% (7.2), and 60% (8.2), respectively (Figure 2). Of the total, 24% died during follow-up, defined as starting from the day of surgery. The cause of death was of cardiac

origin in 14.4% (15 patients) of the sample, consisting of heart failure (n=10), sudden death (n=2), acute coronary syndrome (n=1), endocarditis (n=1), and tamponade (n=1). The cause of death was of non-cardiac origin in 7.7% of the sample, consisting of neurological dysfunction (n=5), mesenteric ischemia (n=1), liver disease (n=1), and pneumonia (n=1). It was not possible to identify the cause of death in 2 patients (1.9%). Overall, 60% of the deaths had a cardiac cause.

A multivariate analysis of long-term mortality assessed systolic blood pressure, sex, creatinine concentrations, SPAP, extracardiac vascular disease, urgent surgery due to critical condition, reintervention due to bleeding, and ventricular dysfunction. Predictors of long-term mortality were: creatinine concentrations, urgent surgery due to critical condition, and need for reintervention due to bleeding ($P=.002$, $P=.011$, and $P=.002$, respectively). Systolic blood pressure remained at the limit of statistical significance ($P=.058$).

Before surgery, 95.1% of the patients presented exertional dyspnea, 41.7% were classified in NYHA functional class III-IV and 1.9% in class IV. At follow-up, 76.3% of the patients were asymptomatic, classified as NYHA functional class I, and had a level of activity appropriate for their age, according to their individual criteria, and/or were limited by other comorbidities, such as osteoarticular problems (Table 4).

DISCUSSION

This was a single-center study assessing aortic valve replacement surgery (AVR) due to severe aortic stenosis (SAS) in octogenarians. The most relevant findings of the study are that the short-term and long-term results are good and that survival is associated with renal function, urgent surgery due to critical condition, and the need for reintervention due to bleeding.

Relevance of the Problem

In recent years there has been a steady increase in the need to care for octogenarian patients. According to the most recent information published by the National Institute of Statistics for 2006, life expectancy is 76.3 and 82.9 years for Spanish men and women, respectively. With a total population of 1 903 219 people older than 80 years in Spain, people aged 80, 85, 90, and 95 years have an additional 8.39, 5.84, 3.94, and 2.18 years of life expectancy, respectively. Furthermore, the prevalence of heart disease in people more than 75 years is 25.77%.⁸ Severe calcific arterial stenosis (SAS) is the most frequent valvular heart disease in octogenarians and accounts for 60%-70% of surgical interventions in this age group.^{9,10} Its prevalence steadily increases with age, rising from 2.5% at 75 years to 8.1% at 85 years.³ Its prognosis is bad, especially in symptomatic patients.^{11,12}

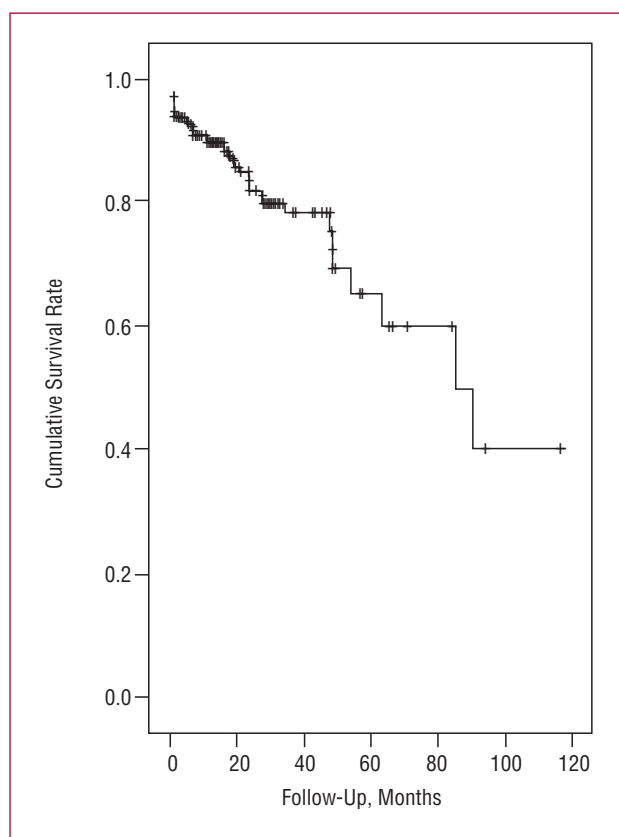
**Figure 2.** Kaplan-Meier survival analysis at follow-up.

TABLE 4. Evaluation of Quality of Life*

NYHA Functional Class	Before Surgery	At Follow-Up
I	4.9%	76.3%
II	51.5%	17.5%
III-IV	41.7%	6.3%
IV	1.9%	0%

*NYHA indicates New York Heart Association.

Perioperative Mortality

Perioperative mortality in our series (3.8%) was considerably lower than that reported in the literature. Total data on valvular and/or coronary surgery in octogenarians places mortality between 4.1%¹³ and 13.9% as reported in a study review.¹⁴ Aortic valve replacement, whether combined with coronary artery bypass graft surgery or not, had a mortality rate of 11%-13%.^{15,16} These studies reported a high percentage of urgent surgery that partly explains the differences observed between them and the present study. Langanay et al,¹⁷ reported a figure of 7.5% in a periodic analysis of hospital mortality in 442 patients undergoing AVR. The most relevant predictors were aortic regurgitation, NYHA class IV, heart failure, chronic renal failure, urgent surgery, left ventricular systolic dysfunction, and surgical reintervention.

Long-Term Survival

The results of our series, with survival rates of 90% (2.9), 81% (4.2), 78% (4.89), 75% (5.3), 65% (7.2), and 60% (8.2) at 1, 2, 3, 4, 5, and 6 years, respectively, are slightly better than those reported by Asimakopoulus et al¹⁸ in the largest series published to date, which included 1100 patients undergoing AVR between 1986 and 1995.¹⁸ Survival rates were higher in our study compared to a recently published series that included a similar number of patients. Sundt et al,¹⁶ reported a survival rate of 55% at 5 years, although 10.5% of patients underwent urgent surgery versus 2.9% in our series. As in our work, this was a strong predictor of mortality that may explain some of the differences observed between the 2 studies. Other demographic features that differed from those in our series were: a greater percentage of previous myocardial infarction (17.3%), severe ventricular dysfunction (14.3%), associated coronary artery bypass graft surgery (66.9%), and associated mitral valve replacement (9%).

Another series reported 5-year survival rates of 78.2%, but only in those surviving the perioperative phase where mortality was 13%.¹⁵ As in the series reported by Sundt et al, there was a high percentage of urgent surgery (23%), whereas the remaining demographic and clinical parameters were similar. Nevertheless, these series only represent a small percentage of the patients undergoing AVR for aortic regurgitation of varied etiology. In our

opinion, this may bias the results when extrapolating them to the context of SAS alone, given that aortic regurgitation has been reported as an independent predictor of mortality in some series. In a series of 442 patients which included 2.3% of patients with aortic regurgitation alone and 10.4% in association with other entities, Langanay et al¹⁷ reported a perioperative mortality rate of 15.2% and 30%, respectively. García et al,¹⁹ reported aortic regurgitation as one of the predictors of mortality in a study of AVR in patients older than 70 years.

There are few studies exclusively dedicated to octogenarian patients with SAS. In 1991, Deleuze et al²⁰ reported a 5-year survival rate of 61% in a series of 60 patients referred for surgery for SAS. In another series of 103 patients with an average age of 82 years, Gilbert et al²¹ reported a survival rate of 78%, 75% and 58% at 1, 2, and 5 years, respectively, in those who survived the postoperative phase. Recently, Varadarajan et al²² reported on a cohort of 277 consecutive patients with SAS of whom 80 underwent AVR. The patients who underwent AVR had a better ejection fraction, greater mean gradient and greater prevalence of coronary heart disease, among other factors. The survival rates of 87%, 78%, and 68% at 1, 2, and 5 years, respectively, among these AVR patients are clearly better than in those not undergoing the procedure (survival rates of 52%, 40% and 22%, respectively). Our series, which had very similar results to this study, assessed 104 patients and is the most extensive study published to date on octogenarian patients undergoing intervention for SAS alone.

Perioperative Complications

The postoperative complications observed in the patients included in the present study was not significantly different from those reported by other authors. Neurological and renal complications, postoperative myocardial infarction,¹⁴ saphenectomy wound infection, prolonged hospital stay,¹³ the need for reintervention due to bleeding, the use of postoperative intraaortic balloon counterpulsation, and pneumonia²³ have been reported as being more frequent in octogenarian patients. In our series, there was a notable need for permanent pacemaker implantation due to atrioventricular conduction disturbances (5.8%) similar to those in other series (6%).¹⁵ The percentage of patients with postoperative stroke was 5.8%, close the figure of 7% reported by Akins et al.⁹ Only 1 of the observed cases of stroke involved significant long-term functional limitations. The association of stroke with permanent atrial fibrillation barely reached statistical significance ($P=.062$), although not all cases of postoperative atrial fibrillation were analyzed. The need for reintervention due to bleeding was 5.8%, similar to the 5.7% previously reported,²³ but contrasting with the 3.6% observed in

another study in patients less than 70 years. This gains particular relevance in the present study as it was subsequently shown to be an independent predictive of mortality. Although deterioration in renal function was not quantitatively evaluated in our study, the need for dialysis was assessed, without any case being found. This agrees with the data cited above, which ranged between 0.9% and 1.8% in octogenarians.¹³ Pneumonia was present in 1.9% of patients, which is considerably lower than that reported in previous registries.²³ This percentage is similar to that observed by these authors in patients less than 70 years, who report that this increases with age. The use of postoperative intraaortic balloon contrapulsation was 7.7%, which was much higher than the 3.7% reported in other series.²³ The percentage of postoperative myocardial infarction (2.9%) was similar to that reported in other series. No case of infected saphenectomy wound was observed, whereas other authors have reported figures ranging between 3.6% and 5.3%, depending on the type of surgery employed.¹³

Predictors of Long-Term Survival

These included urgent surgery due to critical condition, creatinine concentrations, and reintervention due to bleeding. These data are similar to those described in the literature. Most studies report urgent surgery as a strong predictor of mortality, probably due to the critical condition of the patient and other associated predictors, such as ventricular dysfunction and existing comorbidity.²⁴ This explains the high percentage of perioperative deaths in series with high numbers of patients undergoing urgent surgery. As observed in other series, creatinine levels were a strong predictor ($P=.001$), mortality increasing by 12.7% (95% confidence interval [CI], 2.7-59.2) for each increase in creatinine units (mg/dL). Reintervention due to bleeding, which reached percentages similar those observed in other studies,^{13,23} was an independent predictor of mortality ($P=.027$). Surgical reintervention has recently been reported as predictor of mortality.¹⁷ In our series, left ventricular dysfunction was not a predictor of mortality, probably because of the low percentage observed, the almost complete lack of patients with severe systolic dysfunction (1 case), and the low statistical power, given the number of patients studied. The presence of coronary artery disease requiring coronary artery bypass graft surgery have been considered predictors that significantly raise mortality rates to around 15%-20%.² However, similar to other authors, this was not a predictor in our series where there was a significant percentage of combined surgery (27.9%). As recently reported,²⁵ we consider that the low incidence of multiple coronary bypass graft surgery (8.7%) in our series influenced this result. Systolic blood pressure prior to surgery reached statistical significance ($P=.058$) as a protective factor.

Evaluation of Quality of Life

Previous studies have demonstrated improvements in the quality of life of octogenarian patients who have undergone aortic valve replacement due to stenosis and/or aortic regurgitation.¹⁶ Our study evaluated quality of life in relation to both NYHA functional class and the patient's perceptions regarding being able to lead a normal physical life according to their own criteria. The number of patients in NYHA functional class I who considered themselves able to lead a normal life increased from 4.9% prior to surgery to 76.3% at follow-up, which is in agreement with the cited data referring to functional improvements in patients undergoing surgery.

Limitations

This was an observational study and thus limitations exist when interpreting the results. Furthermore, the results are difficult to generalize as this was a single-center study.

Functional class was assessed by telephone, without objective observation of the patient's level of activity. Furthermore, NYHA functional class and the individual perception of leading a normal life were evaluated as an end-point study at follow-up, independently of each patient's individual follow-up time.

CONCLUSIONS

Aortic valve replacement due to aortic stenosis in patients older than 80 years can be performed with good long-term results and a low incidence of perioperative complications. Predictors of mortality were urgent surgery due to critical condition, creatinine concentrations, and reintervention due to bleeding. In addition, there was an increase in the patients' quality of life with good long-term functional outcomes.

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