

# Cardiac Surgery in the Elderly: Comparison Between Medium-Term Clinical Outcomes in Octogenarians and the Elderly From 75 to 79 Years

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**Introduction and objectives.** The age of patients undergoing cardiac surgery has increased in recent years. Our aims were to investigate the medium-term clinical outcomes of surgery in octogenarians and to compare them with outcomes in other elderly individuals of a less advanced age.

**Methods.** We investigated early mortality, the incidence of postoperative complications, medium-term survival and factors associated with these parameters in 589 consecutive elderly patients undergoing surgery: 140 were octogenarians aged 80-87 years (group I) while 449 were aged between 75 and 79 years (group II).

**Results.** The 2 groups were similar. There was no difference in mortality (10.0% in group I vs 10.9% in group II) or in the incidence of postoperative complications (22% in group I vs 30% in group II). Emergency surgery, combined surgery, and pulmonary hypertension were all independent predictors of mortality and of major postoperative complications. The 5-year survival rate was 79% in group I and 65% in group II ( $P=.832$ ) and the cardiac event-free survival rate was 75% in group I and 64% in group II ( $P=.959$ ). Overall, 97% of patients in both groups were in functional class I or II. The additive EuroSCORE and preoperative atrial fibrillation were both associated with increased mortality during follow-up. Being an octogenarian was not a predictor (hazard ratio=0.78; 95% confidence interval, 0.51-1.21;  $P=.373$ ).

**Conclusions.** In selected octogenarians, cardiac surgery gives similar results to those obtained in other elderly individuals of a less advanced age. The medium-term survival rate and quality of life are good. Pulmonary hypertension, emergency surgery and combined surgery all increased risk in these patients.

**Key words:** Surgery. Cardiopulmonary bypass. Geriatrics.

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## Cirugía cardíaca en el anciano: comparación de resultados a medio plazo entre octogenarios y ancianos de 75 a 79 años

**Introducción y objetivos.** La edad de los pacientes sometidos a cirugía cardíaca se ha incrementado en los últimos años. Pretendemos conocer los resultados a medio plazo de la cirugía en octogenarios, comparándolos con los de otros ancianos de menos edad.

**Métodos.** Analizamos la mortalidad precoz, la incidencia de complicaciones postoperatorias, la supervivencia a medio plazo y los factores asociados a éstas de 589 ancianos consecutivos sometidos a cirugía: 140 octogenarios entre 80 y 87 años (grupo I) y 449 entre 75 y 79 años (grupo II).

**Resultados.** Ambos grupos fueron homogéneos. No hubo diferencias en la mortalidad (I, 10%; II, 10,9%) e incidencia de complicaciones postoperatorias (I, 22%; II, 30%). La cirugía de emergencia, la combinada y la hipertensión pulmonar se asociaron de manera independiente a la mortalidad y al desarrollo de complicaciones mayores. La supervivencia a 5 años fue del 79% (I) y el 65% (II) ( $p = 0,832$ ) y la supervivencia libre de evento cardíaco fue del 75% (I) y el 64% (II) respectivamente ( $p = 0,959$ ). El 97% de los pacientes de ambos grupos se encontraban en clase funcional I-II. El EuroSCORE aditivo y la fibrilación auricular preoperatoria se asociaron a una mayor mortalidad en el seguimiento. Ser octogenario no fue predictor ( $hazard\ ratio = 0,78$ ; intervalo de confianza del 95%, 0,51-1,21;  $p = 0,373$ ).

**Conclusiones.** La cirugía cardíaca en octogenarios seleccionados ofrece resultados similares a los de otros ancianos más jóvenes, con una buena supervivencia y calidad de vida a medio plazo. La hipertensión pulmonar, la cirugía de emergencia y la combinada conllevan un riesgo elevado en estos pacientes.

**Palabras clave:** Cirugía. Circulación extracorpórea. Geriatria.

**ABBREVIATIONS**

AF: atrial fibrillation  
 AMI: acute myocardial infarction  
 CPB: cardiopulmonary bypass  
 IABP: intraaortic balloon counterpulsation

**INTRODUCTION**

The gradual aging of the Spanish population poses important social, economic, and public health challenges. According to data provided by the last census, octogenarians currently form 4.3% of the total Spanish population and this percentage is even higher in Castilla and León.<sup>1</sup> On the other hand, progress in surgical techniques and perioperative care has made it possible to operate on elderly patients with a reasonable level of risk. Thus, the age of patients undergoing cardiac surgery has significantly increased in recent years.<sup>2</sup>

However, whereas indications for surgery are rarely discussed in relation to patients aged 75-79 years, they are frequently questioned in relation to octogenarians. A patient older than 80 years represents, for cardiologists and surgeons alike, a psychological barrier that identifies a high-risk population for interventionist procedures, and surgical procedures in particular. This attitude is not always justified and can prevent specific patients benefiting from all the therapeutic resources at our disposal. Unfortunately, we have little information on the outcomes of cardiac surgery in octogenarians in Spain.

The present study has 2 aims: to investigate early morbidity and mortality and the medium-term clinical outcomes of cardiac surgery in octogenarians and compare them with outcomes in other elderly patients (75-79 years), and to identify the factors determining early and late mortality and major complications in this population, with the aim of improving the selection of octogenarians who can benefit from surgical treatment.

**METHODS**

Between October 1999 and September 2006, a total of 2258 patients underwent major cardiac surgery in our hospital. Of these, 140 (6.2%) were ≥80 years (group I) and 449 (19.9%) were 75-79 years (group II). The surgical indication was agreed by cardiologists and surgeons in consensus, either during regular clinician-surgeon review sessions or after conferring with the duty medical team. When selecting octogenarian patients, special attention was paid to the preoperative assessment of comorbidity, the degree of autonomy and

family support. No patient was rejected exclusively because of age. A total of 11.2% of the octogenarians and 9% of the septuagenarians who attended medical-surgical assessment were rejected due to anatomical or clinical circumstances that made surgery inadvisable ( $P=.473$ ). No records were kept in relation to these patients.

The perioperative data and clinical evolution of each patient were prospectively included in the hospital database (Cardiac Surgery Computer System, version 11.3, Sorin, Milan, Italy). The patients who needed more than 1 surgical procedure (4 patients) were included as different patients in the analysis of early morbidity and mortality and as just 1 patient in the survival analysis.

The preoperative variables analyzed were as follows: age, sex, body mass index, cardiovascular risk factors, chronic obstructive pulmonary disease, peripheral vascular disease, kidney failure (creatinine >2 mg/dL), intraaortic balloon counterpulsation (IABP), and a history of cardiac intervention, stroke, or myocardial infarction (AMI). We assessed functional class in line with the Canadian Cardiovascular Society and New York Heart Association criteria, as well as heart rate at admission, coronary anatomy, the valvular lesion, the degree of left ventricular dysfunction (mild, 50%-59%; moderate, 30%-49%; and severe, <30%) and pulmonary hypertension (mild, 25-39 mm Hg; moderate, 40-59 mm Hg; and severe, >59 mm Hg). Surgical risk was calculated for each patient using EuroSCORE.<sup>3</sup>

The perioperative factors analyzed were as follows: priority, type of intervention, number of coronary vessels revascularized and grafts used, type of valvular procedure and intervention times, cardiopulmonary bypass (CPB), aortic cross-clamping, and circulatory arrest.

Surgery with CPB was performed under light hypothermia, using a centrifugal pump, and cold blood cardioplegia in combination (antegrade induction, and maintenance, and retrograde warm blood reperfusion). Intraoperative cell salvage was systematically performed. The myocardial revascularization procedures with CPB were performed during a single aortic cross-clamping period.

The following postoperative complications were recorded: early bleeding requiring reintervention, late tamponade, perioperative AMI (appearance of a new pathological Q wave in the electrocardiogram or ST-segment elevation and markers of myocardial damage) low cardiac output (need for perioperative or postoperative IABP or for inotropic drugs for more than 48 h), bacteremia, pneumonia, mediastinitis, intestinal ischemia, other gastrointestinal complications (intestinal obstruction, cholecystitis, upper or lower gastrointestinal bleeding requiring transfusion), respiratory failure (mechanical ventilation for more than 48 h, tracheostomy, or readmission to the intensive care unit due to respiratory problems), stroke (transient or

permanent neurological dysfunction), delirium, kidney failure requiring extrarenal dialysis, atrial fibrillation (AF), permanent pacemaker, and transfusion of blood components. All such complications were considered major except for well-tolerated AF, delirium, and the need for transfusion not associated with other complications. Early mortality was defined as occurring during hospitalization or during the first 30 days after surgery following discharge.

Follow-up was conducted by telephone interview and check-up in the hospital outpatient department between 1 September and 1 December 2006. Data on the clinical history of the patients attending our hospital were included. Patients from other hospitals who had experienced adverse events sent in a copy of their discharge report by mail. The average follow-up time was 2.8 (1.5) (median, 2.6) years, and was completed in all patients. Early death, cardiovascular death, or death due to unknown causes during follow-up, the need for new procedures, and hospitalization due to cardiac causes were considered adverse cardiac events.

### Statistical Analysis

The Kolmogorov-Smirnov test was used to verify whether the variables followed a normal distribution. Continuous variables were expressed as the mean and standard deviation or the median and interquartile range (IQR, 25-75) when the variable was not distributed normally. Discrete variables were expressed as absolute numbers and percentages. Continuous variables were compared by analysis of variance or Student *t* test, and discrete variables by  $\chi^2$  corrected with Fisher's exact test when necessary. All variables with  $P \leq .1$  in the univariate analysis were included in a multivariate logistic regression model to investigate the determinants of serious postoperative complications and hospital mortality. The validity of the model was assessed by ROC curve analysis. The survival rate was determined by the Kaplan-Meier method, using the log-rank test for between-group comparisons. Independent risk factors of mortality during follow-up were analyzed by Cox proportional hazard model. The statistical analysis was performed with SPSS software version 13.0 (SPSS, Chicago, Illinois, USA).

## RESULTS

The proportion of octogenarians undergoing interventions in our hospital increased from 2.1% in 2000 to 9.2% in 2006, whereas the percentage of patients between 75 and 79 years varied little during the same period (from 17.3% to 19.4%).

### Preoperative Patient Characteristics

Table 1 shows the preoperative characteristics of the 2 groups. Both were similar, except for the higher

prevalence of previous AMI and moderate or severe ventricular dysfunction in the septuagenarians and unstable angina in the octogenarians. The estimated risk using Euro-SCORE was significantly higher in octogenarians, although the additive Euro-SCORE only differed by 1 point.

### Operative Data

The distribution by categories was similar, except for surgery of the ascending aorta that was performed more frequently in octogenarians. A total of 40% of all patients undergoing valvular procedures required associated revascularization, with a similar prevalence in both groups. Mitral valve surgery, isolated and combined, were more frequent in the septuagenarians (Table 2).

Tricuspid valve annuloplasty was performed in 21% of the septuagenarian patients who required valvular surgery patients and in 14% of octogenarians. The use of tissue valves was significantly more frequent in octogenarians (97% vs 72%;  $P < .001$ ). Mechanical valves were implanted in 2 octogenarians who required aortic valve surgery: 1 patient needed a valvular conduit and 1 was implanted with a small ring. Mechanical valves were implanted in septuagenarians in the case of preoperative AF.

Table 2 presents the data on coronary surgery. The total number of anastomoses per patient was similar in both groups. Revascularization without CPB was performed more frequently in octogenarians. The use of the internal mammary artery and the number of arterial grafts were significantly greater in the younger group. Nevertheless, the left anterior descending coronary artery was revascularized using the internal mammary artery in 91% of octogenarians.

### Mortality

The early mortality rate was 10.7% divided by group as follows: 10% (14 patients) in group I and 10.9% (49 patients) in group II ( $P = .876$ ). The main cause of death was infection (group I, 58.3%; group II, 48.8%), followed by low cardiac output (group I, 16.7%; group 2, 34.9%), respiratory complications (group I, 16.7%; group II, 2.3%) and gastrointestinal complications (group I, 8.3%; group II, 11.6%). Table 3 shows the mortality rates associated with the different types of intervention.

As expected, mortality associated with elective surgery was less than that associated with urgent or emergency surgery, both in octogenarians (7.4% and 26.3%, respectively;  $P = .06$ ) and in septuagenarians (7.4% and 36.4%, respectively;  $P < .0001$ ), although this was statistically significant only in the younger group.

Mortality associated with combined surgery was similar in both groups and higher than that associated with isolated valvular surgery, although the difference

**TABLE 1. Preoperative Characteristics of Both Groups**

	1 (n=140)	2 (n=449)	P
Age, mean (SD), y <sup>a</sup>	81.8 (1.64)	76.83 (1.36)	<.001
Women	45 (32.1%)	179 (39.95%)	.060
AHT	85 (60.7%)	276 (61.5%)	.474
Diabetes mellitus	32 (22.9%)	118 (26.3%)	.243
Hypercholesterolemia	53 (37.9%)	187 (41.6%)	.243
Smoking	55 (39.3%)	183 (40.8%)	.418
Obesity (BMI≥30)	22 (15.7%)	82 (18.3%)	.290
Family history	11 (7.9%)	40 (8.9%)	.425
COPD	31 (22.1%)	90 (20%)	.497
Peripheral vascular disease	11 (7.9%)	40 (8.9%)	.335
Kidney failure	6 (4.3%)	22 (4.9%)	.487
Stroke	9 (6.4%)	35 (7.8%)	.372
Previous myocardial infarction	37 (26.4%)	154 (34.3%)	.050
PTCA	2 (1.4%)	21 (4.7%)	.060
Preoperative IABP	8 (5.7%)	38 (8.5%)	.192
Previous cardiac surgery	5 (3.6%)	20 (4.5%)	.431
Unstable angina	49 (35%)	113 (25.2%)	.016
NYHA			.698
I-II	73 (52.1%)	224 (54.3%)	
III-IV	67 (47.9%)	205 (45.7%)	
CCS			.081
I-II	64 (45.7%)	245 (54.6%)	
III-IV	76 (54.3%)	204 (45.4%)	
LVEF			.036
Normal-mildly depressed	118 (84.3%)	339 (75.5%)	
Moderate-severely depressed	22 (15.7%)	110 (24.5%)	
PP			.083
Normal-mildly elevated	101 (72.1%)	287 (63.9%)	
Moderate-severely elevated	39 (27.9%)	162 (36.1%)	
Preoperative rhythm			.505
Sinus rhythm	111 (79.3%)	358 (79.7%)	
Atrial fibrillation	3 (16.4%)	80 (17.8%)	
Pacemaker rate	6 (4.3%)	11 (2.4%)	
Indication			.918
Elective	121 (86.4%)	394 (87.8%)	
Emergency	11 (7.9%)	32 (7.1%)	
Emergency	8 (5.7%)	23 (5.1%)	
Additive EuroSCORE <sup>b</sup>	8 (7-10)	7 (6-9)	.001
Logistic EuroSCORE <sup>b</sup>	9.52 (6.6-15.7)	7.62 (5.1-13.6)	<.001

AHT indicates arterial hypertension; BMI, body mass index; CCS, Canadian Cardiovascular Society; COPD, chronic obstructive pulmonary disease; IABP, intraaortic balloon contrapulsation; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; PP, pulmonary pressure; PTCA, percutaneous transluminal coronary angioplasty.

<sup>a</sup>Mean (standard deviation).

<sup>b</sup>Median (interquartile range, 25-75).

was statistically significant in octogenarians (6/28 vs 1/43;  $P=.022$ ). No significant differences in mortality were found between isolated and combined aortic valve replacement (group I, 0/33 vs 2/19;  $P=.129$ ; group II, 4/84 vs 1/52;  $P=.649$ ). In contrast, mortality associated with combined mitral valve replacement and coronary artery bypass graft surgery was significantly higher than isolated mitral valve replacement only in the younger group (group I, 2/5 vs 0/5;  $P=.444$ ; group II, 10/36 vs 4/42;  $P=.043$ ).

The discrimination of the additive and logistic EuroSCORE was good, with an area under the ROC

curve of  $>0.76$  for both groups. The logistic EuroSCORE was a better predictor of total mortality and in the subgroups at greater risk (data not presented).

Table 4 shows the results of the multivariate analysis. Moderate-severe pulmonary hypertension, emergency surgery, and combined surgery were independent predictors of mortality. The area under the ROC curve was 0.78 for the model. The inclusion of serious postoperative complications in the model had a strong impact on mortality, especially gastrointestinal complications (odds ratio [OR], 146.4) and kidney failure (OR, 54.89).

**TABLE 2. Surgical Procedures**

	Group I (n=140)	Group II (n=449)	P
Coronary	60 (42.9%)	192 (42.8%)	1
Without CPB	15 (25%)	16 (8.3%)	.001
Total number of anastomoses	3.3 (1)	3.5 (0.9)	.233
Number of arterial anastomoses	0.9 (0.3)	1.1 (0.5)	.002
Use of mammary to LAD	91.7%	97.9%	.037
Valvular	43 (30.7%)	144 (32.1%)	.835
Aortic	33 (23.6)	84 (18.7%)	.225
Mitral	5 (3.6%)	42 (9.4%)	.031
Mitral-aortic	5 (3.6%)	18 (4%)	.523
Combined surgery	28 (20%)	99 (22%)	.640
Aortic	19 (13.6%)	52 (11.68%)	.553
Mitral	5 (3.6%)	36 (8%)	.047
Mitral-aortic	4 (2.9%)	11 (2.4%)	.762
Aortic surgery	5 (3.6%)	4 (0.9%)	.039
Dissection	4 (2.9%)	3 (0.7%)	.059
Annuloaortic ectasia	1 (0.7%)	1 (0.2%)	.419
Mechanical complications of AMI	4 (2.9%)	8 (1.8%)	.343
Free-wall rupture	1 (0.7%)	3 (0.7%)	.663
Ventricular septal defect	3 (2.1%)	5 (1.1%)	.290
Pericardiectomy	–	2 (0.4%)	1
Concomitant procedures	15 (10.7%)	78 (17.4%)	.320

CPB indicates cardiopulmonary bypass; LAD, left anterior descending.

**TABLE 3. Early Mortality (In-hospital and Within 30 Days After Surgery Following Hospital Discharge)**

	Group I (n=140)	Group II (n=449)	P
Total	10%	10.9%	.876
Elective surgery	7.6%	6.8%	.566
Coronary	8.3%	7.3%	.782
Valvular	2.3%	8.3%	.304
Aortic	–	6%	.320
Mitral	–	14.3%	.489
Mitral-aortic	20%	5.6%	.395
Combined	21.4%	15.2%	.484
Aortic and coronary	10.5%	3.8%	.283
Mitral and coronary	40%	33.3%	.564
Mitral-aortic and coronary	50%	18.2%	.516
Other procedures	22.2%	57.1%	.197
Aortic surgery	20%	50%	.524
Surgery MCI (VSD and rupture)	25%	75%	.222
Pericardiectomy	–	–	–

MCI indicates mechanical complications of infarction; VSD, ventricular septal defect.

### Postoperative Morbidity

A total of 22% of the octogenarians and 30% of the septuagenarians presented some major complication during the postoperative period, although this difference did not reach statistical significance. Table 5 shows the major complications. The most frequent was AF (group 1, 41.4%; group 2, 42.1%) and was often associated with

**TABLE 4. Multivariate Analysis: Predictors of Hospital Mortality**

	OR	95% CI	P
Emergency surgery	19.84	8.51-46.27	<.001
Moderate-severe PHT	2.62	1.41-4.87	.002
Combined surgery	2.62	1.34-5.14	.005

CI indicates confidence interval; OR, *odds ratio*; PHT, pulmonary hypertension. Adjusted for a history of chronic obstructive pulmonary disease, stroke, kidney failure, atrial fibrillation, functional class III-IV, preoperative intraaortic balloon contrapulsation, previous cardiac surgery, moderate-severe left ventricular dysfunction, EuroSCORE, and cardiopulmonary bypass time.

other more serious hemodynamic or respiratory complications. Only 30.3% (group I) and 27.2% (group II) presented isolated AF.

Six (4.3%) octogenarians and 21 (4.7%) septuagenarians required readmission to the ICU. The most frequent cause was respiratory failure, especially in the older group (group I, 83.3%; group II, 47.6%). Other causes included gastrointestinal complications, alterations in heart rate and subacute cardiac tamponade.

In the multivariate analysis, emergency surgery, moderate or severe pulmonary hypertension, CPB lasting more than 2 h, combined surgery, and advanced functional class (grade III-IV) were independently associated with the development of major postoperative complications (Table 6). The area under the ROC curve was 0.75 for the model.

**TABLE 5. Postoperative Complications and Hospital Stay**

	Group I (n=140)	Group II (n=449)	P
Major complications, n (%)	31 (22.1%)	136 (30.3%)	.068
Reintervention due to bleeding	2 (1.4%)	9 (2%)	.271
LCO	8 (5.7%)	31 (6.9%)	.701
Postoperative IABP	3 (2.1%)	11 (2.4%)	.565
Perioperative AMI	1 (0.7%)	8 (1.8%)	.694
AF	58 (41.4%)	189 (42.1%)	.922
AV block needing ECP	7 (5%)	16 (3.6%)	.325
Respiratory failure	11 (7.9%)	49 (10.9%)	.340
Stroke	2 (1.4%)	14 (3.1%)	.381
Delirium	9 (6.4%)	27 (6%)	.841
Pneumonia	12 (8.6%)	35 (7.8%)	.724
Bacteremia	5 (3.6%)	21 (4.7%)	.814
Mediastinitis	–	3 (0.7%)	.442
Kidney failure	4 (2.9%)	30 (6.7%)	.062
Intestinal ischemia	1 (0.7%)	5 (1.1%)	.475
Other gastrointestinal	3 (2.1%)	10 (2.2%)	.626
Transfusion	108 (77.1%)	320 (71.3%)	.193
Readmission to ICU	6 (4.3%)	21 (4.7%)	.530
Hospital stays. median (interquartile range, 25-75)			
Preoperative	1 (0-1)	1 (0-2)	.324
ICU	2 (2-3)	2 (2-4)	.323
Postoperative total	7 (7-12)	7 (7-13)	.777

AF indicates atrial fibrillation; AMI, acute myocardial infarction; AV, atrioventricular; ECP, endocardial pacemaker; IABP, intraaortic balloon contrapulsation; ICU, intensive care unit; LCO, low cardiac output.

## Hospital Stay

There were no significant differences between the 2 groups in relation to preoperative and postoperative hospital stay (Table 5). The hospital stay of the patients who developed some complication were significantly longer (group I, 10 [8-15] days vs 8 [6,7-9] days;  $P<.0001$ ; group II, 11 [8-16] days vs 7 [6-9] days;  $P<.0001$ ). Postoperative AF not associated with other complications prolonged hospital stay by an average of 3.4 days in the octogenarians and 1.8 days in the septuagenarians.

## Follow-up

The mean follow-up time of discharged patients was 2.6 (1.4) (median, 2.3) years in the octogenarians and 2.8 (1.3) (median, 2.6) years in the septuagenarians. There were 83 new deaths, 15 (10.8%) among octogenarians and 68 (15.2%) among septuagenarians, with no differences found in the cause of death. A total of 53% of the deaths among the octogenarians and 54% among the septuagenarians were of cardiovascular origin. Neoplasms were more frequent in septuagenarians (25%) than in octogenarians (6.7%).

The actuarial survival rate, which included hospital mortality at 1 year, 3 years, and 5 years, was 82%, 79%, and 79% among the octogenarians and 85%, 77%, and 65% among the septuagenarians ( $P=.832$ ) (Figure 1).

**TABLE 6. Multivariate Analysis: Predictors of Major Postoperative Complications**

	OR	95% CI	P
Emergency surgery	6.30	2.37-16.79	<.001
PHT moderate-severe	2.46	1.63-3.73	<.001
CPB time >120 min	1.97	1.28-3.03	.002
Combined surgery	1.93	1.21-3.08	.006
Functional class III-IV	1.61	1.02-2.55	.041

CI indicates confidence interval; CPB, cardiopulmonary bypass; OR, odds ratio; PHT, pulmonary hypertension.

Adjusted for a history of chronic obstructive pulmonary disease, stroke, kidney failure, previous cardiac surgery, moderate-severe left ventricular dysfunction, and EuroSCORE.

Cardiac event-free survival at 1 year, 3 years, and 5 years was 77%, 75%, and 75% among the octogenarians and 76%, 72%, and 64% among the septuagenarians ( $P=.959$ ) (Figure 2). The survival curves diverge at 3 years, in favor of the octogenarians, although the number of patients at risk is small. The multivariate analysis showed that the additive EuroSCORE and preoperative AF were associated with increased mortality during follow-up (Table 7).

A total of 97% of the patients from both groups were in functional class I-II during follow-up and 71% of octogenarians were independent regarding daily life activities.

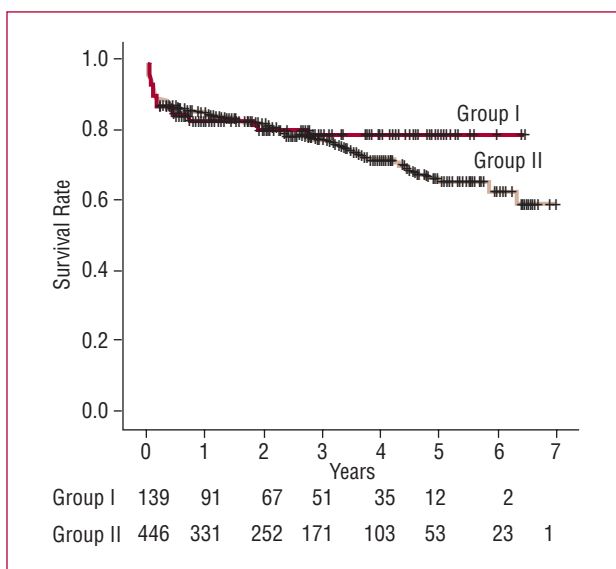


Figure 1. Kaplan-Meier survival analysis during follow-up ( $P=.$ 832).

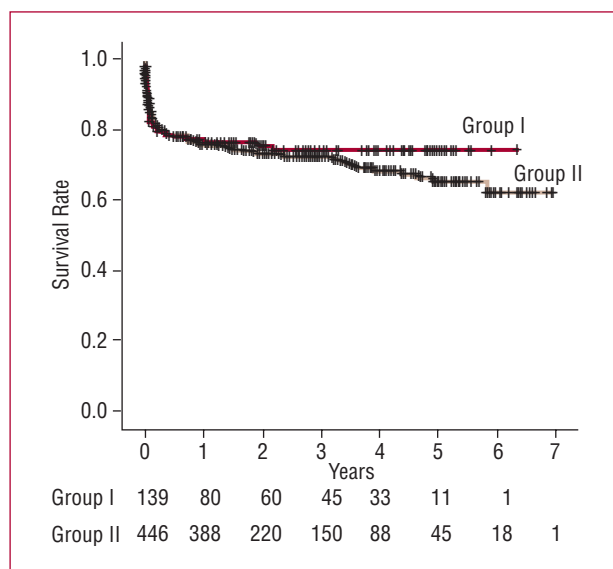


Figure 2. Cardiac event-free survival during follow-up; Kaplan-Meier analysis ( $P=.$ 959).

## DISCUSSION

Age is an independent determinant of early mortality in cardiac surgery,<sup>4,5</sup> and as such is included in different surgical risk scales.<sup>3,6</sup> Surgery in octogenarians also involves an increased incidence of complications and increased hospital stay and consumption of resources.<sup>7-9</sup> Their greater vulnerability to surgical trauma is due to the decreased functional reserve of different organs and systems. However, recent series have shown that mortality among octogenarians approaches that of younger patients.<sup>10</sup>

The aim of surgery in these patients is not only to improve the quality of life, as often argued, but also to survive diseases that have poor short-term prognosis with medical treatment.<sup>11</sup> It should be borne in mind that life expectancy for 80-year-old people in Spain is 8.6 years.<sup>12</sup> Indications for surgery in octogenarian patients is a complex issue and, in addition to clinical practice guidelines, other important aspects should be taken into account, such as the possible disparity between biological and chronological age, concomitant morbidity, autonomy, and family support.

Less than a third of the octogenarians who underwent surgery were women, despite constituting 65% of this population segment due to their greater life expectancy. Although this could be due to a selection bias regarding patients scheduled for surgery, other authors have highlighted less use of diagnostic and therapeutic resources in women.<sup>13</sup>

Total mortality among the octogenarians in our series was similar to that recently reported by other authors<sup>7,14-17</sup> and less than that among the elderly reported by different Spanish groups.<sup>18,19</sup> This was the case despite not

TABLE 7. Multivariate Analysis: Predictors of Mortality During Follow-up

	HR	95% CI	P
Female sex	1.15	0.76-1.75	.498
Octogenarian	0.78	0.51-1.21	.373
Diabetes mellitus	0.99	0.68-1.48	.997
Previous infarction	1.16	0.78-1.73	.460
Preoperative AF	1.86	1.21-2.58	.006
Functional class III-IV	0.97	0.63-1.50	.899
Moderate-severe LV dysfunction	1.25	0.82-1.89	.502
Moderate-severe PHT	1.01	0.67-1.52	.959
Vascular disease	1.02	0.66-1.57	.930
Preoperative kidney failure	1.52	0.80-1.99	.603
Previous cardiac surgery	1.26	0.62-2.56	.526
Combined surgery	1.23	0.82-1.85	.318
EuroSCORE	1.18	1.17-1.40	<.001
Year of intervention			
October 1999-September 2000	—	—	.865
October 2000-September 2001	0.83	0.36-1.87	.650
October 2001-September 2002	0.94	0.43-2.09	.888
October 2002-September 2003	0.97	0.48-1.95	.933
October 2003-September 2004	1.04	0.53-2.06	.905
October 2004-September 2005	0.72	0.34-1.51	.400
October 2005-September 2006	0.73	0.33-1.58	.420

AF indicates atrial fibrillation; CI, confidence interval; HR, hazard ratio; LV, left ventricular; PHT, pulmonary hypertension.

excluding specific disorders that entail high surgical risk, such as the mechanical complications of myocardial infarction. Furthermore, mortality among the octogenarians was similar to that of septuagenarians. The

octogenarians who underwent elective surgery had a mortality of 7.4% and this confirms that cardiac surgery can be performed in these patients with an acceptable level of risk.

Mortality among the octogenarians undergoing coronary surgery was similar to that reported by other authors.<sup>8,15,16</sup> The use of the internal mammary artery, although significantly less in octogenarians (92% vs 98%), was far higher than that of other series (0% to 77%).<sup>7,8,20</sup> Coronary revascularization without CPB in the elderly seems to be associated with less morbidity and mortality,<sup>21</sup> although the low number of patients who were operated on with this technique in our series prevents us from drawing conclusions.

We should note the absence of mortality in isolated valve surgery (aortic and mitral) in the octogenarian group. Mortality in the octogenarians undergoing combined aortic and coronary surgery, although high, was similar to that reported in other series,<sup>8,15,22,23</sup> nor was it greater than mortality in the septuagenarians. There is little experience with combined mitral valve surgery in octogenarians and, in general, the procedure has bad outcomes.<sup>8,22</sup> Age and associated coronary revascularization are well-defined risk factors of mortality in mitral valve surgery.<sup>4</sup> Disorders treated by emergency surgery, such as aortic dissection and mechanical complications of myocardial infarction, had high mortality in both groups, as found in other series.<sup>24,25</sup> Emergency and combined surgery were independent risk factors of early mortality and postoperative complications, as reported by other authors.<sup>5,15,20,23</sup>

The estimated risk using EuroSCORE was significantly higher in octogenarians, although the difference was only 1 percentage point for the additive EuroSCORE and 2 points for the logistic EuroSCORE. This finding could be due to the fact that age involves a minimum of 5 points in octogenarians and 4 in septuagenarians. In our experience, the discrimination of the EuroSCORE was good in the elderly. The logistic EuroSCORE was a better predictor of mortality in the patients at greater risk, as other researchers have pointed out.<sup>26</sup>

The incidence of postoperative complications in the octogenarians was similar to that in the septuagenarians and to that reported in other studies.<sup>8,14,15,20</sup> It should be recalled that age is an independent risk factor for the development of many such complications.<sup>27,28</sup> Atrial fibrillation was the most frequent complication and its appearance prolonged hospital stay, in view of the fact that recurrences are not infrequent and patients were not discharged until conversion to sinus rhythm had occurred. Less frequent complications, such as gastrointestinal ones and kidney failure, were associated with greater hospital mortality in the multivariate analysis, as other authors have noted.<sup>18,19,28</sup>

In our study, the low incidence of reinterventions due to bleeding and neurological complications (stroke and delirium) should be noted.<sup>8,14,15,20,29</sup> The former could be

due to the standard administration of antifibrinolytic agents, and the latter due to the protocol followed in our group to prevent neurological complications. This consists in maintaining high perfusion pressure during CPB, external compression of both carotid arteries during aortic cross-clamping and unclamping maneuvers, the systematic use of transesophageal echocardiogram to guide cardiac venting and proximal anastomosis of the coronary grafts with single aortic cross-clamping. Furthermore, the use of the centrifugal pump seems to reduce the incidence of stroke.<sup>30</sup>

Although a cost analysis was not one of the aims of the present study, no differences were found between the 2 groups regarding intubation time, hospital stay, or the need for transfusions, that would entail a similar consumption of resources, unlike that reported by other authors.<sup>7,16</sup>

The actuarial survival of the octogenarians was similar to that of the septuagenarians, with 75% of the patients being free of cardiac events at 5 years. This result could be partly due to the natural selection of individuals we could call “biologically advantaged” and who have reached 80 years with excellent life expectancy. On the other hand, the almost unvarying use of the internal mammary artery for coronary revascularization could have contributed to these outcomes.<sup>22,31</sup>

The additive EuroSCORE and preoperative AF were independently associated with increased mortality during follow-up, as other authors have reported.<sup>32,33</sup> The former could be due to including some of the variables of greater prognostic relevance in these patients, such as ventricular dysfunction, peripheral vascular disease, etc. Atrial fibrillation is a risk factor of stroke and bleeding complications associated with anticoagulation treatment and AF itself may lead to heart failure.

The results may have been affected due to the study being retrospective. In addition, there may have been biases in the selection of octogenarians referred for surgical evaluation and in relation to those accepted for intervention. Furthermore, no record was made of patients who were not referred for surgery, those who refused surgery or those who refused after being given further information. On the other hand, it is difficult to control all the possible confounding variables, some of which are difficult to quantify, such as the general state of the patient. However, the fact that octogenarians with complex diseases underwent surgery indicates that this subgroup was fully represented.

## CONCLUSIONS

Cardiac surgery in selected octogenarians has outcomes similar to those obtained in other elderly individuals of a less advanced age, including those with complex diseases, with good medium-term survival rates, and quality of life. Pulmonary hypertension, emergency surgery, and combined surgery are risk factors of mortality



and, together with advanced functional class, and prolonged CPB time, are risk factors of serious postoperative complications. Early surgical correction may avoid the need for operating on these patients in such unfavorable conditions. Preoperative AF and the additive EuroSCORE were associated with increased mortality during follow-up.

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