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ORIGINAL ARTICLE

Adding coronary artery bypass grafting to aortic valve replacement increases operative mortality for elderly (70 years and older) patients with aortic stenosis

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Abstract

Objective This retrospective study aimed to determine the effect of simultaneous aortic valve replacement (AVR) and coronary artery bypass grafting (CABG) on operative outcomes and long-term survival in elderly patients with a high prevalence of comorbidity.

Methods One hundred and fifty-seven elderly patients (70 years old or older) undergoing isolated AVR ($n = 120$) or combined AVR/CABG ($n = 37$) were evaluated. Operative outcomes were compared between the two surgical groups. Long-term survival was also compared between the groups using the Kaplan–Meier method and long-rank (Mantel–Cox) test.

Results Operative mortality was 0.8 % for the isolated AVR group and 5.4 % for the combined AVR/CABG group ($p = 0.076$). The length of the intensive care unit stay for the combined AVR/CABG group was significantly longer than that for the isolated AVR group (median: 40 vs. 21 h, $p = 0.008$). However, the occurrence rate of hospital complications, such as reoperation for bleeding, deep sternal infection, supra-ventricular arrhythmia, and neurological complications, was similar between the two groups. Actuarial survival at 3 and 5 years was 82.3 and 80.9 % for the isolated AVR group, and 88.3 and 73.0 % for the combined AVR/CABG group, respectively ($p = 0.637$).

Conclusions The satisfactory operative and long-term results in our study support a more aggressive simultaneous coronary revascularization combined with AVR for aortic valve stenosis in elderly patients.

Keywords Aortic stenosis · Coronary artery bypass grafting · Aortic valve replacement · Elderly patients · Simultaneous AVR and CABG procedures

Introduction

The ACC/AHA guidelines recommend that patients undergoing aortic valve replacement (AVR) for aortic stenosis with significant stenoses in major coronary arteries (greater than or equal to 70 % reduction in luminal diameter) should be treated with coronary artery bypass grafting (CABG) (Class I) [1]. Several recent series [2–5] have shown that adding CABG to AVR has little or no adverse effect on operative mortality. Moreover, combined AVR and CABG reduces the rates of perioperative myocardial infarction, operative mortality, and late mortality and morbidity compared with patients with significant coronary artery disease (CAD) who do not undergo revascularization at the time of AVR.

In elderly patients who have dysfunction of systemic organs and a high prevalence of comorbidity, combined AVR and CABG has the potential to increase perioperative myocardial infarction and early postoperative morbidity because of increased cross-clamp time and operative time [3, 4]. An alternative therapeutic strategy could be used instead of simultaneous AVR and CABG procedures in elderly patients with aortic stenosis and significant coronary stenosis. For example, percutaneous coronary intervention could be performed prior to AVR, and isolated AVR under close monitoring of coronary ischemic events and percutaneous coronary revascularization could be

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performed at the postoperative period. Therefore, to clarify the validity of simultaneous AVR and CABG in elderly patients, we investigated whether combined AVR and CABG increases operative mortality and morbidity compared with isolated AVR in elderly patients aged 70 years or older, who have higher operative risks than those in younger patients.

Patients and methods

Patients

From October 1990 to April 2011, AVR with or without CABG was performed in 157 consecutive patients who were 70 years of age or older with severe aortic stenosis. We compared the operative and long-term results in patients who underwent combined AVR/CABG ($n = 37$, group AC), with those who underwent AVR only ($n = 120$, group A). The following preoperative data were collected from hospital records: age, sex, New York Heart Association (NYHA) functional class, left ventricular ejection fraction, and coronary angiographic findings. Follow-up data were collected for 119 isolated AVR patients and 35 combined AVR/CABG patients discharged from hospital, with a final end of study date of October 2011. Consequently, 100 % follow-up was obtained. The follow-up period for isolated AVR patients ranged from 1 month to 16.3 years (mean, 4.6 ± 3.6 years) and for combined AVR/CABG patients it was from 1 month to 13.6 years (mean, 4.1 ± 3.3 years). This study was approved by our institutional ethical committee and institutional review board.

Definitions of variables

All patients received preoperative cardiac catheterization and echocardiography. Coronary arteries with greater than 75 % narrowing were considered stenosed, and the left main coronary with greater than 50 % narrowing was considered stenosed. Categorization of the extent of CAD (one-, two-, or three-vessel disease) was based on stenosis of a major artery or one of its branches. Patients who underwent an operation within 24 h of referral were classified as emergent, and patients within the same hospital as that for the initial referral were considered urgent. Operative death was defined as any death occurring within 30 days of the operation if the patients had been discharged from the hospital, or any death occurring during the hospitalization for the operation. Re-intervention was performed because of bleeding, or suspected cardiac tamponade.

Surgical technique

All surgical procedures were carried out via a midline sternotomy, and AVR and CABG were performed employing the usual techniques of cardiopulmonary bypass. After 1997, strategies for myocardial protection during the operation included intermittent antegrade and retrograde tepid blood cardioplegia. In patients who underwent combined AVR/CABG procedures, distal coronary anastomoses of free grafts (reversed saphenous veins and radial arterial grafts) were performed first, followed by AVR. Finally, anastomoses of internal thoracic arterial grafts and proximal coronary anastomoses of free grafts were performed. An internal thoracic arterial graft was used for the left anterior descending coronary artery (LAD). The selection of an aortic valve prosthesis was based on the patient's age, expected survival, and the surgeon's preference.

Statistical analysis

Categorical data, such as sex, were compared between the two groups (group A vs group AC) using the Chi-square test or Fisher's exact test. Continuous data, such as age, are expressed as the mean and standard deviation with ranges, and were compared between the two groups using t tests. Cumulative long-term survival for patients operated on using isolated AVR or combined AVR and CABG was analyzed by the Kaplan–Meier method and log-rank (Mantel–Cox) test. Statistically significant differences were assumed when p values were lower than 0.05.

Results

Preoperative patient characteristics

Preoperative patients' characteristics are presented in Table 1. The age in the study population ranged from 70 to 86 years (mean age, 76.4 ± 3.8 years) with no difference between the two groups. There was no difference in sex between the two groups. The NYHA functional class in group AC was significantly higher than that in group A ($p = 0.025$). Left ventricular ejection fraction in group A ranged from 28 and 94 %, and in group AC, it ranged from 30 and 75 %. In group AC, diabetes was more frequent ($p = 0.006$), and urgent and emergent operations were more frequent than those in group AC ($p = 0.002$). In group AC, coronary pathology included 14, 9, and 9 patients with single, double, and triple vessel disease, respectively, and 5 patients with left main coronary disease. In group A, 12 patients had coronary lesions, and 10 and 2 patients had single and double vessel disease,

Table 1 Patients' characteristics

	Group A	Group AC	*p* value
Number (male/female)	120 (53/67)	37 (16/21)	NS
Age (range)	76.3 ± 3.5 (70–85)	77.0 ± 4.7 (70–86)	NS
NYHA class	2.4 ± 0.7	2.7 ± 0.7	0.025
Ejection fraction (%)	59.4 ± 11.8	55.7 ± 9.1	NS
Extent of CAD			
1 VD	10 (8.3)	14 (3.8)	
2 VD	2 (1.7)	9 (24.3)	<0.001
3 VD	0 (0)	9 (24.3)	
LMCD	0 (0)	5 (13.5)	
Diabetes mellitus	23 (19.2)	13 (35.1)	0.006
Hypertension	78 (65.0)	25 (67.6)	NS
Hyperlipidemia	45 (37.5)	17 (45.9)	NS
Hemodialysis	9 (7.5)	5 (13.5)	NS
Urgent/emergent op	0 (0)	3 (8.1)	0.002

Values are mean + SD; numbers in parentheses indicate percent

NS not statistically significant, *NYHA* New York Heart Association, *CAD* coronary artery disease, *VD* vessel disease, *LMCD* left main coronary disease, *op* operation

Table 2 Operative data

	Group A ($n = 120$)	Group AC ($n = 37$)	*p* value
Operative time (min)	265 ± 72	384 ± 82	<0.001
ECC time (min)	141 + 36	203 + 54	<0.001
Aortic clamp time (min)	102 ± 27	158 ± 41	<0.001
Mechanical valve/bioprosthesis	46/74	18/19	NS
Valve position			
Intra-annular	49 (40.8)	14 (37.8)	
Supra-annular	71 (59.2)	23 (62.2)	NS
EOAI (cm^2/m^2)	0.89 + 0.13	0.90 + 0.11	NS
EOAI < 0.85	43 (35.8)	11 (29.7)	NS
EOAI < 0.65	2 (1.7)	0 (0)	NS
Aortic root enlargement	7 (5.8) (Manouguian; 1 Nicks; 6)	1 (2.7) (Manouguian; 1)	NS
Number of distal anastomosis		1.6 ± 0.9 (1–4)	
ITA use		26 (70.3)	

Values are mean + SD, numbers in parentheses indicate percent

NS not statistically significant, *ECC* extracorporeal circulation, *EOAI* effective orifice area index, *ITA* internal thoracic artery

Table 3 Operative results

	Group A ($n = 120$)	Group AC ($n = 37$)	*p* value
Operative death	1 (0.8)	2 (5.4)	0.076
ICU stay (hours, median)	21	40	0.008
Reoperation for bleeding	9 (7.5)	1 (2.7)	NS
Deep sternal infection	1 (0.8)	0 (0)	NS
Arrhythmia	47 (39.2)	18 (48.6)	NS
Stroke	5 (4.2)	0 (0)	NS

Numbers in parentheses indicate percent

NS not statistically significant, *ICU* intensive care unit

respectively. Patients with unbypassed CAD had a significantly greater frequency of single-vessel disease compared with that in patients who underwent CABG for CAD.

Operative data

Operative data are shown in Table 2. The duration of extra corporeal circulation (ECC) and aortic cross-clamping time in group AC were significantly longer than those in group A ($p < 0.001$). Aortic root enlargement was performed in one patient in group AC, and seven patients ingroup A. In group AC, the number of distal anastomoses ranged from one to four (mean, 1.6 ± 1.0). Internal thoracic arterial grafts were used in 26 patients (70.3 %). In 32 patients with revascularization to LAD lesions, we used internal thoracic arterial grafts in 26 patients (81.3 %).

Operative results

Three of 157 patients died (1.8 %), including 1 of 120 patients (0.8 %) in group A, and 2 of 37 patients (5.4 %) in group AC, with no significant difference in mortality between the two groups (Table 3). Details of the three patients who died are summarized in Table 4. The median time of intensive care unit stay was significantly longer in group AC than in group A (40 vs. 21 h, $p = 0.008$). A series of hospital complications were documented for both groups. These complications included reoperation for bleeding, deep sternal infection, supra-ventricular arrhythmia, and neurological complications (Table 3). There were no significant differences in complications between the two groups.

Long-term survival

In group A, 29 patients died, and in group AC, 11 patients died during follow-up. Actuarial survival rates in group A

Table 4 Cases of hospital deaths

Group	Age/sex	Clinical diagnosis	Op method	Post op (days)	Cause of death
A	73/M	Calcified AS	AVR (Medtronic freestyle valve 21 mm)	14	LOS
AC	75/F	Calcified AS +AP	AVR (SJM Regent 19 mm) + CABG (1)	28	PVE
	78/F	Calcified AS + AP, HD	AVR (MOSAIC 19 mm) + CABG (1)	64	Liver dysfunction

Op operation, *AS* aortic stenosis, *AVR* aortic valve replacement, *LOS* low cardiac output syndrome, *SJM* St. Jude Medical prosthetic valve, *AP* angina pectoris, *CABG* coronary artery grafting, *PVE* prosthetic valve endocarditis, *HD hemodialysis*

were 97.3 % after 1 year, 82.3 % after 3 years, and 80.9 % after 5 years. Actuarial survival rates in group AC were 88.3 % after 1 year, 88.3 % after 3 years, and 73.0 % after 5 years. Kaplan–Meier survival was not different between the two groups (Fig. 1). Nine patients in group A died because of cardiac causes, including five from heart failure, three from sudden unexplained causes, and one from an unknown cause. Four patients in group AC died because of cardiac causes, including three from heart failure, and one from an unknown cause. The rates of freedom from cardiac death in group A were 98.3 % after 1 year, 94.3 % after 3 years, and 92.8 % after 5 years. The rates of freedom from cardiac death in group AC were 96.7 % after 1 year, 96.7 % after 3 years, and 84.3 % after 5 years. There was no significant difference between the two groups by the Kaplan–Meier method and log-rank (Mantel–Cox) test (Fig. 2).

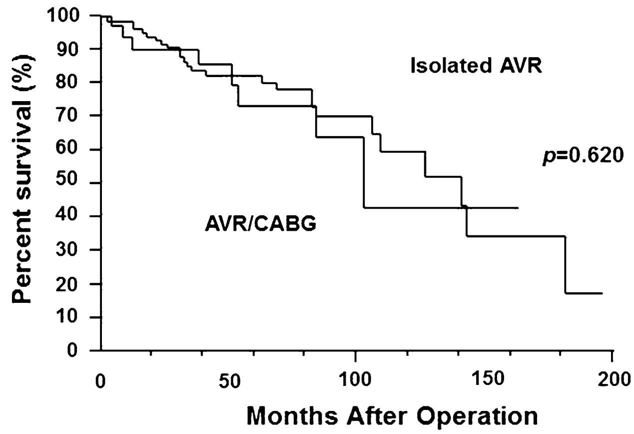

Fig. 1 Actuarial survival of all patients including hospital deaths after simultaneous aortic valve replacement and coronary artery bypass grafting (AVR/CABG), and isolated aortic valve replacement (isolated AVR)

Discussion

With an increase in the elderly population, the prevalence of aortic valve disease is likely to increase. Moreover, the percentage of elderly patients with significant CAD continues to rise. Therefore, elderly patients who undergo AVR with CAD are becoming increasingly common. AVR with concomitant CABG has become an accepted surgical intervention. In the United States, more than 50 % of patients undergoing AVR also require concomitant CABG. However, studies in the 1990s [6–8] showed that when CABG was required in addition to AVR in elderly patients, simultaneous AVR and CABG increased early mortality and worsened long-term survival compared with those in isolated AVR. AVR combined with CABG has been reported to be associated with early mortality of 6.0–9.0 %. However, major advances in the manufacture of prosthetic heart valves, operative techniques, myocardial preservation, anesthesia, and perioperative care during the last decades have yielded improved outcomes in valvular and coronary artery surgery in elderly patients. Therefore, we investigated whether CABG in addition to AVR in elderly patients adversely affect early outcome and long-term survival.

Our operative mortality (5.4 %) after simultaneous AVR and CABG is comparable with previously reported

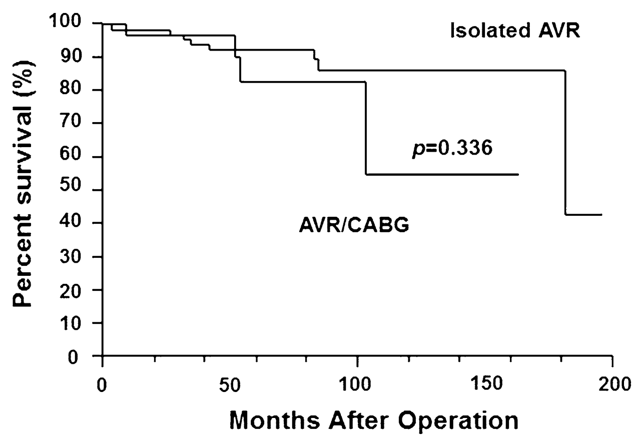

Fig. 2 Actuarial freedom from cardiac death, including all deaths after simultaneous aortic valve replacement and coronary artery bypass grafting (AVR/CABG), and isolated aortic valve replacement (isolated AVR)

mortality (6.4, 8.9, and 9.4 %) in other recent studies, which were well matched in terms of the patients' ages and preoperative patients' characteristics [2, 9, 10]. Preoperative NYHA functional class and left ventricular function have been reported to be the main independent risk factors for hospital mortality [11]. The patient selection in these previous studies [2, 9, 10], in which 50–75 % of patients had NYHA class III–IV and the average left ventricular ejection fraction was 45–55 %, was similar to our report. Furthermore, there were no significant differences regarding postoperative complications between our study groups, with the exception of the duration of intensive care unit stay (21 h in group A vs. 40 h in group AC). In the present study, the ECC and aortic cross clamping times were significantly longer in the combined AVR/CABG procedures than those with AVR only. However, longer procedural times were not associated with adverse outcomes. In several recent reports, which compared operative outcomes after isolated AVR and a simultaneous procedure in octogenarians and elderly patients (65 years of age or older), coronary revascularization did not add a significant risk of early mortality and morbidity in patients with simultaneous AVR and CABG [2, 3, 5].

The cumulative 5-year survival rate of 73.0 % in our study is comparable with survival rates reported in several previous studies [2, 9, 10], which had similar ages and preoperative patient characteristics. Kurlansky et al. [2] did not demonstrate a significant difference in cumulative survival between patients with isolated AVR and combined AVR/CABG (59.4 vs. 54.5 % at 7 years). Our long-term survival and the rate of freedom from cardiac death after combined AVR/CABG were similar to those after isolated AVR. In a study by Czer et al. [7], patients undergoing isolated AVR who had unbypassed CAD had lower late survival and a higher rate of late sudden death than those in patients with CAD who received CABG. Mullany et al. [12] also found that their patients with CAD who received coronary bypass grafts had better late survival than patients who did not. In these previous studies, a significant protective effect on CAD of revascularization by CABG was apparent [7, 12, 13]. Unrevascularized CAD in AVR could have negatively affected results in that group of patients, adversely influencing outcomes compared with those in combined AVR/CABG patients. Moreover, we routinely use the internal thoracic artery for revascularization to LAD lesions. Consequently, the internal thoracic artery was used in 81.3 % of patients in which revascularization to LAD lesions was required. The role of the internal thoracic artery to LAD grafting in enhancing survival in the setting of isolated CABG has been established [14]. In a cohort of patients who required combined AVR/CABG, internal thoracic artery grafting to the LAD was suggested to be beneficial by Gall et al. [15]. The excellent long-term patency rate of the internal thoracic artery may have contributed to long-term survival of our patients with coronary revascularization in this study.

The present study was a retrospective review of data obtained from hospital charts. Therefore, possible selection bias cannot be excluded. Although a significant difference in outcome between isolated AVR and combined AVR/CABG was not found in the present study, it is possible that an insufficient number of patients was studied.

In conclusion, the present study clearly shows that elderly patients undergoing isolated AVR and simultaneous AVR/CABG surgery have good operative and long-term outcomes. Moreover, there is no significant difference in outcome between isolated AVR and simultaneous AVR/CABG surgery. Based on these data, we conclude that a more aggressive combined AVR/CABG procedure is appropriate, even in elderly patients, following the recommendation of simultaneous AVR and CABG surgery as mentioned in the ACC/AHA guidelines.

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