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Coronary artery bypass grafting in the octogenarians: should we intervene, or leave them be?

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Abstract

Objective Coronary artery bypass grafting (CABG) is gradually increasing in the elderly population. We aimed to investigate the risk factors and the results of CABG along with the long term survival in patients at an age of 80 and older. **Methods** Between January 2002 and December 2011, a total of 101 consecutive patients at an age of 80 and older who underwent CABG in our hospital were included in the study. The patients were followed and the long-term survival was estimated. **Results** The mean age of the patients was 82.98 ± 2.27 years. Sixty-four (63.4%) were males and 37 (36.6%) were females. Emergency surgery, duration of cardiopulmonary bypass, the intensive care unit (ICU) stay, inotropic support, intra aortic balloon pulsation application, amount of erythrocyte transfusion and fresh frozen plasma transfusion and ventilation period were significantly higher in the patients who died in the hospital. The duration of cardiopulmonary bypass (CPB) was found to be an independent predictor of mortality (OR: 1.18, 95% CI 1.01−1.38, $P = 0.034$). The in-hospital mortality was 16.8%. Kaplan-Meier analyses revealed a survival ratio of 91.3% at one year, 82.9% at three years and 69.0% at five years. **Conclusions** Patients at the age of 80 and older can be candidates for the CABG procedure bearing in mind that they may have a longer ventilation period and intensive care unit stay. The morbidity and mortality of this age group is considered within an acceptable range. Approaches to minimize CPB, or the choice of off-pump surgery, may be a preventive method to lower the incidence of mortality. Hence, CABG may be performed in this age group with a satisfactory survival ratio.

1   Introduction

Avoiding coronary artery bypass grafting (CABG) in the elderly population is attributed to the increased morbidity and mortality of this age group. The main reasons to avoid surgery in this group are due to low life expectancy and the intolerance to cardiopulmonary bypass which is an important constituent of the operation. Furthermore, most of these patients possess multiple systemic disorders, such as diabetes, renal failure and neurological problems.[1]

Coronary artery disease presents a rapid increase that is directly proportional to age after the fourth decade. Cardiovascular disease is frequent over the age of 80.[2,3] Edmunds, *et al.*[1] revealed the prevalence of symptomatic cardiac disease at 40% in this age group. The population over the age

of 80 reached 12 million in the USA in 2010,[4] and the expected increase in the aging population in Turkey between 2008 and 2040 is 201%.[5]

Akins, *et al.*[6] displayed that 87% of the patients over the age of 80 benefited dramatically from CABG resulting in an increase in the quality of life. We aimed to investigate the morbidity and mortality of CABG, along with the long-term survival, in patients at age 80 and older.

2   Methods

The study was approved by the institutional board and the appropriate ethical committee and has been performed in accordance with the ethical standards detailed in the Declaration of Helsinki and its later amendments.

2.1   Patient profile

A total of 101 patients at age 80 and older, who underwent CABG in our hospital between 2002 January and 2011 December were included in the study. In this study, 17 potential confounding variables were studied: age, sex, diabe-

tes mellitus, hypertension, chronic obstructive pulmonary disease, hyperlipidemia, obesity, family history, increased levels of urea and creatinine (not more than 0.3 mg/dL from the basal value of creatinine), carotid artery stenosis, preoperative ejection fraction, emergency surgery, total number of grafts used, surgery type, duration of cross clamp and operation time. We were interested in the following seven outcomes: mortality, length of time in intensive care unit (ICU) and hospital stay, use of inotropics and intra aortic balloon pulsation (IABP), transfusion and need for ventilator support.

Patients were divided into two groups: Group 1 consisting of the patients who died in the hospital and Group 2 including the patients who were discharged from the hospital.

2.2 Surgical technique

Sternotomy was followed by aortocaval cannulation. The site of the aortic cannulation was decided by epiaortic ultrasonography. The plaque free sites were used for aortic cannulation. Cardiopulmonary bypass (CPB) was initiated by cooling the patient down to 32°C. After application of cross-clamp onto the aorta, the heart was arrested using antegrade and retrograde cardioplegia, and then the distal anastomoses were performed. The proximal anastomoses were performed using a site biting clamp following defibrillation of the heart. Fifteen (17.9%) patients underwent beating heart operation due to diffuse atherosclerotic disease of the aorta.

The CPB procedures were similar in most cases, except in the patients undergoing concomittant replacement of the ascending aorta. Axillary artery cannulation was applied for these patients and the distal anastomosis was held under low flow (10 mL/kg per minute) unilateral cerebral antegrade perfusion at 28°C.

Patients with high levels of urea and creatine were hydrated and dopamine was administered (2.5 mg/kg per minute). The perfusion pressure was kept around 70 mmHg and hemofiltration was applied during the surgery when required.

The patients regaining muscular power following surgery without severe left ventricular dysfunction and postoperative hemorrhage were extubated generally within the first eight hours. Early mobilization was enhanced the next day following surgery.

2.3 Statistical analysis

Kolmogorov Smirnov test was used for analyzing the normal distribution of the data. Normally distributed continuous variables were expressed as mean ± SD, or median values if abnormally distributed. Categorical variables were expressed as numbers and percentages. Demographic characteristics and perioperative variables were compared using "independent samples *t*-test" or "Mann-Whitney-*U* test" for continuous variables and "chi-square test" or "Fisher's exact test" for categorical variables. Potential predictive preoperative and intraoperative significant variables were further analyzed by logistic regression models. Survival analysis was performed by the Kaplan Meier method. SPSS pocket program, version 15.0, was used for statistical analysis. A *P* value < 0.05 was accepted as significant.

3 Results

The demographic characteristics of the patients are summarized in Table 1. The mean age of the patients was 82.98 ± 2.27 years. A total of 64 (63.4%) were male and 37 (36.6%) were female. Number of patients with a variable number of vessels bypassed are as follows: 17 (16.8%) patients with one vessel, 37 (36.6%) patients with two vessels, 23 (22.8%) patients with three vessels, 24 (23.8%) patients with five or more vessels.

Table 1. Demographic characteristics of the patients.

Age, years	82.98 ± 2.27
Male sex	64 (63.4%)
Diabetes mellitus	16 (15.8%)
Hypertension	44 (43.6%)
Chronic obstructive pulmonary disease	8 (7.9%)
Hyperlipidemia	21 (20.8%)
Obesity	5 (5.0%)
Positive family history	11 (10.9%)
Number of smokers	6 (5.9%)
Raised levels of urea and creatinine	28 (27.7%)
Carotid artery stenosis	8 (7.9%)
Preoperative ejection fraction, %	50.25% ± 9.69%

Data are presented as *n* (%) or mean ± SD.

The operative and postoperative variables of the patients are given in Table 2. The procedures in addition to CABG were: aortic valve replacement (AVR) in one patient (0.9%), AVR together with supra-coronary graft implantation in two patients (1.9%), carotid endarterectomy together with patch plasty in six patients (5.9%), plication of left ventricular aneurysm together with closure of atrial septal defect in one patient (0.9%), supra-coronary graft implantation in three patient (2.7%), post-infarct ventricular septal defect (VSD) repair (0.9%) in one patient, David I operation in one patient (0.9%), and mitral repair together with atrial septal defect and VSD closure in one patient (0.9%).

Table 2. Operative and postoperative variables of the patients.

Number of bypassed vessels	2.64 ± 1.24
Cardiopulmonary bypass	
On-pump	84 (83.2%)
Off-pump	17 (16.8%)
Duration of cardiopulmonary bypass, min (*n* = 84)	96.39 ± 40.17
Duration of cross-clamp, min (n = 84)	57.41 ± 29.30
Duration of the operation, min	233.77 ± 77.18
Intensive care unit stay, days	4.36 ± 11.42
Inotropic support	40 (39.6%)
Intra-aortic balloon pump	5 (5.0%)
Erythrocyte suspension (units)	1.92 ± 1.96
Fresh frozen plasma (units)	3.30 ± 3.47
Ventilator support (hours)	43.37 ± 127.68
Hospital stay (days)	10.80 ± 13.38

Data are presented as *n* (%) or mean ± SD.

There were no differences concerning the preoperative data among the patients who died in the hospital and the patients discharged from the hospital (Table 3). However, the percentage of emergency surgery was predominantly higher in the mortality group (*P* = 0.003). Among the intraoperative factors, the duration of CPB was found to be significantly different between the groups (*P* = 0.022). There were no differences among the groups concerning the number of bypassed vessels, duration of cross-clamp, and the duration of the operation. The intensive care unit stay (*P* < 0.001), inotropic support (*P* = 0.001), IABP application (*P* = 0.003), number of erythrocyte suspension (*P* < 0.001), and fresh frozen plasma (*P* = 0.002) transfused and ventilation periods (*P* < 0.001) were higher in the patients who died in the hospital. CABG with additional procedures compared to the isolated CABG group did not reveal a statistically significant difference in mortality (*P* = 0.206).

Table 3. In-hospital mortality *vs.* patients discharged.

	Discharged (*n* = 84)		In-hospital mortality (*n* = 17)		*P*-value
	Mean	***n* (%)**	**Mean**	***n* (%)**	
Preoperative characteristics					
Age, yrs	83.05 ± 2.35		82.65 ± 1.84		0.515
Male sex		55 (65.5%)		9 (52.9%)	0.328
Diabetes mellitus		13 (15.5%)		3 (17.6%)	0.823
Hypertension		36 (42.9%)		8 (47.1%)	0.750
Chronic obstructive pulmonary disease		8 (9.5%)		0 (0.0%)	0.185
Hyperlipidemia		21 (25.0%)		0 (0.0%)	0.021
Obesity		4 (4.8%)		1 (5.9%)	1.000
Positive family history		9 (10.7%)		2 (11.8%)	0.899
Number of smokers		5 (6.0%)		1 (5.9%)	1.000
Raised levels of urea and creatine		28 (33.3%)		0 (0.0%)	0.005
Carotid Artery Stenosis		7 (8.3%)		1 (5.9%)	0.733
Preoperative ejection fraction, %	50.08 ± 10.08		51.71 ± 5.53		0.984
Emergency surgery		3 (3.6%)		4 (23.5%)	0.003
Operative characteristics					
Number of vessels bypassed	2.55 ± 1.20		3.06 ± 1.34		0.126
Cardiopulmonary bypass duration (n = 84)	89.85 ± 33.90		123.40 ± 52.75		0.022
On-pump		69 (82.1%)		15 (88.2%)	0.540
Off-pump		15 (17.9%)		2 (11.8%)	
Duration of cross-clamp, min	55.27 ± 28.45		66.86 ± 32.21		0.203
Duration of the operation, min	225.90 ± 67.12		272.65 ± 109.19		0.111
Postoperative characteristics					
Intensive care unit stay, days	2.10 ± 3.15		15.53 ± 24.59		< 0.001
Inotropic support		27 (32.1%)		13 (76.5%)	0.001
Intra-aortic balloon pump		1 (1.2%)		4 (23.5%)	0.003
Erythrocyte suspension	1.54 ± 1.43		3.94 ± 2.98		< 0.001
Fresh frozen plasma	2.55 ± 1.43		7.25 ± 6.93		0.002
Ventilator support, h	18.33 ± 22.42		174.81 ± 287.89		< 0.001
Hospital stay, days	8.70 ± 5.96		21.18 ± 28.23		0.147

Data are presented as *n* (%) or mean ± SD.

Further logistic regression analysis revealed that the duration of CPB is an independent predictor of mortality in our patient population (OR: 1.18, 95%CI 1.01−1.38, *P* = 0.034).

The in-hospital mortality was 16.8%. Postoperatively, twenty-one (21%) patients required prolonged ventilation, eight (8%) underwent surgical re-exploration due to bleeding or pericardial tamponade, eight (8%) developed atrial fibrillation following the operation, eight (8%) developed pulmonary or wound infection, five (5%) had low cardiac output, two (2%) had sternal dehiscence and one (1%) had a permanent pacemaker implantation due to complete AV block.

At follow-up, a total of 98 patients were contacted and three patients remained out of reach. The mean follow up period was 39.8 ± 23.9 months (range 2–108 months). Kaplan Meier analyses revealed a survival ratio of 91.3% in one year, 82.9% in three years and 69.0% in five years (Figure 1), while 74% of the patients were angina free (totally angina-free or Class I according to Canadian Cardiovascular Society grading of angina pectoris) among the survivors.
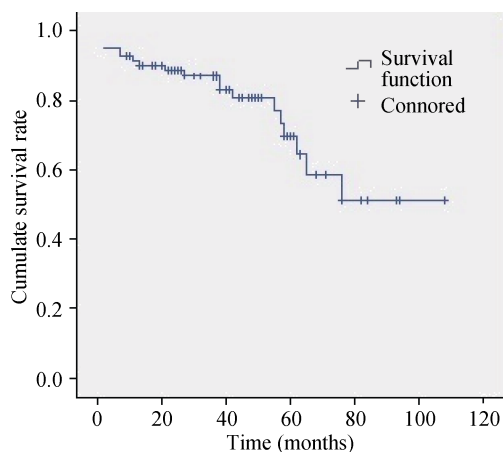

Figure 1. Kaplan-Meier analysis of the patients.

4   Discussion

In this study, we found that octogenarians continue to have higher morbidity and mortality after cardiac surgery than the younger population. Additionally, the duration of CPB was found to be an independent predictor for mortality in the elderly.

Cardiac surgery in octogenarians has risen steadily since the 1980s. The elderly are now the fastest growing population in Western countries, and the number of elderly patients with coronary artery disease potentially eligible for surgery is expected to increase.[7] Is it cost-effective to operate on these patients? To answer this question, it is important to examine late postoperative survival and functional outcome

in addition to morbidity and mortality.

There are three options for treatment of octogenarians with coronary artery disease: medical therapy, coronary intervention, and surgery. It was found that revascularization is superior to optimal medical treatment in those older than 75 years.[8,9] At present, open heart surgery in octogenarians is more safe and efficient as a result of improvements in myocardial protection, surgical technique, extracorporeal perfusion, anesthetic management and postoperative care.[10,11]

In our study, we found that 86% of our patients required isolated CABG and 14% of patients required additional procedures. Although bypass surgery in elderly patients is associated with favorable outcomes, combined CABG with additional procedures is associated with significantly higher risks.[12] However, CABG with additional procedures compared to the isolated CABG group did not reveal a statistically significant difference in mortality in our study.

Off-pump CABG is known to be less invasive, reduces mortality, the postoperative complications and shortens the postoperative recovery period.[13,14] However, we found that there was no statistically significant difference in terms of mortality between these two groups. As a result of additional procedures and severe atherosclerosis of coronary arteries, our off-pump CABG rate was only 15%.

We used the left internal mammary artery (LIMA) in the majority of the patients. Harvesting the single LIMA in the octogenarians is safe, and the LIMA graft provides better patient outcomes, even in octogenarians.[15,16]

Mortality in octogenarians after CABG has been reported to range from 8% to 24% and the in-hospital mortality was 16.8%. In our series, however, mortality is higher than what had been observed in the three major previous studies.[12,17,18] Peterson, *et al*.[17] reported a hospital mortality of 11.5%. Likosky, *et al*.[18] and Alexander, *et al*.[12] observed a mortality of 7.7% and 8.1%, respectively.

It should be emphasized that the long-term survival and functional improvement can be achieved in elderly patients despite the existence of a serious cardiovascular disease. In this study, Kaplan Meier analyses revealed a survival ratio of 91.3% in one year, 82.9% in three years, and 69.0 % in five years. The 3-year survival rates after CABG in other series were between 66.1%–84.5%.[19] Our results were similar to those reports. Salomon, *et al*.[20] demonstrated in a 6-year follow-up period a percentage of angina-free survival of 77% and Mullany, *et al*.[21] in a 5-year follow-up period with 159 patients over 80 years old, observed a percentage of 79. The percentage of angina-free survival in our study was also similar to the one of Solomon and colleagues.

Previous series have reported a high incidence of postop-

erative complications in elderly patients.[22] In this study, the most common complication was prolonged ventilation (21%) followed by arrhythmias (9%). Other complications included postoperative bleeding, infection, low cardiac output and sternal dehiscence. The incidences and nature of postoperative complications in our study are comparable to other reports.[7,23–27] It has been previously reported that octogenarians tend to have a longer postoperative length of stay than younger patients.[23] In this report, the mean intensive care unit length of stay was significantly higher in the in-hospital mortality group.

4.1 Clinical predictors of mortality

For patients of any age, the variables that were independent predictors of mortality in patients following CABG were age, gender, prior CABG, vascular disease, chronic obstructive pulmonary disease, history of congestive heart failure, shock or emergency procedure, ejection fraction, renal insufficiency or dialysis and preoperative myocardial infarct. Previous studies have reported different predictors of mortality in octogenarians undergoing open heart surgery. Akins, *et al*.[6] identified chronic lung disease and congestive heart failure as independent predictors of mortality, while Edmunds, *et al*.[1] found that preoperative variables predictive of early death, include New York Heart Association (NYHA) functional classification IV, previous myocardial infarction, and emergency operation. In our study, we found that CPB duration was the only independent predictor of mortality. Besides, in the mortality group, potential predictors such as intensive care unit stay, inotropic support, application of IABP, transfusion and ventilator support time were found statistically higher than the discharged group. However, these parameters should be addressed as a consequence of the procedure rather than as a predictor.

In our study, the hospital mortality was 17 (16.8%). It was cardiac related and associated with co-morbid conditions which were similar to those reported by others.[10,24-30] The main causes of death in our series were due to low cardiac output, respiratory failure and the consequent of infections.

4.2 Limitations

This report is retrospective and describes a series of cases transpiring or occurring operated at a single center. Outcome comparisons are made with literature and are also discussed, since a reliable statistical comparison could not be performed with reports by other authors. Meta-analysis regarding this subject may clarify this issue further. Comparative analyses with other forms of treatment were not carried out, such as drug, or percutaneous treatment. Our off-pump CABG rate was only 15%. Comparison of sur-

vival of surgically treated patients and percutaneously, or medically treated, patients would give more detailed information about the benefits of therapy strategy.

In conclusion, this clinical series provides a profile of octogenarians currently undergoing cardiac surgery and their associated outcomes. Octogenarians represent an operable cohort (or population of patients) despite a longer ventilation period, and prolonged ICU stay. Duration of CPB should be minimized for this age group of patients. The morbidity and mortality of this age group is within an acceptable range. Therefore, CABG can be performed in this age group with a reasonable survival ratio.

Acknowledgement

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