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Aorta No-Touch Off-Pump Coronary Artery Revascularization in Octogenarians: 5 Years' Experience

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ABSTRACT

Background: Approximately 18% of octogenarians have ischemic heart disease. Increasingly, they are being referred for coronary artery revascularization by surgical and/or percutaneous procedures. These strategies have been questioned, however, because of reports of poor outcomes in the elderly. In this study, we aimed to determine the impact of age on morbidity and mortality in patients undergoing off-pump coronary artery bypass (OPCAB) with the π-circuit procedure during 5 years of follow-up.

Materials and Methods: From February 2001 to November 2005, 1359 patients underwent isolated coronary revascularization with the π-circuit technique, which consists of (1) beating heart surgery, (2) OPCAB, (3) no touching of the aorta, (4) use of composite grafts, and (5) arterial revascularization. Sixty-two patients were ≥80 years of age (group A), and 1297 were <80 years old (group B). Both groups were compared with respect to preoperative risk factors, intraoperative parameters, and postoperative morbidity and mortality. Follow-up lasted from 4 to 60 months. Data were analyzed with the χ^2 test, the Fisher exact test, the Kaplan-Meier method, and the Cox model of regression analysis.

Results: Females predominated among the octogenarians ($P < .0005$). Octogenarians more frequently underwent emergent operations ($P < .031$) and had worse ejection fractions ($P < .026$). Obesity was also less prevalent among these patients ($P < .007$). There were no differences between the groups in the preoperative and postoperative use of an intraaortic balloon pump. Octogenarians had lower cholesterol levels ($P < .0005$) and had fewer distal anastomoses (2.24 ± 0.0.76 versus 2.77 ± 0.92, $P < .0005$). The 2 groups were not significantly different with respect to 30-day mortality (3.2% versus 1.5%) and 7-day mortality (1.6% versus 0.2%). Differences were noted in the incidences of pulmonary complications (12.9% versus 5.6%, $P < .027$), atrial fibrillation (41.9% versus 19%, $P < .0005$), and cognitive disturbances (6.5% versus 0.3%, $P < .0005$). During follow-up, survival seemed to favor the younger group ($P < .001$). Nevertheless, further analysis of the data with the Cox regression model to exclude confounding risk factors, revealed the survival rates of the 2 groups to be similar.

Conclusions: Use of the π-circuit technique is very effective for octogenarians. Although these older patients have a higher incidence of early postoperative morbidity, overall survival is not affected.

INTRODUCTION

In the past 25 years, cardiac surgery has played an increasing role in reducing morbidity and mortality caused by ischemic heart disease in the adult population [Myers 1985]. Approximately 40% of all octogenarians have symptomatic cardiovascular disease, including 18% with ischemic heart disease [National Nursing Home Survey 1985]. Increasingly, elderly patients with ischemic heart disease are being referred for coronary artery revascularization by surgical and percutaneous means. These strategies are being questioned, however, because of reports of poor outcomes in the elderly [Michael 2005].

In recent years, this "pessimistic" philosophy has been adjusted because of improvements in myocardial protection, surgical techniques, extracorporeal perfusion, anesthesia management, and perioperative care. Several reports have confirmed the safety and efficacy of open heart operations in octogenarians [Merrill 1990].

In this study, we aimed to determine the impact of age on morbidity and mortality in patients undergoing off-pump coronary artery bypass (OPCAB) with the π-circuit procedure, with up to 5 years of follow-up.

MATERIALS AND METHODS

Our study is a prospective observational study in the Department of Cardiac Surgery, Henry Dunant Hospital, Athens, Greece. From February 2001 to November 2005,

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Table 1. Baseline Characteristics of the Patients*

Preoperative variables	Group A (≥80 y) (n = 62)	Group B (<80 y) (n = 1297)	*P*
Male/female sex, n	41/21	1118/179	<.0005
Obesity, n	5 (8.1%)	290 (22.4%)	.007
Diabetes, n	13 (21%)	424 (32.7%)	.08
Cholesterol >250 mg/dL, n	6 (9.7%)	504 (38.9%)	<.0005
Stroke, n	1 (1.6%)	40 (3.1%)	1.000
PVD, n	5 (8.1%)	80 (6.2%)	.591
TIA, n	2 (3.2%)	21 (1.6%)	.283
GIT disease, n	4 (6.5%)	61 (4.7%)	.535
COPD, n	5(8.1%)	63 (4.9%)	.233
Renal failure, n	6 (9.7%)	103 (7.9%)	.629
Renal dialysis, n	0 (0.0%)	19 (1.5%)	1.000
Arterial hypertension, n	20 (32.3%)	564 (43.5%)	.090
LV function, n			
Good	938 (72.3%)	35 (56.5%)	.026
Moderate	268 (20.7%)	20 (32.3%)	
Poor	91 (7.0%)	7 (11.3%)	
Preoperative IABP, n	2 (3.2%)	25 (1.9%)	.351
Emergency, n	16 (25.8%)	196 (15.1%)	.031
Redo operation, n	4 (6.5%)	74 (5.7%)	.777

*PVD indicates peripheral vascular disease; TIA, transient ischemic attack; GIT, gastrointestinal tract; COPD, chronic obstructive pulmonary disease; LV, left ventricular; IABP, Intra-aortic balloon pump.

1359 patients were included in the study. Sixty-two patients were octogenarians (ie, ≥80 years, group A), and 1297 were younger than 80 years (group B). All patients underwent OPCAB surgery with our special technique, the π-circuit technique, which consists of the following: (1) beating heart surgery, (2) OPCAB, (3) no touching of the aorta, (4) use of composite grafts, and (5) arterial revascularization. Follow-up lasted from 4 to 60 months.

Surgical Technique

The standard approach was median sternotomy. Skeletonized internal mammary arteries and radial artery pedicle (from the nondominant arm) were then harvested. Composite arterial grafts were used (T graft, Y graft, extensions, π graft [Prapas 2002], sequential use), including one or both internal mammary arteries, with or without a radial artery. Every patient underwent total arterial myocardial revascularization based on the native origin of the internal mammary arteries, and aortic manipulations were completely avoided (aorta no-touch technique). We thereby decreased the risks of late aortic dissection, thromboemboli in the brain, and adverse effects of cardiopulmonary bypass. The exposure of the epicardial arteries of the heart was achieved with deep pericardial traction sutures, which allowed us to access the lateral and inferior wall of the heart. Stabilization of the anastomotic site was achieved with the aid of the Octopus tissue stabilizer (Octopus II; Medtronic, Minneapolis, MN, USA).

Table 2. Numbers of Performed Anastomoses*

	Group A	Group B	*P*
Distal anastomoses	2.24 ± 0.76	2.77 ± 0.92	<.0005
Grafts on LIMA	1.45 ± 0.64	1.79 ± 0.76	<.0005
Grafts on RIMA	0.77 ± 0.61	0.98 ± 0.67	<.018

*Data are presented as the mean ± SD. LIMA indicates left internal mammary artery; RIMA, right internal mammary artery.

Anesthesia Technique

Anesthesia was managed according to standard protocol. All patients had one central venous catheter; a Swan-Ganz catheter was also used. Diazepam was administered as a preanesthesia agent. We then used a combined dose of opioid/volatile agents (30 μg/kg fentanyl, 0.2 mg/kg etomidate, and sevoflurane) along with cisatracurium as a neuromuscular blocking agent. Heparin was administered at a dose of 100 IU/kg before the start of the first anastomosis to achieve an activated clotting time of 250 to 350 seconds. After completion of all anastomoses, protamine was given to reverse the effects of heparin and return the activated clotting time to near the preoperative levels. Radial artery, central venous, and pulmonary arterial pressures were monitored in all patients.

Data Collection and Analysis

The preoperative baseline characteristics of the patients, operative data, and overall postoperative events were recorded. The data of the octogenarians were recorded, and correlations between these patients and the other patients were made with regard to preoperative risk factors and operative data. All statistical tests were performed as 2-tailed tests. The Fisher exact test, the χ^2 test, the Kaplan-Meier method, and the Cox regression model were used for data analyses. A *P* value <.05 was considered statistically significant. Statistical analysis was performed with the commercially available statistical software package SPSS (version 13 for Windows; SPSS, Chicago, IL, USA).

Definitions of Variables

Diabetes is defined as a fasting plasma glucose concentration ≥126 mg/dL. Obesity is defined as a body mass index >30 kg/m^2. Stroke is defined as a cerebrovascular accident that leaves the patient with brain damage that has been confirmed with computed tomography or magnetic resonance imaging. Peripheral vascular disease refers to diseases of blood vessels outside the heart and brain as diagnosed by x-ray angiography, Doppler study, or magnetic resonance angiography. Chronic obstructive pulmonary disease occurs in patients with long-term bronchodilators or who are receiving steroids for lung disease. Renal failure is defined as an increase in the creatinine level of ≥200 μmol/L on admission or a history of renal transplantation or dialysis.

Table 3. Early Postoperative Complications*

Postoperative Variable	Group A (≥80 y) (n = 62)	Group B (<80 y) (n = 1297)	*P*
Stroke, n	1 (1.6%)	2 (0.2%)	.131
Renal complications, n	3 (4.8%)	27 (2.1%)	.154
Pulmonary complications, n	8 (12.9%)	73 (5.6%)	.027
Prolonged ventilation (>48 h), n	4 (6.5%)	35 (2.7%)	.102
Sternal wound infection, n	1 (1.6%)	12 (0.9%)	.457
Postoperative AF, n	26 (41.9%)	247 (19%)	<.005
Postoperative IABP, n	2 (3.2%)	19 (1.5%)	.248
Psychological complications, n	4 (6.5%)	4 (0.3%)	<.005
GIT complications, n	3 (4.8%)	33 (2.5%)	.224
Urine retention, n	2 (3.2%)	6 (0.5%)	.105
Hospital mortality (30-day), n	2 (3.2%)	19 (1.5%)	.248
7-Day mortality, n	1 (1.6%)	2 (0.2%)	.131

*AF indicates atrial fibrillation; IABP, intra-aortic balloon pump; GIT, gastrointestinal tract.

Table 4. Late Outcomes*

	Group A (≥80 y) (n = 62)	Group B (<80 y) (n = 1297)	*P*
Total mortality, n	8 (12.9%)	57 (4.4%)	.008
Postoperative PCI, n	2 (3.2%)	12 (0.9%)	.131
Recatheterization, n	2 (3.2%)	30 (2.3%)	.654
Reoperation, n	0 (0.00%)	9 (0.7%)	1.000
Cardiac mortality, n	3 (4.9%)	31 (2.4%)	.463

*PCI indicates percutaneous intervention.

Emergency surgery is defined as the necessity to take the patient to the operating theater on referral before the beginning of the next morning's operation schedule. Pulmonary complication is defined as the occurrence of pleural effusion and/or atelectasis. Psychological changes are defined as changes in mental condition, as documented by comparison of the mental component summary scale of the short-form health survey (SF-36) preoperatively and at 2 weeks postoperatively. Thirty-day death is defined as death within the first postoperative month, and 7-day death is death within the first 7 days postoperatively.

RESULTS

All of the patients underwent their operations with the π-circuit technique. The 2 study groups were compared with respect to preoperative and operative data to clarify factors that were significantly related to the differences in the postoperative outcomes.

The preoperative characteristics of the study population are summarized in Table 1. The percentage of female individuals was significantly higher in the octogenarian group ($P \leq .005$). The incidences of obesity and a high cholesterol level were significantly increased in group B, whereas left ventricular function was more impaired in group A. The need for emergency surgical interference was significantly more frequent in group A.

The operative data of the study population are summarized in Table 2. Group A had significantly fewer anastomoses performed, fewer composite grafts on the left internal mammary artery, and fewer composite grafts on the right internal mammary artery.

Table 5: Total Survival for the 2 Groups*

	Survival Time, mo	95% CI, mo	*P*
Group B	54.453 ± 0.321	53.824-55.081	.001
Group A	48.208 ± 2.411	43.481-52.934	
Overall	54.228 ± 0.327	53.588-54.869	

*Data are presented as the mean ± SE. CI indicates confidence interval.

Table 6. Cardiac Mortality–Free Interval for the Study Population*

	Survival Time, mo	95% CI, mo	*P*
Group B	55.571 ± 0.242	55.097-56.044	.177
Group A	52.819 ± 1.546	49.788-55.850	
Overall	55.502 ± 0.242	55.027-55.977	

*Data are presented as the mean ± SE. CI indicates confidence interval.

Early Outcomes

The in-hospital mortality rate (30 days) was 3.2% (2 of 62 patients) for the octogenarian group and 1.5% (19 of 1297 patients) for group B ($P = .248$), whereas 7-day mortality rates were 1.6% and 0.2% ($P = .131$), respectively (Table 4).

Postoperative complications of the study population are listed in Table 3. Postoperative use of an intra-aortic balloon pump tended to be more frequent in octogenarians (3.2% versus 0.3%, not statistically significant), as were ventilation for >48 hours (6.5% versus 2.7%, not statistically significant) and renal insufficiency (4.8% versus 2.1%, not statistically significant).

In the early postoperative period, differences were noted between groups A and B with respect to pulmonary complications (12.9% versus 5.6%, respectively; $P < .027$), the incidence of atrial fibrillation (41.9% versus 19%, $P < .0005$), and cognitive disturbances (6.5% versus 0.3%, $P < .0005$).

Late Outcomes

Follow-up was up to 60 months. Total mortality was higher in the octogenarian group ($P = .008$); however, the groups showed no statistically significant differences with respect to mortality due to cardiac reasons ($P = .463$; Table 4). Consequently, total survival favored group B ($P = .001$; Table

5, Figure A). On the other hand, the 2 groups were similar with respect to the interval free of cardiac mortality ($P = .177$; Table 6, Figure B).

Further analysis of the data with the Cox regression model and exclusion of confounding risk factors revealed that global and cardiac mortality–free survival rates were similar for the octogenarian patients and the younger patients.

In the follow-up period, the groups were comparable with respect to the need for diagnostic recatheterization, percutaneous intervention, and reoperation.

DISCUSSION

As life expectancy has increased, so have the numbers of elderly patients with symptomatic coronary artery disease [Bergsland 1997; Mack 1998; Tasdemir 1998; Nashef 1999; Wennberg 1999]. Compared with younger patients, the elderly generally have a higher incidence of significant comorbidities, which lead to an increased perioperative mortality rate and a higher rate of complications [Hannan 1994; Craver 1999; Wennberg 1999].

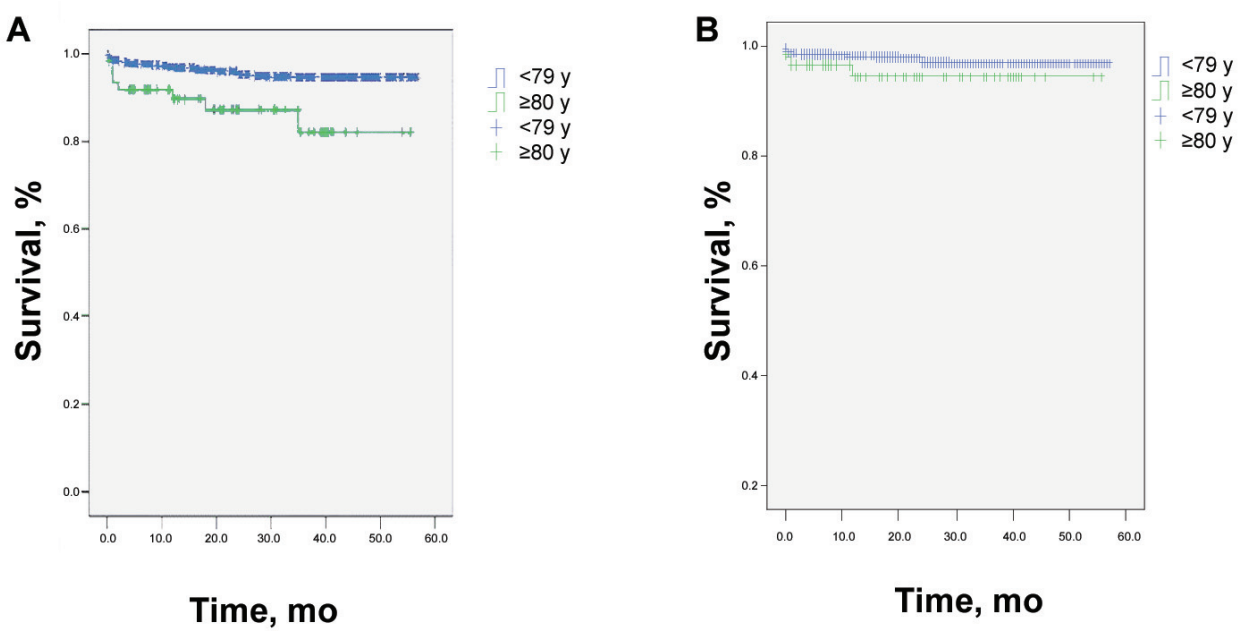
A poorer preoperative status, the prevalence of congestive heart failure, higher left ventricular end-diastolic pressures (often due to age-related changes in left ventricular architecture and function), sternal osteoporosis and related healing problems, inconsistent myocardial protection, atheroemboli from the aorta, cerebrovascular disease, comorbidity leading to a diminished reserve of subsystems, and tissue fragility contribute to the increased risks of complications and mortality in octogenarians [Ghosh 2003].

Because of the growing surgical experience, coronary artery bypass grafting in elderly and high-risk patients has become an accepted strategy, with significant and cost-effective improvements in the quality of life [Sollano 1998; Heijmeriks 1999]. Reports have confirmed the safety and efficacy of open heart operations in octogenarians [Merrill 1990]. In our series, the octogenarian group was more likely to have an emergency surgical intervention, whereas the patients younger than 80 years were more likely to experience obesity and diabetes. The 2 study groups showed no statistically significant differences with respect to other preoperative characteristics, however.

The significantly fewer anastomoses performed in the octogenarian group may have been due to the worse quality of these patients' coronary vessels. Pulmonary complications [Prapas 2007], postoperative atrial fibrillation, and cognitive disorders were significantly greater in the octogenarian group.

Postoperative cognitive dysfunction is a condition characterized by impairment of memory or concentration, which is detected by neuropsychological testing. Cognitive dysfunction presents clinically with deficits in cognition and memory and represents a significant change from the patient's previous level of functioning [Rasmussen 1998]. In the postoperative period of our study, the occurrence of cognitive disorders was statistically higher in the octogenarian group than in the other group ($P < .005$). The risk of cerebral dysfunction has been suggested to be less pronounced with OPCAB [Potger 2002; Parolari 2003]; however, we agree with the statement that neurocognitive decline is strongly age dependent [Newman 1989]. We had only 4 cases in group A and 4 cases in group B with such a complication; these incidences are considered very low. We believe that the aorta no-touch technique plays a very important role in reducing the risk of postoperative cognitive dysfunction.

With respect to mortality, we found, as have other investigators, that octogenarians were at higher risk of postoperative



A, Kaplan-Meier survival curve, freedom from cardiac mortality. B, Kaplan-Meier actuarial probability of survival.

death [Alexander 2000]. The total mortality rate was significantly higher in the octogenarians, but there were no statistically significant differences in the rate of mortality due to cardiac reasons. Further analysis of the survival curve in the 60 months of follow-up showed no difference between the groups with respect to mortality for cardiac reasons.

In this study, all of the patients underwent their operations with total arterial revascularization, on the beating heart, and with an aorta no-touch technique. This exceptional technique can be the reason for the good results in octogenarians. Furthermore, other studies have suggested that OPCAB techniques are superior to and have better outcomes than on-pump coronary artery bypass grafting with vein grafts and that use of vein grafts is a risk factor for recurrent angina or graft failure [Muneretto 2004].

CONCLUSION

Use of the π-circuit technique is very effective and safe for octogenarians. Although these older patients have a higher incidence of early postoperative morbidity, overall survival is not affected.

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