

Effect of Age on Postoperative Results in Elderly Coronary By-pass Patients

Koroner Baypas Hastalarında Postoperatif Sonuçlara Yaşın Etkileri

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ABSTRACT

Introduction: The purpose of this study is to analyze the outcome results of coronary by-pass operations from a single institution. The post-operative neurologic complications have been analyzed in detail in order to find out the risk factors and the relation of age and occurrence of neurologic complications has been assessed.

Patients and Methods: In this retrospective study, we analyzed the prospectively collected data of 510 coronary by-pass patients. Neurological morbidity and mortality were evaluated with logistic regression analysis for elderly patients.

Results: Of these 510 patients, 382 (74.9%) were male and 89 (17.5%) were older than 70 years of age. Post-operative mortality, pulmonary and neurologic morbidity occurred in 27 (5.3%), 78 (15.3%) and 26 (5.1%) patients, respectively. The comparison of patients with ≤ 70 and > 70 years of age showed that the differences were significant (mortality 4.0% vs. 11.2%, $p= 0.012$; pulmonary morbidity 13.5% vs. 23.6%, $p= 0.022$; neurologic morbidity 3.3% vs. 13.5%, $p= 0.0001$). Presence of cerebrovascular disease (odds ratio= 4.72; $p= 0.014$) and advanced age (odds ratio= 3.55; $p= 0.016$) were independent predictors of neurologic complications. Every year increase above 51.5 years of age was associated with 5.8% ($p= 0.049$) increased neurologic complication risk.

Conclusion: Elderly patients have higher rates of mortality, pulmonary and neurologic morbidity after coronary by-pass operations. Although no significant associations were found between age and mortality, age constitutes an independent risk factor for neurologic morbidity along with presence cerebrovascular disease.

Key Words: Coronary artery by-pass grafting, neurologic dysfunction, risk factors.

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ÖZET

Giriş: Bu çalışmanın amacı tek bir merkezde yaşlı hastalarda yapılan koroner baypas ameliyatlarının sonuçlarını analiz etmektir. Postoperatif nörolojik komplikasyonlar ayrıntılı olarak analiz edilmiş ve yaşla beraber diğer risk faktörlerinin nörolojik komplikasyonların oluşumuna etkisi incelenmiştir.

Hastalar ve Yöntem: Bu retrospektif çalışmada 510 koroner baypas hastasının prospektif olarak toplanan verileri analiz edildi. Nörolojik morbidite ve mortalitenin yaşlı hastalarda görülme riski lojistik regresyon analiziyle incelendi.

Bulgular: Çalışmada incelenen 510 hastanın 382 (%74.9)'si erkekti ve 89 (%17.5)'u 70 yaşın üzerindeydi. Postoperatif mortalite, pulmoner ve nörolojik komplikasyon sırasıyla 27 (%5.3), 78 (%15.3) ve 26 (%5.1) hastada görüldü. Yetmiş yaş ve altındaki hastalar ile 70 yaş üzerindeki hastaların karşılaştırılmasında bu değerler arasında istatistiksel olarak anlamlı fark mevcuttu (mortalite %4.0 ve %11.2, $p=0.012$; pulmoner morbidite %13.5 ve %23.6, $p=0.022$; nörolojik morbidite %3.3 ve %13.5, $p=0.0001$). Serebrovasküler hastalık varlığı (OR= 4.72; $p=0.014$) ve ileri yaş (OR= 3.55; $p=0.016$) nörolojik komplikasyon gelişiminde anlamlı değişkenler olarak bulundu. Hastaların yaşının 51.5'in üzerinde olduğu her yıl için nörolojik komplikasyon gelişme riskinin %5.8 artmakta olduğu hesaplandı ($p=0.049$).

Sonuç: Yaşlı hastalarda yapılan koroner baypas ameliyatları sonrası mortalite, pulmoner ve nörolojik komplikasyonlar daha sık görülmektedir. Yaş ve mortalite arasında anlamlı bir ilişki olmasa da, ileri yaş ve serebrovasküler hastalık nörolojik komplikasyon görülme riskini artırmaktadır.

Anahtar Kelimeler: Koroner arter baypas grefti, nörolojik disfonksiyon, risk faktörleri.

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INTRODUCTION

The number of elderly patients having coronary by-pass operations (CABG) are steadily increasing^(1,2). These patients are regarded as high risk group for the higher surgical risks because of the associated high mortality and morbidity rates along with greater length of hospital stay^(2,3). Postoperative neurologic events and neuropsychological disorders constitute significant sources of mortality and morbidity after coronary by-pass operations^(4,5).

Age is a known risk factor for many postoperative complications in coronary surgery and the outcome results of CABG operations in the elderly have been studied extensively^(2,3,6-8). The purpose of this study is to analyze the outcome results in the elderly in a large number of patients from a single institution. The postoperative neurologic complications have been analyzed in detail in order to find out the risk factors and the relation of age and occurrence of neurologic complications has been assessed.

PATIENTS and METHODS

The rationale for this analysis is the view of our patient sample as a representative cohort of individuals for preoperative assessment units admitting for coronary bypass surgery. Age of the patients was evaluated as an independent risk factor for postoperative mortality and neurologic morbidity.

We have analyzed the hospital records of the patients and our prospectively collected coronary by-pass database after the study was approved by the institutional ethics board and all patient consents were completed. The

outcome data of coronary by-pass operations performed from December 1, 2010 to July 31, 2012 were included in the analysis.

We have obtained the preoperative demographic characteristics, operation details and postoperative outcome results from the hospital records and the prospectively collected database. Neurological complication was defined as presence of any cerebrovascular event (stroke, transient ischemic attack or reversible ischemic neurologic deficit) documented by tomography and clinical examination; encephalopathy (onset after 4th postoperative day or lasting more than four days postoperatively in order to rule out effect of anesthesia) and neurologic complications of other causes⁽⁹⁾. As a routine preoperative work-up, all patients were evaluated with carotid duplex ultrasonography for presence of any extracranial cerebrovascular disease. In case a hemodynamically significant cerebrovascular disease detected, computerized tomographic (CTA) or magnetic resonance angiography (MRA) was performed. Presence of any cerebrovascular disease was used as a binary variable in the analysis regardless of the hemodynamic significance. Patient demographic characteristics and intraoperative measurements were recorded to the coronary by-pass database by the anesthesiologist.

All patients were operated under general anesthesia and conventional cardiac surgery via median sternotomy was performed. In patients operated for concurrent carotid procedures, carotid procedure was performed prior to sternotomy. Carotid by-pass with saphenous vein graft was used in patients with localized stenosis of internal carotid

artery. In carotid endarterectomies, carotid shunts were used in each case. Seventy seven (15.1%) patients were operated off-pump. Cardiopulmonary by-pass was established using a non-pulsatile hypothermic flow of 2.0-2.4 L/min/m², with mean arterial pressure maintained from 50-70 mmHg and α -stat blood gas management. Pulsatile perfusion was used in 33 patients. Total circulatory arrest was utilized in 3 (0.6%) cases. One of them had graft interposition in the ascending aorta and the other two were operated for aortic root replacement with modified Bentall procedure. They had ascending aortic aneurysms along with coronary artery disease. Axillary arterial cannulation was utilized in these cases and cerebral protection was maintained with selective antegrad cerebroplegia. Arterial cannulation was made on the ascending aorta in the remaining cases. Since we do not have epiaortic ultrasonography available, ascending aorta was assessed intraoperatively by palpation and cannulation was made in the atherosclerosis free areas. According to the procedural needs, myocardial protection was modified as antegrade, retrograde or both using cold or isothermic blood cardioplegia. As a standard cardioplegia strategy we preferred antegrade induction with 1000 mL at the time of the aortic cross-clamping and afterwards either continuous retrograde or intermittent antegrade (500 mL/20 min) infusion was used until aortic cross-clamp removal. Antifibrinolytic therapy was administered with aminocaproic acid as institutional routine. The intraoperative blood glucose management was made either with bolus or continuous infusions of insulin were administered to obtain a target serum glucose < 200 mg/dL (11.1 mmol/L). In the postoperative intensive care unit, normoglycemia was achieved following the Portland cardiac surgery insulin protocol⁽¹⁰⁾.

The primary clinical endpoint of this study was postoperative mortality and secondary end point is the occurrence of any neurologic complication after coronary bypass. Patients with diabetes were defined as those with a diagnosis of type 1 or type 2 diabetes mellitus before hospital admission and who were on oral or parenteral hypoglycemic drugs. Renal function was analyzed as a binary variable in the database. We used Acute Kidney Injury Network criteria that was \geq 50% postoperative increase from baseline creatinine to peak postoperative creatinine level in the first ten postoperative days^(11,12). Pulmonary complication was defined as presence of postoperative respiratory problems necessitating intensive physiotherapy, re-intubation or prolonged mechanical ventilation and presence of pneumothorax or pulmonary effusion. Infectious complications

were defined as positive blood, urine, sputum or wound cultures postoperatively, requiring dressings and intravenous antibiotics, requiring revision surgery (like mediastinal infection) or presence of radiographic infiltrate. Gastrointestinal complication was defined as presence of any postoperative complication requiring medical or surgical intervention.

Continuous variables were described as means (\pm standard deviation) or median (interquartile range) as appropriate; categorical variables were described as a percentage. For descriptive purposes, patients were grouped according to age: \leq 70 and $>$ 70. Logistic regression model was constructed twice with age either as a continuous variable and a binary variable. At the end of the analysis a ROC curve was obtained to assess how well the variable could be discriminated and the area under curve (AUC) was calculated. A logistic regression model for the outcome neurologic morbidity and mortality was constructed with the following dependent predictors: gender, age, previous cerebrovascular event, previous myocardial infarction, hypertension, known diabetes mellitus at the time of admission, hypercholesterolemia, chronic obstructive pulmonary disease (COPD), cerebrovascular disease, family history of coronary disease, peripheral arterial disease (PAD), tobacco use, left ventricular dysfunction (ejection fraction < 40%), chronic renal failure at the time of admission, emergency operation, use of pulsatile cardiopulmonary by-pass, off-pump procedure, any concomitant procedure and degree of hypothermia during the operation. The data management and analysis was made with SPSS version 11.0 (SPSS Inc, statistical software package). A p value of 0.05 was considered statistically significant.

RESULTS

Five hundred and ten patients were operated for CABG during the study period. Of these 510 patients, 382 (74.9%) were male and 128 (25.1%) female. The preoperative characteristics were outlined in Table 1 and procedural characteristics were outlined in Table 2.

Postoperative mortality was seen in 27 (5.3%) of patients and mortality rate was significantly higher in elderly patients (Table 3). It can be seen that one patient had delayed awakening (Table 3). This patient was considered to have an encephalopathy since no tomographic changes were present. He had pulmonary and infectious complications and he was discharged on postoperative 52nd day without neurologic sequel. It can be seen that elder patients were extubated later than the younger patients and the incidence of pulmonary complications were signifi-

Table 1. Preoperative characteristics

	Overall (n= 510)	Age ≤ 70 (n= 421)	Age > 70 (n= 89)	p1*	p2**	p3***
Age	60.6 ± 9.9 (34-86)	57.4 ± 7.6	75.6 ± 3.6	0.0001	0.426	0.016
Gender				0.0001	0.697	0.287
Male	382 (74.9%)	329 (78.1%)	53 (59.6%)			
Female	128 (25.1%)	92 (21.9%)	36 (40.4%)			
BMI (kg/m ²)	27.6 ± 4.1 (18-40)	27.8 ± 4.2	27.7 ± 3.9	0.827	-	-
Previous cardiac surgery	4 (0.8%)	3 (0.7%)	1 (1.1%)	0.537	-	-
Previous MI	151 (29.6%)	125 (29.8%)	26 (29.2%)	0.907	0.725	0.277
Preoperative EF (%)	50.6 ± 8.8 (30-60)	50.7 ± 8.7	50.3 ± 9.2	0.676	-	-
LVD (EF < 40%)	97 (19.0%)	77 (18.3%)	20 (22.5%)	0.369	0.900	0.148
Hypertension	277 (54.3%)	222 (52.7%)	55 (61.8%)	0.117	0.222	0.115
Previous CVE	23 (4.5%)	15 (3.6%)	8 (9.0%)	0.041	0.050	0.201
CVD	45 (8.8%)	30 (7.1%)	15 (16.9%)	0.007	0.270	0.014
COPD	122 (23.9%)	101 (24.0%)	21 (23.6%)	0.937	0.249	0.628
Known diabetes mellitus	205 (40.2%)	176 (41.8%)	29 (32.6%)	0.103	0.549	0.162
Hypercholesterolemia	293 (57.5%)	247 (58.7%)	46 (51.7%)	0.228	0.104	0.274
Tobacco use	258 (50.6%)	239 (56.8%)	19 (21.3%)	0.0001	0.983	0.115
Family history for CAD	219 (42.9%)	185 (43.9%)	34 (38.2%)	0.318	0.113	0.281
Preoperative CRF	23 (4.5%)	18 (4.3%)	5 (5.7%)	0.560	0.261	0.228
PAD	51 (10.0%)	39 (9.3%)	12 (13.5%)	0.248	0.786	0.644
Preoperative Hb (mg/dL)	12.4 ± 1.6 (7.0-17.0)	12.6 ± 1.6	11.8 ± 1.6	0.0001	-	-
Preoperative Htc (%)	37.9 ± 6.2 (16.0-54.0)	38.2 ± 6.3	36.9 ± 5.7	0.086	-	-

BMI: Body mass index, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease, CRD: Chronic renal disease, CVD: Cerebrovascular disease, CVE: Cerebrovascular event, PAD: Peripheral arterial disease, EF: Ejection fraction, Hb: Hemoglobine, Htc: Hematocrite, LVD: Left ventricular dysfunction, MI: Myocardial infarction.

*p values for univariate analyses.

**p values for logistic regression analysis for mortality.

***p values for logistic regression analysis for neurologic mortality.

cantly higher (Table 3). However, the incidences of pulmonary complications were not significantly different among groups in patients with neurologic morbidity (Table 4).

The data of the patients with neurologic complications were summarized in Table 4. Facial paralysis was seen in two patients over 70 years of age. They had carotid endarterectomy concurrent with coronary by-pass. The facial paralysis was attributed to the intraoperative retraction of the facial nerve and the patient had complete recovery during their follow-up in the outpatient clinic. None of the patients who had valvular operations or operated with total circulatory arrest had any neurologic complication. None of the patients with total circulatory arrest had any neurological morbidity but the number is too small to draw significant

conclusions. Of the 23 patients who had a history of previous cerebrovascular event, only 3 of them had postoperative neurologic complications. All three were over 70 years of age and none of them had stroke. Two had facial paralysis and one had encephalopathy. The patient with encephalopathy died because of pneumonia. Of the 45 patients with cerebrovascular disease, seven patients had postoperative neurologic complication. Three of them had postoperative cerebrovascular event, two had facial paralysis, one had encephalopathy and one showed delayed awakening. Two of them (with stroke) had mortality. The patients with mortality had isolated CABG procedure and the etiology for mortality was massive stroke in one and low cardiac output in the other.

Table 2. Periprocedural characteristics

	Overall	Age ≤ 70 (n= 421)	Age > 70 (n= 89)	p1*	p2**	p3***
Number of distal anastomosis	2.8 ± 1.0 (1-6)	2.9 ± 1.0	2.8 ± 1.0	0.607	-	-
Concomitant procedure	39 (7.6%)	26 (6.2%)	13 (14.6%)	0.012	0.641	0.342
Valve procedure	19 (3.7%)	15 (3.6%)	4 (4.5%)	0.757	-	-
Carotid procedure	6 (1.2%)	4 (1.0%)	2 (2.2%)	0.283	-	-
Emergency operation	67 (13.1%)	58 (13.8%)	9 (10.1%)	0.335	0.685	0.914
OPCAB	77 (15.1%)	66 (15.7%)	11 (12.4%)	0.417	0.961	0.863
Pulsatile CPB	33 (6.5%)	32 (7.6%)	1 (1.1%)	0.018	0.444	0.576
ACC duration (min)	61.8 ± 30.9 (11-235)	61.0 ± 30.1	65.9 ± 34.1	0.195	-	-
CPB duration (min)	100.6 ± 41.5 (18-392)	99.7 ± 39.4	105.1 ± 50.4	0.284	-	-
Intraoperative bleeding (mL)	541.7 ± 180.5 (100-1500)	540.0 ± 181.8	549.4 ± 174.9	0.655	-	-
Intraoperative use of blood products					-	-
ES (U)	0.6 ± 0.9 (0-5)	0.5 ± 0.8	0.9 ± 1.0	0.0001		
FFP (U)	1.4 ± 0.9 (0-4)	1.4 ± 0.9	1.6 ± 1.0	0.182		
FWB (U)	0.7 ± 0.7 (0-10)	0.7 ± 0.7	0.8 ± 0.6	0.096		
Postoperative use of blood products					-	-
ES (U)	1.6 ± 1.6 (0-10)	1.5 ± 1.5	2.2 ± 2.1	0.021		
FFP (U)	1.7 ± 1.8 (0-14)	1.6 ± 1.5	2.1 ± 2.6	0.072		
FWB (U)	0.7 ± 0.7 (0-3)	0.7 ± 0.7	0.8 ± 0.8	0.131		
Hypothermia (°C)	30.3 ± 1.4 (18-36)	30.3 ± 1.2	30.0 ± 2.1	0.134	0.948	0.677
Use of TCA	3 (0.6%)	1 (0.1%)	2 (2.2%)	0.080	-	-

ACC: Aortic cross clamp, CPB: Cardiopulmonary by-pass, ES: Erythrocyte suspension, FFP: Fresh frozen plasma, FWB: Fresh whole blood, OPCAB: Off-pump coronary artery by-pass, TCA: Total circulatory arrest.
* p values for comparison between groups.
** p values for logistic regression analysis for mortality.
*** p values for logistic regression analysis for neurologic mortality.

The logistic regression analysis was run twice; one for age as a continuous variable and the other for age as a binary variable (≤ 70 and > 70). Advanced age was significantly associated with postoperative neurologic complication in each run. Advanced age was associated with neurologic complications with an odds ratio (OR) of 3.55 [95% confidence interval (CI)= 1.27-9.90; $p= 0.016$]. Every year increase above 51.5 is associated with 5.8% (95% CI= 0.1%-11.9%; $p= 0.049$) increased neurologic complication risk. The ROC curve also showed 92.0% sensitivity with statistical significance (area under curve = 0.702, 95% CI= 0.599-0.804; $p= 0.001$) (Figure 1). The other significant associations with postoperative neurologic complica-

tion was presence of cerebrovascular disease (OR= 4.72) (95% CI= 1.38-16.13; $p= 0.014$).

DISCUSSION

In this study, we evaluated the outcome data of heterogeneous group of patients operated for CABG for comparison between elderly and younger patients. The result of the analysis revealed marked difference of neurologic complications in elderly patients ($p= 0.0001$). The main difference between the groups was related to the more frequent occurrence of encephalopathy in elderly patients. The significance of age persisted in the multivariate analysis and 5.8% risk increase was found for every year increase in patients older than 51.5 years of age.

Table 3. Postoperative mortality and morbidity

	Overall (n= 510)	Age ≤ 70 (n= 421)	Age > 70 (n= 89)	p*
Mortality	27 (5.3%)	17 (4.0%)	10 (11.2%)	0.012
ICU stay (days)	3.8 ± 3.3 (1-36)	3.5 ± 2.6	4.0 ± 2.2	0.146
Total hospital stay (days)	8.9 ± 6.9 (1-69)	7.6 ± 5.5	9.0 ± 8.1	0.157
Time to extubation (hours)	9.5 ± 8.6 (2-124)	9.1 ± 8.4	11.6 ± 9.0	0.017
Any morbidity	237 (46.5%)	186 (44.3%)	51 (57.3%)	0.025
Arrhythmia**	85 (16.7%)	69 (16.4%)	16 (18.0%)	0.717
AF	76 (14.9%)	60 (14.3%)	16 (18.0%)	0.380
Persistent AF	17 (3.3%)	12 (2.9%)	5 (5.6%)	0.217
Pulmonary	78 (15.3%)	57 (13.5%)	21 (23.6%)	0.022
Renal	39 (7.6%)	31 (7.4%)	8 (9.0%)	0.607
Need for dialysis	13 (2.5%)	9 (2.1%)	4 (4.5%)	0.256
Neurological	26 (5.1%)	14 (3.3%)	12 (13.5%)	0.0001
Encephalopathy	9 (1.8%)	5 (1.2%)	7 (7.9%)	
Hepatic encephalopathy	2 (0.4%)	2 (0.5%)	0	
Delayed awakening	1 (0.2%)	0	1 (0.2%)	
CVE	10 (2.0%)	8 (1.9%)	2 (2.2%)	
Facial paralysis	3 (0.6%)	0	3 (3.4%)	
Convulsion	1 (0.2%)	1 (0.2%)	0	
Ischemic ECG change	17 (3.3%)	14 (3.3%)	3 (3.4%)	1.000
Low cardiac output	21 (4.1%)	14 (3.3%)	7 (7.9%)	0.072
Need for inotropic support	49 (9.6%)	37 (8.8%)	12 (13.5%)	0.190
Need for IABP support	15 (2.9%)	11 (2.6%)	4 (4.5%)	0.311
Revision surgery for bleeding	23 (4.5%)	18 (4.3%)	5 (5.6%)	0.590
Tamponade	11 (2.2%)	10 (2.4%)	1 (1.1%)	0.699
Infection	30 (4.9%)	21 (5.0%)	9 (10.1%)	0.082
Mediastinitis	6 (1.2%)	3 (0.7%)	3 (3.4%)	0.069
Sternal dehiscence	9 (1.8%)	8 (1.9%)	1 (1.1%)	1.000
Gastrointestinal morbidity	16 (3.1%)	15 (3.6%)	1 (1.1%)	0.328
Readmission to ICU	21 (4.1%)	17 (4.0%)	4 (4.5%)	0.773

AF: Atrial fibrillation; CVE: Cerebrovascular event; IABP: Intraaortic balloon counterpulsation; ICU: Intensive care unit; TND: Transient neurologic dysfunction.

* Independent samples t-test or chi-square or Fisher's exact test.

** Occurrence of any heart rhythm disorder.

Aortic atheroma is a well known risk factor for stroke and it has been postulated that it may have significant correlation with postoperative neurocognitive dysfunction⁽¹³⁾. We do not analyze the cognitive functions routinely in our daily practice. Patients were evaluated for their mental status as a part of routine daily examination and mainly the distinctive alterations detected in the physical exami-

nations were noted. A detailed analysis of neurocognitive function may reveal higher incidences in both groups. Cognitive dysfunction was reported to be decreasing in the early postoperative period and the amount of decline was shown to be correlated with delayed or absence recovery of such functions⁽¹⁴⁾. The incidence of cerebrovascular event was 2% in the overall cohort and groups did

Table 4. Patients with neurologic morbidity

	Overall* (n= 26)	Age ≤ 70 (n= 14)	Age > 70 (n= 12)	p [#]
PREOPERATIVE				
Age	70 (61-75)	63	75	0.0001
Concurrent procedure**	2 (7.7%)	0	2 (16.7%)	0.203
Number of distal anastomoses	3 (3-4)	4	3	0.560
Emergency procedure	3 (11.5%)	2 (14.3%)	1 (8.3%)	1.000
Hypertension	20 (76.9%)	12 (85.7%)	8 (66.7%)	0.365
Known diabetes mellitus	10 (38.5%)	6 (42.9%)	4 (33.3%)	0.701
Hypercholesterolemia	15 (57.7%)	8 (57.1%)	7 (58.3%)	0.951
Previous CVE	3 (11.5%)	0	3 (25%)	0.085
Presence of CVD	7 (26.9%)	3 (21.4%)	4 (33.3%)	0.665
PAD	3 (11.5%)	1 (7.1%)	2 (16.7%)	0.580
Chronic renal failure	3 (11.5%)	1 (7.1%)	2 (16.7%)	0.580
COPD	7 (26.9%)	5 (35.7%)	2 (16.7%)	0.391
Tobacco use	7 (26.9%)	6 (42.9%)	1 (8.3%)	0.081
Family history of CAD	9 (34.6%)	7 (50.0%)	2 (16.7%)	0.110
Previous MI	6 (23.1%)	4 (28.6%)	2 (16.7%)	0.652
EF (%)	50 (40-60)	47%	58%	0.212
LVD (EF < 40%)	8 (30.8%)	6 (42.9%)	2 (16.7%)	0.216
PROCEDURAL				
OPCAB	6 (23.1%)	4 (28.6%)	2 (16.7%)	0.652
Pulsatile CPB	2 (7.7%)	2 (14.3%)	0	0.483
ACC (min)	61 (44-73)	70	60	0.260
CPB duration (min)	106 (79-134)	117	88	0.347
Hypothermia (°C)	30 (30-30)	30	30	0.695
POSTOPERATIVE				
Time to extubation (hours)	10.0 (7.5-11.0)	8	10	0.251
ICU stay (days)	4 (3-9)	4	4	0.824
Hospital stay (days)	11 (7-26)	13	9	0.882
Mortality	5 (19.2%)	3 (21.4%)	2 (16.7%)	1.000
Any morbidity***	19 (73.1%)	10 (71.4%)	9 (75.0%)	1.000
Arrhythmia (AF)	7 (26.9%)	3 (21.4%)	4 (33.3%)	0.665
Persistent AF	2 (7.7%)	2 (14.3%)	0	0.483
Pulmonary	15 (57.7%)	8 (57.1%)	7 (58.3%)	0.951
Renal	6 (23.1%)	4 (28.6%)	2 (16.7%)	0.652
Need for dialysis	3 (11.5%)	2 (14.3%)	1 (8.3%)	1.000
Ischemic ECG change	1 (3.8%)	1 (7.1%)	0	1.000
Low cardiac output	5 (19.2%)	3 (21.4%)	2 (16.7%)	1.000
Need for inotropic support	7 (26.9%)	4 (28.6%)	3 (25.0%)	1.000
Need for IABP support	1 (3.8%)	1 (7.1%)	0	1.000

Table 4. Patients with neurologic morbidity (continue)

	Overall* (n= 26)	Age ≤ 70 (n= 14)	Age > 70 (n= 12)	p#
Revision surgery for bleeding	2 (7.7%)	1 (7.1%)	1 (8.3%)	1.000
Tamponade	2 (7.7%)	1 (7.1%)	1 (8.3%)	1.000
Infection	8 (30.8%)	3 (21.4%)	5 (41.7%)	0.401
Mediastinitis	3 (11.5%)	2 (14.3%)	1 (8.3%)	1.000
Sternal dehiscence	3 (11.5%)	2 (14.3%)	1 (8.3%)	1.000
Gastrointestinal morbidity	3 (11.5%)	3 (21.0%)	0	0.225
Readmission to ICU	9 (34.6%)	7 (50%)	2 (16.7%)	0.110

ACC: Aortic cross clamp, AF: Atrial fibrillation, COPD: Chronic obstructive pulmonary disease, CPB: Cardiopulmonary by-pass, CVD: Extracranial cerebrovascular disease, CVE: Cerebrovascular event, EF: Ejection fraction, LVD: Left ventricular dysfunction, MI: Myocardial infarction, OPCAB: Off-pump coronary by-pass, PAD: Peripheral arterial disease, SD: Standard deviation.
 * Median (interquartile range)/n (%)
 ** Carotid endarterectomy.
 *** Except neurologic morbidity.
 # Mann-Whitney U test, chi-square or Fisher's exact test.

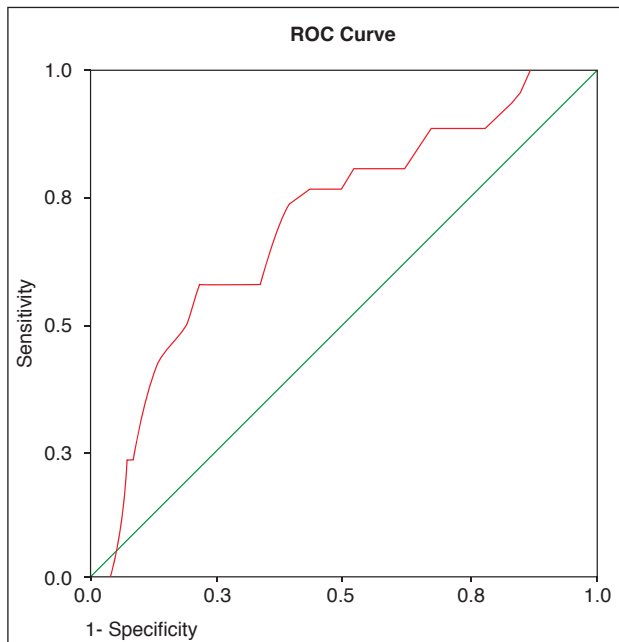


Figure 1. ROC curve graph for age cut-off point.

not show significant difference. The results were similar to previous reports^(2,15). Goto and colleagues analyzed the relation of arteriosclerosis severity and postoperative neurologic morbidity in patients older than 60 years of age⁽¹⁶⁾. The grouped the patients according to the degree of arteriosclerosis of the ascending aorta. The incidences of stroke in normal or mild, moderate and severe arteriosclerosis were 10.5%, 7% and 1.8%, respectively⁽¹⁶⁾. It was previously stated that (in the methods section) we did not

use epiaortic ultrasound intraoperatively. However, the incidence of cerebrovascular event in our study group is compatible with the normal or mild arteriosclerosis group in the aforementioned study⁽¹⁶⁾. This may be related to the fact that our study group is a heterogeneous group of patients admitted for CABG in our clinic.

Apart from cerebrovascular event, other neurologic complications constitute important sources of postoperative morbidity. A recent analysis showed that low minimal mental state examination score and high creatinine values preoperatively and prolonged cardiopulmonary by-pass durations were predictors of postoperative delirium in the elderly patients⁽¹⁷⁾. Bucerius and colleagues analyzed the predictors of postoperative delirium in cardiac surgery patients⁽⁵⁾. In the aforementioned analysis of more than 16.000 patients, the prevalence of delirium was 8.4% and 16.2% of these cases had postoperative stroke. The prevalence of postoperative delirium was reported to be higher in patients over 70 years of age (12.9%) and lower after off-pump coronary by-pass operations (5.1%). Unlike their analysis, we did not detect significant associations with off-pump operations in our series. No-touch strategies have been postulated to be more important in occurrence of neurologic complications⁽¹⁶⁾. The use of pulsatile cardiopulmonary by-pass also did not have any significant effect. So, this analysis does not add any additional information on the contradictory results of pulsatile cardiopulmonary by-pass literature, however, the number of patients is small draw meaningful conclusions⁽¹⁸⁾. The patients with postoperative delirium had higher rates of pulmonary prob-

lems, sternum instability and longer duration of intensive care stays. However, as indicated in Table 4, the extra-neurologic morbidity was similar in elderly and younger patients in our study group. So, the latter associations may be independent of patient's age unlike the occurrence of neurologic morbidity. The higher prevalence of encephalopathy constitutes the major difference between the age groups (Table 3) in our study. Excluding the two patients with hepatic encephalopathy in the younger patients, the significance will be greater. In our analysis, we analyzed the patients with neurologic morbidities according to the age groups (Table 4). Elderly patients did not show significant differences of morbidity (other than neurologic) than the younger counterparts. The overall group comparisons (Table 3), however, revealed significant differences in terms of mortality, extubation times, neurologic and pulmonary morbidity. Considering the fact that age persisted as a significant risk factor in the multivariate analysis, the higher neurologic morbidity should be explained by some other mechanisms.

The preoperative characteristics were summarized in Table 1. It can be seen that the prevalence of a previous cerebrovascular event and presence of extracranial cerebrovascular disease was higher in the elderly patients. Presence of cerebrovascular disease was also significantly associated with postoperative neurologic morbidity in regression analysis unlike presence of a history of cerebrovascular event. This may be due to the fact that, lower perfusion may be a more important factor. The association of age and neurologic morbidity may be due to the lower reserve in elderly patients. Although there was lack of association of atherosclerotic parameters with neurologic morbidity (peripheral arterial disease, diabetes mellitus, hypertension, and hypercholesterolemia), the higher incidence of cerebrovascular disease and significant association in regression analysis may still favor the importance of atherosclerotic process. The prevalence of hemodynamically significant cerebrovascular disease was reported to be between 12% and 17%⁽¹⁹⁾. Our patient cohort had lower rates overall but the patients over 70 years of age had compatible rates. The risk of perioperative stroke was reported to be lower than 2% in the absence of cerebrovascular disease⁽¹⁹⁾. This is compatible with the cerebrovascular event rate in the overall group cerebrovascular event prevalence. Although more up to 10% stroke rates were reported for the concomitant CABG and carotid procedures, we did not have perioperative cerebrovascular event in these concomitant cases^(19,20). Still, the expected stroke rates are

higher than 2.4% in combined procedures⁽¹⁹⁾. Combined procedures did not have significant associations with mortality or neurologic morbidity in our study group (Table 2). Another importance of cerebrovascular disease may be the importance of lower perfusion and lower reserve in elderly patients. Another important factor was the blood transfusion. It can be seen that elderly patients had lower preoperative hemoglobin values (Table 1) and higher need of erythrocyte transfusions (Table 2). Bucerius et al. also reported increased risk of delirium with high transfusion requirements in cardiac surgery patients⁽⁵⁾.

Another important finding was the higher prevalence of pulmonary complications in elderly patients. It could be objected that the pulmonary complications were too high. This difference was mainly due to the definition of pulmonary complications. Many studies reporting lower numbers consider mostly respiratory failure patients. A more strict definition of pulmonary morbidity was given in the methods section. Even the patients requiring prolonged respiratory physiotherapy were accepted morbid in this analysis. Again, with any definition, older patients were reported to have higher pulmonary problems^(1,21). In spite of this high morbidity, satisfactory mid and long results have been reported^(2,7).

The patient population that was analyzed is a heterogeneous group of patients. Patients who had concomitant procedures were included in the analysis in order to simulate a real-world situation. It can be seen from our data that a significant number of patients (about 8%) had concomitant procedures. As it may be a limiting factor in interpreting the results, it has other advantages. First, we tried to make a risk assessment for neurologic complications in CABG patients. It can be seen that, elderly patients had concomitant procedures significantly more often (Table 2). So, we used this fact intentionally in order to analyze this variable as a separate variable in the regression analysis. Our results confirm our hypothesis that concomitant procedures do not pose an additional risk on the neurologic outcome.

In conclusion, elderly patients have higher rates of mortality, pulmonary and neurologic morbidity after CABG operations. Although no significant associations were found between age and mortality, age constitutes an independent risk factor for neurologic morbidity along with presence cerebrovascular disease.

CONFLICT of INTEREST

None declared.

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