

Evaluating the Postoperative Complications of Coronary Artery Bypass Graft Surgery in the Elderly

Kaveh Hosseini^{1,*}; Mehrnam Amouei¹; Mahmood Alemohammad¹

¹Department of Anesthesiology, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, IR Iran

*Corresponding author: Kaveh Hosseini, Department of Anesthesiology, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, IR Iran. Tel: +98-9113538440, E-mail: kaveh_hosseini130@yahoo.com

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Background: Higher life expectancy and increased ischemic heart disease (IHD) have resulted in increasing number of the elderly patients undergoing cardiac surgeries. Age along with many other comorbidities influence the outcome of major surgeries in the elderly patients; hence, case selection before major surgeries is challenging.

Objectives: The pure effect of age after adjusting for other major preoperative risk factors is on the center of debate in literature.

Materials and Methods: In this retrospective study, 1377 patients who had undergone coronary artery bypass graft surgery (CABG) from June 2006 to August 2012 were included. Patients were categorized in two age groups: group A, < 70 and group B, ≥ 70 years old. Preoperative and postoperative variables were evaluated between these groups. Sex, diabetes mellitus (DM), hypertension (HTN), left ventricular ejection fraction (LVEF), and glomerular filtration rate (GFR) were assessed as preoperative factors. Postoperative complications such as sternal wound infection, nosocomial pneumonia, prolonged ventilation, atrial fibrillation (AF), and operation for rebleeding were registered to evaluate their association with age groups and preoperative comorbidities.

Results: Patients in group B were more likely to have DM, HTN, and GFR < 60. In binary logistic regression, age ≥ 70 years was significantly associated with postoperative AF (OR = 2.26, 95% CI, 1.33-3.83) and prolonged ventilation (OR = 2.38, 95% CI, 1.2-4.5) while it was not associated with other complications. Nonetheless, the age was not a major risk factor for prolonged ventilation after adjustment for other main risk factors in multivariate analysis. AF was the most common complication of CABG in the elderly (age ≥ 70 years old). There was not a significant sex predilection in two age subgroups. In logistic regression, GFR > 60 mL/min/1.73 m² was significantly associated with all complications except reoperation for bleeding, and it was a protective factor in those complications. After adjustment for age, in binary logistic, GFR < 60 mL/min/1.73 m² was significantly associated with prolonged ventilation (P value = 0.036, OR = 2.2) and sternal wound infection (P value = 0.022, OR = 7.7). In multivariate analysis, the effect of GFR < 60 mL/min/1.73 m² on AF was not significant. Left ventricular dysfunction (EF < 40%) was significantly associated with postoperative pneumonia (OR = 2.95; 95% CI, 1.2-7.6) and reoperation for bleeding (OR = 1.74, 95% CI: 1.09-2.85).

Conclusions: CABG in the elderly patients is accompanied with higher morbidity. In addition, comorbidities are also major determinants of postoperative outcomes even after adjustment for age. Age alone is not a strong predictor of complications and preoperative health status of the elderly patient is also a major factor.

Keywords: Coronary Artery Bypass; Adverse Effects; Comorbidities

1. Background

Coronary artery bypass graft surgery (CABG) is the effective treatment for ischemic heart disease (IHD) in the case of multiple vessels involvement and has become a common procedure these days. In addition to certain preoperative criteria for CABG, the quality of life after CABG surgery was shown to be higher in comparison with other treatments such as drug and percutaneous coronary intervention (1). Like other major surgeries, CABG has some unwanted complications in several organs of the body (2); however, postoperative mortality, morbidity, and length of stay in hospital are affected by preoperative risk factors. Identification and assessment of these risk factors will improve quality of clinical management (3, 4). Age is among the strongest risk factor for postoperative complications of major surgeries such as

CABG. The prevalence of cardiovascular disease in the elderly patients is approximately 25% (5). This age group is susceptible to develop a number of comorbidities, which may worsen the postoperative prognosis (6). Since development of the surgical techniques, anesthesia, and postoperative care, the number of the elderly patients undergoing CABG has increased. Risk assessment and accurate patient selection before the surgery will help decrease the rate of mortality and morbidity.

2. Objectives

In this study, we aimed to evaluate the association between age and other major preoperative factors such as sex, diabetes mellitus (DM), hypertension (HTN), glo-

merular filtration rate (GFR), and left ventricular ejection fraction (LVEF) with postoperative complications of CABG surgery including sternal wound infection, atrial fibrillation (AF), pneumonia, prolonged ventilation, and reoperation for bleeding.

3. Materials and Methods

In this retrospective study, we enrolled 1377 patients that had undergone CABG for the first time, in Imam Khomeini Hospital from April 2006 to March 2012. Patients who had undergone other cardiac surgery (e.g. valvular surgery, aneurysmectomy and surgeries for congenital heart disease) were excluded. All basic data and demographic characteristics were extracted from hospital database. In literature, several definitions of elderly can be found (7, 8); we define the 70 years of age and older as the elderly in this study (6).

HTN was diagnosed when blood pressure was $\geq 140/90$ mm Hg or the patient was under antihypertensive medication. DM was defined as abnormal glucose tolerance test, a fasting blood-glucose level > 126 mg/dL on two separate tests, or the regular use of oral hypoglycemic agents or insulin, alone or in combination. Chronic kidney disease (CKD) was defined as creatinine clearance < 60 mL/h, or the patient being under dialysis. GFR was calculated according to the Cockcroft-Gault equation. LVEF was measured using transthoracic echocardiography. Postoperative complications such as sternal wound infection, nosocomial pneumonia, prolonged ventilation (> 24 hours), AF, and reoperation for bleeding were evaluated for their association with age groups.

3.1. Statistical Analysis

Values are given as mean \pm SD. Independent-samples t-test was used to compare means of quantitative variables in subgroups of length of stay. Associations between dichotomous data were analyzed with Chi square test. Univariate and multivariate analysis in binary logistic regression was also used to define the association between predictors and outcome in terms of odds ratio and 95%

confidence interval. Analysis was performed by SPSS 11.5 for windows (SPSS Inc., Chicago, IL, USA).

4. Results

We categorized patients in two age groups: group A < 70 ; and group B ≥ 70 years old. Group A consisted of 1093 patients, including 768 men (70%); in group B, 69% of the patients were male. Female patients were older than male patients (60 ± 10.9 and 59 ± 10.9 years, respectively). Based on independent sample t-test analysis, age there was a significant difference between two groups with regard to age ($P = 0.000$). Postoperative mortality rate was 4.6%. Basic, demographic and preoperative factors of the study groups are illustrated in Table 1.

In our study, preoperative factors that were significantly associated with different age subgroups (< 70 vs. ≥ 70 years) were as follow: DM, HTN, Hyperlipidemia, smoking, and $GFR < 60$. Postoperative complications in age groups are shown in Table 2. The most common complications of CABG were reoperation for bleeding (5.4%) and AF (4.7%), consecutively. AF was the most common complication of CABG in the elderly patients (age ≥ 70 years). Association between complications and age ≥ 70 years, in terms of OR and 95% confidence intervals, are shown in Table 2. In binary logistic regression, age ≥ 70 years was significantly associated with postoperative AF (OR = 2.26; 95% CI, 1.33-3.83) and prolonged ventilation (OR = 2.38; 95% CI, 1.2-4.5). However, the association between age ≥ 70 years and other complications was not significant (Table 2).

Univariate analysis of preoperative major risk factors and postoperative complications is described in Table 3. In binary logistic regression, $GFR > 60$ mL/min/1.73 m² was significantly associated with all complications except reoperation for bleeding, and it was a protective factor for those complications. After adjustment for age, in binary logistic, $GFR < 60$ mL/min/1.73 m² was significantly associated with prolonged ventilation (P value = 0.036, OR=2.2) and sternal wound infection (P value = 0.022, OR = 7.7). Female patients were less likely to have reoperation for bleeding but they were more prone to pneumonia

Table 1. Basic Demographic Features and Preoperative Factors in Age Groups (Group A vs. Group B)^{a,b,c}

Variable	Group A (< 70 years old) (n = 1093)	Group B (≥ 70 years old) (n = 284)	P value
Age, y	55.7 \pm 8.1	74.4 \pm 3.6	0.000
Female Sex	325 (30)	88 (31),	0.684
DM	379 (35)	71 (25)	0.002
HTN	461 (42)	156 (55)	0.000
Hyperlipidemia	359 (33)	68 (24)	0.004
Statin use	337 (31)	76 (27)	0.103
Smoking	395 (36)	69 (24)	0.000
LVEF < 40%	384 (34)	110 (39)	0.26
GFR < 60 mL/min	278 (25)	199 (70)	0.000

^a Abbreviations: DM, diabetes mellitus; HTN, hypertension; LVEF, left ventricular ejection fraction; and GFR, glomerular filtration rate.

^b P value for Chi-square analysis of variables and age groups.

^c Data are presented as No. (%) or mean \pm SD.

Table 2. Postoperative Complications in Two Age Groups

Complication	Group A (< 70 years old) (n = 1093), No.	Group B (≥ 70 years old) (n = 284), No.	P Value
Sternal Wound Infection	7 (0.6)	2 (0.7)	0.92
Atrial Fibrillation	41 (4)	23 (8)	0.002
Pneumonia	14 (1.3)	7 (2.5)	0.14
Prolonged Ventilation	25 (2.3)	15 (5.3)	0.007
Reoperation for Bleeding	56 (5)	18 (6.3)	0.41

Table 3. Univariate Analysis Major Preoperative Factors and Postoperative Complications Without Age Adjustment ^{a,b}

Preoperative Factors	Postoperative Complication, No.				
	Sternal Wound Infection	AF	Pneumonia	Prolonged Ventilation	Reoperation for Bleeding
Female	0.61	0.15	0.03 (OR = 2.6; 95% CI, 1.1-6.1)	0.002 (OR = 2.6; 95% CI, 1.4-5)	0.01 (OR = 0.43; 95% CI, 0.23-0.81)
DM	0.52	0.017 (OR: 0.46; 95% CI, 0.24-0.9)	0.007 (OR = 3.14; 95% CI, 1.4-8.3)	0.18	0.18
HTN	0.51	0.73	0.019 (OR = 3.13, CI; 1.2-8.3)	0.002 (OR = 3; 95% CI, 1.5-5.8)	0.44
GFR ≥ 60 mL/min/1.73 m ²	0.018 (OR = 0.15; 95% CI, 0.03-0.72)	0.019 (OR = 0.54; 95% CI, 0.33-0.9)	0.035 (OR = 0.39; 95% CI, 0.16-0.93)	0.001 (OR = 0.34; 95% CI, 0.18-0.65)	0.17
LVEF < 40%	0.59	0.18	0.017 (OR = 2.95; 95% CI, 1.2-7.6)	0.12	0.019 (OR = 1.74, 95% CI: 1.09-2.85)

^a Abbreviations: DM, diabetes mellitus; HTN, hypertension; GFR, glomerular filtration rate; LVEF, left ventricular ejection fraction; and AF, atrial fibrillation.

^b P value is presented in the table, in binary logistic regression. Odds ratio and 95% CI are calculated when P value < 0.05.

and prolonged ventilation after CABG. Interestingly, in this database analysis, DM was a protective factor for AF but a major risk factor for nosocomial pneumonia. Left ventricular dysfunction (LVEF < 40%) was significantly associated with postoperative pneumonia (OR = 2.95; 95% CI, 1.2-7.6) and reoperation for bleeding (OR = 1.74, 95% CI, 1.09-2.85). In univariate analysis HTN was associated with pneumonia and prolonged ventilation, but after adjustment for age, there were no significant association between HTN and complications.

Post-CABG respiratory infection was significantly associated with AF (OR = 3.5; 95% CI, 1.2-12.3). The association between respiratory infection and other complication was not significant. In multivariate regression analysis, two postoperative complications, namely, AF and prolonged ventilation were significantly associated with aging. In multivariate regression analysis, we entered preoperative risk factors that had significant associated with outcome in univariate analysis (Tables 4 and 5). Although age, DM, and GFR were separately associated with AF, the effect of GFR < 60 mL/min/1.73 m² on AF was not significant in multivariate analysis (Table 4). Prolonged ventilation was shown to have a significant association with Age, HTN, GFR < 60 mL/min/1.73 m² and female sex (Table 5 and 3). However, age was not a major risk factor for prolonged ventilation after adjustment for other main risk factors in multivariate analysis (Table 5).

Table 4. Multivariate Analysis ^{a,b}

Preoperative Factors	Odds Ratio (95% CI)	P Value
GFR < 60 mL/min/1.73 m ²	1.49 (0.85-2.6)	0.155
Age ≥ 70 years	1.86 (1.04-3.33)	0.036
DM	0.47 (0.25-0.9)	0.024

^a Abbreviations: GFR, glomerular filtration rate; and DM, diabetes mellitus.

^b Age with two other major risk factors for AF.

Table 5. Multivariate analysis ^{a,b}

Preoperative Factors	Odds Ratio (95% CI)	P Value
GFR < 60 mL/min/1.73 m ²	2.13 (1.06-4.29)	0.033
Age ≥ 70 years	1.6 (0.78-3.26)	0.195
HTN	2.2 (1.08-4.48)	0.029
Female Sex	2.03 (1.05-3.93)	0.033

^a Abbreviations: GFR, glomerular filtration rate; and HTN, hypertension.

^b Age along with three major risk factors for prolonged ventilation.

5. Discussion

The risk of mortality and morbidity are higher in the elderly patients but this higher risk is acceptable when undergoing CABG (9, 10). Postoperative adverse outcomes

for octogenarians, which undergo cardiac surgery, are less than previously reported in literature, especially for CABG surgery. In selected octogenarians without significant comorbidity, mortality is somehow near that in younger patients (9). However, comorbidities (renal dysfunction, HTN, DM, etc.) may predispose the elderly patients to worse outcomes. Although these comorbidities will affect the decision to operate the elderly patients, age and left ventricular dysfunction are the main criteria for such decision-making (11). In a study by Najafi et al., postoperative complications of CABG were higher in opium-addicted patients in comparison to other cases. LVEF was evaluated as one of the main determinants of lower quality of life among addicted patients who underwent CABG surgery (12). This study showed that some of the complications of CABG are higher in the elderly patients, but we can decline adverse outcomes with a precise preoperative risk assessment, patient selection, providing perfect anesthesiologic management, and employing appropriate surgical techniques. For instance, GFR > 60 mL/min/1.73 m² not only was associated with age groups but also played a protective role against postoperative complications in the elderly patients. Hence, the elderly patients with kidney disease are at higher risk for complications. However, defining the ideal candidates for CABG among the elderly patients is still a challenging issue. Each elderly patient should be assessed on his or her own merit (13). The type of cardiac surgery (emergent vs. elective) is another important issue that influences the prognosis. Many surgeons choose "off-pump" technique to avoid cardiopulmonary bypass and decline the likelihood of stroke (14). However there is not enough and clear evidences in literature about the benefit of this technique in the elderly patients (15). In this study, we did not discuss surgical techniques (clamp time, pump time, etc.) and their influence on postoperative complications in the elderly patients. Prevalence of female patients undergoing CABG after 70 years old is increasing (16). Longer life expectancy and increased body mass after menopause are among the causes that predispose women to IHD in higher age groups (17). In present study, Iranian female patients were older but there was not a significant sex predilection among CABG patients between age subgroups. In this study, postoperative mortality rate was 4.6% and it was 5.2% for patients with hospital stay of > 5 days. Unfortunately, due to incomplete database, we could not report the mortality rates in the elderly patients; however, it was between 2.3% and 16.2% in similar studies (18).

Nosocomial respiratory infection is a serious complication after CABG surgery. In this study, the probability of pneumonia was not significantly higher in the elderly patients. Lung involvement in pneumonia and resulting hypoxia may cause AF in this circumstance (17). The positive correlation between postoperative pneumonia and AF was shown in this study. After adjusting for age, preoperative determinants of health were still significantly associated with postoperative complications. This repre-

sent that age effect along with assessment of other risk factors is crucial to predicting the complications.

In conclusion, although elderly patients are prone to higher postoperative complications, the assessment and identification of comorbidities and preoperative health status of these patients are also important. Healthy elderly patient without any organ (kidney, lung, cerebrovascular system, etc.) impairment will tolerate major surgeries like CABG. Hence, considering age as the only risk factor for complications is not practical and rational.

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Authors' Contributions

Kaveh Hosseini: analysis and interpretation of data, statistical analysis, and drafting the manuscript; Mehrnam Amouei: acquisition of data, analysis, and interpretation of data; Mahmood Alemohammad: administrative, technical, and material support, study supervision, and critical revision of the manuscript for important intellectual content.

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