Original Article

Early Outcome of Coronary Artery Bypass Grafting in Patients Less Than 40 Years Old Comparing with Elderly Patients

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Abstract

Background: *Age is one of the most important factors that have consistently emerged as the most potent predictors of mortality and morbidity after coronary artery bypass graft (CABG) surgery. However, early results of CABG in young patients in comparison with elderly ones have been different in previous surveys. The aim of this study was to compare short-term mortality and morbidity in young versus older patients and evaluate the presence of risk factors and their influence on outcome in both groups.*

Methods: *We conducted a retrospective database review of 13222 patients divided into two age groups: patients less than 40 years old (411 patients) and those older (12811 patients), who underwent CABG at Tehran Heart Center between January 2002 and January 2007. We also compared preoperative, operative, and postoperative characteristics between them and assessed the influence of the variables on the length of stay in hospital (LOS) in the two groups.*

Results: *Among postoperative complications, only atrial fibrillation (P<0.001) was more prevalent in the elderly group and other complications were similar. The thirty-day mortality rate was higher in the elderly group (1.1% vs. 0%, P=0.023). Also, prolonged LOS (P<0.001) and ICU stay (P<0.001) were found more prevalent in the elderly group. Among the preoperative and postoperative variables, emergency surgery, diabetes mellitus, and previous myocardial infarction influenced the prolonged LOS in the young patients.*

Conclusion: *Early mortality rate and prolonged length of stay in ICU and hospital were higher in the elderly than those in the young patients; however, other postoperative early complications were similar between the two groups.*

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Keywords: *Coronary artery bypass grafting • Age • Outcome*

Introduction

During the past two decades, the mean age of patients selected for coronary artery bypass graft (CABG) surgery has increased.[1] Despite the fact that improved myocardial preservation, anesthesia, surgical techniques, and postoperative care have improved the outcome of surgery, older age still causes increased morbidity and longer hospital stays.[1] Thus, age is one of the most important factors that have consistently emerged as the most potent predictors of mortality and morbidity after CABG. Elderly patients being considered for CABG has a higher average risk for mortality

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and morbidity in a direct relation to age.

However, early results of CABG in young patients in comparison with elderly ones have been different in previous surveys. In some studies, the prognosis for young patients was worse with decreasing age of the first coronary episode;[2] and in some others, the outcome for young patients was better than that for older patients.[3,4] Also, coronary artery disease (CAD) carries a significant morbidity, psychological effects, and financial constraints for the person and the family when it occurs at a young age. Furthermore, the prevalence of risk factors is on the rise in young adults and children. This will result in an increased disease burden in the near future.[5]

According to the different results of CABG in young versus elderly patients and the increase of risk factors for CAD in young groups, we compared short-term mortality and morbidity in young patients and evaluated the presence of risk factors and their influence on early outcome in this group versus elderly patients.

Methods

Preoperative, intraoperative, and postoperative characteristics were collected and entered into a computerized database from 13222 patients undergoing isolated CABG at Tehran Heart Center from January 2002 to January 2007. In this study, CAD was considered significant if there was a 75% or greater stenosis in the luminal diameter of coronary arteries in any view. A stenosis of 50% or more in the left main coronary artery was considered significant.[6] The following data were included for analyzing the preoperative variables: 1) general characteristics: age, gender, and body mass index (BMI); 2) preoperative risk factors: current smoking history (patient regularly smokes a tobacco product/products one or more times per day or has smoked in the 30 days prior to admission),[7] hypercholesterolemia (total cholesterol≥220 mg/dl, HDL-cholesterol≤35 mg/dl, LDL- cholesterol≥160 mg/dl),[8] family history of CAD (first-degree relatives before the age of 55 in men and 65 years in women),[9] hypertension (systolic blood pressure>140 mmHg and/or diastolic>90 mmHg and/or on anti-hypertensive treatment),[10] diabetes mellitus (symptoms of diabetes plus plasma glucose concentration>200 mg/dl or fasting plasma glucose>126 mg/dl or 2-hp>200 mg/dl),[11] renal failure (creatinine>4.0 mg/dl with a rise of >44 units or urine output below 0.3 ml/kg for 24 h), cerebrovascular disease, and chronic lung disease; 3) preoperative cardiac status: previous myocardial infarction (an acute event with abnormal creatine phosphokinase and troponin levels), New York Heart Association (NYHA) score, Euroscore, and arrhythmia; and 4) preoperative homodynamic status: number of defected coronary vessels, left main disease>50%, and left ventricular ejection fraction.

The operative data included type of surgery (elective or emergency), the number of distal anastomoses with vein grafts, and the use of internal mammary artery (IMA) as grafts.

We considered four criteria for postoperative short-term outcome:

1) In-hospital postoperative complications (existence of at least one of these complications): cardiac complications (heart block, cardiac arrest, tamponade, and atrial fibrillation) and non-cardiac complications (brain stroke, renal failure, pulmonary emboli, acute limb ischemia, multi-system failure, continuous coma>24 hours, and prolonged ventilation>10 hours) ; 2) prolonged length of stay in ICU; 3) prolonged hospital stay; and 4) 30-day mortality rate (sometimes termed as operative mortality) defined as death within 30 days of operation.[12]

Numerical variables were presented as the mean±SD, while categorized variables were summarized by percentages. Continuous variables were compared using the Student's t test or nonparametric Mann-Whitney U test whenever the data did not appear to have normal distributions, and categorical variables were compared using the chi-square or Fisher's exact test.

Power analysis showed that there was about 90% chance of detecting a significant difference using a two-sided test with significance level=0.05.

Multivariate stepwise logistic regression model for risk factors predicting prolonged LOS was constructed separately for young and elderly patients. Variables were included into the multivariate model if the p value was found to be less than or equal to 0.15 in the univariate analysis. The associations of independent predictors with prolonged LOS in the final model were expressed as odds ratios (OR) with

95% Confidence Intervals (CIs). Model discrimination was measured using the c statistic, which is equal to the area under the ROC (Receiver Operating Characteristic) curve. Model calibration was estimated using the Hosmer Lemeshow (HL) goodness-of-fit statistic (higher P values imply that the model fit the observed data better). For the statistical analysis, the statistical software SPSS version 13.0 for windows (SPSS Inc., Chicago, IL) and the stasistical package SAS version 9.1 for windows (SAS Institute Inc., Cary, NC, USA) were used. All p values were 2-tailed, with statistical significance defined by p≤0.05.

Results

There were 411 and 12811 CABG operations performed on patients≤40 years old and elderly patients, respectively. The main preoperative characteristics are summarized in Table 1. Among CAD risk factors, family history of

CAD (P<0.001), previous myocardial infarction (P=0.001), and cigarette smoking (P=0.001) were higher in group≤40 years old, whereas history of hypertension (P<0.001), diabetes mellitus (P<0.001), peripheral vascular disease

(P=0.044), and arrhythmia (P=0.011) were more prevalent in the elderly group. Also, the mean of Euroscore in the young patients was less than that in the elderly group (P<0.001). No significant differences in other risk factors between the two groups were found. Preoperative ejection fraction and the mean of NYHA score were also similar between the two groups. There was a significant difference in the number of defected vessels between the two groups (P<0.001). Also, left main disease>50% was more prevalent in group>40 years old (P=0.007).

Table 1. Preoperative patients characteristics

Characteristics	Group with age≤40 (n=411)	Group with age>40 (n=12811)	P value
Male (%)	87.6	74.1	<0.001
Age (mean±SD)	36.7±5.5	59.3±9.0	<0.001
BMI (mean±SD)	27.2±4.2	27.1±4.2	0.671
Current cigarette smoking (%)	22.4	16.0	0.001
Opium addiction (%)	15.9	16.0	0.986
Family history of CAD (%)	53.9	35.2	<0.001
Diabetes mellitus (%)	16.8	32.2	<0.001
Hypercholesterolemia (%)	68.4	65.7	0.257
Renal failure (%)	1.0	1.1	0.999
Hypertension (%)	36.3	53.5	<0.001
Cerebrovascular disease (%)	5.1	6.8	0.170
Peripheral vascular disease (%)	0.5	1.8	0.044
Previous MI (%)	46.8	38.5	0.001
NYHA score (mean±SD)	1.9±0.9	2.0±0.9	0.158
Arrhythmia (%)	0.7	2.9	0.011
Ejection fraction (mean±SD) (%)	48.6±10.2	49.3±10.4	0.139
Left main disease (>50%) (%)	5.8	9.8	0.007
Single vessel disease (%)	13.0	4.6	<0.001
Two vessels disease (%)	26.6	20.9	<0.001
Three vessels disease (%)	60.5	74.5	<0.001
Euroscore (mean±SD)	4.8±2.0	5.4±2.2	<0.001

BMI, Body mass index; CAD, Coronary artery disease; MI, Myocardial infarction; NYHA, New York heart association

The operative cardiac indices are shown in Table 2. Arterial grafts were used more in group≤40 years old (P=0.031), whereas the use of vein grafts was found more in the other group (P<0.001).

Table 2. Operative patients characteristics

Characteristics	Group with age≤40 (n=411)	Group with age >40 (n=12811)	P value
Emergency CABG (%)	8.8	11.6	NS
Anastomoses with arterial conduits (%)	99.1	97.4	0.031
Anastomoses with venous grafts (%)	94.7	98.2	<0.001
IMAs used as graft (%)	98.8	96.9	0.045

CABG, Coronary artery bypass grafting; IMA, Internal mammary artery

The main postoperative characteristics are summarized in Table 3. Among postoperative complications, only atrial fibrillation (P<0.001) was more prevalent in the elderly patients, and the other studied complications were similar between the two groups. The thirty-day mortality rate in group≤40 years was significantly less than that in the other group. Also, prolonged length of stay in hospital (LOS) (P<0.001) and total ICU stay (P=0.001) were more prevalent in the elderly patients.

Table 3. Postoperative early outcome of patients

Characteristics	Group with age≤40 (n=411)	Group with age>40 (n=12811)	P value
Re-intubation (%)	0.6	1.2	0.267
Continuous coma (%)	0.0	0.3	0.626
Prolonged ventilation (%)	1.2	2.3	0.137
Cardiac arrest (%)	0.0	0.1	0.521
Heart block (%)	0.0	0.5	0.277
Atrial fibrillation (%)	0.5	6.3	<0.001
Renal failure (%)	0.2	0.9	0.273
Brain stroke (%)	0.2	0.4	0.524
Pulmonary emboli (%)	0.5	0.4	0.673
Acute limb ischemia (%)	0.2	0.1	0.271
Multi system failure (%)	0.0	0.1	0.521
30 days mortality (%)	0.0	1.1	0.023
30 days readmission (%)	3.4	4.6	0.428
LOS/day (mean±SD)	14.1±6.3	16.2±7.0	<0.001
LOS >14 days (%)	38.0	51.2	<0.001
ICU stay/hour (mean±SD)	35.8±18.9	43.0±34.5	0.001
ICU stay >72 hours (%)	6.6	11.8	0.001

LOS, Length of stay in hospital

A multivariate stepwise logistic regression analysis showed that several preoperative and postoperative characteristics influenced the prolonged LOS in the elderly patients (Table 4). However, only three factors of emergency versus elective surgery (P=0.0003), history of diabetes mellitus (P=0.0047), and pre-CABG myocardial infarction (P=0.0038) were main predictors for prolonged LOS in hospital in young patients (table 5).

Table 4. Predictors for prolonged LOS in elderly patients

Variable	Univariate P value	Multivariate P value	Odds Ratio	95% Confidence Interval
Preoperative variables:				
Male gender	<0.0001	<0.0001	0.541	0.492-0.595
Emergency surgery	<0.0001	<0.0001	2.269	1.041-4.946
Diabetes mellitus	<0.0001	<0.0001	1.332	1.221-1.453
Dyslipidemia	<0.0001	<0.0001	1.192	1.007-1.296
Hypertension	<0.0001	<0.0001	1.253	1.156-1.359
Peripheral vascular disease	<0.0001	<0.0001	2.466	1.741-3.492
Previous PCI	<0.0001	0.0003	1.459	1.185-1.797
Previous MI	<0.0001	0.0020	1.143	1.050-1.244
Three vessels disease	<0.0001	<0.0001	1.215	1.130-1.305
Ejection Fraction	<0.0001	<0.0001	0.986	0.982-0.990
Postoperative complications:				
Brain stroke	<0.0001	0.0395	2.782	1.014-7.629
Prolonged ventilation	<0.0001	<0.0001	2.073	1.502-2.860
Pulmonary emboli	<0.0001	0.0003	3.984	1.707-9.296
Heart block	<0.0001	0.0018	2.647	1.412-4.961
Atrial fibrillation	<0.0001	<0.0001	2.301	1.929-2.745

LOS, Length of stay in hospital; PCI, Percutaneous intervention, MI, Myocardial infarction
Hosmer-Lemeshow statistic: $\chi 2 = 18.81$, P=0.016
Area under the ROC curve c= 0.656

Table 5. Predictors for prolonged LOS in young patients

Variable	Univariate P value	Multivariate P value	Odds Ratio	95% Confidence Interval
Emergency surgery	<0.0001	0.0003	0.244	0.113-0.526
Previous MI	0.002	0.0038	1.904	1.239-2.925
Diabetes mellitus	0.002	0.0047	2.253	1.289-3.939

LOS, Length of stay in hospital; MI, Myocardial infarction
Hosmer-Lemeshow statistic: $\chi 2 = 0.51$, P=0.776
Area under the ROC curve c=0.636

Discussion

CABG surgery has been shown to be an effective method for treating angina pectoris and prolonging life in patients with severe coronary artery disease. Be that as it may, it has not yet been determined whether younger patients benefit from this procedure to the same extent as elderly patients. The present study compares three preoperative, operative, and postoperative characteristics of patients≤40 years old who underwent CABG with elderly patients in this center between 2002 and 2006.

In this study, frequency of CABG procedures in men ≤40 years old and elderly men were 87.6% and 74.1%, respectively. In line with our study, French et al. reported the frequency of 84% for men≤40 years old who underwent CABG procedures.[13] Furthermore, in the Keskimaki et al. study, in relation to hospitalization due to CAD, women received proportionally less surgery than men.[14]

The average age of patients≤40 years old in our study was 36.7 years old. In the Kelly study, the average age of these patients was reported to be 35 years.[15] In our study, history of cigarette smoking and family history of CAD in the young patients were more frequent than those in the patients>40 years old. We also found that history of hypertension and diabetes mellitus in patients≤40 years old was seen less than that in the elderly patients. Kelly[15] and Rohrer-Gubler[16] et al. found similar results in their studies. In marked contrast to their studies, however, we found no significant difference between history of hypercholesterolemia in the young patients and patients>40 years old that underwent CABG procedure. In the Kelly and Rohrer studies, patients less than 40 years were more likely to have elevated cholesterol levels. In the French et al. study, the prevalence of cigarette smoking, hypertension, diabetes mellitus, hypercholesterolemia, and family history of CAD was strikingly less than that in our study.[13]

In our study, previous myocardial infarction was more prevalent in the younger group. Rohrer et al. found that the group≤40 years old had more preoperative myocardial infarction.[14] Casas et al. found that the younger patients appeared to carry the same risks for myocardial infarction and death as an elderly patient.[17] In their study, a total of 61% of young patients had a recent history of a myocardial infarction and 60% had NYHA Class IV just prior to operation, whereas we found the prevalence of recent myocardial infarction in 45.8% of younger patients and NYHA Class≥3 only in 20.3% of our patients. Results of several studies have suggested that CABG is becoming safer to perform in very old persons; and although older patients are referred for CABG at a significantly lower functional level, the functional improvement after CABG is not significantly different among age groups.[18, 19]

Among postoperative criteria, atrial fibrillation was more frequent in patients>40 years old. Atrial fibrillation after CABG is the most common sustained arrhythmia. Its pathophysiology is unclear, and its prevention and management remain suboptimal.[20] Post-CABG atrial fibrillation seems to require a well-definite anatomical and electrical substrate that is generated by increased left atrial dimensions, a greater extension of coronary lesions, and a possible electrical remodeling consequent to prior repetitive episodes of paroxysmal atrial fibrillation.[21]

In our study, the 30-day mortality rate was more in the elderly group. In the Kelly et al. study, the percentage of death was much higher for younger patients.[14] In the Peterson et al. study, age was a significant predictor of the 30-day mortality. For example, an 85-year-old patient undergoing bypass surgery would have nearly 40% higher odds for mortality at 30 days than a similar patient of age 80 years.[22] Also, measures of acute coronary disease, such as acute myocardial infarction before bypass surgery and congestive heart failure, and comorbid illnesses such as peripheral vascular disease and chronic renal disease were highly predictive of 30-day mortality.[22]

We also found that the length of hospital stay in the elderly patients was higher than the other group. Results of other studies indicated that elderly patients were much more likely to be discharged to extended-care facilities.18 In our study, the female gender was an important predictor for prolonged length of stay in hospital, which chimes in with the results of the Borzak study.[23] In several studies, the female sex is reported to be an independent predictor of length of stay in hospital.[24-26] Vaccarino et al. reported that women undergoing CABG had higher rates of hospital readmission than men at 6 weeks.[27] It seems that the most common causes of prolonged lengths of stay in hospital in females are a higher incidence of preoperative risk factors and postoperative complications of CABG in females than in males.[28] Therefore, it is important to control these risk factors in female patients before operation.

Conclusion

Finally, it can be concluded that early mortality rates and prolonged lengths of stay in ICU and hospital are higher in elderly patients by comparison with young ones. However, other postoperative complications are similar between the two groups.

In view of our findings, additional investigations are needed to compare long-term mortality rates of young with elderly patients who undergo CABG and study the effects of operative and postoperative indices on late CABG outcome in younger patients.

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References

1. Jarvinen O, Huhtala H, Laurikka J, Tarkka MR. Higher age predicts adverse Outcome and readmission after coronary artery bypass grafting. World J Surg 2003;27:1317–1322.
2. Certler MM, White PD, Simon R, Gottsch LG. Long-term follow-up of young coronary patients. Am J Med Scm 1964;247:145-154.
3. Urn JS, Proudfit WL, Sones FM Jr. Selective coronary arteriography in young men: a follow-up of 449 patients. Circulation 1974;49:1122-1126.
4. Roth 0, Berki A, Wolff CD. Long range observations in fiftythree young patients with myocardial infarction. Am J Cardiol 1967;19:331-338.
5. Egred M, Viswanathan G, Davis GK. Myocardial infarction in young adults. Postgrad Med J 2005;81:741-745.
6. Tavakoli R, Weber A, Brunner-La Rocca H, Bettex D, Vogt P, Pretre R, Jenni R, Turina M. Results of surgery for irreversible moderate to severe mitral valve regurgitation secondary to myocardial infarction. Eur J Cardiothorac Surg 2002;21:818-824.
7. Barrett-Connor E, Giardina, EGV, Gitt AK, Gudat U, Steinberg HO, Tschoepe D. Women and heart disease: the role of diabetes and hyperglycemia. Arch Intern Med 2004;164:934-942.
8. Wood D, De Backer G, Faergeman O,Graham I, Mancia G, Pyorala K. Prevention of coronary heart disease in clinical practice: recommendations of the second joint task force of European and other societies on coronary prevention. Eur Heart J 1998;19:1434-1503.
9. Bartnik M, Ryden L, Ferrari R, Malmberg K, Pyorala K, Simoons M, Standl E, Soler-Soler J, Ohrvik J; Euro Heart Survey Investigators. The prevalence of abnormal glucose regulation in patients with CAD across Europe. The Euro heart survey on diabetes and the heart. Eur Heart J 2004;25:1880-1890.
10. 1999 World Health Organization-international society of hypertension guidelines for the management of hypertension: guidelines subcommittee. J Hypertens 1999;17:151-183.
11. Kuzuya N. Guidelines for dining out for diabetics. Nippon Rinsho 2002;60:697-705.
12. Edmunds HL, Clark RE, Cohn LH, Grunkemeier GL, Miller DC, Weisel RD. Guidelines for reporting morbidity and mortality after cardiac valvular operations. Ann Thorac Surg 1996;62:932–935.
13. French JK, Scott DS, Whitlock RML, Nisbet HD, Vedder M, Kerr AR. Late outcome after coronary artery bypass graft surgery in patients ≤40 years old. Circulation 1995;92:14-19.
14. Keskimaki I, Koskinen S, Salinto M. Aro S. Socioeconomic and gender inequities in access to coronary artery bypass grafting in Finland. Eur J Public Health 1997;7:392-397.
15. Kelly MF, DeLaria GA , Najafi H. Coronary artery bypass surgery in patients less than 40 years of age. Chest 1988;94:1138-1141.
16. Rohrer-Gubler I, Niederhauser U, Turina MI. Late outcome of coronary artery bypass grafting in young versus older patients. Ann Thorac Surg 1998;65:377-382.
17. Casas L, LoCicero J, Sanders LH, Michaelis LL. Complete surgical revascularization: the treatment of choice in young patients with multivessel coronary disease. Tex Heart Inst J 1985;12:349–353.
18. Nallamothu BK, Saint S, Eagle KA, Langa KM, Fendrick AM, Hogikyan RV, Kelley K, Ramsey SD. Coronary artery bypass grafting in octogenarians: clinical and economic outcomes at community-based healthcare facilities. Am J Manag Care 2002; 8:749-755.
19. Hedeshian MH, Namour N, Dziadik E, Stewart RD, Campos CT. Does increasing age have a negative impact on six-month functional outcome after coronary artery bypass? Surgery 2002;132:239-244.
20. Aranki SF, Shaw DP, Adams DH, Rizzo RJ, Couper GS, Vanderveliet M. Predictors of atrial fibrillation after coronary artery surgery: current trends and impact on Hospital resources. Circulation 1996;94:390-397.
21. Ducceschi V, D'Andrea A, Liccardo B, Alfieri A, Sarubbi B, De Feo M. Perioperative clinical predictors of ftrial fibrillation occurrence following coronary artery surgery. Eur J Cardiothorac Surg 1999;16:435-439.
22. Peterson ED, Cowper PA, Jollis JG, Bebchuk JD, DeLong ER, Muhlbaier LH, Mark DB, Pryor DB. Outcomes of coronary artery bypass graft surgery in 24461 patients aged 80 years or older. Circulation 1995;92:85-91.
23. Borzak S, Tisdale JE, Amin NB, Goldberg AD, Frank D, Padhi ID, Higgins RS. Atrial fibrillation after bypass surgery: does the arrhythmia or the characteristics of the patients prolong hospital stay? Chest 1998;113:1489-1491.
24. Aldea GS, Gaudiani JM, Shapira OM. Effect of gender on postoperative outcomes and hospital stays after coronary artery bypass grafting. Ann Thorac Surg 1999;67:1097-1103.
25. Woods SE, Noble G, Smith JM, Hasselfeld K. The influence of gender in patients undergoing coronary artery bypass graft surgery: an eight-year prospective hospitalized cohort study. J Am Coll Surg 2003;196:428-434.
26. Butterworth J, James R, Prielipp R, Cerese J, Livingston J, Burnett D. Female gender associates with increased duration of intubation and length of stay after coronary artery surgery. CABG clinical benchmarking database participants. Anesthesiology 2000;92:414-424.
27. Vaccarino V, Lin ZQ, Kasl SV. Gender differences in recovery after coronary artery bypass surgery. J Am Coll Cardiol 2003;41:307-314.
28. Athanasiou T, Al-Ruzzeh S, Del Stanbridge R, Casula RP, Glenville BE, Amrani M. Is the female gender an independent predictor of adverse outcome after off-pump coronary artery bypass grafting? Ann Thorac Surg 2003;75:1153-1160.