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Short and long-term outcomes of patients with coronary artery bypass surgery

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Original Article

Abstract

BACKGROUND: Coronary artery disease (CAD) is a major problem in Iran as well as throughout the globe, and coronary artery bypass grafting (CABG) surgery is an appropriate option for many patients with symptomatic and severe CAD. The main purpose of this study was assessment of the short and long-term outcomes of patients undergoing CABG in Yazd Province, Iran.

METHODS: This historical cohort study examined the mortality rates of patients who had undergone CABG in Afshar Hospital in Yazd from 2011 to 2013. During this period, 2510 patients undergoing CABG were entered into the study and then followed for in-hospital and long-term mortality.

RESULTS: Mean age of the patients was 61.37 ± 10.50 years and 34.1% were women. In-hospital mortality turned out to be 3.7% and age over 70, left ventricular (LV) dysfunction, female gender, and left main (LM) involvement induced significant higher in-hospital mortality. Of all the patients, 84.1% were followed for a period of 41 ± 20 months. The survival rate proved to be 92.4% in one year and 82.9% in five years. The patients with age over 70, diabetes mellitus (DM), and LV systolic dysfunction (LVSD) showed significant lower survival rate, whereas the patients with utilization of left internal mammary artery (LIMA) demonstrated significant higher survival rate.

CONCLUSION: In-hospital and long-term mortality rate of patients undergoing CABG surgery is acceptable in comparison with other studies and more effort is needed into making this event a success.

Keywords: Coronary Artery Bypass Surgery; Patient Outcomes Assessment

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Introduction

Coronary artery disease (CAD) is a major health concern in the world and is predicted to be the most leading cause of death by 2020.[1] Today, the mortality rate of CAD has clearly been decreased, partly due to the advances made in the coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI) techniques.[2] Treating the symptoms and increasing the survival rate of the patients, especially in multivessel stenosis and left main coronary artery (LMCA) stenosis, are common indicators of CABG.[2] Other factors that can be considered in the decision-making process include the general health status and associated morbidity rate affecting the surgical risks and long-term performance of the patients.[3-5]

Risk factors for mortality after CABG have been described by some researchers[6,7] and include those which can elevate perioperative myocardial infarction (PMI), preoperative risk factors indicating arteriosclerosis [peripheral arterial disease (PAD) and carotid disease], preoperative demographic factors (older age at the time of surgery, associated illnesses including pulmonary and kidney disease, and possibly female gender), and intraoperative factors [ischemic damage during operation and non-use of left internal mammary artery (LIMA)].

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The patient population undergoing CABG has changed over time, especially after widespread use of PCI. When the results of some more recent studies are compared with those of the 1970s, it is revealed that the patients currently undergoing CABG appear to be older. In addition, the female rate is higher and there is a higher proportion of unstable angina, three-vessel stenosis, history of revascularization, CABG, or PCI, left ventricular (LV) dysfunction, and associated diseases including high blood pressure, diabetes, and PAD. Despite the higher risk profile of these patients, the impacts of CABG have remained stable or improved.[2,6] The Afshar Hospital located in Yazd Province (center of Iran) is the major center for CABG with high volume (about 1200 patients per year). As there is no information around long-term survival of patients undergoing CABG to date, this study was designed and conducted for this purpose.

Materials and Methods

This historical cohort study examined the mortality rates of the patients who underwent CABG in Afshar Hospital in Yazd from 2011 to 2013. In this center, patients diagnosed with unstable angina, stable angina, and myocardial infarction (MI) and finally predicated on the results of coronary angiography were selected as appropriate candidates for CABG. Based on the patients' conditions and the surgeon preference, patients underwent the off-pump or on-pump CABG, and through the surgical technique, the LIMA and one or more veins were used. Patients who had undergone simultaneous surgical valvular surgery or aortic concomitant surgery were excluded from the study. Demographic data, clinical status, coronary angiography results, and operating conditions were extracted from the patients' medical records which were all recorded in special forms. In order to obtain the patients' follow-up information, a physician and a trained nurse made contacts with the patient or his/her family by phone through which, information was obtained about the conditions of the patients' lives and deaths added to other information as around the reason for their deaths.

Statistical analysis: Finally, the collected data were coded and entered into the SPSS software (version 24, IBM Corporation, Armonk, NY, USA). Categorical variables were presented via frequency and percent. Continuous variables, if enjoying normal distribution via Kolmogorov-Smirnov test, were presented by mean and standard deviation (SD). Continuous variables in different groups were analyzed through t-test and categorical variables using a chi-square test. Kaplan-Meier (KM) estimator was employed as the standard graphical plot of the cumulative survival probability in patients undergoing CABG. To determine the survival predictors, log-rank test and Cox proportional hazards model were deployed. The log-rank test is an unadjusted nonparametric method, whereas the Cox proportional hazards model allows comparison while adjusting for multiple covariates. All the predictors in univariate analysis with P-value < 0.20 or by experts' opinion were entered into Cox model.

Results

During the years 2011 to 2013, 2510 patients, including 856 women (34.1%) and 1654 men (65.9%) were enrolled in the study. The mean age of all patients was 61.37 ± 10.50 years, 60.65 ± 10.80 in men and 62.85 ± 8.90 in women (P = 0.0001). Baseline demographics, clinical and angiography characteristics, and surgical conditions are presented in table 1. The number of intraoperative grafts was shown to be 2.57 ± 0.77 [number of patients with 1 graft: 170 (6.8%), 2 grafts: 983 (39.5%), 3 grafts: 1089 (43.0%), 4 grafts: 236 (9.5%), 5 grafts: 12 (0.5%)] and the mean LV ejection fraction (LVEF) turned out to be 46 ± 10 percent.

Table 1. Patients' characteristics

Patients' characteristic (n = 2510)	Value
Age (year)	61.37 ± 10.50
Gender (female)	856 (34.1)
DM	999 (40.0)
HTN	1241 (50.0)
Previous stroke	46 (1.9)
Dialysis-dependent	19 (0.8)
Previous CABG	18 (0.7)
Creatinine > 1.4 (mg/dl)	493 (19.6)
Preoperative anemia [Hb < 12 (g/dl)]	369 (15.0)
3VD	1755 (70.0)
LMCA disease	405 (16.0)
LVEF < 40 (%)	659 (26.0)
Use of LIMA	2278 (90.0)
Off-pump CABG	2127 (84.0)

Data are presented as mean ± standard deviation (SD) or number and percentage

DM: Diabetes mellitus; HTN: Hypertension; CABG: Coronary artery bypass grafting; 3VD: Three-vessel disease; LMCA: Left main coronary artery; Hb: Hemoglobin; LVEF: Left ventricular ejection fraction; LIMA: Left internal mammary artery

Follow-up information was obtained from 2112 patients by phone calls to the subjects or their families (84.1%). Patients were then followed up to

41 ± 20 months. 94 patients died in hospital during or after surgery; in-hospital mortality turned out to be 3.7%. The factors influencing in-hospital mortality were then assessed. The age above 70 years escalated in-hospital mortality, that is, 7.6% (n = 47) at the age ≥ 70 vs. 2.5% (n = 47) at the age < 70 (P < 0.0001). The results of our study indicated in-hospital mortality being higher in women than men (P = 0.035). Patients with ejection fraction (EF) ≤ 40% showed significantly higher mortality in the hospital [6.8% mortality in patients with LVEF ≤ 40% (n = 45) vs. 2.6% (n = 45) in patients with LVEF > 40% (P < 0.0001)]. Diabetes also augmented the mortality risk, but it was not statistically significant (P = 0.16). The patients with LMCA disease turned out to have higher rates of in-hospital mortality (P = 0.024). However, LIMA graft utilization was significantly associated with reduction of in-hospital mortality (P < 0.0001). Figure 1 displays the most important factors affecting the mortality rate of the patients undergoing CABG.

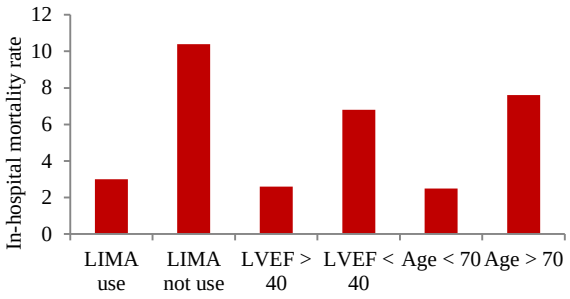

Figure 1. In-hospital mortality predictors in patients undergoing coronary artery bypass grafting (CABG) in Afshar Hospital in Yazd, Iran (LVEF: Left ventricular ejection fraction; LIMA: Left internal mammary artery)

Long-term survival results: The median follow-up time for the patients in this study was 43 months. On the whole, 290 patients (13.7%) died during this period and using KM method, the 5-year survival rate leveled at 82.9% (1-year: 92.4%, 2-year: 90.8%, 3-year: 88.4%, 4-year: 86.2%) (Figure 2).

KM estimator, log-rank test, and Cox proportional hazards model were used in this regard and then the assessments showed that the elderly patients suffered from a less survival rate of 75.4% vs. 90.0% (P < 0.0001). The women showed a survival rate of lower than men (84.0% vs. 87.4%, P < 0.037). Moreover, patients with preoperative history of diabetes exhibited a survival rate of lower than non-diabetics (83.8% vs. 88.7%, P < 0.001). Surgical revascularization of the LMCA surgery was also associated with less long-term survival rate (81.9% vs. 86.8%, P < 0.009) than the others. Patients with three-vessel disease (3VD) showed a lower long-term survival rate (84.9% vs. 89.0%, P < 0.007) than single-vessel disease (1VD) and two-vessel disease (2VD). Patients with LIMA utilization proved to have a higher survival rate (88.0% vs. 69.5%) than the others (P < 0.0001).

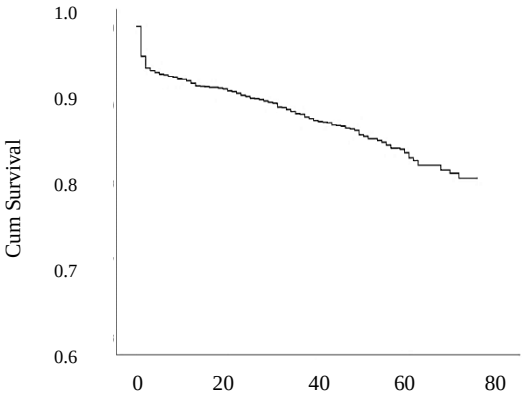

Figure 2. Kaplan-Meier (KM) survival curve during the follow-up (CABG: Coronary artery bypass grafting)

Cox regression model was used to determine the most important predictors of long-term survival rates in patients undergoing CABG. All variables that were significant in univariate analysis and also all of the long-term survival predictors based on master opinions were entered into the multiple Cox regression model. The results illustrated that age, history of diabetes, renal dysfunction, perioperative anemia, and LVEF before surgery independently reduced the long-term CABG survival rates. In addition, the use of LIMA in CABG surgeries independently improved long-term survival rate after CABG. Other CABG long-term survival predictors such as 3VD, left main (LM) disease, female gender, history of cerebrovascular accident (CVA), hypertension (HTN), and on-pump or off-pump surgeries failed to significantly alter the survival rate of patients after CABG (Table 2).

Discussion

In-hospital mortality rate of the patients in this study reached 3.7%, which is considered acceptable in comparison with other studies in Iran as well as other countries. By examining the data recorded in the United States (US), the mortality rate of CABG in the years 1997 to 2001 in the patients with low risk was about 1% and in the overall patients 2%-5%.[8] In-hospital mortality risk is strongly associated with comorbidities and postoperative complications.

Table 2. Multiple Cox regression model results showing the factors associated with long-term survival rate of patients undergoing coronary artery bypass grafting (CABG)

Variables	Hazard ratio	95% CI		P
		Lower	Upper	
Age*	2.278	1.734	2.992	< 0.0001
Female gender	1.020	0.769	1.360	0.8700
DM	1.510	1.146	1.989	0.0030
HTN	1.061	0.805	1.398	0.6730
History of CVA	1.253	0.463	3.392	0.6560
LVEF < 40 (%)	2.589	1.987	3.372	< 0.0001
3VD	1.302	0.951	1.782	< 0.1000
On-pump	0.964	0.611	1.521	0.8750
LIMA utilization	0.456	0.319	0.651	< 0.0001
LM disease	1.399	1.020	1.921	0.0380

*Age over 70 years

LIMA: Coronary artery bypass grafting; 3VD: Three-vessel disease; LVEF: Left ventricular ejection fraction; CVA: Cerebrovascular accident; DM: Diabetes mellitus; HTN: Hypertension; LM: Left main; CI: Confidence interval

In another study in Brazil, 66000 patients who had undergone CABG surgery (from 2000 to 2003) demonstrated in-hospital mortality rate of 7%. In this study, it was stated that the difference in surgical outcomes might have affected decision-making as well as indications for CABG.[9] In a report from The Society of Thoracic Surgeons (STS), 267089 patients who had undergone CABG during 2000 and 2001 showed a mortality rate of 2.66%.[10] In a study by Hasantash et al. in Modarres Hospital, Iran, one-month in-hospital mortality rate of 5.3% was reported.[11]

In our study, older age, female gender, low LVEF, LMCA stenosis, and non-usage of LIMA were some predictors of in-hospital mortality.

Age is one of the independent predictors for increasing the risk of CABG surgery; this predictor becomes more important in patients over 70 years of age.[12] In a study conducted by Ivanov et al., the outcome of 3330 patients aged over 70 years (from 1982 to 1996) was evaluated for CABG surgery. In this study, operative mortality rate in old patients was high, but it decreased from 7.2% to 4.4% during this period.[13] In another study performed by Baskett et al. in Canada, out of 725 patients older than 80, 6.2% underwent CABG from 1996 to 2001. In this study, in-hospital mortality rate of the patients < 80 years reached 3.8%, whereas in-hospital mortality in those of > 80 years old amounted to 9.2%.[14]

LVEF is another significant risk factor impacting decision-making for CABG and CABG outcome as well. In the present study, low LVEF had significant effect on increasing in-hospital and long-term mortality. Moreover, in Yau et al. study, it was reported that low EF tended to be the most important independent predictor of in-hospital mortality and perioperative events after CABG.[15] In this retrospective observational study, 8600 patients who had undergone CABG from 1992 to 1997 were studied; the operative mortality in patients with LVEF > 40% proved to be 2% but increased to 3.5%-4.3% in patients with LVEF of 20%-40%. In our study, the patients with LVEF < 40% showed higher in-hospital mortality than the patients with LVEF > 40% (6.8% vs. 2.6%).

The use of LIMA is effective for the long-term survival rate of the patients; higher rate of graft patency after surgery is associated with lower in-hospital mortality. When surgeries were performed on an emergency basis for older patients, the LIMA usage decreased. For this reason, the in-hospital mortality rate of these patients turned out to be higher than that of the others.[16]

In-hospital mortality failed to decrease in patients with off-pump compared with those with on-pump surgeries in the present study. Many studies have shown that off-pump surgeries bear fewer side effects, especially in high-risk patients. This procedure may reduce the risk of postoperative renal failure, and in elderly patients, it can reduce the risk of brain complications. However, randomized studies do not appear to show clear reduction in morbidity and mortality rates.[17]

The long-term survival rate of patients in this study is comparable to other studies.[18] In our study, survival rates of 1, 3, and 5 years were 92.4%, 88.4%, and 82.9%, respectively. Age and function of the LV were the most important factors affecting the long-term survival rate of the patients.

Additionally, the history of diabetes, female gender, LM artery stenosis, 3VD, preoperative anemia, renal dysfunction, and non-usage of LIMA were also associated with a reduction in the long-term survival rate of the patients.

Wu et al. designed a study to predict the long-term mortality of the patients after CABG surgery. In this study, patients' mortality after 1, 3, and 5 years amounted to 6.2%, 11.2%, and 17.6%, respectively. The most important predictors for in-hospital mortality comprised age, LV function, LM artery stenosis, heart failure, diabetes, and renal failure.[18]

In a study by Weintraub et al., the survival rate of 1 year and 5 years reached 97.6% and 91.9%, respectively.[19] The strongest risk factor of the survival after surgery was reported to be old age. Female gender, LV dysfunction, the number of involved vessels, and diabetes were also associated with reduced survival rate.[19] Further, in a study conducted by van Domburg et al., the patients with normal LV function showed a longer life expectancy of 4.5 years compared with those affected with LV dysfunction.[20] In this study, patients with 3VD demonstrated 3.3 years of life expectancy, i.e., lower than those who had 2VD. The most important causes of mortality in this study proved to be 3VD and LV dysfunction. While 50% of the patients with a normal LV survived after 20 years, almost 20% affected with LV dysfunction survived in 20 years. Other factors such as old age, 2VD, and LM involvement were associated with higher mortality in patients. The survival rate of men and women proved similar during the follow-up.[20]

In our study, 91.1% of the patients received LIMA grafts and showed a better long-term survival rate. In a study conducted by Loop et al., the survival rate of the patients who received LIMA grafts was compared with those who received only saphenous vein grafts (SVGs). The 10-year survival of patients with 3VD receiving LIMA appeared to be 83% compared with 71% who were the other way round. In the patients with only vein graft, 1.61 times greater risk of death was observed in 10 years as compared with those who received an internal mammary artery (IMA) graft. In addition, patients who received only vein grafts appeared to be at 1.41 times higher risk of late MI ($P < 0.0001$).[21]

Conclusion

Short and long-term outcome of patients undergoing CABG in our hospital in Yazd which is a high potential center is comparable with many other centers; however, more investigations need to be fulfilled to improve outcome.

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Conflict of Interests

Authors have no conflict of interests.

Authors' Contribution

MHS and MR: Acquisition of data; MR, MHS, and SMN: Analysis and interpretation of data; MHS, MR, and MS: Drafting of the manuscript; MHS and MS: Critical revision of the manuscript for important intellectual content; SMN: Statistical analysis; MHS and MS: Study supervision

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