

Predictors of reintervention after coronary artery bypass grafting

S. INCI, S. ARSLAN¹, E.M. BAKIRCI², M.H. TAS²,
F. GUNDOGDU², S. KARAKELLEOGLU²

Department of Cardiology, Aksaray State Hospital, Aksaray, Turkey

¹Department of Cardiology, Antalya Training and Research Hospital, Antalya, Turkey

²Department of Cardiology, Ataturk University, Erzurum, Turkey

Abstract. – **AIM:** Percutaneous and surgical reintervention after coronary artery bypass grafting (CABG) is frequent. The purpose of this study was to determine the predictors of reintervention in patients with symptoms of recurrent ischemia after coronary artery bypass graft surgery (CABG).

PATIENTS AND METHODS: The data of 20000 patients who had coronary angiography (CAG) from 2003 to 2010 in our centre were retrospectively analysed. 485 of these patients with CABG who had CAG were included in this study. Demographic characteristics, the presence of coronary artery disease (CAD), risk factors for CAD, electrocardiographic (ECG) changes, troponin and CKMB levels, and left ventricular function were evaluated in terms of time elapsed after CABG.

RESULTS: Reintervention was performed significantly more frequent in patients with acute coronary syndrome, diabetes mellitus (DM), hypertension (HT), family history of CAD, ECG changes, positive troponin level, elevated CKMB, ejection fraction (EF) > 50% and in smoker patients ($p < 0.05$). Multivariate backward logistic regression analysis revealed that DM, smoking, family history of CAD, HT, ECG changes and patients with EF > 50% were found the independent predictors of reintervention.

CONCLUSIONS: Reintervention after CABG is especially higher in patients with risk factors for atherosclerosis and those who have ECG changes and normal EF. Knowledge of these risk factors is useful in the determination of CABG requirement and modification of risk factors for atherosclerosis may play an important role in reducing reintervention.

Key Words:

Coronary artery disease, Reintervention, Risk factors.

Introduction

As a treatment for coronary artery disease (CAD), coronary artery bypass grafting (CABG) has a 30 year history. The size of patient populations who undergo successful coronary revascu-

larization is constantly increasing and these populations are now also aging. In a proportion of these cases, symptoms often recur and necessitate reintervention. During the first 5 years following CABG, indications of reintervention were reported to occur in 3% of the cases as a result of early stage graft degeneration, stenosis, or incomplete revascularization. In the late stage, atherosclerosis progression in native coronary arteries and/or factors associated with late graft failure were reported as causes of reintervention^{1,2}. During 15 year follow-ups after surgery, recurrent ischemia in 62% of the patients, myocardial infarction in 36%, and coronary re-operation and percutaneous coronary intervention in 28% of the patients were reported^{3,4}. In the present study, our aim was to determine the predictors of reintervention in patients with symptoms emerging after CABG.

Patients and Methods

Patient Population

The data of 20000 patients who had coronary angiography (CAG) from 2003 to 2010 in our centre were retrospectively analysed. 485 of these patients with CABG who had CAG were included in this study. Demographic characteristics, the presence of coronary artery disease (CAD), risk factors for CAD, electrocardiographic (ECG) changes, troponin and CKMB levels, and left ventricular function were evaluated retrospectively in terms of time elapsed after CABG. The patients who had undergone percutaneous coronary intervention (PCI) after CAG and for whom re-operation was decided were recorded. The evaluations were made by catheter laboratory records, CAG reports, the hospital automation system, and patient files.

Diagnosis

The diagnosis of the patients were recorded as acute coronary syndrome (ACS) or stable angina pectoris (SAP) according to their complaints and clinical symptoms. Patients with a previous history of diabetes mellitus (DM) or patients newly diagnosed with DM when they were admitted to our clinic were included in DM group. Previously diagnosed patients and the group of patients who were diagnosed while on follow-up in our clinic were included in the hypertension (HT) group. To define smoking, smokers were considered to be those who smoked 1 cigarette a day. For positive family history, patients having at least one first- degree relative in whom CAD emerged at an early age (male < 55 years, female < 65 years) were included. ECG was graded in 2 groups: the first group consisted of patients without any ECG change, while the second group consisted of patients with ST-segment elevation, ST segment depression, and T negativity in at least 2 derivations associated with each other in ECG. ST-segment deviation (elevation or depression) was interpreted at 0.08 seconds after the J point. ST elevation was considered to be an upward deviation of the ST segment of at least 1 mm from the isoelectric line, whereas ST depression was viewed as a downward deviation of the ST segment of at least 1 mm from the isoelectric line. A troponin level of at least 0.1 µg/L was considered positive. CK-MB level above 25 U/L and a rise in total CK activity above 5% were considered positive. Ejection fraction (EF) grade was divided into two groups as > 50% and < 50%.

Statistical Analysis

Qualitative data were presented as mean ± standard deviation, whereas quantitative data were presented as percentage (%). All data were analyzed by using SPSS for Windows version 15.0 software (Chicago, IL, USA) in two stages. The first stage was univariate analysis and used chi-square test for the analysis of categorical data, whereas a Student's t-test was used to analyze continuous variables. In the second stage, a backward reduction modeling strategy was used. Backward elimination started with all of the variables in the model, and then, at each step, variables were evaluated for entry and removal. The score statistic was always used for determining whether variables should be removed from the model. A Wald statistic was used to select variables for removal (by default, 0.10). The size of

the effect of each of the risk factors was measured with an odds ratios (ORs) and 95% confidence intervals (CIs).

Results

485 patients with mean age 61.2 ± 9.2 years of 374 (77.1%) men who underwent CABG from 2003 to 2010 were studied and analyzed. A total of 423 patients (87.2%) were diagnosed with acute coronary syndrome, whereas 62 patients (12.8%) had stable angina pectoris. In total, 114 patients (23.5%) had ECG changes and 141 patients (29.1%) had positive troponin values. CK-MB levels of 129 patients (26.5%) were significantly increased. Overall, 173 patients (35.6%) had EF values < 50%, whereas 312 patients (64.4%) had EF values > 50%. Clinical characteristics of patients are shown in Table I. 307 patients underwent CAG (63.3%) only, whereas 165 patients underwent PCI (balloon angioplasty and/or stent application). The number of years elapsed for reintervention after CABG was 5.4 ± 3.6 years. In total, 121 patients underwent coronary reintervention with PTCA outside the grafted zones and 44 patients with grafted vessels. 13 patients were reoperated. Six of these had recurrent stenosis in the SVG, five had stenosis in the LIMA, 1 had left main coronary artery stenosis

Table I. Clinical characteristics of patients.

Age (years, mean ± SD)	61.2 ± 9.3
Male (%)	77.2
Diagnosis	
Acute coronary syndrome (%)	87.2
Stable angina pectoris (%)	12.8
Diabetes mellitus (%)	34.6
Smoking (%)	68.0
Family history (%)	13.6
Hypertension (%)	54.4
ECG change (%)	23.1
Troponin positivity (%)	29.1
CKMB elevated (%)	26.5
EF grade (< 50% and > 50%)	64.3
Cholesterol level (mg/dl, mean ± SD)	193.4 ± 44.7
LDL cholesterol level (mg/dl, mean ± SD)	124.7 ± 34.5
HDL cholesterol level (mg/dl, mean ± SD)	40.3 ± 8.7
Triglyceride level (mg/dl, mean ± SD))	173.7 ± 99.4
Number of years elapsed after CABG (year, mean ± SD)	5.4 ± 3.6
Reintervention (%)	36.7

ECG: Electrocardiography; CKMB: creatine kinase; EF: ejection fraction; LDL: low-density lipoprotein; HDL: high-density lipoprotein; CABG: coronary artery bypass grafting.

and 1 had stenosis in the LIMA-LAD anastomosis. Perioperative mortality was defined as death from any cause during the entire stay at either hospital. One perioperative death occurred, resulting in an overall mortality rate of 7.6%. The major complications for reoperation were renal failure (7.6%) and prolonged ventilation (7.6%).

When risk factors were assessed in terms of reintervention, this procedure was performed more frequently on those diagnosed with ACS compared to those diagnosed with SAP (39.0% vs 21.0%, $p = 0.006$); those with DM compared to those without (56.0% vs 26.5%, $p < 0.001$); smokers compared to non-smokers (46.1% vs 16.8%, $p < 0.001$); those with family history compared to those without (65.2% vs 32.2%, $p < 0.001$); those with HT compared to those without (61.0% vs 7.7%, $p < 0.001$); those with ECG change compared to those without (78.9% vs 21.4%, $p < 0.001$); patients with positive troponin value compared to those with negative troponin value (68.1% vs 23.8%, $p < 0.001$); those with high CKMB values compared to those with normal CKMB values (68.2% vs 25.3%, $p < 0.001$); and those with EF $> 50\%$ compared to those with EF $< 50\%$ (43.9% vs 23.7%, $p < 0.001$).

Although more reintervention was performed on patients with high total cholesterol levels, LDL levels, and TG levels compared to those with low levels, on patients with low HDL levels compared to those with high levels; on patients with long CABG time compared to those with short time, and on patients with a high number of vein lesions compared to those with low number, these differences were not statistically significant. On the other hand, no difference was found between the groups in terms of age and gender of the patients, in terms of reintervention. Risk factors of reintervention are shown in Table II.

Multivariate backward logistic regression analysis indicated that DM, smoking, family history, HT, ECG change, EF grade were predictors of reintervention (Table III).

Discussion

Patients with CABG were not sufficiently analysed in the clinical trials. Furthermore, in many studies the history of prior CABG operation was an exclusion criterion⁵⁻⁸. In recent literature most of these studies have analysed efficiency of the

Table II. Risk factors for reintervention.

Variables	Reintervention		<i>p</i> -value
	Yes (n: 178) N (%)	No (n: 307) N (%)	
Age	61.2 ± 9.3	61.4 ± 9.1	0.79
Female gender	41 (8.4)	70 (14.4)	0.95
Diagnosis			
Acute coronary syndrome	165 (34.0)	258 (53.1)	0.006
Stable angina pectoris	13 (2.6)	49 (10.1)	
Diabetes mellitus	94 (19.3)	74 (15.2)	< 0.001
Smoking	157 (32.3)	57 (11.2)	< 0.001
Family history	43 (8.8)	135 (27.8)	< 0.001
Hypertension	161 (33.1)	17 (3.5)	< 0.001
Operative Procedure			
Intra-aortic balloon pump	159 (32.7)	284 (58.5)	0.23
IMA grafting	145 (29.8)	262 (54.0)	0.26
Mean number of grafting	2.4 ± 0.94	2.3 ± 0.89	0.61
Troponin positivity	96 (19.7)	82 (16.9)	< 0.001
CKMB elevated	88 (18.1)	90 (18.5)	< 0.001
EF grade			
$> 50\%$	137 (28.2)	175 (36.1)	< 0.001
$< 50\%$	41 (8.4)	132 (27.2)	
Cholesterol level (mg/dl)	195.9 ± 46.5	190.7 ± 43.7	0.26
LDL level (mg/dl)	126.4 ± 35.7	123.2 ± 33.2	0.33
HDL level (mg/dl)	40.2 ± 8.1	40.3 ± 9.2	0.90
Triglyceride level (mg/dl)	175.9 ± 98.9	172.5 ± 100.5	0.71

ECG: Electrocardiography; CKMB: creatine kinase; EF: ejection fraction; LDL: low-density lipoprotein; HDL: high-density lipoprotein.

Table III. Multivariate backward logistic regression analysis in CABG patients who underwent coronary angiography with respect to reintervention predictors.

Variables	O.R. [95% C.I.]	p value
Diabetes mellitus	6.6 [3.5-12.3]	< 0.001
Smoking	5.5 [2.8-10.9]	< 0.001
Family history	4.1 [1.8- 8.9]	< 0.001
ECG change	8.5 [4.1-17.8]	< 0.001
Hypertension	19.3 [9.9-37.5]	< 0.001
EF > 50%	11.6 [4.1-17.8]	< 0.001

ECG: Electrocardiography; CKMB: creatine kinase; EF: ejection fraction.

medical treatment or compared patients with CABG to medically treated patients⁸⁻¹².

Although CABG surgery increases life expectancy and eliminates anginal symptoms in 15% cases that undergo this procedure needs reintervention¹³. Despite advances and innovations in both cardiopulmonary bypass (CPB) techniques and CABG techniques such as IMA (internal mammary artery) use, reasons such as incomplete revascularization, graft failure or degeneration, and native disease progression negatively affect the CABG results. In our study, we have investigated the predictors of the need for reintervention in 485 patients who underwent CAG after CABG in our center.

The most important result of our study was the determination of the predictors of the need for reintervention after CABG. These predictors were found to be coronary risk factors such as DM, smoking, family history, and HT. Although the percentage of reintervention is high in patients with high cholesterol, high LDL, low HDL, and high TG levels, these parameters were not found to be independent predictors of the need for reintervention. In the literature, some studies indicate that the rate of reintervention is high in patients with risk factors for atherosclerosis.

Sabik et al¹⁴ reported a high reintervention rate in patients with DM, low HDL, high cholesterol, high TG level and onset of CAD at young age.

Can et al. analysed patients with acute coronary syndrome after CABG and showed that reducing cardiovascular risk factor and increasing doses of treatment agent were effective on reducing mortality¹⁵.

In our work, the reintervention rate was 36.7%. In the literature, reintervention rates were reported as about 15-30% during a period of 5-10 years in follow-ups after CABG. In the case of 25 year fol-

low-ups, this rate was expected to be over 60%¹⁴. The characteristics, clinical features, surgery techniques, and the vein selected for CABG play a principal role in the need for reintervention.

Another important result of our study is that ECG changes, such as ST segment depression, ST segment elevation and T negativity, were independent predictors of reintervention. Other studies have indicated that ECG changes show the progression of atherosclerosis¹⁶. This situation also increases the rate of reintervention. On the other hand, cardiac biomarkers were not found as independent predictors, even though cardiac biomarkers (CK-MB, troponin) often reflect myocardial cell damage¹⁷. CK-MB and troponin levels are used in the diagnosis of unstable angina pectoris and myocardial infarction¹⁸⁻²⁰. In the literature, especially in studies evaluating perioperative ischemia after CABG, cardiac biomarker elevation was reported to be effective in showing a graft failure²¹. In long-term follow-up, this relationship was no longer evident.

An EF > 50% was an independent predictor of reintervention in our research, similar to previous results. Menkis et al²² showed that EF is an independent predictor for re-operation after CABG. This situation can be explained by the increased risk of reintervention in patients with low EF and the fact that these patients are more suitable for medical treatment. However, it is possible that the patients with lower EF died before reintervention was needed or performed.

Conclusions

Reintervention after CABG is common. The rate is especially high in patients with risk factors for atherosclerosis and those who have ECG changes and normal EF. It is useful to know these risk factors for the determination of CAG requirement. Modification of atherosclerosis risk factors may play an important role in reducing reintervention.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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