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Coronary artery bypass surgery in patients with low EuroSCORE preoperative risk

Research Article

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Abstract: Patients with EuroSCORE <2 are usually considered to have a low surgical risk and the lowest mortality. In our study preoperative factors in a group of 250 consecutive low-risk patients (EuroSCORE<2), who underwent first isolated coronary artery by-pass surgery during 1999 and 2000., were analyzed. Cumulative follow-up period was 1178.48 patient-years and the primary clinical outcome was all-cause mortality. Patients` average age was 59.2±7.5 yr. The following preoperative risk factors of increased 5-year mortality were identified: older age (P<0.001), smoking, prior non-recent myocardial infarction and reinfarction, anteroseptal localization of myocardial infarction (P<0.001), poor ejection fraction<=35% (P<0.001), dilatative cardiomyopathy (P<0.001), wall motion systolic index >2 (P<0.001), left atrial dilatation (P<0.001), mitral regurgitation more than 2+ (P<0.001), presence of left main disease, triple vessel coronary artery disease (P<0.001), absence of collaterals (P<0.001) and presence of more than 3 distal anastomoses. Through the present study it has been shown that it is possible to identify a subgroup of patients with low operative mortality and excellent 5-year survival after surgical treatment for coronary artery bypass surgery using preoperative clinical, echocardiographic, coronarographic and intraoperative data, even in difficult conditions of the civil war in the region.

Keywords: *Cardiac surgery • Coronary artery bypass • Preoperative risk prediction • EuroSCORE*

1. Introduction

The effect of the coronary artery by-pass surgery (CABG) is determined according to short- and long-term mortality [1-3]. Several risk calculation systems, for perioperative risk prediction in patients undergoing cardiac surgery, have been proposed [1-7]. The EuroSCORE risk system (European System for Cardiac Operative Risk Evaluation), developed in the late 1990s in Europe [4], is the most widely used and has a strong predictive value, evaluated through numerous studies in the US [1], Japan [7], and other countries [8,9].

EuroSCORE risk system identifies several factors of increased perioperative mortality: co-morbidities (renal failure, chronic obstructive pulmonary disease (COPD), peripheral arterial disease, neurological dysfunction disease and active endocarditis), cardiac related factors (critical state of the patient, recent myocardial infarction, -less than 90 days, pulmonary hypertension, severe left ventricular (LV) dysfunction) and operation-related factors (non-isolated CABG surgery, surgery on thoracic aorta and postinfarction septal rupture).

Patients with EuroSCORE <2 are considered to have low operative risk and the lowest mortality. High-risk patients have often been studied [8,9], but the number of studies on low-risk subgroup of patients is limited. Although nowadays PCI is successful in treatment of numerous lesions, that should have been surgically treated several years ago, some patients still are not eligible for PCI, but they are mostly eligible for CABG surgery [12].

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The aim of this study was to identify clinical, echocardiographic, and angiographic preoperative risk factors of the long-term 5-yr postoperative mortality in the group of patients with low preoperative risk- low EuroSCORE, in patients without co-morbidities.

2. Materials and methods

2.1 Subjects

From January 1999 to December 2000, 446 patients underwent primary isolated CABG at the Clinic for Cardio-Surgery, Clinical Center of Serbia, Belgrade, referral tertiary facility for cardiac surgery in Serbia. Operative mortality was 4.3% - nineteen patients died during postoperative in-hospital period.

Study exclusion criteria were:

A. Co-morbidities reported in previous studies as statistical bias of increased mortality (diabetes mellitus, renal and liver failure, chronic obstructive pulmonary disease (COPD), cerebral and peripheral arterial disease, neurological dysfunction disease and active endocarditis),

B. Cardiac related factors (critical state of the patient, unstable angina, recent myocardial infarction,-less than 90 days, pulmonary hypertension - >60mmHg)

C. Operation-related factors (concomitant valve surgery, emergency, surgery on thoracic aorta and postinfarction septal rupture)

2.2 Study design

Study methodology was approved by Institutional Review Board - Belgrade Faculty of Medicine Ethical Committee, by the principles embodied in the Declaration of Helsinki. Two hundred and fifty consecutive patients according to study criteria were enrolled in the retrospective study, collecting the data 60 months after the surgery. Written informed consent was provided for all patients included in study, given at the time of the data collection.

The planned follow-up period was 60 months. The primary clinical outcome of this study was all-cause mortality. The exact cause of death (cardiac or non-cardiac) could not be clearly obtained for all patients. The data of the patient's vital status and time of death were collected by the phone contact with patient or the close member of the family after follow-up period. Survival period was calculated according to months of life after CABG procedure.

According to vital status at the end of the follow-up period all patients were divided into a group of live patients – Group A and group of dead patients – Group D.

The analyzed preoperative and perioperative variables were: a) demographic and clinical characteristics (sex, age and risk factors for the ischemic heart disease: hypertension, history of current or past smoking – more than 5 years, obesity – body mass index BMI>30, hyperlipoproteinemia-HLP, heredity), previous non-recent myocardial infarction and reinfarction (more than 90 days before operation), myocardial infarction localization (anteroseptal, inferoposterior, inferior, lateral), Canadian Cardiovascular Society Functional Class -angina CASS class; b) echocardiographic factors: dilatative cardiomyopathy, left ventricular hypertrophy, left ventricle end-diastolic dimension (EDDLV), left ventricle end-systolic dimension (ESDLV), ejection fraction (EF), wall motion systolic index (WMSI), presence and severity of mitral regurgitation, left atrium dilatation, left ventricular septum and posterior wall thicknesses; c) coronarographic factors: left main disease, number of diseased arteries and presence of collateral arteries and finally, d) operative factors:, presence of arterial graft – mammary arterial graft, number of distal anastomoses.

Echocardiographic parameters were preoperatively measured according to the American Society of Echocardiography in referral echo-laboratory [13]. Standard echocardiography was performed using commercially available equipment with 2.0–4.0 MHz transducer. M-mode echocardiographic study of the left ventricle was performed under 2-D control. Left ventricular ejection fraction (EF) was calculated by cross sectional echocardiography devised by Teicholz *et al.* [13].

The extent of vessel disease was defined by the number of major coronary arteries with luminal narrowing ≥50% by visual estimation. Major coronary arteries included left anterior descending artery, left circumflex artery and right coronary artery.

2.3 Surgical technique

All patients had surgery using the standard cardiopulmonary bypass technique and standard cardioplegia. None of them was operated 'off-pump'.

2.4 Statistical analysis

The statistical Package for Social Sciences (SPSS) for Windows, version 12.0 was used for all analyses. The clinical characteristics of the patients are presented as mean ± SD for continuous variables and as percentages for categorical variables. Discrete data were analyzed using chi-square test and continuous data were analyzed using Student`s t-test. The impact of potential risk factors on the development of major complications and mortality after surgery was univariately analyzed with the chi-square statistic. In all tests, p value <0.05 was considered statistically significant.

3. Results

A total of 250 consecutive patients receiving first isolated CABG, with preoperatively calculated EuroSCORE risk less than 2 were retrospectively studied. Cumulative follow-up period was 1178.48 patient-years. Mean follow-up period in the group of patients who died during a 5-yr follow-up period was 2.25 ±1.4 years (27 ± 16.8 months), (minimum 1 month, maximum 58 months). During 60-months follow-up period 26 patients died and overall mortality was 10.4% (5-yr survival rate was 89.6%).

The demographic characteristics of examined population are shown in the Table 1. There was no difference in 5-yr mortality in male and female population. Older age was predictor of increased 5-yr mortality, *P*< 0.001.

The number of risk factors wasn't significant predictor of increased 5-yr mortality (*P*=0.588). Smoking was the most common risk factor in both groups and the only risk factor that had significant influence on the postoperative mortality, while others (heredity, hypertension, hyperlipoproteinemia and obesity) did not influence 5-yr mortality rate.

Prior non-recent myocardial infarction (*P*=0.003), anteroseptal localization (p<0.001) and reinfarction (*P*=0.018) were significantly more frequent in the group of patients who died during follow-up period. Anteroseptal localization was related to increased 5-yr mortality (*P*<0.001).

The greatest proportion of patients in both groups was in the CASS II angina stage. The preoperative CASS angina stage was not the predictor of increased 5-yr mortality (P=0.962).

3.1 Echocardiographic characteristics

Echocardiographic characteristics are shown in Table 2. Even 90.8% of investigated patients had ejection fraction (EF) more than 40%. EF greater than 40% was predictor of better 5-yr survival (P<0.001).

Left ventricular hypertrophy was without significance in mortality prediction (P=0.116).

Presence of dilatative cardiomyopathy (P<0.001), WMSI more than 2 (P<0.001), left atrial dilatation (P<0.001) and mitral regurgitation more than 2+ (P<0.001) were predictors of increased 5-yr mortality.

Patients who died during follow-up period had sig-

Table 1. The demographic characteristics of examined population.

Parameters	Group A (n =224)		Group D (n =26)		Overall (n =250)		*P value*
	No	%	No	%	No	%	
Sex							
Male	173	77.2	18	69.2	191	76.4	0.363
Female	51	22.8	8	30.8	59	23.6	
Age (yr)							
<50	30	13.3	0	0	30	12	
50-59	90	39.8	5	20.8	95	38	0.001**
60-69	96	42.5	20	83.3	116	46.4	
>70	10	4.4	1	4.2	11	4.4	
Risk factors							
Hypertension	150	67.0	20	76.9	170	68.0	0.303
Current or past smokers (> 5 years)	196	87.5	26	100.0	222	88.8	0.038*
Obesity (BMI>30)	59	26.3	10	38.5	69	27.6	0.191
HLP	185	82.6	19	73.1	204	81.6	0.236
Heredity	180	80.4	20	76.9	200	80.0	0.679
Prior non-recent MI	103	46.0	20	76.9	123	49.2	0.013*
MI localization							
Anteroseptal	30	29.4	11	55.0	41	33.6	
Inferoposterior	63	61.8	5	25.0	68	55.7	<0.001**
Apical	7	6.9	2	10.0	9	7.4	
Lateral	2	2.0	2	10.0	4	3.3	
Prior non-recent ReMI	14	6.3	5	19.2	19	7.6	0.018*
CASS classification							
II	16	7.1	2	7.7	18	7.2	
III	127	56.7	14	53.8	141	56.4	0.962
IV	81	36.2	10	38.5	91	36.4	

MI – myocardial infarction, Re-MI- myocardial reinfarction
*P value: * - <0.05, **-<0.01*

Table 2. Echocardiographic characteristicsof the patients.

Parameters	Group A (n = 224)		Group D (n = 26)		Overall (n = 250)		*P value*
	No	%	No	%	No	%	
EF							
>35%	210	93.8	17	65.4	227	90.8	
>50%	114	50.9	3	11.5	117	46.8	
46-50%	75	33.5	11	42.3	86	34.4	<0.001**
45-41%	14	9.4	3	11.5	24	9.6	
35-40%	14	6.3	9	34.6	23	9.2	
LVH	57	25.4	3	11.5	60	24.0	0.116
Dilatative cardiomyopathy	58	25.9	18	69.2	76	30.4	<0.001**
WMSI							
WMSI=1	119	53.1	6	23.1	125	50.0	
1<WMSI<2	87	38.8	9	34.6	96	38.4	<0.001**
WMSI ≥2	18	8.1	11	42.3	29	11.6	
MR							
Without or 1+	177	79.0	12	46.2	189	75.6	
2-3+	46	20.5	12	46.2	58	23.2	<0.001**
More then 3+	1	0.5	2	7.6	3	1.2	
LA dilatation	105	46.9	20	76.9	125	50.0	<0.001**

EF - ejection fraction, LVH – left ventricular hypertrophy, WMSI – wall motion segmental index , MR – mitral regurgitation, LA – left atrium
*P value: * - <0.05, **-<0.01*

Table 3. Mean values of patients' parameters.

Mean value of patients' parameters	Group A (n = 224)	Group D (n = 26)	*P value*
Age (yr)	58.63+/-7.57	63.84+/-4.31	0.001**
No of diseased vessels	2.44+/-0.68	2.85+/-0.37	0.003**
EDDLV (mm)	55.1+/-4.8	60.1+/-5.0	<0.001**
ESDLV (mm)	38.2+/-4.9	43.3+/-6.4	<0.001**
LA (mm)	38.1+/-3.6	41.7+/-4.7	<0.001**
EF (%)	52.6+/-9.0	43.2+/-9.8	<0.001**
PW (mm)	9.2+/- 1.2	9.2 +/-1.1.1	0.727
SS(mm)	9.5 +/- 1.5	8.9+/- 1.3	0.072
ECC (min)	80.6+/-19.6	86.2+/- 19.0	0.170
AC (min)	36.0+/-10.6	38.0+/-11.9	0.382
No of distal venous anastomoses	2.57+/-0.75	2.96+/-0.72	0.014*

EDDLV – left ventricle end-diastolic dimension, ESDLV - left ventricle end-systolic dimension, LA – left atrial dimension, SS – septum thickness, PW – posterior wall thickness, ECC –extra-corporal circulation time, AC- aortic-clamping time.
*P value: * - <0.05, **-<0.01*

Table 4. Angiographic characteristics of the patients.

Parameters	Group A		Group D		Overall		*P*
	No	%	No	%	No	%	
Left main disease	11	4.9	4	15.4	15	6.0	0.033*
No of diseased vessels							
1	11	4.9	1	3.8	12	4.8	<0.001**
2	81	36.2	3	11.5	84	33.6	
3	132	58.9	22	84.7	154	61.6	
Collaterals	122	54.5	3	11.5	125	50.0	<0.001**

*P value: * - <0.05, **-<0.01*

Table 5. Surgical characteristics of the patients

Parameters	Group A		Group D		Overall		P value
	No	%	No	%	No	%	
Arterial graft (mammary graft)	38	16.5	5	19.2	43	20.8	0.890
No of distal anastomoses							
1	16	7.1	0	0.0	16	6.4	
2	81	36.2	7	26.9	88	35.2	
3	111	49.6	13	50.0	124	49.6	0.007**
4	14	6.3	6	23.1	20	8.0	
5	2	0.9	0	0.0	2	0.8	

*P value: * - <0.05, **-<0.01*

Table 6. Mean survival time of different patients' categories

Parameters	Catagories	Mean survival (months)	Long Rank	*P value*
Age	< 60	58.8	10.43	0.013
	≥ 60	54.3		
Prior non-recent MI	Yes	54.5	8.95	0.017
	No	58.6		
Localization of prior MI	anteroseptal	50.2	15.52	<0.001**
	other	57.8		
Prior non-recent re-MI	Yes	48.7	6.65	0.023*
	No	57.2		
No of diseased vessels	One and two-vessel	58.9	9.09	0.035*
	Three-vessel	54.8		
Left main stenosis	No	56.8	4.69	0.038*
	Yes	52.1		
Colleterals	Yes	59.0	16.9	<0.001**
	No	54.1		
EDDLV	≤ 56 mm	59.2	13.09	<0.001**
	>56 mm	54.0		
ESDLV	≤ 41 mm	58.6	16.48	<0.001**
	>41 mm	52.9		
Dilatative cardiomyopathy	Yes	52.1	21.52	<0.001**
	No	58.5		
Ejection fraction	≤ 35%	57.5	25.89	<0.001**
	>35%	47.1		
WMSI	≥2	47.7	30.24	<0.001**
	<2	57.7		
Mitral regurgitation	1-2+	52.5	14.12	<0.001**
	2-3+ and 3+	57.8		
LA	≤ 40 mm	58.4	14.56	<0.001**
	> 40 mm	52.8		
No of distal anastomoses	≤ 3	57.0	7.90	0.029*
	≥ 4	51.4		

EDDLV – left ventricle end-diastolic dimension, ESDLV - left ventricle end-systolic dimension, LA – left atrial dimension, WMSI – wall motion segmental index.
*P value: * - <0.05, **-<0.001*

nificantly larger dimensions of EDDLV, ESDLV and LA and poorer left ventricular EF. However, there were no significant differences in left ventricular septum thickness and posterior wall thickness (Table 3).

3.2 Angiographic characteristics

Angiographic characteristics of patients are shown in Table 4.

Left main disease was a predictor of increased 5-ys mortality (*P*=0.033), as well as three-vessel disease (*P* <0.001) and presence of collateral arteries.

Mean number of diseased vessels was significantly bigger in the group D (*P*=0.003).

3.3 Surgical characteristics

Surgical characteristics of patients are shown in Table 5.

Arterial graft (mammary a. graft) was used only in 43 patients (20.8%), more frequently in group D, but it was not related to increased mortality rate.

Presence of more than 3 venous grafts was significant predictor of increased 5-yr mortality. (*P*=0.007). Mean number of venous grafts was also significant predictor of increased mortality (2.96+/-0.72 in group D, compared to 2.57+/-0.75 in group A, *P*=0.014)

3.4 Operative characteristics

The mean time on the extra-corporal circulation (ECC) was 89+/-15 min (range 22-127 min), and the mean duration of aortic cross-clamping (AC) was 56+/-13 min (range 18-79 min). Mean duration of ECC and AC were similar in both groups and these parameters did not influence mortality rate (Table 2).

Mean survival time in different patients` categories is presented in Table 6.

4. Discussion

The main goal of CABG is relief of symptoms of angina pectoris and prolongation of life expectancy [12]. There are a limited number of studies analyzing preoperative risk factors and long-term morbidity in low risk patients undergoing CABG. The study enrolled low-risk patients (EuroSCORE <2) undergoing the first isolated CABG. We identified clinical, echocardiographic, and angiographic preoperative predictors of the 5-yr postoperative mortality. Five-year mortality (10.5 %) was low. It was lower than reported in some other studies [9], but not surprisingly since our group was homogenous, consisting of low-risk patients without co-morbidities.

Mean patients` age in the study was similar to results of other investigators [3-9,14]. Our patients had multiple risk factors, with higher frequency compared to some other investigated groups [8]. However, risk factors except smoking (hypertension, hyperlipoproteinemia, heredity, obesity) were not predictors of increased 5-yr mortality, similarly to the investigations of Baslaim *et al.* [15].

The following preoperative risk factors for increased 5-year mortality were identified: older age, smoking, prior not-recent myocardial infarction, prior not-recent reinfarction, anteroseptal localization of MI, poor systolic function – EF<=40%, dilatative cardiomyopathy, WMSI>2, left atrial dilatation, mitral regurgitation more than 2+, presence of left main disease, three-vessel coronary artery disease and presence of more than 3 distal anastomoses.

Sex, CASS angina stage, left ventricular hypertrophy presence of arterial graft, ECC and AC duration were not predictors of increased 5-yr mortality.

Older age was an independent predictor of increased surgical mortality in the large study of Gopaldas *et al.* [16]. The same results were reported by some other investigators [8,17-19]. Although the patients in our group were younger, without comorbitidies, older age was even in low-risk patients an important predictor of increased 5-yr mortality.

Postoperative CABG mortality was not gender influenced. Analyzing a group of 1, 758 patients with primary isolated CABG surgery Sharoni *et al.* have also shown that female sex is not an independent risk factor of postoperative mortality [20]. On the other side, in older patients (aged > 80) female sex is identified as predictor of increased mortality [9].

In our study a large number of patients had prior non-recent MI. This proportion was higher than in other investigations [10,17]. Prior non-recent (MI) and its anteroseptal localization were important predictors of increased 5-yr mortality. Recent MI (less than 90 days prior to CABG) was determined as the predictor of increased perioperative mortality in EuroSCORE risk system prediction [1-7,17]. This study showed that even non-recent myocardial infarction was related to increased 5-yr mortality. Patients without myocardial infarction had better 5-yr survival, implicating that early diagnosis of coronary artery disease is of the highest importance for patients` life expectancy.

There was a great proportion of the patients with myocardial reinfarction, surprisingly different to other investigations. This could be use as a measure of a poor health service in that period, since our patients were operated during 1999, after a long period of very low socioeconomic level and specific organization of the public health service Our results are similar to the results of the surrounding population, suggesting the same problem of health service organization of that time [21].

Several echocardiographic factors have been identified as predictors of increased 5-yr mortality, all related to diminished left ventricular systolic function. Low EF as a predictor of increased mortality after CABG surgery has been identified in several other studies [8,17,22]. None of our patients had structural changes on mitral valve causing mitral regurgitation, but the mitral regurgitation was caused by mitral annulus dilatation, due to left ventricular remodeling. These results are similar to results of Goland *et al.* [23].

Left atrial dilatation was also identified as the predictor of increased 5-yr mortality. Since left atrium has not strong myocardial fibers, elevated end-diastolic pressure vastly results in left atrial dilatation. Thus, being the

consequence of elevated left ventricular end-diastolic pressure, left atrial dilatation relation to increased mortality can be understand as a relation of LVEDP to increased mortality. These findings are similar to the results of Qiu *et al.* [24].

Left ventricular hypertrophy did not influence 5-yr mortality, nor did CASS angina stage. Although Toumpoulis *et al.* [24] have shown that LVH did not influence in-hospital mortality, their results suggest that it influence survival 3 years after CABG, but in a group of patients with higher risk (EuroSCORE >7) and with numerous comorbidities related to LVH. Not similar to the findings of Sharoni *et al.* [20], in our patients ECC was not the predictor of increased mortality. This is probably due to small variations in ECC time between patients measured through similar mean values and small SD.

Left main disease was present in smaller proportion than in some other studies [14]. Presence of LM disease, triple vessel disease and use of more than 3 distal anastomoses are factors of increased mortality. All these factors are related to advanced complex coronary artery disease. Herman *et al.* also reported presence of LM disease and triple vessel disease as independent predictors of increased mortality [17]. On the other hand, in study of urgent CABG LM disease was not identified as factor of increased mortality, but triple vessel disease was important predictor of 10-yr mortality [8].

The use of arterial graft was not the predictor of increased mortality. This could be caused by relatively small proportion of arterial graft used in this group compared to other investigations and it should be evaluated in a bigger group of patients [26].

In the present study, we have shown that it is possible, using preoperative clinical, echocardiographic and coronarographic data as well as intraoperative data, to identify a subgroup of patients with low operative mortality and excellent 5-year survival after surgical treatment for coronary artery bypass surgery. New preoperative risk factors in a group of patients with low preoperative risk and without comorbidities were analyzed. The use of these risk factors would allow identification of a group of patients at risk prior to surgery and their better medical postoperative care.

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