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## Evaluations of factors affecting the outcome of redo coronary bypass surgery and long term results: A retrospective observational study

Redo koroner arter bypass ameliyatlarının sonuçlara etki eden faktörler ve uzun dönem sonuçların değerlendirilmesi: Retrospektif gözlemsel çalışma

Levent Altınay<sup>1</sup>, Ertan Demirdaş<sup>2</sup>, Ufuk Mungan<sup>3</sup>, Kıvanç Atılğan<sup>2</sup>, Erdem Çetin<sup>4</sup>, Ferit Çiçekçiöglü<sup>2</sup>

<sup>1</sup> Bulent Ecevit University, Faculty of Medicine, Department of Cardiovascular Surgery, Zonguldak, Turkey

<sup>2</sup> Bozok University, Faculty of Medicine, Department of Cardiovascular Surgery, Yozgat, Turkey

<sup>3</sup> Lokman Hekim Akay Hospital, Department of Cardiovascular Surgery, Ankara, Turkey

<sup>4</sup> Karabük University, Faculty of Medicine, Department of Cardiovascular Surgery, Karabük, Turkey

### Abstract

**Aim:** Advanced atherosclerosis of coronary arteries, existence of patent arterial grafts, redo sternotomy, shortage of available vascular conduits, difficulty of exploration of the coronary vessels are the factors that render the coronary reoperations challenging and they may be responsible of higher mortality and morbidity rates of reoperations. The aim of this study is to evaluate the factors that affect the progression of atherosclerotic coronary artery disease in the post-operative period of coronary artery bypass surgery which results in a redo operation.

**Methods:** A number of 115 patients who underwent coronary bypass re-operations between January 1997 and August 2007 were included. Patients were divided into two groups as follows: Group 1 was the risk factor positive group, Group 2 was the risk factor negative group. The time interval between the initial operative procedure and the redo operation was calculated and the effect of risk factors upon this time interval and the mortality rates were evaluated.

**Results:** The time interval between the first operative procedure and the reoperation was 77.31 months in Group 1 and 93.88 months in Group 2. Smoking had a more negative effect on the reoperation rate compared to the other risk factors ( $p=0.025$ ). Mortality rate was higher in the risk factor positive group ( $p=0.027$ ). Preoperative EF had a significant effect on the mortality rates ( $p=0.018$ ).

**Conclusion:** The presence of any risk factor for CAD increases the chance of having a reoperation. Off-pump surgery technique should be chosen in appropriate cases to lower the mortality risk of redo CABG operations and choosing the combined cardioplegia administration in on-pump redo coronary bypass operations would lower the mortality rate as well.

**Keywords:** Coronary artery bypass surgery, Vascular graft occlusion, Redo surgery

### Öz

**Amaç:** Koroner arterlerin ilerlemiş aterosklerozu, patent arteriyel greftlerin varlığı, redo sternotomi, muhtemel vasküler kondüitlerin kısalığı, koroner damarların eksplorasyonundaki zorluklar gibi faktörler koroner reoperasyonları zorlu hale getiren etkenler olup reoperasyonlarda gözlenen daha yüksek mortalite ve morbidite oranlarından sorumludurlar. Bu çalışmanın amacı redo koroner arter baypas greftleme (KABG) ameliyatlarında postoperatif dönemde aterosklerotik koroner arter hastalığının progresyonuna etki eden faktörleri değerlendirmektir.

**Yöntemler:** Ocak 1997 ve Ağustos 2007 tarihleri arasında redo KABG ameliyatı yapılan 115 hasta çalışmaya dahil edildi. Hastalar şu şekilde iki gruba ayrıldı: Grup 1 risk faktörü pozitif olan grup, Grup 2 risk faktörü negatif olan grup. İlk ameliyat ile redo ameliyat arasındaki süre ve bu süre üzerine etki eden risk faktörleri ile mortalite oranları değerlendirildi.

**Bulgular:** İlk ameliyat ile tekrarlanan ameliyat arasında geçen süre Grup 1'de ortalama 77,31 ay iken Grup 2'de 93,88 ay idi. Diğer risk faktörleri ile karşılaştırıldığında sigara kullanımı tekrarlayan ameliyat üzerinde daha güçlü bir negatif etkiye sahipti ( $p=0,025$ ). Risk pozitif olan grupta mortalite oranı daha yüksekti ( $p=0,027$ ). Preoperatif ejeksiyon fraksiyonu mortalite oranları üzerinde önemli bir etkiye sahipti ( $p=0,018$ ).

**Sonuç:** Koroner arter hastalığı ile ilgili herhangi bir risk faktörü varlığı redo KABG olasılığını artırmaktadır. Klinik tecrübelerimize dayanarak, redo KABG'nin mortalite oranlarını azaltmak için uygun olan vakalarda off-pump cerrahi tekniği tercih edilmelidir. Aynı zamanda on-pump redo KABG olgularında kombine kardiyopleji uygulaması mortalitenin azaltılmasına yardımcı olacaktır.

**Anahtar kelimeler:** Koroner arter baypas greftleme, Vasküler greft tıkanması, Redo ameliyat

### Introduction

Redo coronary artery bypass operations are technically more challenging than the initial bypass operations because of more serious conditions of the patients [1-3]. Advanced atherosclerosis is usually present in the existing vein grafts of these patients. Besides that, the native vessel coronary artery atherosclerotic disease (CAD) may be advanced too. Existence of patent arterial grafts, redo sternotomy, shortage of available vascular conduits, difficulty of exploration of the coronary vessels are the other factors that render the coronary reoperations challenging and they may be responsible of higher mortality and morbidity rates of reoperations [2,3].

Corresponding author / Sorumlu yazar:

Kıvanç Atılğan

Address / Adres: Bozok Üniversitesi, Tıp Fakültesi, Kardiyoasküler Cerrahi Anabilim Dalı, Yozgat, Türkiye

E-mail: kivancaatilgan@gmail.com

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The necessity of redo coronary bypass operations depends on multiple factors such as patient related factors, initial operation related factors, compliance of patients with preventive medical therapy after initial bypass surgery against progression of the CAD and the opinion of the surgeon about the benefits of the redo operation. Generally, the reoperation rates in the literature are 3% in the first postoperative 5 years, 10% in 10 years and 20% in 20 years [4]. This study was designed to evaluate the mortality rates and the risk factors that affect the progression of the CAD in the postoperative period of the coronary artery bypass graft (CABG) surgery.

**Materials and methods**

This retrospective observational study included 115 patients who underwent coronary artery bypass surgery and had coronary angiographic imaging between January 1997 and August 2007 in the Cardiovascular Surgery Clinic of Türkiye Yüksek İhtisas Hospital. The positivity of risk factors for CAD such as family history, smoking, diabetes mellitus (DM), hypertension (HT), hyperlipidemia (HL) and obesity was the criteria for including the patients into Group 1. The patients with no risk factors made up the Group 2.

Group 1 consisted of 88 patients in which 16 patients were female and 72 patients were male. The average age of the group was 58±8 years. Group 2 consisted of 27 patients in which four patients were female and 23 patients were male. The average age of the group was 60±11 years.

The time interval between the first operation and re-operation was calculated for each group and the effect of risk factors for CAD on this time interval and the mortality rate was evaluated. Mortality rates amongst the groups according to gender, preoperative ejection fraction (EF), intraoperative inotropic agent and intraaortic balloon pump (IABP) need were also compared.

The operation technique:

Twenty-two patients in Group 1 and 75 patients in Group 2 were operated using on-pump technique. Thirteen patients in Group 1 and 5 patients in Group 2 were operated using off-pump technique.

For the on pump technique, sternotomy was followed by aortocaval cannulation. The site of the aortic cannulation was decided by palpation. The plaque free sites were used for aortic cannulation. Cardiopulmonary bypass (CPB) was initiated by cooling the patient down to 32°C. After application of cross-clamp onto the aorta, the heart was arrested using antegrade and retrograde cardioplegia, and then the distal anastomoses were performed. The proximal anastomoses were performed using a side-biting clamp following defibrillation of the heart.

The off-pump procedures were performed without CPB and cross clamping the aorta. Stabilizers placed on the epicardium were used during the operations.

Patients with high levels of urea and creatine were hydrated and dopamine was administered (2.5 mg/kg per minute). The perfusion pressure was kept around 70 mmHg and hemofiltration was applied during the surgery when required. The patients regaining muscular power following surgery without severe left ventricular dysfunction and postoperative

hemorrhage were extubated generally within the first eight hours. Early mobilization was enhanced the next day following surgery.

**Statistical analysis**

The Statistical Package for Social Sciences (SPSS) for Windows Release 13.0 program was used for statistical analysis. The normality of the data was tested with Kolmogorov Smirnov test. Mann Whitney U test was used for the evaluation of non-parametric data. Pearson chi square test was used for intergroup comparison of the qualitative data. Arithmetic mean and standard deviation was calculated for descriptive statistics and measurable data. The p value of 0.05 and lower than 0.05 was accepted as statistically significant.

**Results**

The mean time interval between the initial operation and the reoperation was 77.31±6.07 months in the risk factors positive group (Group 1) and 93.88±13.9 months in the risk factors negative group (Group 2) (p=0.280). Thirteen out of 88 patients died (14.8%) in Group 1 and 10 out of 27 patients (37%) died in Group 2 (p=0.012). Age, gender and preoperative EF were found to have no effect on the time interval. Preoperative EF had a significant effect on the mortality rates (p=0.018). Twenty-three patients died in total and mean EF of these patients was 35±10% (Table 1).

Table 1: Factors affecting the mortality rates

	Mortality		p
	No (n=92)	Yes (n=23)	
Mean Age (years)	57±8	59±11	0.815
Gender			
Female	16	4	0.634
Male	76	19	
Mean EF (%)	50±8	35±10	0.018
Operation types			
On-pump	16	2	0.021
Off-pump	76	21	
Risk Factor			
Yes	75	13	0.012
No	17	10	

The types and numbers of grafts used for LAD bypass in reoperations were as follows: LIMA in 33 patients, RIMA in 29 patients, SVG in 52 patients and radial artery in 1 patient.

Smoking was found to be significantly affecting the reoperation time interval (p=0.025) (Table 2). Mean reoperation time interval for tobacco product consumers (36 patients, 31.3%) was 62.26±54.4 months. Mean reoperation time interval for non-smokers (79 patients, 68.7%) was 89.84±62.16 months.

Table 2: Reoperation time interval (months) according to risk factor positivity

Risk Factor	Group 1	Group 2	p
Family history of CAD	67 ± 51	86 ± 63	0.205
Smoking	63 ± 54	89 ± 62	0.025
Diabetes mellitus	76 ± 57	82 ± 61	0.779
Hypertension	85 ± 54	78 ± 65	0.298
Obesity	68 ± 54	82 ± 61	0.469
Hyperlipidemia	95 ± 55	77 ± 62	0.102

Table 3: Distribution of the number of the patients who need intraoperative inotropic support

		Group 1 (n=88)		p	Group 2 (n=27)		p
		Deceased			Deceased		
		Yes	No		Yes	No	
Inotropic agent	Yes	7	13	0.008	3	2	0.249
	No	6	62		7	3	
IABP	Yes	5	3	0.001	2	0	0.128
	No	8	72		8	17	

In Group 1, 20 (22%) out of 88 patients needed intraoperative inotropic agent support and 13 (14.7%) of them died (p=0.008). In Group 2, 5 (18.5%) out of 27 patients needed this support and three (11%) of them died (p=0.249). Eight (9%) out of 88 patients needed intraoperative IABP support and three

(3%) of them died in Group 1 ( $p=0.001$ ). Two (7%) out of 27 patients needed this support in Group 2 and 2 (7%) of them died ( $p=0.128$ ) (Table 3).

## Discussion

The patients may have repeating angina episodes or symptoms of acute coronary syndrome after coronary bypass grafting operations and may need an intervention for revascularization [5]. In a study, it was reported that 31% of the CABG patients needed a revascularization procedure in the postoperative period in a 12 years follow-up [6]. These symptoms of angina in the post-CABG period usually occur due to progressive atherosclerosis in the native vessels or bypass conduits [7].

The angina in the postoperative period may be stable or unstable. Burton et al. reported that unstable angina pectoris may be more common before the reoperation and 20% of the patients may even be asymptomatic [8]. In another study, this asymptomatic patient percentage was reported as 16% [9]. However, there is no significant difference among the mortality rates of symptomatic and asymptomatic patients [10]. In another study of Burton et al they stated that, as an angiographic indication for reoperation, 80% of the patients had coronary bypass graft disorder, 12% had native vessel atherosclerosis besides coronary bypass graft disorder, 8% had solitary native vessel atherosclerosis [8]. Although vein graft occlusions are usually due to atherosclerosis [11,12]; intimal hyperplasia, thrombosis because of thrombocyte dysfunction in the intimal injury site, calcifications in the fatty plaques in the long term period may also back up the graft occlusion process [13]. In support of autopsy findings and bypass graft biopsy findings Qureshi et al reported that 71% of the patients had graft atherosclerosis in postoperative 6-12 years period [14]. The pathology of native vessel and bypass graft atherosclerosis may be the same but atherosclerosis in grafts progresses more rapidly [11] and these atherosclerotic lesions are more fragile and instable in nature [8].

The patency rates of bypass grafts may positively be affected by older age, low serum cholesterol levels, low thrombocyte count (although it slightly affects) and acetylsalicylic acid administration after CABG surgery. Smoking, hyperlipidemic, low EF, family history of CAD and diabetes mellitus were reported to affect negatively the graft patency rates in some studies [15] but in contrast of this, Goldman et al reported that insulin dependent DM and smoking have no effect on the graft patency rates [16]. In some other studies, it is reported that continuous smoking in male patients after first CABG operation increases the graft atherosclerosis and occlusion rates [8]. Life style changes and anti-hyperlipidemic medications may suppress the progression of the atherosclerotic lesions as well as decrease their extensity and size [17,18]. Also in 4S (Scandinavian Simvastatin Survival Study) it is reported that anti-hyperlipidemic therapy reduces the mortality of the coronary disease by 42% and general mortality by 30% [19]. In this study, we found that smoking increases the risk for the need of a reoperation and ventricular dysfunction and positivity of a risk factor for CAD increases the mortality rates.

The survival rates after reoperations are worse than primary operations. Weintraub et al reported that survival rates 5 years and 10 years after the reoperation were 76% and 55% respectively [20]. Loop et al [21] reported that 10 years survival rate was 69% in their study. The factors worsen the survival rates after reoperations could be listed as follows: left ventricle (LV) dysfunction, age, continuous smoking, hypertension, left main coronary artery (LMCA) lesion  $>50\%$ , three-vessel disease, New York Heart Association (NYHA) class III/IV symptoms, peripheral vascular disease, absence of IMA graft in the primary operation and preoperative kidney failure [21,22]. In the literature it is reported that IMA graft has a positive effect on the late survival rates of reoperations but not as dramatic as the in the primary operation [23].

The state of the patients having more than one reoperation is nearly the same as the patients having first reoperation but in-hospital mortality rates of these patients are moderately higher [24,25]. In a 13 years follow-up of 4518 patients who have more than one reoperations, it is reported that in-hospital mortality rate in the first reoperation was 4.3%, in the second reoperation 5.1% and in the third reoperation was 6.4%. In the same study, the mortality rates after 5 and 10 years were reported as 84% and 66% respectively. The age of the patient is accepted to be the most important factor affecting the late mortality rate of the reoperation. In-hospital mortality of the patients younger than 70 years is reported as 1-2% but it is about 10% in the patients older than 70 years [26].

In a study published by Usta et al [27], which they compared the surgical results of on-pump and off-pump redo coronary bypass surgery, it was reported that mortality rates, postoperative drainage, operation time, intensive care unit time, perioperative myocardial infarction rates were significantly lower in off-pump group compared to on-pump group. In our study, we found that mortality rates were significantly lower in off-pump group similar to that study. But we think that lower case number in off-pump group would have an effect in that result. In another study, the mortality rate was found to be higher when cardioplegia was administered antegrade compared to combined cardioplegia administration [28].

Sabik et al [26] reported that the impaired left ventricle function and presence of diffuse coronary vascular disease increased the mortality rate. In our study, we found that diffuse coronary artery disease and low left ventricle ejection fraction, increased the mortality rate similar to the literature.

It is important to decide when to refer the patients to reoperation as advancements in the percutaneous revascularization techniques can provide an easier and less risky revascularization process. Thus if there is late stenosis in the grafts ( $\geq 5$  years), multiple stenotic vein grafts, diffuse atherosclerosis in vein grafts, a stenotic vein graft on the LAD, stenotic IMA grafts and LV dysfunction, it is suggested that these patients should be referred to surgical treatment [any reference?].

The intraoperative need for inotropic agent or IABP support may be an indicator of impaired LV functions, incomplete revascularization in the primary operation or impaired graft patency [15]. In a study conducted on 289 reoperation patients, 6% of these patients needed postoperative

IABP support, 52% of them needed postoperative inotropic agent support and the postoperative mortality rates in the first 30 days was reported as 6.6% [29]. We found higher mortality rates in patients who needed IABP or inotropic agent support in favor of these findings.

#### Conclusion

The presence of any risk factor for CAD increases the chance of having a reoperation. The correlation between low left ventricle ejection fraction, operation technique, administration way of cardioplegia, presence of diffuse coronary vascular disease and postoperative mortality rate in redo coronary bypass surgery was presented in many studies. In conclusion, we think that off-pump surgery technique should be chosen in appropriate cases to lower the mortality risk of redo coronary bypass operations. In addition, we think that choosing the combined cardioplegia administration in on-pump redo coronary bypass operations would lower the mortality rate.

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