Emergency management for acute left main coronary artery total occlusion

Akut sol ana koroner arter tıkanıklığına acil yaklaşım

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Background: In this study, we described the survival rates of patients who underwent myocardial revascularization for acute left main coronary artery occlusion.

Methods: Thirty-two consecutive patients who underwent surgical revascularization for acute left main coronary artery occlusion (26 males, 8 females; mean age 62.9±10.9 years; range 34 to 82 years) were included in this study. The preoperative clinical and demographic variables and postoperative follow-ups were collected retrospectively to detect predictors of outcome and risk-adjusted survival rates of the patients.

Results: Early mortality was 37.5% with 12 patients. Early mortality rate was found significantly higher in patients above 65 years of age [OR 4.667 (1.0-21.65)] and patients with retrograde collateralization from the right coronary artery [OR 4.667 (1.01-21.65)]. Female gender [OR 1.889 (0.31-11.34)], diabetes mellitus [OR 2.692 (0.45-15.87)], hypertension [OR 1.615 (0.32-7.98)] and intraaortic balloon pump usage [OR 4.500 (0.67-29.80)] were not found as significant risk factors for early mortality (p>0.05).

Conclusion: Although the early mortality rate is high, surgical revascularization is still the standard treatment approach in patients with acute left main coronary artery occlusion. In patients with hemodynamic instability and without good collateral flow from right coronary artery, percutaneous intervention may be performed as a bridge to surgery.

Key words: Acute left main coronary artery occlusion; coronary artery bypass grafting; early mortality; emergency management.

Amaç: Bu çalışmada akut sol ana koroner arter tıkanıklığı nedeni ile miyokardiyal revaskülarizasyon yapılan hastaların sağkalım oranları tanımlandı.

Çalışma planı: Bu çalışmaya akut sol ana koroner arter tıkanıklığı nedeni ile cerrahi revaskülarizasyon yapılan 32 ardışık hasta (26 erkek, 8 kadın; ort. yaş 62.9±10.9 yıl; dağılım 34-82 yıl) dahil edildi. Hastalara ilişkin sonuç öngöstergelerinin ve riske göre ayarlanmış sağkalım oranlarının tespit edilmesi amacıyla ameliyat öncesi klinik ve demografik değişkenler ve ameliyat sonrası takip verileri geriye dönük olarak toplandı.

Bulgular: Erken mortalitenin 12 hasta ile %37.5 olduğu tespit edildi. Altmış beş yaş üzeri hastalarda [OR 4.667 (1.0-21.65)] ve sağ koroner arterden retrograd kollateralizasyona sahip olan hastalarda [OR 4.667 (1.01-21.65)] erken mortalite oranının anlamlı ölçüde daha yüksek olduğu saptandı. Kadın cinsiyet [OR 1.889 (0.31-11.34)], diabetes mellitus [OR 2.692 (0.45-15.87)], hipertansiyon [OR 1.615 (0.32-7.98)] ve intraaortik balon pompa kullanımının [OR 4.500 (0.67-29.80)] erken mortalite açısından anlamlı risk faktörleri olmadığı saptandı (p>0.05).

Sonuç: Erken dönem mortalite yüksek olsa da, akut sol ana koroner arter tıkanıklığı olan hastalarda cerrahi revaskülarizasyon hala standart tedavi yaklaşımıdır. Hemodinamik instabilitesi bulunan ve sağ koroner arterden kollaterale sahip olmayan hastalarda, perkütan girişim cerrahiye köprü amaçlı uygulanabilir.

Anahtar sözcükler: Akut sol ana koroner arter oklüzyonu; koroner arter bypass greftleme; erken mortalite; acil yaklaşım.

Acute left main coronary artery (LMCA) occlusion is rare but often fatal. Despite the crucial anatomic location of the occlusion and its severe interference with the left ventricular function, clinical presentation may vary considerably. It usually manifests as an acute myocardial infarction with cardiogenic shock and/or fatal arrhythmias. This circumstance is rarely observed, as most affected patients die before seeking medical attention.[1,2]

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On the other hand, chronic total occlusion of the LMCA is considered to be very rare,[3,4] because patients with this lesion can survive when good collaterals have been developed from the right coronary artery (RCA). Some investigators have reported that this condition represents only 0.04-0.4% of the patients with coronary artery disease.[5] The reported angiographic incidence varies from 0.03% in 20.332 patients in the Medical College of Virginia experience to 0.06% in 20.197 patients in the coronary artery surgery study (CASS).[6,7]

The purpose of this study is to delineate the survival rates of patients with acute LMCA occlusion who underwent myocardial revascularization. We examined the survival outcome of 32 patients with LMCA occlusion after their first revascularization procedures [Coronary artery bypass graft (CABG) operation], at our institution. Preoperative clinical and demographic variables were examined to detect predictors of outcome, and risk-adjusted survival rates of CABG operation in patients with LMCA occlusion.

PATIENTS AND METHODS

Patient population

The study was retrospective and non-randomized. Institutional database was used to identify patients who underwent CABG operation as their first revascularization procedure between January 2002 and December 2006.

During this period a total of 62.236 patients underwent diagnostic coronary angiography. Percutaneous transluminal coronary angioplasty (PTCA) was performed on 18.227 and 9.499 patients who underwent surgical myocardial revascularization. Among them, 32 patients (6 females, 26 males; mean age 62.9±10.9 years; range 34 to 82 years) had acute LMCA occlusion (0.05%). Patients were operated on by different surgeons but with the same myocardial protection method according to our hospital policy. Myocardial protection was maintained with 28 °C systemic hypothermia, antegrade and retrograde cold blood cardioplegia. The preoperative clinical and demographic variables and post procedural follow-ups were collected retrospectively to detect predictors of outcome, and risk-adjusted survival rates of CABG in patients with acute LMCA occlusion.

The demographic and clinic parameters that were previously demonstrated as risk factors for myocardial revascularization were obtained from the database and their predictive effects on outcome were analyzed.

Statistical analysis

Numerical parameters were described with mean and standard deviations while the distribution of categorical measurements was analyzed according to frequency and percentages. Chi square test was used in univariate assessment by classifying numerical parameters among our study parameters. Odds ratios were calculated by estimated risk measurements.

Significant parameters or nearly-significant parameters found on univariate analysis were evaluated with logistic regression analysis among multivariate analysis for early mortality and risk factors effective on total mortality. Here, mortalities were coded as 1 and alive cases as 0. As a result of this procedure, independent risk factor effects on mortality were determined.

Survival analysis was performed by Kaplan Meier method. Assessments were performed with log-rank test in survival analysis performed according to the treatment options. The results were evaluated with 95% confidence interval and at a significance level of $p<0.05$. Number Cruncher Statistical System (NCSS, Kaysville, Utah USA 2007) and Power Analysis and Sample Size (PASS, Kaysville, Utah, USA 2008) statistical software program was used for statistical analysis.

RESULTS

Demographic data of 32 patients who underwent CABG for acute LMCA occlusion are summarized in table 1. Risk factors for early mortality are expressed in table 2. Early mortality was 37.5% with 12 patients. Early mortality rate was found significantly higher when the age of the patient was above 65 [$p<0.05$, OR 4.667 (1.0-21.65)]. The effect of female gender [OR 1.889 (0.31-11.34)], diabetes mellitus [OR 2.692 (0.45-15.87)] and hypertension [OR 1.615 (0.32-7.98)] was not found as significant risk factors for early mortality ($p>0.05$). The mortality rate was found

Table 1. Demographic findings of the patients

	n	%
Age ≥65	14	43.8
Gender		
Female	6	8.8
Male	26	81.3
Diabetes mellitus	23	71.9
Hypertension	22	68.8
Ejection fraction ≤40 with risk	27	90.0
Inotropic support	22	68.8
Intraaortic balloon pump	6	18.8
Acute coronary syndrome	24	75.0
Pulmonary edema	4	12.5
Ventricular fibrillation	1	3.1
ACS+pulmonary edema	3	9.4
Cardiopulmonary resuscitation	7	21.9
Early mortality	12	37.5

ACS: Acute coronary syndrome.

higher in patients with retrograde collateralization from the right coronary artery p<0.05, OR=4.667, range 1.01-21.65).

The EF of the patients with early mortality was below 50% in all patients. Also, the EF was also below 50% in most of the patients who survived (84.2%). The EF was not found as a significant risk factor (p>0.05) although the risk could not be calculated because all of the early mortalities had EFs below 50%.

Inotropic support was used in all of the patients with early mortality, but 50% of the survivors also received inotropic agents and this was found to be statistically significant. Because inotropic support was used in all of the patients with early mortality, the risk could not be calculated.

Early mortality was present in four of the patients who had IABP. Only two patients survived after CABG. However, IABP use was not found as a significant risk factor for early mortality (p>0.05, OR= 4.500; range 0.67-29.80).

All of the patients who experienced CPR in the catheterization laboratory prior to surgery died and CPR was found as a highly significant risk factor for early mortality after CABG, but the risk could not be calculated either.

The mortality rate of total emergency CABG operations in our hospital was 11.6% (33/284) and 37.5% (12/32) in our patient group. This was found statistically highly significant (p=0.001, p<0.01). The mechanism of early mortality in this group of patients was poor left ventricular function and myocardial failure.

Survival analysis

Thirty-two patients with acute total left main coronary artery occlusion were studied. In this group, the early mortality rate was 37.5% (12/32). Twenty patients survived (62.5%). Mean survival time was 34.1±4.8 months. The latest mortality was seen in the second postoperative month and the cumulative survival rate was 61.7% with a standard error in this month of 8.7% (Fig. 1).

Four patients had cardiac arrest and were excluded from the survival analysis. Eighteen patients underwent surgery and eight patients survived (44.4%); the mean survival time was 28.4±6.0 months. The latest death was seen in the 52nd month and the cumulative survival rate was 25% and standard error was 18.6% in this month (Table 3).

Among the 10 patients on whom surgery was not performed (medical treatment or elective), two patients survived (20%); mean survival time was 7.2±2.9 months. The latest death was seen in the 20th month and the cumulative survival rate was 12.8% with a standard error in this month of 2.9% (Table 3; Figure 2).

When survival rates for emergency operations were evaluated with log-rank test, the survival rates were not found to be statistically significant (p=0.137; p>0.05).

When we examined the risk factors which affect the early mortality rates by univariate regression analysis, we found that the risk of early mortality was increased by 4.6 times in patients older than 65 years

Table 2. Risk factors for early mortality

	Early mortality					OR (%95 CI)	
	Yes (n=12)		No (n=20)		*p*•		
	n	%	n	%			
Age >65	8	66.7	6	30.0	0.043*	4.667	(1.00-21.65)
Gender							
Female	3	25.0	3	15.0	0.647	1.889	(0.31-11.34)
Diabetes mellitus	10	83.3	13	65.0	0.264	2.692	(0.45-15.87)
Hypertension	9	75.0	13	65.0	0.555	1.615	(0.32-7.98)
Retrograde	8	66.7	6	30.0	0.043*	4.667	(1.01-21.65)
Ejection fraction ≤50 risk (+)	12	100.0	16	84.2	0.279	–	–
Inotropic support	12	100	10	50.0	0.003**	–	–
Intraaortic balloon pump	4	33.3	2	10.0	0.165	4.500	(0.67-29.80)
Acute coronary syndrome	6	50.0	18	90.0	0.011*	0.111	(0.018-0.71)
Pulmonary edema	3	25.0	1	5.0	0.136	6.333	(0.57-69.68)
Ventricular fibrillation	–	–	1	5.0	1.000	–	–
Acute coronary syndrome+pulmonary edema	3	25.0	–	–	0.044*	–	–
Cardiopulmonary resuscitation	7	58.3	–	–	0.001**	–	–

p•: Chi square test, Fisher's exact test; OR: ODDS Ratio; CI: Confidence interval; *: p<0.05; **: p<0.01.

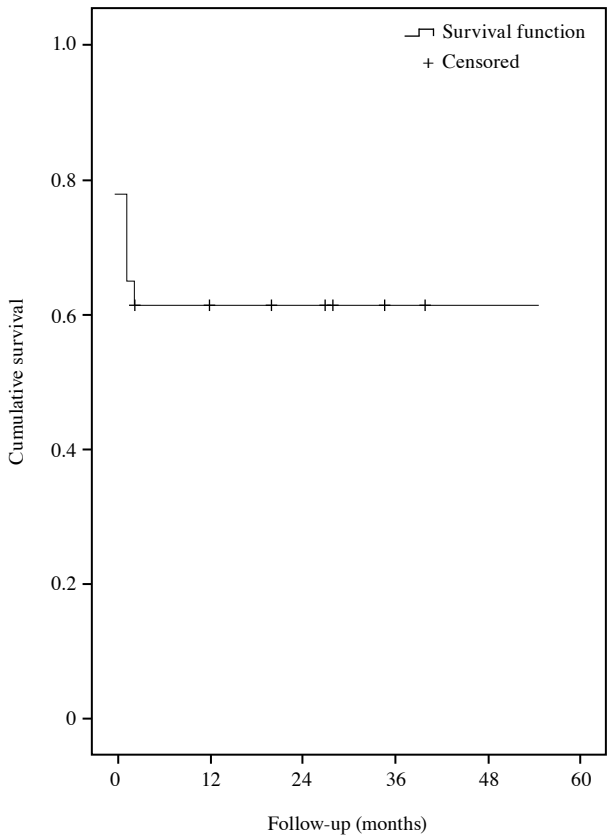

Fig. 1. Survival of all patients.

of age, by 2.7 times in diabetic patients, by 1.6 times in hypertensive patients, by 4.5 times in patients with IABP and 6.3 times in patients with pulmonary edema.

DISCUSSION

Obstruction or stenosis of the left main coronary artery is a very serious problem. Acute LMCA occlusion is almost invariably fatal, since the myocardium in jeopardy may be 70% to 95% of the entire left ventricular muscle mass, depending on the dominance of the circumflex artery's distribution. However, if obstruction of the left main coronary artery occurs chronically, allowing time for collateral-flow channels to develop, survival after total occlusion is indeed possible.

Treatment approaches described in publications include balloon pumping, intracoronary thrombolysis, PTCA, and emergency CABG operation.[8] Coronary artery bypass graft operation has been regarded as the treatment of first choice for chronic LMCA occlusion, although some cases are known to survive several years without CABG operation.[9] Nevertheless, some investigators suggested poor visualization of the distal left coronary arteries due to poor dye opacification at coronary arteriography as a potential problem.[7] Recently, chronic total occlusion of the coronary artery has been recognized as a target of coronary intervention. Some investigators have attempted to perform percutaneous coronary intervention (PCI) on the total LMCA occlusion when the left coronary arteries were protected by CABG operation or good collaterals[10] or even when unprotected.[11] However, no consensus has been obtained on the safety and effectiveness of interventional procedures on the left main lesions, especially for the chronic total LMCA occlusion, because, the analysis of cardiac-catheterization-related mortality has repeatedly revealed that severe left main disease is the predominant contributing factor. The Coronary Artery Surgery Study (CASS) noted a seven-fold increase in risk of death in the presence of LMCA disease[7] and other investigators have detected LMCA disease in 46% to 75% of cardiac catheterization related deaths.[12] However, the literature has revealed a growing number of such patients who survived with the aid of early reperfusion[2] most of whom underwent CABG operation as well. Although PCI alone may be effective in some patients with left main shock syndrome, subsequent CABG operation is almost always necessary in order to achieve complete revascularization and to improve the probability of survival. Yip et al.[1] reported 55.2% survival by PCI. Nowadays, it is generally accepted that the most common cause of LMCA stenosis is arteriosclerosis affecting particularly the mid-part and distal bifurcation; often associated with two-vessel or three-vessel disease and isolated stenosis of the ostium and first third of the LMCA has a prevalence of only 1 percent.[13]

Coronary artery bypass graft operation is an excellent treatment for LMCA stenosis but has some

Table 3. Survival analysis for emergency operations (n=28)

Emergency surgery	n	Dead	Survived	Survived rate	Cumulative survival		Mean survival time
					Mean	Std. error	
				(%)	(%)	(%)	Mean±SD
Surgery (+)	18	10	8	44.4	25.0	18.6	28.41±5.98
Surgery (–)	10	8	2	20.0	15.0	12.8	7.20±2.88

SD: Standard deviation.

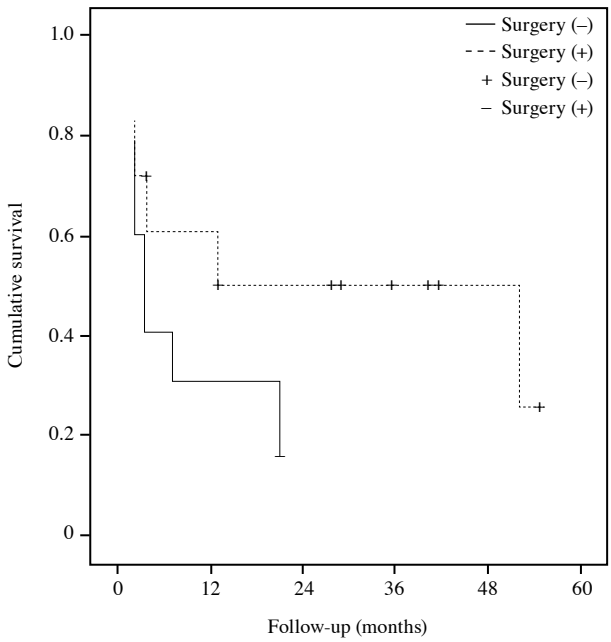

Fig. 2. Survival of surgery patients.

potential limitations, such as complete graft-dependent perfusion because of progressive occlusion of the LMCA and the risk of arteriosclerotic changes of the graft or occlusion of the grafts.[14,15] Nevertheless, functional status was greatly improved by surgery in surviving patients.[16] It has also been suggested that retrograde perfusion of a large area of the myocardium would be suboptimal.[9] Therefore, there is a growing experience in interventional procedures on left main coronary artery lesions for early myocardial revascularization.

In our clinic, 32 patients with acute LMCA occlusion underwent CABG for myocardial revascularization. Twelve out of 32 patients died during the early period and the early mortality rate was 37.5 percent.

In our hospital, the patients who received PTCA were in cardiogenic shock and there was not enough time to transfer the patients to the operating room to perform emergency surgery so the comparison of two groups may not be optimal. The patients who received PTCA were high-risk group with low EF, high pulmonary artery pressures and all in cardiogenic shock; which were limitations for ideal comparison of our study. It may also be due to the willingness of physicians to refer predominantly high-risk patients for intervention to our hospital because our hospital serves as a regional referral center for community hospitals.

American Heart Association guidelines state that PCI for LMCA stenosis is contraindicated and CABG operation is required.[17] Some studies have shown PCI for LMCA disease can be performed at highly experienced centers for high-risk patients who are not candidates for bypass surgery.[11,18]

Although the procedure is technically feasible, the long-term mortality rate and the incidence of repeat coronary angioplasty or CABG operation are still high. Therefore, it is unlikely that percutaneous coronary angioplasty will replace CABG operation in the treatment of unprotected LMCA occlusion. The restenosis rate of either elective or primary LMCA stenting may remain high, and the clinical impact of restenosis after LMCA stenting may present more serious complications, such as acute pulmonary edema, malignant arrhythmia, or sudden death so the many authors suggested CABG operation after survival from the acute phase.[16-18] Yip et al.[1] reported mortality rates up to 22% for subsequent CABG following PCI, 33% in-hospital, 11% after discharge and 55% for long-term survival in the case of total or subtotal LMCA occlusion. Given the fact that these patients are at high risk, we believe LMCA total occlusion is a surgical emergency requiring immediate intervention and should not be delayed. While the patients may maintain hemodynamic stability in case of right coronary artery collateral and/or retrograde blood supply, sudden deterioration might occur and intraaortic balloon pump assistance and high inotropic support may be mandatory. Cardioprotection during operation has a key role for such critical patients thus; coronary venous retroperfusion should be administered.[19]

Another limitation of our study was the number of patients, because of the low incidence of acute LMCA occlusion who survived until a revascularization procedure. Although it is very difficult to conduct a randomized trial in such patients, larger series of patients from different institutions and their meta-analyses may provide chances for better evaluation.

These results demonstrated that CABG operation should be still the technique of choice for myocardial revascularization in patients with LMCA occlusion. Emergency CABG operation may save the patient's life in cases of acute LMCA occlusion, enable myocardial salvage and improve the functional status. However, the patients without good collaterals from the right coronary artery and with severe hemodynamic instability may have to receive PCI stenting to bridge to operation. We believe fast-track evaluation of these patients and transfer to surgery in the early period after PCI stenting may significantly reduce the mortality and morbidity.

Declaration of conflicting interests

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