Results of Isolated Emergency Coronary Bypass Surgery According to Acute Coronary Syndrome

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ABSTRACT

Introduction: The aim of the present study was to evaluate the results of isolated emergency coronary artery bypass grafting (CABG) according to acute coronary syndrome (ACS) types in a single center with 5-year experience.

Patients and Methods: A total of 138 patients who underwent emergency isolated CABG surgery from September 2009 to July 2014 in our hospital were enrolled in this retrospective descriptive study. The cohort was divided into four groups according to the type of ACS: (1) unstable angina (USAP) (n= 14, 10.1%), (2) non-ST segment elevated myocardial infarction (NSTEMI) (n= 43, 31.2%), (3) ST segment elevated myocardial infarction (STEMI) (n= 65, 47.1%), and (4) cardiogenic shock (SHOCK) (n= 16, 11.6%). There were three co-primary outcomes in the study: (1) in-hospital and 30-day mortality rate results, (2) mortality analysis according to subgroups, and (3) to assess the performance of European System for Cardiac Operative Risk Evaluation (EuroScore) II in patients with ACS who underwent emergency isolated CABG.

Results: No significant differences were observed between the groups with regard to demographic and preoperative risk factors. The observed 30-day total mortality rate was 15.9% (n= 22). Mortality rates in the subgroups were 7% (n= 1) in USAP, 4.65% (n= 2) in NSTEMI, 15.38% (n= 10) in STEMI, and 68.75% (n= 11) in SHOCK, respectively. There was a significant difference in mortality between the groups ($p< 0.05$). The receiver operating characteristic curve value of EuroScore II was 0.890 (95% Confidence Interval, 0.826-0.937).

Conclusion: The current study demonstrates that the observed mortality rate for STEMI and SHOCK patients requiring emergency CABG remains high. Moreover, EuroScore II has a good risk prediction in NSTEMI patients while significantly underestimates the mortality in the other groups.

Key Words: Acute coronary syndrome; coronary artery bypass grafting; emergency surgery; outcome; EuroScore II

Akut Koroner Sendrom Tipine Göre Acil İzole Koroner Baypas Cerrahisinin Sonuçları

ÖZET

Giriş: Bu çalışmada, akut koroner sendrom (AKS) tiplerine göre izole acil koroner baypas (KABG) sonuçlarının tek merkezde beş yıllık tecrübeyle değerlendirilmesi amaçlanmıştır.

Hastalar ve Yöntem: Eylül 2009 ile Temmuz 2014 tarihleri arasında KABG yapılan toplam 138 hasta bu çalışmaya retrospektif yöntemle dahil edilmiştir. Kohort AKS tipine göre dört gruba ayrılmıştır; 1: Unstabil anjina (n= 14, %10.1); 2: non-ST segment yükselmeli miyokart infarktüsü (NSTEMİ) (n= 43, %31.2); 3: ST segment yükselmeli miyokart infarktüsü (STEMİ) (n= 65, %47.1); 4: Kardiyojenik şok (n= 16, %11.6). Çalışmanın üç esas amacı vardır; hastane içi ve 30 günlük erken mortalite sonuçlarının tespiti, alt gruplara göre mortalite oran analizi, acil izole KABG uygulanan AKS hastalarında EuroScore II'nin performansının değerlendirilmesi.

Bulgular: Gruplar arasında demografik ve preoperatif risk faktörleri açısından anlamlı fark bulunmadı. Gözlenen 30 günlük toplam mortalite oranı %15.9 (n= 22) idi. Alt gruplarda mortalite oranları sırasıyla; stabil olmayan anjina (USAP)'da %7 (n= 1), NSTEMİ'de %4.65 (n= 2), STEMİ'de %15.38 (n= 10) ve şok alt grubunda %68.75 (n= 11) idi. Gruplar arasında mortalitede anlamlı fark vardı ($p< 0.05$). EuroScore II'nin ROC değeri 0.890 (%95 GA, 0.826-0.937) olarak tespit edilmiştir.

Sonuç: Bu çalışma, acil izole KABG gerektiren STEMİ ve Şok hastalarında gözlenen ölüm oranının yüksek olduğunu göstermektedir. Ayrıca, Euroscore II NSTEMI hastalarında iyi bir risk öngörüsüne sahipken, diğer gruplarda mortaliteyi önemli ölçüde küçümsemektedir.

Anahtar Kelimeler: Akut koroner sendrom; koroner arter baypas greftleme; acil cerrahi; Euroscore II

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INTRODUCTION

Patients with acute coronary syndrome (ACS) requiring emergency coronary artery bypass grafting (CABG) represent a high operative risk that remains challenging for cardiac surgeons[1]. While the percentage of patients undergoing emergency CABG has been decreasing recently, there is still a need for surgery in a significant group of patients[2].

Risk stratification and prediction models allow surgeons and institutions to compare surgical results objectively. They are also important in surgical decision-making, providing accurate preoperative informed consent and enhancing the quality of health care[3]. In addition, they help the patient and caregivers to weigh the surgical risks and benefits and to build their expectations[4]. Emergency CABG surgery is associated with a high mortality and morbidity; therefore, the prediction of mortality and morbidity is important in decision-making. Many risk evaluation systems for cardiac surgery have been developed. The European System for Cardiac Operative Risk Evaluation (EuroScore) is the most widely accepted and currently used model[5]. There is a gap in the literature about EuroScore II's erroneous predictions in high-risk and emergency CABG cases. Furthermore, there are limited data in the literature regarding the results of isolated CABG in patients with ACS.

The aim of the present study was to evaluate the real-world outcomes of emergency isolated CABG in patients presenting with ACS and to assess the performance of EuroScore II due to ACS subtypes.

PATIENTS and METHODS

The present study was a cohort analysis of patients with an admitting diagnosis of ACS who underwent isolated emergency CABG within 24 h in a single center. Data were obtained using our institutional patient database. A total of 186 patients underwent emergency coronary bypass surgery for ACS from September 2009 to July 2014. A retrospective study was performed in 138 of these 186 consecutive patients who had only isolated CABG. Exclusion criteria for patients included concomitant cardiac procedure (e.g., valvular repair or replacement and aortic graft interposition) with CABG, presence of post-myocardial infarction (MI) mechanical complications (e.g., free wall rupture, ventricular septal defect, ischemic mitral regurgitation, and ventricular aneurysm), surgery not performed within 24 h, patients without ACS, and lost to follow-up within 30 days after CABG.

All procedures were performed under cardiopulmonary bypass (CPB) via median sternotomy. Emergency surgery was defined as a requirement for operation within 24 h of presentation. Generally, a left internal mammarian artery (LIMA) graft was used for left anterior descending (LAD) coronary artery in hemodynamically stable patients, and saphenous vein grafts were selected for revascularization at the surgeon's discretion.

Indications for emergency CABG surgery were decided according to the American College of Cardiology Foundation/ American Heart Association guidelines as lesions of the left main trunk or left main equivalent severe stenosis, persistent angina for which non-surgical treatment was ineffective, persistent angina for which percutaneous coronary intervention had been unsuccessful, and presence of persistent arrhythmia for which medical treatment was inadequate[1-4,6].

ACS was defined as unstable angina (USAP), non-ST segment elevated myocardial infarction (NSTEMI), ST segment elevated myocardial infraction (STEMI), or cardiogenic shock (SHOCK) according to the current guidelines[7,8].

The cohort was divided into four groups according to the type of ACS: (1) USAP, (2) NSTEMI, (3) STEMI, and (4) SHOCK.

Preoperative factors examined were age, gender, type of ACS, rate of left ventricular ejection fraction, necessity for inotropes and intraaortic balloon pump (IABP), presence of chronic obstructive pulmonary disease, hypertension, diabetes mellitus, peripheral arterial disease, cerebrovascular disease, EuroScore II value, preoperative troponin, hematocrit, creatinine, and alanine transaminase and aspartate transaminase levels. Intraoperative factors investigated were CPB time, cross-clamp time, and types and number of grafts used. Postoperative variables were incidence of postoperative stroke, renal failure, necessity of hemodialysis, surgical site infection, bleeding amount, reoperation rate, left ventricular ejection fraction, in-hospital mortality, 30-day mortality, length of time supported by mechanical ventilation, duration of stay in intensive care unit (ICU), and postoperative length of hospital stay. An online tool was used to calculate the EuroScore II scores (www.euroscore.org). Observed and expected mortalities were calculated by EuroScore II. The efficacy of risk model was analyzed in four subgroups. Values of the area under the receiver operating characteristic (ROC) curve (AUC) were calculated for EuroScore to evaluate the predictive power and accuracy in emergency isolated CABG patients.

Outcomes

There were three co-primary outcomes in the present study: (1) in-hospital and 30-day mortality rate results, (2) mortality analysis according to ACS subgroups, and (3) to assess the performance of EuroScore II in patients with ACS who underwent emergency isolated CABG.

Statistical Method

IBM SPSS Statistics (ver. 22.0; SPSS Inc., Chicago, IL, USA) software was used for statistical analysis. Data are

presented as mean ± standard deviation. Mann-Whitney U test was used for comparison of quantitative data. Fisher's exact test and continuity correction (Yates) test were used for comparison of qualitative data. Pearson's chi-square test was used to assess two types of qualitative comparisons. ROC curve was plotted, and the area under the curve was determined. The sensitivity and specificity were calculated for EuroScore II. A p value < 0.05 was considered as statistically significant.

Ethics Statement

The present study was approved by the institutional ethics committee (SE 2014.YON.FR.16).

RESULTS

Patient Characteristics

A total of 138 patients who underwent emergency isolated CABG for ACS were included in the study. The mean age of the patients was 56.9 ± 11.4 years, and 118 were male. Patients were grouped according to etiology as follows: USAP (n= 14, 10.1%), NSTEMI (n= 43, 31.2%), STEMI (n= 65, 47.1%), and SHOCK (n= 16, 11.6%). No significant differences were observed between the groups with regard to demographic, preoperative risk factors, or preoperative laboratory tests. The baseline demographic and clinical characteristics of the patients are depicted in Table 1. Patients with STEMI ACS underwent emergency CABG more often (47.1%) than the other patients. Cardiogenic shock was present in 11.6% of patients. The mean EuroScore II value was 6.5 ± 5.4 (range: 1.9-25.4).

Intraoperative Data

The operative data are listed in Table 2. All procedures were performed under CPB via sternotomy. The mean operative time was 220.2 ± 66 min. The mean CPB time was 107.3 ± 44.3 min, whereas the mean cross-clamp time was 61.2 ± 25.5 min. Complete revascularization was achieved in all patients. The mean number of distal anastomoses was 2.6 ± 0.9. LIMA graft was used in 65.2% (n= 90) of cohort. There was a significant difference in mortality rate between LIMA using in cohort. While 91.1% (n= 82) of patients who survived had LIMA graft, the mortality rate was 33.3% in patients who had no LIMA graft (p< 0.001).

Table 1. Demographic and preoperative clinical parameters of patients (n= 138)

Parameters		Min-max	Mean ± SD
Age (year)		19-84	56.9 ± 11.4
Preoperative LVEF (%)		20-65	42.9 ± 9.4
Troponin level (ng/mL)		0-50	5.8 ± 12.8
Hematocrit (%)		23-54	40.3 ± 5.6
Creatinine (mg/dL)		0.3-3.2	0.94 ± 0.3
ALT (U/L)		3-164	31.8 ± 20.4
AST (U/L)		5-258	51.4 ± 49.7
		n	%
Gender	Female	20	14.5
	Male	118	85.5
Type of ACS	USAP	14	10.1
	NSTEMI	43	31.2
	STEMI	65	47.1
	SHOCK	16	11.6
Risk factors	Chronic lung disease	10	7.2
	Hypertension	62	44.9
	Extracardiac arteriopathy	4	2.8
	Renal impairment	5	3.6
	Dialysis	2	1.4
	Diabetes on insulin	25	18.1
	Neurological dysfunction	3	2.2
	Pulmonary hypertension	5	3.6
	Smoking	101	73.2

LVEF: Left ventricular ejection fraction, ALT: Alanine transaminase, AST: Aspartate transaminase, ACS: Acute coronary syndrome, USAP: Unstable angina, NSTEMI: Non-ST segment elevated myocardial infarction, STEMI: ST segment elevated myocardial infarction, SHOCK: Cardiogenic shock.

Table 2. Operative features of patients

		Min-max	Mean ± SD
Time of operation (min)		120-490	220.2 ± 66
CPB (min)		23-305	107.3 ± 44.3
Cross-clamp (min)		10-123	61.2 ± 25.5
		n	%
IABP	Yes	10	7.2
	No	128	92.8
Inotrope	Yes	29	21.2
	No	109	78.9
No. of grafts	1	13	9.4
	2	51	37
	3	45	32.6
	4	23	16.7
	5	6	4.3
Mammarian graft	Yes	90	65.2
	No	48	34.8
SVG	0	9	6.5
	1	35	25.4
	2	46	33.3
	3	40	29
	4	5	3.6

CPB: Cardiopulmonary bypass, IABP: Intraaortic balloon pump, SVG: Saphenous vein graft.

Postoperative Data

Data about postoperative course are summarized in Table 3. The mean left ventricular ejection fraction (LVEF) was found to be higher according to the perioperative period (47.8 ± 11 vs. 42.9 ± 9.4). A total of 84.7% (n= 117) of patients received transfusion postoperatively. The mean ICU stay was 3.6 days, and the mean hospital stay was 9.6 days. In 14 (10.6%) patients, a reoperation was needed because of bleeding. Postoperative stroke was observed to be 3.1% in our emergency CABG population. The most common complication was pulmonary problems (n= 23, 18%) in the postoperative course.

IABP and Inotropic Support

In 7.2% (10/138) of patients, an IABP was implanted before emergency CABG, and in 38.4% (53/138), an IABP was inserted after myocardial revascularization in the intra- or postoperative period. Overall, 45.6% (n= 63) of patients received IABP support. A total of 91 (65.9%) patients were treated with inotropic support. Patients who presented with STEMI or cardiogenic shock or who needed preoperative IABP or inotropic support were more likely to die (p< 0.001).

Mortality Analysis

In the entire cohort, the mean observed 30-day total mortality rate was 15.9% (n= 22), whereas the total mortality was 17.4% (n= 24). Mortality rates in the subgroups were 7% (n= 1) in USAP, 4.65% (n= 2) in NSTEMI, 15.38% (n= 10) in STEMI, and 68.75% (n= 11) in SHOCK, respectively. There was a significant difference in mortality between the groups, and chi-square test showed that the patients in the SHOCK group were more likely to die than the other patients (p< 0.001). No statistically significant difference was found between gender (female 15%, n= 3 and male 17.7%, n= 21; p> 0.05) according to mortality.

Risk Score Evaluation

The calculated mean score for EuroScore II was 6.51 ± 5.44 (range: 1.9-25.4). The mean score for EuroScore II of patients who died was significantly higher than that of survivors (p< 0.01). Expected and observed mortality analysis is shown in Table 4. The observed mortality rates were significantly increased as the calculated risk increased (p< 0.001). A ROC curve was plotted for the EuroScore II. The AUC value was calculated for predictive power and accuracy of EuroScore II. The AUC value of EuroScore II was 0.890 (95% confidence interval (CI), 0.826-0.937) (Figure 1). In the analysis of ROC curve results, a good risk prediction was observed using EuroScore II in the NSTEMI group; however, EuroScore II significantly underestimated the mortality in the STEMI and SHOCK groups.

Table 3. Postoperative parameters of patients

		Min-max	Mean ± SD
Drainage (cc)		100-2200	659 ± 357
Time to extubation (h)		4-360	14.4 ± 32.6
Daily urine output (cc)		2000-5902	3386.7 ± 796.6
EF (%)		20-65	47.8 ± 11
Creatinine (mg/dL)		0.4-1.9	0.97 ± 0.2
Hematocrit (%)		21-48	29.3 ± 4
ALT (U/L)		5-648	50 ± 69
AST (U/L)		21-1022	141.1 ± 162.6
ICU stay (days)		1-42	3.6 ± 5.5
Stay of hospital (days)		4-61	9.67 ± 7
		n	**%**
IABP	Yes	43	31.1
	No	95	68.8
Inotropic support	Yes	91	65.9
	No	47	34.1
Transfusion	Yes	117	84.7
	No	21	10.7
Hemofiltration	Yes	1	0.7
	No	137	99.3
Revision		14	10.6
Arrhythmia		17	13.2
Stroke		4	3.1
Respiratory insufficiency		23	18
Wound infection		10	7.8

ALT: Alanine transaminase, AST: Aspartate transaminase, EF: Ejection fraction, ICU: Intensive care unit, IABP: Intraaortic balloon pump.

Table 4. Expected and observed mortality analysis

	Expected mortality (EuroScore II)	Observed mortality
Type of ACS	**Mean ± SD (min-max) %**	**%**
USAP	3.1 ± 0.6 (1.9-4.7)	7.1
NSTEMI	4.5 ± 3.1 (2.2-21.1)	4.6
STEMI	5.7 ± 3.8 (2.5-24.9)	15.3
SHOCK	17.7 ± 4.5 (9.4-25.4)	68.7
Total	6.5 ± 5.4 (1.9-25.4)	30-day: 15.9 Overall: 17.4

ACS: Acute coronary syndrome, USAP: Unstable angina, NSTEMI: Non-ST segment elevated myocardial infarction, STEMI: ST segment elevated myocardial infarction, SHOCK: Cardiogenic shock.

DISCUSSION

Emergency CABG in patients with ACS is associated with increased morbidity and mortality. In our study, the main findings were that emergency CABG in patients with ACS was an effective procedure that has various outcomes in the early clinical course according to ACS type. However, the mortality in STEMI and cardiogenic shock was higher than that expected in cohort. Currently, surgical mortality in patients who underwent emergency CABG for ACS varies between 5% and 20% [9-12]. Reasons for these highly variable mortality rates include: multicentricity of the studies, different experience levels in centers, and different selection criteria of patients. Khaladj et

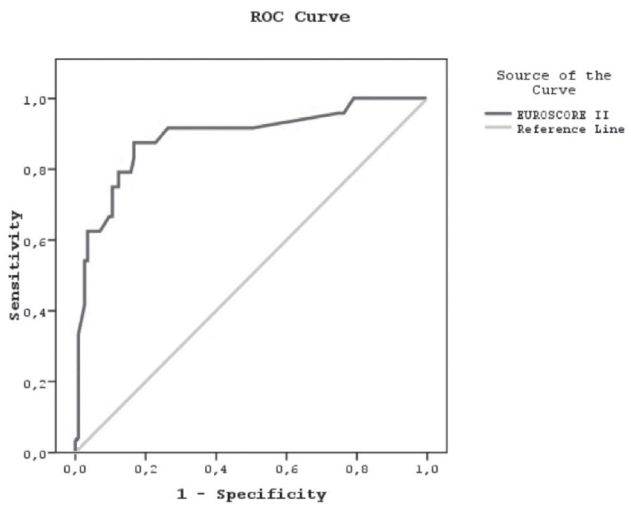


Figure 1. Receiver operating characteristic curve for the EuroScore II.

al. analyzed 127 patients (NSTEMI, n= 86, 68% and STEMI, n= 41, 32%) who underwent emergency CABG and reported an overall mortality rate of 6% in the NSTEMI group and 15% in the STEMI group[10]. In our study, the 30-day overall mortality rate was 15.9%, and total mortality was 17.4%. Patient selection was one of the main reasons for the gap between our mortality rates because 58.9% of our cohort had STEMI or cardiogenic shock. Danner et al. reported an even higher mortality rate of 18.3% in a study of 109 emergent CABG cases (39.4% had STEMI and 15.6% had SHOCK)[11]. Constance et al. examined 985 patients who underwent emergency CABG and reported the rate of mortality as 16.3%. In addition, reoperation was performed in 14.1% of cases, and stroke was observed in 3.2% of patients[12]. Similar postoperative complication rates were seen in our study. In the SHOCK trial, White et al. performed a study to compare the outcomes of acute MI complicated by cardiogenic shock. The 30-day mortality rate was 57% in the emergency CABG group[13]. These data were correlated with the results of our study.

Our results regarding the number of grafts used in emergency CABG were similar to previous studies[14]. Various results have been reported regarding the use of LIMA graft[2,10]. We found that the use of LIMA (65.2%) was higher in our study than reported (58.2%) in other studies. As well known, arterial grafts have higher long-term patency rates than saphenous grafts. We recommend that if patients have a stable hemodynamic status, LIMA graft should be selected for LAD instead of saphenous vein graft.

Some studies reported that EuroScore II underestimates the mortality rates of high-risk cardiac surgery, whereas others reported that it overestimated the risk[15-17]. However, Kunt et al. compared risk prediction and reported that EuroScore II significantly underestimates (observed overall mortality: 7.9% and predicted mortality: 1.7, p= 0.001) the mortality risk for coronary surgery[15]. Barili et al. noted that the predictive power of EuroScore II is similar to the older risk stratification models. Moreover, no superiority was found in the high-risk patient group[16]. Grant et al. aimed to assess the performance of EuroScore and reported that it demonstrates poor calibration and comparatively poor discrimination for emergency cardiac surgery[17]. In our study, we evaluated the efficiency of the EuroScore II for predicting the mortality in emergency isolated CABG operations. The area under the curve was 0.89 (95% CI, 0.826-0.937). Generally, EuroScore II underestimated and failed to predict the mortality of emergency isolated CABG cases, and it could predict the mortality only in NSTEMI patients.

Recently, Slottosch et al. reported that preoperative IABP support does not provide any additional clinical benefit on patients undergoing CABG for ACS[18]. In our study period, 7.2% of patients had an IABP implanted before emergency CABG, and 38.4% had IABP after myocardial revascularization in the intra- or postoperative period. Overall, 45.6% of patients received IABP support. However, we observed that IABP has a valuable effect on the clinical course and hemodynamic parameters in patients with ACS who underwent emergency CABG.

Limitations

The present study is limited by the fact that it is retrospective in nature and reflects the experience of a single center. In addition, our results are limited to in-hospital events, and follow-up outcomes on midterm and long-term survival are not available. Finally, the present study included a relatively small sample size.

CONCLUSION

Emergency surgical revascularization of patients presenting with ACS is achievable and results in good outcomes in NSTEMI patients. Mortality in STEMI patients, especially in cardiogenic shock, is significantly high. In addition, the risk prediction of EuroScore II was admissible in NSTEMI patients, whereas it significantly underestimated the mortality in the other patients who underwent emergency CABG presenting with ACS.

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CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: MA, BT, EE

Analysis/Interpretation: CK, TC, MY, GI

Data Acquisition: GI, TC, MY

Writting: MA, CK, UC

Critical Revision: MA, BT, CK

Final Approval: All of authors.

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