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ARAŞTIRMA YAZISI / RESEARCH ARTICLE

KORONER ARTER BYPASS CERRAHİSİ SONRASI MAJOR ADVERS OLAYA ETKİ EDEN FAKTÖRLER

FACTORS AFFECTING MAJOR ADVERSE EFFECTS AFTER CORONARY ARTERY BYPASS SURGERY

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ÖZET

AMAÇ: Çalışmamızda Koroner arter baypas greft (KABG) operasyonu geçiren hasta popülasyonumuzu mortalite ve major advers olay (MAO) gelişimi açısından incelemeyi ve MAO gelişimine etki eden faktörleri incelemeyi amaçladık.

GEREÇ VE YÖNTEM: Ocak 2017 ile Aralık 2019 tarihleri arasında KABG operasyonu olmuş 169 ardışık hasta retrospektif olarak incelenmiştir. Ölüm, miyokardiyal infarkt, reoperasyon, kardiyak tamponad, stroke, böbrek yetmezliği, sternal enfeksiyon extracorporeal membran oksijenatör ihtiyacı ve kardiyo pulmoner resüsitasyon MAO olarak tanımlandı.

BULGULAR: Hastaların yaş ortalaması 63,19 ±0,72 yıl, ortalama Kardiyopulmoner bypass (KPB) süresi 106,95 ±27 dakika, ortalama Aort Kros Klemp Süresi 44,87 ±1,05 dakika idi. 11 (%6,5) hastatya Ekstra Korporeal Membran Oksijenatör desteği sağlandı, 7 (%4,1) hastaya reoperasyon uygulandı, 5 (%3) hastada postoperatif stroke gözlendi, 5 (%3) hastaya kardiyopulmoner resusitasyon uygulandı ve 1 (%0,6) hasta postoperatif miyokardiyal enfarktüs gözlendi. Toplamda 28 (%16,6) hastada MAO gözlendi. Mortalite 9 (%5,3) hastada gözlendi. Univaryant analizde Euroskor, KPB sırasındaki ortalama arteryel basınç ve ultrafiltrasyon volümünün MAO ile ilişkili olduğu gözlendi (sırası ile p=0,004, p=0,026 ve p=0,037). Ancak multivaryant analizde sadece Euroskor (oddsratio: 1,453, %95 CI 1,166-1,811 p=0,001) ve ultrafiltrasyon volümü (oddsratio:-0,002, %95 CI 0,996-1 p=0,04) MAO ile ilişkili bulundu.

SONUÇ: Çalışmamızda yüksek Euroskor düzeylerinin sadece mortaliteyi değil aynı zamanda MAO insidansını da arttırdığı ve artmış ultrafiltrasyon volümlerinin MAO insidansını azalttığını gözlemledik. Uygun ultrafiltrasyon ve KPB stratejisinin MAO insidansını azaltabileceği KABG cerrahisi sırasında akılda bulundurulması gerektiği kanaatindeyiz.

ANAHTAR KELİMELER: Majoradvers olay, Mortalite, Morbidite, Koroner arter bypass greftleme.

ABSTRACT

OBJECTIVE: The present study aimed to evaluate the patient population who underwent coronary artery bypass grafting (CABG) operation in terms of mortality and major adverse effects (MAE) incidence and examine the factors affecting MAE incidence.

MATERIAL AND METHODS: 169 consecutive patients who underwent CABG surgery between January 2017 and December 2019 were retrospectively analyzed. Mortality, myocardial infarction, reoperation, cardiac tamponade, stroke, renal failure, sternal infection, need for extracorporeal membrane oxygenator and cardio pulmonary resuscitation were defined as MAO.

RESULTS: The mean age of the patients was 63.19 ±0.72 years, the mean duration of cardiopulmonary bypass (CPB) was 106.95 ±27 minutes, and the mean duration of aortic cross-clamp was 44.87 ±1.05 minutes. Extracorporeal membrane oxygenator support was provided to 11 (6.5%) patients, 7 (4.1%) patients underwent reoperation, 5 (3%) patients experienced a postoperative stroke, 5 (3%) patients required cardiopulmonary resuscitation, and postoperative myocardial infarction was observed in 1 (0.6%) patient. In total, MAE was determined in 28 (16.6%) patients. Mortality occurred in 9 (5.3%) patients. In the univariate analysis, Euroscore, mean arterial pressure during CPB, and ultrafiltration volume were associated with MAE (p=0.004, p=0.026, and p=0.037, respectively). However, in multivariate analysis, only Euroscore (odds ratio: 1.453, 95% CI 1.166-1.811 p=0.001) and ultrafiltration volume (odds ratio:-0.002, 95% CI 0.996-1 p=0.04) were correlated to MAE.

CONCLUSIONS: In our study, we observed that high Euroscore levels increased not only mortality but also the incidence of MAO, and increased ultrafiltration volumes reduced the incidence of MAO. We believe that it should be kept in mind during CABG surgery that appropriate ultrafiltration and CPB strategy can reduce the incidence of MAO.

KEYWORDS: Major adverse effects, Mortality, Morbidity, Coronary artery bypass grafting.

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INTRODUCTION

Although cardiac morbidity, cardiopulmonary bypass (CPB)-related morbidity, and major adverse effects (MAE)-related mortality have decreased after coronary artery bypass grafting (CABG) operations, it remains to be a problem today. Especially in recent years, the fact that preoperative risk factors of the patient population referred to surgery for CABG are considered to be more complicated has severe impacts on postoperative mortality and morbidity. The early mortality of CABG is reported to be between 1-7.4% in the literature (1 - 4). Although there is plenty of data from both our country and abroad in the literature on mortality, there is no definite consensus on MAE definition (4, 5). Moreover, we believe there is insufficient data on MAE development after CABG, especially in our country.

The present study aimed to evaluate the patient population who underwent CABG operation in terms of mortality and MAE development and examine the factors affecting MAE development.

MATERIAL AND METHOD

Patient Population

With the approval of the institution's ethics committee, 169 consecutive patients who underwent CABG operations between January 2017 and December 2019 in our hospital were retrospectively analyzed. To create a more homogeneous patient group, isolated CABG patients were included in the study. Patients who had valve replacement or repair together with CABG and off-pump CABG patients were excluded.

Definitions

Complications were defined as per the Society of Thoracic Surgeons (STS) criteria (4). Mortality was defined as death during the time in hospital or within 30 days of discharge, stroke as neurological deficit lasting longer than 72 hours, renal failure as creatinine values above 2.0 mg/dL or a doubling of the last measured creatinine, and prolonged mechanical ventilation (MV) as the duration of mechanical ventilation (MV) lasting longer than 24 hours. Euroscore was used for mortality risk scoring (5). Mortality, myocardial infarction (MI), reoperation, cardiac tamponade, stroke, renal failure, sternal infection, need for extracorporeal membrane oxygenator (ECMO), and cardiopulmonary resuscitation (CPR) were determined as MAE.

Cardiopulmonary Bypass Protocol

Medtronic Affinity (Medtronic Operational Headquarters, Minneapolis, MN) oxygenator and reservoir were used for all patients for the CPB system. Sets were washed with the prime solution. The prime solution consisted of Ringer lactate solution and 20% mannitol solution. CPB flow was calculated based on patient body surface areas with a cardiac index of 2.4 L/min/m^2. All operations were performed under mild hypothermia (32-34 C0). A heparin loading dose was administered with an activated clotting time (ACT) of >480. Heparin reversal was performed using protamine sulfate. Del Nidocardioplegia was applied anterograde to all patients. During CPB, blood pH was aimed to be 7.35-7.40, PaO2 be > 200 mmHg and PaCo2 be = 35-40 mmHg.

Surgical Technique

All patients were operated under standard CPB after median sternotomy and aortic arterial, and two stages of right atrial venous cannulation. Del Nidocardioplegia solution is used in our clinic as anterograde cardioplegia. The left internal mammary artery was used as the left anterior descending artery bypass graft and the great saphenous vein for other coronary vessels in all patients. All distal anastomoses were performed under the aortic cross-clamp (ACC), and all proximal anastomoses were performed under side-clamping in the beating heart after removing the ACC.

Ethical Committee

Ethics committee approval was obtained on 04/10/2021 with the decision number of 2021/17-246 by applying to the ethics committee of Erzurum Regional Training and Research Hospital.

Statistical Analysis

Statistical analyzes were performed using SPSS version 22 software. The normal distribution of the variables was analyzed visually (histogram and graphs) and analytically (Kolmogorov-Smirnov). Descriptive statistics were applied using frequency tables for categori-

cal variables, mean and standard deviation for normally distributed variables, and median and interquartile range (IQR) of 25-75% for non-normally distributed variables. Risk factors were identified using univariate analysis. Variables with a p-value of <0.05 in the univariate analysis and not correlated with each other were included in the multivariate logistic regression analysis. Variables with a p-value of <0.05 were considered statistically significant.

RESULTS

Demographic: A total of 169 CABG operations were performed between January 2017 and December 2019. The mean age of the patients was 63.19±0.72 years, mean body weight was 77.69±0886 kilograms, and mean body surface area was 1.85±012. Forty-four (26.1%) of the patients were female, and 125 (73.9%) were male. The median Euroscore was 2 (IQR1-5) **(Table 1)**.

Table 1: Demographics

Number	N=169
Age (years)	63.19±0.72
Weight (kg)	77.69±0.886
BSA (m^2)	1.85 ±012
Gender	
Female	44 (20.1%)
Male	125 (79.9%)
Euroscore	2 (IQR 1-5)
Comorbid disease	
COPD	15 (8.9%)
DM	43 (25.4%)
HT	116 (68.6%)
BPH	11 (6.5%)
CVE	2 (1.2)
Hyperlipidemia	23 (13.6%)
PAD	18 (10.6%)

BSA: Body surface area, COPD: Chronic obstructive pulmonary disease, DM: Diabetes mellitus, HT: Hypertension, BPH: Bening prostatic hyperplasia, CVE: Cerebrovascular event, PAD: Peripheral artery disease

Operative Data: The mean CPB duration was 106.95±27 minutes, the mean ACC duration was 44.87 ±1.05 minutes, and the mean CPB output was 4.43 ±29.05 L. The mean temperature during CPB was 31.1±09 Cº, the mean arterial pressure during CPB was 61.11±1.3 mmHg, and the amount of ultrafiltration during CPB was 1.6±0.17 L **(Table 2**).

Table 2: Operative date

Variables	N=169
CPB duration (min)	106.95 ±27
ACC duration (min)	44.87±1.05
Total flow (L/min)	4.43±29.05
Temperature (Cº)	31.1 ± 09
Mean arterial pressure during CPB (mmHg)	61.11±1.3
Ultrafiltration volume (L)	1.6±0.17

CPB: Cardiopulmonary bypass, ACC: Aortic cross clamp

Postoperative Complications and Major Adverse Effects: The most common complication was respiratory complications (atelectasis, pneumothorax, pleural effusion, pneumonia), which occurred in 32 (18.9%) patients. Arrhythmia was observed in 3 (1.8%) patients. There was superficial wound infection in 17 (10.1%) patients, and infectious complications other than wound infection were determined in 11 (6.5%) patients. Mediastinitis was detected in 14 (8.3%) patients and delayed sternal closure in 11 (6.5%) patients. Intraaortic balloon pump (IABP) support was required in 5 (3%) of the patients. ECMO support was provided to 11 (6.5%) patients, 7 (4.1%) patients underwent reoperation, 5 (3%) patients had a postoperative stroke, 5 (3%) patients underwent CPR, and 1 (0.6%) patient was determined to have postoperative MI. In total, MAE was observed in 28 (16.6%) patients. Mortality occurred in 9 (5.3%) patients **(Table 3)**.

Table 3: Postoperative complications and major adverse events

Variables (%)	N=169
MAE	28 (16.6%)
ECMO	11 (6.5%)
MI	1 (0.6%)
Stroke	5 (3%)
Renal failure	2 (1.2%)
Reoperation	7 (4.1%)
CPR	5 (3%)
Mortality	9 (5.3%)
Mediastinitis	14 (8.3%)
Respiratory complication	32 (18.9%)
Arrhythmia	3 (1.8%)
Infectious	11 (6.5%)
Wound complication	17 (10.1%)
Delayed sternal closure	11 (6.5%)
IABP	5 (3%)
Intubation duration	1 (IQR 1-1)
ICU duration	4 (IQR 4-4)
Duration of hospitalization	13 (IQR 11-15)

MAE: Major adverse effects, ECMO: Extracorporeal membrane oxygenator, MI: Myocardial infarction, CPR: Cardiopulmonary resuscitation, IABP: Intraaortic balloon pump, ICU: Intensive care unit

Factors Affecting Major Adverse Effects: Preoperative and postoperative parameters such as age, weight, body surface area (BSA), gender, Euroscore, the temperature during CPB, duration of CPB, duration of ACC, CPB flow, mean arterial pressure during CPB, and ultrafiltration volume were examined in the univariant analysis **(Table 4)**.

Table 4: Univariate analysis results

Variables	P-value
Age	0.478
Weight	0.736
BSA	0.794
Gender	0.423
Euroscore	**0.004**
Temperature	0.777
CPB duration	0.233
ACC duration	0.417
Total flow	0.620
Mean arterial pressure during CPB	**0.026**
Ultrafiltration volume	**0.037**

BSA: Body surface area, CPB: Cardiopulmonary bypass, ACC: Aortic cross-clamp

Euroscore, mean arterial pressure during CPB, and ultrafiltration volume were associated with MAE (p=0.004, p=0.026, and p=0.037, respectively). However, in multivariate analysis, only Euroscore (odds ratio: 1.453, 95% CI

1.166-1.811 p=0.001) and ultrafiltration volume (odds ratio:-0.002, 95% CI 0.996-1 p=0.04) were found to be correlated to MAE **(Table 5)**.

Table 5: Factors affecting major adverse event in multivariate analysis

Variables	Odds ratio	95%CI lower	95% CI	P-value
Euroscore	1.453	1.166	1.811	**0.001**
Ultrafiltration volume	-0.002	0.996	1.000	**0.04**

DISCUSSION

Our study aimed to examine the incidence of mortality and MAE development after CABG operation and the factors affecting their occurrence. MAE developed in 28 (16.6%) of our patients, and it was determined that MAE development increased as the high Euroscore increased and MAE incidence decreased as the ultrafiltration volume increased.

CABG operations are performed with relatively low mortality rates today. However, in recent years, the older patient group with impaired ventricular functions needs to be operated on, and the patient population with more extensive coronary artery disease and more complicated preoperative risk factors is referred to surgery, with invasive cardiology being more aggressive in the percutaneous intervention (6). This situation plays a vital role in surgical mortality and the incidence of MAE development. Knowing and managing the factors affecting mortality and MAE incidence is critical in obtaining better surgical results (7). Since coronary artery disease progresses with age, it is known that mortality and morbidity increase after CABG (8 - 13).

The female gender also is crucial in mortality and morbidity (9, 11 - 15). It was reported that obesity, especially morbid obesity with a body mass index above 40, is a risk factor for mortality after CABG (16). Studies in the literature report that hypertension alone increases morbidity by approximately 40% (17). Furthermore, chronic obstructive pulmonary disease (COPD) plays an essential role in morbidity and mortality, such as prolonged intubation time, sternal dehiscence, and prolonged hospital stay after CABG (18, 19). Diabetes mellitus (DM) also is critical in mortality and morbidity after CABG (9, 11, 12, 19 - 21). Besides, it was reported in the literature that male diabetic patients have a higher incidence of MAE than female patients (22). Factors such as extracardiac arteriopathy (23 - 25), neurological dysfunction (26, 27), preoperative MI (28, 29), low left ventricular ejection fraction (9, 30 - 33) also have a part in CABG surgery mortality and morbidity. Moreover, apart from preoperative factors, long noncoding RNA NEAT1 and microRNA-125a tests have been reported to be useful as predictors of MAE (22). Total revascularization has been revealed to reduce MAE development (34). In our study, each of these factors was not examined separately. However, as is known, in the Euroscore scoring system, the estimated mortality score of the patient is calculated by using parameters such as age, female gender, kidney failure, neurological deficit, COPD, DM, obesity, peripheral arterial disease (PAH), and left ventricular ejection fraction (5). The present study demonstrated that the incidence of MAE increased as the Euroscore increased (p=0.001). Also, we found that the incidence of MAE development decreased as the intraoperative ultrafiltration volume increased (p=0.04). We believe that UF reduces MAE incidence in the postoperative period due to reasons such as using fewer blood products after the operation, removing more inflammatory mediators, and having positive effects on coagulation by reducing hemodilution (35 - 37).

Mortality after CABG operations is reported to be between 1-7.4% (4, 35, 36). A study by Kamel et al. revealed that the incidence of mortality as a MAE was 18.7% (4). In our study, mortality was 5.3%, and MAE was 16.6%, consistent with the literature.

The main limitation of our study was that it was a single-center observational retrospective study and was performed with a relatively small study group. Besides, the fact that we could not include all the factors affecting MAE incidence in the study makes it difficult to evaluate the results. Knowing and managing the factors affecting mortality and MAE incidence play a key role in obtaining better surgical results. Our study concluded that high Euroscore levels increase mortality and the incidence of MAE, and increased ultrafiltration volumes reduce the incidence of MAE.

We believe that appropriate ultrafiltration and CPB strategy can reduce MAE incidence and should be kept in mind during CABG surgery.

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