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Original Article

Noteworthy Effect of Hemoglobin on Short-Term Mortality and Extubation Time of Elderly Patients Undergoing OPCABG

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Abstract

Objective: Interest in off pump technique has markedly expanded in recent years. It has been shown that peroperative complications and mortality rates are reduced with the off-pump coronary bypass grafting (OPCABG) technique, even in high risk elderly patient groups. This study aimed to evaluate the results of patients over the age of 65 who underwent OPCABG. ***Methods:*** This study included 116 patients aged 65 and over who underwent coronary artery bypass graft surgery (CABG). Patients' datas were collected from digital database. Demographic and clinical data such as peroperative data, comorbidities, additional treatment requirements and discharge status of all patients were recorded. ***Results:*** The mean age of the patients was 67.97 ±3.40 years. The extubation time of the patients was 331.68 ±222.08 minutes. When the factors affecting the extubation time were evaluated, hemoglobin (p: 0.016) was found to be statistically significant. The mortality rate was found to be 5.17% (n:6). When survivors and non-survivors were compared, the differences in ejection fraction, extubation time, troponin and hemoglobin level were found to be statistically significant. Logistic regression analysis revealed statistical significance for ejection fraction (0.011), troponin (0.036), and hemoglobin level (0.036). The discrimination power of troponin value was determined to be more successful than other parameters (odds ratio 1.105, AUC: 0.755, p: 0.036). ***Conclusion:*** Our findings support that, when performed by an experienced surgical team, OPCABG can be safely and effectively utilized in patients above 65 years. Although hemoglobin was found to be effective on both extubation time and short-term mortality rate, troponin was found to be the most effective factor on mortality rate.

Keywords: ***Off-pump coronary bypass, hemoglobin, troponin, mortality.***

Introduction

Coronary artery bypass grafting (CABG) has a vital role in treating advanced coronary artery disease [1]. Initially CABG which carried out under cardiopulmonary bypass and cardioplegic arrest, since the mid-1990s increasingly been performed with off pump cardiopulmonary bypass (OPCABG) [2,3].

Comparative studies indicate that relative to conventional CABG, OPCABG technique has been reported that the need for peroperative inotrope and intra-aortic balloon pump as well as lower blood loss and transfusion needs. Also, complications such as kidney failure, respiratory system problems, cerebrovascular complications and atrial fibrillation are less common in the postoperative period. Furthermore, OPCABG has also been shown to reduce the postoperative length of intensive care unit (ICU) and hospital stay, morbidity and mortality rates [4-6]. Therefore, OPCABG is gaining popularity among cardiac surgeons. In recent years, there have been many reports suggesting that OPCABG may be more advantageous for elderly patients [5-7].

We aimed to evaluate the results of our patients who underwent OPCABG between 2019 and 2024 in our center, which is a newly established rural hospital.

Methods

This descriptive study was conducted at Karabuk Education and Training and Research Hospital in Karabuk, Turkey, after was approved by the Karabük University Non-interventional Clinical Research Ethics Committee (2024/1795). The study protocol was executed by related to the ethical standards outlined in the Declaration of Helsinki.

The patients who were over 65 years who underwent coronary artery bypass graft surgery (CABG) from January 1, 2019 to January 1, 2024 were evaluated. The data were obtained by reviewing the patients' records. Patients who were under the age of 65, underwent valve and aortic surgery, on-pump CABG, underwent emergency surgery were not included in the study. Also, patients with insufficient file information were excluded.

Collected preoperative variables comprised demographic factors (age, sex), comorbidities (hypertension, atrial fibrillation (AF), diabetes mellitus (DM), cerebrovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic renal failure (CRF)), ejection fraction, smoking history, EUROSCORE, ASA (American Society of Anesthesiologists physical status classification system), troponin, creatine and hemoglobin level. The

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number of operated vessels, operation time, need for inotrope and additional treatments were recorded. Primary early outcomes included new-onset AF, stroke, new-onset renal failure requiring dialysis, respiratory complications (respiratory failure, pneumonia, or reintubation), red blood cell suspension replacement, revision surgery and death. Postoperative extubation time, ICU and hospital stay, and ICU readmission and short-term mortality rate (28 days) were collected.

The anesthesia protocol was standardized for the patients. İt included routine monitoring, including electrocardiography (ECG), pulse oximetry (SpO2), and invasive blood pressure measurements. After local anesthesia with 2% lidocaine, an arterial catheter was placed before anesthesia induction. Induction of general anesthesia was performed using midazolam (0.05–0.1 mg/kg), fentanyl (5–7 µg/kg), and rocuronium (0.1 mg/kg). Volume-controlled mechanical ventilation was applied. In all patients, tidal volume was determined as 8 ml/kg of body weight, respiratory rate was 12/minute, inspiration/expiration ratio (I:E) was 1:2, and positive end-expiratory pressure (PEEP) was 5 cmH2O. Anesthesia was maintained by inhalation of sevoflurane (0.8-1.0 MAC), a mixture of 40% oxygen and 60% air. Additional analgesia was provided intraoperatively with intravenous bolus fentanyl.

We have a three-person surgical team led by an expert, high-volume surgeon with approximately 1500-2000 off-pump surgeries over the last 15 years. The same surgical team conducted all procedures, ensuring consistency in operative approach.

After surgical access was achieved via median sternotomy, saphenous vein grafts (SVG) and left internal mammary artery (LIMA) were collected according to the number of target vessels. The bilateral internal mammary arteries were not used in any cases.

Systemic anticoagulation was achieved with 100–200 IU/kg of heparin, after which the activated clotting time (ACT) was monitored and maintained within the 200–400 second range.

After the left internal mammary artery (LIMA) was removed, the pericardium was opened. A deep pericardial suture was placed to elevate and stabilize the heart.

If bypass of the circumflex (Cx) coronary artery and its branches was planned, an opening was created in the right pleura and the heart was allowed to bend towards the right hemithorax. Proximal anastomoses were made to the ascending aorta under a side clamp. Following the proximal anastomoses, the distal ends of the grafts were closed with clips. The side clamp was removed. Moistened gauze was placed in the transfer and oblique sinuses. A tissue stabilization system (Octopus® Evolution, Medtronic) was used in the area where anastomosis was planned.

For the anastomosis of the left anterior descending artery (LAD) to LIMA, gauze was loosened to sufficient tension to prevent compression of the heart. During the right coronary artery (RCA) anastomosis, the operating table was positioned away from the surgeon. Anastomosis was performed with gauze (**Figure 1**). All distal anastomoses except total occlusion were performed using intracoronary shunt.

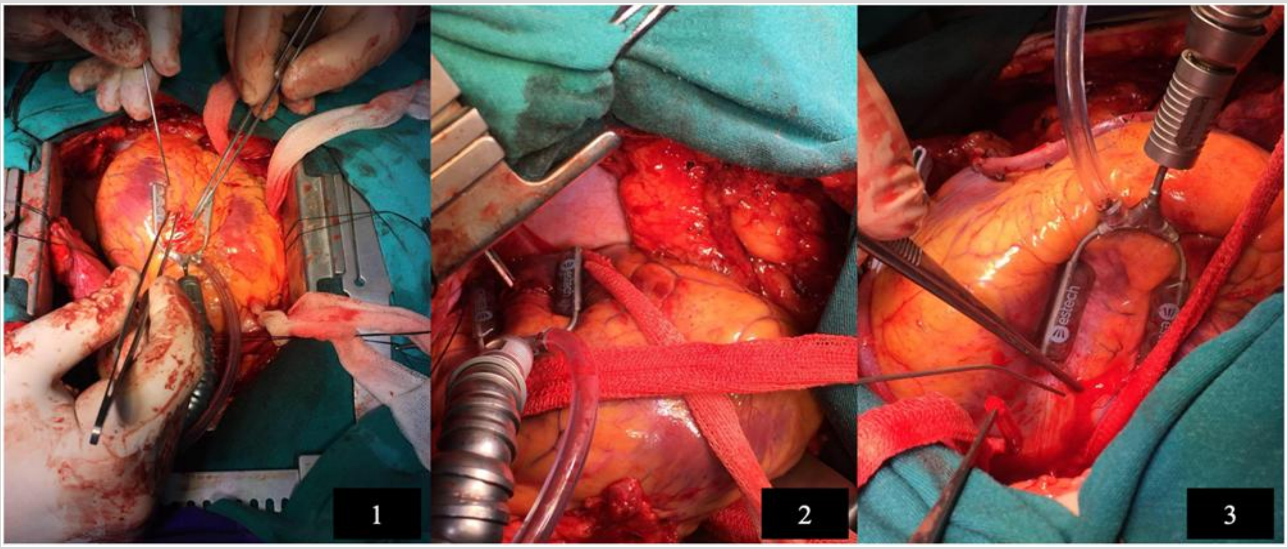

Fig. 1: 1: LAD control, 2: OM control, 3: RCA control.

ACT control was performed after all anastomoses were completed and checked. Subsequently heparin was neutralized by administration of 50-100 IU/kg protamine. Hemostasis was achieved and drains were placed in both the hemithorax and mediastinum. The patient was transferred intubated to ICU for post-operative care.

Descriptive statistics in the study were as follows; mean ± standard deviation (SD) values were used for quantitative data. Frequency and percentage (n, %) values were used for qualitative data. Comparisons between survivors and non-survivors were performed using the independent samples t-test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. The statistical significance level was determined as $p < 0.05$. To identify variables affecting mortality rates, logistic regression analysis was performed using the Wald test. Furthermore, the ROC (Receiver Operating Characteristic) curve method was applied to differentiate between survivor and non- survivor according to predictive factors. For all analyses, the SPSS version 22 software package was used.

Results

In our study 123 patients were evaluated, 116 OPCAB patients were included in the study. A total of 7 patients were excluded because 3 patients underwent valve surgery and 4 patients had switched to intraoperative on-pump CABG.

The demographic and clinical datas of patients are summarized in Table 1. The mean age of the patients was 67.97 ± 3.40 years. Hypertension (n: 98) and diabetes mellitus (n: 71) were the most common comorbidities. Nine patients had preoperative atrial fibrillation and 6 patients had preoperative renal failure. When preoperative cardiac functions were examined, it was seen that the mean left ventricular ejection fraction (LVEF) of our patients was 51.25%.

The postoperative findings in our study are shown in Table 2. The number of cases in which 2 or fewer vessel anastomoses were performed was 85 (73.27%). Our mean operation time was 203.53 ± 47.16 minutes. The mean extubation time after the OPCABG technique, which we think provides faster recovery in postoperative lung functional capacity, was determined as 331.68 ± 222.08 minutes. Atrial fibrillation, cerebrovascular disease, kidney failure and pneumonia were included as postoperative complications. Postoperatively, newly diagnosed atrial fibrillation developed in 6 patients. Hemodialysis was applied to a total of 9 patients, including 3 patients with newly developed renal failure. The mean length of stay in ICU of the patients was 2.86 ± 0.89 days. 6 of patients died. The mortality rate was calculated as 5.17%.

Parameters associated with extubation time and mortality are presented in Table 3. Hemoglobin level was determined as the effective factor on extubation time. Age, EF, troponin and hemoglobin were found to have statistically significant effects on mortality.

There were significant differences in terms of EF, extubation time, troponin and hemoglobin between survivors and non-survivors. The data from the t-test results of the mortality analysis are summarized in Table 4.

Logistic regression analysis was applied to all the significant parameters. The results are presented in Table 5. Ejection Fraction (0.011), troponin (0.036), and hemoglobin (0.036) were statistically significant among the mortality variables. Other variables were not significant.

The ROC curve method was applied to using EF, troponin, and hemoglobin levels which found to be significant in the logistic regression analysis. Results are presented in Figure 2. The other test results are shown in Table 6.

It was determined that the discriminatory power of the troponin value was more successful than other parameters, with area under the curve (AUC) = 0.755.

Table I: Demographic and Clinical Datas of Patients

Variables	n (%) or mean ±SD
Age (years)	67.97 ±3.40
Gender (male/female)	26/90
Comorbidity	
Hypertension	98 (84.48)
Diabetes Mellitus	71 (61.20)
Chronic Obstructive Pulmonary Disease	21 (18.10)
Cerebrovascular Disease	11 (9.48)
Atrial Fibrilation	9 (7.75)
Chronic Kidney Disease	6 (5.17)
Pre-operative left ventricular ejection fraction (LVEF)	51.25
Smoke	64 (55.17)
Euroscore (low/middle/high)	60/47/9
ASA (3/4)	62/54
Troponine (ng/ml)	0.56 ±1.28
Creatinine (mg/dl)	1.01 ±0.55
Hemoglobin (g/dl)	12.56 ±1.55

Table II: Table The Postoperative Findings

Variables	n (%) or mean ± SD
Number of vessels	
2 or less vessels	85 (73.27)
3 or more vessels	31 (26.72)
Operation time (minute)	203.53 ± 47.16
Extubation time (minute)	331.68 ± 222.08
Inotropes	
Noradrenaline	41 (35.34)
Dopamine	27 (23.27)
Doputamine	2 (1.72)
Additional Treatment	
Hemodialysis	9 (7.75)
CPAP	14 (12.07)
Tamponade	5 (4.31)
Post-operative complications	
Atrial Fibrilation	6 (5.17)
Cerebrovascular Disease	2 (1.72)
Pneumonia	5 (4.31)
ICU stay (days)	2.86 ± 0.89
Postoperative hospital stay (days)	5.98 ± 1.52
Readmission	18 (15.52)
Mortaltiy rate	6 (5.17)
Erythrocyte Suspension	2.07 ± 2.03

Notes: Data are presented as mean ± SD or n (%).
Abbreviations: CPAP: Continuous Positive Airway Pressure; ICU: Intensive care unit.

Table III: Parameters Associated with Extubation Time and Mortality

Character	Extubation time		Mortality	
	CC (r)	p	CC (r)	p
Age	-0.088	0.349	0.200	0.034*
Operation time	0.081	0.360	-0.065	0.487
EF	-0.101	0.281	0.242	0.009*
ASA	0.034	0.714	0.093	0.325
Troponine	-0.019	0.836	-0.196	0.036*
Creatinine	0.146	0.066	-0.024	0.802
Hemoglobin	-0.233	0.016*	0.198	0.034*

*Notes: *, Statistically significant*

Abbreviations: CC: Correlation Coefficient; ASA: American Society of Anesthesiologists physical status classification system; EF: Ejection Fraction

Table IV: A Comparison of Survivors and Nonsurvivors

	Mortality Analysis				
	Non survival		Survival		
	Mean	SD	Mean	SD	p
Operation time	213.33	31.88	202.52	47.86	0.218
EF	40.83	8.61	51.78	8.91	0.024*
ASA	3.67	0.51	3.45	0.50	0.419
Extubation time	316.67	50.76	333.44	228.67	0.042*
Troponine	2.13	4.12	0.48	0.91	0.001*
Creatinine	1.01	0.30	1.01	0.57	0.877
Hemoglobin	11.18	1.54	12.65	1.53	0.046*

*Notes: *, Statistically significant*

Abbreviations: SD: Standard Deviation; ASA: American Society of Anesthesiologists physical status classification system; EF: Ejection Fraction

Table V: Logistic Regression Analysis of All Parameters

Variables	B	SE	Wald	Sign.	Odds Ratio
Operation time	1.134	0.095	3.818	.509	2.317
EF	0.417	0.214	1.949	.011	0.792
ASA	-0.078	0.116	-0.716	.383	0.889
Extubation time	1.042	0.096	1.551	.128	1.026
Troponine	0.886	0.070	1.244	.036	1.105
Creatinine	0.967	0.130	0.947	.784	0.905
Hemoglobin	0.997	0.091	1.087	.036	1.916

Abbreviations: ASA: American Society of Anesthesiologists physical status classification system; EF: Ejection Fraction

Table 6: Results Between Survivor and Nonsurvivor Groups Based on ROC Analysis

Area Under the Curve						
Variable(s)	Area	Std.Error	Asymp. Sig.	Asymptotic 95% CI		Cuttoff Value
				Lower Bound	Upper Bound	
Ejection Fraction	0.189	0.073	0.011	0.046	0.333	32.5
Troponin	0.755	0.07	0.036	0.618	0.891	0.1
Hemoglobin	0.245	0.091	0.036	0.066	0.424	9.45

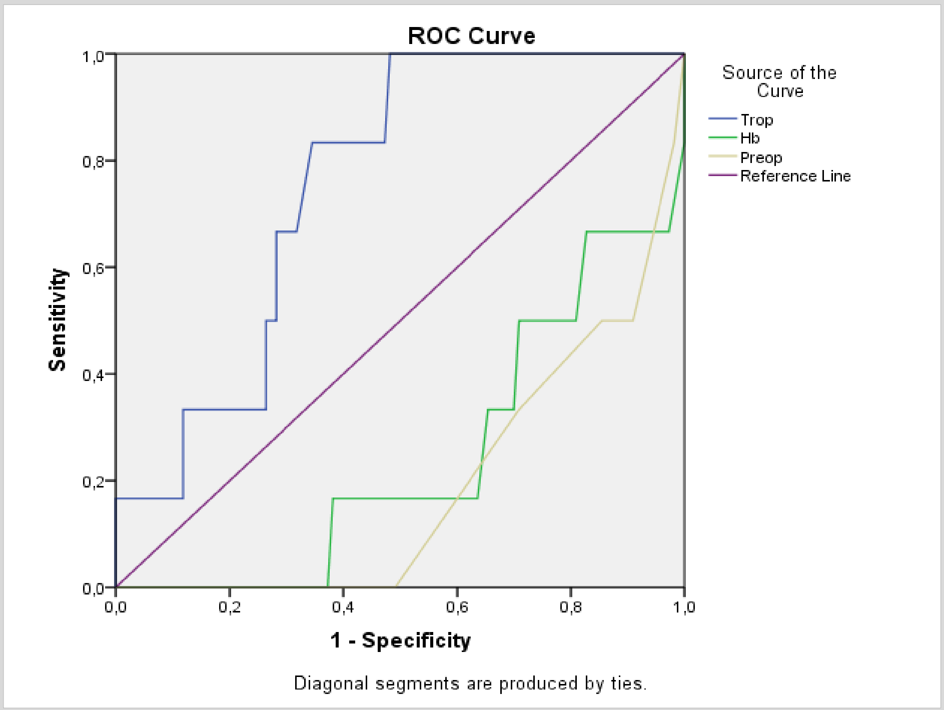

Fig. 2: ROC Curve for Troponin, Hemoglobin and Ejection Fraction

Discussion

OPCABG is a specialized surgical technique and it is very important that the surgical team is sufficiently experienced. In this study, we evaluated the results of our elderly patients who underwent OPCABG at our institution.

Several studies have shown that OPCABG is more advantages over conventional CABG in terms of morbidity and mortality in elderly patients. Zhu *et al* found that mortality was lower with off-pump compared to on-pump CABG. They suggested that OPCABG may have some benefits in terms of length of hospital stay and mortality risk [4]. Panesar *et al*. also argued that OPCABG may decrease the risk of mortality in elderly patients [5]. Similarly, Wang *et al*. reported that OPCABG is an alternative surgery for revascularization for elderly patients with coronary artery disease. They emphasized association with reduced risk of postoperative renal insufficiency and reoperation due to bleeding [8]. In a meta analysis by Saebra *et al*., it was found that OPCABG may reduce the incidence of postoperative acute kidney ınjury but may not affect the need for dialysis [9].

On the other hand, not all studies have confirmed the superiority of OPCABG in elderly patients. For example, Yuksel *et al*. reported that no significant differences between off-pump and on-pump CABG with respect to postoperative complications or mortality [10]. Diegeler *et al*. also reported similar results [11]. Conflicting data on this subject have been reported in the literature.

OPCABG is a specialized surgical technique, and it is very important that the surgical team is sufficiently experienced. In our hospital, OPCABG has been performed since 2018.

The surgeon's experience and patient-related factors may affect the operation time. In our study, we found the operation time to be 203.53 ± 47.16 minutes, which is consistent with the literature. For instance, Kitamura *et al* reported this time as 235 ± 64 minutes in their study [12].

Very variable results for extubation time have been reported in the literature. This may be due to the fact that each clinic manages the postoperative weaning process from extubation time differently. Wang *et al* compared elderly patients who underwent off-pump or on-pump CABG. When they evaluated the early clinical results, they found that mean extubation time to be 45.3 ± 63.0 hours, Kitamura *et al* reported this time as 3.7 ± 3.9 hours in their study [8,12]. For these patients, Talas *et al* reported the extubation time as 8.4± 6.6 hours [13]. In our previous study, we found the extubation time duration as 6.31 hours [6]. In the current analysis, it was determined as 331.68 ± 222.08 minutes. When we evaluated the factors that may affect this period, hemoglobin level was the only factor significantly influencing extubation time.

When postoperative complications were analyzed in these patients; dialysis requirement was detected in 6 patients, AF in 5 patients and CVA in 2 patients. Our findings were consistent with the literature [5,6,14].

For OPCABG patients, postoperative ICU stay and the mortality rate were reported as 3.6 ± 3.3 days and 3.5 %, respectively, in the studies of Wang *et al*. Talas *et al* found the ICU stay to be 2.3 days and the mortality rate to be 3% [8,13]. In our patients, the ICU stay was 2.86 days and the mortality rate was 5.17 %. When we analyzed the variables that may affect mortality, we found that age, EF, troponin and hemoglobin levels were significant.

What was remarkable here was the effect of hemoglobin on both extubation time and mortality. The relationship between hemoglobin level and length of stay in ICU, mortality, and utilization of hospital resources continues to be researched in the literature [15,16]. In the study by Paparella *et al*. in which they evaluated 939 anemic patients, 361 of them underwent CABG surgery. Patients undergoing opcabg had a shorter ICU length of stay and lower blood transfusion rate [17]. Slavenka Straus reported in his study that anemia in these patients may cause prolonged MV duration, increased need for inotrope and mortality rates [18].

The most important limitations of our study are the relatively small sample of cases and the fact that it is a retrospective and single-center design.

Conclusion

In conclusion we found that hemoglobin level has an effect on both MV duration and mortality. Following the ROC analysis, which was consistent with the literature, troponin value was determined to be the most valuable biomarker on mortality [19,20]. More detailed, prospective studies on this subject may contribute to the literature. OPCABG performed for elderly patients in rural hospitals like ours is successfully performed by experienced teams.

Declarations

Ethical Clearance

The study was conducted in accordance with the Declaration of Helsinki. The research protocol was approved by the Non-interventional Clinical Research Ethics Committee of Karabuk University (Ethic Approval Number: 2024/1795), and all of the participants provided signed informed consent.

Conflict of interest

The author(s) report no conflicts of interest in this work. The authors declared that they have no conflicts of interest this article.

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Contributors

EÇ and MA designed the research study. EÇ, MA, AY and EM performed the research. AY and EM provided help and advice on analyzed the data. EÇ, MA, AY and EM wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

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