



Does Advanced Obesity Affect CABG Surgery Outcomes?

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Abstract

Introduction: Obesity has been identified as a key risk factor for coronary artery bypass grafting (CABG) surgery. This study examines the short-term effects of obesity on clinical outcomes and mortality following CABG.

Methods: A total of 216 CABG patients were recruited and categorized into two groups according to body mass index (BMI): ≥ 35 kg/m² and < 35 kg/m². Preoperative data included age, sex, height, weight, EuroSCORE II, diabetes mellitus (DM), hyperlipidemia (HL), chronic obstructive pulmonary disease (COPD), ejection fraction (EF), and smoking status. Postoperative outcomes included intubation time, intensive care unit (ICU) stay, wound complications, sternal separation, atrial fibrillation (AF), cerebrovascular disease (CVD), pleural effusion (PE), mortality, and reoperation.

Results: Patients with BMI ≥ 35 kg/m² had higher rates of DM, hypertension, HL, COPD, smoking, and EuroSCORE II scores, while EF scores were lower. In this group, the durations of intubation, ICU stay, and hospital stay were longer; wound complications, sternal separation, atrial fibrillation, and pulmonary embolism were more frequent. Obesity was identified as an independent risk factor for prolonged ICU stay (OR: 5.16; 95% CI: 1.39–19.17; p=0.014). No significant difference in mortality rates was observed between the two groups.

Discussion and Conclusion: Although early mortality is not affected in obese patients with BMI ≥ 35 kg/m², the durations of intubation, ICU stay, and hospital stay are prolonged; wound healing problems, sternal separation, AF, and PE incidence are increased.

Keywords: Atrial fibrillation; body mass index; coronary artery bypass grafting; mortality; obesity; pulmonary embolism.

Obesity is a chronic disease whose prevalence is on the rise and is now a global epidemic ^[1]. This increase has been attributed primarily to sedentary lifestyles, unhealthy dietary habits, and changing socioeconomic structures ^[2]. Obesity is a multifaceted condition that has been demonstrated to be a risk factor for the development of cardiometabolic diseases. These diseases include, but

are not limited to, hypertension, heart failure, peripheral arterial disease, atrial fibrillation, and coronary disease ^[3]. As a result, the need for coronary artery bypass grafting (CABG) is increasing in obese individuals. The importance of revascularization in patients with severe comorbidities has been clearly emphasized in the literature ^[4]. In clinical practice, obesity is often considered a surgical risk factor.

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Recent studies have suggested that overweight or class I obese patients ($\text{BMI}=30\text{--}34.9\text{ kg/m}^2$) may have better outcomes after CABG compared to non-obese individuals, which could be explained by the "obesity paradox". However, results in patients with class II and III obesity ($\text{BMI}\geq 35\text{ kg/m}^2$) are inconsistent [5,6]. The widespread prevalence of obesity in the general population necessitates an examination of its effects on clinical outcomes of CABG procedures, with particular emphasis on high-risk patient demographics. This research aimed to evaluate the initial clinical outcomes after CABG in obese individuals with a $\text{BMI}\geq 35\text{ kg/m}^2$.

Materials and Methods

In this study, patients who underwent CABG surgery at Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Hospital between 2020 and 2023 and had a body mass index ($\text{BMI}\geq 35\text{ kg/m}^2$) were retrospectively evaluated. The study included patients who underwent isolated CABG surgery. Patients with a history of previous cardiac surgery, emergency surgery, minimally invasive surgery, or chronic renal failure were excluded from the study.

The study comprised 122 patients who underwent surgery from November to December 2023 and fulfilled the established criteria. A total of 100 patients who underwent CABG surgery were randomly selected from the hospital database using the RAND function in Excel. A grand total of 100 patients were initially considered, from which individuals with a $\text{BMI}<35\text{ kg/m}^2$ were excluded, resulting in a control cohort of 94 patients. The study examined data from 216 patients.

Patients were categorized into two groups based on the World Health Organization's classification system for obesity to maintain a standardized approach. A $\text{BMI}\geq 35\text{ kg/m}^2$ indicates Class II obesity ($35\text{--}39.9\text{ kg/m}^2$) or Class III obesity ($\geq 40\text{ kg/m}^2$). The classification of body mass index (BMI) is as follows: Class I obesity is defined as a $\text{BMI}=30\text{--}34.9\text{ kg/m}^2$; overweight is categorized as a $\text{BMI}=25\text{--}29.9\text{ kg/m}^2$; normal weight ranges from $\text{BMI}=18.5\text{--}24.9\text{ kg/m}^2$; and underweight is indicated by a $\text{BMI}<18.5\text{ kg/m}^2$. Acute kidney injury (AKI) is characterized by an elevation in serum creatinine levels of $\geq 0.5\text{ mg/dL}$ from baseline or a reduction in creatinine clearance of $\geq 50\%$.

Hyperlipidemia (HL), hypertension (HT), and diabetes mellitus (DM) diagnoses were made according to the 2021 Dyslipidemia Guidelines, 2022 Hypertension Guidelines, and 2024 Diabetes Guidelines of the Türkiye Endocrine

and Metabolism Association, respectively [7–9]. Sternal separation was defined as disruption of sternal integrity on physical examination.

Wound healing failure was defined as the absence of a healthy scar at the surgical site (leg or sternum) within 1 month. Atrial fibrillation (AF) was diagnosed by electrocardiography (ECG). Cerebrovascular disease (CVD) diagnoses were confirmed by neurological consultation. Pleural effusion (PE) was diagnosed on the basis of costodiaphragmatic sinus occlusion on chest radiographs. An intensive care unit (ICU) stay of ≥ 4 days was considered a "prolonged ICU stay". Deaths occurring before discharge after surgery were defined as "in-hospital mortality," and deaths occurring within 1 month after discharge were defined as "1-month mortality".

Ethical Approval

This research received approval from institutional and national ethical boards and complied with the principles of the Declaration of Helsinki and its supplementary protocols. Prior to data collection, approval was obtained from the Clinical Research Ethics Committee of Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Hospital (approval number: 2024.05-49, date: 10.09.2024). To protect patient confidentiality throughout the study, identifying information was removed and only anonymous data were used. The entire process was completed in accordance with established ethical guidelines.

Statistical Analysis

Statistical analyses were performed utilizing IBM SPSS Statistics 23.0 software (SPSS Inc., Chicago, IL, USA). Continuous data were presented as mean $\pm$ standard deviation (SD), whereas categorical variables were reported as counts and percentages (%). The Kolmogorov-Smirnov test was employed to assess the normality of data distribution. The independent sample t-test was used to compare variables exhibiting a normal distribution, whereas the Mann-Whitney U test was applied to variables lacking a normal distribution. Chi-square and Fisher's exact tests were employed to assess differences among categorical variables. A logistic regression analysis was conducted to identify preoperative factors influencing the length of stay in the ICU. Variables of significance revealed through univariate testing were further evaluated in multivariate analysis. Statistical significance was established at $p<0.05$.

Results

A total of 216 patients participated in the study, categorized into two groups based on BMI: BMI $\geq$ 35 kg/m² (122 patients, 56.5%) and BMI<35 kg/m² (94 patients, 43.5%). The percentage of female patients was greater in the BMI $\geq$ 35 kg/m² cohort. Moreover, the prevalence of DM, HT, HL, chronic obstructive pulmonary disease (COPD), and smoking was significantly higher in this group ($p<0.05$). In this group, EuroSCORE 2 scores were elevated, while ejection fraction (EF) was diminished ($p<0.05$). Table 1 delineates the demographic and preoperative characteristics of the study cohort.

Postoperative outcomes are presented in Table 2. Patients with BMI $\geq$ 35 kg/m² experienced significantly longer intubation times (17.6 $\pm$ 14.2 vs. 10.2 $\pm$ 4.3 hours, $p<0.001$),

ICU stays (2.6 $\pm$ 2.3 vs. 1.4 $\pm$ 0.7 days, $p<0.001$), and total hospital stays (10.7 $\pm$ 6.7 vs. 5.8 $\pm$ 1.6 days, $p<0.001$). Moreover, the incidence of postoperative complications, including wound healing defects (17% vs. 1.6%, $p<0.001$), sternal dehiscence (8.5% vs. 1.6%, $p=0.022$), pulmonary embolism (25.5% vs. 4.9%, $p<0.001$), and AF (18.1% vs. 7.4%, $p=0.016$), was significantly higher in the BMI $\geq$ 35 kg/m² group. However, no statistically significant differences were observed between the groups in terms of AKI, CVD, need for surgical revision, in-hospital mortality, or early mortality (all $p>0.05$), suggesting that obesity mainly affects morbidity rather than early mortality.

The univariate analysis results indicate that a high EuroSCORE 2, elevated BMI, hyperlipidemia, and the

Table 1. Demographic and Preoperative Characteristics

	Total (216, 100%)	BMI <35 kg/m ² (122, 56.5%)	BMI $\geq$ 35 kg/m ² (94, 43.5%)	p
Age / years	59.1 $\pm$ 8.8	60.1 $\pm$ 8.2	57.9 $\pm$ 9.4	0.078
Gender / female %	53 (24.5%)	17 (13.9%)	36 (38.3%)	<0.001*
Height / m	1.67 $\pm$ 0.07	1.71 $\pm$ 0.07	1.63 $\pm$ 0.05	<0.001*
Weight / kg	90 $\pm$ 16	78.2 $\pm$ 10.2	105.4 $\pm$ 8.8	<0.001*
EuroSCORE 2	1.37 $\pm$ 0.62	1.29 $\pm$ 0.60	1.48 $\pm$ 0.64	0.01*
DM %	149 (69%)	74 (60.7%)	75 (79.8%)	0.003*
HT %	138 (63.9%)	66 (54.1%)	72 (76.6%)	0.001*
HL %	109 (50.5%)	49 (40.2%)	61 (64.9%)	<0.001*
COPD %	48 (22.2%)	19 (15.6%)	29 (30.9%)	0.007*
Smoking %	129 (59.7%)	64 (52.5%)	65 (69.1%)	0.013*
EF %	55.06 $\pm$ 7.65	56.6 $\pm$ 6.1	53.0 $\pm$ 8.8	0.002*

DM: Diabetes Mellitus; HT: Hypertension; HL: Hyperlipidemia; COPD: Chronic Obstructive Pulmonary Disease; EF: Ejection Fraction.

Table 2. Postoperative Characteristics

	Total (216, 100%)	BMI <35 kg/m ² (122, 56.5%)	BMI $\geq$ 35 kg/m ² (94, 43.5%)	p
Intubation Duration / hours	13.4 $\pm$ 10.5	10.2 $\pm$ 4.3	17.6 $\pm$ 14.2	<0.001*
ICU Stay / days	1.93 $\pm$ 1.7	1.4 $\pm$ 0.7	2.6 $\pm$ 2.3	<0.001*
Ward Stay / days	5.9 $\pm$ 3.8	4.5 $\pm$ 1.3	7.7 $\pm$ 5.0	<0.001*
Wound Healing Defect %	18 (8.3)	2 (1.6)	16 (17)	<0.001*
Sternal Dehiscence %	10 (4.6)	2 (1.6)	8 (8.5)	0.022*
Postoperative AKI %	21 (9.7)	9 (7.4)	12 (12.8)	0.185
Postoperative AF %	26 (12)	9 (7.4)	17 (18.1)	0.016*
Postoperative CVD %	4 (1.9)	2 (1.6)	2 (2.1)	>0.99
Postoperative PE %	30 (13.9)	6 (4.9)	24 (25.5)	<0.001*
Postoperative Revision %	15 (6.9)	6 (4.9)	9 (9.6)	0.182
Hospital Mortality %	4 (1.9)	1 (0.8)	3 (3.2)	0.32
Early Mortality %	4 (1.9)	1 (0.8)	3 (3.2)	0.32
Discharge / days	7.8 $\pm$ 5.1	5.8 $\pm$ 1.6	10.7 $\pm$ 6.7	<0.001*

AKI: Acute Kidney Injury; AF: Atrial Fibrillation; CVD: Cerebrovascular disease; PE: Pleural Effusion.

Table 3. Univariate and Multivariate Analysis for Prolonged ICU Stay

Analysis	OR	CI	P
Univariate Analysis			
Age / years	1.05	0.99-1.11	0.065
Gender / female %	2.45	0.93-6.47	0.069
EuroSCORE 2	1.95	1.02-3.71	0.041*
BMI ≥ 35 kg/m ²	8.13	2.29-28.85	0.001*
EF %	0.98	0.92-1.03	0.505
DM %	0.97	0.35-2.67	0.956
HT %	2.25	0.72-7.05	0.162
HL %	4.02	1.29-12.5	0.016*
COPD %	3.64	1.38-9.58	0.009*
Smoking %	1.51	0.55-4.14	0.421
Multivariate Analysis			
EuroSCORE 2	1.93	0.92-4.04	0.082
BMI ≥ 35 kg/m ²	5.16	1.39-19.17	0.014*
HL %	2.71	0.8-9.17	0.109
COPD %	2.63	0.93-7.38	0.066

OR: Odds Ratio; CI: Confidence Interval; BMI: Body Mass Index; EF: Ejection Fraction; DM: Diabetes Mellitus; HT: Hypertension; HL: Hyperlipidemia; COPD: Chronic Obstructive Pulmonary Disease.

presence of COPD are associated with an extended ICU stay ($p < 0.05$). In multivariate analysis, a high BMI (≥ 35 kg/m²) emerged as an independent risk factor for extended ICU stay. The results are presented in Table 3.

Discussion

EuroSCORE 2 is one of the most commonly used risk assessment models in cardiovascular surgery practice [10]. In our study, we found that the prevalence of HT, HL, DM, and COPD was higher and the EF was lower in obese patients with a BMI ≥ 35 kg/m² before CABG. In line with these findings, the EuroSCORE 2 scores were also significantly higher in these patients.

Despite the expectation that early mortality would be higher in patients with a BMI ≥ 35 kg/m², no statistically significant difference in mortality was observed between the two groups after adjustment for demographic characteristics and risk scores. In the literature, several studies have reported lower early mortality rates in class I obese (BMI=30–34.9 kg/m²) and overweight patients compared to normal weight or underweight patients [6,11–13]. This phenomenon is explained by the concept of the "obesity paradox". The obesity paradox refers to the fact that although obesity is an important risk factor for the development of cardiovascular disease, it may confer a survival advantage for certain surgical procedures, such

as CABG surgery, in obese patients. Mechanisms such as increased metabolic reserves, increased secretion of amino acids and adipokines, lower levels of B-type natriuretic peptide, and reduced oxidative stress and inflammation have been proposed to explain this paradox [6]. However, there are conflicting findings in the literature regarding whether the protective effect of obesity—often referred to as the "obesity paradox"—applies to patients with class II and III obesity (BMI ≥ 35 kg/m²). Some studies have reported increased mortality in this subgroup, which contradicts the outcomes suggested by previous studies supporting the obesity paradox [5,6,14]. In our study as well, higher BMI was associated with adverse postoperative outcomes, although no significant difference in early or in-hospital mortality was observed. These inconsistencies highlight the need for further large-scale, prospective studies to clarify the impact of severe obesity on surgical outcomes in this patient population.

Our study also demonstrated that intubation duration, ICU stay, and ward stay were significantly prolonged in the BMI ≥ 35 kg/m² group. In multivariate analysis, high BMI was independently associated with prolonged ICU stay. These findings are consistent with the literature indicating that the recovery process is prolonged in obese patients [11,15]. Prolonged hospital stay increases both the workload of health care workers and hospital costs. In Türkiye, the number of ICU beds and the ratio of health care workers per patient are lower than those reported in the literature from other countries, while bed occupancy rates are higher [16]. This situation may lead to difficulties in meeting the demand for ICU beds, especially in emergency situations, and may place an additional burden on the health care system.

The negative effects of obesity on wound healing have been known for a long time. The risk of surgical site infection after open heart surgery is higher in obese patients, as several studies have shown [17–19]. In our investigation, the incidence of wound healing defects was significantly higher in patients with a BMI ≥ 35 kg/m². Although wound healing problems do not directly affect mortality, they prolong hospital stay, negatively affect patient psychology, and increase healthcare costs. Therefore, it is crucial to implement measures to support wound healing prior to CABG in patients with a BMI ≥ 35 kg/m².

This study's primary limitation is its single-center, retrospective design. This text aims to offer a thorough overview of the subject matter. Historically, obesity was solely characterized by an individual's BMI. However,

additional assessments, such as waist circumference measurement, which reflects body fat distribution and actual adiposity, were not routinely performed. In future studies, more detailed assessment of waist circumference measurements and body fat percentages in obese patients may contribute to more accurate results. In addition, there is a need for multicenter and prospective studies. Such studies may provide a clearer roadmap for clinical practice by more clearly demonstrating the effects of obesity on clinical outcomes after CABG.

Conclusion

Our study indicates that obesity, defined as a BMI ≥ 35 kg/m², does not directly contribute to increased early mortality following CABG. This patient cohort exhibited a significantly prolonged duration of intubation, ICU stay, and ward stay, as well as a significantly increased incidence of wound healing problems, sternal separation, AF, and PE. Based on these findings, we believe that reducing body mass index through appropriate preoperative nutrition programs in stable obese patients scheduled for CABG may help reduce the length of ICU and hospital stay, thereby reducing health care costs and improving the efficient use of hospital resources, even if it does not have a direct effect on mortality.

Ethics Committee Approval: The study was approved by Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Hospital Ethics Committee (No: 2024.05-49, Date: 10.09.2024).

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