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Original Article

Effect of Body Mass Index on Morbidity and Mortality in Patients Undergoing Coronary Artery Bypass Grafting

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Abstract

Background: Obesity affects cardiovascular morbidity and mortality, and it increases the risk of coronary artery disease. Despite that, several cardiac surgery risk stratification scores do not consider the effect of obesity on the outcomes. The objective of this research is to study the impact of body mass index (BMI) on morbidity and mortality after coronary artery bypass grafting (CABG) in Egyptian patients.

Methods: This prospective cohort study included 200 patients who underwent CABG for atherosclerotic coronary artery disease. Patients were divided into two groups, group A: patients with BMI ≥ 25 Kg/m2 and group B: patients with BMI < 25 Kg/m2. The mean age in group A was 56± 4.95 years vs. 54± 5.5 years in group B (p= 0.102). Male patients presented 58% of the population in group A vs 74% in group B (p= 0.017). 60% of patients were hypertensive in group A compared to 63% in group B (p= 0.66) and 62%, and 48% were diabetics in group A and B respectively (p= 0.04).

Results: Postoperatively, there was a significant increase in wound infection (40% vs 8%; p< 0.001), chest infection (47% vs. 10% p< 0.001), surgical re-exploration (28% vs. 1%; p< 0.001), prolonged ICU stays (5.3 ± 2.88 vs. 3.93 ± 1.71 days; p< 0.001), ward stay (11.28 ±8.9 vs. 5.48 ± 2.45 days; p< 0.001), mediastinitis (34% vs. 6%; p< 0.001), the occurrence of sternal wound sinus within 8 months (26% vs. 7%; p< 0.001), in group A more compared to group B. There was no difference in ejection fraction (54.2 ±7.38 vs. 54.7 ± 9.1%; p= 0.69) and mortality (4% vs. 2%; p= 0.68) between groups.

Conclusions: BMI 25 Kg/m2 or higher is associated with increased infectious complications and prolonged stay after CABG; however, it did not affect mortality. Optimizing body weight is recommended before elective surgery.

KEYWORDS
Coronary artery bypass grafting; Body mass index; Morbidity; Mortality; Obesity

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Introduction

The prevalence of obesity is increasing worldwide, producing significant repercussions in cardiovascular disease, morbidity, mortality and healthcare costs [1, 2]. Obesity with increasing waist diameter is significantly associated with an increased risk for coronary artery disease (CAD) [3]. Coronary artery bypass grafting (CABG) remains the standard of care in the management of advanced CAD, and it is associated with improved quality of life and reduced cardiac-related mortality [4]. Several studies found that obese patients have a higher incidence of morbidity and mortality after CABG [5].

Body mass index (BMI) was classified according to the World Health Organization (WHO) into three groups: normal weight (BMI between 18.5 and 24.9 kg/m2), overweight (BMI ≥ 25 Kg/m2 and < 30 Kg/m2), and obese (BMI ≥ 30 Kg/m2) [6, 7]. Although higher BMI was associated with major morbidity and increased the cost of healthcare, BMI is not included in several cardiac risk stratification scores [8]. This study aims to evaluate the effect of BMI on early and late morbidity and mortality after CABG in the Egyptian population.

Patients and Methods:

This is a prospective cohort study that included 200 adult patients who underwent CABG at Benha University Hospital and the National Heart Institute from January 2018 to January 2019. The study was approved by the Ethical Committee of Benha Faculty of Medicine, and written consent was obtained from all patients. All patients were followed up for eight months postoperatively. Exclusion criteria included age <30 years, concomitant cardiac procedures, end stage renal and hepatic disease and left ventricular ejection fraction (LVEF) < 35%. Patients were divided into two groups according to their BMI; group A included patients with BMI ≥ 25 Kg/m2 and group B had patients with BMI < 25 Kg/m2. Preoperative, operative and postoperative data were prospectively collected and entered into a computerized database.

Data collection:

Preoperative data included patients' demographics and co-morbidities. Preoperative echocardiography data included ejection fraction (EF), left ventricular end diastolic dimension (LVEDD) and left ventricular end systolic dimension (LVESD), systolic wall motion abnormalities (SWMA). Routine laboratory investigations were done for all patients; additionally, the requirements for preoperative inotropic support and intra-aortic balloon pump (IABP) were recorded.

Operative data included the urgency of the intervention, the use of cardiopulmonary bypass (CPB) (on-pump vs off-pump CABG), cardiopulmonary bypass and aortic cross-clamp (ACC) time and the type of conduits used; in addition to the need for inotropic support and IABP.

Post-operative data included; duration of mechanical ventilation, intensive care unit (ICU) stay and mortality. Post-operative complications included arrhythmia, MI (diagnosed by new Q wave on ECG and rise in CPK-MB), re-exploration for bleeding, neurological complications (stroke), pulmonary complications (pulmonary infection, atelectasis and re-intubation) and wound complications (sternotomy wound infection and/or dehiscence, mediastinitis diagnosed when exploration and debridement were required for deep sternal infection).

Surgical technique:

Conventional anesthetic and cardiopulmonary bypass techniques were standardized for all patients in both groups. A median sternotomy was used in all patients. Aortic and two-stage right atrial cannulation were used. Left internal mammary artery (LIMA) and saphenous vein were harvested conventionally. We did not use the bilateral internal mammary artery (BIMA) to decrease the risk of deep sternal wound infection. Intermittent antegrade cold and warm blood cardioplegia were delivered every 25 minutes. LIMA was grafted to the left anterior descending coronary artery (LAD) and saphenous vein grafts for the other anastomosis. Following distal anastomoses, proximal ones were done during reperfusion with the aorta partially clamped. During CPB time, hematocrit levels were maintained above 20%. Three drains were inserted before chest closure, two mediastinal and

*Table 1: Preoperative Data: Continuous variables are presented as mean± SD and range. Categorical variables are presented as number and percentage. * indicate significant difference between the groups (p < 0.05).*

		Group A (n=100)	Group B (n=100)	P
Age (years)		56.12 ± 4.95 (43 - 69)	54.9 ± 5.53 (39 - 68)	0.102
Male		58 (58%)	74 (74%)	0.017*
Hypertensives		60 (60%)	63 (63%)	0.66
Diabetics		62 (62%)	48 (48%)	0.04*
EDD (cm)		6 ± 4.58 (3.9- 5.1)	5.56± 0.52 (4.1- 7)	0.34
ESD (cm)		3.61± 0.49 (2.5- 5.1)	3.69± 0.52 (2.3- 5.4)	0.22
EF (%)		53.3± 6.3 (40-69)	55± 7.2 (40-80)	0.07
CAD	One vessel disease	2 (2%)	2 (2%)	0.012*
	Two vessel disease	16 (16%)	5 (5%)	
	Three-vessel disease	59 (59%)	78 (78%)	
	Four-vessel disease	23 (23%)	15 (15%)	

CAD: Coronary artery disease; EDD; End diastolic diameter; EF: Ejection fraction; ESD: End systolic diameter

one in the left pleural space. Patients were extubated in ICU after regaining consciousness with good motor power, satisfactory arterial blood gases (ABG) and hemodynamic stability. Regulation of blood glucose level was achieved by continuous intravenous insulin infusion to maintain glucose level below 200mg /dl.

Statistical analysis

The collected data were summarized as mean ± standard deviation (SD) and range (minimum-maximum) for quantitative data and frequency and percentage for qualitative data. Comparisons between the different study groups were carried out using the Chi-squared test ($\chi 2$) and the Fisher Exact Test (FET) to compare proportions as appropriate, the Independent t-test (t) was used to detect the difference between parametric quantitative data. The statistical analysis was conducted using SPSS version 21 (IBM Corporation, Chicago, IL, USA).

*Table 2: Intraoperative Data: Continuous variables are presented as mean± SD and range. Categorical variables are presented as number and percentage. * indicate significant difference between the groups (p < 0.05).*

		Group A (n=100)	Group B (n= 100)	P
Cardiopulmonary bypass time (min)		118 ± 35.4 (50-220)	115.7 ± 29 (60-180)	0.61
Cross clamp time (min)		76.17 ± 21.7 (35- 130)	27.5 ±18.8 (45-150)	0.21
IABP		23 (23%)	2 (%)	<0.001*
Graft	One graft	2 (2%)	3 (3%)	0.06
	Two grafts	16 (16%)	11 (11%)	
	Three grafts	58 (58%)	74 (74%)	
	Four grafts	24 (24%)	12 (12%)	
Inotropes	No used	3 (3%)	0	0.27
	One inotrope	15 (15%)	19 (19%)	
	Two inotropes	47 (47%)	47 (47%)	
	Three inotropes	35 (35%)	32 (32%)	
	Four inotropes	0	2 (2%)	

IABP: intra-aortic balloon pump

*Table 3: Early postoperative data: Continuous variables are presented as mean± SD and range. Categorical variables are presented as number and percentage. * indicate significant difference between the groups (p < 0.05).*

	Group A (n=100)	Group B (n=100)	P
Duration of mechanical ventilation (hours)	18.78 ± 22.7 (4- 168)	9.32 ± 6.12 (5- 48)	<0.001*
ICU stay (days)	5.3 ± 2.88 (2- 18)	3.93 ± 1.71 (3- 14)	<0.001*
Ward stay	11.28 ±8.9 (3- 30)	5.48 ± 2.45 (2- 15)	<0.001*
Mortality	4 (4%)	2 (2%)	0.68

Results

Preoperative data

There was no statistically significant difference between the studied groups regarding mean age (p=0.102) or hypertension (p=0.66). Group A had more patients with diabetes (p= 0.04). There was no significant difference in echocardiographic data between groups. However, the distribution of CAD differed significantly (p= 0.012) (Table 1).

Operative data

There were no significant differences in CPB time (p=0.61) and aortic cross-clamping time (p=0.21) between groups (Table 2).

Postoperative data

Duration of mechanical ventilation, ICU and ward stay were significantly higher in group A (p< 0.001) but no difference in mortality (p= 0.68) (Table 3).

There was a significant difference between both groups as regard to wound infection, chest infection, stroke, surgical re-exploration and the occurrence of sternal wound sinus within eight months (P<0.001). No liver or renal impairment had occurred in both groups. There was no significant difference in mean ejection fraction postoperatively (P=0.69) between the studied groups (Table 4).

Discussion

Despite the risk of obesity on cardiovascular disease, it is not included in several cardiac surgery risk stratification tools. The purpose of this study was to evaluate the effect of increased BMI on the outcomes after CABG in the Egyptian population. The study included 200 adult patients who underwent isolated CABG. They were classified into two groups according to BMI; group A included patients with BMI ≥ 25 kg/m2 and group B had patients with BMI < 25 kg/m2. There were no underweight patients (BMI < 20 kg/m2) included in the study.

There was no statistically significant difference between the studied groups regarding age or hypertension. Meanwhile, there was a statistically significant difference regarding sex and DM distribution. Male gender predominated in both groups; however, group A had more females than group A, a finding which is consistent with a previous Study [9].

*Table 4: Late postoperative complications: Continuous variables are presented as mean± SD and range. Categorical variables are presented as number and percentage. * indicate significant difference between the groups (p < 0.05).*

	Group A (n=96)	Group B (n= 98)	P
Wound infection	38 (40%)	8 (8.1%)	<0.001*
Mediastinitis	33 (34%)	6 (6%)	<0.001*
Chest infection	45 (47%)	10 (10)	<0.001*
Stroke	14 (15%)	0	<0.001*
Re-exploration	27 (28%)	1 (1%)	<0.001*
Sternal wound sinus	25 (26%)	7 (7%)	<0.001*
EF (%)	54.2 ±7.38 (40- 69)	54.7 ± 9.1 (40-70)	0.69

EF: Ejection fraction

Although obesity is associated with younger patients undergoing CABG [10, 11], this study did not show a difference between overweight and normal weight Egyptian patients undergoing CABG.

Smoking is more common in normal weight patients [9, 10, 12] which could confound the effect of obesity on the results of surgery. Consistent with previous studies [9, 11, 12], diabetes is more common in obese patients which contribute to the increased severity of the coronary artery disease and further increase the risk of surgery. We apply strict measures to control blood sugar level preoperatively in elective surgery and our target HbA1C is less than 7.5. Obesity increases the risk of hypertension and for every one-kilogram increase in body weight, an increase of blood pressure by 1 mmHg occurs [12]. Several studies confirmed the association between hypertension and obesity [9,11,12] which was not elicited by our study. This could be attributed to the difference in sex distribution between groups, in addition, the study did not include patients with markedly elevated BMI. Moreover, we excluded all patients with chronic diseases and end organ damage such as liver or renal diseases.

Patients with increased BMI had significantly more severe CAD, a finding that could be attributed to the obesity itself or the associated increase in DM in this group [13]. Despite the difference in the preoperative patients' characteristics, operative data were comparable between groups. This finding is consistent with other studies [9, 11, 13] and could be attributed in our study to the standardized anesthetic and CPB techniques used in all patients, in addition, we did not use BIMA in all patients to decrease the risk of infectious complications.

In early postoperative period, ventilation time, ICU and hospital stay were significantly higher in group A. Obesity was found to be associated with prolonged mechanical ventilation [8] and several mechanisms contributed to this. Obese patients had slower return to their consciousness and restoration of the muscle power and many anesthetic agents are fat soluble with prolonged duration of action in obese patients due to redistribution.

Re-exploration occurred more in group A which is inconsistent to previous studies [9, 12]. Group A had more patients with 4 grafts which increased the number of anastomosis and could contribute to the postoperative bleeding risk. We did not find significant difference in infection rate at the site of vein harvest between groups; however, other infectious complications were significantly higher with the increased BMI group. Infectious complications were inconsistently reported in obese patients in the literature. [9-12,14-15] The difference in the reported infectious complications rate in the literature could be attributed to different patients' population and surgical techniques among the published series. Additionally, several preventive measures were applied to prevent infectious complications in this subset of patients [16].

Neurological complications were significantly higher in group A which is consistent with previous studies [9, 10, 12]. Obese patients have more risk of diabetes and vascular disease which increase the risk of neurological complications. This effect can be due to the obesity itself or the associated co-morbidity. Postoperative complications tend to occur more frequently with higher BMI patients; however, this did not affect the overall mortality. Previous study showed an increased mortality in obese patients [17] and this was attributed to the severity of CAD in these patients. Obesity can affect long-term survival which was not studied in our series.

In summary; obesity had a negative impact on the outcomes after CABG with marked increase in the infectious complications. Preoperative optimization of this subset of patients and additional aseptic precaution could decrease the risk of these complications.

Study limitations:

The study has several limitations including short term follow-up and the effect of obesity on long-term survival and revascularization rate could not be evaluated. Longer study of these outcomes is recommended. Another limitation is the small number of patients, despite the detection of significant difference between groups, the number of events was too small to power the multivariable analysis to balance the difference in baseline patients' characteristics and identify the independent effect of obesity on the outcomes.

Conclusion

BMI 25 Kg/m^2 or higher is associated with increased infectious complications and prolonged stay after CABG; however, it did not affect mortality. Optimizing body weight is recommended before elective surgery.

Conflict of interest: Authors declare no conflict of interest.

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