Original Article

Impact of Body Mass Index on In-Hospital Mortality and Morbidity after Coronary Artery Bypass Grafting Surgery

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Abstract

Background: *Obesity is a common risk factor for morbidity and mortality after cardiac surgery. However, the relationship between obesity and postoperative risk has not been fully defined.*

Methods: *A prospective study of 1015 consecutive patients undergoing isolated coronary artery bypass grafting (CABG) was carried out. Body mass index (BMI) was used as the measure of obesity and was categorized as normal weight (BMI=20-25) and obese (BMI>25 and<35). The preoperative, operative, and postoperative risk factors as well as the complication and in-hospital death rates were compared between the two groups.*

Results: *Of the 1015 patients, 40% had a normal weight and 49% were obese. Compared with the normal-weight group, the obese group had a significantly higher incidence of diabetes mellitus (P=0.007) and lower arterial partial pressure of oxygen (PaO2) (P=0.03). The normal-weight patients had a higher New York Heart Association (NYHA) Functional Class (P=0.03) and were at a higher risk for emergent surgery (P=0.003) or reoperation (P=0.002). Among the postoperative complications, respiratory complications (P=0.027) were more frequent in the obese patients. The duration of mechanical ventilation (P=0.001), the incidence of arrhythmia (P=0.011), low cardiac output syndrome (P=0.001), reintubation (P=0.001), and neurological complications (P=0.003) were significantly higher in the normal-weight patients. Obesity was associated with a lower risk of reoperation for bleeding (P=0.032). There were no significant differences in infective complications, length of intensive care unit (ICU) stay, total length of stay in hospital, and operative mortality between the groups.*

Conclusion: *In the patients undergoing isolated CABG procedures, obesity did not increase the risk of operative mortality and morbidity with the exception of respiratory complications. The normal body weight patients were at a higher risk for complications than were the obese patients. Therefore, obese patients may safely undergo CABG without previous weight reduction if due attention is paid to minimize respiratory complications.*

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Keywords*: Body mass index • Obesity • Coronary artery bypass grafting • Mortality • Morbidity*

Introduction

The rate and number of obese persons in all societies have been increasing at epidemic speed.[1] The pathophysiologic consequences of obesity involve every major organ system.[2] Obesity has been identified as a risk factor for the

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developing of diabetes mellitus, hypercholesterolemia, and hypertension.[3] Obesity is defined by the American Heart Association (AHA) as a major risk factor for coronary artery disease.[4] The results of prior studies of the relationship between obesity and risk of adverse outcomes of coronary artery bypass grafting (CABG) have been contradictory. Large numbers of studies have shown that postoperative mortality and morbidity rates are higher in obese patients than are those in non-obese patients after cardiac surgery.[5-10] Increasing numbers of more recent studies, however, have demonstrated no significant association between obesity and major cardiac surgical mortality and morbidity.[11,12] In the present study, the degree of obesity was defined by the body mass index (BMI), because BMI has correlates most with the body fat content.[13] This study was designed to determine the influence of body size on operative mortality and morbidity after isolated CABG and to assess whether obesity was a risk factor for bypass surgery.

Methods

Between September 2005 and April 2006, 1015 consecutive patients underwent isolated CABG procedure with cardiopulmonary bypass (CPB) at Shaheed Rajaie Cardiovascular Center.

BMI was calculated with standard formulas, as the weight in kilograms divided by the height in meters squared. Initially, all the patients were divided into four groups on the basis of their BMI: underweight (BMI<20 Kg/m^2), normal weight (BMI=20-25 Kg/m^2), obese (BMI>25 and<35 Kg/m^2), and severely obese (BMI≥35 Kg/m^2). Then, the patients who had a normal weight and were obese were considered for entry into the study; and the remaining 117 patients, who were underweight or severely obese, were excluded. Finally, a total of 898 patients were subdivided into two groups for investigation.

Anesthesia was induced with opioids (primarily sufentanil) plus etomidate, and cisatracurium and was maintained with 100% oxygen, midazolam, sufentanil, and atracurium. All the patients underwent isolated CABG with CPB. Cardiopulmonary bypass was instituted with mild hypothermia (30˚-34˚C) and cardioplegia technique. Myocardial protection was performed in all the cases using retrograde or antegrade cold blood cardioplegia.

At the end of surgery, the patients were transferred to the intensive care unit (ICU) and extubated as soon as they met our ICU extubation criteria, namely hemodynamic stability, satisfactory arterial blood gas, no excessive bleeding (<100mL/h), normothermia, and consciousness with pain control.

The preoperative, operative, and postoperative variables were prospectively collected and entered into a computer data base. The variables selected for this study are listed in Table1.

Table 1. Preoperative, operative and post operative variables

Preoperative variables
Age
Sex
Body mass index (BMI)
New York Heart Association(NYHA) Functional Class
Ejection fraction(EF)
Hemoglobin
Arterial partial pressure of oxygen (PaO_2)
Smoking
Comorbidities[diabetes mellitus, chronic obstructive pulmonary disease (COPD),renal insufficiency]
Operative Variables
Emergency
Prior coronary artery bypass grafting
Operation time
Cardiopulmonary bypass (CPB)
Aortic cross clamp time
Number and type of distal bypass
Postoperative variables
Mechanical ventilation time
Reintubation
Arrhythmia
Low cardiac output syndrome
Reoperation for bleeding
Myocardial infarction(MI)
Respiratory complications (atelectasia, plural effusion)
Renal complication
Neurological complications
Infective complications
Intensive care unit stay
Total hospital stay
Operative death

Smoking was defined as more than 15 cigarettes per day for more than 5 years. Diabetes was determined to be present in patients receiving medication to control blood sugar values. Chronic obstructive pulmonary disease (COPD) was defined if the patient was treated with medication for COPD. Preoperative renal insufficiency was defined as serum creatinine>2 mg/dL.

Priority of surgery was assessed by cardiac surgeons and was defined as follows: “emergency” means that surgery should be performed within hours to prevent morbidity or death, and “elective” constitutes the remaining operation cases.

Postoperatively, all the patients were assessed daily for evidence of complications. Arrhythmia was considered if associated with hemodynamic compromise or medication requirement.

Postoperative bleeding was recorded as present if the patient required re-exploration to assess bleeding. Myocardial infarction (MI) was documented by a rise in cardiac isoenzyme values or electrocardiographic changes with documentation of MI by a physician. Low cardiac output syndrome was diagnosed if the patient required inotropic medication or an intra-aortic balloon pump in the operating room or in the ICU because of hemodynamic compromise or to maintain systolic blood pressure greater than 90 mmHg and a cardiac index

greater than 2.2 L/min/m^2 for at least 2 hours. Respiratory complications included plural effusion as requiring placement of a chest tube or atelectasia as radiologic appearance of complete atelectasia of one pulmonary lobe at least. Renal complications included a rise in creatinine concentration of 1 mg/dL greater above baseline or the continued presence of preoperative renal insufficiency. Postoperative neurological complications were diagnosed by a neurologic consultant and included both transient ischemia attacks and strokes. Infective complications included septicemia and deep sternal and leg wound infection as defined by positive culture and requiring antibiotic therapy. Finally, operative mortality was defined as any death that occurred during the hospital stay.

Statistical analysis was performed with SPSS, version11 statistical software. The study groups were compared using the Student's t-test for the continuous variables and the X^2 test or Fisher exact test where appropriate for the categorical variables. The continuous variables were presented as mean±standard deviation. In all the cases, P values<0.05 were considered significant.

Results

After the exclusion of the 72 (7%) underweight and 45 (4%) severely obese patients, the remaining 898 patients were classified into two groups: 403 (40%) normal-weight and 495 (49%) obese patients. The distribution of the BMI for all the patients in the study population is depicted in Figure1.

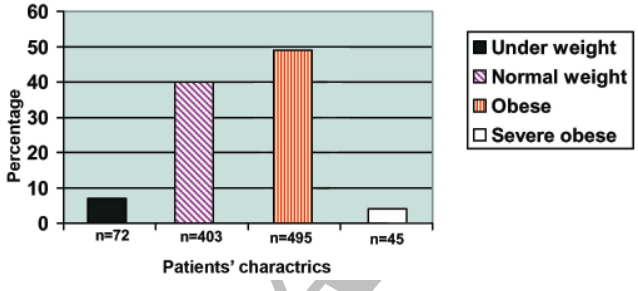

Figure1. Distribution of body mass index in the study population

Tables 2-4 describe and compare the two study groups with respect to the preoperative, operative, and postoperative patient variables. There were no significant differences in age and sex between the two groups. The obese group had a significantly higher incidence of diabetes (P=0.007) and lower preoperative PaO_2 (P=0.03), whereas the normal-weight patients were significantly more likely to have a higher NYHA Functional Class (P=0.03) than were the obese patients. No significant differences were found between the normal-weight and obese patients in the rates of preoperative renal insufficiency, COPD, and smoking. There were also no differences in terms of preoperative ejection fraction.

Table 2. Preoperative patient's variables

Variables	Normal weight patients (n=403)	Obese patients (n=495)	P value
Age (y)	54±13	56±10	NS
Sex (M/F)	61/39	65/35	NS
NYHA class (I-II/III-IV)	74/26	80/20	0.03
EF (<35/35-49/≥50)	12/36/52	9/40/51	NS
PaO_2 (mmHg)	74±10	71±11	0.03
Smoking	23.1	24.6	NS
Diabetes mellitus	16.9	24	0.01
COPD	3.2	2.7	NS
Renal insufficiency	4	3.2	NS

*Data are presented as mean±SD or percentage
NS, Not significant; NYHA, New York heart association; PaO2, Arterial partial pressure of oxygen; COPD, Chronic obstructive pulmonary disease

Table 3. Operative patients' variables

Variables	Normal weight patients (n=403)	Obese patients (n=495)	P value
Emergency case	8.2	3.7	0.003
Reoperation	10	5.2	0.002
Operative time (min)	235±69	231±55	NS
CPB time (min)	96±42	89±32	NS
Aortic cross clamp (min)	53±27	49±22	NS
No. of coronary grafts			NS
One	8.3	4.2	
Two	18.7	17.4	
Three	46.5	53.7	
≥ Four	26.5	24.7	
LIMA use	95.7	95.4	NS

*Data are presented as mean±SD or percentage
NS, Not significant; CPB, Cardiopulmonary bypass ; LIMA, Left internal mammary artery

Table 4. Postoperative patients' variable

Variables	Normal weight patients (n=403)	Obese patients (n=495)	P value
Mechanical ventilation time (hr)	10±10.0	6±5.0	0.001
Reintubation	5	1.3	0.001
Arrhythmia	12.4	7.6	0.011
Low out put syndrome	16	8.2	0.001
Myocardial infarction	7	5	NS
Reoperation for bleeding	10	6	0.032
Respiratory complications	5.5	9.1	0.027
Renal failure	3	2.2	NS
Neurological complications	5	2.2	0.003
Infective complications	4.5	3	NS
Days in ICU (d)	4.1±4.3	3.4±2.2	NS
Hospital stay,	12±6.4	10±7.3	NS
Operative death	4.4	2.5	NS

* Data are presented as mean±SD or percentage
NS, Not significant; ICU, Intensive care unit

Regarding the operative factors, more normal-weight patients received emergent surgery (P=0.003) and reoperation (P=0.002). Nonetheless, there were no statistically significant differences between the two groups in the operation, CPB, and aortic clamp times or the number and type of coronary grafts.

Among the postoperative variables, the normal-weight patients received ventilator support longer (P=0.001) and had a higher incidence of arrhythmia (P=0.011), low output syndrome (P=0.001), reintubation (P=0.001), re-exploration for bleeding

(P=0.032), and neurological complications (P=0.003). On the other hand, the incidence

of respiratory complications (P=0.027) were significantly higher in the obese patients than that of the other group. The incidences of infective complications and operative deaths were higher in the normal-weight patients and they stayed in the ICU and hospital for longer periods compared to the obese patients, but there was no statistically significant difference between the groups. The incidences of major complications in this group of patients compared to the total study patients (n=898) are shown in Figure 2.

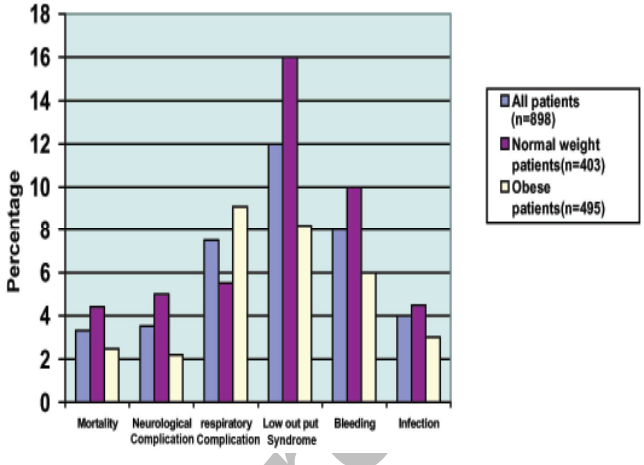

Figure 2. Incidence of major complications between study groups

Discussion

The present study seems to be the first of its kind to examine the relationship between BMI and the early outcome of CABG in an Iranian population. This study had access only to data on postoperative complications occurring in the hospital.

It is commonly assumed that obesity is a risk factor for a poor outcome for operative mortality following CABG [5-8,11,12] because of the increased incidence of comorbid factors such as diabetes, hypertension, alternations of pulmonary function, and technical difficulty of performing surgery and hemostasis.[11] Be that as it may, several previous studies have shown that underweight patients are at an increased risk of mortality or common complications after cardiac surgery.[14-20]

In this study, we found that the combination of obesity with diabetes and lower PaO_2 was not associated with increased postoperative complications except for respiratory complications such as atelectasia and plural effusion. Similar to our results, Prasad et al.[8] demonstrated an increase in the incidence of respiratory problems in obese patients following cardiac surgery. Obesity is known to alter the pulmonary function, leading to a decrease in functional residual capacity, vital capacity, and maximum voluntary ventilation.[21] Furthermore, the obesity and limited ability to perform activity in this group of patients may account for this finding.

On the other hand, obesity may be protective against some adverse outcomes.[14,22] Interestingly, the obese group compared to the normal-weight group was significantly less likely to experience postoperative bleeding. This chimes in with the finding of some previous studies[11,12,17,20] maintaining that the risks of postoperative bleeding and reoperation for bleeding were significantly lower in obese patients. Nonetheless, these studies also failed to document any significant protective effect of obesity.[5,6,11] In the present study, the lower number of emergent operations and reoperations in the obese patients may be related to the lower risk of re-exploration for bleeding in this group of patients.

Many prior studies[5-8,11,12,23-25] have indicated a higher incidence of infective complications in obese patients. The decreased perfusion of subcutaneous fat tissue and the higher incidence of diabetes mellitus in the obese, postoperative hemorrhage, prolonged operation time, age, renal failure, and low cardiac output syndrome may lead to an increase in infective complications.[5-8,12,15,25,26] We found a similar incidence of infective complications between the obese and the normal-weight groups.

Multiple mechanisms are likely to explain this finding: in patients with diabetes mellitus, the treatment of hyperglycemia in the postoperative period may reduce infection. On the other hand, a higher incidence of emergent operation, reoperation,

postoperative bleeding, and low cardiac output syndrome in normal weight patients may lead to a similar incidence of infective complications between the two study groups.

In the current study, the normal-weight patients had a higher incidence of postoperative complications such as arrhythmia, low cardiac output syndrome, longer ventilation time, reintubation, and neurological complications. Interestingly, the increased rates of these complications in this group of patients were not risk factors for in-hospital mortality, length of ICU, or hospital stay; and the incidence of these factors were not different between the two study groups. Ennker et al.[23] reported a higher incidence of postoperative complications in their morbidly obese patients, but they found no significantly higher mortality in this group of patients compared with normal-weight patients. Some previous studies[5,11,12,14,17,22] have shown that obese patients are younger than non-obese patients and have less severe

ischemic heart disease, comorbidities, and similar incidence of in-hospital mortality.

Nutritional status may be an important factor with impact on morbidity and mortality after cardiac surgery,[27,28] and patients with a higher percentage of body fat may have better nutritional status, which may allow them to handle operative stress and postoperative complications more efficiently.

Conclusion

Obesity does not increase the risk of major adverse outcomes in patient undergoing CABG. In fact, normal weight patients are seen to be at a higher risk for postoperative complications than obese patients. This study does indicate that while obese patients are at risk of postoperative respiratory complications such as atelectasia and plural effusion, they are not at a higher risk of reintubation or longer mechanical ventilation time. Respiratory complication rates can be decreased in these patients in the postoperative period with early ambulation, pulmonary toilet, and use of incentive spirometry. Therefore, obese patients may safely undergo coronary surgery without previous weight reduction. Further studies are needed to identify the protective effect of obesity on postoperative bleeding after CABG.

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