ORIGINAL ARTICLE

Effect of body mass index on early outcomes of coronary artery bypass grafting

Ghulam Hussain,[1] Mirza Ahmad Raza Baig,[2] Abdul Ghaffar,[3] Sara Zaheer,[4] Hafiz Muhammad Azam Raheel,[5] Sehrish Khalid[6]

Abstract

Objective: To assess the impact of body mass index on early outcomes of coronary artery bypass grafting in terms of morbidity and mortality.

Methods: This retrospective comparative study was conducted at Chaudhry Pervaiz Elahi Institute of Cardiology, Multan, Pakistan, and comprised data of patients who underwent isolated coronary artery bypass grafting from December 2007 to December 2015. Analysis of variance and chi-square test were used for analysis of groups formed on the basis of body mass index. SPSS 20 was used for data analysis.

Results: Of the 2,366 patients, 830(35.1%) had normal body mass index, 1,024(43.3%) were overweight, 402(16.9%)were obese and 110(4.6%) were morbidly obese. The overall mean age was 55.82±9.58 years. The mean age of morbidly obese patients was significantly lower (p=0.02). Additive euro score was high in patients with normal body mass index (p=0.006). Post-op creatine kinase muscle and brain MB levels and incidence of peri-operative myocardial infarction was significantly high in obese and morbidly obese groups (p=0.002 and p=0.01, respectively). Hospital stay time was significantly longer in obese and morbidly obese patients (p=0.01). The incidence of post-operative complications was the same in all groups (p>0.05). Operative mortality was also the same between the groups (p=0.58).

Conclusion: Higher body mass index was associated with increased risk of short-term morbidity in terms of myocardial infarction after surgery and increased length of hospital stay. Our study did not support the concept of obesity paradox.

Keywords: Body mass index, Coronary artery bypass grafting, Obesity. (JPMA 67: 595; 2017)

Introduction

There has been a long-standing perception that obesity increases the risk of adverse operative outcomes following coronary artery bypass grafting (CABG). This perception is perhaps due to the fact that obesity is a well-known risk factor for the development of co-morbid conditions such as diabetes, respiratory dysfunction, hypertension and coronary artery disease.[1-3] Several researches have shown equal or even less operative mortality rate in obese patients versus non-obese patients.[4-7] Some studies have concluded that obesity is a risk factor for sternal wound infections but not for other adverse outcomes.[8,9] According to the society of thoracic surgeons adult cardiac surgery database, low body mass index (BMI) is a predictor of higher mortality rate.[10] Many other researchers have shown a higher incidence of morbidity and mortality in obese patients following CABG surgery.[8,11-13] So there is still a considerable debate whether obesity is a risk factor for adverse outcomes or not. The current study was planned to rule out the effect of different BMI on operative outcomes in patients of CABG surgery.

[1-3,5,6]Chaudhry Pervaiz Elahi (CPE) Institute of Cardiology, Multan, [4]Woman Medical Officer, Civil Hospital Multan, Pakistan.

Correspondence: Mirza Ahmad Raza Baig.

Email: ahmadraza.perfusion@gmail.com

Patients and Methods

This retrospective study was conducted at Chaudhry Pervaiz Elahi Institute of Cardiology (CPEIC), Multan, Pakistan, and comprised patients who underwent isolated CABG between December 2007 to December 2015. The data was retrieved from the cardiac surgery database software of the hospital. Ethical approval for the study was obtained from CPEIC's department of academic affairs. To minimise bias, patients who underwent any concomitant procedure along with CABG and patients who underwent emergency and salvage procedures were excluded. This was done because patients who underwent valvular surgery in this region have much dilated hearts, pre-operative atrial fibrillation, greater haemodynamic instability and usually normal BMI, and that could bias the outcomes of the study. BMI was calculated for all patients. They were divided into four groups on the basis of BMI, i.e. group 1 comprising normal weight patients (BMI 20.0-24.9 kg/m^2), group 2 overweight patients (BMI 25.0-29.9 kg/m^2), group 3 obese patients (BMI 30-34.9 kg/m^2) and group 4 had morbidly obese patients (BMI >35 kg/m^2).[14] Underweight patients (BMI <20 kg/m^2) were excluded because of their smaller number. The sample size was calculated by taking the average incidence of peri-operative myocardial infarction (MI) (i.e. myocardial infarction immediately after surgery) in normal weight patients 20.2% and 12.3% in obese

patients.[7] Power of the test was taken at 0.80 and level of significance at 0.05. We took more than double the required sample size to make our results more reliable.

Surgical risk factors were examined in terms of age, gender, hypertension, smoking history, diabetes mellitus, family history and urgency of the surgical procedure. Surgical outcomes were examined in terms of ventilator support time, intensive care unit (ICU) stay, requirement of pharmacologic and mechanical support, post-op bleeding, renal failure, pulmonary complications, neurologic complications, hospital stay and operative mortality. Any death due to cardiac cause within thirty days after surgery was taken as operative mortality. The following criteria were used to define inotropic support: mild (dobutamine <5 ug/kg/min, adrenaline or nor-adrenaline <0.0.6 ug/kg/min), moderate (dobutamine >5-10 ug/kg/min, adrenaline or nor-adrenaline 0.6-1.0 ug/kg/min), and high dose (dobutamine >10 ug/kg/min, adrenaline or nor-adrenaline >1.0 ug/kg/min).

SPSS 20 was used for data analysis. One-way analysis of variance (ANOVA) test was used for the analysis of continuous variables. Chi-square test was used to analyse quantitative variables. P<0.05 was considered significant.

Results

Of the 2,366 patients, 830(35.1%) had normal BMI, 1,024(43.3%) were overweight, 402(16.9%) obese and 110(4.6%) were morbidly obese. The overall mean age was 55.82±9.58 years. The mean age was56.53±10.14 years in group-1, 55.73±9.30 years in group-2, 55.03±9.34 years in group-3 and 54.32+8.16 years in group-4 (p=0.02). The number of male participants was 729(87.8%), 888(86.7%), 323(80.3%) and 81(73.6%) in the groups 1, 2, 3 and 4, respectively (p<0.001). There were

Table-1: Comparison of Demographic Variables and Risk Factors of Coronary Artery Disease.

Variable	Group I (Normal Weight)	Group II (Overweight)	Group III (Obese)	Group IV(Morbidly Obese)	P-value
Number	830	1024	402	110	--
Body Mass Index	22.99±1.37	27.24±1.38	31.91±1.33	38.17±3.29	--
Age (Y)	56.53±10.14	55.73±9.30	55.03±9.34	54.32±8.16	0.02
Male Gender (%)	729 (87.8)	888 (86.7)	323 (80.3)	81 (73.6)	<0.001
Hypertension (%)	317 (38.2)	469 (45.8)	208 (51.7)	66 (60.0)	<0.001
Diabetic History (%)	274 (33.0)	382 (37.3)	159 (39.6)	41 (37.3)	0.10
Smoking History (%)	324 (39.0)	396 (38.7)	137 (34.1)	35 (31.8)	0.18
Family History (%)	202 (24.3)	209 (20.4)	92 (22.9)	26 (23.6)	0.23
Pre-op Creatinine Levels	1.00±0.00	0.99±0.29	0.99±0.21	0.97±0.17	0.67

Table-2: Comparison of Angiographic and Echocardiographic Characteristics.

Variable	Group I (Normal Weight)	Group II (Overweight)	Group III (Obese)	Group IV(Morbidly Obese)	P-value
Pre-op EF (Mean+SD)	51.12±10.14	51.30±10.08	51.82±10.23	52.95±9.56	0.25
Severity of the Coronary Artery Disease (N & %)					
Single Vessel Disease	25 (3.0)	31 (3.0)	15 (3.7)	2 (1.8)	0.47
Double Vessel Disease	98 (11.8)	128 (12.5)	58 (14.4)	15 (13.6)	
Three Vessel Disease	527 (63.5)	687 (67.1)	250 (62.2)	71 (64.5)	
Left Main Stem disease	180 (21.7)	178 (17.4)	79 (19.7)	22 (20.0)	
Angina Class CCS (N &%)					
Class III	622 (74.9)	789 (77.1)	305 (75.9)	78 (70.9)	0.14
Class IV	42 (5.1)	38 (3.7)	8 (2.0)	3 (2.7)	
LV Function Grades (N &%)					
Grade II	197 (23.7)	201 (19.6)	80 (19.9)	17 (15.5)	0.15
Grade III-IV	104 (12.5)	134 (3.1)	51 (12.7)	10 (9.1)	
Priority Status (N & %)					
Elective	802 (96.6)	995 (97.2)	392 (97.5)	109 (99.1)	0.48
Urgent	28 (3.4)	29 (2.8)	10 (2.5)	1 (0.9)	
Add-euro Score	1.28±1.36	1.19±1.25	1.05±1.04	0.97±1.21	0.006

Continuous variables are presented as mean+ standard deviation (SD) while qualitative variables are presented in number and percentages.
EF: Ejection fraction
CCS: Canadian cardiovascular scoring.

Table-3: Comparison of Operative and Early Post-operative Outcomes.

Variable	Group I (Normal Weight)	Group II (Overweight)	Group III (Obese)	Group IV (Morbidly Obese)	P-value
Bypass Time (min)	110.38±30.52	109.52±30.94	108.58±30.53	104.60±29.68	0.31
Clamp Time (min)	63.87±19.79	63.29±19.61	62.93±21.88	56.70±17.77	0.008
Number of Grafts	2.79±0.73	2.83±0.65	2.80±0.74	2.84±0.71	0.54
Post-op CKMB Levels (IU)	54.91±56.61	63.63±74.87	73.21±124.84	81.33±96.45	0.002
Peri-op MI (%)	23 (2.8)	52 (5.1)	23 (5.7)	8 (8.2)	0.01
Duration of Support (hours)	10.56±15.45	12.01±19.29	11.80±15.14	12.16±16.42	0.32
Ventilation time (hours)	7.37±11.57	7.86±16.57	7.55±11.01	8.51±19.13	0.82
ICU Stay (hours)	40.37±30.1379	41.25±27.65	41.68±22.80	42.33±34.61	0.82
Hospital stay (days)	6.96±2.64	7.23±3.24	7.44±4.02	7.87±3.60	0.01
Post-op Drainage (ml)	679.65±378.54	680.26±382.05	640.00±331.25	710.23±436.97	0.21
Inotropic Support (%)					
Mild	472 (56.9))	597 (58.3)	251 (62.4)	71 (64.5)	0.67
Moderate	209 (25.2)	255 (24.9)	85 (21.1)	23 (20.9)	
High Dose	24 (2.9)	28 (2.7)	9 (2.2)	5 (4.5)	
Nil	125 (15.1)	144 (14.1)	57 (14.2)	11 (3.3)	
Intra-aortic balloon pump use (%)	27 (3.3)	38 (3.7)	16 (4.0)	4 (3.6)	0.92
Renal Complications (%)	12 (1.4)	12 (1.2)	4 (1.0)	0 (0.0)	0.59
Pulmonary Complications (%)	28 (3.4)	57 (5.6)	15 (3.7)	6 (5.5)	0.11
Neurologic complications (%)	15 (1.8)	13 (1.3)	5 (1.2)	1 (0.9)	0.72
Operative Mortality (%)	12 (1.4)	11 (1.1)	3 (0.7)	2 (1.8)	0.58

ICU: Intensive care unit
MI: Myocardial Infarction
CKMB: Creatine kinase MB.

more hypertensive patients 66(60.0%) in the morbidly obese group and the least in normal BMI group 317(38.2%) (p<0.001). There was no significant difference regarding other risk factors, i.e. diabetic, smoking and family history between the groups (Table-1).

The mean additive euro score was 1.28±1.36 among patients with normal BMI as compared to 1.19±1.25, 1.05±1.04 and 0.97±1.21 among overweight, obese and morbidly obese patients (p0.006). There was no significant difference in the severity of coronary artery disease and Canadian cardiovascular scoring (CCS) system class between the groups (p=0.47 and p=0.14, respectively). There was no significant difference in the priority status of surgery between the groups (p=0.48) (Table-2).

The mean aortic cross clamp time was 56.70±17.77 minutes among morbidly obese patients as compared to 63.87±19.79, 63.29±19.61and 62.93±21.88 in groups 1, 2 and 3(p=0.008). Post-op creatine kinase muscle and brain (CK-MB) levels, at 81.33±96.45 international units (IU), and the incidence of peri-operative MI, at 8(8.2%), was significantly high in morbidly obese group as compared to the other groups (p= 0.002 and p=0.01, respectively). There was no significant difference in the need and duration of pharmacologic and inotropic support, mechanical ventilation duration and ICU stay time between the groups. However, the mean hospital stay time among morbidly obese patients was significantly higher at 7.87±3.60 days (p=0.01). The incidence of post-operative complications, e.g. renal, pulmonary and neurologic complications, was the same in all groups. Operative mortality was also the same between the groups (Table-3).

Discussion

Many studies have concluded that obesity is associated with more favourable outcomes in terms of mortality (short-term and long-term) after cardiac surgery,[4,6] despite its association with higher cardiovascular risk factors and risk of death in normal population.[15] The reason for this may be that excessive adipose tissues may confer advantage at times of stress and illness.[16] So the improved outcomes in obese patients may be due to high metabolic reserves and body fat which is absent in patients with low BMIs.[17-19]

In this study, most of the patients who underwent cardiac surgery were in the overweight group. We found an inverse linear relationship between age at the time of surgery and BMI. The patients were younger in morbidly obese group and were older in normal body weight group. This indicates that obese patients underwent cardiac surgery at a younger age. Several other studies also have concluded that obese patients undergo cardiac surgery in younger age.[7,20,21] In this study, higher number

of females underwent cardiac surgery in morbidly obese group; this finding was similar to many other studies. The mean age of patients at the time of surgery in this study was 55.82±9.58 years but in other studies the mean age was more than 60 years at the time of surgery.[7,20,22]

It is also postulated that because obese patients are receiving preoperative statin treatment, there is a lower release of biochemical markers of myocardial damage during surgery.[23] In the present study, the release of CK-MB was high in obese patients, very high in morbidly obese patients and at the lowest value in normal weight patients. Similarly, the incidence of in-hospital MI was also high in morbidly obese patients. In this study, we found a higher hospital stay time in morbidly obese patients (p=0.01).

We did not find any significant difference in operative mortality in all patients' subgroups. Operative mortality was little high in morbidly obese patients as compared to the other subgroups but this difference was not statistically significant. Some studies have found lower incidence of in-hospital mortality in morbidly obese patients[6] while some other studies found no difference in in-hospital mortality after cardiac surgery.[8,21] In a study conducted by Engel et al., the operative mortality in morbidly obese group was 1% and 2% in both normal and obese group patients.[20] In another study, operative mortality was 0.6% in morbidly obese patients, 0.8% in both obese and overweight patients, and 0.9% in normal BMI patients.[21] Johnson et al. found lower mortality rate in overweight and obese subgroups with mortality rates of 0.9% and 1.0%, respectively. In their study, mortality rate was higher in normal and morbidly obese subgroup of patients (1.5% and 1.2%, respectively).[7] These findings are similar to the results of our study. In our study, mortality rate was only 0.7% in obese group and 1.1% in overweight patients as compared to 1.4% in normal weight and 1.8% in morbidly obese patients. This difference was statistically insignificant.

The main power of this study is that we took only those patients who underwent isolated CABG while other studies also included those patients who underwent other concomitant procedures along with CABG. So, our study population was more homogenous as compared to other studies, and it helped minimise bias in this study. The other main strength is the large sample size that allowed for robust comparison among BMI groups that made findings of this research more reliable.

However, the study had some limitations as well. The main limitation was the retrospective nature of this study. Furthermore, the number of patients in morbidly obese group was less as compared to other subgroups that could create bias. Another limitation was the short follow-up period of only one month after surgery. However, other studies with the mean follow-up time of three years or more have shown similar results as that of our study.[7,24,25]

Conclusion

Higher BMI was associated with increased risk of short-term morbidity in terms of MI after surgery and increased length of hospital stay. The operative mortality was little high in morbidly obese patients. Our study did not support the concept of obesity paradox on short-term operative outcomes after surgery.

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