Case report

A Study of Relationship between Body Mass Index and Short Term Outcome of Isolated Coronary Artery Bypass Graft Surgery

Azhar AH[1](✉), Zulkarnain H, Ziyadi G, Rahman MNG

[1]Department of Surgery, Hospital Universiti Sains Malaysia, Kubang Kerian, Kelantan

Abstract

Coronary artery disease (CAD) is the most common cause of death in the industrialized world. Obesity is one of the risk factor for developing CAD and also postoperative morbidity and mortality. However, in published articles the relationship between body mass index (BMI) and outcome of coronary artery bypass graft surgery depict conflicting results. This study evaluated the relationship between BMI and outcome of isolated coronary artery bypass graft performed in Hospital Universiti Sains Malaysia (HUSM). Cardiothoracic Unit HUSM is a referral centre for east coast of West Malaysia. Data was retrospectively collected from the medical records retrieved from the hospital record office. All patients who underwent isolated CABG in Cardiothoracic Unit, Hospital Universiti Sains Malaysia Kubang Kerian, Kelantan from November 2001 till October 2004 were identified and their demographic and clinical data were collected. Patients were divided into non overweight (BMI= or <25 kg/m^2) and overweight (BMI>25 kg/m^2) group. Data was then analyzed using SPSS version 12.0. There were 141 patients who underwent isolated CABG over the three year period. There were 80 patients with BMI < or =25 kg/m^2 and 61 patients with BMI of >25 kg/m^2. The demographic data of the two groups were similar. There was no statistical significant differences in the outcome of isolated coronary artery bypass graft. In conclusion, body mass index does not influence the outcome of isolated coronary artery bypass graft.

Keywords: Body mass index, coronary artery bypass graft, outcome

Correspondence:

Dr. Azhar bin Amir Hamzah, Department of Surgery, School of Medical Sciences, Universiti Sains Malaysia, Health Campus, 16150 Kubang Kerian, Kelantan, Malaysia. Tel: +609-7664542 Email: drazhar786@hotmail.com

Date of submission: 25th June 2011 Date of acceptance: 19th Sept 2011 Date of publication: 3rd Oct 2011

Introduction

Coronary artery disease is the most important cause of morbidity and mortality in the industrialized world. It is also true in Malaysian population as heart disease is the number one cause of death. Each year over 1 million people around the world die from coronary atherosclerosis. Coronary artery bypass grafting (CABG) developed in the 1960s has dramatically changed the management of patients with ischaemic heart disease.

Several factors have been identified to influence outcome of CABG operations and risk stratification models have been developed to calculate such risks (1-7). However these risks stratifications do not include differences in BMI to the outcome of cardiac surgery. Only Higgins (1) and Parsonnet (2) score which include obesity as a risk factor.

Although there is little evidence in the literature, obesity is often thought to be a risk factor for perioperative morbidity and mortality with cardiac surgery and other major surgical procedures. The reports showing higher BMI as a risk factor for complications and in-hospital mortality after CABG also contains conflicting results (8-13). Several recent publications also suggested that overweight and obesity has no influence on morbidity and mortality of

CABG even though there is an increased risk of in hospital and early post operative morbidity after CABG (1-3, 14-17). Many of previous studies on the association between obesity and outcomes with cardiac surgery have limitations due to small sample size and a lack of data about potentially confounding factors. Only studies with large sample size found obesity to be a significant risk factor (8-9, 11-21).

Based on these apparently contradictory findings, this study used the Cardiothoracic Unit, Hospital Universiti Sains Malaysia database to evaluate the role of BMI in outcome of isolated CABG at Hospital Universiti Sains Malaysia, Kubang Kerian Kelantan.

Materials and Methods

This was a cross retrospective study on of patients who underwent isolated CABG from November till October 2004 at Cardiothoracic Unit Hospital Universiti Sains Malaysia Kubang Kerian, Kelantan.

All patients who underwent isolated CABG during the study period were included in the study. Patients who underwent concomitant valve surgery were excluded.

Secondary data were obtained from the medical records of all patients who underwent coronary artery bypass graft (CABG) at Hospital Universiti Sains Malaysia. Patients were divided into two groups; Group 1 consisted

Table 1: Independent Variables and definitions

Variable	Definition
Race	Malay, Chinese, Indian, Siamese
Age (years)	Years
Sex	Male, female
Diabetes mellitus	Diet-controlled, oral therapy or insulin-dependent diabetes
Hypertension	Systolic blood pressure >160 mmHg, or diastolic pressure >100 mmHg or on antihypertensive medication
Hyperlipidaemia	Total cholesterol .250 mg/dl or triglyceride level 200 mg/dl or on lipid lowering agent
New York Heart Association	Classification of cardiac failure.
Ejection Fraction	Percentage of blood volume emptied from heart between diastolic and systolic phase of cardiac cycle. Determined using echocardiography Ejection fraction: good (>50%), poor (>30%-50%), bad (<30%)
Renal disease	Renal failure (creatinine >120 mmol/l) preoperative dialysis,
Bypass time	Time on extra-corporal circulation, duration in minutes
Cross clamp time	Aortic cross-clamp, duration in minutes
Cardioplegia	Hartman's with high potassium used to produce asystolic myocardial arrest, volume in millilitre
Days of hospital stay	Number of days patients stay after CABG
Days in CICU	Number of days patients stay in CICU after CABG
Time extubated	Time patient extubated after completion of surgery in hours

Table 2: Dependent Variables and Definition

Variables	Definition
BMI	Body mass index
Leg wound infection	Wound dehiscence, discharge or dehiscence
Sternotomy wound infection	Sternal dehiscence with or without refixation.
Postoperative bleeding	Excessive bleeding postoperatively requiring immediate reoperation, mediastinitis
Chest infection	Radiological evidence of area of consolidation associated with clinical signs of cough, elevated neutrophil counts with or without fever.
Pleural effusion	Blunted costophrenic angle(s) on chest radiograph.
Neurological insult	Cerebrovascular accidents and/or transient ischemic attack
Sternal non union	Mobile or unstable sternum after surgery
Dysrhythmias	Persistent abnormal cardiac rhythm other than normal sinus rhythm after surgery requiring intervention (medical or mechanical cardioversion)

Table 3: Characteristics of patients who underwent isolated CABG

Variables	Group 1 BMI < 25		Group 2 BMI >25		χ^2, t[a]	Mean difference (95% CI)	p
	n	%	n	%			
Race							
Malay	70	49.6	50	35.5			
Chinese	9	6.4	10	7.1	0.841		0.657
Indian	1	0.7	0	0			
Siamese	0	0	1	0.7			
Age, mean± sd	58.6±8.2		55.6±8.7		2.060	2.956 (0.119 5.793)	0.041
Sex							
Male	64	45.4	53	37.6	1.162		0.281
Female	16	11.3	8	5.7			
DM							
Yes	28	21.7	23	17.8	2.619		0.980
No	43	33.3	34	27.1			
HPT							
Yes	58	45.0	44	34.1	0.528		0.418
No	13	10.1	14	10.9			
HPL							
Yes	54	41.9	46	35.7	0.021		0.660
No	15	13.2	12	9.3			
DM AND HPT							
Yes	24	18.8	18	14.1	0.152		0.697
No	46	35.9	40	31.3			
DM AND HPL							
Yes	19	14.8	19	14.8	0.479		0.489
No	51	39.8	39	30.5			
HPT AND HPL							
Yes	43	33.9	35	27.6	0.052		0.820
No	26	20.5	23	18.1			
DM, HPT AND HPL							
Yes	18	14.1	15	11.7			
No	52	40.6	43	33.6	<0.001		0.985
Preoperative ejection fractions (EF)							
30-50%	11	7.8	10	7.1			0.662
>50%	69	48.9	51	36.2	0.191		
NYHA							
1	31	22.0	23	16.3			
2	36	25.5	23	16.3	2.573		0.462
3	13	9.2	14	9.9			
4	0	0	1	0.7			

of patients with BMI = and < 25 kg/m^2 and Group 2 consisted of patients with BMI >25 kg/m^2. BMI, derived from Quetelet's formula, equal weight (in kilograms) divided by the square of height (in meters).Table 1 (independent variables) and Table 2 (dependent variables) showed the studied variables and their definition.

The demographic characteristics such as age, race and sex of patients who underwent coronary artery bypass graft were determined. The distribution of NYHA classification, ejection fraction by echocardiography and incidence of hypertension, diabetes mellitus and hyperlipidaemia were recorded. Length of stay was taken in this study as number of days of in hospital care post coronary artery bypass graft. Incidence of post operative complications were also obtained from case notes.

Statistical Analysis

Statistical analysis used descriptive and univariable analysis. Descriptive used graph and tabulation. Univariable analysis used chi square (χ^2 for categorical dependent variables and independent τ test or one way ANOVA for numerical dependent variables. Patients were divided into two groups. Group 1 – patients with BMI $\leq$ 25 and Group 2- patients with BMI $\geq$ 25. Continuous variables are shown as mean and standard deviation and categorical variables are shown as percentage. In all cases a P value of < 0.05 was considered significant. All statistical analysis was performed with Statistical Package of Social Science (SPSS) version 12.0.

Results

Patients characteristics

For the period of 36 months from November 2001 to October 2004 146 patients underwent coronary artery bypass grafts with 141 patients had isolated CABG. There was no significant difference in racial distribution, mean age, gender, NYHA class and preoperative echocardiographic ejection fractions between the two groups (Table 3). There was however significant different of age between male and female in patients with BMI > 25 (Table 4b).

Risk Factors

There was no significant difference between the two groups in the incidence of one or more co-morbid risk factors namely hypertension, diabetes mellitus and hyperlipidaemia (Table 5).

Outcome of isolated coronary artery bypass graft surgery

The differences in postoperative coronary intensive care unit stay, postoperative extubation time, length of hospital stay renal functions and incidence of complications between the two groups were not statistically significant (Table 4).

There were 5 in hospital deaths following isolated CABG with overall mortality rate of 3.4% and the difference between the two groups was not statistically significant (p>0.05) (Table 5). Causes of death included postoperative aortic dissection (1 case), sepsis secondary to sternal wound infection with multiorgan failure (1 case), postoperative cardiac failure followed by multi organ failure (2 cases) and ventricular arrhythmia with cardiac failure (1 case).

Discussion

In this study, patients with BMI>25 were more likely to be male and had CABG at younger age group (Table 3,4). This was well understood because of cardioprotective effect of oestrogen among females. Similar findings were also noted in other studies (9,10,18,22). It was also noted that patients with BMI > 25 had coronary artery disease at younger age. Overweight and obesity or presence of excess fat is known to cause persistent inflammatory process, endothelial dysfunction and glucose intolerance. These processes are major contributors of formation of atheroma. Hence, coronary artery disease started at an earlier age. It has also been proven that endothelial dysfunction also occurred in overweight and obese children (23).

Table 4: Mean age in males and females patients in: non Overweight (a) and overweight (b)

BMI $\leq$ 25	**n**	**%**	**Mean $\pm$ sd**	**t[a]**	**p**
Male	64	45.4	58.4$\pm$8.5		
Female	16	11.3	59.00$\pm$7.4	0.236	0.814

(a)

BMI $\geq$25	**n**	**%**	**Mean $\pm$ sd**	**t[a]**	**p**
Male	53	37.6	54.8$\pm$8.6		
Female	8	5.7	61.3$\pm$7.8	2.105	0.049

(b)

Table 5: Outcome of patients who underwent isolated CABG

Variables	Group 1 BMI < 25		Group 2 BMI > 25		$\chi 2$, t[a]	Mean difference (95% CI)	p value
	n	%	n	%			
Days of hospital stay, mean ± sd	9.8 ± 5.2		8.9 ± 4.3		0.822	0.72 (-2.446 1.011)	0.413
Days in CICU, mean± sd	1.5 ± 1.3		1.3 ± 0.5		1.181	0.21 (-0.57 0.14)	0.240
Post op creatinine							
<120	47	34.1	40	29.0	0.300		0.584
>=120	30	21.7	21	15.2			
Time extubated							
<12 hours	36	28.8	32	25.6			
12-24 hours	32	25.6	23	18.4	0.360		0.835
>25 hours	1	0.8	1	0.8			
Leg wound infection							
Yes	24	17.0	19	13.5	0.022		0.883
No	56	39.7	42	29.8			
Sternal wound infection							
Yes	6	4.3	5	3.5	0.023		0.879
No	74	52.5	56	39.7			
Postoperative bleeding							
Yes	4	2.8	0	0	3.139		0.076
No	76	53.6	61	43.3			
Chest infection							
Yes	1	0.7	1	0.7			
No	79	56.0	60	42.6	0.038		0.846
Pleural effusion							
Yes	6	4.3	9	6.4			
No	74	52.5	52	36.9	1.916		0.166
Neurological insult							
Yes	1	0.7	1	0.7	0.038		0.846
No	79	56.0	60	42.6			
Sternal non-union							
Yes	2	1.4	2	1.4	0.076		0.783
No	78	55.3	59	41.8			
Dysrhtymia							
Yes	4	2.8	4	4	0.157		0.692
No	76	53.9	57	57			

BMI, body mass index; CI confidence interval; DM, diabetes mellitus; HPT, hypertension; HPL, hyperlipidaemia; NYHA, New York Heart Association; sd, standard deviation; CICU, cardiac intensive care unit; Preop, preoperative; Postop, postoperative. a-Pearson Chi-Square value

Table 6: Mortality of patients who underwent isolated CABG

Variables	Group 1 BMI < 25		Group 2 BMI > 25		$\chi 2$, t[a]	P value
	n	%	n	%		
In hospital death						
Yes	3	2.1	1	0.7	0.559	0.455
No	77	54.6	60	42.6		

BMI, body mass index; a-Pearson Chi-Square value

This study found that overweight and obesity does not increase the risk of in-hospital mortality as well as occurrence of postoperative complications. Results from this study are similar to those of another recent study. Moulton et al (9) analyzed data from 2299 cardiac surgery patients. Obesity was identified as a risk factor for superficial sternal wound infection (OR, 2.3), leg infections (OR, 1.8), and atrial dysrhythmias (OR, 1.2) but not operative mortality, mediastinitis, stroke, renal failure, acquired respiratory distress syndrome, prolonged mechanical ventilation, pneumonia, sepsis, pulmonary embolism, or ventricular arrhythmias.

Other studies have reported the lack of association between overweight and obesity and operative mortality with CABG (2,9,11). However, many of these studies had limited statistical power to detect such a difference if it existed because of very small numbers of deaths. In a comparison of 250 obese CABG patients and 250 age- and sex-matched control CABG patients, who were not obese, Prasad et al. found a greater risk of any postoperative morbidity among the obese (11). In a retrospective analysis of 502 patients, Fasol et al found the obese had greater risk of perioperative and postoperative myocardial infarction, arrhythmias, respiratory infection, leg wound infection, and sternal dehiscence (21). A study by Koshal et al. found greater risk of postoperative hypertension and bronchoconstriction and possibly wound infection (the numbers of wound infections were very small, six in the obese group compared with three in the non obese group) among the obese group (24). In a study comparing 56 obese and 56 age-, sex-, and height-matched control subjects, Gadaleta et al. found increased risk of complications and a longer length of stay among obese diabetics (25). In this and another study that examined overweight and obesity as a risk factor for neurological insult found no association (11,25). In this study, we found that in our population there is no association between different BMI group and outcome of isolated CABG.

However, there are several potential limitations that should be considered in the interpretation of the results of this study. BMI was chosen as the measure of obesity in this study because, of the indexes that are based on combinations of weight and height, BMI correlates least with height and most with more direct measures of percent body fat (26). However, there is still some error in measurement of obesity with BMI because there is substantial variation in lean body mass among people of the same height (26-27). This potential problem with the use of BMI to measure obesity has been shown to be of greater concern in studies of younger people who have much greater variation in lean body mass than older people (27). Another potential limitation to consider is that this study had access only to data on postoperative complications occurring in the hospital. This limitation may underestimate the true effect of obesity on these outcomes to the extent that they occur after discharge from the index hospitalization. A prior study found that 14% of patients undergoing CABG are rehospitalized within 30 days after discharge and that the most common reason for rehospitalization is wound infection (19%) (28). Additionally, this study did not collect information for other outcomes, such as post operative myocardial infarction, pulmonary embolism, gastrointestinal problems, prolonged operative site pain and reintubation which others have found to be associated with obesity.

Conclusion

Based on our results, we conclude that overweight and obesity does not increase morbidity and mortality in patients who underwent isolated coronary artery bypass surgery in Hospital Universiti Sains Malaysia. Coronary artery bypass should not be delayed merely because someone has a higher BMI. However, further study is needed to evaluate confounding factors in which overweight and obese patients associated with namely diabetes mellitus, hypertension and hyperlipidaemia.

This study also evaluated immediate in hospital outcome of patients with different BMI. Evaluation of long term outcome is needed to give more perspective of outcome different of patients with different BMI.

References

1. Higgins TL, Estafanous FG, Loop FD, Beck GJ, Blum JM, Paranandi L. Stratification of morbidity and mortality outcome by preoperative risk factors in coronary artery bypass patients. A clinical severity score. JAMA 1992; 26**7**(17): 2344-2348.

2. Parsonnet V, Dean D, Bernstein AD. A method of uniform stratification of risk for evaluting the results of surgery in acquired adult heart disease. Circulation 1989; 79(6 Pt 2):I3-12.

3. Roques F, Gabrielle F, Michel P, De Vincentiis C, David M, Baudet E. Quality care in adult heart surgery: proposal for a self assessment approach based on French multicenter study. Eur J Cardiothorac Surg 1995; 9(8): 433-440.

4. Nashef SA, Roques F, Michel P, Gauducheau E, Lemeshow S, Salamon R. European system for cardiac operative risk evaluation (EuroSCORE). Eur J Cardiothorac Surg 1999; 16(1): 9-13.

5. Pons JM, Granados A, Espinas JA, Borras JM, Martin I, Moreno V. Assessing open heart surgery mortality in Catalonia (Spain) through a predictive risk model. Eur J Cardiothorac Surg 1997; 11(3): 415-423.

6. Huijskes RV, Rosseel PM, Tijssen JG. Outcome prediction in coronary artery bypass grafting and valve surgery in the Netherlands: development of the Amphiascore and its comparison with the Euroscore. Eur J Cardiothorac Surg 2003; 24(5): 741-749.

7. Wouters SC, Noyez L, Verheugt FW, Brouwer RM. Preoperative prediction of early mortality and morbidity in coronary bypass surgery. Cardiovasc Surg 2002; 10(5): 500-505.

8. Birkmeyer NJ, Charlesworth DC, Hernandez F, et al. Obesity and risk of adverse outcomes associated with coronary artery bypass surgery. Northern New England Cardiovascular Disease Study Group. Circulation 1998; 97(17): 1689-1694.

9. Moulton MJ, Creswell LL, Mackey ME, Cox JL, Rosenbloom M. Obesity is not a risk factor for significant adverse outcomes after cardiac surgery. Circulation 1996; 94(9 Suppl): 1187-92.

10. Engelman DT, Adams DH, Byrne JG et al. Impact of body mass index and albumin on morbidity and mortality after cardiac surgery. J Thorac Cardiovasc Surg 1999; 118(5): 867-873.

11. Prasad US, Walker WS, Sang CT, Campanella C, Cameron EW. Influence of obesity on the early and long term results of surgery for coronary artery disease. Eur J Cardiothorac Surg 1991; 5(2): 67-72; discussion 72-3.

12. Ranucci M, Cazzaniga A, Soro G, Morricone L, Enrini R, Caviezel F. Obesity and coronary artery surgery. J Cardiothorac Vasc Anesth 1999; 13(3): 280-284.

13. Brandt M, Harder K, Walluscheck KP, Schottler J, Rahimi A, Moller F, Cremer J. Severe obesity does not adversely affect perioperative mortality and morbidity in coronary artery bypass surgery. Eur J Cardiothorac Surg 2001; 19(5): 662-666.

14. Kuduvalli M, Grayson AD, Oo AY, Fabri BM, Rashid A. Risk of morbidity and in-hospital mortality in obese patients undergoing coronary artery bypass surgery. Eur J Cardiothorac Surg 2002; 22(5): 787-793.

15. Reeves BC, Ascione R, Chamberlain MH, Angelini GD. Effect of body mass index on early outcomes in patients undergoing coronary artery bypass surgery. J Am Coll Cardiol 2003; 42(4): 668-676.

16. Kim J, Hammar N, Jakobsson K, Luepker RV, McGovern PG, Ivert T. Obesity and the risk of early and late mortality after coronary artery bypass graft surgery. Am Heart J 2003; 146(3): 555-560.

17. Prabhakar G, Haan CK, Peterson ED, Coombs LP, Cruzzavala JL, Murray GF. The risks of moderate and extreme obesity for coronary artery bypass grafting outcomes: a study from the Society of Thoracic Surgeons' database. Ann Thorac Surg 2002; 74(4): 1125-1130; discussion 1130-1121.

18. Schwann TA, Habib RH, Zacharias A et al. Effects of body size on operative, intermediate, and long-term outcomes after coronary artery bypass operation. Ann Thorac Surg 2001; 71(2): 521-531.

19. Potapov EV, Loebe M, Anker S et al.Impact of body mass index on outcome in patients after coronary artery bypass grafting with and without valve surgery. Eur Heart J 2003; 24(21): 1933-1941.

20. Rockx MA, Fox SA, Stitt LW et al. Is obesity a predictor of mortality, morbidity and readmission after cardiac surgery? Can J Surg 2004; 47(1): 34-38.

21. Fasol R, Schindler M, Schumacher B et al. The influence of obesity on perioperative morbidity: retrospective study of 502 aortocoronary bypass operations. Thorac Cardiovasc Surg 1992; 40(3): 126-129.

22. Kuduvalli M, Grayson AD, Oo AY, Fabri BM, Rashid A. The effect of obesity on mid-term

survival following coronary artery bypass surgery. Eur J Cardiothorac Surg 2003; 23(3): 368-373.

23. Avogaro A, Kreutzenberg SA. Mechanisms of endothelial dysfunction in obesity. Clin Chimi Acta 2005; 360(1-2): 9-26.

24. Koshal A, Hendry P, Raman SV, Keon WJ. Should obese patients not undergo coronary artery surgery? Can J Surg 1985; 28(4): 331-334.

25. Gadaleta D, Risucci DA, Nelson RL et al. Effects of morbid obesity and diabetes mellitus on risk of coronary artery bypass grafting. Am J Cardiol 1992; 70(20): 1613-1614.

26. Criqui MH, Klauber MR, Barrett-Connor E, Holdbrook MJ, Suarez L, Wingard DL. Adjustment for obesity in studies of cardiovascular disease. Am J Epidemiol 1982; 116(4): 685-691.

27. Manson JE, Stampfer MJ, Hennekens CH, Willett WC. Body weight and longevity. A reassessment. JAMA 1987; 257(3): 353-358.

28. Beggs VL, Birkemeyer NJ, Nugent WC, Dacey LJ, O'Connor GT. Factors related to rehospitalization within thirty days of discharge after coronary artery bypass grafting. Best Pract Benchmarking Healthc 1996; 1(4): 180-186.