Outcomes of the Morbidly Obese Having Cardiac Surgery

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ABSTRACT

Objective: *Obesity has been perceived to be a risk factor for adverse outcomes following cardiac surgery. The aim of this study was to test the hypothesis that patients with morbid obesity (defined as a body mass index (BMI) greater or equal to 40 kg/m^2) would have increased rates of mortality and morbidity following cardiac surgery.*

Methods: *The case records of patients who had cardiac surgery between January 1996 and August 2002, who had a BMI greater or equal to 40 kg/m^2, were reviewed retrospectively and compared with a representative control group randomly selected from the same database. Differences between the two groups were determined using multiple and logistical regression.*

Results: *Out of the 4381 patients who had cardiac surgery, 28 patients were morbidly obese (0.6%). No morbidly obese patients and one control patient died in hospital (p = 0.31). Patients with morbid obesity had non-statistically significant increases in length of postoperative intensive care stay, hospital stay, infections, inotrope use and requirements for pacing.*

Conclusions: *This study was unable to demonstrate that morbidly obese patients having cardiac surgery had statistically significant increased morbidity or mortality.* (**Critical Care and Resuscitation 2005; 7: 166-172**)

Key words: Cardiac surgery, heart surgery, obesity, outcome assessment, morbid obesity

Obesity is considered to be a major risk factor in patients undergoing cardiac surgery.[1] Several studies have shown no differences in mortality between the obese and non-obese.[2-4] Obese patients, however, do have higher rates of wound infections, wound dehiscence, hypoxia and dysrhythmias.[5]

Class I obesity has been previously defined as a body mass index (BMI) from 30 to 34.9 kg/m^2, class II obesity a BMI from 35 to 39.9 kg/m^2 and class III obesity (otherwise known as morbid obesity) defined as a BMI greater or equal to 40 kg/m^2.[6] The aim of this study was to test the hypothesis that patients with morbid obesity would have increased rates of mortality and morbidity following cardiac surgery.

METHODS

The case records of all patients who had a BMI greater or equal to 40kg/m^2, and who underwent cardiac surgery, as identified in the St Vincent's Hospital, Sydney Cardiac Surgery Database, during the period January 1996 to August 2002 were retrospectively reviewed. A control group of the same number of patients was randomly selected from the same database, over the same time period. The following factors were controlled for, in the matching process, in the stated order of priority: age > gender > type of operation > urgency of operation > left ventricular ejection fraction (LVEF) > and previous cardiac surgery. These factors were chosen as all are proven core risk factors in determining cardiac surgical outcome.[7,8] Many other factors can be used to stratify risk, in cardiac surgery, but are not as predictive as these factors chosen.

We recorded preoperative co-morbidities and post-operative outcomes and complications.[7,8] All data were extracted from the patients' paper notes, with the exception of name, medical record number, date of birth, and type of operation, which were extracted from

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the computerised records, and subsequently cross-checked against the paper notes. Preoperative data collected included age, gender, BMI as derived from Quetelet's formula (weight, as recorded in the anaesthetic records) in kilograms divided by the square of the height in metres),[6] urgency of operation, previous cardiac surgery, left ventricular ejection fraction (LVEF), number of coronary artery stenoses greater or equal to 70%, left main disease greater or equal to 50%, angina in preceding 2 weeks, previous myocardial infarct (MI) and MI within the preceding 2 weeks, coronary artery angioplasty or stenting in the preceding 2 months, ventricular arrhythmias requiring cardioversion in the preceding 2 months, permanent pacemaker, use of preoperative inotropes or intra-aortic balloon pump (IABP), preexisting diabetes mellitus, cerebrovascular disease, peripheral vascular disease, chronic airways limitation (CAL), renal impairment, smoking, hyperlipidaemia, hypertension, liver disease, and medication use: aspirin, beta-blockers, and angiotensin-converting enzyme (ACE) inhibitors. Definitions and criteria used for diagnosis are described in Appendix 1.

We examined in-hospital death, length of post-operative ICU and postoperative hospital stay, and time to extubation, as our main outcome measures. Other outcomes recorded were prolonged mechanical ventilation (greater than 24 hours), reintubation, trach-eostomy, infections, re-sternotomy for any reason, sternal wound dehiscence, postoperative myocardial infarct, inotrope and IABP use, atrial arrhythmias, ventricular arrhythmias, pacing and insertion of permanent pacemaker (PPM), and acute renal failure.

In our regression analysis, as *a priori* independent variables, we used age, sex, urgency of operation, number of coronary artery stenoses, left main stenosis, and ejection fraction, as the baseline model.[7,8] Two-sample t-test and chi-squared tests, performed using SPSS for Windows, Release 11.00, were used to analyse differences in postoperative outcome.

Multiple regression and logistical regression, performed using STATA 8.0 for Windows, were used to adjust for risk factors. Ethics approval to conduct the study was obtained from the hospital research ethics committee.

RESULTS

Out of 4381 patients who underwent cardiac surgery between January 1996 to August 2002, 28 patients (0.6%) were identified as having a BMI greater or equal to 40 kg/m^2.

Diabetes mellitus was significantly more common in the morbidly obese group (p = 0.001), but chronic airways limitation (p = 0.069), and hypertension (p = 0.057) were not. ACE inhibitors were more frequently used in the morbidly obese group (61% versus 29% (p = 0.016)). Due to the small sample size no other baseline differences between the two groups were significant.

Matching was inconsistent, using the order of priority described before, to control for risk factors. Of the morbidly obese patients, 19 patients had coronary artery bypass grafting (1 off bypass), 2 had "redo" grafting, 6 patients had valve surgery, and 1 patient had an aortic repair. The same number of patients had coronary artery bypass grafting in the control group, 2 patients had "redo" grafting (1 patient had a second "redo"), 5 patients had valve surgery, with the remaining 2 patients having an aortic repair and repair of an Ebstein anomaly.

The average BMI of the study group was 45.2 kg/m^2, and the control group BMI was 27.7 kg/m^2.

The "Perfusion Chart", a chart used to record data during cardiac bypass, was missing from several patient records, therefore bypass times and core temperature were not used in the final analysis. The collection of the pre-specified data from the notes was otherwise complete.

A particular problem with assessing LVEF was that many echocardiographs reported LVEF as being "normal", without specific quantification. A "normal" LVEF for all patients, including children, is 64% to 83% (95% prediction interval), with an average of 74%.[9] Echocardiographic measurements can vary according to sex, body surface area, and age, and complex formulas are available to predict normal values.[9] For simplicity, we elected to quantify LVEF, if reported as "normal", as 65% for females and 70% for males, based on a study looking at "normal", adult patients, and athletes.[10]

Two-sided sample t-test with unequal variances did not find any significant differences in death rate, post-operative ICU stay or hospital stay, or time to extubation between the cases and controls (p set at 0.05). The only death recorded was in the control group (p = 0.31). Mean length of postoperative ICU stay was 2.7 days in the morbidly obese group and 1.7 days in the control group (p = 0.16), and mean length of hospital stay was 9.4 days and 6.1 days respectively (p = 0.12).

For the main outcome measures, as shown in table 2, morbid obesity was not a significant predictor, using the baseline multiple regression model, adjusted for age and sex. This remained so after adjustment for other published predictors of outcome, including urgency of operation, number of coronary artery stenoses, > 50% left main coronary artery stenosis, and ejection fraction.

Given the suspicion that diabetes and the use of ACE Inhibitors could be additional confounders, these

Table 1. Preoperative characteristics of 28 morbidly obese and 28 control cardiac surgery patients

	Morbidly obese	*Control*
Age (years) Mean [median], range, standard deviation	56 [57], 24-75, 11	56 [57], 23-75, 11.2
% Male	50	50
Body mass index (BMI – kg/m^2) Mean [median], range, standard deviation	45.2 [44.8], 40.2-54.7, 3.9	27.7 [27.9], 18.6-37.3, 5.1
Operation considered urgent (within 24 hr)	4 patients	2 patients
Left ventricular ejection fraction (LVEF - %)	67.0	65.0
Coronary vessel stenosis (if undergoing coronary artery graft surgery)		
Left Main ≥ 50% stenosis	4 patients	4 patients
Mean number of stenoses ≥ 70%	1.9	2.0
Cardiac disease (number of patients)		
Angina – exertional or unstable	16 (57%)	15 (54%)
Previous myocardial infarct (MI)	13 (46%)	9 (32%)
MI within previous 2 weeks	4 (14%)	2 (7%)
Angioplasty/stent within previous 2 months	0	1 (4%)
Ventricular arrhythmia requiring cardioversion in previous 2 months	2 (7%)	0
Preoperative inotropes/intra-aortic balloon pump	1 (4%) *	0
Permanent pacemaker	1 (4%)	0
Respiratory disease (number of patients)		
Smoking up to admission	4 (14%)	7 (25%)
Chronic airways limitation	7 (25%)	2 (7%)
Vascular disease		
Cerebrovascular disease	2 (7%)	2 (7%)
Peripheral vascular disease	2 (7%)	1 (4%)
Other disease states (numbers of patients)		
Diabetes mellitis	16 (57%)	4 (14%)
Hypertension	20 (71%)	13 (46%)
Hyperlipidaemia	16 (57%)	15 (54%)
Chronic renal failure	0	0
Preoperative creatinine clearance – mean **	126 mL/min	81 mL/min
Liver disease	1 (4%)	0
Medications		
Aspirin within previous 1 week	13 (46%)	13 (46%)
Beta-blocker	15 (54%)	12 (43%)
Angiotensin-converting enzyme inhibitor	17 (61%)	8 (29%)

* 1 patient required inotropes only
** calculated using Cockcroft-Gault formula

Table 2. Postoperative outcomes of 28 morbidly obese and 28 control patients following cardiac surgery

	Morbidly Obese	*Control*
Mortality		
In-hospital (p = 0.31)	0 deaths	1 death (4%)
Postoperative ICU stay (days) (p = 0.16)		
Mean (standard error), median [range]	2.7 (0.7),1 [1-17]*	1.7 (0.3), 1 [1-7]*
Postoperative hospital stay (days) (p = 0.12)		
Mean (standard error), median [range]	9.4 (1.6), 6 [4-42]**	6.1 (0.6), 5 [4-19]**
Respiratory Problems		
Hours to extubation (p = 0.64)		
Mean (standard error), median	11.7 (2.1), 7	10.3 (2.2), 6
Number of patients intubated > 24 hr	3 (11%)	2 (7%)
Number of patients reintubated	2 (7%)	2 (7%)
Tracheostomy	0	0
Infections requiring antibiotic treatment		
Total numbers of patients with infections (p = 0.30)	13 (46%)	6 (21%)
Respiratory tract infection (p = 0.22)	9 (32%)	5 (18%)
Mediastinitis	0	0
Wound including sternal and leg	3 (11%)	0
Sepsis	1 (4%)	1 (4%)
Surgical problems (number of patients)		
Sternal wound dehiscence	2 (7%)	0
Resternotomy for any reason	1 (4%) ***	1 (4%)
Graft occlusion	0	0
Cardiac Problems (numbers of patients)		
Requiring inotropes (p = 0.06)	16 (57%)	9 (32%)
Requiring intra-aortic balloon pump	0	0
Atrial arrhythmia requiring treatment	9 (32%)	9 (32%)
Ventricular arrhythmia requiring treatment	0	0
Requiring pacing (p = 0.08)	5 (18%) ****	1 (4%)
Requiring permanent pacemaker	0	1 (4%)
Renal problems		
Acute renal failure	3 (11%)	3 (11%)
Number of patients requiring haemodialysis/ filtration	1 (4%)	0
Vascular problems		
Cerebrovascular accident	0	0
Deep vein thrombosis or pulmonary emboli	0	0

* 3 patients in both cohorts stayed in ICU greater than 3 days
** 7 patients in the morbidly obese group and 5 patients in the control group stayed in hospital greater than 7 days
*** 1 other patient had a re-sternotomy 2 days after discharge from hospital
**** 1 patient had permanent pacemaker previously inserted

were tested for significance in the baseline model. Only diabetes was found to be a significant predictor of outcome, predicting ICU stay and hospital stay, but not time to extubation. Diabetes was therefore added to the baseline model for the outcomes of ICU stay, and hospital stay, but morbid obesity was not found to be a significant predictor upon testing with forward selection procedures in these new models. Morbid obesity was also not a predictor of outcome after adjustment for chronic airways limitation in the respiratory tract infection (pneumonia) model.

The morbidly obese patients had higher rates of postoperative infections (46% versus 21%) but again this difference was not significant (p = 0.30).

The apparent increased need for postoperative pacing in the morbidly obese (18% versus 4%), and the apparent increased need for inotropic support (57% versus 32%) was also not statistically significant.

Using logistical regression, in terms of the outcomes of infections, respiratory tract infections, and need for pacing, morbid obesity again was not a significant predictor in a baseline model adjusted for age and sex.

DISCUSSION

This study attempted to determine if there was a higher rate of mortality or morbidity in morbidly obese patients having cardiac surgery, however, it was unable to show any statistically significant differences in postoperative outcomes, even though our database contained over 4000 patients. Our results show that cardiac surgery can be performed successfully on selected patients with morbid obesity, and we did not conclusively demonstrate that these patients encountered more complications. Our cohort of morbidly obese patients was relatively young (mean age 56 years), had good preoperative cardiac function (mean LVEF 67%) and none died during their hospital stay. The longer length of ICU stay and postoperative hospital stay for morbidly obese patients were not statistically significant. Only 3 of 28 patients stayed in ICU greater than 4 days, (median 1 day) and only 7 of 28 patients stayed in hospital postoperatively longer than 7 days. Apparent increases in other outcome measures, such as infections and pacing, were also not statistically significant.

There are many significant weaknesses to this study. Matching was very difficult and inconsistent. We decided to match for the proven "core" risk factors, as described earlier, in the stated order of priority, but many patients had inconsistent matches, mainly due to the rarity of some of the operations, and their relatively uncommon ages. A 70 year old male, having triple-vessel bypass grafting and a normal LVEF, is easier to match, than a 45 year old female, having an aortic repair, a less common operation, even with a 4000 patient database.

Another major weakness of this study was that it was retrospective. It is likely that our complication rates were under-reported as many of them may not have been recorded in the notes. It is possible that complications, such as pulmonary emboli, or minor cerebrovascular accidents may not have been detected. We only recorded infections where a clinical diagnosis was made, and where the patients were treated with antibiotics beyond prophylaxis. A prospective study would have used stricter criteria for diagnosing these infections and other complications. All patients in the study received prophylactic antibiotics for 24 hours. We chose to control for proven predictors of outcome following cardiac surgery, but the large numbers of confounding risk factors made matching controls difficult.

Our study is not able to specifically address the issue of inotropic support. We defined inotropic support as the use of any inotropic agent by infusion during the patients' postoperative ICU stay. Inotropes were used in 57% of the morbidly obese patients, despite relatively preserved cardiac function (mean LVEF 67%). We did not collect information on type of inotrope drug used, dosing, duration or target end-points of therapy, as this varied considerably. Some patients only required low-dose inotropic support for a short period, whereas others required high-dose, prolonged therapy. Fluid input and output, and other haemodynamic parameters may have influenced inotrope use, but we did not collect this information.

Our cohort is undoubtedly a select group in which the outcomes were expected to be reasonable. We did not attempt to ascertain how many patients with morbid obesity, and who had surgically correctable cardiac disease, were not considered for, or who had been refused cardiac surgery. This information would be difficult to obtain retrospectively. If all such patients with operable cardiac disease were subjected to surgery, ignoring other co-morbidities, the death and complication rates could potentially be much higher. Patients who were perceived as high risk may have been refused surgery, and therefore patient selection probably had a significant bearing on our results.

Had this study looked at both class II and class III obesity together as a group, the results may have been statistically significant, but this would not have answered our questions regarding patients at the extreme end of the obesity spectrum, i.e. the morbidly obese. Ultimately, to accurately address our hypothesis that morbidly obese patients have higher rates of mortality and morbidity following cardiac surgery, a larger, multicentre, prospective study is needed.

Lastly, even if the morbidly obese are shown to have different outcomes compared with the non-morbidly obese, no studies have looked at the effect of large reductions in weight prior to major surgery, and whether this benefits outcome. A lot of major surgery is relatively urgent in nature, or the disease process for which the surgery is supposed to correct precludes patients from participating in an effective weight reduction program. The same holds true for cardiac surgery.

In summary, although our study group originated from a database of more than 4000 patients who had cardiac surgery over a 6 year period, only 28 patients were identified as being morbidly obese, and once other confounders had been controlled for, we were unable to demonstrate that these patients had higher rates of mortality or morbidity, compared with patients who were not morbidly obese. Our study shows that cardiac surgery can successfully be performed in selected patients with morbid obesity. Potentially adverse outcomes such as longer extubation times, longer postoperative ICU and hospital stay, increased need for pacing and increased infections in the morbidly obese patients, did not reach statistical significance.

Acknowledgements

I would like to thank Clement Loy for his help with the statistical analysis, Frank Junius for help with the St Vincent's Hospital, Sydney Cardiac Surgery Database, and Prof. G. A. Harrison for his words of wisdom

Received: 6 May 2005
Accepted: 2 June 2005

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APPENDIX 1

Definitions and criteria

Acute renal failure: ≥ 40% decrease in creatinine clearance.

Atrial arrhythmia: any atrial arrhythmia requiring pharmacological treatment or cardioversion.

Chronic airway limitation/asthma: clinical diagnosis requiring chronic administration of bronchodilators, steroids, or FEV_1 < 75% predicted.

Cerebrovascular disease: any previous cerebrovascular accident, transient ischaemic attack, reversible ischaemic neurological deficit, or carotid surgery.

Chronic renal failure: pre-operative creatinine clearance < 40mL/min

Creatinine clearance: as defined using the Cockcroft-Gault formula

((140-age) x mass) / (814 x creatinine conc (mmol/L)) (x 0.85 for females)

Deep vein thrombosis: any diagnosed on lower limb doppler/ultrasound leading to anticoagulation therapy or inferior vena cava (IVC) filter

Diabetes mellitis: clinical diagnosis of, or treatment with any hypoglycemic drug.

Hyperlipidaemia: any previous diagnosis of or treatment for

Infection: clinical diagnosis requiring treatment with additional antibiotics other than prophylaxis

Left ventricular function: last known, on echocardiography, radionucleotide scan, or ventriculography. If reported as being normal, but not quantified then EF considered to be 70% for males, and 65% for females.[10]

Inotrope support: the use of any inotropic drug in infusion form

Operation considered urgent: unstable angina or ischaemia, as determined by treating physician, despite maximal treatment; acute pulmonary oedema, shock, or cardiorespiratory arrest.

Peripheral vascular disease: claudication, absent pedal pulses, positive non-invasive or invasive tests, or previous vascular surgery.

Pulmonary emboli: any intermediate to high probability ventilation/perfusion study or CT pulmonary angiogram leading to anticoagulation therapy or IVC filter

Respiratory tract infection: clinical or radiological diagnosis requiring additional antibiotic treatment other than prophylaxis

Ventricular arrhythmia: any ventricular arrhythmia requiring direct current cardioversion