

Effects of Obesity on Outcomes in Endoscopically Assisted Coronary Artery Bypass Operations

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ABSTRACT

Background: Obesity has been shown to be an independent risk factor for adverse outcomes and prolonged hospitalization following conventional coronary artery bypass (CAB). For this reason and because of increased technical challenges, obesity has been considered a relative contraindication for minimally invasive bypass. The purpose of this study was to determine if in fact severe or morbid obesity is an independent risk factor for patients undergoing minimally invasive CAB.

Methods: Outcome data of 350 consecutive endoscopic, atraumatic CAB procedures performed at our institution over a 4-year period were reviewed with respect to patient body mass index (BMI). All operations consisted of thoracoscopic left or right internal mammary artery (IMA) harvesting followed by off-pump grafting of the left anterior descending (with/without diagonal coronary artery) or right coronary artery via a 4-cm thoracotomy. Patients were divided into 4 groups: small ($\text{BMI} \leq 24 \text{ kg/m}^2$), normal to mild obesity ($24 \text{ kg/m}^2 < \text{BMI} \leq 34 \text{ kg/m}^2$), severe obesity ($34 \text{ kg/m}^2 < \text{BMI} \leq 40 \text{ kg/m}^2$), and morbid obesity ($\text{BMI} > 40 \text{ kg/m}^2$).

Results: Although the $\text{BMI} > 34 \text{ kg/m}^2$ groups had a higher incidence of hypertension, diabetes, and hypercholesterolemia, there was no statistical difference in operative risk between groups. Thirty-day mortality, conversion to sternotomy, transfusion rate, and wound, pulmonary, neurological, and myocardial complications were not significantly different between groups. The $\text{BMI} > 34 \text{ kg/m}^2$ patients required longer IMA harvest times and total operating times, but the intensive care unit length of stay was not significantly different between groups. Hospital length of stay was longer for the $\text{BMI} \leq 24 \text{ kg/m}^2$ group than for the $\text{BMI} 18$ to 34 kg/m^2 group ($P = .025$).

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Conclusion: Despite increased technical difficulty caused by obesity, it is not an independent risk factor for patients undergoing minimally invasive CAB.

INTRODUCTION

There is a widely held perception that severely obese patients undergoing coronary artery bypass grafting (CABG) have more complications in the immediate postoperative period, particularly the need for prolonged ventilatory support and increased risk of sternal wound infections [Birkmeyer 1998]. It has been suggested that the risk for complications in this group of patients is in part due to the higher incidence of comorbid factors such as diabetes, impaired respiratory function, and hypertension [Bader 2001]. The purpose of this study was to determine the effects of severe obesity on clinical outcomes in patients undergoing endoscopically assisted, minimally invasive CABG.

PATIENTS AND METHODS

Patients

This study encompassed 350 consecutive endoscopically assisted minimally invasive CAB (endoACAB) operations performed by the same surgeon (T.A.V.) at Sacred Heart and Baptist Hospitals of Pensacola, Florida, USA. Patient data were collected and analyzed according to the Society of Thoracic Surgeons (STS) National Cardiac Surgery Database guidelines and definitions. This study was performed with the approval of each institution's investigation review committee.

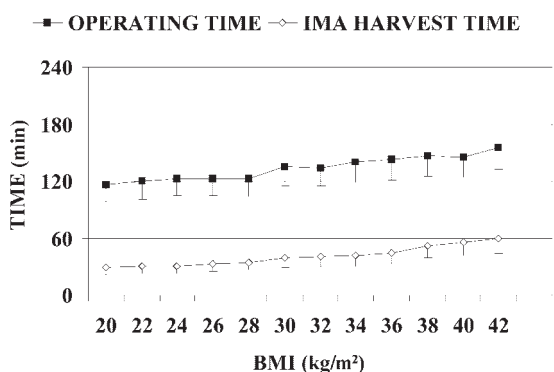
Definition of Terms

Body Mass Index (BMI): An international standard for measuring obesity defined as weight (kilograms) divided by the square of height (meters): kg/m^2 (WHO 1997). It is this index that best correlates with body fat content [Criqui 1982].

Four BMI Groups: Small ($\text{BMI} \leq 24 \text{ kg/m}^2$), normal to mild obesity ($24 \text{ kg/m}^2 < \text{BMI} \leq 34 \text{ kg/m}^2$), severe obesity ($34 \text{ kg/m}^2 < \text{BMI} \leq 40 \text{ kg/m}^2$), and morbid obesity ($\text{BMI} > 40 \text{ kg/m}^2$).

Conventional CABG: Coronary artery revascularization using cardiopulmonary bypass and cardioplegia through a sternotomy.

EndoACAB: Coronary artery revascularization using thoracoscopic internal mammary artery (IMA) harvesting and



Influence of body mass index (BMI) on total operating time and internal mammary artery (IMA) harvest time.

off-pump grafting through a muscle sparing, non-rib-spreading thoracotomy.

Surgical Aspects

The technique of the endoACAB operation has been previously described in detail [Vassiliades 2001]. In brief, the technique consists of thoracoscopic IMA harvesting followed by a muscle-sparing, non-rib-spreading chest incision through which a direct-vision anastomosis is performed off-pump using conventional instruments. Disruption of the thoracic skeleton is completely avoided by performing the entire operation with a combination of endoscopic or direct-vision techniques without alteration of the natural interspaces. Carbon dioxide insufflation, at levels of 8 to 10 mm, facilitates dissection of the IMA, particularly in the severely obese patient. Intercostal nerve blocks are performed, and the patient is extubated in the operating room. A 16 Fr pleural drain is left in for 24 to 48 hours.

Data Collection and Statistical Analysis

The hospital and clinic records of each patient were reviewed in detail. Data and results are presented as mean ± standard error of the mean or as median and range. Repeated measures were analyzed using repeated measures analysis of variance (ANOVA). Categorical variables were analyzed using chi-square test or Fischer exact test as appropriate. For analysis of length of stay and 30-day mortality, 2 groups were created by combining data from small patients with data from patients with normal to mild obesity and combining data from patients with severe obesity and patients with morbid obesity (1-way ANOVA). Univariate linear and nonlinear regression analyses were used to determine which variables were significantly altered in relation to BMI. A P value of less than .05 was always used to indicate significance.

RESULTS

Preoperative Data

The 350 consecutive endoACAB patients included 219 men (62.6%) and 131 women (37.4%). Their mean age ± SD was 56 ± 11 years. BMIs ranged between 18 and 48 kg/m² and

were distributed in a normal fashion (mean, 31.9 kg/m²). Patient characteristics including mean age, sex ratio, comorbid factors, risk score, and coronary anatomy were similar in all body-size groups.

Operative Data

Mean IMA harvest time was 37.8 ± 12 minutes, and total operating time was 126 ± 36 minutes. Thoracoscopic IMA harvest time and total operating time were increased for patients with a higher BMI (Figure).

Patient Outcome

Operative mortality (within 30 days) occurred in 4 (1.1%) of the 350 patients. The study size is too small to correlate the BMI with operative mortality. Major complications for each BMI group are summarized in the Table. There were 33 pulmonary complications (9.4 %) consisting of 22 cases of left-lung atelectasis, 7 cases of pleural effusion, and 4 cases of pneumonia. There was no correlation between BMI and the postoperative hemoglobin level or the transfusion rate. Length of stay in the intensive care unit (ICU) and hospital was longer for the groups of patients with the lowest and highest BMI (Table).

DISCUSSION

The influence of patient size and body habitus on outcome after conventional CABG has recently been studied in detail [Brandt 2001, Gurm 2002]. Among the conclusions of these studies is that operative mortality increases at the low end of the body size spectrum. Small patients have a 5% operative mortality rate compared with a 2% operative mortality rate in normal-sized and obese patients [Schwann 2001]. Perioperative myocardial infarction and stroke are similarly increased in these smaller patients. On the opposite end of the scale, severely obese patients tend to require prolonged ventilatory support and have a longer ICU stay and a higher rate of sternal wound problems [Engelman 1999]. Although obese patients do not have a higher incidence of major complications and mortality following conventional CABG, the long-term benefits of coronary revascularization are reduced [Schwann 2001]. In this study of endoscopically

Patient Outcome Data Combined in 2 Groups by Body Mass Index (BMI) (kg/m²)*

Variable	Total	18 < BMI ≤ 35	BMI >35	P
n	350	243	107	
30-d mortality	4	2	2	.864
Conversion to sternotomy	9	5	4	.584
Transfusion rate	30	23	7	.487
Wound complication	6	5	1	.764
Pulmonary complication	33	21	12	.578
Neurological complications	3	2	1	.600
Infarction and/or graft failure	8	6	2	.966
Intensive care unit LOS, h	5.23 ± 4.33	5.86 ± 4.95	4.67 ± 3.88	.481
Hospital LOS, d	2.34 ± 1.19	2.65 ± 1.07	2.15 ± 1.03	.025

*LOS indicates length of stay.

assisted CABG, any effects of body size on outcomes is independent of the use of cardiopulmonary bypass or sternotomy, which are not part of the endoACAB procedure.

For the patients in this study undergoing endoACAB, unlike patients undergoing conventional CABG, BMI did not have a consistent effect on the need for a blood transfusion. This result is likely due to the absence of the use of the cardiopulmonary bypass circuit. Following conventional CABG, as BMI increases above 30 kg/m², sternal wound problems are increasingly more prevalent, and the need for ventilatory support is prolonged. The latter is a result of the negative effects of a sternotomy on postoperative ventilation compounded by the decreased vital capacity characteristic of obese patients. Additionally, obese patients can have a sustained respiratory drive depression by virtue of the release of anesthetic agents from fatty tissue stores [Ranucci 1999]. However, we did not see an increase in ventilatory support time or in length of stay in the ICU in the obese patients following the endoACAB procedure. In fact, patients in the small BMI group had a statistically longer stay in the ICU and hospital primarily because of pulmonary concerns. This result may be partly explained by the relatively lower hemoglobin and oxygen delivery capacity of these patients [Yamagishi 2000]. The smaller BMI group may have also included more outlying patients with severe emphysema.

Although the endoACAB procedure is technically more demanding in the obese patient, we did not see an increase in any major morbidity or technical misadventures requiring conversion to sternotomy. Our experience has given us some insight in performing minimally invasive surgery in the obese patient. Perhaps the most important aspect in performing an endoscopically assisted CAB in a severely obese patient is recognition of the increased technical and time demands that will be placed on the entire surgical team. Surface anatomy and landmarks are more obscured in the obese patient, so careful positioning of endoscopic port sites is crucial. The surgeon must be mindful of the increased distance and altered angle the instruments will travel from the skin to the chest wall and adjust port placement accordingly. In obese patients, the surgeon begins by dissecting most of the mediastinal fat off the pericardium and medial chest wall before starting the actual IMA harvesting. This first maneuver provides better identification of the IMA course as well as providing much-needed additional working space. This procedure is not necessary in patients with normal or low BMIs. We have generally increased the length of the skin incision 50% to 100% (up to 8 cm) without changing the approach through the actual chest wall. The size of the skin incision appears to have little effect on postoperative pain. Rather, the degree of rib distraction appears to be the primary cause of postoperative pain, as is seen in the classic minimally invasive direct CAB procedure that uses a direct-vision IMA harvest technique.

There appear to be advantages to performing the endoACAB operation instead of a conventional CAB in patients with a higher BMI. Because the endoACAB operation avoids a sternotomy, there are no sternal wound complications. Additionally, the endoACAB operation does not rely on rib spreading to perform the anastomoses. In fact there is no vio-

lation of the skeletal component of the thoracic cavity, and this characteristic of the procedure probably contributes to the low rate of pulmonary problems seen in this "at-risk" subgroup of patients. Unfortunately, almost all operations are technically more demanding in obese patients, especially minimally invasive procedures. We have seen longer operating times in these patients because every phase of the procedure is prolonged by virtue of the layers of adiposity on both sides of the thoracic cavity. Nonetheless, we feel that obesity should not be regarded as a contraindication for minimally invasive CAB. The minimally invasive approach clearly offers advantages for the obese patient if the surgeon is willing to put forth the additional time and effort required.

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