Effect of Body Mass Index on Postoperative Transfusions and 24-Hour Chest-Tube Output

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ABSTRACT

An increasing obese population in the United States focuses attention on the effect of obesity on surgical outcomes. Our objective was to see if obesity, determined by body mass index (BMI), contributed to bleeding in coronary artery bypass graft (CABG) surgery as measured by intraoperative and postoperative packed red blood cell transfusion frequency and amount and 24-hour chest-tube output. A retrospective chart review examined 150 subjects undergoing single-surgeon off-pump or on-pump CABG surgery between September 2006 and April 2009. BMI groups included normal-weight (BMI <25), overweight (BMI 25 to 29), and obese (BMI ≥ 30). Analyses used a chi-square test to determine variances in number of transfusions, and ANOVA for transfusion amount and 24-hour chest-tube amount. The percentage of subjects receiving intraoperative transfusions varied significantly by BMI group ($p = 0.022$). The percentage of subjects receiving transfusions in the 72-hour postoperative period showed a decreasing linear trend based on BMI group ($p = 0.054$). The percentage of subjects receiving transfusions in the combined intraoperative or 72-hour postoperative period showed a decreasing linear trend based on BMI group ($p = 0.054$). The transfusion amount during the 72-hour postoperative period varied significantly between BMI groups ($p = 0.021$), and the test for a linear decrease across groups was significant ($p = 0.020$). Twenty-four hour chest-tube output showed variation across all three BMI categories ($p = 0.018$) with chest-tube output decreasing with increasing obesity in a linear fashion ($p = 0.006$). Transfusion rate and amount indicate total blood loss is decreased in the obese, and chest-tube output findings give a direct measurable indicator of blood loss from the surgical site indicating increasing BMI is linearly correlated with decreasing postoperative bleeding.

KEYWORDS: Obesity, BMI, CABG, postoperative bleeding, chest-tube output

Obesity is a prominent health care concern affecting populations around the globe. The latest projections from the World Health Organization estimate that by 2015, the number of overweight adults will reach

2.3 billion and the number of obese adults will exceed 700 million,¹ indicating that appropriate understanding of how to manage health care for this population is a necessity. Cardiovascular surgery, and coronary artery

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bypass graft (CABG) surgery in particular, is not immune to this trend with obese patients carrying an increased risk of sternal wound infection, prolonged mechanical ventilation, and prolonged postoperative stays after CABG surgery.²⁻⁴ Yet, conversely, increased mortality after CABG surgery is associated with the underweight population.⁵⁻⁷ Thus, the effect of weight cannot be managed with wide-sweeping generalizations; rather specific measurable variables must be evaluated and considered.

One such variable is perioperative bleeding. Perioperative bleeding is most often managed with transfusions, which inherently come with elevated morbidity via transfusion reactions, viral transmission, and sepsis,^{8,9} as well as increased mortality.^{9,10} It has been shown that a low body surface area (BSA) and lower body weight are independent predictors¹¹⁻¹³ of transfusion requirements. Causes belying this trend may include the assertion that the need for a transfusion is attributable to lower preoperative blood volume, as reported by Ferraris et al in 2007¹⁴ and by Shevde et al in a study evaluating gender.¹⁵ With much attention on the existing preoperative states that could be possible contributors to and/or predictors of transfusion requirements, little research exists that evaluates bleeding directly from the surgical site as it relates to variances in body mass.

Thus, the objective of our study was to see if obesity, determined by body mass index (BMI), contributed to bleeding in CABG surgery. We chose two measures of bleeding: transfusions to account for symptomatic total blood loss and chest-tube output to measure blood lost directly from the surgical site. We examined intraoperative and postoperative packed red blood cell transfusion frequency and amount, as well as 24-hour chest-tube output draining the surgical site.

METHODS

We obtained approval of the Institutional Review Board before collecting data for this study. Data were collected via a retrospective chart review. Data from the medical record database as well as from the paper charts were entered into a custom Microsoft Access database and organized into the following categories: preoperative laboratories, preoperative medications, procedure data, other complications, transfusions, 24-hour chest-tube output, postoperative medications, and postoperative laboratories. Data were collected from subjects who received isolated CABG surgery, either on-pump or off-pump, performed by a single surgeon (C.R.). Procedures were performed at the University of Kentucky Medical Center between September 2006 and April 2009. Subjects undergoing simultaneous valve procedures, aneurysms, or patent foramen ovale repair were excluded. A total of 150 subjects were examined.

We calculated the BMI by dividing the weight in kilograms by the height in meters squared. Following the American Heart Association and the World Health Organization guidelines, subjects were divided into groups based on BMI and included normal-weight (BMI <25) ($n=34$), overweight (BMI 25 to 29) ($n=58$), and obese (BMI ≥ 30) ($n=58$).^{16,17} Postoperative bleeding was assessed by analyzing chest-tube output and transfusions. Chest-tube output was calculated using the amount in milliliters collected from the chest-tube draining the surgical site during the immediate 24-hour postoperative period. Packed red blood cell transfusions were assessed looking at both the total transfusion amount in milliliters as well as the total number of transfusions received intraoperatively and postoperatively within the first 72 hours.

Subjects' intraoperative transfusion amount, postoperative transfusion amount, and 24-hour chest-tube amount were presented in each BMI category as mean $\pm$ SD. Pearson's chi-square test compared the number of intraoperative and postoperative transfusions across BMI categories. Evaluations of transfusion amount were done by ANOVA. Finally, a chi-square test for linear trend was performed to analyze both postoperative transfusion amount and chest-tube output amount against BMI. In all the analyses, the significance level was $\alpha < 0.05$. SPSS version 17 software was used for all statistical analysis (SPSS Inc., Chicago, IL).

RESULTS

The normal-weight BMI group accounted for 22.6% of the cohort. The overweight group and the obese group each accounted for 38.6% of the cohort. In the normal-weight BMI group, 41.1% ($n=14$) received intraoperative transfusions and 32.3% ($n=11$) received postoperative transfusions within the first 72 hours. In this same group, the intraoperative transfusion amount had a mean volume of 557 mL with a standard deviation of ± 330 , and the 72-hour postoperative transfusion amount had a mean volume of 709 mL with a standard deviation of ± 336 . In the overweight group, 15.5% ($n=9$) received intraoperative transfusions and 32.7% ($n=19$) received postoperative transfusions within the first 72 hours. In this same group, the intraoperative transfusion amount had a mean volume of 566 mL with a standard deviation of ± 278 , and the 72-hour postoperative transfusion amount had a mean volume of 474 mL with a standard deviation of ± 182 . In the obese group, 24.1% ($n=14$) received intraoperative transfusions and 24.1% ($n=14$) received postoperative transfusions within the first 72 hours. In this same group, the intraoperative transfusion amount had a mean volume of 493 mL with a standard deviation of ± 302 , and the 72-hour postoperative transfusion amount had a mean volume of 471 mL with a standard deviation

Figure 1 The percentage of subjects receiving intraoperative transfusions varied significantly by BMI group ($p=0.022$). Similarly, the percentage of subjects receiving transfusions in the 72-hour postoperative period showed a decreasing trend based on BMI group ($p=0.054$).

of ± 194 . The chi-square test showed the percentage of subjects receiving intraoperative transfusions varied significantly by BMI group ($p=0.022$) and was the lowest in the overweight cohort. Similarly, the percentage of subjects receiving transfusions in the 72-hour postoperative period showed a decreasing trend based on BMI group ($p=0.054$), and the lowest percentage was in the obese cohort (Fig. 1). Looking at the combined picture, 61.8% ($n=21$) of the normal-weight BMI group, 43.1% ($n=25$) of the overweight BMI group, and 39.7% ($n=23$) of the obese BMI group received intraoperative or 72-hour postoperative transfusions. Chi-square test analysis showed a decreasing trend by group ($p=0.103$) and a nearly significant linear trend ($p=0.054$). An ANOVA analysis showed the amount of packed red blood cells intraoperatively is similar between groups ($p=0.808$) but during the 72-hour postoperative period varied significantly between BMI groups ($p=0.021$). The packed red blood cell amount was lowest in the obese cohort, and the test for a linear decrease across groups was significant ($p=0.020$) (Fig. 2).

The mean chest-tube output amount for the normal-weight group was 1005 mL with a standard

Figure 2 The amount of packed red blood cells during the 72-hour postoperative period varied significantly between BMI groups ($p=0.021$), and the test for a linear decrease across groups was significant ($p=0.020$).

Figure 3 Chest-tube output varied significantly across categories ($p=0.018$), and a chi-square test for linear trend showed chest-tube output decreasing with increasing obesity in a linear fashion ($p=0.006$).

deviation of ± 327 . The mean chest-tube output amount for the overweight group was 944 mL with a standard deviation of ± 454 . The mean chest-tube output amount for the obese group was 798 mL with a standard deviation of ± 273 . An ANOVA test of the chest-tube output was significant for variation across categories ($p=0.018$). A chi-square test for linear trend showed chest-tube output decreasing with increasing obesity in a linear fashion ($p=0.006$) (Fig. 3).

CONCLUSION

Obesity as defined by BMI has significant correlations with blood loss and thus blood product use. Transfusion rate and amount decreased with increasing obesity, significantly so in the 72-hour postoperative period. This finding follows closely with the results of other studies, which found transfusion requirements increased with lower body weight^{7,12,13} and lower BSA.¹¹ Decreased transfusions indicate that the obese population experienced less total blood loss after wound closure than that of other populations. This conclusion correlates with studies by both Birkmeyer et al and Engel et al, which showed obese populations have a decreased requirement for reoperations to assess bleeding.^{2,5}

Although a decrease in the number of transfusions indicates a decrease in symptomatic total body blood loss, the chest-tube output gives a more direct measurement of bleeding at the surgical site. The 24-hour chest-tube output showed statistically significant variances based on BMI, with higher BMIs seeing lower chest-tube output amounts. When this finding was further assessed by a chi-square test for linear trend, it showed that not only did the amount vary by BMI, but also it varied linearly, with chest-tube output decreasing as obesity increased. This finding directly underscores how surgical site bleeding varies not purely across broad BMI categories but even within categories based on individual BMI numerical values.

Limitations of this study revolved mainly around a small sample size. The small sample size not only limited further subdivision of the BMI categories but also restricted the ability to perform effective multi-variable analysis. Additional variables could increase postoperative bleeding, such as the use of on-pump versus off-pump CABG surgery^{18,19} or the use of antiplatelet or anticoagulant therapies.²⁰ A larger number of subjects would also have allowed us to further test the converse relationship of BMI with thrombosis, which could possibly shed more light on the effect of preoperative BMI on hemostasis.

This study's findings, evaluating chest-tube output along with transfusion amount, show that increasing obesity leads to decreased symptomatic bleeding as well as decreased operative site bleeding. Recently, we have implemented protocols to standardize the transfusion intraoperatively and postoperatively with a trigger of hemoglobin level of 7 g/dL in stable patients. Further research is required to understand the full depth of this information. Another variable we are looking at is admission and discharge hemoglobin and hematocrit in a larger population to see if there is correlation with BMI and BSA. Additional studies might be able to further clarify if this variance is based on preoperative total blood volume or if there is a more microscopic force at work, such as variances in the coagulation cascade, directly attributable to changes in body weight. In the study by Shevde et al, variances in preoperative blood volumes were seen in gender, but these volume differences were not a result of body mass.¹⁵ Alternatively, studies have shown that increased adipose tissue increases aromatization of androstenedione to estrone,²¹ and that estrogens have a variety of procoagulant effects on the coagulation system.²² Such findings indicate that another possible cause for the decreased bleeding in obese patients is attributable to adipose-related effects on coagulation. Such insight could yield new strategies for preoperative and postoperative care that use preoperative BMI to help guide treatments to minimize blood loss.

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