DOI: 10.14744/ejmi.2020.78002
EJMI 2020;4(1):51–55

Research Article

The Effect of Body Mass Index on Postoperative Bleeding and Blood Transfusion in Patients with Coronary Bypass Surgery

Hakan Kartal,[1] Ertan Demirdas,[1] Huseyin Sicim,[1] Ufuk Mungan,[2] Gokhan Erol,[1] Murat Koc,[1] Elgin Hacizade,[1] Tuna Demirkiran,[1] Hakan Comakli,[3] Celalettin Gunay,[1] Bilgehan Savas Oz[1]

[1]Department of Cardiovascular Surgery, University of Health Sciences, Gulhane Training and Research Hospital, Gulhane Faculty of Medicine, Ankara, Turkey
[2]Department of Cardiovascular Surgery, Lokman Hekim Akay Hospital, Ankara, Turkey
[3]Department of Cardiovascular Surgery, Konya Training and Research Hospital, Konya, Turkey

Abstract

Objectives: The use of blood and blood products, which is a major complication, significantly increases the duration of stay in intensive care and hospitalization, as well as hospital costs on open heart surgery. In our study, we aimed to investigate the relationship between postoperative early bleeding, blood and blood product use in coronary artery bypass grafting (CABG) surgery under cardiopulmonary bypass (CPB).

Methods: In this study, 843 patients who underwent consecutive CABG operation between May 2012 and March 2014 were included. The patients were classified into three categories according to their body mass index (BMI); weak group (BMI ≤19 kg/m^2), normal weight group (BMI 20-29 kg/m^2) and obese group (BMI ≥30 kg/m^2). Preoperatively; age, gender, height, weight, diabetes mellitus (DM), hypertension, hyperlipidemia, chronic obstructive pulmonary disease (COPD), preoperative myocardial infarction, left ventricular ejection fraction (LVEF), mean hemoglobin and platelet values, Intraoperatively; cross clamp time, cardiopulmonary bypass time, total duration of the operation, amount of cardioplegia given, number of grafts used in coronary bypass. Postoperatively; the total amount of blood used, drainage amount, given vasopressor treatment, given positive inotropic support, intraaortic balloon pump usage, intubation duration, intensive care stay, hospital stay, bleeding-related re-exploration and mortality of all patients were examined.

Results: It was observed that more blood transfusions performed in patients with low and normal weight compared to the obese group (11.22±2.85 ml/kg, p=0.011). Also in patients with low and normal weight compared to the obese group more blood loss was observed (7.12±1.87 ml/kg, p=0.017).

Conclusion: In our study, in accordance with the general opinion of previous studies, we found that patients with high BMI had lower postoperative blood loss and blood use than patients with low BMI.

Keywords: Body mass index, blood transfusion, coronary bypass surgery

Cite This Article: *Kartal H, Demirdas E, Sicim H, Mungan U, Erol G, Koc M, et al. The Effect of Body Mass Index on Postoperative Bleeding and Blood Transfusion in Patients with Coronary Bypass Surgery. EJMI 2020;4(1):51–55.*

Obesity is becoming a worldwide burden. By 2025, the percentage of obesity is expected to be over 18% in males and 21% in females; severe obesity will be more than 6% in males and 9% in females.[1] Obesity increases annually at an average of 0.4-0.5 kg m-2 BMI worldwide.[2]

Bleeding after open heart surgery is a major complication, and blood loss and transfusion amounts are an important

Address for correspondence: Hakan Kartal, MD. Gulhane Tip Fakultesi, Saglik Bilimleri Universitesi, Gulhane Tip Fakultesi, Kalp ve Damar Cerrahisi Anabilim Dali, Ankara, Turkey
Phone: +90 533 035 99 70 **E-mail:** hakhankartal@gmail.com

Submitted Date: December 31, 2020 **Accepted Date:** January 27, 2020 **Available Online Date:** February 17, 2020

indicator in evaluating open heart surgery results.[3]

Severe postoperative bleeding after cardiac surgery can cause some complications such as stroke, acute kidney injury, perioperative myocardial infarction and mortality.[4, 5]

The use of blood and blood products, which is a major complication, significantly increases the duration of stay in intensive care and hospitalization, as well as hospital costs. Therefore, studies have been carried out aimed at different strategies for using blood and blood products and reducing postoperative bleeding in patients underwent open heart surgery.[6–8]

In our study, we aimed to investigate the relationship between postoperative early bleeding, blood and blood product use in coronary artery bypass grafting (CABG) surgery under cardiopulmonary bypass (CPB).

Methods

In the study, 843 patients who underwent consecutive CABG operation between May 20012 and March 2014 at the Private Akay Hospital Cardiovascular Surgery Clinic were included.

The patients were classified into three categories according to their body mass index; weak group (BMI ≤19 kg/m^2), normal weight group (BMI 20-29 kg/m^2) and obese group (BMI ≥30 kg/m^2).

Patients with chronic kidney failure, peripheral vascular disease, chronic liver disease, patients underwent emergency surgery, reoperations, patients with chronic malnutrition, patients underwent additional surgery for the CABG operation, patients received antiaggregant within 5 days before the operation and patients with a prior history of bleeding diathesis and the cases with comorbidity which is enhancing the risk of bleeding were excluded.

Demographic data, preoperative risk factors, postoperative data, postoperative complications, laboratory findings, observed mortality and morbidity records of the patients were obtained retrospectively from patient files and hospital database.

Preoperatively; age, gender, height, weight, diabetes mellitus (DM), hypertension, hyperlipidemia, chronic obstructive pulmonary disease (COPD), preoperative myocardial infarction, left ventricular ejection fraction (LVEF), mean hemoglobin and platelet values,

Intraoperatively; cross clamp time, cardiopulmonary bypass time, total duration of the operation, amount of cardioplegia given, number of grafts used in coronary bypass,

Postoperatively; the total amount of blood used, drainage amount, given vasopressor treatment, given positive inotropic support, intraaortic balloon pump usage, intubation duration, intensive care stay, hospital stay, bleeding-related re-exploration and mortality of all patients were examined.

Operative Technique

The operation was performed by median sternotomy in all CABG operated cases.

Extracorporeal circuit was consisted of atmospheric type venous reservoir, roller pump (Sorin Stockert S3 heart lung machine, sorin group Inc.Milan, Italy), heat exchanger, membrane oxygenator (Capiox SX18; Terumo Inc., Tokyo, Japan), arterial filter (Quart arterial filter; Maquet Cardiopulmonary AG, Hirrlingen, Germany).

The tube diameter of the perfusion set for both the arterial and venous side (two tubes) was 5/16 inches (7.9 mm). The circuit (uncoated) was prepared with approximately 1000 ml sodium acetate Ringer's solution, 0.25 g/kg mannitol (20%), 20 meq bicarbonate and 5000 IU heparin.

For CPB, standard cannulation (with two stage cannula) of the ascending aorta and right atrium was performed. After cardiac arrest was achieved with antegrade-retrograde cold crystalloid cardioplegia and topical hypothermia, the continuation of the arrest was achieved with intermittent retrograde cold blood cardioplegia.

CPB management; Operations were completed under moderate hypothermia (28 °C), using alpha-stat pH management, with targeted mean arterial blood pressure between 50 and 80 mmHg and pump flow rates of 2.4 l/min/m^2.

In all 843 patients who underwent CABG, anastomosis was performed on the left anterior descending artery (LAD) using the left internal mamarian artery (LIMA). The saphenous vein graft removed from the leg was also used in bypasses performed to other coronary arteries. Prosimal anastomoses were performed under the cross clemp. Hot blood cardioplegia was given before the cross clamp was removed. The blood in the reservoir in the CPB circuit was always returned to the patient before leaving the operating room.

Statistical Analysis

Statistical analysis was performed using the SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics were expressed in mean±standard deviation (SD), percent or number and frequency for continuous variables. Categorical variables were compared between the groups using the chi-square test. The Fisher exact test was used, if the expected contingency table cell frequency was less than 5. The Mann-Whitney U test and independent samples t-test were used to analyze significant differences between the groups for continuous variables. P value <0.05 was considered significant.

Results

There was no statistically significant difference between the mean ages and gender distribution of all three groups (p=0.654, p=0.347) (Table 1).

In terms of risk factors, it was found statistically significant that it correlated with BMI increase between DM, HT and HL values, respectively (p=0.001, p=0.003, p=0.027) (Table 1).

No statistically significant difference regarding COPD, Previous myocardial infarction, Left ventricular ejection fraction (LVEF), hemoglobin and platelet values was detected in all three groups (Table 1).

In comparison of intraoperative data of patients, no statistically significant difference was found between cross-clamp time, cardiopulmonary bypass time, operation duration time and total amount of cardioplegia (p=0.356, p=0.531, p=0.455, p=0.127) (Table 2).

Besides, the number of coronary arterial anastomoses was higher in obese patients (p=0.001) (Table 2).

It was observed that more blood transfusions performed in patients with low and normal weight compared to the obese group (11.22±2.85ml/kg, p=0.011) (Table 3).

Also in patients with low and normal weight compared to the obese group more blood loss was observed (7.12±1.87 ml/kg, p=0.017) (Table 3).

Discussion

In our study, we found an inverse relationship between increased BMI and the need for blood transfusion and decreased amount of blood loss in patients after CABG. In addition, as an additional finding, although there were more coronary artery anastomoses in obese patients, blood loss was less. We evaluated this finding toward that the number of anastomoses did not affect blood loss. Our results were toward that low or normal weight is an important preoperative indicator of increased chest tube drainage and perioperative bleeding.

The relationship between Body Mass Index (BMI), postoperative bleeding volume and blood transfusion remains uncertain.[9]

Table 1. Baseline demographic and clinical characteristics of patients

Variable	Underweight (BMI ≤19 kg/m²) n=76	Normal weight (BMI 20–29 kg/m²) n=408	Obese (BMI ≥30 kg/m²) n=359	p
Age	62.55±8.45	61.87±9.12	60.93±10.34	0.654
Sex (female)(n/%)	28/36.84	157/38.48	133/37.04	0.347
Diabetes mellitus	40	247	287	0.001
Hypertension	22	203	265	0.003
Hiperlipidemia	34	214	147	0.027
COPD	17	231	246	0.462
Previous myocardial infarction	27	186	278	0.735
LVEF (mean±SD)	50.3±7.9	46.7±8.4	48.3±.9.2	0.159
Hemoglobin (gr/dl, mean±SD)	13.4±1.6	13.7±1.8	14.1±1.6	0.347
Platelet (109/L)	202.4±62.3	204.95±61.53	211.7±65.6	0.563

COPD: Cronic Obstructive Pulmonary Disease; LVEF: Left Ventricule Ejection Fraction.

Table 2. Intraoperative data of patients

Variable	Underweight (BMI ≤19 kg/m²) n=76	Normal weight (BMI 20–29 kg/m²) n=408	Obese (BMI ≥30 kg/m²) n=359	p
Cross-clamp time (min)	83.2±23.5	78.3±36.2	85.2±28.8	0.356
Cardiopulmonary bypass time (min)	102.5±22.3	98.3±25.7	108.3±32.7	0.531
Operation duration (min)	187.3±32.1	196.5±29.8	227.7±49.6	0.455
Total amount of cardioplegia (mL)	1570±420	1530±390	1660±450	0.127
Number of anastomosis (n/%)				
≤2	35/46.05	227/55.63	120/43.43	0.017
≥3	41/53.95	181/44.37	239/66.57	0.001

Table 3. Postoperative data of patients

Variable	Underweight (BMI ≤19 kg/m²) n=76	Normal weight (BMI 20–29 kg/m²) n=408	Obese (BMI ≥30 kg/m²) n=359	p
Total RBC transfusion (mL/kg)	11.22±2.85	8.65±1.41¶	6.56±1.05¶	0.011
Total blood loss (mL/kg)	7.12±1.87	4.26±1.38¶	3.23±1.15¶ˣ	0.017
Vasopressor therapy (epinephrine, norepinephrine)	5	73	127	0.006
Positive inotropic support (dopamine)	9	92	134	0.019
Intra-aortic balloon pump	1	3	5	0.029
Ventilation time (h)	6.3±1.7	7.6±1.9	10.4±3.2	0.017
Length of ICU stay (day)	2.1±0.9	2.2±1.1	2.4±1.5	0.632
Length of hospital stay (day)	4.9±2.1	5.2±2.4	5.7±2.9	0.764
Re-exploration for bleeding or tamponade (n/%)	5/6.5	3/0.73	1/0.27	0.032
Mortality	1	0	2	0.056

¶ Indicating a difference on comparison with BMI: <24 kg/m² with p 0.05; ˣIndicating a difference on comparison with BMI: 24–28 kg/m² with p<0.05; RBC: Red blood cell; Hb: Hemoglobin; PLT: Platelet; BMI: body mass index; ICU: intensive care unit.

There are studies indicating that the transfusion rate and amount and total blood loss are reduced in obese individuals and there is a linear correlation between BMI and postoperative bleeding volume.[10]

On the other hand, there have been studies showing that the risk of postoperative bleeding complications does not differ between obese and non-obese patients.[11]

In some studies evaluating risk factors and re-explorations due to bleeding in obese patients underwent CABG, similar results were obtained with our study, including reduced re-exploration among obese patients.[12]

In a research, which supports our study, conducted by Mertens and his friends, it has been demonstrated that adipocytes produce plasminogen activator inhibitor-1, which probably explains why we have less perioperative bleeding and less blood transfusion in our obese patient group underwent CABG.[13]

Likewise, it has been suggested that the connecting link between BMI and postoperative bleeding volume and transfusions may be related to procoagulant status. There are studies toward that obese patients have higher plasma clotting factor II (FVII), thrombin and thrombin-antithrombin (TAT) complexes and tissue factor procoagulant activity (TF).[14]

There are also studies showing that obesity is associated with increased platelet activation.[15]

In our study, in accordance with the general opinion of previous studies, we found that patients with high BMI had lower postoperative blood loss and blood use than patients with low BMI. There were some limitations in our study. First of all, the fact that our study is retrospective and single-centered, is the main one. However, we think that the sample size reduces the negativity caused by this limitation.

More clinical studies are needed to find out the underlying reasons why high BMI reduces blood loss and blood use.

However, regardless of the reason for less blood loss and blood use in patients with high BMI, looking at with an eye of a surgeon, we think that BMI is a very important biomarker that should be kept in mind in terms of reducing the postoperative mortality and morbidity of the patient.

Disclosures

Ethics Committee Approval: The Ethics Committee of Lokman Hekim University provided the ethics committee approval for this study (25.12.2019/2019039).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – H.K., E.D.; Design – H.S.; Supervision – M.K.; Materials – U.M.; Data collection &/or processing – E.H., T.D.; Analysis and/or interpretation – E.D., H.Ç.; Literature search – G.E., H.Ç.; Writing – H.K.; Critical review – B.S.O., C.G.

References

1. NCD Risk Factor Collaboration. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19· 2 million participants. The Lancet 2016;387:1377–1396.
2. Finucane, M. M., Stevens, G. A., Cowan, M. J., Danaei, G., Lin, J. K., Paciorek, C. J., ... & Farzadfar, F. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9· 1 million participants. The Lancet 2011;377:557–567.

3. Koch, C. G., Li, L., Duncan, A. I., Mihaljevic, T., Loop, F. D., Starr, N. J., & Blackstone, E. H. (2006). Transfusion in coronary artery bypass grafting is associated with reduced long-term survival. The Annals of thoracic surgery 2006;81:1650–1657.
4. Dyke, C., Aronson, S., Dietrich, W., Hofmann, A., Karkouti, K., Levi, M., ... & Ranucci, M. (2014). Universal definition of perioperative bleeding in adult cardiac surgery.
5. Ranucci, M., Baryshnikova, E., Castelvecchio, S., Pelissero, G., & Surgical and Clinical Outcome Research (SCORE) Group. Major bleeding, transfusions, and anemia: the deadly triad of cardiac surgery. The Annals of thoracic surgery 2013;96:478–485.
6. Unsworth-White, M. J., Herriot, A., Valencia, O., Poloniecki, J., Smith, E. J., Murday, A. J., ... & Treasure, T. Resternotomy for bleeding after cardiac operation: a marker for increased morbidity and mortality. The Annals of thoracic surgery 1995;59:664–667.
7. Moulton, M. J., Creswell, L. L., Mackey, M. E., Cox, J. L., & Rosenbloom, M. Reexploration for bleeding is a risk factor for adverse outcomes after cardiac operations. The Journal of thoracic and cardiovascular surgery 1996;111:1037-1046.
8. Dacey, L. J., Munoz, J. J., Baribeau, Y. R., Johnson, E. R., Lahey, S. J., Leavitt, B. J., ... & O'Connor, G. T. Reexploration for hemorrhage following coronary artery bypass grafting: incidence and risk factors. Archives of surgery 1998;133:442–447.
9. Zhang, W., Chen, S., Liu, X., Wang, L., Wang, S., Yu, Y., & Ao, H. (2019, August). Can Higher Body Mass Index Patients Save Blood Following On-pump Coronary Artery Bypass Grafting?. In The heart surgery forum (Vol. 22, No. 5, pp. E352-E356)
10. Nolan, H. R., & Ramaiah, C. Effect of body mass index on postoperative transfusions and 24-hour chest-tube output. International Journal of Angiology 2011;20:81–86.
11. Ao, H., Wang, X., Xu, F., Zheng, Z., Chen, M., Li, L., ... & Hu, S. The impact of body mass index on short-and long-term outcomes in patients undergoing coronary artery graft bypass. PLoS One 2014;9:e95223.
12. Birkmeyer, N. J., Charlesworth, D. C., Hernandez, F., Leavitt, B. J., Marrin, C. A., Morton, J. R., ... & O'Connor, G. T. Obesity and risk of adverse outcomes associated with coronary artery bypass surgery. Circulation 1998;97:1689–1694.
13. Mertens, I., & Gaal, L. V. Obesity, haemostasis and the fibrinolytic system. Obesity reviews 2002;3:85–101.
14. Ay, L., Kopp, H. P., Brix, J. M., Ay, C., Quehenberger, P., Schernthaner, G. H., ... & Schernthaner, G. Thrombin generation in morbid obesity: significant reduction after weight loss. Journal of Thrombosis and Haemostasis 2010;8:759–765.
15. Santilli, F., Vazzana, N., Liani, R., Guagnano, M. T., & Davì, G. Platelet activation in obesity and metabolic syndrome. Obesity reviews 2012;13:27–42.