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Which Is More Effective In Determining The Risk of Mortality and Complications After Coronary Artery Bypass Graft Surgery; Body Mass Index Or Albumin?

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ABSTRACT

Preoperative risk analysis is important in predicting postoperative outcomes in patients undergoing cardiac surgery.These analyzed risk factors influence both the mortality and the morbidity results of coronary artery bypass graft (CABG) surgery. The aim of this study is to emphasize that the serum albumin value is a predictor of survival during the preoperative period for the patients that we prepared for surgery, and to indicate whether body mass index (BMI) is as valuable as albumin in predicting survival and postoperative period results.

This study included patients who underwent CABG surgery between 2019 -2020 at the Cardiac Surgery Center. Patient's demographic information and all laboratory data were collected. Patients were grouped according to BMI and serum albumin values. Descriptive statistics for the continuous variables were presented as Mean, Standard deviation while count and percentages for categorical variables.

A total of 174 patients, who underwent CABG surgery were included in the study.While postoperative complications were seen in 3.2% of patients with high BMI (>30 kg/m2), these complications did not develop in patients with low BMI (<20 kg/m2) (P=0.034).Patients who have serum albumin levels below 2.5g/dL are 22 times more likely to exitus than patients who have normal albumin levels (p=0.001, OR=22.246) whereas patients with normal BMI, obese patients have 16 times higher risk of exitus after bypass (OR=15.952)

When we compare albumin and BMI, more extensive studies are needed to determine whether low serum albumin or increased BMI can independently predict the risk factors for poor short-term surgical outcomes.

Keywords: Coronary artery bypass graft, albumin, body mass index

Introduction

Obesity, smoking, diabetes mellitus, hypertension, and hyperlipidemia are the main risk factors of coronary artery disease (1). Although one of the main risk factors is stated as obesity for heart failure and coronary heart disease, it is also one of the leading causes for negative outcomes postcardiac surgery (2,3). According to the information in the database of the Society of Thoracic Surgeons (STS), especially in coronary artery bypass graft (CABG) surgery, the STS states that BMI affects mortality and morbidity (4).

During the preparation of patients for cardiac surgery, the patient's albumin values are routinely checked. The albumin value may decrease in patients during the preoperative and postoperative periods (5), and a low serum albumin level, perioperative, is related to increased mortality during surgery and a higher mortality risk following surgery (6). Hypoalbuminemia is a low serum albumin level, which proteinuria, hemodilution, chronic inflammation, infection, malnutrition, and other mechanisms can cause.

Like hypoalbuminemia is associated to poor outcomes in diseases like cancer, end-stage renal disease, infection and for the elderly, it has been reported that bad results are also experienced after CABG surgery (7). Even though the relationship between hypoalbuminemia and poor surgical outcomes was documented many years ago, the pathophysiology behind this association is still unknown. There are three working theories which can explain this relationship. The first theory is that albumin may serve as a nutritional marker so that hypoalbuminemia, which indicates malnutrition in patients with poor postoperative outcomes. The second theory is that albumin has its own pharmacological properties, like an antioxidant or transporter, so that, a deficiency in albumin can cause a deficiency of these functions, which would result in a poor postoperative

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outcome. The third theory is that since albumin is known as a negative acute phase protein, hypoalbuminemia may indicate an increase in the patient's inflammatory state and potentially lead to a poor postoperative outcome (8).

It is important to do a thorough preoperative risk analysis in order to predict postoperative outcomes for all patients that will undergo cardiac surgery.

The aim of our study is to emphasize that the serum albumin value, which is already used as a prognostic indicator, is a predictor of survival during the preoperative period for the patients that we prepare for surgery, and to indicate whether body mass index (BMI) is as valuable as albumin in predicting survival and postoperative period results.

Material and Method

Our study retrospectively analyzed all patients who had elective CABG surgery at the Cardiac Surgery Center in Van between January 2019 and December 2020. All patients filled out a demographic information form, and their BMI and laboratory data was collected (Table 1). Clinical tests were run for hypertension (HT), hyperlipidemia, diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), chronic renal failure (CRF), and smoking status results were examined. Postoperatively, regular follow-up data was recorded for six months. Patients who did not follow up for six months, were under the age of 18, had a past history of cardiac surgery or died during the surgical preparations were not included in the study. Patients were divided into three categories according to their BMI: low BMI <20 kg/m2, normal BMI 20- 30 kg/m2, and high BMI >30 kg/m^2 Patients were divided into three groups in accordance with their serum albumin levels: very low albumin level <2.5 g/dL, low albumin level 2.5- 3.5 g/dL and normal albumin level >3.5 g/dL).

Statistical Analysis: All data was analyzed using the IBM SPSS Statistics 25.0.0 program. Descriptive statistics for continuous variables were presented as mean, standard deviation (SD), and minimum-maximum values as percentages for categorical variables. The Kolmogorov-Smirnov test was used for normality test in this study. The relationships between the variables were examined with Pearson's chi-squared test. A p value less than <0.05 (5%) was considered statistically significance. The one-way analysis of variance (ANOVA) was performed for the comparison of group means. Logistic regression analysis was also performed to determine the relationships between exitus rates and the explanatory variables such as age, gender, BMI and Albumin level.

Results

A total of 174 patients who underwent coronary surgery between 2019-2020 were included in this study, of which 99 (57%) were men and 75 (43%) were women. The median age of the patients was 69 (23-90). Of the included patients, 126 (72.4%) of the them had HT, 91 (52.3%) of them had hyperlipidemia, 73 (42%) of them had diabetes, 22 (12.6%) of them had COPD, 11 (6.3%) of them had CRF, 108 (62.1%) of them had a history of smoking (Table 2).

Although patient weights ranged from 47 kg to 110 kg, the average was 68 kg. The BMI of the patients was between a minimum of 17.7 kg/m2 and a maximum of 44 kg/m2, with an average of 24.7 kg/m2. When we examined our patients, 28% of them had a low BMI score of <20 kg/m2, 60.3% of them had a normal BMI score of 20-30 kg/m2 and 11.5% of them had a high BMI score of >30 kg/m2.

The median serum albumin level of patients was normal, with a score of 3.9 g/dL. When comparing patients, 5.7% had a very low serum albumin level of <2.5 g/dL, 33.9% had a low serum albumin level of 2.5-3.5 g/dL, and 60.3% had a high serum albumin level of >3.5 g/dL.

While the median age of the patients with a very low serum albumin level (<2.5 g/dL) was 60.7 years, the median age of the patients with a low serum albumin level (between 2.5-3.5 g/dL) was 61.7 years, and the median age of the patients with a normal serum albumin level (above 3.5 g/dL) was 67.93 years. There was no statistically meaningful correlation between age and serum albumin levels (p=0.743). When the gender and age of patients were considered, the median age of women was 65 years, and 65.74 years for men.

While the median age of patients with a BMI score below 20 was 63 years, the median age for patients with a BMI score between 20-30 was 65 years, and for patients with a score above 30 was 65.15 years. There was no meaningful correlation found between age and BMI scores (p=0.363).

It was observed that 2.7% of female patients had an albumin level below 2.5, 32% had an albumin level between 2.5-3.5 g/dL, and 65.3% had an albumin level above 3.5 g/dL. For male patients,

Table 1. Demographic Characteristics of the Patients

Profiles		(%)	N
Gender			
Male	56,9		99
Female	43,1		75
Age (Years)			
18-59		45.4	
>60	54.6		79
BMI			
<20kg/m2		28.2	95
20-30 kg/m2	60.3		
>30 kg/m2	11.5		
*n: number of people ;%:percentage			
BMI:Body Mass Index			49
			105
			20

Table 2. Baseline Characteristics of The Patients

	%	N
Hypertension	72.4	126
Hyperlipidemia	52.3	91
Diabetes Mellitus	42	73
Chronic Obstructive Pulmonary Disease	12.6	22
Chronic Renal Failure	6.3	11
Smoking Status	62	108

*n: number of people; %: percentage

8.1% had an albumin level below 2.5 g/dL, 35.4% had an albumin level between 2.5-3.5 g/dL, and 56.6% had an albumin level above 3.5 g/dL. Of those with albumin levels below 2.5 g/dL, 20% were female and 80% were male. There was no meaningful correlation between serum albumin levels and gender (p= 0.239).

It was observed that 26.7% of (20) women and 29.3% of (29) men had a low BMI (< 20kg/m2) level. Additionally, it was observed that 20% of (15) women and 5.1% of (5) men had a high BMI (>30 kg/m2). This study found a statistically meaningful relationship between BMI and gender (p = 0.009).

While 30.6% of patients with BMI <20 had an albumin level below 3.5 g/dL, 45% of patients with a BMI >30 had an albumin level below 3.5 g/dL. In addition, 69.4% of patients with a BMI <20 and 50% of patients with a BMI >30 had an albumin level above 3.5 g/dL. Although there was no statistically meaningful relationship between BMI and albumin (p=0.147), there was an increase in albumin level in patients with increased BMI.

While 21% of patients who had serum albumin levels below 3.5 g/dl required prolonged mechanical ventilation, 6.4% of patients who had serum albumin levels below 3.5 g/dl required long-term respiratory support. While there is a statistically meaningful relationship between the albumin value and the number of days a patient needed mechanical ventilation (p=0.034), there is no statistically meaningful relationship between BMI and the number of days a patient needed mechanical ventilation (p=0.082).

No meaningful correlation was found between BMI and serum albumin levels in patients with, cerebrovascular stroke, low cardiac output or postoperative complications that require staying in the intensive care unit after CABG. While postoperative infection, pneumonia or myocardial infarction was seen in 3.2% of patients with high BMI (>30 kg/m2), these complications did not develop in patients with low BMI (<20 kg/m2).

Table 3. Result of Risk Factor For Exitus Rate

Risk Factor	p	OR	95% CI
Age	0,121	1,056	0,986 - 1,131
Gender	0,642	0,676	0,130 - 3,509
BMI	0,011		
BMI <20kg/m2	0,502	1,961	0,275 - 14,001
BMI >30kg/m2	0,003	15,952	2,516 - 101,138
Albumin	0,220		
Albumin < 2.5g/dl	0,001	22,246	2,236 - 221,373
Albumin 2.5-3.5g/dl	0,034	7,033	1,163 - 42,529

*The level of statistical significance is set at p<0.05; OR, Odds Ratio; CI, Confidence Interval: BMI,Body Mass Index

There is a meaningful relationship between the variables (p=0.034).

While only 1% of patients who had normal serum albumin levels (>3.5 g/dL) needed reoperation due to bleeding, 8.2% of patients who had low serum albumin levels (<3.5 g/dL) required reoperation (p=0.002). It can be said that there is a positive and meaningful correlation between low serum albumin levels and the increased probability of reoperation due to bleeding.

When we looked at BMI, 13.2% of the patients who had low BMI levels and 19.1% of the patients who had high BMI levels were reoperated for bleeding. The relationship here is significant (p=0.003).

Of the 174 patients, 10 (5.7%) were accepted as exitus. Although it was not found to be statistically meaningful, it was observed that the risk of exitus increased for each year a patient's age increased (Odds Ratio (OR) = 1.056). There was no statistically meaningful difference in the number of deaths based on gender between male and female individuals (p= 0.838).

We found that, patients who have serum albumin levels below 2.5g/dL are 22 times more likely to exitus than patients who have normal albumin levels (p=0.001, OR=22.246), whereas patients who have an albumin level between 2.5-3.5g/dL have a 7 times higher risk of exitus than individuals with normal albumin levels (OR=7.033).

Our study found that compared to patients with normal BMI, obese patients have 16 times higher risk of exitus after bypass (OR=15.952), whereas patients with a low BMI (<20) have 2 times higher risk of exitus compared to patients with normal BMI (OR=1.961) (Table 3). Alternately, 4.1% of the patients who had a low BMI (<20 kg/m2) and 25% of the patients who had a high BMI (>30 kg/m2) died peri- or post-surgery. There is a statistically meaningful relationship between death and BMI (p<0.01).

Discussion

While the female gender was reported as being a risk factor for early mortality after CABG surgery in one study (9), the male gender was reported as being a risk factor for late mortality in another study (10). However, in our study, no meaningful relationship was found between genders being an independent risk factor for early or late mortality (p=0.838).

A study by Habib et al., found that people with high BMI compared to normal BMI have an increased rate of postoperative complications and morbidity, and that a high BMI results in an increase in the length of the hospital stay after CABG, especially in severely obese (BMI >40 kg/m2) patients. It was also concluded that a high BMI leads to a decrease in long-term survival (11). On the other hand, there is an opinion that obese patients show better outcomes and higher survival rates than patients with normal BMI (12).

In our study, while post-operative complications such as pneumonia, myocardial infarction or infection increased in 3.2% of the patients with high BMI, these complications did not develop in patients with low BMI. There was a meaningful relationship between the variables (p=0.034). Postoperative mortality was higher in patients who had a high BMI level (>30 kg/m2) (p<0.001).

It has been shown in a study that preoperative hypoalbuminemia is a strong indicator that

surgical patients will need prolonged postoperative ventilation and a prolonged hospital stay (13). For patients undergoing surgery, a low albumin level (<3.5 g/dL) can be an indication for poor postoperative outcomes. Hypoalbuminemia is a sign of poor nutritional status, antioxidant deficiency, and increased inflammatory status. A study by Kim et al. found that hypoalbuminemia would lead to poor results in the postoperative period (8).

In our study, we observed in postoperative follow up that there was an increase in the number of days a patient required mechanical ventilation in the intensive care unit for patients who have low serum albumin levels. There was a meaningful difference between the decrease in albumin value and the increase in the number of ventilator days (p=0.027).

Surgical patients with hypoalbuminemia have an increased risk of postoperative morbidity and mortality. A large portion of the literature on this subject has been associated with postoperative organ dysfunction, gastrointestinal bleeding, postoperative surgical bleeding, hospital infections, and depression (14,15). Karas et al. wrote that patients with low preoperative serum albumin levels who undergo cardiac surgery have an increased risk of postoperative mortality and morbidity (16). In our study, we observed that mortality, morbidity and reoperation due to bleeding increased in the postoperative period. This correlation was also statistically meaningful (p=0.002).

It has been shown in a study that cardiac surgery patients with a low BMI have high mortality rates and that a low serum albumin level increases the risk of post-surgical infection (17). In other studies of mortality and outcomes based on serum albumin levels and BMI levels, they found that patients who had low albumin levels and high BMI levels also experienced increase mortality after they underwent CABG surgery (18,19).

Both low BMI and hypoalbuminemia have been reported as the cause of increased mortality and postoperative complications in CABG surgeries. When BMI is compared to albumin, hypoalbuminemia has been found to be an independent risk factor for poor short-term surgical outcome (20). Because of the strength of this correlation, hypoalbuminemia has become part of the widely used Acute Physiology and Chronic Health Assessment (APACHE) IV prognostic system that predicts mortality in critically ill, medical and surgical patients (21).

In our study, while the mortality rate was high in low preoperative serum albumin levels (<3.5g/dl) patients, postoperative pneumonia, myocardial infarction, infection risk and mortality rates were high in patients with high BMI (>30).

A high BMI is accepted as a risk factor for cardiac surgery operations. These patients have a high risk of complications after cardiac surgery and have more negative outcomes. Patients with low serum albumin levels have higher mortality after CABG and more postoperative complications. The main limitations of the study were the small sample size that was available at the single center research hospital, and the retrospective design of the research.

In order to predict the risk of perioperative mortality and morbidity, the use of preoperative serum albumin and BMI separately is important for the outcome of the disease. When we compare albumin and BMI, more extensive studies are needed to determine whether low serum albumin or increased BMI can independently predict the risk factors for poor short-term surgical outcomes.

References

1. Schwann TA, Habib RH, Wallace A et all. Operative outcomes of multiple-arterial versus single-arterial coronary bypass grafting. The Annals of thoracic surgery 2018; 105(4):1109-19.
2. Watanabe A, Kohnoe S, Shimabukuro R et al. Risk factors associated with surgical site infection in upper and lower gastrointestinal surgery Surgery today. 2008; 38(5):404-12.
3. Hussain SM, Zia K, Mangi AR et al. Operative Mortality of Coronary Artery Bypass Grafting in Patients with Low Serum Albumin after Nutritional Support. Pakistan Heart Journal 2021; 54(3):235-8.
4. Bowdish ME, D'Agostino RS, Thourani VH et al. The Society of Thoracic Surgeons adult cardiac surgery database: 2020 update on outcomes and research. The Annals of thoracic surgery 2020; 109(6):1646-55.
5. Engelman DT, Ali WB, Williams JB et al. Guidelines for perioperative care in cardiac surgery: enhanced recovery after surgery society recommendations. JAMA surgery 2019; 154(8):755-66.
6. Kingeter AJ, Raghunathan K, Munson SH et al. Association between albumin administration and survival in cardiac surgery: a retrospective cohort study. Canadian Journal of Anesthesia/Journal canadien d'anesthésie. 2018; 65(11):1218-27.
7. Doweiko JP, Nompleggi DJ. The role of albumin in human physiology and pathophysiology, Part

III: Albumin and disease states. JPEN. Journal of parenteral and enteral nutrition 1991; 15(4):476-83.

8. Kim S, McClave SA, Martindale RG, Miller KR, Hurt RT. Hypoalbuminemia and clinical outcomes: what is the mechanism behind the relationship?. The American Surgeon 2017; 83(11):1220-7.
9. Zitser-Gurevich Y, Simchen E, Galai N, Mandel M, ISCAB Consortium. Effect of perioperative complications on excess mortality among women after coronary artery bypass: the Israeli Coronary Artery Bypass Graft Study (ISCAB). The Journal of Thoracic and Cardiovascular Surgery. 2002; 123(3):517-24.
10. Van Straten AH, Bramer S, Hamad MA et al. Effect of body mass index on early and late mortality after coronary artery bypass grafting.The Annals of thoracic surgery 2010; 89(1):30-7.
11. Habib P, Scrocco JD, Terek M, Vanek V, Mikolich JR. Effects of bariatric surgery on inflammatory, functional and structural markers of coronary atherosclerosis. The American journal of cardiology 2009; 104(9):1251-5.
12. Stamou SC, Nussbaum M, Stiegel RM et al. Effect of body mass index on outcomes after cardiac surgery: is there an obesity paradox?. The Annals of Thoracic Surgery 2011; 91(1):42-7.
13. Delgado-Rodríguez M, Medina-Cuadros M, Gómez-Ortega A et al. Cholesterol and serum albumin levels as predictors of cross infection, death, and length of hospital stay. Archives of surgery. 2002; 137(7):805-12.
14. Lohsiriwat V, Lohsiriwat D, Boonnuch W, Chinswangwatanakul V, Akaraviputh T, Lert-Akayamanee N. Pre-operative hypoalbuminemia is a major risk factor for postoperative complications following rectal cancer surgery.World journal of gastroenterology 2008 ;14(8):1248.
15. DiMaria-Ghalili, Rose Ann. Nutrition risk factors in older coronary artery bypass graft patients.Nutrition in Clinical Practice 2008; 23(5):494-500.
16. Goh S. L., De Silva R. P., Dhital K., Gett R. M. Is low serum albumin associated with postoperative complications in patients undergoing cardiac surgery?. Interactive cardiovascular and thoracic surgery 2015; 21(6) :777-86.
17. Rapp-Kesek D, Ståhle E, Karlsson T. Body mass index and albumin in the preoperative evaluation of cardiac surgery patients. Clinical nutrition 2004; 23(6):1398-404.
18. Zhao D, Chen S, Liu Y et al. Blood Urea Nitrogen-to-Albumin Ratio in Predicting Long-Term Mortality in Patients Following Coronary Artery Bypass Grafting: An Analysis of the MIMIC-III Database. Frontiers in surgery. 2022; 9.
19. Dudina A, Cooney MT, Bacquer DD et al. Relationships between body mass index, cardiovascular mortality, and risk factors: a report from the SCORE investigators. European Journal of Cardiovascular Prevention & Rehabilitation. 2011;18(5):731-42.
20. Bhamidipati CM, LaPar DJ, Mehta GS et al. Albumin is a better predictor of outcomes than body mass index following coronary artery bypass grafting. Surgery. 2011; 150(4):626-34.
21. Zimmerman JE, Kramer AA, McNair DS, Malila FM. Acute Physiology and Chronic Health Evaluation (APACHE) IV: hospital mortality assessment for today's critically ill patients. Critical care medicine 2006; 34(5):1297-310.