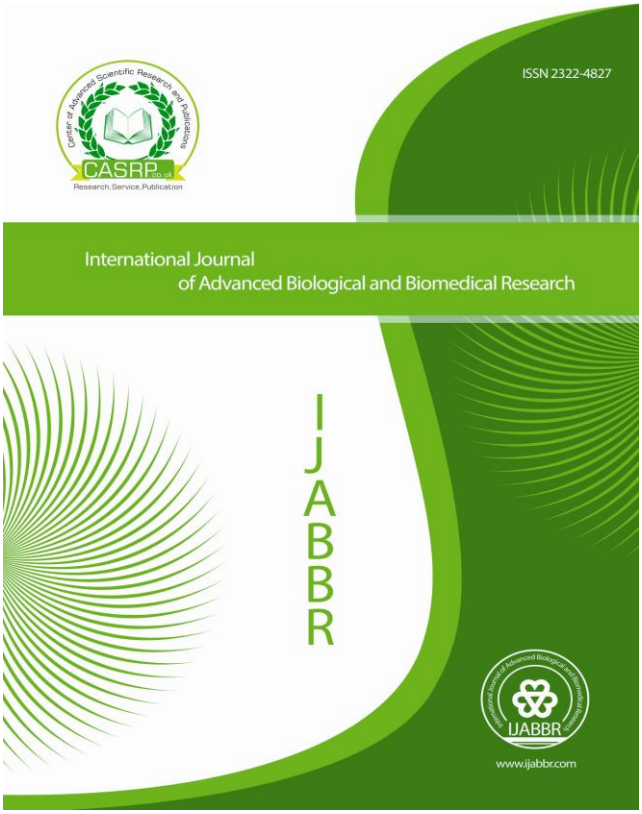

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Investigating the impact of Body Mass Index on the outcomes of Coronary Artery Bypass Graft Surgery: A single referral center experience

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Abstract

The aim of this study is to evaluate the relationship between Body Mass Index (BMI) and the outcomes of isolated CABG (Coronary Artery Bypass Graft) performed in Shahid Madani Hospital of Khorramabad, Iran. Data was retrospectively collected from the medical records retrieved from the hospital records office. All patients who had undergone isolated CABG under cardiopulmonary bypass in the Cardiothoracic Unit from 2007 till 2013 were identified and their demographic and clinical data were collected. Clinical data included BMI, ejection fraction (EF), history of COPD, MI, CVA, diabetes mellitus, hyperlipidemia, hypertension and the main outcomes included pulmonary complications, renal complications, transfusion, duration of ventilation, reoperation, intensive care unit stay, hospital stay and death. Patients were divided into six groups according to the BMI as follows: group 1: (BMI < 18.5), group 2: (18.5 ≤ BMI < 25), group 3: (25 ≤ BMI < 30), group 4: (30 ≤ BMI < 35), group 5: (35 ≤ BMI < 40), group 6: (BMI ≥ 40). Finally, perioperative variables in the six mentioned groups were compared using appropriate statistical methods. The obtained data were analyzed using SPSS software. In this study, 648 patients met the inclusion criteria of the study. The average age of the patients in the study was reported to be 61.35 ± 10.72 years. The average BMI was reports as 26.3 ± 4.03. The average cardiopulmonary bypass time was compared between the various BMI groups, which showed that the highest average belonged to group V^+ (groups V and VI) and the

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lowest average belonged to group I, but this difference was not statistically significant (PV > 0.05).There was no statistically significant difference between the groups in terms of the mean duration of mechanical ventilation, mean extubation time, drainage rate from the chest tube, and the amount of blood transfusion (PV > 0.05). Moreover, in 99.4% of the patients, broad-spectrum antibiotics, in 99.5% of the patients, inotropic drugs, and in 5.4% of the patients, IABP were used. Re-intubation was done in 3.1% of the patients. The average duration of hospitalization was 5.45 ± 1.48. There was no statistically significant difference between the groups in terms of hospitalization time (PV>0.05). In this study, 3.55% of the patients died. Smirnov and Kolmogorov tests showed that the distribution of quantitative variables is not normal in all the patients (PV<0.001). Therefore, to study the relationship between these quantitative variables, the Spearman correlation coefficient was used, which showed that none of the relationships were statistically significant. Therefore, considering these results, it can be suggested that if there is enough time before surgery, changes in the lifestyle of the individual be recommended so that he/she can attain a better health status. So, proper training and education can be very effective.

Keywords: Body Mass Index, Coronary Artery Bypass Grafting, Postoperative complication.

1. Introduction

Cardiovascular diseases are currently the most common cause of death in most parts of Iran and the world (Salarifar et al., 2008). Statistics published by the American Heart Association (AHA) in 2010 indicates that one out of five deaths in the United States are due to cardiovascular diseases and it is predicted that 20 million people worldwide will die of heart attack by 2015 (Llold-Jones et al., 2010). Coronary artery diseases are the leading cause of mortality and morbidity in industrial countries. One of the common procedures to treat cardiovascular diseases is Coronary Artery Bypass Graft (CABG) surgery, which has astonishingly changed the treatment of patients with ischemic heart disease since 1960 (Azhar et al., 2011; Eagle et al., 2005). One of the issues that has received much attention in the field of heart surgery research is the investigation of the risk factors that determine the mortality and morbidity accompanying heart surgery. So far several factors affecting the short-term and long-term outcomes of CABG surgery have been identified and predictive models to calculate the risk of such operations have been put forward (Azhar et al., 2011).

Obesity is a major risk factor in the development of cardiovascular disease (Wee et al., 2008; Jin et al., 2005; Yap et al., 2007; Rockx et al., 2004). In the last few decades, improvements in the economic and social situation have led to an increase in the obese population around the world (Reeves et al., 2003). The prevalence of obesity in the United States of America increased from 8% in 1994 to 33% in 2008 (Sun et al., 2009; Wigfield et al., 2006). The same issue can be observed in other developed and developing countries as well (Wee et al., 2008) and, it has become a challenge throughout the world. Per unit increases in Body Mass Index (BMI) can enhance the probability of occurrence of myocardial infarction (4%), stroke (3%), hypertension (6%), venous thromboembolism (8%), and atrial fibrillation (5%) (Sun et al., 2009).

Although the adverse effects of obesity on cardiovascular disease is well known, it is not clear whether obesity has an impact on the CABG surgery outcomes (Wee et al., 2008). Additionally, cardiac surgery risk predictive models have not adequately investigated obesity as a risk factor in risk-scoring systems. Only in Euro-SCORE and Parsonnetscoring systems, obesity has been considered a risk factor. But in these systems, the impact of various degrees of obesity and body mass index values on the results of cardiac surgery has not been specified (Jin et al., 2005; Wigfield et al., 2006).

The results of studies trying to determine whether higher BMI is a risk factor for morbidity and mortality after CABG surgery are inconsistent (Azhar et al., 2011). Given the contradictory results obtained from studies (Yap et al., 2007; Tokmakoglu, 2010; Rahmanian et al., 2007) on the impact of BMI on the surgical outcomes of patients undergoing cardiac surgery, there is a need to do more research in this context. Additionally, given that so far, such a study has not been done in our country, the present study is conducted to evaluate the impact of BMI on the outcomes of CABG in Shahid Madani Hospital of Khorramabad, Iran.

2. Materials and methods

The studied population included all the patients undergoing open heart surgery (pump-on) in the Shahid Madani Heart Hospital of Khorramabad over a period of 5 years. A retrospective census sampling method was used. Referring to the medical records department of the hospital, the cases of the patients who had undergone open-heart surgery during the past five years were identified and included in the study and cases with incomplete information were excluded from the study.The research instrument used in this study was a self-designed questionnaire and the target variables included demographic information such as age, sex, height, and weight. Preoperative variables included the number of vessels involved, the cardiac Ejection Fraction (EF), a history of Diabetes Mellitus (DM), hyperlipidemia, Myocardial Infarction (MI), and hypertension (HTN). Variables related to the operation included cross clamp time, and cardiopulmonary bypass time. Postoperative variables included reoperation after bleeding, mechanical ventilation time, extubation time, re-intubation, re-use of intra-aortic balloon pump, the use of inotropic drugs, the amount of transfusion of blood products, postoperative infection, the incidence of renal dysfunction, pulmonary complications, length of stay in the ICU, length of hospitalization, and death in the hospital. Then, using the height and weight as recorded in the patients' files, based on the body mass index calculation formula, the person's weight (in kilograms) was divided by the height squared (in meters) (weight / height^2), and then the BMI was interpreted. Based on the calculated BMI, the patients were divided into six categories, including: Group I: underweight (thin): BMI < 18.5; Group II: normal weight: 18.5 < BMI < 25; Group III: overweight: 25 < BMI < 30; Group IV: mildly obese: 30 < BMI < 35; Group V: averagely obese: 35 < BMI < 40 and Group VI: severely obese: BMI> 40.

Finally, perioperative variables in the six mentioned groups were compared using appropriate statistical methods. The obtained data were entered into SPSS software and the statistical consultant analyzed them.

3. Results and discussion

In this study, 648 patients met the inclusion criteria of the study, from among whom 427 patients (65.9%) were male and 221 patients (34.1%) were female. The average age of the patients in the study was reported to be 61.35 ± 10.72 years. The oldest patient was 79 years old and the youngest 30 years old. The average weight of the patients was 70.53 ± 12.97 kg. The heaviest patient was 120 kg and the lightest was 38 kg. Moreover, the average weight among males was 73.67 ± 12.51 and it was 64.45 ± 11.65 among females. The average height of the patients was 164.37 ± 9.87 cm. The tallest patient was 196 cm and the shortest patient was 105 cm. The average height was 168.65 ± 7.78 among male patients and 156.04 ± 8.02 among female patients. The average BMI was reports as 26.3 ± 4.03. The highest BMI was 43.97 and the lowest was 14.52. Also, the average BMI was 25.82 ± 3.75 among males and 26.44 ± 4.5 among females. Based on the BMI, the patients were divided into different groups and studied accordingly. The percentage of the patients in group I (underweight) was 1.8%, in group II (normal weight) was 39.2%, in group III (overweight) was 44%, in group IV (mild obesity) was 13.3%, in group V was 1.4%, and in group VI (severe obesity) was 0.3%. Finally, due to the low number of patients in groups V and VI, the two groups were merged and a new group V^+ was created and examined.

In this study, the number of people with different blood types was examined. Most of the patients were of the O^+ blood type (N=234 patients), while the least common blood type was the B^- type with 3 patients.

In the present study, from among the patients, 19.3% had a history of DM, 68.3% had a history of HTN, 34.2% had hyperlipidemia, 40.5% had a history of smoking, and 71.8% had suffered from MI. Additionally, 38.7% had Chronic Obstructive Pulmonary Disease (COPD) and 2.5% had CVA.The mean left ventricular ejection fraction in patients was reported as 42.82 ± 9.76, the highest value of which was 65 and the lowest was 4. The average aortic cross clamp time in patients was 60.05 ± 23.38, of which the highest time was 205 minutes and the lowest was 16 minutes. The average aortic cross clamp time was compared between various BMI groups, which showed that the highest average aortic cross clamp time belonged to groups V and VI (V^+) and the lowest belonged to group I; But no significant differences was observed between groups in terms of the average aortic cross clamp time. (PV > 0.05). The average cardiopulmonary bypass time in patients was reported to be 98.71 ± 36.89. The longest time was 389 minutes and the shortest was 25 minutes. Additionally, the average cardiopulmonary bypass time was compared between the various BMI groups, which showed that the highest average belonged to group V^+ and the lowest average belonged to group I, but this difference was not statistically significant (PV > 0.05).

Table 1
Frequency distribution of the demographics of the patients.

Type of variable		Patients N (%)
Age groups	20-39	34 (5.25)
	40-59	225 (34.72)
	60-79	389 (60.03)
	>80	0 (0.0)
Sex	Male	427 (65.9)
	Female	221 (34.1)
Marital status	Married	563 (86.88)
	Single	85 (13.12)
Educational attainment	Illiterate	37 (5.71)
	Junior high school or less	137 (21.14)
	High school or High school diploma	360 (55.56)
	University	114 (17.59)
Occupation	Office employee	82 (12.65)
	Laborer	12 (1.85)
	Self-employed	214 (33.02)
	Unemployed	21 (3.24)
	Housewife	135 (20.83)
	Farmer or Stockbreeder	184 (28.41)

The mean duration of mechanical ventilation in the patients was reported as 13.78±17.43, of which the longest time was 240 hours and the shortest was 4.25 hours. The average extubation time in the patients was reported to be 18.96±16.99, the longest of which was 240 hours and the shortest was 4 hours. Also, the average rate of thoracic drainage from chest tubes in the patients was 1692.34±1199.73, the highest of which was 9500 and the lowest was 20. Additionally, the average blood transfusion in the patients was reported as 7.74±6.31, the highest of which was 75 and the lowest was 1. There was no statistically significant difference between the groups in terms of the mean duration of mechanical ventilation, mean extubation time, drainage rate from the chest tube, and the amount of blood transfusion (PV > 0.05).

Moreover, in 99.4% of the patients, broad-spectrum antibiotics, in 99.5% of the patients, inotropic drugs, and in 5.4% of the patients, IABP were used. Re-intubation was done in 3.1% of the patients. Also, a return to the operating room happened in 3.1% of the patients. The average duration of hospitalization was 5.45 ± 1.48, the longest of which was 27 days and the shortest was 1 day. There was no statistically significant difference between the groups in terms of hospitalization time (PV>0.05). On the other hand, the average duration of stay in ICU was reported to be 2.53 ± 1.3, the longest of which was 25 days and the shortest was 1 day.

In the present study, the amount of creatinine was ≥ 2 mg/dl in 5.9% of the patients, post-operatively. The occurrence of hemothorax or pneumothorax was confirmed in 0.9% of the patients postoperatively using CXR. In this study, 3.55% of the patients died.

Smirnov and Kolmogorov tests showed that the distribution of quantitative variables (number of involved vessels, cardiac EF, cross clamp time, and cardiopulmonary bypass time) is not normal in all the patients (PV<0.001). Therefore, to study the relationship between these quantitative variables, the Spearman correlation coefficient was used, which showed that none of the relationships were statistically significant.

In the present research, 648 patients who had referred to the Shahid Madani hospital of Lorestan province (southwest of Iran) over a period of five years were studied. Given the fact that the a fore-mentioned hospital is the only center providing cardiac sub-specialty services, this study can provide valuable information regarding the impact of BMI on the outcomes of CABG in this region. In connection with the first aim of the study, namely the relationship between body mass index and a history of previous diseases, the results showed that no significant relationships existed between a history of the mentioned diseases and the body mass index of the patients. In a study conducted by Reeves et al on 4372 patients in London to investigate the effects of BMI on the early outcomes of coronary artery bypass surgery in a 5-year period, there were significant relationships between body

mass index and diabetes, myocardial infarction, and hypercholesterolemia, and the emergence of these diseases was higher in individuals with a BMI more than 35 (Reeves et al., 2003). In another study conducted by Wee et al. on 1314 patients in the United States regarding the relationship between obesity and the prognosis and progression of atherosclerosis among patients who had undergone open heart surgery, there was also a significant relationship between having a history of diabetes and hypertension and body mass index (Wee et al., 2008).

The mean duration of mechanical ventilation in different weight groups was investigated, based on which the highest average belonged to groups V and VI (V^+) and the lowest average belonged to group IV, but there was no significant difference between the weight groups in terms of mean duration of mechanical ventilation (PV>0.05). In a study by Reeves et al. (Reeves et al., 2003), as well as in a study by San et al in Washington on 14449 patients, the longest duration of intubation was seen in obese and underweight patients (Sun et al., 2009). In another study by Yap et al. also, pathological obesity was associated with long mechanical ventilation (Yap et al., 2007). In Engelman et al. research in Boston on 5168 patients, which investigated the effects of BMI and the level of albumin on postoperative heart surgery morbidity and mortality (Engelman et al., 1999) concluded that ventilation was significantly longer among underweight patients.

In the present study, there was no statistically significant relationship between BMI and the number of involved vessels, cardiac EF, cross clamp time, and cardiopulmonary bypass time. In a study by Yap et al. on 11736 patients in Australia, the relationship between obesity and short-term postoperative complications of heart surgery was investigated; the results showed that there was a significant relationship between cardiac ejection fraction and body mass index, but there was no significant relationship between cardiopulmonary bypass time and body mass index (Yap et al., 2007). Also, in a study conducted by Mahoori et al. the researchers concluded that some complications such as stroke are accompanied with the short-term postoperative morbidity and mortality of open heart surgery. The complication risk factors can be estimated based on pre- or postoperative clinical factors. The incidence of major complications after open heart surgery in different studies and different societies varies (Mahoori et al., 2008). Johnson et al. in a study that was conducted in 2015 reported that overweight and obese patients had fewer deaths after open heart surgery, but postoperative complications was more pronounced among them compared with most people with normal weight (Johnson et al., 2015).

Comparing the average rate of drainage from chest tubes within the weight groups, the highest average belonged to the first group and the lowest average belonged to the fourth group. The results of the studies of Reeves et al. (Reeves et al., 2003), De Cocker et al in Washington on 1566 patients (De Cocker et al., 2011), and Engelman et al. (Engelman et al., 1999) indicated that a return to the operating room after intensive chest drainage was more likely in underweight patients. Tokmakoglu's research in Turkey on 437 female patients (Tokmakoglu, 2010), which examined CABG outcomes in different weight groups, showed that chest drainage in the first 24 hours after the operation was more likely to occur in patients with a BMI < 30 than those with a BMI between 30 to 35 or higher than 35.

The average amount of blood transfusion was highest in groups V and VI and lowest in the first group. Contrary to the results of this study, the results of Reeves's study showed that receiving blood products was higher in overweight and obese patients (Reeves et al., 2003).

The average duration of hospitalization of patients was 5.45 ± 1.48. There was no statistically significant difference between the groups in terms of hospitalization time (PV>0.05). In studies by Engelman et al. (Engelman et al., 1999), Reeves et al. (Reeves et al., 2003), and Jin et al. in Portland (Jin et al., 2005) on 16218 patients investigating the risk factors predicting hospital mortality after CABG surgery, underweight patients experienced the longest stays in the hospital or the ICU. In a study by De Coker et al. which examined the factors predicting long stays in the ICU after heart surgery, BMI was not associated with prolonged stays (De Cocker et al., 2011). The results of a study by Sun et al. in 2009 investigating the risk factors for cardiac surgery in patients with a BMI greater than 50 showed that severe obesity is a factor which predicts long stays in the ICU (Sun et al., 2009).

Moreover, in 99.4% of the patients, the broad-spectrum antibiotics, in 99.5% of the patients, inotropic drugs, and in 5.4% of them, IABP were used. Re-intubation was performed in 3.1% of the patients and a return to the operating room occurred in 3.1% of the patients. In 5.9% of the patients, the postoperative blood creatinine levels was ≥ 2 mg/dl. Hemothorax or pneumothorax was confirmed in 0.9% of the patients by CXR. In addition, 3.5% of the patients died postoperatively. The chi square test did not show a significant relationship between the use of inotropic drugs and the use of IABP with BMI. The results vary in other studies, too. For instance, in a study by Reeves et al. (Reeves et al., 2003), and Engelman et al. (Engelman et al., 1999), IABP using and the occurrence of pulmonary and renal complications were more likely in underweight patients. In a study by Rockx et al in London

(Rockx et al., 2004) on 1310 patients, which investigated the relationship between obesity with morbidity and re-hospitalization after heart surgery, the results showed that obesity increases the possibility of readmission in the first 30 days after discharge, but the incidence of complications such as the use of IABP, and the occurrence of respiratory and renal complications were not different in obese and non-obese patients.

In this study, 3.55% of the patients died. Reeves's study which compared underweight patients with patients who had normal weight, more deaths occurred in the hospital (Reeves et al., 2003). Jackson et al's study in 2012 in Washington on 3645 patients, which examined obesity as a risk factor for death and postoperative cardiac complications after endarterectomy concluded that the class II and III of obesity was significantly associated with death and cardiac complications after surgery (Jackson et al., 2012). In Jin et al's study, although BMI was not a predicting risk factor for earlier mortality, the lowest risk for mortality was observed among overweight and normal-weight patients (Jin et al., 2005).

4. Conclusion

Body mass index affects the outcomes of cardiopulmonary bypass surgery and BMI can be used to predict the risks involved such high-risk surgical procedures. Underweight and overweight are two important factors affecting open heart surgery (Zittermann et al., 2014). Due to the accumulation of fat, overweight people are particularly at risk for postoperative complications and also often need more hospitalization time. Therefore, considering these results, it can be suggested that if there is enough time before surgery, changes in the lifestyle of the individual be recommended so that he/she can attain a better health status. So, proper training and education can be very effective.

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