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Original Article / Özgün Makale

The impact of body mass index on mortality and morbidity in patients undergoing isolated valve surgery

İzole kapak cerrahisi uygulanan hastalarda vücut kütle indeksinin mortalite ve morbidite üzerine etkileri

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Background: This study aims to investigate the impact of body mass index (BMI) on early mortality and morbidity in patients undergoing isolated valve surgery.

Methods: Between January 2004 and December 2012, medical records of 196 patients (115 males, 81 females; mean age 62.0 years; range 28 to 81 years) who underwent isolated valve surgery in our clinic with prospective follow-up data were retrospectively analyzed. The patients were divided into three groups according to their BMI values. Group 1 consisted of patients with a BMI <25 kg/m^2, group 2 consisted of patients with a BMI of ≥25 kg/m^2 to <30 kg/m^2 and group 3 consisted of patients with a BMI of ≥30 kg/m^2. Obesity was defined as a BMI of ≥30 kg/m^2. Groups were compared in terms of morbidity parameters including bleeding, respiratory, renal, neurological and sternal complications and in-hospital mortality.

Results: Increased BMI was associated with increased diabetes prevalence and use of bronchodilator. According to postoperative data, there was no significant difference in duration of extubation, postoperative renal functions, neurological complications such as stroke and transient ischemic attack, length of intensive care unit or hospital stay among three groups. Obese patients in group 3 had significantly higher rates of respiratory complications including re-intubation (p=0.011) and postoperative bronchodilator need (p=0.034), sternal dehiscence and sternal infections (p=0.023) and in-hospital mortality (p=0.021). The bleeding complications were significantly higher in group 1 (p=0.004).

Conclusion: Our study results suggest that obesity results in increased 30-day mortality and several morbidity parameters such as respiratory and sternal complications in patients undergoing isolated valve surgery.

Key words: Body mass index; isolated valve surgery; morbidity; mortality.

Amaç: Bu çalışmada izole kapak cerrahisi yapılan olgularda vücut kütle indeksinin (VKİ) mortalite ve morbidite üzerine olan etkileri incelendi.

Çalışma planı: Kliniğimizde Ocak 2004 - Aralık 2012 tarihleri arasında izole kapak cerrahisi yapılan ve ileriye dönük tıbbi kayıtları tutulan 196 hastanın (115 erkek, 81 kadın; ort. yaş 62.0 yıl; dağılım 28-81 yıl) kayıtları retrospektif olarak incelendi. Hastalar VKİ değerlerine göre üç gruba ayrıldı. Buna göre grup 1, VKİ <25 kg/m^2 olan hastalardan oluşurken, grup 2 VKİ ≥25 ile <30 kg/m^2 olan kilolu hastalar ve grup 3 VKİ ≥30 kg/m^2 olan hastalardan oluşuyordu. Obezite ≥30 kg/m^2 VKİ olarak tanımlandı. Gruplar kanama, solunum, böbrek, nörolojik ve sternum komplikasyonları dahil olmak üzere morbidite parametreleri ve hastane mortalitesi açısından karşılaştırıldı.

Bulgular: Artan VKİ, diyabet prevalansı ve bronkodilatör kullanımında artış ile ilişkili bulundu. Ameliyat sonrası verilere göre ekstübasyon süresi, ameliyat sonrası böbrek fonksiyonları, inme veya geçici iskemik atak gibi nörolojik komplikasyonlar, yoğun bakımda ve hastanede yatış süreleri açısından üç grup arasında anlamlı bir fark yoktu. Grup 3'teki obez hastalarda reentübasyon (p=0.011) ve ameliyat sonrası bronkodilatör gereksinimi (p=0.034) gibi solunum komplikasyonları ile sternum ayrılması ve sternum enfeksiyonlarının (p=0.0.23) ve hastane içi mortalitenin (p=0.021) artmış olduğu tespit edildi. Kanama komplikasyonları grup 1'de daha fazla idi (p=0.004).

Sonuç: Çalışma bulgularımız, izole kapak cerrahisi uygulanan hastalarda obezitenin 30 günlük mortalite ile solunum komplikasyonları ve sternum komplikasyonları gibi bazı morbidite parametrelerini artırdığını göstermektedir.

Anahtar sözcükler: Vücut kütle indeksi; izole kapak cerrahisi; morbidite; mortalite.

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Obesity is a preventable yet growing worldwide health problem that affects approximately 35% of communities in developed countries.[1,2] Of all the measures of obesity, body mass index (BMI) is the one that reflects body fat content the best as it defines it as having a BMI of 30 and above. As the obesity rate has grown, a corresponding increase in the number of obese patients undergoing open heart surgery has also been seen. Although many studies have addressed the effect of obesity on mortality in coronary artery bypass grafting (CABG) surgery, there is much less evidence related to its effect on isolated valve surgery, and the few results that do exist are conflicting.[3,4] Therefore, in our study, we aimed to investigate the impact of obesity on mortality and morbidity in connection with isolated valve surgery.

PATIENTS AND METHODS

After gaining the approval of the local ethics committee, the medical records of 196 patients (115 males, 81 females; mean age 62 years; range 28 to 81 years) who underwent isolated valve surgery between January 2004 and December 2012 were examined retrospectively and included in this study. Those who underwent concomitant CABG or emergency valvular surgery were excluded. All of the patients were operated by the same surgical team under standard anesthesia using cardiopulmonary bypass (CPB).

A median sternotomy was then performed on each patient along with systemic heparinization, and this was followed by aortic cannulation. For those who underwent aortic valve replacement (AVR), two-stage venous cannulation was performed through the right atrial appendage while bicaval venous cannulation was performed on patients who underwent mitral valve replacement (MVR) or both AVR and MVR. Myocardial protection was achieved by normothermic hyperpotassemic blood cardioplegia given both antegradely and retrogradely.

We used the BMI to define the extent of obesity in our patients, and this was calculated preoperatively according to Quetelet's index by dividing the weight (in kg) of the patient by the square of the height (m^2). The patients were then subdivided into three groups according to their BMIs. Group 1 (n=100) was comprised of those with a BMI of <25 kg/m^2, group 2 (n=65) was made up of overweight patients with a BMI of ≥25 but <30 kg/m^2, and group 3 (n=31) was composed of obese patients with a BMI of ≥30 kg/m^2 (n=31). The demographic data of the three groups was recorded along with information related to the patients' medical history.

In addition, the operative outcomes were analyzed according to the need for revision due to bleeding, respiratory, renal, neurological, and sternal complications, and in-hospital mortality. Operating times were calculated as the cross-clamp time plus the total bypass time. We also noted the patients' mean extubation time (in hours) and their need for reintubation due to respiratory failure or bronchodilators, which contained nebulized forms of ipratropium/salbutamol, salbutamol alone, or budesonide. Additionally, the postoperative urea and creatinine levels were recorded along with any neurological complications, for example such a transient ischemic attack (TIA) and stroke. Finally, we recorded any instances of sternal infections or sternal dehiscence. All of the parameters listed, except for the in-hospital mortality, were included in the study under the category of postoperative morbidity.

Prolonged ventilation was defined as the need of ventilation for more than 24 hours while a prolonged intensive care unit (ICU) stay was signified by a period of longer than 72 hours. In addition, a prolonged hospital stay was defined as a stay of longer than 14 days. The mortality category included in-hospital mortality along with mortality that occurred in the first 30 postoperative days either at the hospital or after the patients were discharged.

The morbidity rates of the patients were calculated after excluded the data related to mortality.

Statistical analysis

The results were expressed as median values [minimum (min) and maximum (max)] or as numbers and percentages as appropriate. The Kruskall-Wallis test was used to compare the continuous variables across the three groups, and the Mann-Whitney U test was used to compare continuous variables between two groups. In addition, comparisons of categorical variables were made using a chi-square test. All calculated p values were two-sided, and p values of <0.05 were considered to be significant. All statistical calculations were performed using the IBM SPSS Statistics version 19.0 for Mac software program (IBM Corporation, Armonk, NY, USA).

RESULTS

A mitral valve prosthesis was implanted in 92 patients (47%) and an aortic valve prosthesis was implanted in 86 patients (44%). Furthermore, both aortic and a mitral valve prostheses were implanted in 18 patients (9%). The median BMI was 24.91 kg/m^2 (min: 15.59; max: 43.35). The distribution of BMI in terms of

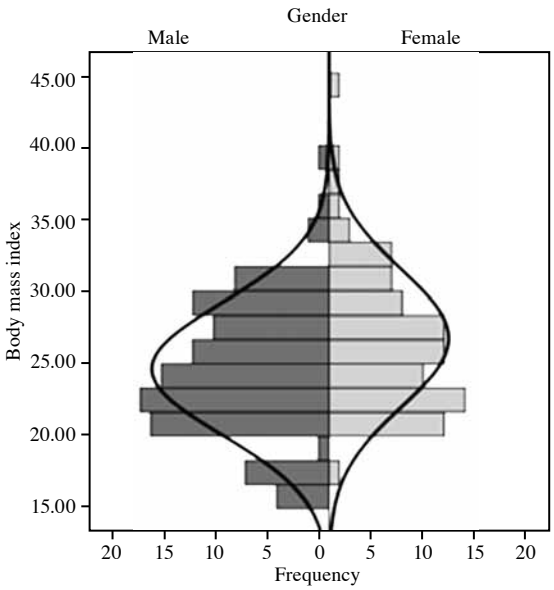

Figure 1. Distribution of body mass index in terms of gender.

gender is presented in Figure 1, and the preoperative demographic data of the patients along with dual comparisons of the three groups are given in Table 1. Table 2 shows the type of surgery performed in each group.

The information regarding the BMI of the patients in all of the groups is also presented in Table 1. When the three groups were compared in terms of age, history of smoking, hypertension, DM, left ventricular ejection fraction (LVEF), COLD, preoperative creatinine, preoperative New York Heart Association (NYHA) class, and pulmonary artery systolic pressure (PASP), there were no statistically significant differences between the groups. The percentage of female patients gradually increased as the BMI increased, eventually resulting in a statistically significant difference between group 1 (n=34, 34% female) and group 3 (n=18 58% female) (p=0.017). There were also 29 females (44%) in group 2. The number of diabetic patients also grew higher as the BMI increased, and there was a statistically significant difference between the numbers of diabetics in the groups 1 and 2; and 1 and 3. Moreover, the number of patients using bronchodilators preoperatively was significantly higher in group 3 with five (16.1%) than for group 1 with two (2%) and group 2 with three (4.6%) (p=0.002). When the operations were performed, we evaluated and compared the three groups with different BMIs and found there were slightly more AVR operations performed in group 1 than group 2. In addition, 10 dual valve prostheses were implanted in group 2 (15.3%) while only seven were implanted in group 1 (7%) and two were implanted in group 3 (6.4%), and the difference between group 2 and the other groups was statistically significant (p=0.042). In addition, there was a significant statistical difference (p=0.02) in the cross-clamp times in group 2 (103 minutes; range 39-166) compared with group 1 (76.00 minutes; range 50-171 and group 3 (86 minutes; range 64-124), but there was no statistically significant difference between the total bypass times in the three groups. The perioperative data is shown in Table 2.

Table 3 shows the morbidity and mortality outcomes after surgery, and there were no significant

Table 1. Patient and disease characteristics in the three groups

	Group 1 BMI <25 (n=100)				Group 2 ≤25 BMI <30 (n=65)				Group 3 BMI ≥30 (n=31)				*p*		
	n	%	Mean	Range	n	%	Mean	Range	n	%	Mean	Range	1 vs. 2	2 vs. 3	1 vs. 3
Age (years)			63.5	18-79			60	37-78			62	48-81	NS	NS	NS
Gender															
Females	34	34			29	44			18	58			NS	NS	<0.05
Hypertension		43				49.2				54.8			NS	NS	NS
Diabetes mellitus	5	5			9	13.8			7	22.5			<0.05	NS	<0.05
Ejection fraction			52.5	25-74			55.00	30-75			56.00	25-70	NS	NS	NS
NYHA class IV		6				6.1				9.6			NS	NS	NS
Smoking history		27				25				16.1			NS	NS	NS
COLD		10				9.2				9.6			NS	NS	NS
Brochodilator use		2				3.6				6.5			NS	<0.05	<0.05
PASP			22.00	15-70			23.00	20-65			25.00	20-80	NS	NS	NS
Preoperative creatinine			1.00	0.5-1.6			1.1	0.6-1.4			1.14	0.6-1.9	NS	NS	NS
Preoperative urea (mg/dL)			54	14-85			59	29-86			50	20-90	NS	<0.05	NS

BMI: Body mass index; NYHA: New York Heart Association; COLD: Chronic obstructive lung disease; PASP: Pulmonary artery systolic pressure; NS: Non significant.

Table 2. Perioperative data of the three groups

	Group 1 (n=100)				Group 2 (n=65)				Group 3 (n=31)				*p*		
	n	%	Mean	Min.-max.	n	%	Mean	Min.-max.	n	%	Mean	Min.-max.	1 vs. 2	2 vs. 3	1 vs. 3
AVR	49	49			23	35.3			14	45.1			<0.05	NS	NS
MVR	44	44			32	49.2			16	51.6			NS	NS	NS
AVR+MVR	7	7			10	15.3			2	6.4			<0.05	<0.05	NS
TR	11	11			9	13.8			2	6.4			NS	NS	NS
TBT (minutes)			113	49-198			128	49-201			122	46-185	NS	NS	NS
CCT (minutes)			76.00	50-171			103.0	39-166			86.0	64-124	<0.05	<0.05	NS

Min.: Minimum; Max.: Maximum; AVR: Aortic valve replacement; MVR: Mitral valve replacement; TR: Tricuspid repair; TBT: Total bypass time; CCT: Cardiac cross time; NS: Non significant.

differences between the three groups in terms of extubation times, postoperative renal functions, occurrence of stroke/TIA, or duration of ICU or hospital stays. However, there was a higher number of revision operations in group 1 (n=19, 19%) than in group 2 (n=4, 6.2%) and group 3 (n=2, 6.5%), and this was statistically significant (p=0.004). Furthermore, four patients in group 3 (12.9%) needed bronchodilators and reentubation for respiratory failure, whereas the numbers fell to two in group 1 (2%) and one in group 2 (1.6%), and this was also statistically significant (p=0.011). Similarly, four patients (12.9%) in group 3 had sternal complications while there was only one patient (1.5%) in group 2 and three in group 1 (3%) with this issue (p=0.023). When we evaluated the mortality rates, we found that group 3 had statistically significantly higher rates (p=0.021) than the other groups as no patients died in group 1 (0%) while group 2 had one (1.5%), and group 3 had four (12.9%).

DISCUSSION

Obesity has been recognized as the most important health problem in the 21st century by the World Health Organization.[5] As previously mentioned, with obesity on the rise, the number of obese patients who need open heart surgery has also increased. Although some studies[6,7] have concluded that obesity does not increase operative mortality in open heart surgery, a considerable number of studies[3,8] claim the opposite.

The prevalence of obesity in open heart surgery varies in parallel with the obesity rates in the specific community. The National Health and Nutrition Examination Survey (NHANES) revealed an obesity rate of 33.5-35.3% in the United States.[9] In concordance with these figures, Pan et al.[6] reported that 34% of 9,862 patients who underwent open heart surgery in the United States were obese. Interestingly, the authors also noted that the mortality rate did not increase with obesity.

Table 3. Early outcomes following valve surgery

	Group 1 BMI <25 (n=100)				Group 2 ≤25 BMI <30 (n=65)				Group 3 BMI ≥30 (n=31)				*p*		
	n	%	Mean	Range	n	%	Mean	Range	n	%	Mean	Range	1 vs. 2	2 vs. 3	1 vs. 3
Revision operation for bleeding	19	19			4	6.2			2	6.5			<0.05	NS	<0.05
Long extubation time (hours)	3	3			2	3.7			1	3.2			NS	NS	NS
Mean extubation time (hours)			13.00	4-59			12.00	6-120			13.00	7-21	NS	NS	NS
Reentubation	2	2			1	1.6			4	12.9			NS	<0.05	<0.05
Bronchodilator use	2	2			3	4.6			5	16.1			NS	<0.05	<0.05
Post-creatinine			1.09	0.5-2			1.1	0.7-2.5			1.1	0.7-4.5	NS	NS	NS
Post-urea			55.5	23-89			61.0	21-180			58.0	32-245	NS	NS	NS
Stroke/TIA	1	1			2	3.7			1	3.2			NS	NS	NS
Dehiscence	3	3			1	1.5			4	12.9			NS	<0.05	<0.05
Infection	1	1			1	1.5			4	12.9			NS	<0.05	<0.05
ICU stay (hours)			48.0	24-120			47.0	24-336			49.0	24-360	NS	NS	NS
Hospital stay (days)			10.0	5-31			11.0	3-28			12.0	1-26	NS	NS	NS
Mortality	0	0			1	1.5			4	12.9			NS	<0.05	<0.05

BMI: Body mass index; NYHA: New York Heart Association; COLD: Chronic obstructive lung disease; PASP: Pulmonary artery systolic pressure; NS: Non significant.

In a study conducted in Turkey, Dişcigil et al.[7] found that 14% of the patients who underwent open heart surgery were obese, and the mortality rate also did not increase with obesity. In our study, we determined that 15.8% of the patients who underwent isolated valve surgery were obese.

The effect of obesity on operative outcomes has been assessed more widely in CABG operations. In fact, it was once considered to be a risk factor in risk stratification systems like the Parsonnet scoring system.[3] The basis of this hypothesis was the high incidence of comorbidities, such as diabetes, hypertension, and hypercholesterolemia, and respiratory problems, for example increased residual volume, decreased lung capacity, ventilation-perfusion abnormalities, bronchospasms, increased impedance of the thorax, obstructive sleep apnea, and hypoventilation, that accompanied obesity.[10] All of these were once commonly believed to result in prolonged mechanical ventilation and extended ICU stays.[11] The preoperative data of our patients partially supported previous notion since the number of diabetic patients was significantly higher for those with higher BMIs. We also found that the use of a bronchodilator during the perioperative period was also more common in the obese patients.

Females made up the majority of the obese population in our study, which is one of the patient-related risk factors in the European System for Cardiac Operative Risk Evaluation (EuroSCORE) system. Moreover, higher incidence rates of obesity, diabetes, hypercholesterolemia, and hypertension in females were well documented in a study by Ünlü and Sönmez[12] that involved 5,067 isolated CABG patients. In spite of this, they found that the operative mortality rates in their study were not related to gender.

Although conflicting results have been reported in the literature, Reeves et al.[13] have addressed only morbid obesity as an independent predictor of increased mortality after CABG surgery. For valve surgery, on the other hand, little evidence exists.

Rahmanian et al.[8] studied 5,950 patients who had open heart surgery (valve surgery, CABG, or both) and reported that obesity was an independent predictor of hospital mortality but only in patients who underwent valve surgery. They also found that obesity was associated with an increased risk for sternal infection, whereas being underweight correlated with postoperative bleeding. These findings are in agreement with our results. Furthermore, we also found that for patients with a BMI of ≥30, the mortality rates were significantly higher than for those with lower BMIs.

There is less debate concerning the influence of obesity on the parameters of morbidity after cardiac surgery. In our study, we showed that the BMI was positively correlated with sternal complications and minor respiratory complications. In addition, our obese patients suffered more often from sternal wound infections and sternal dehiscence. Most studies, whether conducted on CABG or valvular surgery patients, have reported similar results and concluded that obesity independently increases the risk of sternal complications.[14-16] We also found that the obese patients in our study experienced more frequent respiratory problems and needed bronchodilators more often during both the perioperetive and postoperative periods. Consequently, they also needed reentubation, but this difference did not translate into prolonged mechanical ventilation or longer ICU stays for the obese patients. Alam et al.[4] also determined that obesity was associated with an increased risk for postoperative respiratory failure and surgical site infections after CABG in 4,619 patients but found that this was not true for mortality. They also determined that the risk for revision surgery due to bleeding was higher for patients with lower BMIs.

We ended up with similar results with regard to bleeding complications after valve surgery. In our study, the patients with a BMI of <25 had bleeding and revision operations significantly more than the other groups, as has been commonly reported in the literature.[4,17]

We believe that the similar ICU and hospital stay durations along with the similar rates of prolonged ventilation in the different BMI groups in our study were due to the balance between respiratory and sternal complications in the obese patients and the bleeding complications in those with lower BMIs.

Finally, in the patients who had isolated valve surgery, obesity was found to increase both mortality and some morbidity. Furthermore, the obese patients experienced more respiratory and sternal complications but less bleeding complications than the non-obese patients.

We believe that prospective studies with larger numbers of patients are needed to reveal the effect of BMI on mortality and morbidity in isolated valve surgery.

Conclusion

The growing numbers of obese patients who undergo open heart surgery has increased the level of concern regarding the effect of obesity on mortality and

morbidity after both valvular and CABG operations. The data related to CABG operations has made it clear that obesity alone is not an independent risk factor with regard to mortality, although it does seem to have some negative influence on morbidity outcomes such as sternal infections and respiratory problems. In isolated valve surgery, the picture is less clear. In our study, we found that obese patients, defined as those with a BMI of ≥30, had higher mortality rates in the first 30 days, more sternal wound infections and dehiscence, a greater postoperative need for bronchodilators, and a need for reentubation. On the other hand, the bleeding risk was lower in this group of patients.

We believe that more prospective studies with larger numbers of patients are needed to accurately determine the influence of BMI on isolated valve surgery.

Declaration of conflicting interests

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