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Effects of ABO/RhD Blood Types and HbA1c Levels on the Postoperative Cardiac Morbidity in Morbidly Obese Patients who Underwent Sleeve Gastrectomy

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ABSTRACT

Objective: This study was designed to evaluate the impacts of high preoperative HbA1c levels and ABO and Rhesus D antigen (RhD) blood types on the risk of postoperative cardiac morbidity in morbidly obese patients who underwent sleeve gastrectomy.

Materials and Methods: In this retrospective study, 364 morbidly obese patients who underwent elective laparoscopic sleeve gastrectomy operation were included. Data regarding patients' demographics, preoperative HbA1c levels (low: 4–6%, high: >6%), ABO/RhD blood types, cardiac complaints within the first postoperative week and serum cardiac troponin levels (ng/mL) in patients with postoperative cardiac complaints were recorded.

Results: The findings showed that HbA1c levels were >6.0% in 38.2% of the patients, blood type A (45.9%) was the most prevalent blood type, and postoperative cardiac symptoms were evident in 16.5% of patients. Patients with high and low HbA1c levels were similar concerning ABO/RhD blood type or rate of postoperative cardiac complaints. In patients with postoperative cardiac complaints, a significant positive weak correlation was noted with high troponin levels and high preoperative HbA1c levels ($r=0.215$, $p=0.022$).

Conclusion: In conclusion, these findings of a retrospective cohort of morbidly obese patients who underwent sleeve gastrectomy revealed a significant positive weak correlation between high preoperative HbA1c levels and cardiac troponin levels in patients with postoperative cardiac complaints, while ABO/RhD blood type was not associated with preoperative HbA1c levels or the likelihood of postoperative cardiac complaints.

Keywords: Obesity, glycosylated hemoglobin A, morbidity, troponin, blood group antigens

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INTRODUCTION

Obesity is a rapidly growing public health problem associated with increased risk of many severe health problems, such as hypertension, cardiovascular diseases, and type 2 diabetes mellitus (DM) (1).

Given the expression of ABO antigens not only on red blood cell membranes but also on the epithelium, platelet and vascular endothelium, ABO antigen type has been considered likely to be involved in cardiovascular disease and postoperative outcomes in addition to its well-known role in determining the compatibility of transfusion (2). Accordingly, ABO blood type has been postulated to be associated with dyslipidemia (3), obesity (4), stroke (5), coronary artery disease (CAD) (6) and DM (3, 7) specifically, non-O blood groups have been associated with increased risk cardiovascular events including myocardial infarction (MI) (8), increased risk of thrombosis (9), peripheral vascular disease (10) and cerebral ischemia (11), while blood type B vs. type O has been considered to be associated with an increased risk of type 2 DM (3). Blood concentration of high-sensitivity cardiac troponin T (hs-cTnT) is an established and standard biomarker for predicting cardiovascular events (12) while haemoglobin A1c (HbA1c) reflects long-term glycemic control and is considered important not only for monitoring the clinical management of hyperglycemia but also as an independent predictor of increased risk of CAD in diabetic patients (13). Notably, a close relationship has been suggested between DM and hs-cTnT elevation in the general population (14). The risk of coronary artery disease increases in patients with diabetes over 10 years.

The racial and ethnic disparities in the distribution of ABO blood groups in different people globally emphasize the relevance of population-based studies, while the relationship of ABO blood group with obesity, diabetes or CAD remains inconclusive with inconsistent findings reported in the literature (2, 15).

Given that surgery is a source of stress, research into the evaluation of the effects of ABO blood group and diabetes on postoperative cardiac morbidity is scarce in the literature. This study was designed to investigate the effects of ABO/RhD blood groups and preoperative high HbA1c values on postoperative cardiac morbidity (cardiac complaints, unstable angina, high cardiac troponin levels, ST elevation, collapse, myocardial infarction findings on ECG) in morbidly obese patients who underwent sleeve gastrectomy.

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MATERIALS and METHODS

Study Population

This study was conducted in accordance with the Declaration of Helsinki from 2017 to 2018 after obtaining approval from the Institutional Ethics Committee (Date-Decision no: 28.03.2019 - 10/9).

A total of 364 morbidly obese (BMI >40 kg/m²) patients (mean±SD 39.6±11.8 years, 73.1% were females) who underwent elective laparoscopic sleeve gastrectomy operation were included in this retrospective study conducted between 2017 and 2018 at a tertiary care hospital. Patients with available data on preoperative HbA1c levels and ABO/RhD blood types and patients with diabetes over ten years were included in this study. Hypertension, smoking and hyperlipidemia comorbidity were excluded from this study. Patients with familial heart disease who had unstable hemodynamics during the operation and who were transferred to the postoperative intensive care unit were not evaluated. Patient data, electronic patient data system (SARUS) and patient files were created by examining.

Assessments

Troponin values are not routinely measured after sleeve gastrectomy. Data were recorded from patients' demographics (age, gender), preoperative HbA1c levels, ABO/RhD blood types, and serum cardiac troponin levels (ng/mL) in patients with postoperative cardiac complaints. Troponin and blood groups were evaluated in patients with unstable angina in the postoperative hospitalization period (1 week) and in patients with ST elevation, collapse, myocardial infarction findings on ECG. ABO/RhD blood type and preoperative HbA1c levels (low: 4–6%, high: >6%) were analyzed in respect to the presence of cardiac complaints within the first postoperative week.

Anesthesia

Following monitoring with electrocardiography (ECG), and peripheral oxygen saturation (SpO₂), general anesthesia was induced with 2% lidocaine (1 mg/kg) intravenously to reduce the pain of propofol. After induction with propofol (3 mg/kg) and fentanyl (1 µg/kg), rocuronium (0.6 mg/kg) was administered for muscle relaxation. For maintenance of anesthesia, a 50% air-oxygen, remifentanyl (0.5 µg/kg/min) infusion and desflurane inhalation (1 MAC) was applied. After inserting the orogastric catheter, end-tidal CO₂ (EtCO₂) was monitored with capnography. When the bispectral index (BIS) was at a level between 40–60, the reverse-Trendelenburg position was obtained and 15 mmHg intra-abdominal insufflation pressure was applied for the operation. This protocol was applied to all patients and the surgical and anesthesia team were the same.

Statistical Analysis

Statistical analysis was carried out using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Fisher's exact test, Freeman Halton test (Monte Carlo) and Pearson Chi-Square test (Monte Carlo or Exact) were used for the comparison of categorical data, while numerical data were analyzed using the Mann-Whitney U test (Monte Carlo). Correlation analysis was performed with Kendall's tau-b test. Data were expressed as median

Table 1. Baseline characteristics (n=364)

	n	%
Age (year), mean±SD– median (min/max)	39.6±11.9–39 (17/69)	
Gender		
Female	266	73.1
Male	98	26.9
Preoperative HbA1c		
4.0–6.0	225	61.8
>6.0	139	38.2
ABO blood grouping		
O	122	33.5
A	167	45.9
AB	26	7.1
B	59	16.2
Blood type		
O-	7	1.9
O+	105	28.8
A-	17	4.7
A+	150	41.2
AB-	3	0.8
AB+	23	6.3
B-	6	1.6
B+	53	14.6
Rh factor		
Rh-	33	9.1
Rh+	331	90.9
Postoperative cardiac complaints		
No	304	83.5
Yes	60	16.5

SD: Standard deviation

(min-max) and n (%) where appropriate. A value of p<0.05 was considered statistically significant.

RESULTS

Overall, HbA1c levels were 4.0–6.0% in 225 (61.8%) patients and >6.0% in 139 (38.2%) patients. Blood type A (45.9%) was the most prevalent blood type, followed by blood type O (33.5%), and 90.9% of patients were RhD-positive. RhD-negative rates per blood type were 4.7%, 1.6%, 0.8% and 1.9% for A, B, AB and O blood types, respectively. Postoperative cardiac symptoms were evident in 60 (16.5%) patients (Table 1). In patients with postoperative cardiac complaints, a significant positive weak correlation was found in the relationship between high HbA1c levels and high postoperative troponin levels (r=0.215, p=0.022) (Table 2). No significant difference was noted in ABO/RhD blood types between patients with cardiac complaints in the preoperative high vs. low HbA1c groups (Table 3).

Table 2. ABO/RhD blood type and postoperative cardiac complaints in patients with low vs. high preoperative HbA1c levels

HbA1c values ABO/RhD blood type	Preoperative Hb-A1c levels		p
	Low (4–6%)	High (>6%)	
Age (year), median (min/max)	35 (17/64)	44 (19/69)	<0.001 ¹
Preoperative HbA1c (%)			
4.0–6.0	–	–	–
>6.0	–	–	–
ABO types, n (%)			
O	69 (30.7)	43 (30.9)	0.743 ²
A	104 (46.2)	63 (45.3)	
AB	17 (7.6)	9 (6.5)	
B	35 (15.6)	24 (17.3)	
Blood type, n (%)			
O-	6 (2.7)	1 (0.7)	0.957 ³
O+	63 (28.0)	42 (30.2)	
A-	12 (5.3)	5 (3.6)	
A+	92 (40.9)	58 (41.7)	
AB-	2 (0.9)	1 (0.7)	
AB+	15 (6.7)	8 (5.8)	
B-	2 (0.9)	4 (2.9)	
B+	33 (14.7)	20 (14.4)	
RhD factor status			
Rh-	22 (9.8)	11 (7.9)	0.580 ³
Rh+	203 (90.2)	128 (92.1)	
Postoperative cardiac complaint			
No	193 (85.8)	111 (79.9)	0.148 ³
Yes	32 (14.2)	28 (20.1)	
Troponin, median(min/max) in pa-tients with cardiac complaints	3.38 (3/448)	5.68 (3/138.1)	0.052 ¹

1: Mann-Whitney U Test (Monte Carlo); 2: Freeman Halton Test (Monte Carlo); 3: Pearson Chi-Square Test (Monte Carlo or Exact)

DISCUSSION

These findings of a retrospective cohort of morbidly obese patients who underwent sleeve gastrectomy revealed preoperatively high HbA1c (>6.0%) levels in 38.2% of patients, blood type A in 45.9% of patients and the presence of cardiac complaints within the first postoperative week in 16.5% of patients. No significant association of ABO/RhD blood type was noted of postoperative cardiac complaints. A significant positive weak correlation was noted between high preoperative HbA1c levels and troponin levels in patients with postoperative cardiac complaints.

The positive weak correlation of high preoperative HbA1c levels

with age and with cardiac troponin levels in patients with postoperative cardiac complaints in this study supports the findings from a previous study of patients with type 2 DM, which indicated significantly higher age and HbA1c levels in those with a detectable elevation of hs-cTnT levels compared to those without elevated levels (12). A significant association of elevated cardiac troponin blood concentrations with markers of glycemic control (fasting blood glucose, HbA1c levels) has also been reported in other studies (16). In addition, a significant increase in cardiac troponin I (cTnI) levels has been reported in diabetic patients compared to a healthy control group as well as in diabetic patients with vs. without ischemic heart disease or hypertension and a strong positive correlation between the duration of diabetes and the serum levels of cTnI (17).

Given that cardiac troponin is an extremely sensitive specific biomarker of myocardial necrosis and MI (13), the current study findings seem to emphasize the adverse impacts of poor glycemic control on the development of myocardial damage, which has been suggested to occur via dysfunction of the microcirculation, increased oxidative stress, or other pathways (12, 18). Stress hormones due to surgical stress in non-cardiac surgery can cause myocardial damage (19). Insulin resistance and oxidative stress are among the causes of vascular aging (20). In this study, we did not find a significant difference in the preoperative HbA1c groups concerning troponin levels. However, a significant positive weak correlation between cardiac complaints and troponin and preoperative HbA1c levels may be due to surgical stress.

In this cohort of morbidly obese patients, including patients with type 2 diabetes for at least 10 years, ABO blood grouping revealed blood type A (45.9%) to be the most prevalent type, followed by blood type O (33.5%), B (16.2%) and AB (7.1%), and 90.9% of patients were RhD-positive. This seems consistent with the previously reported distribution of ABO blood groups in Turkish patients with acute ST elevation MI and healthy subjects, including similar rates for A (43.1 vs 44.3%), O (31.1 vs. 28.1%), B (15.1 vs. 15.3%) and AB (10.7 vs. 12.3%) in patients versus a control group, in accordance with the official data from the general Turkish population (21). Similarly, in an analysis of ABO blood group distribution of 238 patients with CAD in the general population, the authors reported rates for blood types A, O, B and AB to be 47.6%, 30.1%, 14.6% and 7.5%, respectively, and RhD positivity in 90.3% of patients (22). In addition, blood group A was reported to be higher in Turkish patients with type 2 DM compared to control subjects (23).

In an analysis of ABO/RhD blood types in a study with 3.815 patients with chronic heart failure in the USA, the authors reported ABO blood type distribution (A 40%, O 33%, B 20%, AB 8%) and RhD-negative per blood type (A 10%, B 9%, AB 10%, and O 7%) in the heart failure population to be similar to that of the general national population, while RhD-negative was reported to be associated with a worse prognosis in patients with ischemic cardiomyopathy (24).

RhD-negative per blood type (A 4.7%, B 1.6%, AB 0.8%, and O 1.9%) rates were much lower in the current study cohort together with similar RhD status in respect of high vs. low preoperative HbA1c levels and the presence or absence of postoperative cardiac complaints.

Table 3. ABO/RhD blood types according to postoperative cardiac status in patients with low vs. high preoperative HbA1c levels

ABO/RhD blood types	Preoperative HbA1c level								p
	Low (4.0–6.0 %) Cardiac symptoms				High (>6%) Cardiac symptoms				
	No (n=193)		Yes (n=32)		No (n=111)		Yes (n=28)		
	n	%	n	%	n	%	n	%	
ABO blood grouping									
0	57	82.6	12	17.4	35	81.4	8	18.6	0.999 ¹
A	88	84.6	16	15.4	48	76.2	15	23.8	0.218 ¹
AB	17	100.0	0	0.0	7	77.8	2	22.2	0.111 ²
B	31	88.6	4	11.4	21	87.5	3	12.5	0.999 ¹
Blood type									
0-	5	83.3	1	16.7	1	100.0	0	0.0	–
0+	52	82.5	11	17.5	34	81.0	8	19.0	0.999 ¹
A-	8	66.7	4	33.3	4	80.0	1	20.0	0.528 ²
A+	80	87.0	12	13.0	44	75.9	14	24.1	0.120 ¹
AB-	2	100.0	0	0.0	1	100.0	0	0.0	–
AB+	15	100.0	0	0.0	6	75.0	2	25.0	0.111 ²
B-	2	100.0	0	0.0	4	100.0	0	0.0	–
B+	29	87.9	4	12.1	17	85.0	3	15.0	0.999 ¹
RhD factor status									
Rh-	17	77.3	5	22.7	10	90.9	1	9.1	0.637 ¹
Rh+	176	86.7	27	13.3	101	78.9	27	21.1	0.068 ¹

1: Pearson Chi-Square Test (Exact); 2: Fisher Exact Test (Exact)

Therefore, the lack of a significant association of ABO blood groups with preoperative HbA1c levels or postoperative cardiac risk in morbidly obese patients seems to support the view that ABO blood group might not be significantly associated with cardiovascular risk factors, CAD and MI (21).

In fact, the distribution pattern of ABO blood groups in the Caucasian population worldwide is considered to involve blood type O (44.0%) as the most prevalent blood group, followed by group A (43%) group B (9%) and group AB (4%) (2), while blood group O has been reported to be the most common blood type in obese individuals (44.7%), followed by A (30%), B (20%), and AB (5.3%) groups (25).

Although no statistically significant differences have been reported between different ABO/RhD blood types in respect of overweight or obesity (25), it should be noted that blood type A was the most prevalent blood group in the current study cohort of morbidly obese patients, which seems to differ from the rates reported in the healthy or obese Caucasian population (2, 25).

A higher prevalence of blood type A in the general population has been reported in other studies (21–23) and seems notable given the association of blood type A with higher levels of cholesterol and low-density lipoprotein and increased risk of CAD or MI (2, 21, 26–28) as well as with higher baseline troponin T and creatine kinase-MB (CK-MB) index and post-interventional CK-MB index in patients who have undergone percutaneous coronary intervention

(29). However, the association of ABO blood group with cardiovascular risk and mortality remains inconclusive (2) given that reported studies also involve the association of blood type O (30) or AB (11) with a higher risk of CAD or no association between blood type and CAD (31). Indeed, it has been emphasized that there is a risk of bias due to studying the association of MI and ABO blood group only in survivors of hospital-admitted MI, together with a lack of clarity on which ABO phenotypes or genotypes increase CAD and/or MI risk (2). The limiting aspect of this study was the lack of postoperative troponin values in all patients due to its retrospective nature.

CONCLUSION

In conclusion, these findings of a retrospective cohort of morbidly obese patients who underwent sleeve gastrectomy revealed a significant positive weak correlation between high preoperative HbA1c levels and cardiac troponin levels in patients with postoperative cardiac complaints, while ABO/RhD blood type was not associated with preoperative HbA1c levels or the likelihood of postoperative cardiac complaints. Blood type A was the most prevalent blood type, which was consistent with the official data from the general population. Future prospective larger-scale studies with healthy individuals, as well as patients at risk of coronary atherosclerosis, are needed to more appropriately address the association of ABO blood group distribution with the development or prognosis of cardiac morbidity.

Ethics Committee Approval: This study was conducted in accordance with the ethical principles stated in the “Declaration of Helsinki” and permission was obtained from Ethics Committee of Antalya Training and Research Hospital for the use of patient data for publication purposes (date: 28.03.2019, number: 10/9).

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