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Original Article

The impact of bariatric surgery on hematological inflammatory parameters

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Abstract

Aim: The aim of this study was to evaluate hematological inflammatory parameters before and after bariatric surgery and investigate the effect of surgery on these parameters.

Material and Methods: A total of 71 patients who underwent a Roux-en-Y gastric bypass (RYGBP) or a sleeve gastrectomy (SG) procedure were included in the study. The preoperative levels of the inflammatory parameters of C-reactive protein (CRP) and the white blood cell count (WBC), as well as the hematological inflammatory parameters of red blood cell distribution width (RDW), mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), and the neutrophil-to-lymphocyte ratio (NLR) were compared with the postoperative 6th and 12th month values.

Results: Both the RYGBP and SG surgical techniques were used in this study. Significant reductions were seen in the postoperative 6th and 12th month values of CRP and WBC, which were used as an indicator of the severity of inflammation. Along with the decrease in BMI and the standard indicators of inflammation, there were also corresponding statistically significant changes in the levels of the more recently used hematological inflammatory markers of RDW, MPV, PDW, PCT, and NLR ($p<0.05$).

The statistical evaluation revealed a significant positive correlation between the serum WBC and CRP values and NLR measured at postoperative 6 th months. The postoperative 12 th month results indicated a significant positive correlation between the serum WBC and PCT values and also between the CRP and MPV values.

Conclusion: Significant improvements were observed in previously elevated hematological inflammatory parameters in obese patients after bariatric surgery.

Keywords: Bariatric surgery; hematological inflammatory parameters; metabolic syndrome; obesity.

INTRODUCTION

Obesity surgery (bariatric surgery) is an effective treatment for obesity. The aim of this surgical treatment is to reduce morbidity and mortality due to obesity and to improve metabolic and organ function (1). The effects of obesity surgery on weight loss and the resolution of diabetes and metabolic parameters vary according to the method used. Improvements in weight loss and metabolic parameters are associated with changes in neuroendocrine hormones such as glucagon-like peptide-1, peptide YY and ghrelin (2).

Hematological inflammatory parameters can easily be measured using standard devices that perform a complete blood count (CBC) and in recent years they have been used in many studies to highlight indications of inflammation (3). They may predict conditions with underlying chronic low-grade inflammation, such as cardiovascular pathology, type 2 diabetes, and metabolic syndrome (4). As yet, there are few studies in the literature evaluating these parameters after bariatric surgery performed in obese patients and those with type 2 diabetes (5,6).

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The aim of this study was to evaluate inflammatory hematological parameters measured before and after bariatric surgery and to investigate the impact of bariatric surgery on these parameters.

MATERIAL and METHODS

This was a retrospective study of patient files in the gastroenterology surgery clinic of an education and research hospital. Patients with insufficient data were excluded. Between September 2016 and June 2018, 71 patients aged 18 to 65 years who underwent RYGBP or SG were included in the study.

The 1991 US National Institutes of Health consensus criteria were used for patient selection prior to bariatric surgery. Patients with a body mass index (BMI) ≥35 kg/m2 and at least 1 comorbidity associated with obesity, such as type 2 diabetes, hypertension, dyslipidemia, or sleep-apnea syndrome; those with a BMI ≥40 kg/m2; age 18 to 65 years; obesity not related to hormonal disease; a history of obesity for at least 3 years or obesity refractory to various treatments for at least 1 year; no alcohol or drug dependence, significant psychiatric disorder, or high risks that would preclude surgery; and those who could demonstrate sufficient understanding of the method to be applied and commitment to observe the required measures to be followed were included in the study (7).

Before the operation, testing was conducted to evaluate a CBC, prothrombin time, and activated partial thromboplastin time, as well as a biochemical test, hormone test, pregnancy test, chest X-ray, electrocardiography, pulmonary function test, abdominal ultrasonography, and esophagogastroscopy. Consultations with the departments of endocrinology and metabolic disease, chest diseases, cardiology, psychiatry, and anesthesia were conducted, as well as dietitians. The choice of an SG or RYGBP surgical procedure was made according to the patient's BMI, age, and any comorbidity.

The patients were called for follow-up 1 month after surgery and then at 3-month intervals. During follow-up, a CBC; routine biochemistry values; levels of calcium, iron, iron-binding capacity, ferritin, transferrin, folate, vitamin B12, zinca and 25-hydroxy vitamin D3; and changes in body weight were investigated, and any necessary changes in treatment were made. The CBC was performed with laser-based impedance using an automated blood cell counter (Mindray BC-6800; Shenzen Mindray Bio-Medical Electronics Co., Ltd., Shenzhen, PR China). Red cell distribution width (RDW), mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT) and the neutrophil-to-lymphocyte ratio (NLR) values were calculated as part of the whole blood count. The preoperative values of the new hematological inflammatory parameters of RDW, MPV, PDW, PCT and NLR, as well as C-reactive protein (CRP) and white blood cell (WBC) levels, which are also indicators of inflammation, were compared with the postoperative 6 th month and 12 th month values.

Statistical analysis of the data obtained was performed using PASW Statistics for Windows, Version 18.0 (SPSS, Inc., Chicago, IL, USA). All of the data were summarized in tables and graphs. In addition to descriptive statistical methods (mean, standard deviation, median, interquartile range, minimum and maximum value), a paired T-test was used in the pre- and postoperative intergroup comparisons of quantitative data with normal distribution in the same sample group, and for the comparison of non-normally distributed data, a signed-rank test was used. Pearson correlation analysis was applied to investigate the correlation between variables. Results were evaluated as statistically significant at a 95% confidence interval and were considered statistically insignificant at p>0.05.

RESULTS

Of 71 patients (mean age: 38.2±11.2 years), 61 (86%) were female and 10 (14%) were male. In all, 42 patients (59%) underwent RYGBP and 29 patients (41%) underwent a SG procedure. All 71 patients had complete 6 th month data, while 59 patients had 12 th month data. The mean preoperative BMI was 46±6.4 kg/m2, while it was 34.1±4.9 kg/m2 at the 6 th postoperative month, and 30.5±6.2 kg/m2 at the 12 th month (p<0.001) (Table 1).

When the preoperative values of fasting blood glucose, liver function tests and lipid parameters were compared with the values seen at the 6 th and 12 th month, a statistically significant difference was found, as expected. Vitamin B12, ferritin and zinc levels did not show a significant change in postoperative follow-up, whereas folic acid and 25-hydroxyvitamin D levels were significantly increased due to replacement therapy (Table 1).

Significant decreases were observed in the postoperative CRP and WBC values, which we used as an indicator of a decrease in the severity of inflammation. Statistically significant changes in the new hematological inflammatory markers values of RDW, MPV, PDW, PCT, and NLR were also found with the decrease in BMI and CRP and WBC values (p<0.05) (Table 1).

In the statistical evaluation of the postoperative 6-month results, a significant positive correlation was detected between the serum WBC, CRP, and NLR values (p=0.001, r=0.37; p=0.03, r=0.001, respectively). In the postoperative 12-month results, there was a significant positive correlation between the serum WBC and PCT values (p=0.01, r=0.31) and between the CRP and MPV values (p=0.03, r=0.29) (Tables 2,3).

Table 1. Preoperative and postoperative changes in metabolic and hematological parameters

Variables	Preoperative (n=71)	Postoperative 6 mo (n=71)	Postoperative 12 mo (n=59)	P value (A-B)	P value (A-C)
Glucose, mg/dL	128.7±54.8	102.7±29.5	90.7±6.4	<0.001	<0.001
ALT, U/L,	22 (9-219)	16 (5-121)	13 (5-54)	0.002	0.01
AST, U/L,	20 (9-115)	19 (9-70)	17 (9-31)	0.06	0.04
TSH, µIU/mL	2.50±1.25	2.13±1.50	1.81±0.9	0.02	0.04
Free thyroxine, ng/dL	0.87±0.12	0.91±0.13	0.88±0.13	0.11	0.95
Creatinine, mg/dL	0.83±0.10	0.80±0.09	0.77±0.09	0.005	<0.001
Total cholesterol, mg/dL	201±38.4	168.6±35.9	168±42.1	<0.001	<0.001
LDL cholesterol, mg/dL	115.8±30	100.7±28.1	97.5±35.2	0.002	0.004
HDL cholesterol, mg/dL	46.4±9.1	43.5±10.6	43.9±9.8	0.004	0.06
Triglyceride, mg/dL	202.3±87	121.9±46.4	100.4±34.6	<0.001	<0.001
Vitamin B12, pg/mL	222.8±144.7	200.5±71.6	205.9±102.2	0.23	0.29
Folic acid, ng/mL	7.8±2.4	10.6±5.3	11.1±6.9	<0.001	0.01
25-hydroxyvitamin D, ng/mL	13.3±12.1	28.8±13.5	29.9±12.7	<0.001	<0.001
Ferritin, ng/mL	24(2-102)	21(3-180)	22(2-182)	0.19	0.72
Zinc, mcg/dL	88.5±12.1	94.4±9.9	97.3±9	0.03	0.03
BMI, kg/m2	46±6.4	34.1±4.9	30.5±6.2	<0.001	<0.001
WBC, 103/mm3	8.9±2	7.1±1.7	6.9±1.5	<0.001	<0.001
Neutrophil, 103/mm3	5.6±1.6	4.1±1.3	4.0±1.1	<0.001	<0.001
Lymphocyte, 103/mm3	2.7±0.6	2.4±0.6	2.3±0.6	0.01	<0.001
Hemoglobin , g/dL	13.4±1.6	13.3±4.2	12.8±1.5	0.91	0.08
Platelet, 103/mm3	295.9±68.8	260.2±61.7	264±61.2	<0.001	<0.001
MPV, fL	9.4±1.2	10.3±1.3	11.6±2.6	0.002	<0.001
PCT, %	0.28±0.05	0.27±0.05	0.25±0.04	0.03	0.008
PDW, fL	16.2±0.6	16.1±0.5	16.0±0.05	0.1	0.1
RDW, %	14.4±1.5	14.4±1.2	13.9±1.2	0.87	0.01
NLR	2.17±0.6	1.76±0.5	1.80±0.6	0.01	0.01
CRP, mg/L	11.8±9.3	4.9±4.8	3.7±3.2	<0.001	<0.001

ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; BMI: Body mass index; CRP: C-reactive protein; HDL: High-density lipoprotein; LDL: Low-density lipoprotein; MPV: Mean platelet volume, NLR: Neutrophil-to-lymphocyte ratio; PCT: Procalcitonin ; PDW: Platelet distribution width; RDW: Red cell distribution width; TSH: Thyroid-stimulating hormone; WBC: White blood cell.
Values are presented as mean±SD or median (min-max).

Table 2. Correlation between variables and acute-phase reactants (6th month)

Variables		MPV	PCT	RDW	NLR
WBC	r	-0.20	0.22	0.05	0.37
	p	0.08	0.06	0.65	0.001
CRP	r	-0.06	0.06	0.65	0.001
	p	0.60	0.28	0.15	0.03

CRP: C-reactive protein; MPV: Mean platelet volume, NLR: Neutrophil-to-lymphocyte ratio; PCT: Plateletcrit; RDW: Red cell distribution width; WBC: White blood cell

Table 3. Correlation between variables and acute-phase reactants (12th month)

Variables		MPV	PCT	RDW	NLR
WBC	r	-0.12	0.31	0.009	0.16
	p	0.35	0.01	0.94	0.22
CRP	r	0.29	-0.04	0.25	0.25
	p	0.03	0.72	0.07	0.07

CRP: C-reactive protein; MPV: Mean platelet volume, NLR: Neutrophil-to-lymphocyte ratio; PCT: Plateletcrit; RDW: Red cell distribution width; WBC: White blood cell

DISCUSSION

Obesity is a growing problem that is becoming an epidemic. Bariatric surgery is the most effective treatment for morbid obesity and can provide appropriate and long-term weight loss (8). SG is often the preferred bariatric surgery method due to the ease of application and low morbidity rate (9). RYGBP continues to be another effective technique to treat morbid obesity (10). In our study, 42 of 71 patients underwent RYGBP and 29 underwent an SG procedure.

Obesity is a chronic metabolic disease and is associated with low-grade inflammation (11). The levels of inflammatory parameters that increase with obesity return to normal after bariatric surgery. An increased platelet count has also been associated with obesity (12). A number of factors have been proposed as a means to address the elevated levels of inflammation parameters in obesity. For example, there are studies indicating that necrosis and macrophage infiltration as a result of hypoxia caused by progressive adipocyte expansion in obesity consequently leads to an increase in plasma inflammation markers, such as CRP (13). Excess fat produces proinflammatory markers. Research has also revealed that obesity is associated with cellular stress and the activation of inflammatory pathways (14). As in earlier studies, we observed significant decreases in the levels of inflammatory parameters during the postoperative follow-up period.

A CBC is an inexpensive and easy test. An increased WBC is a very simple and widely used inflammatory parameter. There is clear evidence that the WBC count and proinflammatory cytokines will decrease with weight loss (15,16). The routine use of whole blood counting devices has led to greater understanding of the clinical significance of the NLR, platelet-to-lymphocyte ratio (PLR), MPV, PDW, PCT, and RDW as additional hematological inflammatory parameters (17). Statistically significant changes in the RDW, MPV, PDW, PCT, and NLR values were determined in this study. These simple hematological parameters may provide additional, useful measures for assessing obesity or monitoring the effects of weight loss rather than using high-cost proinflammatory cytokines.

The NLR is a new, inexpensive, and simple marker to assess inflammatory status; a high NLR is generally considered a marker of inflammation. Morbidly obese patients have a higher NLR than individuals with a healthy weight. The NLR and PLR have recently become known as a practical source of valuable information for determining systemic inflammatory diseases and establishing a prognosis (18).

The RDW, which describes differences in the size of red blood cells, is a hematological parameter associated with both anemia and inflammatory status. A relationship between an increase in RDW and a poor prognosis in cardiovascular disease has been reported (19).

Platelets are not just involved in hemostasis, but also regulate inflammatory events. An increase in platelet activation occurs following a release of inflammatory mediators. Changes in platelet production, activation, and function lead to changes in the platelet indices of MPV, PDW, and PCT (20). Shepherd et al. (21) reported that MPV levels were elevated in obese patients. However, in other studies, no evidence of increased platelet activation was found in obese individuals (22). Though an elevated MPV was seen in obese patients in other research examining bariatric surgery, a significant decrease in the platelet count was observed during the postoperative period (23). The SG procedure has been shown to produce a larger decrease in the platelet count than RYGBP. We did not have a sufficient number of patients in our study to evaluate this parameter. However, the MPV, PDW, and PCT levels demonstrated significant postoperative decreases in both surgical groups in our study.

Several studies have shown a strong relationship between excess weight and CRP level; namely, a strongly significant positive relationship between the CRP level and BMI, and a significant increase in the CRP level. A relationship between the CRP value, which is a recognized indicator of inflammation, and adipose tissue as a source of pro-inflammatory cytokines has been suggested (24). In our study, a significant decrease in the CRP level was observed postoperatively.

As BMI increases, the levels of the hematological inflammatory markers of the RDW and PCT also increase. These are uncomplicated and cost-effective markers that can predict cardiovascular complications and other comorbidities in overweight and obese patients. Rather than relying on proinflammatory cytokines, which are more expensive and difficult to study, these simple hematological markers may be very useful in routine outpatient control visits of obese patients.

CONCLUSION

Significant improvements in elevated hematological inflammatory parameters are seen in obese patients after bariatric surgery. The assessment of simple hematological parameters during the regular postoperative follow-up after bariatric surgery may be useful.

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