ORIGINAL ARTICLE

Eastern Journal of Medicine

East J Med 27(1): 57-63, 2022
DOI: 10.5505.2022.93823

Comparison of Hemogram Parameters of Gastrectomy and Diet in Obesity Treatment

Mine Öztürk[1*], Süleyman Kargın[2]

[1]*Department of Endocrinology and metabolism, KTO Karatay University, Konya, Turkey*
[2]*Department of Surgery, KTO Karatay University, Konya, Turkey*

ABSTRACT

We investigated -using hemogram parameters- whether inflammation is more likely to decrease with bariatric surgery or diet.

Pre- and postoperative hemogram values of 41 patients who underwent sleeve gastrectomy were measured and hemogram values of 26 patients on diet were measured before and after diet in venous blood samples. Age, gender, size, weight, body mass index, lymphocyte percentage, neutrophil percentage, lymphocyte, neutrophil, white blood cells, hemoglobin, platelets, RDW (Red Cell Distribution Width), MPV (Mean platelet volume), neutrophil-lymphocyte ratio, platelet-lymphocyte ratio values were recorded.

Twenty eight (%68.3) of the patients who underwent gastrectomy were female and 13 (%31.7) were male. Nine (%34.6) of the cases that were weakened by diet were women and 17 (%65.4) were men. There were significant differences in both groups in terms of preoperative / pre-diet and postoperative / post-diet weights (p = 0.00 / p = 0.03) and body mass index (p = 0.00 / p = 0.00). The group who had bariatric surgery was overweight before and after, and their body mass index was higher. Lymphocyte percentage, Neutrophil percentage, Hemoglobin, Platelets, RDW, MPV, Neutrophil-lymphocyte ratio, Platelet-lymphocyte ratio values were similar in patients who underwent gastrectomy and diet (Respectively p=0.40, p=0.06, p=0.42, p=0.08, p=0.46, p=0.58, p=0.35, p=0.39). Lymphocyte, neutrophil, white blood cell blood cells were higher in the bariatric surgery group, both preoperatively (Respectively p=0.01, p=0.00, p=0.00) and postoperatively (Respectively p=0.02, p=0.00, p=0.04), than those on diet.

Surgery or diet was not superior to each other in obesity treatment. The benefits we expected were available in both groups. They lost enough weight and their body mass index decreased. The important thing here was to lose weight. It is possible to live healthier and minimize inflammation by fighting obesity.

Keywords: Obesity; gastrectomy; diet; inflammation; hemogram parameters

Introduction

The global obesity epidemic affects more than 2 billion people (1). Obesity is an excess of adipose tissue (2). The most important indicator of the damage caused by obesity is inflammation in the body. Obesity causes a chronic systemic inflammation (2,3). Recent studies have revealed the presence of low grade inflammation in obesity (2,4). Obesity is associated with inflammatory and immune changes in dipose tissue that contribute to cardiometabolic risk (5).

Since obesity is a heterogeneous disease; diagnosis, treatment and follow-up should be individualized (6). Diagnosis of obesity; it is determined when the body mass index is 30 kg/cm and above (7). Other parameters commonly used in diagnosis are waist circumference, waist-to-hip and waist-to-height ratios, visceral fat area, body fat and body shape index (8).

Treatment in obesity; it can be in the form of lifestyle changes such as diet and exercise, as well as pharmacotherapy and bariatric surgery (9). Diet therapy in the treatment of obesity; personalized nutritional recommendations and should be applicable in daily life (6). Bariatric surgery; it is more effective than conservative treatments in terms of improving obesity-related diseases such as high blood pressure-cholesterol-sugar, reducing body fat and reducing mortality (6). Bariatric surgery, included Roux-en-Y gastric bypass, laparoscopic adjustable gastric band, duodenal switch, and sleeve gastrectomy (10). We included patients who underwent sleeve gastrectomy in our study.

In this study, we investigated whether inflammation is more likely to decrease with

***Corresponding Author:** Mine Öztürk Endocrinology-Metabolism and Internal Medicine Specialist. KTO Karatay University Medicine Faculty Hospital
E-mail: drmineozturk@gmail.com, Fax:+90 (332) 235 65 56
ORCID ID: Mine Öztürk: 0000-0002-2816-1688, **Süleyman Kargın:** 0000-0003-4597-8654
Received: 09.02.2021, **Accepted:** 12.08.2021

bariatric surgery or diet. For this purpose, we used easily accessible and cheap biomarkers (11), such as neutrophil-lymphocyte ratio, thrombocyte-lymphocyte ratio calculated from hemogram parameters.

Materials and Methods

Sixty-seven patients who came to the endocrine, general surgery and diet outpatient clinic between 2015 and 2020 who were weakened by gastrectomy or diet were included in the study. Pre- and postoperative hemogram values of 41 patients who underwent sleeve gastrectomy were measured and hemogram values of 26 patients on diet were measured before and after diet in venous blood samples placed in EDTA-standard tubes using Abbott Cell-Dyn 3700 Hematology Analyzer with the flow cytometry method. (year), gender, size (centimeter), weight body mass index(kilogram / meter^2), lymphocyte percentage (%), neutrophil percentage (%), lymphocyte (10(9)L), neutrophil (10(9)L), white blood cells (10(9)L), hemoglobin (g/dl), platelets (10(9)L), RDW (Red Cell Distribution Width) (%), MPV (Mean platelet volume) (fL), neutrophil-lymphocyte ratio, platelet-lymphocyte ratio values were recorded. These values were compared between patients who underwent gastrectomy and diet. To avoid acute effects of the operation, hemogram and metabolic values were measured after the first month of the operation. We excluded pregnant women, patients with dietary compliance problems, patients using any long-term medication, those with chronic diseases such as diabetes and hypertension, patients with blood disease and acute-chronic infections. Approval was obtained from the Ethics Committee of Karatay University Medical School for this study.

The data were analyzed with windows compatible SPSS version 22.P <0.05 was accepted as the limit of significance. The compliance of the data with the normal distribution was determined with the Kolmogorov Smirnov Test. In comparison of variables that are not suitable for normal distribution, Wilcoxon test was used.

Results

41 bariatric surgeries were performed and 26 patients who were weakened by diet were included in the study. Sleeve gastrectomy was applied to cases as a bariatric surgery method. 28 (% 68.3) of the patients who underwent gastrectomy were female and 13 (% 31.7) were male. 9 (% 34.6) of the cases that were weakened by diet were women and 17 (% 65.4) were men.

Pre-operative/pre-diet and post-operative/post-diet results: There were significant differences in both groups in terms of preoperative/pre-diet and postoperative/post-diet weights (p = 0.00/p = 0.03) and body mass index (p = 0.00/p = 0.00). The group who had bariatric surgery was overweight, and their body mass index was higher before and after. Lymphocyte percentage, Neutrophil percentage, Hemoglobin, Platelets, RDW, MPV, Neutrophil-lymphocyte ratio, Platelet-lymphocyte ratio values were similar in patients who underwent gastrectomy and diet (Respectively p=0.40, p=0.06, p=0.42, p=0.08, p=0.46, p=0.58, p=0.35, p=0.39). Lymphocyte, Neutrophil, White blood cells were higher in the bariatric surgery group, both preoperatively (Respectively p=0.01, p=0.00, p=0.00) and postoperatively (Respectively p=0.02, p=0.00, p=0.04), than those on diet (Table 1). Pre-operative/post-operative results: Compared to pre-operation, there was a significant reduction in the weight of the cases undergoing bariatric surgery (p=0.00). Body mass index was significantly reduced (p= 0.00). Although there was a significant decrease in the lymphocyte count (p=0.02) and neutrophil count (p=0.03); there was no significant change in the lymphocyte percentage (p=0.80) and neutrophil percentage (p=0.24). There was a significant decrease in white blood cells (p=0.00) postoperatively, there was no significant increase in hemoglobin (p=0.50), platelets (p=0.65) and RDW (p=0.89). There was no change in neutrophil-lymphocyte ratio (p = 0.95) and thrombocyte-lymphocyte ratio (p = 0.06) before and after bariatric surgery (Table 2).

Pre-diet/post-diet results: There were also significant changes in patients who lost weight with diet compared to before diet. Weight (p=0.00) body mass index (p=0.00) were significantly reduced in dieting patients, as in patients who had bariatric surgery. There was a decrease in the number of lymphocytes (p=0.03) but no change in the percentage of lymphocytes (p=0.09). Interestingly, there was no significant increase in the number of neutrophils (p=0.71) and there was a significant increase in the percentage of neutrophils (p=0.02) in patients who were weakened by diet. White blood cells (p=0.01), platelets (p=0.02), RDW (p=0.00) values were significantly decreased after diet. There was no significant change in hemoglobin (p=0.78), MPV value (p=0.51), the Neutrophil-lymphocyte

Table 1. Pre-Operative/Pre-Diet and Post-Operative/Post-Diet Results

	Bariatric surgery(n=41) Mean ± Standard deviation	Control(n=26) Mean ± Standard deviation	Z*	P
Age (year)	33.1±8.4	31.8±9.3	-1.08	0.28
Size (centimeter)	168.0±9.6	172.82±9.7	-1.03	0.30
Weight(kilogram)	124.0±24.3*	104.2±16.9*º	-3.64	0.00
	98.2±24.6**	93.0±17.1**º	-2.07	0.03
Body mass index(kilogram / meter^2)	43.67±5.90*	35.09±4.23*º	-4.43	0.00
	34.19±6.60**	30.99±3.77**º	-3.16	0.00
lymphocyte percentage(%)	31.40±5.30*	33.70±7.30*º	0.82	0.40
	31.30±6.20**	30.60±7.90**º	-0.38	0.70
Neutrophil percentage(%)	58.9±6.9*	54.2±7.3*º	-1.86	0.06
	57.5±7.2**	58.0±8.7**º	-0.41	0.67
Lymphocyte(10(9)L)	2.76±0.59*	2.36±0.72*º	-2.42	0.01
	2.48±0.68**	2.04±0.45**º	-2.28	0.02
Neutrophil (10(9)L)	5.10±1.25*	3.81±0.93*º	-3.16	0.00
	4.64±1.53**	3.83±0.93**º	-2.73	0.00
White blood cells(10(9)L)	8.53±2,01*	6.97±1.41*º	-2.60	0.00
	7.33±2.45**	6.73±0.98**º	-2.00	0.04
Hemoglobin(g/dl)	13.71±1.62*	14.76±1.81*º	-0.79	0.42
	13.83±1.57**	14.74±1.44**º	-0.17	0.85
Platelets(10(9)L)	295.02±72.79*	264.65±61.93*º	-1.74	0.08
	288.51±80.14**	259.38±53.47**º	-1.86	0.06
RDW(%)	15.18±1.58*	14.97±1.77*º	-0.73	0.46
	15.14±1.61**	14.33±1.45**º	-1.98	0.04
MPV(fL)	7.45±0.95*	7.74±1.58*º	-0.54	0.58
	7.81±1.30**	7.60±0.96**º	-1.46	0.14
Neutrophil-lymphocyte ratio	1.91±0.59*	1.75±0.66*º	-0.92	0.35
	1.91±0.61**	1.98±0.71**º	-0.39	0.69
Platelet-lymphocyte ratio	111.03±35.27*	121.20±45.74*º	-0.85	0.39
	121.72±39.54**	130.70±31.98**º	-1.29	0.20

*: before the operation
**: after the operation
*º : before diet
**º: after diet
RDW:Red Cell Distribution Width
MPV:Mean platelet volume
Z*:Wilcoxon associated Z score

Ratio (p=0.14), the Platelet-lymphocyte ratio (p=0.22) (Table 3).

Discussion

İn this study, we compared the results of bariatric surgery and dietary in the obesity treatment. We investigated whether metabolic and hemogram values are better in bariatric surgery or in the treatment of obesity with diet. In both cases, we looked for clues to improvement in chronic inflammation. We reached interesting results.

In our study, among hemogram parameters, white blood cell count, lymphocyte count, neutrophil count tended to decrease in patients who underwent bariatric surgery compared to the preoperative period. This was a positive development in reducing inflammation. We evaluated patients who underwent bariatric surgery before and 1 month after the operation.

Table 2. Pre-Operative/Post-Operative Results

	Bariatric surgery(n=41) before the operation Mean ± Standard deviation	Bariatric surgery(n=41) after the operation Mean ± Standard deviation	Z*	P
Weight(kilogram)	124.0±24.3	98.2±24.6	-5.57	0.00
Body mass index(kilogram / meter²)	43.67±5.90	34.19±6.60	-5.57	0.00
lymphocyte percentage(%)	31.46±5.38	31.32±6.25	-0.24	0.80
Neutrophil percentage(%)	5.10±1.25	4.64±1.53	-1.16	0.24
lymphocyte (10(9)L)	2.76±0.59	2.48±0.68	-2.24	0.02
Neutrophil(10(9)L)	5.10±1.25	4.64±1.53	-2.13	0.03
White blood cells(10(9)L)	8.53±2.01	7.33±2.45	-3.14	0.00
Hemoglobin(g/dl)	13.71±1.62	13.83±1.57	-0.67	0.50
Platelets(10(9)L)	295.02±72.79	288.51±80.14	0.44	0.65
RDW(%)	15.18±1.58	15.14±1.61	-0.13	0.89
MPV(fL)	7.45±0.95	7.81±1.30	-1.43	0.15
Neutrophil-lymphocyte ratio	1.91±0.59	1.92±0.61	-0.5	0.95
Platelet-lymphocyte ratio	111.03±35.27	121.72±39.54	-1.84	0.06

RDW:Red Cell Distribution Width
MPV:Mean platelet volume
Z*:Wilcoxon associated Z score

Table 3. Pre-Diet/Post-Diet Results

	Control(n=26) before diet Mean ± Standard deviation	Control(n=26) after diet Mean ± Standard deviation	Z*	P
Weight(kilogram)	104.2±16.9	93.0±17.1	-4.45	0.00
Body mass index(kilogram / meter²)	35.09±4.23	30.99±3.77	-4.45	0.00
lymphocyte percentage(%)	33.79±7.39	30.63±7.93	-1.66	0.09
Neutrophil percentage(%)	3.81±0.93	3.83±0.93	-2.19	0.02
Lymphocyte(10(9)L)	2.36±0.72	2.04±0.45	-2.08	0.03
Neutrophil(10(9)L)	3.81±0.93	3.83±0.93	-0.36	0.71
White blood cell(10(9)L)	6.97±1.41	6.73±0.98	-2.56	0.01
Hemoglobin(g/dl)	14.76±1.81	14.74±1.44	-0.26	0.78
Platelets(10(9)L)	264.65±61.93	259.38±53.47	-2.22	0.02
RDW(%)	14.97±1.77	14.33±1.45	-2.77	0.00
MPV(fL)	7.60±0.96	7.74±1.58	-0.64	0.51
Neutrophil-lymphocyte ratio	1.75±0.66	1.98±0.71	-1.46	0.14
Platelet-lymphocyte ratio	121.20±45.74	130.70±31.98	-1.20	0.22

RDW:Red Cell Distribution Width
MPV:Mean platelet volume
Z*:Wilcoxon associated Z score

We encountered a significant weight loss and a decrease in body mass index.

As in our study, the leukocyte counts were lower in 494 patients who had sleeve gastrectomy compared to the preoperative period (12). In one study, adipose tissue leukocyte count remained higher than baseline after bariatric surgery (13). Lymphocyte count was significantly reduced; There was no change in lymphocyte percentage. Likewise, the neutrophil count was significantly

reduced: There was no change in neutrophil percentage. In a study in which all bariatric surgical methods were evaluated, a decrease was found in the neutrophil count of the patients after the operation, similar to our study (14).

One study showed that low hemoglobin and anemia worsened after the operation in 77 patients who had sleeve gastrectomy (15). On the contrary, hemoglobin levels and RDW values did not change in our work. The reason for this may be the use of nutritional and vitamin supplements before and after bariatric surgery.

In this study, there was no change in platelet levels and MPV. Platelet values decreased in 128 obese patients who underwent bariatric surgery, and MPV remained the same, unlike our study (16). In another study, 205 patients with sleeve gastrectomy had a decrease in postoperative platelet values, MPV values were elevated (17).

In one study, 46 patients who underwent bariatric surgery had a decrease in neutrophil lymphocyte ratios (18). In a similar study, the neutrophil lymphocyte ratio decreased in parallel with the increase in neutrophil count in patients with bariatric surgery (19). In our study, neutrophil-lymphocyte ratio and thrombocyte lymphocyte ratio did not change.

In a study comparing bariatric surgery cases with and without complications, neutrophil lymphocyte ratio and platelet lymphocyte ratio were found to be higher in complicated cases (20). There were no patients who developed complications in our cases; there was no change in neutrophil lymphocyte ratio and thrombocyte lymphocyte ratio.

In obese patients weakened by diet, white blood cell count, lymphocyte count, RDW, platelet count tended to decrease compared to pre-diet. It was noteworthy that the percentage of neutrophils was increased. When we look at the obesity treatment with diet, weight loss and decrease in body mass index were significant as in bariatric surgery. The white blood cell count decreased significantly. Although the lymphocyte percentage did not change, the lymphocyte count decreased. Neutrophil percentage increased, neutrophil count did not change. In a study investigating inflammation in people who did diet and diet + exercise, while the leukocyte count did not change, the neutrophil count decreased (21). In our study, the white blood cell count decreased, but the neutrophil count increased. In one study, it has been shown that a diet in the form of calorie restriction reduces inflammation by reducing the numbers of leukocytes, lymphocytes and neutrophils in the blood, even in non-obese individuals (2).

Unlike bariatric surgery, a significant reduction in RDW was seen. Because dieting takes longer to lose weight, nutritional disorders and vitamin deficiencies develop. Generally, nutritional supplements are started immediately after the operation in bariatric surgery. As in our study, a decrease in lymphocyte count was observed in obese patients who diet before bariatric surgery (22). There was a decrease in the platelet count. Neutrophil lymphocyte ratio and thrombocyte lymphocyte ratio did not change as in bariatric surgery.

The increase in leukocytes is a good biomarker in acute - chronic infection and tissue damage (23). In our study, the leukocyte count decreased in patients who were weakened by both bariatric surgery and diet.

In our study, white blood cell count and lymphocyte count were low in addition to weight loss and decreased body mass index in both bariatric surgery and dietary obesity treatment. There was no change in lymphocyte percentage in both groups. In another study, it has been shown that even short-term calorie restrictive diets reduce the microparticles of platelets and leukocytes, thus contributing to the reduction of inflammation (24). Interestingly; in our study, the neutrophil count did not change in the dieters, but the neutrophil percentage increased; neutrophil count decreased and neutrophil percentage did not change in those who had bariatric surgery. In a separate study, an increase in neutrophil count was observed in both groups in the form of bariatric surgery and lifestyle intervention in the treatment of obesity (25).

Likewise, hemoglobin and MPV did not change in the bariatric surgery group and in the group that lost weight with diet. This may be due to the fact that nutritional supplements begin immediately after surgery in patients who undergo surgery. Neutrophil lymphocyte ratio and thrombocyte lymphocyte ratio did not change in both groups. Unlike our study, in one study, the ratio of thrombocyte and thrombocyte lymphocyte was higher in the obese group compared to the non-obese group (26). The limitations of our study are the small number of cases and the failure to examine the metabolic and inflammation values of the cases in the 3rd and 6th months after 1 month.

In conclusion, obesity surgery or diet was not superior to each other in obesity treatment. The benefits we expected were present in both groups. They lost enough weight and body mass index decreased. White blood cells, lymphocyte counts, platelets, and RDVs decreased. Neutrophil lymphocyte ratio, thrombocyte lymphocyte ratio, neutrophil count, neutrophil percentage, MPV, hemoglobin values were not significantly different when the two groups were compared with each other. The important thing here was to lose weight. It is possible to live healthier and minimize inflammation by fighting obesity.

References

1. Caballero B. Humans against Obesity: Who Will Win? Adv Nutr 2019; 10: 4-9.
2. Meydani SN, Das SK, Pieper CF, Lewis MR, Klein S, Dixit VD, et al. Long-term moderate calorie restriction inhibits inflammation without impairing cell-mediated immunity: a randomized controlled trial in non-obese humans. Aging (Albany NY) 2016; 8: 1416-1431.
3. Xu C, Mathews AE, Rodrigues C, Eudy BJ, Rowe CA, O'Donoughue A, et al. Aged garlic extract supplementation modifies inflammation and immunity of adults with obesity: A randomized, double-blind, placebo-controlled clinical trial. Clin Nutr ESPEN 2018; 24: 148-155.
4. Ringseis R, Eder K, Mooren FC, Krüger K. Metabolic signals and innate immune activation in obesity and exercise. Exerc Immunol Rev 2015; 21: 58-68.
5. Heffron SP, Parham JS, Pendse J, Alemán JO.Treatment of Obesity in Mitigating Metabolic Risk. Circ Res 2020; 126: 1646-1665.
6. Wirth A, Wabitsch M, Hauner H.The prevention and treatment of obesity. Dtsch Arztebl Int 2014; 111: 705-713.
7. Apovian CM.Obesity: definition, comorbidities, causes, and burden. Am J Manag Care. 2016
8. Gažarová M, Galšneiderová M, Mečiarová L.Obesity diagnosis and mortality risk based on a body shape index (ABSI) and other indices and anthropometric parameters in university students. Rocz Panstw Zakl Hig 2019; 70: 267-275.
9. Leitner DR, Frühbeck G, Yumuk V, Schindler K, Micic D, Woodward E, et al.Obesity and Type 2 Diabetes: Two Diseases with a Need for Combined Treatment Strategies - EASO Can Lead the Way. Obes Facts 2017; 10: 483-492.
10. De Lorenzo A, Soldati L, Sarlo F, Calvani M, Di Lorenzo N, Di Renzo L. New obesity classification criteria as a tool for bariatric surgery indication. World J Gastroenterol 2016; 22: 681-703.
11. Furuncuoğlu Y, Tulgar S, Dogan AN, Cakar S, Tulgar YK, Cakiroglu B. How obesity affects the neutrophil/lymphocyte and platelet/lymphocyte ratio, systemic immune-inflammatory index and platelet indices: a retrospective study. Eur Rev Med Pharmacol Sci 2016; 20: 1300-1306.
12. Kyio NH, Turgut S, Ozkan T, Cetin G. Evolution of Hematological Parameters During the First 2 Years After Laparoscopic Sleeve Gastrectomy: Results of a Retrospective Study. Obes Surg 2020; 30: 2606-2611.
13. Hagman DK, Larson I, Kuzma JN, Cromer G, Makar K, Rubinow KB, et al. The short-term and long-term effects of bariatric/metabolic surgery on subcutaneous adipose tissue inflammation in humans. Metabolism 2017; 70: 12-22.
14. Cunha FM, Saavedra A, Barbosa J, Freitas P, Carvalho D, Varela A. Effect of different bariatric surgery type on the leukocyte formula. Surg Obes Relat Dis 2016; 12: 1418-1423.
15. Ben-Porat T, Elazary R, Yuval JB, Wieder A, Khalaileh A, Weiss R. Nutritional deficiencies after sleeve gastrectomy: can they be predicted preoperatively? Surg Obes Relat Dis 2015; 11: 1029-1036.
16. Raoux L, Moszkowicz D, Vychnevskaia K, Poghosyan T, Beauchet A, Clauser S,et al. Effect of Bariatric Surgery-Induced Weight Loss on Platelet Count and Mean Platelet Volume: a 12-Month Follow-Up Study. Obes Surg 2017; 27: 387-393.
17. Kutluturk F, Ozsoy Z. Effect of Sleeve Gastrectomy on Platelet Counts and Mean Platelet Volumes. Obes Surg 2018; 28: 3159-3164.
18. Santos J, Salgado P, Santos C, Mendes P, Saavedra J, Baldaque P, et al. Effect of bariatric surgery on weight loss, inflammation, iron metabolism, and lipid profile. Scand J Surg 2014; 103: 21-25.
19. Lo T, Rudge EJM, Chase RP,. Early changes in immune cell metabolism and function are a hallmark of sleeve gastrectomy: a prospective human study. medRxiv 2020 Nov 3:2020.07.31.20161687.
20. Mari A, Mahamid M, Ahmad HS, Lubany A, Abu El Hija S, Shorbaji N, et al. The Role of Pre-Operative Neutrophil-to-Lymphocyte Ratio in Predicting Post Bariatric Surgery Related Complications. Isr Med Assoc J 2020; 22: 294-298.

21. 2Imayama I, Ulrich CM, Alfano CM, Wang C, Xiao L, Wener MH, et al. Effects of a caloric restriction weight loss diet and exercise on inflammatory biomarkers in overweight/obese postmenopausal women: a randomized controlled trial. Cancer Res 2012; 72: 2314-2326.
22. Bennasar Remolar MÁ, Martínez Ramos D, Ortega Serrano J, Salvador Sanchís JL. Nutritional alterations after very low-calorie diet before bariatric surgery. Cir Esp 2016; 94: 159-164.
23. Babio N, Ibarrola-Jurado N, Bulló M, Martínez-González MÁ, Wärnberg J, Salaverría I, et al; PREDIMED Study Investigators. White blood cell counts as risk markers of developing metabolic syndrome and its components in the PREDIMED study. PLoS One 2013; 8: e58354.
24. Morel O, Luca F, Grunebaum L, Jesel L, Meyer N, Desprez D, et al. Short-term very low-calorie diet in obese females improves the haemostatic balance through the reduction of leptin levels, PAI-1 concentrations and a diminished release of platelet and leukocyte-derived microparticles. Int J Obes (Lond) 2011; 35: 1479-1486.
25. Kratz M, Hagman DK, Kuzma JN, Foster-Schubert KE, Chan CP, Stewart S, et al. Improvements in glycemic control after gastric bypass occur despite persistent adipose tissue inflammation. Obesity (Silver Spring) 2016; 24: 1438-1445.
26. Erdal E, İnanir M. Platelet-to-lymphocyte ratio (PLR) and Plateletcrit (PCT) in young patients with morbid obesity. Rev Assoc Med Bras (1992) 2019; 65: 1182-1187.