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Changes in laboratory findings and early postoperative radiological evaluations following laparoscopic sleeve gastrectomy

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ABSTRACT

Introduction: Obesity is an important public health problem with its related comorbidities associated with chronic inflammation. Secretion and continued release of inflammatory mediators such as tumor necrosis factor-alpha and interleukin-6 are caused by hypertrophic growth of adipose tissue and lead to chronic inflammation. In this study, we aimed to retrospectively evaluate the changes in the hematological and biochemical profiles and also to review complications established in post-operative radiological imaging studies following laparoscopic sleeve gastrectomy (LSG).

Materials and Methods: The changes in the obesity-related biochemical and hematological parameters 6 months after LSG were retrospectively analyzed in 143 consecutive patients older than 18-year of age who underwent LSG. In addition, the findings of abdominal ultrasonography (US) examinations in all patients and computed tomography findings in patients who had been performed were retrospectively reviewed in terms of post-operative complications.

Results: The decrease in body mass index (BMI) compared to the pre-operative BMI was statistically significant. Both inflammatory markers and glucose-lipid profiles showed improvement with a positive correlation parallel to the change in BMI. Neutrophil-lymphocyte ratio was found to be decreased significantly. However, no significant change was observed in PLR 6 months after LSG. Newly developed gallstones appeared in six of the patients when compared with their pre-operative abdominal US reports. None of the patients had gastric leak, perigastric collection, or hemorrhage.

Conclusion: LSG is one of the most effective bariatric surgery methods in the treatment of obesity. We showed improvements in inflammatory markers in addition to glucose and lipid profiles with a positive correlation parallel to the changes in BMI.

Keywords: Laparoscopic sleeve gastrectomy, Meta-inflammation, Neutrophil-lymphocyte ratio, Obesity, Platelet/lymphocyte ratio

Introduction

Obesity, with its many associated diseases, is the fastest growing public health problem worldwide. In many obesity-related comorbidities, chronic inflammation is the main pathophysiological problem. Surgical treatment has been found to be effective for obese patients with a body mass

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index (BMI) above 40 kg/m^2 and even for those having BMI between 35 and 39.9 kg/m^2 with concomitant diseases related to the obesity.[1] In obesity, hypertrophic growth of adipose tissue is associated with the stimulation of the secretion of inflammatory mediators such as tumor necrosis factor-alpha and interleukin-6 (IL-6).[2,3] Continued release of inflammatory mediators leads to chronic inflammation. The increase in IL-6 causes an increase in the number of white blood cells in addition to the level of C-reactive protein (CRP).[2,4] Inflammatory markers such as neutrophil-lymphocyte ratio (NLR) and platelet/lymphocyte ratio (PLR), which are used as diagnostic and prognostic factors in infectious diseases, have been shown to play an important role in the prognostic evaluations in many diseases such as cardiovascular diseases, chronic obstructive pulmonary disease, pneumonia, rheumatic diseases, different types of cancers, and also obesity.[5-8] Furthermore, they have proven to be useful markers for the prognosis of post-operative complications.[9-11] The aim of this study is to retrospectively evaluate the changes in the hematological and biochemical profiles and also to review complications established in post-operative radiological imaging studies including abdominal ultrasonography (US) in all patients and abdominal computed tomography (CT) in existing patients following laparoscopic sleeve gastrectomy (LSG).

Materials and Methods

Study Population

A total of 163 consecutive patients older than 18-year of age who underwent LSG at Altınbaş University Bahçelievler Medical Park Hospital between January 2015 and June 2020 were assessed for enrollment in the study. After evaluating the data, 14 patients were excluded due to the lack of minimum 6 months of follow-up (Fig. 1). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or the national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All of the patients received Vitamin B12, iron, and folic acid supplements in the first 6 months after the surgery. The files of the study patients were retrospectively investigated. The demographic characteristics of the patients, obesity-related chronic diseases (diabetes mellitus type II, hypertension, and dyslipidemia), body mass indices, and blood tests performed in the past 1 month before the surgery, and blood tests performed in 6 months after the surgery were investigated. In addition, abdominal US and CT performed 6 months after the surgery were reviewed in terms of complications, if any. Pre-operative and 6 months post-operative biochemical parameters (fasting blood glucose, insulin, homeostatic model assessment of cell function and insulin resistance [HOMA-IR], glycated hemoglobin [HbA1c], total cholesterol [TC], high-density lipoprotein [HDL], low-density lipoprotein [LDL], very LDL [VLDL], triglyceride [TG], aspartate aminotransferase [AST], alanine aminotransferase [ALT], white blood cell count [WBC], hemoglobin level [HGB], hematocrit level, platelet count, neutrophil count, and lymphocyte count), NLR, and PLR were statistically compared.

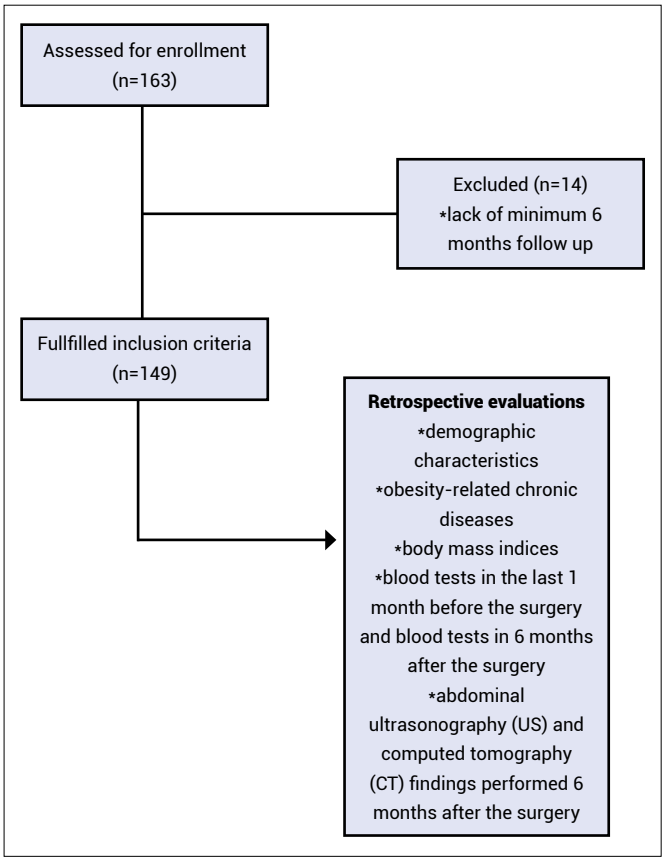

Figure 1. Study flowchart.

Statistical Analysis

IBM SPSS 22 (IBM Co., Armonk, NY, USA) program was used in the statistical evaluation of findings obtained in the study. The suitability of the parameters to the normal distribution was evaluated by Kolmogorov–Smirnov and Shapiro–Wilk tests. In the evaluation of the study data, in addition to descriptive statistical methods (mean, standard deviation, and frequency), paired sample t-test was used for the post-operative comparison of the parameters

showing normal distribution compared to the pre-operative in the comparison of the quantitative data, and the Wilcoxon sign test was used for the comparison of the parameters that did not show normal distribution. Significance was evaluated at p<0.05 level.

Results

The study was conducted with a total of 149 patients including 85 (57%) female and 64 (43%) male patients with an average age of 42.47±12.15 years (range between 19 and 72) who had undergone LSG; 47 of the cases (31.5%) had type 2 diabetes, 61 (40.9%) had hypertension, and 66 (44.3%) had dyslipidemia. Post-operative changes observed in the study parameters compared to the pre-operative values are shown in Table 1.

The decrease in BMI seen after the operation compared to the pre-operative BMI was statistically significant (p=0.001 and p<0.05) (Fig. 2).

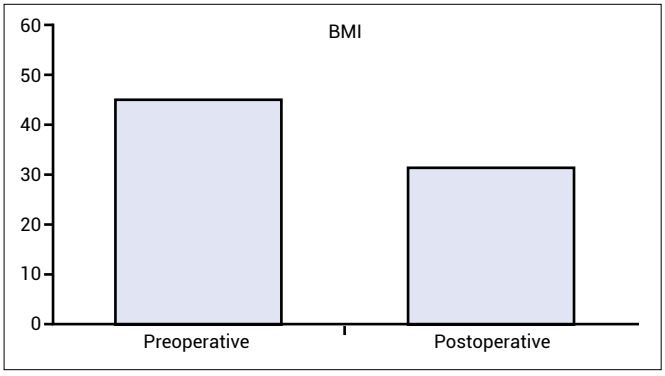

Figure 2. The changes in BMI.

Table 1. Postoperative changes observed in the study parameters compared to the preoperative values

	Preoperative Mean±SD	Postoperative Mean±SD	Difference Mean±SD	95% confidence interval of the difference		
				Lower limit	Upper limit	p
Weight	134,31±17,4	94,17±11,44	40,14±8,34	38,79	41,49	[1]0,001*
BMI	44,96±5,07	31,53±3,31	13,44±2,64	13,01	13,86	[1]0,001*
FBG	120,87±53,36 (102)	93,52±14,77 (91)	27,34±54,43	18,53	36,15	[2]0,001*
Insulin	22,92±12,39 (20,1)	7,43±2,85 (7,2)	15,49±12,63	13,44	17,53	[2]0,001*
HOMA-IR	6,9±4,87 (5,2)	1,73±0,79 (1,6)	5,17±4,87	4,38	5,96	[2]0,001*
HbA1c	6,97±2 (6,2)	5,89±0,68 (5,7)	1,08±2,22	0,73	1,44	[2]0,001*
Triglyceride	162,48±91,4 (142)	102,08±24,11 (99)	60,4±95,44	44,95	75,85	[2]0,001*
VLDL	32,53±18,31 (28)	20,40±4,79 (20)	12,13±19,10	9,04	15,23	[2]0,001*
Total cholesterol	214,15±40,3	180,26±21,22	33,89±44,58	26,67	41,11	[1]0,001*
LDL	136,84±31,47	111,79±18,26	25,05±36,2	19,19	30,91	[1]0,001*
HDL	41,18±8,92	46,49±8,39	-5,32±11,58	-7,19	-3,44	[1]0,001*
ALT	46,26±42,76 (31)	20,71±10,4 (16)	25,55±42,67	18,64	32,46	[2]0,001*
AST	32,57±28,64 (22)	20,32±9,08 (18)	12,25±27,68	7,77	16,73	[2]0,001*
WBC	9,34±3,17 (8,9)	7,26±1,35 (7,3)	2,08±3,5	1,51	2,64	[2]0,001*
HB	13,72±1,48	13,52±1,35	0,2±1,61	0,06	0,46	[1]0,128
HCT	41,5±4,12	40,49±3,97	1,01±4,52	0,28	1,74	[1]0,007*
PLT	279,64±69,47 (270)	251,68±56,92 (240)	27,96±75,85	15,68	40,24	[2]0,001*
Neutrophil	6,25±3,40 (5,2)	4,17±1,17 (4,2)	2,08±3,57	1,50	2,65	[2]0,001*
Lymphocytet	2,66±0,8	2,24±0,71	0,42±1,01	0,26	0,59	[1]0,001*
NLR	2,59±2,03 (2)	2,03±0,78 (2,1)	0,56±2,15	0,21	0,91	[2]0,013*
PLR	113,96±41,47 (104,3)	120,28±36,48 (121,8)	-6,32±44,55	-13,53	0,89	[2]0,071

[1]Paired samples t test; [2]Wilcoxon sign test; *p<0.05; Normally distributed parameters are shown as mean ±SD, non-normally distributed parameters are shown as mean±SD (median); SD: standard deviation; BMI:body mass index; FBG:fasting blood glucose.

The decreases in the average level of fasting blood glucose, insulin, HOMA-IR, and HbA1c seen after the operation compared to the pre-operative values were statistically significant (p=0.001 and p<0.05) (Fig. 3).

The decreases in the level of TG, VLDL, TC, and LDL seen after the operation compared to the pre-operative values were statistically significant (p=0.001 and p<0.05). The increase in the level of HDL seen after the operation compared to the pre-operative values was statistically significant (p=0.001 and p<0.05). The decreases in the level of ALT and AST seen after the operation compared to the pre-operative were statistically significant (p=0.001 and p<0.05) (Fig. 4).

The decrease in the level of hematocrit seen after the operation compared to the pre-operative value, although it was slight, was found to be statistically significant (p=0.007 and p<0.05). No statistically significant change was observed in HGB after the operation compared to the pre-operative values (p>0.05). The decrease seen in WBC, platelet, neutrophil, and lymphocyte after the operation compared to the pre-operative values was statistically significant (p=0.001 and p<0.05). The decrease seen in the level of NLR after the operation compared to the pre-operative value was statistically significant (p=0.013 and p<0.05). No statistically significant change was observed in platelet-lymphocyte ratio (PLR) after the operation compared to the pre-operative values (p>0.05) (Fig. 5).

All patients had at least one abdominal US 6 months after the surgery and newly developed gallstones appeared in six of the patients when compared with their pre-operative abdominal US reports. The gallstones were multiple, small, mainly non-calcified stones. In nine patients, abdominal CT had been performed for the evaluation of gastric leakage but none of the patients had gastric leak, perigastric collection, or hemorrhage.

Discussion

Obesity is characterized by the increased adipose tissue which, in turn, is associated with increased release of pro-inflammatory mediators resulting in a chronic, sterile, systemic inflammatory state through both innate and adaptive immune responses. This is named as metabolic inflammation or meta-inflammation and is thought as the major factor in the pathophysiology of obesity-related comorbidities known as metabolic syndrome.[12]

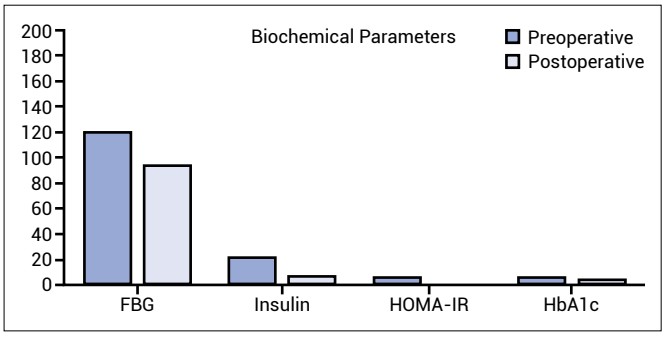

Figure 3. The changes in biochemical parameters.

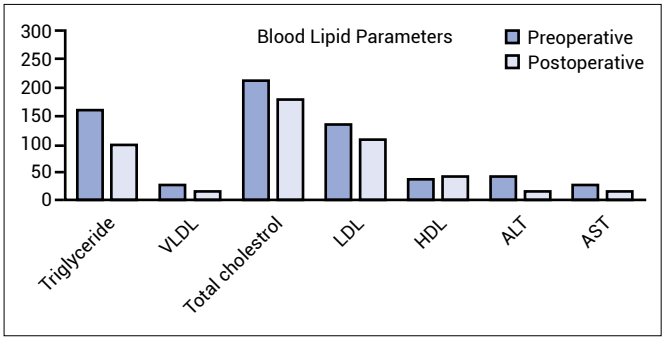

Figure 4. The changes in blood lipid parameters.

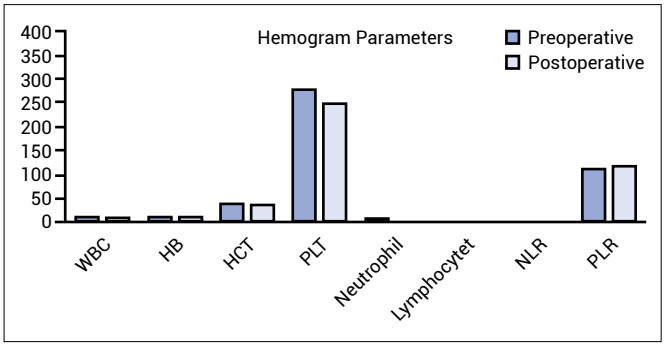

Figure 5. The changes in hemogram parameters.

Surgical treatment of obesity has been shown to be affected in not only weight loss but also in the improvement of metabolic profile. Following surgical treatment, the decrease in the ongoing inflammatory process has been demonstrated with various serum inflammatory markers, particularly CRP.[13,14] LSG is one of the most effective bariatric surgery methods in the treatment of obesity.[15] In a study conducted on 21 obese patients who underwent LSG, it has been reported that CRP showed a significant decrease at 3 months after surgery. However, no significant differences of IL-6 and TNF-α were established. In this study, HbA1c, TG, and TC also improved.[16] The most obvious decrease in inflammatory parameters were reported particularly in the short-term results during the first 6 months. As a long-term follow-up study, a retrospective cohort study including 163 obese patients reported com-

plete normalization of hs-CRP in 84.0% of patients in 4 years demonstrated the reduction in the meta-inflammation up to 4 years after the bariatric surgery. The intensity of weight loss was also reported to have a significant linear effect on change in WBC and change in hs-CRP at long-term follow-up.[17] Inflammatory biomarkers such as CRP, WBC, fibrinogen, and procalcitonin have also been studied regarding their potential to determine perioperative morbidity following various obesity surgeries.

The efficacy of malabsorptive bariatric surgery on daily blood glucose fluctuations and oxidative stress in type 2 diabetic obese patients was evaluated by comparing 36 type 2 diabetic patients before and 1 month after biliopancreatic diversion (BPD) and 20 patients after diet-induced equivalent weight loss. The study concluded that oxidative stress reduction after BPD seems to be related to the regulation of glucose fluctuations resulting from intestinal bypass.[18] Improvements in blood glucose and lipid profile (TC, LDL-C, and TG) are important to decrease major cardiovascular risk factors and it has been well documented in various studies within the 6 months after the surgical intervention.[13,19] In our study, a significant decrease in TC, LDL, and also VLDL has been achieved at the 6th month after LSG. Furthermore, HDL level also increased significantly in our patients. A prospective cohort study conducted to evaluate the long-term (5-year follow-up) results of LSG in terms of weight loss and obesity-related comorbidities, as well as the risk factors associated with post-operative nutritional deficiencies reported long-term weight loss of 61.0% at 5 years in addition to a long-term significant improvement in lipid profile including TG, LDL-C, and HDL-C but not on TC levels.[20]

LSG may cause nutritional deficiencies and may lead to anemia. In our patients, some minor statistically significant decrease in the HTC levels have been observed but the Hb levels were not decreased. All of the patients received Vitamin B12, iron, and folic acid supplements in the first 6 months after the surgery and there was no significant decrease in the Hb values. In the study of Kikkas et al., the risk of post-operative Vitamin B12 and iron deficiency was noted by the authors in their 5-year follow-up study.[20] In another study, evaluating the 6-month follow-up data of 33 patients who underwent sleeve gastrectomy for obesity, serum iron levels were significantly higher on the 6-month follow-up but mean Hb did not showed a significant difference compared to the baseline and between months.[21] In a retrospective study including 494 obese patients who underwent LSG and followed up to 2 years, it was shown that proper vitamin and mineral supplementation therapy keep hematological parameters within the normal range.[22]

Studies are also investigating the biomarkers that might be useful to predict gastric leak before its clinical presentation. A study conducted in 151 patients who underwent LSG reported that NLR and procalcitonin detected gastric leak with significantly higher sensitivity and specificity than CRP, fibrinogen, and WBC.[23] In our study, we did not observe any gastric leak. Another possible adverse effect that may occur after LSG is newly developed gallstones. Ursodeoxycholic acid (UDCA) administration to reduce gallstone formation after diet-induced weight reduction is recommended by some authors. In a recent study performed with the aim to determine the incidence of cholelithiasis after LSG and whether UDCA treatment reduces gallstone formation, among 280 patients eligible for evaluation, 64 of 280 (23%) patients developed cholelithiasis after LSG and cholecystectomy was performed in 24 patients (8.6%). A 4-fold decrease in the rate of new gallstone formation (with 500 mg daily) UDCA treatment was reported.[24] A prospective randomized controlled study conducted to evaluate gallstone incidence after prophylactic administration of UDCA in patients undergoing one anastomosis gastric bypass (OAGB) reported that a regular post-operative UDCA intake during the first 6 months seems to significantly reduce cholelithiasis incidence after OAGB, with no case of intolerance reported.[25] We did not used prophylactic UDCA and newly developed gallstones were established in six of our patients 6 months after LSG.

Our study includes some limitations associated with its retrospective design like including relative small sample size, being prone to selection bias, and being subject to confounding due to some other possible risk factors which may be present but not measured.

Conclusion

In our study, the improvements in inflammatory markers in addition to glucose and lipid profiles have been showed with a positive correlation parallel to the change in BMI. We found that NLR decreased significantly and no significant change was observed in PLR 6 months after LSG. More studies are needed to understand the potential role of NLR and PLR ratios in the pathophysiology after obesity surgery and related complications.

Disclosures

Ethichs Committee Approval: The Ethics Committee of Altınbas University Faculty of Medicine, 31.03.2021, 2021/58.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – H.A., B.E.; Design – H.A., B.E.; Supervision – H.A., B.E.; Materials – H.A., B.E.; Data collection and/or processing – H.A., B.E., A.I.; Analysis and/ or interpretation – H.A., B.E.; Literature search – B.E., H.A., A.I.; Writing – B.E., H.A.; Critical review – H.A., B.E.

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