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Trabajo Original

Obesidad y síndrome metabólico

Evaluation of the nutritional status of morbid obesity patients in the first six months after sleeve gastrectomy

Evaluación del estado nutricional de pacientes con obesidad mórbida en los primeros seis meses después de una gastrectomía en manga

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Abstract

Objective: in recent years, bariatric surgery has gained popularity as a treatment for obesity worldwide. While patients do experience weight loss after surgery, it is important to be aware that serious nutritional deficiencies may also occur. This study was conducted to evaluate the nutritional status of morbidly obese patients in the first six months after sleeve gastrectomy.

Methods: the study was planned as a retrospective study. The data of 76 patients aged 19-64 years who had undergone bariatric surgery and were followed by a dietitian for at least 6 months were included in the study. Preoperative and postoperative biochemical parameters and anthropometric measurements of the patients were taken.

Results: the lowest body weight of the patients was found at postoperative month 6 (81.74 ± 14.83 kg), the body weight at the preoperative period (115.86 ± 21.28 kg) and postoperative month 1 (100.39 ± 18.28 kg), and the body weight at postoperative month 1 was statistically lower than at the preoperative period. The preoperative body weights and BMI values of the patients were higher than at postoperative months 1 and 6, and the postoperative month 1 values were higher than at postoperative month 6 ($p < 0.05$). The lowest fasting blood glucose (83.48 ± 8.44 mg/dL), HbA1c (4.96 ± 0.95 %), and Homa-IR (3.34 ± 0.92) were observed at the postoperative month 6. Compared with the preoperative period, the iron level of the patients increased from 69.54 ± 29.82 µg/dL to 96.52 ± 25.39 µg/dL in postoperative month 6, vitamin D levels from 14.48 ± 8.70 µg/dL to 23.96 ± 4.79 µg/dL. While preoperative blood triglyceride and LDL values were statistically higher than in postoperative months 1 and 6, the HDL value was lower ($p < 0.05$).

Conclusion: as a result, after sleeve gastrectomy, patient body weight decreased, and blood lipid profile and diabetes symptoms improved.

Keywords:

Gastrectomy. Bariatric surgery. Nutritional status.

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Resumen

Objetivo: en los últimos años, la cirugía bariátrica ha ganado popularidad como tratamiento de la obesidad en todo el mundo. Si bien los pacientes experimentan pérdida de peso después de la cirugía, es importante tener en cuenta que también pueden producirse deficiencias nutricionales graves. Este estudio se realizó para evaluar el estado nutricional de pacientes con obesidad mórbida en los primeros seis meses después de la gastrectomía en manga.

Métodos: el estudio se planificó como un estudio retrospectivo. Se incluyeron en el estudio los datos de 76 pacientes de entre 19 y 64 años sometidos a cirugía bariátrica y seguidos por un dietista durante al menos 6 meses. Se recogieron los parámetros bioquímicos y las medidas antropométricas preoperatorias y postoperatorias de los pacientes.

Resultados: el peso corporal más bajo de los pacientes se encontró en el mes 6 postoperatorio (81,74 ± 14,83 kg), el peso corporal en el período preoperatorio (115,86 ± 21,28 kg) y el mes 1 postoperatorio (100,39 ± 18,28 kg), y el peso corporal en el mes 1 postoperatorio fue estadísticamente menor que en el período preoperatorio. Los pesos corporales preoperatorios y los valores de IMC de los pacientes fueron superiores a los de los meses 1 y 6 del postoperatorio, y los valores del mes 1 del postoperatorio fueron superiores a los del mes 6 del postoperatorio ($p < 0,05$). Los valores más bajos de glucosa en sangre en ayunas (83,48 ± 8,44 mg/dL), HbA1c (4,96 ± 0,95 %) y Homa-IR (3,34 ± 0,92) se observaron en el mes postoperatorio 6. En comparación con el período preoperatorio, el nivel de hierro de los pacientes aumentó de 69,54 ± 29,82 µg/dL a 96,52 ± 25,39 µg/dL en el mes postoperatorio 6 y los niveles de vitamina D de 14,48 ± 8,70 µg/dL a 23,96 ± 4,79 µg/dL. Aunque los valores preoperatorios de triglicéridos en sangre y LDL fueron estadísticamente mayores que en los meses 1 y 6 postoperatorios, el valor de HDL fue menor ($p < 0,05$).

Conclusión: como resultado, después de la gastrectomía en manga, el peso corporal de los pacientes disminuyó, el perfil de lípidos en sangre y los síntomas de la diabetes mejoraron.

Palabras clave:

Gastrectomía. Cirugía bariátrica. Estado nutricional.

INTRODUCTION

The prevalence of obesity, characterized by excessive fat accumulation in the body, is increasing worldwide. Obesity is an important risk factor for many diseases such as diabetes, cardiovascular diseases, cancer, metabolic syndrome, and psychological disorders (1). The main treatment for obesity is diet and lifestyle changes. Pharmacotherapy is used in patients who cannot lose bodyweight with these two methods. The bariatric surgery (BC) method is discussed in patients who do not experience a higher rate of body weight loss and permanent body weight loss (2).

Recently, bariatric surgery has become popular in the treatment of obesity worldwide and in our country. The fact that patients experienced faster body weight loss and improvements in comorbid diseases with this method compared to other treatment methods led to an increase in the number of patients choosing this method (3). It has been reported that the morbidity associated with bariatric surgery is less than 1 % when performed by an experienced center (2). However, bariatric surgery is not applied to every patient, and this method may be preferred if the patient has some indications (1). Primarily, it is deemed suitable to follow up the patient who is decided to have bariatric surgery by the endocrinology unit for at least six months. In addition, for bariatric surgery to be performed, the patient must have: a) body mass index (BMI) ≥ 40 kg/m^2 or b) BMI ≥ 35 kg/m^2 and at least one comorbidity such as obesity-related hypertension, dyslipidemia, type-2 diabetes *mellitus,* or sleep apnea (2).

Bariatric surgery includes surgical techniques that ensure body weight loss by reducing stomach volume, shortening and/or bypassing the intestinal segment, or using both methods. Sleeve gastrectomy (SG), adjustable gastric band (AGB), gastric bypass, and biliopancreatic diversion with duodenal switch (BPD-DS) are the most commonly applied bariatric surgical methods (2).

Sleeve gastrectomy is a volume-limiting method and a procedure in which the greater curvature of the stomach is removed. In this method, the stomach is reduced, and appetite also decreases due to a decrease in the level of some orexigenic hormones (2). Besides, significant body weight loss, ease of surgical technique, and maintaining the integrity of the pyloric sphincter are among the advantages of this method (4). In this method, the risk of malnutrition is low, and dumping syndrome does not occur. However, leaks in the stapler line, being an irreversible method, and limited long-term (5-10 years) data are among the disadvantages of this method (2).

Despite the postoperative improvement in the health status of the patients, serious nutritional deficiencies may occur in these patients. Especially insufficient energy intake, reduced stomach volume, nausea, vomiting, sudden weight loss, and irregular use of dietary supplements lead to nutritional deficiency in patients (5). Some studies have reported that calcium, iron, vitamin B12, folate, and vitamin D deficiencies can be seen in these patients due to nutritional deficiencies (6,7). Considering the gender, age, dietary habits, physical activity levels, psychology, and physiological conditions of the patients before and after the surgery, providing adequate and balanced nutrition is among the basic principles of the diet (8). After bariatric surgery, anthropometric measurements (body weight, height, etc.) and biochemical parameters should be followed regularly in order to evaluate the nutritional status of the patient (5). For this reason, this study was conducted to evaluate the nutritional status of morbidly obese patients in the first six months after sleeve gastrectomy.

MATERIALS AND METHODS

RESEARCH PLAN

Data from 75 patients aged 19-64 years who applied to the General Surgery Obesity and Metabolic Surgery clinic and were followed up for six months were included. The study includes no intervention, and only the patient data were collected from the hospital computer. The data were collected between February 2022 and December 2022. The research was planned as

a retrospective study. This study is an observational study. The study was approved by Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee. The study started with a total of 87 patients, but 12 patients who did not attend regular doctor and dietitian check-ups were excluded.

The surgical technique to be performed was determined based on the results of preoperative examinations, assessments, and interviews from the anesthesia and endocrine departments, the patient's biomedical measurements (BMI, fat percentage, internal fat percentage), and the patient's informed consent.

Inclusion criteria for the study included: a) data of patients aged 19-64 years; b) data of patients with BMI ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 and at least one comorbidity such as obesity-related hypertension, dyslipidemia, type 2 diabetes *mellitus,* and sleep apnea (2); c) data of patients who underwent sleeve gastrectomy; d) volunteering.

Exclusion criteria in the study were: a) data of patients who were not deemed suitable for surgery by the physician and to whom a surgical technique different from sleeve gastrectomy was applied; b) data of patients who were not followed up by a dietitian for six months after surgery; c) data of patients with gastrointestinal inflammatory bowel disease; d) data of patients with psychiatric disorders diagnosed by a physician; e) data of patients with cancer, pregnant and lactating women, alcohol or drug addiction.

ANTHROPOMETRIC MEASUREMENTS

Bodyweight (kg) and body composition (body fat mass (kg), lean body mass (kg), bone mass (kg), body fat ratio (%), body water ratio (%), and abdominal adiposity coefficient) measurements of the patients were taken with a Tanita MC 780 body analyzer.

The body mass index of the patients was calculated by dividing their body weight by the square of their height (body weight / height [kg/m^2]) (9,10). The WHO classification was used in the evaluation, and those with BMI < 18.5 kg/m^2 were considered underweight, those with BMI at 18.5-24.99 kg/m^2 were considered normal, those with BMI at 25.0-29.99 kg/m^2 were considered slightly overweight, and those with BMI ≥ 30 kg/m^2 were considered obese (11).

BIOCHEMICAL PARAMETERS

Preoperative and postoperative (months 1 and 6) fasting blood glucose, HbA1C, insulin, creatinine, GFR, ALT, AST, iron, calcium, vitamin B12, 25-OH-vitamin D, HDL, LDL, and triglyceride values were collected from the hospital system. This values were collected during the week before surgery.

NUTRITION PLAN

The data of patients treated with a nutrition plan following the nutritional principles of the American Society for Metabolic and Bariatric Surgery (ASMBS) by a dietitian were included in the study (12). Patients were given vitamin and mineral supplements in accordance with the recommendations of this guideline after bariatric surgery.

STATISTICAL ANALYSIS

The statistical analyses were performed using the SPSS (IBM SPSS Statistics 24) software suite. Independent-sample t-test (t-table value) statistics were used to compare the measured values of two independent groups regarding the data with a normal distribution. The Mann-Whitney U-test (Z-table value) statistics were used to compare the measurement values of two independent groups regarding the data that did not have a normal distribution. Pearson's χ^2 test statistics were used according to the expected value levels in examining the relations between two qualitative variables.

RESULTS

The data of 76 individuals, 50 women and 26 men, were included in the study. Women were 32.38 ± 8.55 years old and men were 39.19 ± 11.90 years old, with a mean age of 34.71 ± 10.27 years. Age, height, body weight, and lean mass values of men are significantly higher than women. Fat mass values of women are significantly higher than men (Table I).

Table I. Preoperative age, height, and bodyweight of patients by gender

	Women (n = 50)	Men (n = 26)	Total (n = 76)	*p*
	$\bar{X}$ ± S.S.	$\bar{X}$ ± S.S.	$\bar{X}$ ± S.S.	
Age (year)	32.38 ± 8.55	39.19 ± 11.90	34.71 ± 10.27	$p = 0.01$
Height (cm)	163.56 ± 6.18	176.89 ± 8.42	168.11 ± 9.43	$p = 0.00$
Bodyweight (kg)	108.88 ± 17.57	129.29 ± 21.65	115.86 ± 21.28	$p = 0.00$
Body fat mass (kg)	45.33 ± 5.77	37.35 ± 5.62	42.60 ± 6.85	$p = 0.00$
Lean body mass (kg)	54.74 ± 10.24	76.02 ± 10.21	62.02 ± 14.37	$p = 0.00$

While 57 (75 %) of individuals did not have food addiction, 19 (25 %) had it (Table II and Fig. 1).

The preoperative body weights of women and men were significantly higher than the values obbtained at months 1 and 6 postoperatively. The body weights of the participants at month 1 postoperatively were significantly higher than the values at month 6 in the postoperative period.

The preoperative BMI values of women and men were significantly higher than the values at months 1 and 6 postoperatively. BMI values at postoperative month 1 were significantly higher than those at postoperative month 6 (Table III).

While the difference in body weight of men before surgery and at both the 1st and 6th months after surgery is greater than that of women, there is no statistically significant difference in BMI (Table IV).

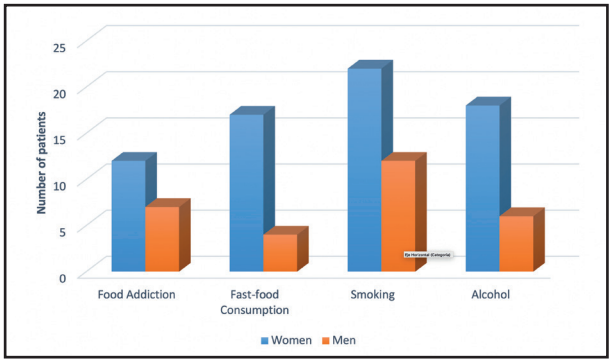

Figure 1.

Preoperative chronic disease, alcohol, smoking, and eating habits of the sleeve gastrectomy patients.

Table II. Preoperative alcohol, smoking, and eating habits of the sleeve gastrectomy patients

	Women (n = 50)		Men (n = 26)		Total (n = 76)		*p*
	n	%	*n*	%	*n*	%	
Food addiction							
Yes	12	24.0	7	26.9	19	25.0	$p = 0.78$
No	38	76.0	19	73.1	57	75.0	
Fast-food consumption							
Yes	17	34.0	4	15.4	21	27.6	$p = 0.09$
No	33	66.0	22	84.6	55	72.4	
Smoking							
Yes	22	44.0	12	46.2	34	44.7	$p = 0.86$
No	28	56.0	14	53.8	42	55.3	
Alcohol							
Yes	18	36.0	6	23.1	24	31.6	$p = 0.25$
No	32	64.0	20	76.9	52	68.4	

Table III. Changes in body mass index and body weight of patients before and after surgery

	Pre-op(1)			Post-op 1 month(2)			Post-op 6 month(3)			p (Women)	*p* (Men)	*p* (Total)
	Women (n = 50)	Men [n = 26]	Total (n = 76)	Women (n = 50)	Men [n = 26]	Total (n = 76)	Women (n = 50)	Men [n = 26]	Total (n = 76)			
	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.	$\bar{X} \pm$ S.S.			
Weight kg	108.88 ± 17.57	129.29 ± 21.65	115.86 ± 21.28	94.76 ± 15.69	111.20 ± 18.29	100.39 ± 18.28	77.34 ± 13.55	90.18 ± 13.65	81.74 ± 14.83	$p = 0.00$	$p = 0.00$	$p = 0.00$
	$p = 0.00$			$p = 0.00$			$p = 0.00$			[1-2,3] [2-3]	[1-2,3] [2-3]	[1-2,3] [2-3]
BMI kg/m^2	40.75 ± 6.46	41.14 ± 4.97	40.88 ± 5.96	35.47 ± 5.77	35.41 ± 4.23	35.45 ± 5.26	28.96 ± 5.08	28.71 ± 2.94	28.87 ± 4.44	$p = 0.00$	$p = 0.00$	$p = 0.00$
	$p = 0.56$			$p = 0.87$			$p = 0.53$			[1-2,3] [2-3]	[1-2,3] [2-3]	[1-2,3] [2-3]

BMI: body mass index.

Table IV. The difference and percentage of body weight and BMI loss of the patients between preoperative and post-operative 1st and 6th month

	1 mo-preop difference		*p*	6 mo-preop difference		*p*
	Women $\bar{X} \pm$ S.S.	Men $\bar{X} \pm$ S.S.		Women $\bar{X} \pm$ S.S.	Men $\bar{X} \pm$ S.S.	
Weight kg	-14.1 ± 4.60	-18.1 ± 6.41	*0.00*	-31.5 ± 6.94	-39.1 ± 11.08	*0.00*
BMI kg/m^2	-5.3 ± 1.76	-5.7 ± 1.91	0.41	-11.8 ± 2.56	-12.4 ± 3.21	0.66
% Weight and BMI loss	-12.9 ± 4.12	-13.8 ± 4.19	0.72	-28.9 ± 4.85	-29.8 ± 5.26	0.61

BMI: body mass index.

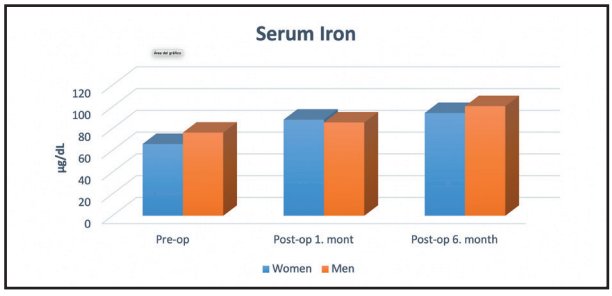

Figure 2.

Pre-and postoperative serum iron levels of patients.

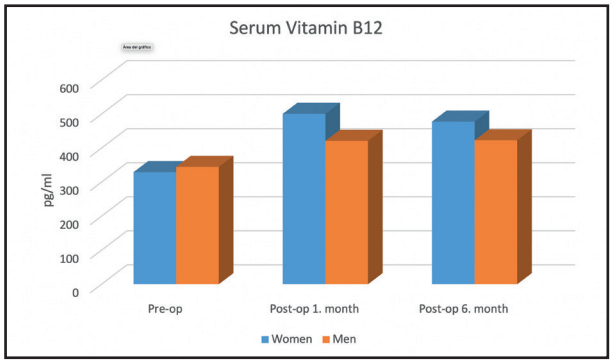

Figure 3.

Pre-and postoperative serum vitamin B12 levels of patients.

Glucose level (83.48 ± 8.44 [mg/dL]) at month 6 postoperatively was found to be statistically lower compared to month 1 postoperatively (88.48 ± 10.16 [mg/dL]) and the preoperative (107.29 ± 13.89 [mg/dL]) period. Preoperative HbA1c, creatinine, AST and ALT values were higher than the values obtained at months 1 and 6 postoperatively. In addition, glucose and HbA1c values in month 1 in the postoperative period were found to be higher than at postoperative month 6. Preoperative GFR and insulin values were significantly lower than at months 1 and 6 postsurgery ($p < 0.05$) (Table V).

The highest Homa-IR value was detected in the preoperative period. Vitamin D and HDL values were significantly lower than the values seen at months 1 and 6 postoperatively (Table V). Furthermore, LDL and triglyceride values were at their highest level in the preoperative period ($p < 0.05$) (Table V).

Preoperative iron concentration was found to be lower than at month 1 postsurgery and month 6 postsurgery. In addition, iron levels at month 1 of the postoperative period was found significantly lower than at month 6 postoperatively (Fig. 2). Preoperative B12 was significantly lower than at months 1 and 6 in the postoperative period (Fig. 3). There was no statistically significant difference between the pre- and post-operative periods in serum vitamin B12 and serum iron levels both of men and women (Figs. 2 and 3).

DISCUSSION

After 2014, sleeve gastrectomy, one of the bariatric surgery methods, started to gain popularity. The reason for this is that this method provides an improvement in comorbid diseases accompanying obesity as well as body weight loss. Therefore, this study was conducted to evaluate the nutritional status of morbidly obese patients in the first six months after sleeve gastrectomy (13).

In patients with morbid obesity, bariatric surgery is an effective method in providing long-term and permanent body weight loss (14,15). In a study, patients who had bariatric surgery were found to have lower body weight, BMI, lean body mass, and body fat mass in months 1, 3, and 6 compared to the preoperative period (5). In numerous studies on sleeve gastrectomy, postoperative body weight and BMI values were found to be lower than in the preoperative period (16-18). Similarly, in this study, the body weight and BMI values of the patients on months 1 and 6 postoperative were found to be lower than in the postoperative period. The preoperative BMI value decreased from 40.88 ± 5.96 kg/m^2 to 28.87 ± 4.44 kg/m^2 at the end of 6 months.

Since the plasma lipid profile improves after bariatric surgery, a decrease is observed in the morbidity and mortality of cardiovascular diseases (19). In some studies conducted on patients with sleeve gastrectomy, it was found that triglyceride, LDL, and total cholesterol decreased and HDL increased after surgery (20-23). In this study, similar to the literature, the lowest LDL value (98.38 ± 14.07 mg/dL) and triglyceride value (89.31 ± 18.23 mg/dL), as well as the highest HDL value (50.89 ± 4.97 mg/dL), were observed in month 6 postoperative.

Table V. Comparison of preoperative and postoperative biochemical parameters

Biochemical parameters	Pre-op(1)	Post-op 1 month(2)	Post-op 6 month(3)	*p*
	$\bar{X}$ ± S.S.	$\bar{X}$ ± S.S.	$\bar{X}$ ± S.S.	
Glucose (mg/dL)	107.29 ± 13.89	88.48 ± 10.16	83.48 ± 8.44	*p = 0.00 [1-2,3][2-3]*
HbA1c (%)	17.32 ± 7.80	5.97 ± 5.51	4.96 ± 0.54	*p = 0.00 [1-2,3][2-3]*
Insulin (µU/ml)	5.69 ± 1.26	11.14 ± 2.03	6.78 ± 2.23	*p = 0.00 [1-2,3][2-3]*
Creatinine (mg/dL)	110.79 ± 18.53	1.67 ± 7.71	0.92 ± 1.35	*p = 0.00 [1-2,3]*
GFR (mL/dak/1.73 m^2)	0.72 ± 0.22	105.63 ± 9.44	107.72 ± 15.59	*p = 0.00 [1-2,3]*
AST (U/L)	20.31 ± 7.77	17.28 ± 2.59	15.25 ± 3.18	*p = 0.00 [1,2-3]*
ALT (U/L)	26.44 ± 13.44	17.63 ± 3.81	15.43 ± 2.92	*p = 0.00 [1,2-3]*
Calcium (mg/dL)	9.11 ± 0.68	7.83 ± 2.15	9.94 ± 10.49	*p = 0.00 [1-2]*
HOMA-IR	9.83 ± 40.31	3.35 ± 0.39	3.34 ± 0.92	*p = 0.00 [1-2,3]*
Vitamin D (µg/dL)	14.48 ± 8.70	16.06 ± 4.87	23.96 ± 4.79	*p = 0.00 [1,2-3]*
LDL (mg/dL)	135.09 ± 27.70	112.89 ± 17.57	98.38 ± 14.07	*p = 0.00 [1-2,3][2-3]*
HDL (mg/dL)	46.55 ± 9.26	49.99 ± 3.65	50.89 ± 4.97	*p = 0.00 [1-2,3]*
Tg (mg/dL)	132.34 ± 49.89	105.93 ± 20.47	89.31 ± 18.23	*p = 0.00 [1-2,3][2-3]*

AST: aspartate aminotransferase; GFR: glomerular filtration rate; CRP: C-reactive protein; ALT: alanine aminotransferase; HOMA-IR: Homeostatic Model Assesment Insulin Resistant; HDL-C: high density lipoprotein; LDL-C: low density lipoprotein; Tg: triglicerides.

In morbidly obese patients with type 2 diabetes, blood glucose and insulin levels improve after bariatric surgery (24). Two years after bariatric surgery, 38.1 % of obese patients with type 2 diabetes resolved their diabetes, and 10 % had a decrease in their symptoms. In the study, fasting blood glucose has changed from 172.6 ± 63.5 mg/dL to 132.4 ± 5.7 mg/dL, HbA1c value from 7.7 % to 6.5 %, and HOMA-IR value decreased from 4.6 to 3.2 (25). In another study, the postoperative insulin and HbA1C values were found to be lower than in the preoperative period (15). In the study conducted by Zhang et al. (17), fasting and postprandial glucose values after surgery (1st year) were found to be lower than in the preoperative period. In addition, the HbA1c value decreased from 5.9 % to 5.4 %. In this study, when the preoperative period and postoperative month 6 were compared, the fasting glucose value decreased from 107.3 ± 13.8 mg/dL to 83.1 ± 8.44 mg/dL, HbA1c value decreased from 17.5 % to 4.9 %, and the HOMA-IR value decreased from 4.6 to 3.1. In addition, the highest insulin value in the study was observed in the postoperative month 1. It is thought that the patients' liquid and puree diet during the first month, their fruit juice and protein powder intake during this period, the lack of sufficient water consumption, and the lack of physical activity caused an increase in insulin levels in the first month. Also, this shows that the bariatric surgery method provides an improvement in the diabetic symptoms of the patients.

After bariatric surgery, macro and micronutrient deficiencies, especially iron, are observed in patients (26). In one study, preoperative iron and ferritin levels were lower than in the postoper-

ative period, while iron-binding capacity was found to be higher (15). In another study, the plasma iron level of individuals who had a sleeve gastrectomy increased continuously in the postoperative 12-month period (27). In this study, similarly, iron levels on months 3 and 6 postoperative were found to be higher than in the preoperative period. It is thought that the reason iron and ferritin levels were higher in the postoperative period compared to the perioperative period is due to the regular administration of mineral supplements to the patients in this study.

In the bariatric surgery method, a decrease in the absorption of food-induced B12 may occur (28). In the study of Barzin et al. (27), vitamin B12 level was found to be significantly higher in the postoperative period (12th month) than in the preoperative period. In this study, the lowest B12 level was observed in the preoperative period. Regular B12 supplementation to patients undergoing bariatric surgery resulted in an increase in the level of the vitamin.

In the literature, it has been shown that bone density decreases in patients after bariatric surgery and that these patients may have osteoporosis risk (15). The reason for this may be a decrease in body weight and/or nutrient absorption (29). Therefore, it is very important to control the levels of micronutrients such as vitamin D and calcium in postoperative patients (5). In the study conducted by Batar and Alphan (5), vitamin D and calcium levels were found to be higher in the postoperative period than in the preoperative period. In another study, an increase in serum vitamin D levels was observed in the first 6 months after bariatric surgery. Serum calcium value was found to be higher in months 1, 3, and 6 compared to the preoperative period. The lowest serum PTH value was observed in month 6 (17). In this study, the highest level of vitamin D was detected in month 6 postoperative (23.96 ± 4.79 µg/dL) and the lowest in the preoperative period (14.48 ± 8.70 µg/dL). In the study, the lowest calcium value was found in postoperative month 1. It is thought that the reason why the lowest calcium value is observed in month 1 is due to the fact that the patients do not use calcium sources and supplements sufficiently due to the postoperative stress.

Bariatric surgery in morbidly obese patients results in long-term weight loss and improvement in liver function tests. In the study conducted by Aksoy et al. (16) on patients who had sleeve gastrectomy, AST and ALT values were found to be lower in the postoperative period (12th month) than in the preoperative period. In another study, the ALT value of the patients before sleeve gastrectomy decreased from 27.8 ± 19.9 U/L to 25.8 ± 12.4 U/L at the end of 6 months, while the AST value decreased from 23.7 ± 12.8 U/L to 24.7 ± 7.8 U/L. In this study, similar to the literature, AST and ALT values on month 6 postoperative were found to be lower than in month 1 postoperative and the preoperative period.

The strengths of this study include detailed data collection, long-term follow-up and multifaceted analysis. Preoperative and postoperative biochemical parameters and anthropometric measurements were examined during the six-month follow-up period. However, because the study was conducted in a single center and only 76 patients were included This study contributes to the literature on the long-term nutritional status of morbid obesity patients after sleeve gastrectomy.

In this study, the body weight and BMI values of the patients decreased after bariatric surgery. There was also improvement in patients' diabetic symptoms and lipid profiles. Macro and micronutrient deficiencies can be seen in patients after bariatric surgery. Therefore, nutritional supplements should be recommended to patients under the supervision of a doctor. The treatment of these patients should be carried out by a multidisciplinary team including a dietitian, doctor, psychologist, physiotherapist, and nurse, and the patients should be checked at regular intervals.

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