



Metabolic Effectiveness of Laparoscopic Sleeve Gastrectomy in Morbid Obesity Treatment: Early and Mid-Term Results of a Single Center

Mehmet Ali Kırşan¹, Mehmet Tolga Kafadar², Abdullah Oğuz²

1 Viranşehir State Hospital Clinic of General Surgery, Şanlıurfa, Turkey

2 Dicle University School of Medicine Department of General Surgery, Diyarbakır, Turkey

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Abstract

Objective: The aim of this study is to reveal the efficacy of laparoscopic sleeve gastrectomy (LSG) in the preventable metabolic consequences of morbid obesity. We evaluated the weight loss according to body mass index (BMI), changes in comorbid diseases accompanying obesity in patients who underwent surgery in our clinic in the early and mid-period postoperatively, whether there was vitamin deficiency in the mid-term, and the complications associated with the surgery.

Methods: In this study, a total of 50 patients aged 18-60 who underwent LSG intervention due to morbid obesity between January 1, 2010 and December 2019 by Dicle University School of Medicine, General Surgery Clinic, were retrospectively evaluated. Sociodemographic data of the patients, preoperative BMI, postoperative 3th month, 6th month and 1st year BMI values, preoperative and postoperative 12th month HgA1c levels were measured. Mortality and complication rates were evaluated.

Results: The mean BMI of 50 patients at pre-LSG, postoperative 3rd month, 6th month and 1st year controls were respectively; 45.83±6.37, 37.63±5.88, 31.91±5.10 and 26.82±3.08kg/m². Compared to before the intervention, the decrease in BMI was significant at the 3rd month, 6th month and 1st year controls ($p < 0.05$). When paired comparisons were made, the BMI at the 1st year control was lower than the 6th and 3rd month ($p < 0.05$). It was found that the preoperative HbA1c level of 6.55±1.37 decreased to 5.32±0.57 in the postoperative 12th month ($p < 0.05$). Complication rate was determined as 2%. No mortality was observed during the follow-up.

Conclusion: As a result of this study, it has been shown that LSG provides sufficient weight loss. In addition, LSG was found to be effective in achieving glycemic control and remission in Type 2 diabetes. In this study where mortality was not observed, LSG, which is a reliable method with acceptable operation time and postoperative complication rates, seems to be an effective solution in the surgical treatment of obesity. However, there is a need for more comprehensive randomized studies evaluating the long-term results of LSG.

Keywords: Complication; Diabetes; Laparoscopic Sleeve Gastrectomy; Morbid Obesity

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Correspondence / Yazışma Adresi: Mehmet Tolga Kafadar, Dicle University School of Medicine Department of General Surgery, Diyarbakır, Turkey e-mail: drtolgakafadar@hotmail.com

Morbid Obezite Tedavisinde Laparoskopik Sleeve Gastrektominin Metabolik Etkinliği: Tek Merkezin Erken ve Orta Dönem Sonuçları

Öz

Amaç: Bu çalışmanın amacı morbid obezitenin önlenebilir metabolik sonuçlarında yapılan laparoskopik sleeve gastrektominin (LSG) etkinliğini ortaya koymaktır. Kliniğimizde ameliyat olan hastaların ameliyat sonrası erken ve orta dönemde vücut kitle indeksine (VKİ) göre kilo kayıplarını, obeziteye eşlik eden komorbid hastalıklardaki değişimlerini, orta dönemde vitamin eksikliğinin olup olmadığını ve ameliyatla ilişkili komplikasyonları değerlendirdik.

Yöntemler: Bu çalışmada Dicle Üniversitesi Tıp Fakültesi Genel Cerrahi Kliniği tarafından 1 Ocak 2010- Aralık 2019 tarihleri arasında, morbid obezite nedeniyle LSG girişimi uygulanan 18-60 yaş arası toplam 50 hasta retrospektif olarak değerlendirildi. Hastaların sosyodemografik verileri ile preoperatif VKİ, postoperatif VKİ, 3.ay, 6.ay ve 1.yıl VKİ değerleri, preoperatif ve postoperatif 12.ay HgA1c düzeylerine bakıldı. Mortalite ve komplikasyon oranları değerlendirildi.

Bulgular: Elli hastanın LSG öncesi, operasyon sonrası 3.ay, 6.ay ve 1.yıl kontrollerindeki ortalama VKİ sırasıyla; 45.83±6.37, 37.63±5.88, 31.91±5.10 ve 26.82±3.08kg/m² olarak bulundu. Girişim öncesine göre, 3.ay, 6.ay ve 1.yıl kontrollerinde VKİ'ndeki düşüş anlamlı idi (p<0.05). İkili karşılaştırmalar yapıldığında, 1. yıl kontrolündeki VKİ 6.aya ve 3.aya göre daha azdı (p<0.05). Preoperatif HbA1c 6.55± 1.37 düzeyinin postoperatif 12.ayda 5.32±0.57'ye gerilediği tespit edildi (p<0.05). Komplikasyon oranı %2 olarak tespit edildi. Takip süresince mortalite izlenmedi.

Sonuç: Bu çalışmanın sonucunda LSG'nin yeterli düzeyde kilo kaybı sağladığı gösterildi. Ayrıca LSG'nin glisemik kontrol ve Tip 2 diyabette remisyon sağlamada da etkili olduğu saptandı. Mortalitenin gözlenmediği bu çalışmada, kabul edilebilir operasyon süresi ve postoperatif komplikasyon oranları ile güvenilir bir yöntem olan LSG, obezitenin cerrahi tedavisinde etkili bir çözüm gibi görünmektedir. Bununla birlikte LSG'nin uzun dönem sonuçlarının değerlendirildiği daha kapsamlı randomize çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Komplikasyon; Diyabet; Laparoskopik Sleeve Gastrektomi; Morbid Obezite.

INTRODUCTION

According to World Health Organisation (WHO), obesity, one of the most important public health problems in the world with ever-increasing prevalence, is the abnormal or excessive fat tissue accumulation that poses health risks. Obesity is a chronic disease, and genetic, metabolic, endocrine, psychological, behavioural and socio-cultural factors play a role in its emergence. Obesity is a risk factor for main reasons of preventable deaths, including cardiovascular diseases, diabetes mellitus and many cancer types. Therefore, successful treatment and control of obesity is very crucial¹. Permanent treatment of morbid obesity with diet, medicine and psycho-social therapies is almost impossible, and in addition, each unsuccessful experience with the treatment leads to deterioration in individual's psychological state, and results in regaining more weight and further deterioration of metabolism².

Bariatric surgery is the most effective treatment method for patients with morbid obesity^{3,4}. Sleeve gastrectomy is a restrictive bariatric surgery technique, and is one of the most widely used morbid obesity surgery methods across the world. Effectiveness of this method is related to different pathophysiologic mechanisms, like activation of hormonal mechanisms [e.g., increase in Glucagon-Like Peptide 1 (GLP-1) level and decrease in ghrelin level], since it causes fast gastric evacuation and intestinal passage, bile acids and changes in intestinal microflora⁵. GLP-1 is an incretin hormone released by L-cells of distal intestines as a reply to eating. It has positive effects on body weight and glucose metabolism by increasing insulin secretion and inhibiting glucagon secretion and hepatic glucose production⁶. Ghrelin is a neuropeptide with orexigenic effect, which is synthesised by oxyntic cells of gastric fundus⁷. Ghrelin level under physiologic conditions increases during fasting by reaching its peak in preprandial

period, and is suppressed by eating. Ghrelin also has diabetogenic effects such as suppressing insulin secretion⁸.

The objective of this study is to evaluate weight loss levels, changes in co-morbid diseases accompanying obesity and surgery-related complications of patients, who are treated with laparoscopic sleeve gastrectomy due to morbid obesity, in early and medium term after operation.

METHODS

Study Design

This study contains retrospective evaluation of patients who applied to Dicle University School of Medicine Department of General Surgery due to morbid obesity between 1 January 2010 and December 2019 and received laparoscopic sleeve gastrectomy. Approval was obtained from the Clinical Research Ethics Committee of Dicle University (No: 05.03.2020-078), under the Helsinki declaration protocol, for patients whose clinical and laboratory data will be used. The inclusion criteria consist of; 1) Patients between the ages of 18 and 60, who have undergone laparoscopic sleeve gastrectomy, and 2) Patients whose clinical information and complaints are recorded when they have applied, whose pre-operation BMI and postoperative 3rd month, 6th month and 1st year BMI have been examined, and whose follow-up period has ended. 3) Patients with laboratory values.

Patients with BMI >40 or BMI >35 + co-morbidities, patients aged 18 and over who do not have a psychiatric eating disorder, who do not have an endocrinological disease that may cause obesity, who can handle general anesthesia, and who cannot lose weight despite diet and medical treatment before this surgical procedure were included. Patients under the age of 18 and patients with psychiatric disorders were excluded from the study. Glucose, HbA1c,

Folate, Ferritin, Vit D, Vit B12 values were measured in the patients included in the study.

Surgical Technique

A total of 5 trocars, including optics, were used under general anesthesia in patients. Stomach, omentum and spleen were dissected from 6 cm proximal to the pylorus along the greater curvature to the angle of his. A 32 F orogastric tube was inserted into the stomach. Resection was performed using 2 green antrum and 4 or 5 blue stapler cartridges in the remaining stomach part. Clips were applied to the hemorrhages in the stapler line. The specimen was taken out of the 15-degree trocar site. After the leak test with methylene blue, it was aspirated and orogastric was drawn. A foley drain was placed in the lodge. The trocar sites were closed and the operation was terminated. The patients were followed up in the intensive care unit. The patients were mobilized at the 8th hour. Fluid regimen was started on the 4th postoperative day. After the drain was removed, the patients who were clinically comfortable were discharged.

Data collection

The main clinical characteristics, such as age, gender, BMI, serum HgA1c levels were extracted in retrospective medical records. In order to evaluate laparoscopic sleeve gastrectomy's impact on blood sugar regulation, HgA1c's pre-operative and post-operative one-year parameters were examined. Associated diseases accompanying morbid obesity and post-operative recovery status were analysed. Results of endoscopy in patients before obesity surgery were examined, and existing stomach disorders were assessed.

Statistical Analysis

Analysis of data obtained in this study was conducted by using statistical software package SPSS 17 (Statistical Package for the Social Sciences-IBM®). Descriptive statistics were

given as figures and percentages for categorical variables. It was evaluated whether data for numeric variables is normally distributed, and it was presented as average \pm standard deviation or median (minimum-maximum). Data distribution was evaluated through Kolmogorov-Smirnov and Shapiro-Wilk tests. Statistical significance level was accepted as $p < 0.05$. T test was used while evaluating data, and ANOVA test was used for recurrent measurements. $p < 0.05$ value was considered statistically significant.

RESULTS

In this study, a total of 50 patients, who applied to Dicle University School of Medicine Department of General Surgery due to morbid obesity between 1 January 2010 and 31 December 2019 and received laparoscopic sleeve gastrectomy, was retrospectively evaluated. 12 patients (24%) are male patients while 38 of them (76%) are female patients. While average age of female patients is 35.50 ± 10.45 (min.-max.: 20-60), average age of male patients is 38.00 ± 10.28 (min.-max.: 18-51). It is determined that average age of all patients is 36.00 ± 10.31 (min.-max. 18-60). It is observed that 30 patients (60%) smoke and drink alcohol. It is detected that 14 of them (28%) has hypertension and 10 of them (20%) has Type 2 Diabetes Mellitus (DM). Socio-epidemiological characteristics of patients are given in Table 1. It is identified that average operation time of patients is 199.80 ± 37.8 min. (min.-max.: 120-360), and their hospitalisation period is 7.12 ± 2.1 days (min.-max.: 4-10). Pre-operative average BMI values of participant patients are identified as 45.83 ± 6.37 (kg/m²) (min.-max.: 44.02-47.64). It is observed that post-operative BMIs of 50 patients vary 37.63 ± 5.88 kg/m² (35.96-39.30 kg/m²) on

average in 3rd month control, 31.91 ± 5.10 kg/m² (30.46-33.36 kg/m²) in 6th month control, and 26.82 ± 3.08 kg/m² (25.95-27.70 kg/m²) in first year control.

When BMI change level in quarterly, semi-annual and first year checks is analysed through ANOVA test in recurrent measurements, it is identified that such change is significant ($p < 0.0001$). It is found out in mutual comparisons that BMI in 6th month check is significantly lower than BMI in 3rd month check (for both of them ($p < 0.0001$)). BMIs calculated before surgery and in quarterly, semi-annual and first year checks are given in Table 2 and Figure 1.

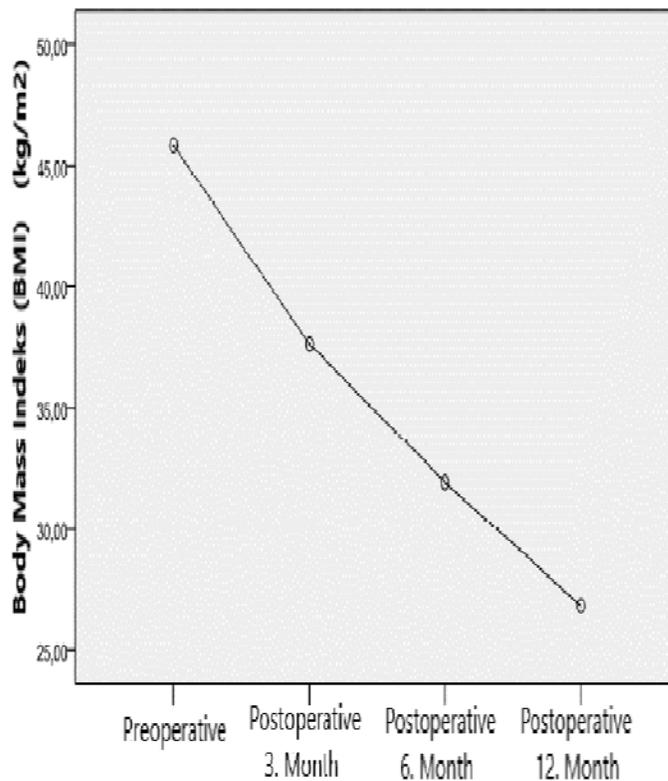


Figure 1. Patients' BMI change compared to post-operative 3rd month, 6th month and first year controls

Table I: Distribution of patients according to their socio-epidemiological characteristics

Properties	Number	Percentage (%)
Civil status		
Married	35	70
Single	15	30
Residential location		
Urban	37	74
Rural	13	26
Educational background		
Illiterate	5	10
Primary school	9	18
Secondary school	2	4
High school	16	32
University	18	36
Profession		
Unemployed	17	34
Housewife	6	12
Student	6	12
Worker	9	18
Officer	11	22
Habit		
None	20	40
Smoking	26	52
Smoking and alcohol	4	8
Associated disease		
Hypertension	4	8
Obstructive sleep apnea syndrome	3	6
Type 2 Diabetes Mellitus + Hypertension	3	6
Hypertension + Hyperlipidaemia	2	4
Type 2 Diabetes Mellitus + Hypertension + Arrhythmia	2	4
Bipolar disorder	2	4
Asthma	2	4
Type 2 Diabetes Mellitus	1	2
Acute coronary syndrome + Type 2 Diabetes Mellitus + Hypertension	1	2
Hypertension + Obstructive sleep apnea syndrome	1	2
Panic attack	1	2
Type 2 Diabetes Mellitus + asthma + sequelae poliomyelitis	1	2
Coronary artery disease+ Hypertension +cervical hernia	1	2
Hepatitis B	1	2
Vasculitis	1	2

Acute lymphoblastic leukaemia-	1	2
Cervical hernia	1	2
None	22	44

Table II: Patients' BMI values calculated before surgery and in their follow-ups

BMI (kg/m ²)	Average±Std	Min.-Max.	P value
Pre-operative	45.83±6.37	44.02 - 47.64	<0.0001
3 rd month	37.63±5.88	35.96- 39.30	<0.0001
6 th month	31.91±5.10	30.46-33.36	<0.0001
1 st year	26.82±3.08	25.95-27.70	<0.0001

It is identified that while patients' pre-operative HbA1c level is 6.55±1.37, its post-operative level in 12th month is 5.32±0.57 (Table 3 and Figure 2). When HbA1c change level is analysed through ANOVA test in recurrent measurements, it is detected to be significant (p<0.05). It is found that while 20 patients' (40%) HbA1c level in pre-operative period is 6.5% and above, only 1 patient's (2%) HbA1c level is 6.5% and above in post-operative 12th month.

Table III: Patients' HbA1c level change in post-operative 1st year follow-up

HbA1c level	Average±Std	Min.-Max.	P value
Pre-operative	6.55± 1.37	5.0-12.60	<0.05
Post-operative 12 th month	5.32±0.57	3.70-8.10	

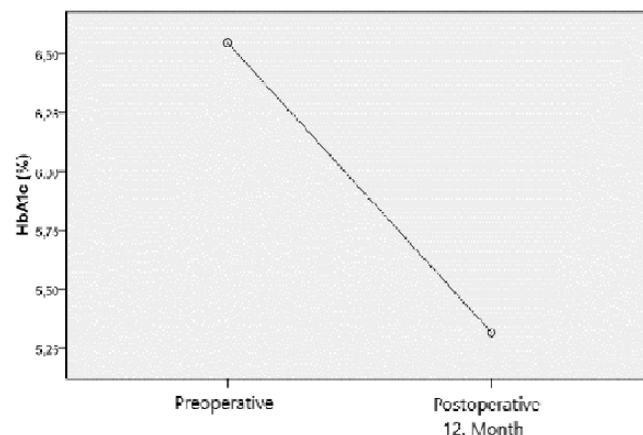


Figure 2. Patients' HbA1c level change in post-operative 1st year follow-up

It is determined that patients' post-operative 12th month 25-hydroxy Vitamin D average is 31.27±24.28 ng/ml (min.-max.: 4.23-12357), Vitamin B12 average is 367.69±198.95 pg/ml (min.-max.: 118.0-955.20), pholic acid average is 8.25±3.96 µg/L (min.-max.: 1.82-20.0), and ferritin average is 85.87±75.49 µg/L (min.-max.: 3.30-280.90).

In post-operative 12th month, Vitamin B12 level is checked in 49 patients, and it is ascertained that it is below 200 pg/ml in 6 patients (12.2%), it is 200 pg/ml and above in 43 patients (87.8%). In post-operative 12th month, while pholic acid level of a total of 49 patients (98%) is above 3 µg/L, it is below 3 µg/L only in 1 patient (2%). In post-operative 12th month, while 25-hydroxy Vitamin D level of a total of 19 patients (38%) is 20 ng/mL and below, it is between 21 and 29 ng/mL in 14 patients (28%), and it is 30 ng/mL and above in 17 patients (34%). It is detected that in post-operative 12th month, while serum ferritin level is above 50 µg/L in a total of 22 patients (44%), it is between 50 and 200 µg/L in 23 patients (46%), and above 200 µg/L in 5 patients (10%).

In this study, it is identified that mortality rate based on LSG is 0%. Complications are observed in 2 participant patients (4%) (one of them is wound site infection, and the other is fistulae/leak).

DISCUSSION

Weight loss in obesity ensures a healthy life by reducing associated diseases caused by this illness. Three methods are used in obesity treatment, namely life style change, medical treatment and bariatric surgery. Exercise programmes are recommended for patients who have difficulty in obeying nutrition

suggestions. Bariatric surgery is recommended for patients who cannot achieve targeted weight with behaviour change and medical treatment⁹.

Today, all bariatric interventions used in obesity treatment are performed with laparoscopic and even robotic surgery. Thanks to this method, a lower pain level is observed, compared to open surgery, and incidence of complications such as wound site infection and incisional hernia is lower. Laparoscopic surgical intervention is also preferred in this study. Weight loss in laparoscopic sleeve gastrectomy, its complications, life quality, and its therapeutic impact on associated diseases underpin recent studies^{10,11}. Success criteria for LSG are short and long term sufficient weight loss and managing to not regain weight, low mortality and morbidity in pre-operative and post-operative periods^{12,13}.

Although literature contains numerous studies conducted on short term results of LSG, studies evaluating its medium term results are limited. Therefore, in this study it is aimed to evaluate DM, which cannot be recovered with medical treatment, and body weight in morbid obese patients after LSG, and to reveal whether such patients regain weight in post-operative short and medium terms, changes in comorbidities accompanying obesity, and whether there is any vitamin deficiency in patients after LSG in medium term.

It is ascertained that average age of participant patients is 36.00 ± 10.31 . In Mihmanlı et al.'s¹² study, which evaluates LSG's post-operative effects in Type 2 diabetes patients with morbid obesity, patients' average age is found out to be 36 ± 9.35 , which is very close to the value provided in our study. This finding can be explained with the peak value fat mass reaches immediately after middle age, in both men and women. In our study, men's average age is detected slightly higher (2.5 years older) than women's. Similarly, in Baltasar et al.'s¹⁰ study, men's average age is found to be 2 years higher.

On the other hand, in Baştürk et al.'s¹³ study, men's average age is determined to be 2 years lower than women's. The difference between these studies can be explained with dissimilarity between patients' socio-epidemiological traits.

Most important health problems observed in morbid obese patients are hypertension, cardiovascular diseases, dyslipidaemia, Type 2 DM, obstructive sleep apnea, gastroesophageal reflux, arthritis, depression, renal failure and menstrual disorders in women. In compliance with literature, the most frequently observed associated diseases in this study are hypertension and Diabetes Mellitus.

T2DM diagnosis as well as its treatment method must be carefully considered during pre-operative evaluation. Even though patient has no T2DM history, pre-operative laboratory tests should contain HbA1c. This laboratory test may help identify undiagnosed T2DM¹⁴. In addition, HbA1c level demonstrates whether diabetes is treated well, and whether blood sugar is in normal intervals¹³. While 20% of participant patients are diagnosed with T2DM before SG intervention, it is detected that 40% of such patients have HgA1c level at the rate of 6.5% or above. This finding emphasised the importance of examination of HgA1c level in pre-operative period. In our study, post-operative HgA1c level significantly reduces in both genders and in total, compared to pre-operative period. In compliance with the findings of this study, Mihmanlı et al.'s¹² study indicates that while pre-operative HbA1c level is $7.33\% \pm 1.24$, it is $5.5\% \pm 0.7$ in 6th month, and $5.2\% \pm 0.33$ in 12th month. Besides, in compliance with literature, it is observed that 95% of patients diagnosed with T2DM according to HbA1c level in pre-operative period no longer have diabetes in the first year after SG. According to the study by Baltasar et al.¹⁰, while 26.32% of patients have T2DM in pre-operative period, in a similar to this study, only 5.26% of these patients have T2DM in post-

operative period. According to a systematic compilation performed by Gill et al.¹⁵, it is acknowledged that normal range of HbA1c level, which causes emergence of clinical symptoms related to diabetes, is full recovery, and decrease in such values in comparison with previous values is recovery. In support of this study, in Gill et al.'s¹⁵ research, it is discovered that 66.2% of cases are fully recovered from diabetes within 13.1 months on average after SG, while 29.9% are recovered. Evaluating findings of this study in the light of Gill et al.'s¹⁵ definition, it can be indicated that 95% of patients are fully recovered, while 5% are recovered. This result demonstrates that LSG is a remarkably effective method in treatment of diabetes.

According to the study carried out by Heusschen et al.¹⁶, iron deficiency, which is shown with low serum ferritin level, is detected in seven patients (5.1%). In post-operative period, reduction in HC1 secretion, use of proton pump inhibitors (PPI) and faster gastric evacuation may limit iron absorption¹⁷⁻¹⁹. Along with low absorption, decrease in oral intake and intolerance against iron-rich sources like red meat may be the causes of iron deficiency after SG¹⁹. In the study conducted by Al-Mulhim et al.²⁰, it is stated that 36% of patients have iron deficiency. In this study, 44% of patients are found out to have low serum ferritin levels. This rate is higher than ferritin levels reported after SG in literature, and demonstrates that provided iron supplement is not sufficient and a higher dose of iron is needed. The most common cause of iron deficiency anaemia with the rate of 23.3% is shown to be erosive gastritis. Although a certain part of stomach is removed during LSG, the fact that the most frequently found pathology in pre-operative endoscopic evaluation of participant patients is gastritis may contribute to low levels of serum ferritin.

Emergence of Vitamin B12 deficiency after sleeve gastrectomy results from decrease in

HC1 and intrinsic factor after the surgery. This becomes more apparent with PPI intake²¹. Deficiency of Vitamin B12 is defined as serum Vitamin B12 level's being under the value of 200 pg/ml¹⁷. In the study conducted by Heusschen et al.¹⁶, a clear decrease in serum Vitamin B12 level has been detected in the first year after SG. In this study, it is detected that 12.2% of patients have low levels of Vitamin B12 in post-operative 12th month. This emphasises the importance of Vitamin B12 supplement.

In studies using pre-operative Vitamin D treatment protocol, prevalence of post-operative Vitamin D deficiency is reported between 14-36%^{22,23}. In studies conducted on Vitamin D level, 25(OH)D level's being lower than 20 ng/ml is defined as Vitamin D deficiency, its being 21-29 ng/ml is defined as Vitamin D insufficiency, and its being higher than 30 ng/ml is defined as sufficient level²⁴. In this study, 38% 25(OH)D deficiency level reported in 12th month after SG is close to the rate reported in literature. In addition to this, high level of 25OH(D) insufficiency (28%) demonstrates that 25OH(D) deficiency or insufficiency in 12th month after SG is prevalent and measures must be taken against prevention of this situation.

Trastulli et al.'s²⁵ study, which carries out evaluation of 1.191 patients, 795 of whom had LSG and who were involved in a total of 15 randomised controlled study, reports that more weight loss ranges from 49% to 81% in SG group, from 62.1% to 94.4% in laparoscopic gastric bypass group, and from 28.7% to 48% in LAGB group. Follow-up period in these randomised controlled studies varies from 6 months to 3 years. In this study, it is discovered that BMI in 12th month is lower than BMI in pre-operative period as well as post-operative 3rd and 6th months. This finding is compatible with literature^{9,11}.

Complication rate (4%) in this study is found to be very low. Surgery and hospitalisation time

revealed as a result of this study also support this view. It is detected that 60% of patients participated in this study smoke. It is determined that post-operative pulmonary complication risk is 1.4-4.3 times higher in smoking patients. In the study conducted by Haskins et al²⁶. patients who have smoked within a year before sleeve gastrectomy are at an increased, albeit still very low, risk for 30-day morbidity and mortality compared with nonsmokers. No pulmonary complication is detected in our study. This finding emphasises the success of surgery and post-operative healthcare team. In compliance with literature, complications after LSG are wound site infection and fistula/leak.

The retrospective nature of our study, the small number of cases included in the study, difficulties in communicating with some patients, and some difficulties in accessing file archives can be seen as limitations of our study.

CONCLUSION

As a result of this study, it is demonstrated that LSG provides sufficient level of weight loss. In addition, it is confirmed that LSG is also effective in providing glycaemic control and Type 2 diabetes. In this study, where mortality is not observed, it seems that LSG as a reliable method with acceptable pre-operative and post-operative complication rates is an effective solution in surgical treatment of obesity. In addition to this, more comprehensive randomised studies which evaluate long-term results of LSG are needed.

Ethical Committee Approval: The study was approved by Dicle University Human Ethics Committee (No: 05.03.2020-078), Diyarbakır, Turkey.

Declaration of Conflicting Interests: The authors declare that they have no conflict of interest.

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