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Short and midterm results of laparoscopic sleeve gastrectomy and its effects on hypertension and type 2 diabetes

Laparoskopic sleeve gastrektomi'nin kısa ve orta dönem sonuçları, tip 2 diyabet ve hipertansiyona etkileri

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Abstract

Purpose: Laparoscopic sleeve gastrectomy (LSG) has become a widely used primary bariatric surgical technique in recent years. We aimed to investigate the short and midterm effects of LSG on weight loss and its effects on comorbid hypertension (HT) and type 2 diabetes mellitus (T2DM).

Materials and methods: 82 patients who underwent LSG between January 2009 and December 2011 and whose postoperative 6-month, 1-year, and 3-year follow-up records were available were included in this retrospective study. Preoperative height/weight values, comorbidities, drug use for HT and/or T2DM, and changes in postoperative 6-month, 1-year, 3-year, and 5-year data were collected.

Results: Comparing to the preoperative data, decrease in body mass index (BMI) at the postoperative 6-month, 1-year, and 3-year follow-ups was statistically significant *(p*=0.0001, for each). A higher increase in BMI was observed at the 3-year follow-up than at the 1-year follow-up (*p*=0.0001). A decrease in the requirement of oral antidiabetics (OAD) and antihypertensives was observed at the postoperative 3-year compared to the preoperative data (*p*=0.0001, for each).

Conclusion: LSG, which can be applied as a primary treatment in the surgical treatment of morbid obesity, is a very effective and reliable method with low mortality and morbidity rates. In addition, it facilitates significant regression in comorbidities such as HT and T2DM. Although there is some weight gain in the midterm; short and midterm results of LSG indicates that it is an effective surgical technique.

Key words: Sleeve gastrectomy, comorbidity, bariatric surgery, short and midterm results.

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Özet

Amaç: Laparoskopik sleeve gastrektomi (LSG) son yıllarda yaygın olarak kullanılan primer bariatrik cerrahi teknik haline gelmiştir. Bu çalışmada, LSG'nin kilo kaybındaki kısa ve orta dönem etkinliğini, eşlik eden tip 2 diyabet ve hipertansiyona (HT) olan etkilerini araştırmayı amaçladık.

Gereç ve yöntem: Bu retrospektif çalışmaya Ocak 2009-Aralık 2011 arasında LSG uygulanan ve postoperatif 6. ay, 1. yıl ve 3. yıl takip kayıtlarına ulaşılabilen seksen iki hasta dahil edildi. Ameliyat öncesi boy/kilo değerleri, komorbiditeler, HT ve/veya tip 2 diyabet için ilaç kullanımı ve postoperatif 6. ay, 1. yıl, 3. yıllık ve 5. yıl verilerindeki değişiklikler kaydedildi.

Bulgular: Ameliyat öncesi verilerle karşılaştırıldığında, postoperatif 6. ay, 1. yıl ve 3. yıl takiplerinde vücut kitle indeksindeki (VKİ) azalma istatistiksel olarak anlamlıydı (*p*=0,0001, her biri için). Üçüncü yılda 1. yıla göre VKİ artışı (*p*=0,0001), operasyon öncesine göre 3. yılda diyabet ilacı ve antihipertansif ilaç kullanım sıklığında azalma izlendi (*p*=0,0001, herbiri için).

Sonuç: Morbid obezitenin cerrahi tedavisinde primer tedavi olarak uygulanabilen LSG, düşük mortalite ve morbidite oranları ile çok etkili ve güvenilir bir yöntemdir. Ek olarak, tip 2 diyabet ve HT gibi komorbiditelerde önemli iyileşme sağlar. Orta dönemde biraz kilo alımı olsa da, LSG'nin kısa ve orta dönem sonuçları etkili bir cerrahi teknik olduğunu göstermektedir.

Anahtar kelimeler: Sleeve gastrektomi, komorbidite, bariatrik cerrahi, orta ve uzun dönem sonuçlar**.**

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Introduction

Obesity is an important public health problem; posing a serious burden on the world economy, and its prevalence is steadily increasing in both developing and developed countries [1]. Being overweight is the sixth most important risk factor contributing to the overall disease burden worldwide. Obesity is a risk factor for several comorbidities such as; cardiovascular diseases, HT, T2DM and dyslipidemia [2].

Failure to achieve adequate weight loss with diet, exercise, and pharmacological treatment has urged researchers to pursue different approaches and have caused current research to focus on hormones and mediators, which are considered a source of obesity, as well as surgical interventions. Although the advantages and disadvantages of many techniques in bariatric surgery have been investigated for many years, a gold standard treatment option has not been determined yet [3]. In the recent years, LSG, which had previously been used as the first stage of biliopancreatic diversion, has become the sole bariatric surgery technique and facilitates distinct regression in obesity-associated comorbidities such as HT, T2DM, hyperlipidemia, asthma, and obstructive sleep apnea [4-9].

In this study, we aimed to investigate the short and midterm effects of LSG, which is performed as the primary bariatric surgery method in our clinic, on weight loss, and its effects on comorbid diseases; HT and T2DM.

Materials and methods

Patient selection

This study was conducted in Pamukkale University Faculty of Medicine (PAUTF) Department of General Surgery with the approval of PAUTF Ethics Committee (by decision no. 2014/15 dated 11/25/2014). Patients who underwent LSG between January 2009 and December 2011 were retrospectively analysed through the hospital information system and patient files. In this period, LSG was performed on 286 patients. 204 patients whose records were missing were excluded from the study.

All the patients were asked to seek professional help for at least 6 months before the surgery in order to lose weight with pharmacological treatment, diet, exercise, and lifestyle changes. Those who failed to lose weight with these methods were recommended LSG according to the indications determined by the National Institutes of Health (NIH) after explaining all of the related risks and complications.

Preoperative Evaluation

Before the surgery, all the patients were evaluated by a team of a bariatric surgeon, an anaesthesiologist, a cardiologist, a gastroenterologist, a psychiatrist, an endocrinologist, a pulmonologist, and a dietitian.

Surgical Technique

All LSG operations were performed by the same surgical team. The stomach was separated from the omentum in the direction of the greater curvature beginning from the pylorus 2-3 cm proximal to the cardiac notch, a 32 Fr orogastric tube placed by the anaesthesiologist; the stomach was vertically transected from the antrum to the cardiac notch. In all ignited cartridges, peristrips were used to reinforce the stapler line. Hemoclip was applied to the bleeding points on the stapler line. Leakage test was performed using methylene blue and pneumatic compression device during and after the surgery, up until discharge.

Postoperative follow-up and evaluation

Patients were mobilized at postoperative 6-8 hours. Esophagogastrography was performed on the first day to evaluate for anastomotic leakage and stenosis. Proton pump inhibitor was administered during hospitalisation and continued for postoperative 6 weeks. 0.4 or 0.6 IU enoxaparin was administered at 00:00 preoperatively and repeated at the same dose at 12-hour intervals postoperatively until discharge. Following discharge, enoxaparin was continued for 7 days.

The patients were advised to consume clear liquids in the postoperative first week, full liquids in the second week, puree in the third week, and solid food in the fourth week.

Statistical analysis

Continuous variables were represented as mean±standard deviation, range (minimum-maximum); and categorical variables were

represented as numbers and percentages. A significance test of the difference between two means was used to compare independent group differences. Independent group comparisons, variant analysis on repeated measures, and McNemar's test were used. $p<0.05$ was considered statistically significant. Data were analyzed using SPSS Version 21.0 Armonk, NY: IBM Corp.

Results

Out of the 82 patients in our study (mean age: 36.33±8.50 years, range: 20-60 years), 65 (79.3%) were female (mean age: 36.80±8.38 years, range: 20-60 years) and 17 (20.7%) were male (mean age: 34.53±8.98 years, range: 21-52 years). Male patients had a BMI of 37.0-58.80 kg/m^2 (mean: 47.26±5.48 kg/m^2), female patients had a BMI of 36.0-68.10 kg/m^2 (mean: 47.71±6.35 kg/m^2), and all patients had an overall BMI of 36.0-68.10 kg/m^2 (mean: 47.61±6.15 kg/m^2). There was no significant difference between male and female patients in terms of age and BMI (p=0.330 and 0.794, respectively).

Operation time ranged from 115 to 220 minutes (mean: 160.73±33.65 min) and length of hospital stay ranged from 4 to 8 days (mean: 5.34±0.89 days). The mean follow-up period was 49.90±10.27 months (range, 36-68 months).

18 patients (22.0%) had T2DM and 21 (25.6%) had HT. 9 (50%) of the patients with T2DM were receiving OAD and 9 (50%) were using insulin. 4 (19%) of the patients with HT were receiving multidrug antihypertensive treatment and 17 (81%) were receiving a single-drug antihypertensive treatment. 10 of these patients had both HT and T2DM; of these, 3 were receiving insulin+multidrug antihypertensive treatment, 4 were receiving insulin+single antihypertensive and 3 were receiving OAD+single antihypertensive treatment. Demographic characteristics, duration of surgery, length of hospital stay and the number of patients with HT and/or T2DM of the patients are summarized in Table 1.

The surgery was performed laparoscopically in all patients and no complications requiring laparotomy have occurred.

Postoperatively, the BMI of all patients were 23.41-51.38 kg/m^2 (mean: 34.67±5.43 kg/m^2) at the postoperative 6-month follow-up, 19.49-43.94 kg/m^2 (mean: 28.82±5.37 kg/m^2) at the 1-year follow-up, and 19.38-46.07 kg/m^2 (mean: 30.45±5.79 kg/m^2) at the 3-year follow-up. Comparing to the preoperative data, the decrease in BMI at the postoperative 6-month, 1-year, and 3-year follow-ups was statistically significant (p=0.0001). In paired comparisons, BMI at the postoperative 1-year follow-up was less than that at the 6-month follow-up (p=0.0001). An increase in BMI was observed at the postoperative 3-year follow-up compared to the 1-year follow-up (p=0.001). However, the BMI at the postoperative 3-year follow-up was less than the one observed preoperatively and

Table 1. Demographic characteristics, duration of surgery, length of hospital stay, and number of patients with type 2 diabetes and/or HT in the study group.

	Study group (n = 82)
Mean age of patients (years)±SD, (range)	36.33±8.50 (20–60)
Male/Female ratio	17/65
The mean BMI (kg/m^2)±SD of patients, (range)	47.61±6.15 (36.00–68.10)
Duration of surgery (min)±SD, (range)	110.55±19.85 (80–160)
Length of hospital stay (days)±SD, (range)	3.33±0.63 (3–5)
Type 2 diabetes n (%)	18 (22.0%)
HT n (%)	21 (25.6%)
Type 2 diabetes+HT n (%)	10 (12.2%)

BMI; body mass index; **HT**; hypertension.

at the 6-month follow-up (p=0.0001 for both). BMI values that were calculated preoperatively and during the follow-ups are shown in Table 2.

The changes in the BMI of patients on the postoperative follow-ups are shown in Figure 1.

27 patients in the study group had 5-year records. Preoperative and postoperative 6-month, 1-year, 3-year, and 5-year BMI of these patients were 36.0-62.2 kg/m^2 (mean: 49.52±5.56 kg/m^2), 23.4-46.9 kg/m^2 (mean: 35.14±5.90 kg/m^2), 19.5-40.3 kg/m^2 (mean: 30.03±6.57 kg/m^2), 19.4-46.1 kg/m^2 (mean: 32.43±7.82 kg/m^2), and 20.4-49.0 kg/m^2 (mean: 33.82±7.82 kg/m^2), respectively. A statistically significant difference was observed between the preoperative and postoperative 6-month, 1-year, 3-year, and 5-year BMI of 27 patients (p=0.0001). In paired comparisons, weight loss on the postoperative 1-year follow-up was significant compared to the 6-month follow-up (p=0.0001). However, the increase in the BMI on the postoperative 3-year follow-up was not significant compared to that at the 1-year follow-up (p=0.1). Furthermore, the increase in the BMI at the postoperative 5-year follow-up was significant compared to that at the 1-year follow-up (p=0.019). Changes in the BMI of 27 patients preoperatively and during postoperative follow-ups are shown in Figure 2.

Table 2. BMIs of the study patients before the surgery and at the 6th month, 1st year, and 3rd year after the surgery.

	BMI (kg/m^2)±SD, (range)	***p*-value**
Before surgery	47.61±6.15 (36.00–68.10)	-
Postoperative 6th month	34.67±5.43 (23.41–51.38)	*0.0001**
Postoperative 1st year	28.82±5.37 (19.49–43.94)	*0.0001**
Postoperative 3rd year	30.45±5.79 (19.38–46.07)	*0.0001**

BMI; Body mass index**, ***;Compared with the preoperative data.

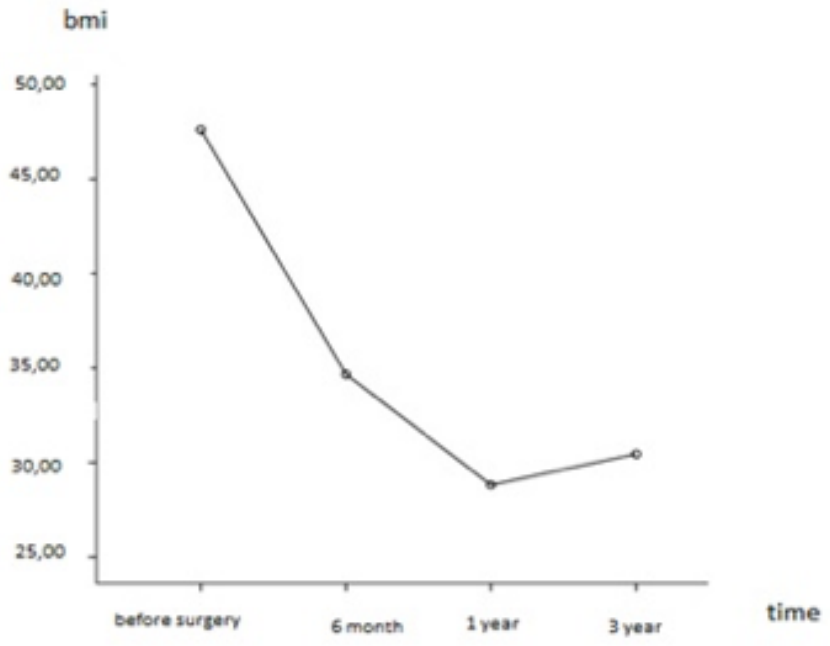

Figure 1. Changes in BMI of 82 patients at the postoperative 6th month, 1st year, and 3rd year follow-ups compared with the preoperative results.

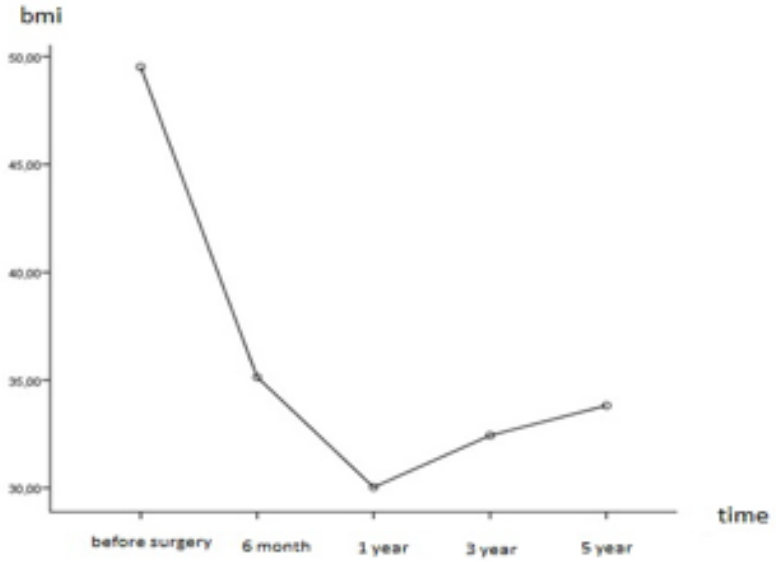

Figure 2. Changes in BMI of 27 patients preoperatively and at postoperative 6th month, 1st year, 3rd year and 5th year

At the postoperative 3-year follow-up, 7 (77.8%) out of 9 patients who used OAD before the surgery was able to discontinue OAD and 8 (88.9%) of 9 patients who used insulin were able to discontinue it. 1 patient who used insulin switched to OAD treatment. 2 patients who received OAD and 1 who used insulin before the surgery continued to receive the same treatment. There were no patients who had to start using OAD in the postoperative 3 years, however, it must be taken into account that they did not use OAD preoperatively. The decrease in the frequency of OAD use at the postoperative 3-year follow-up (23.2% and 4.9%, respectively) was statistically significant (p=0.0001).

At the postoperative 3-year follow-up, 15 (71.4%) of 21 patients who used antihypertensive drugs preoperatively were able to discontinue the medication. 3 (75%) of 4 patients who received multidrug antihypertensive treatment prior to LSG started receiving single-drug treatment, and 1 (25%) patient continued using multidrug antihypertensive treatment. 2 (11.8%) of 17 patients who received antihypertensive medication treatment preoperatively continued the same medication. Notably, there were no patients who started using antihypertensive drugs until the postoperative 3-year follow-up, and it must also be taken into consideration that they did not use antihypertensive drugs preoperatively. The decrease in the frequency of antihypertensive drug use at the postoperative 3-year follow-up (25.6% and 7.3%, respectively) was statistically significant (p=0.0001).

None of the patients in the study group had any major complications or mortality at the follow-up.

Discussion

Recent studies have suggested that bariatric surgery methods are much more effective than non-surgical techniques in terms of weight loss and the sustainability of weight loss [10]. Adequate weight loss has been achieved in the short term after LSG, which was initially performed to reduce high mortality and morbidity rates in morbidly obese patients as the first step of complicated operations such as biliopancreatic diversion, duodenal switch, and gastric bypass, has led to the idea that the technique can be performed solely in bariatric surgery [4, 11]. Generally, a weight loss of >50% of excess weight is considered successful, whereas that of <25% is considered a failure [12].

In our study, there was a decrease in BMI at the postoperative 6-month, 1-year, and 3-year follow-ups; whereas there was an increase in BMI at the additional postoperative 3-year follow-up. However, the increase in BMI at the end of the 3-year follow-up was significant than the one at the end of 1-year.

In a study by Alvarenga et al., the rate of excess weight loss (EWL%) after LSG was 86%±22.3 at the end of 1-year, 63%±19 at the end of 3-years, 61%±11 at the end of 5-years, and 52%±9.2 at the end of 8-years [13]. In a study about long-term results of LSG, the rate of EWL was 76.8% at the end of 5-years. Reportedly, this rate was >50% in 70.7% of patients who were followed up for 8-years. In addition, it was pointed out that 12 patients underwent LSG, 6 underwent gastric bypass, and 5 underwent duodenal switch operation during their follow-up and that LSG is a very effective bariatric surgical technique, particularly for non-super-obese patients [14].

In a study by Dudric et al., the rate of EWL after LSG was 52.61% at the end of 6 months, 71.47% at the end of 1-year, and 69.94% at the end of 2-years [15]. In our study, concurrent with the literature, the maximal decrease in BMI was achieved at the end of postoperative 1-year and there was some weight gain in the patients during the long-term follow-up. Therefore, it can be concluded that the maximum EWL that can be achieved by surgery is obtained with LSG at postoperative 1-year and in cases in which sufficient weight loss is not achieved during follow-ups or weight gain recurs, revision surgeries such as duodenal switch and gastric bypass could be performed.

Comparing to the individuals with normal BMI, mortality rate for all causes among obese individuals was 2-times higher and coronary heart disease-associated deaths were 3.3-times higher [16, 17]. In the Trials of Hypertension Prevention 2 study, the effect of salt restriction and weight loss combination on reducing blood pressure (BP) in overweight patients with high-normal BP was found to be very significant in the initial 6-months; however, the attempts to lower BP in long-term follow-ups have failed because the patients could not maintain salt restriction regimen and weight loss [18]. In a review analyzing the efficacy of LSG on HT, complete recovery was achieved in 58% at the end of 1-year. The percentage of patients who had full recovery or with reduced antihypertensive drug use in number and dose was 75% [19]. The decrease in the use of antihypertensive drugs after LSG was shown in other studies [20, 21].

Studies have reported a dramatic decrease in OAD use 1-month after LSG in obese patients with T2DM; and that this improvement could be sustained and the decrease in drug use was maintained [20-24].

In a study conducted with patients with a mean BMI of 49.61 kg/m^2, 87 (52%) patients had T2DM before bariatric surgery and 78% of patients who used medication due to T2DM discontinued drug use and 7% reduced the drug dosage at the end of 1 year [25]. In a review in which the normalisation of fasting glucose and HbA1c levels leading to the presentation of diabetic clinical symptoms is considered full recovery, 673 patients from 27 studies were analyzed, and 66.2% of T2DM patients who underwent LSG had full recovery [26]. In a study investigating the effects of LSG and gastric bypass on medical therapy; there was a significant reduction in OAD use after the surgery and only 8% of the patients who previously used insulin postoperatively required insulin [22]. In another study, there were no significant differences in terms of fasting glucose and insulin levels between patients who underwent LSG and those who underwent duodenal switch or gastric bypass [27]. In a retrospective study, 2713 patients were screened and 77.8% of obese patients with T2DM demonstrated improvement as they discontinued the medication or reduced drug dosage after bariatric surgery [28]. In a retrospective study involving over 2000 bariatric surgical operations, 85% of patients who used OAD preoperatively discontinued medication at the end of postoperative 2 years [29].

In our study, at the postoperative 3-year follow-up, 7 (77.8%) of 9 patients who used OAD preoperatively and 8 (88.9%) of 9 patients who used insulin were able to discontinue the therapy. 1 patient who used insulin was able to switch to OAD treatment. Prevalence of OAD usage was statistically significant (p=0.0001) at the postoperative 3-year follow-up, relative to the preoperative use (23.2% and 4.9%, respectively).

There were certain limitations to this study. In this retrospective study, blood glucose and systolic/diastolic BP values with HT and/or T2DM were not provided and the number of patients with HT and/or T2DM was low.

In conclusion, LSG is a very effective and reliable method with low mortality and morbidity rates. Revision surgeries could be performed

in patients who have not achieved adequate weight loss or have had weight gain during midterm follow-ups after LSG. We believe that patients who will require revision surgery could be predicted in the first postoperative year which is when the maximal weight loss usually occurs. LSG provides significant improvement in HT and T2DM which are obesity-associated comorbidities.

Conflict of interest: Authors have no conflicts of interest to declare.

References

1. Antipatis VJ, Gill TP. Obesity as a global problem. In: Björntorp P, ed. International textbook of obesity. Chichester: John Wiley & Sons Ltd, 2001;3-21.
2. Haslam DW, James WP. Obesity. Lancet 2005;366:1197-1209. https://doi.org/10.1016/S0140-6736(05)67483-1
3. Buchwald H, Williams SE. Bariatric surgery worldwide 2003. Obes Surg 2004;14:1157-1164. https://doi.org/10.1381/0960892042387057
4. Atila K. Morbid obezitenin cerrahi tedavisi. Archives of clinical toxicology. 2014;1:23-27. Turkey.
5. Sanchez SR, Masdevall C, Baltasar A, et al. Short and mid-term outcomes of sleeve gastrectomy for morbid obesity: The experience of the Spanish national registry. Obes Surg 2009;19:1203-1210. https://doi.org/10.1007/s11695-009-9892-9
6. Menenakos E, Stamou K, Albanopoulos K, Papailiou J, Theodorou D, Leandros E. Laparoscopic sleeve gastrectomy performed with intent to treat morbid obesity: A prospective single-center study of 261 patients with a median follow-up of 1 year. Obes Surg 2010;20:276-282. https://doi.org/10.1007/s11695-009-9918-3
7. Almogy G, Crookes PF, Anthone GJ. Longitudinal gastrectomy as atreatment for the high-risk super-obese patient. Obes Surg 2004;14:492-497. https://doi.org/10.1381/096089204323013479
8. Noah J, Smith A, Birch D, Karmali S. The metabolic effects of laparoscopic sleeve gastrectomy: A review. J Minim Invasive Surg Sci 2013;2:3-7.
9. Nocca D, Guillaume F, Noel P, et al. Impact of laparoscopic sleeve gastrectomy and laparoscopic gastric bypass on HbA1c blood level and pharmacological treatment of type 2 diabetes mellitus in severe or morbidly obese patients. Results of a multicenter prospective study at 1 year. Obes Surg 2011;21:738-743. https://doi.org/10.1007/s11695-011-0385-2
10. Zhou D, Jiang X, Ding W, et al. Impact of bariatric surgery on ghrelin and obestatin levels in obesity or type 2 diabetes mellitus rat model. J Diabetes Res 2014;2014:569435. https://doi.org/10.1155/2014/569435
11. Tucker ON, Szomstein S, Rosenthal RJ. Indications for sleeve gastrectomy as a primary procedure for weight loss in the morbidly obese. J Gastrointest Surg 2008;12:662-667. https://doi.org/10.1007/s11605-008-0480-4
12. Park JY, Song D, Kim YJ. Clinical experience of weight loss surgery in morbidly obese Korean adolescents. Yonsei Med J 2014;55:1366-1372. https://doi.org/10.3349/ymj.2014.55.5.1366
13. Alvarenga ES, Lo Menzo E, Szomstein S, Rosenthal RJ. Safety and efficacy of 1020 consecutive laparoscopic sleeve gasterctomies performed as a primary treatment modality for morbid obesity. A single-center experience from the metabolic and bariatric surgical accreditation quality and improvement program. Surg Endosc 2016;30:2673-2678. https://doi.org/10.1007/s00464-015-4548-4
14. Noel P, Nedelcu M, Eddbali I, Manos T, Gagner M. What are the long-term results 8 years after sleeve gastrectomy? Surg Obes Relat Dis 2017;13:1110-1115. https://doi.org/10.1016/j.soard.2017.03.007
15. Dudric V, Constantea N, Crisan D, et al. Laparoscopic sleeve gastrectomy: Short and mid-term outcome. HVM Bioflux 2016;8:171-175.
16. Greenspan SF, Gardner DG. Basic and clinical endocrinology. 7th ed. NewYork: McGraw-Hill, 2004.
17. Dunitz M, Kopelman PG. The management of obesity and related disorders. 1st ed. London, 2001.
18. The trials of hypertension prevention collaborative res earch group. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The trials of hypertension prevention, phase II. Arch Intern Med 1997;157:657-667.
19. Sarkhosh K, Birch DW, Shi X, Gill RS, Karmali S. The impact of sleeve gastrectomy on hypertension: A systematic review. Obes Surg 2012;22:832-837. https://doi.org/10.1007/s11695-012-0615-2
20. Leonetti F, Capoccia D, Coccia F, et al. Obesity, type 2 diabetes mellitus, and other comorbidities: A prospective cohort study of laparoscopic sleeve gastrectomy vs medical treatment. Arch Surg 2012;147:694-700. https://doi.org/10.1001/archsurg.2012.222
21. Slater BJ, Bellatorre N, Eisenberg D. Early postoperative outcomes and medication cost savings after laparoscopic sleeve gastrectomy in morbidly obese patients with type 2 diabetes. J Obes 2011;2011:350523. https://doi.org/10.1155/2011/350523

22. Schauer PR, Kashyap SR, Wolski K, et al. Bariatric surgery versus intensive medical therapy in obese patients with diabetes. N Engl J Med 2012;26;366:1567-1576. https://doi.org/10.1056/NEJMoa1200225

23. Shah PS, Todkar JS, Shah SS. Effectiveness of laparoscopic sleeve gastrectomy on glycemic control in obese Indians with type 2 diabetes mellitus. Surg Obes Relat Dis 2010;6:138-141. https://doi.org/10.1016/j.soard.2009.06.007

24. Casella G, Abbatini F, Calì B, Capoccia D, Leonetti F, Basso N. Ten-year duration of type 2 diabetes as prognostic factor for remission after sleeve gastrectomy. Surg Obes Relat Dis 2011;7:697-702. https://doi.org/10.1016/j.soard.2011.08.014

25. Hoogerboord M, Wiebe S, Klassen D, Ransom T, Lawlor D, Ellsmere J. Laparoscopic sleeve gastrectomy: Perioperative outcomes, weight loss and impact on type 2 diabetes mellitus over 2 years. Can J Surg 2014;57:101-105. https://doi.org/10.1503/cjs.024212

26. Gill RS, Birch DW, Shi X, Sharma AM, Karmali S. Sleeve gastrectomy and type 2 diabetes mellitus: a systematic review. Surg Obes Relat Dis 2010;6:707-713. https://doi.org/10.1016/j.soard.2010.07.011

27. Roslin MS, Dudiy Y, Weiskopf J, Damani T, Shah P. Comparison between RYGB, DS, and VSG effect on glucose homeostasis. Obes Surg 2012;22:1281-1286. https://doi.org/10.1007/s11695-012-0686-0

28. Juodeikis Ž, Brimas G. Long-term results after sleeve gastrectomy: a systematic review. Surg Obes Relat Dis 2017;13:693-699. https://doi.org/10.1016/j.soard.2016.10.006

29. Makary MA, Clark JM, Shore AD, et al. Medication utilization and annual health care costs in patients with type 2 diabetes mellitus before and after bariatric surgery. Arch Surg 2010;145:726-731. https://doi.org/10.1001/archsurg.2010.150

Ethics committee approval: Ethics committee approval was received for this study from the ethics committee of the Pamukkale University, School of Medicine in Denizli, Turkey (by decision no. 2014/15 dated 11/25/2014).