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Comparison of Laparoscopic Sleeve Gastrectomy and Intragastric Balloon Procedures

Laparoskopik Sleeve Gastrektomi ile İntragastrik Balon Uygulamasının Kıyaslanması

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ABSTRACT

Objective: We aimed to compare laparoscopic sleeve gastrectomy (LSG), which is proven to be effective for obesity, with intragastric balloon procedure (IGB), a minimally invasive technique.

Methods: The study included patients admitted to our surgical clinic between December 2018 and October 2021. During the study period, 106 patients with morbid obesity treated at our clinic were analyzed. The results of 65 patients who underwent LSG and 41 who underwent IGB were retrospectively evaluated. Demographic characteristics, body mass index, and comorbidities were recorded. Furthermore, the quality of life questionnaires that the participants completed before the treatment procedures and one year after the treatment were analyzed. p<0.05 value was considered statistically significant.

Results: The mean age of the patients was 42.97 years. The mean preoperative body weight and BMI value were 122.75±11.03 kg and 43.98±4.19 kg/m^2, respectively, for the LSG patients, while they were 122.75±11.03 kg and 43.98±4.19 kg/m^2, respectively, for the IGB patients. The mean length of hospital stay was 3.31±0.80 days in LSG and 1.12±0.40 days in IGB, and the mean operation time was 63.92±7.07 minutes in LSG and 21.66±4.39 minutes in IGB. Both results were statistically significant (p<0.05). There was no mortality, and one patient who underwent IGB experienced intolerance.

Conclusion: Both LSG and IGB procedures being performed today are effective methods for obesity treatment. However, LSG is more effective in improving obesity-related comorbidities and weight loss, whereas IGB is a safe method that is more easily applicable, reversible, and has lower complication rates.

Keywords: Laparoscopic sleeve gastrectomy, intragastric balloon, obesity

ÖZ

Amaç: Günümüzde obezite üzerine etkinliği ispatlanmış olan laparoskopik sleeve gastrektomi (LSG) operasyonu ile minimal invaziv bir teknik olan intragastrik balon (İGB) uygulamasını kıyaslamayı amaçladık.

Yöntemler: Çalışmamız Aralık 2018 ile Ekim 2021 tarihleri arasında cerrahi kliniğimize başvuran hastalar arasında gerçekleştirildi. Bu dönemde kliniğimizde morbid obezite nedeniyle tedavi görmüş olan 106 hasta incelendi. LSG yapılan 65 hasta ve İGB uygulanan 41 hastanın sonuçları retrospektif olarak değerlendirildi. Çalışmaya dahil edilen hastaların demografik özellikleri, vücut kitle indeksleri, komorbiditeleri kaydedildi. Ayrıca hastaların uygulanan tedavi prosedürleri öncesi ve tedaviden bir yıl sonra doldurmuş oldukları, yaşam kalitesini ölçen anketler analiz edildi. p<0,05 değeri istatistiksel olarak anlamlı kabul edildi.

Bulgular: Hastaların genel ortalama yaşı 42,97 idi. LSG cerrahisi uygulanan hastaların preoperatif vücut ağırlığı ve vücut kitle indeksi ortalamaları sırasıyla 122.75±11,03 kg ve 43,98±4,19 kg/m^2 idi. İGB uygulaması yapılan hastaların ise preoperatif vücut ağırlığı ve VKİ ortalamaları sırasıyla 122,75±11,03 kg ve 43,98±4,19 kg/m^2 idi. Ortalama hastanede kalış süresi LSG'de 3,31±0,80 gün, İGB'de 1,12±0,40 gün olarak; operasyon süresi LSG'de 63,92±7,07 dakika, İGB'de 21,66±4,39 dakika olarak bulunmuştur. Bulunan her iki sonuç istatistiksel olarak anlamlıdır (p<0.05). Çalışmaya katılan hastalarda mortalite kaydedilmedi. İGB yapılan bir hastada intolerans saptandı.

Sonuç: Günümüzde uygulanmakta olan LSG ve İGB prosedürlerinin her ikisi de obezitenin tedavisinde etkili yöntemlerdir. Bununla birlikte LSG, obeziteye bağlı komorbiditelerin iyileşmesinde ve kilo kaybında daha etkili iken; İGB, daha kolay uygulanabilir, reversibl ve daha düşük komplikasyon oranlarına sahip, güvenli bir yöntemdir.

Anahtar Sözcükler: Laparoskopik sleeve gastrektomi, intragastrik balon, obezite

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INTRODUCTION

Obesity is a health problem caused by an imbalance between energy intake and use of energy (1). In recent years, its prevalence has been increasing. It has been classified as a global epidemic by the World Health Organization (2). Although various definitions of obesity exist, body mass index (BMI) is currently used as a standardized measure to ensure consistency in practice (3). The value is calculated by dividing the weight in kilograms by the square of the height in meters.

It has been revealed that many diseases are associated with obesity from the past to the present. The primary diseases associated with obesity include type 2 diabetes mellitus (DM), dyslipidemia, hypertension, and obstructive sleep apnea syndrome (OSAS) (4-9). Alongside comorbidities, the financial burden of obesity and related health issues is increasing on healthcare systems (10,11). Numerous approaches have been developed to fight obesity in response to these challenges. Typically, these approaches are categorized into two main groups: Surgical and non-surgical methods. When healthy eating diets, physical activity, and behavioral therapies fail to produce desired outcomes, invasive and surgical methods with proven efficacy in weight loss are used (12). While laparoscopic sleeve gastrectomy (LSG) is the most common bariatric surgery carried out today, intragastric balloon procedure (IGB) is an increasingly popular method (13-15). IGB can be performed independently for weight loss, and there are instances where it is performed as a preparatory step preceding the intended bariatric procedure (16). The aim of this study was to investigate and compare the safety, efficacy, and impact on quality of life (QoL) between LSG and IGB, both of which are commonly used in bariatric surgery clinics.

MATERIALS AND METHODS

In this study, a total of 106 patients who underwent either LSG or IGB between December 2018 and October 2021 at our surgical clinic were retrospectively analyzed. While 65 of these patients underwent LSG, 41 underwent the IGB procedure. Participants were between 18-65 years of age. Furthermore, the study included patients with a BMI>40 kg/m^2 or those with a BMI>35 kg/m^2 accompanied with obesity-related comorbidities. Patient data were obtained from hospital archive files and the hospital's electronic operating system. Participants' demographic and clinical characteristics, such as type of procedure, age, gender, comorbidities, duration of the procedure, length of hospital stay, and complications, were examined and analyzed. In addition, body weight, BMI values, endoscopy forms recorded during the pre-procedure and 12-month post-procedure follow-up of the patients and our clinic's standardized questionnaires consisting of 40 questions assessing QoL were accessed and analyzed. In the questionnaire, the highest score was 100, with a higher score representing a higher QoL. Those with missing data were excluded from the study. Following the protocols of our bariatric surgery clinic, all patients were thoroughly briefed about the procedures and provided written informed consent before any intervention. All patients were evaluated by a multidisciplinary mechanism consisting of endocrinology, pulmonology, cardiology, psychiatry, and dietitian before the procedures were carried out by a surgical team experienced in bariatric surgery and endoscopy. The study was approved by the Selçuk University of Medical Sciences local ethics committee (approval number: 2024/171, date: 12.03.2024) and was conducted in accordance with the Declaration of Helsinki. LSG was performed under general anesthesia, and the IGB procedure was performed under sedation anesthesia. The IGB procedure was performed endoscopically while the patient was in the lateral decubitus position. The balloon was inflated in the stomach with 500 cc of saline solution and 50 cc of methylene blue, all within direct visualization through endoscopy, reaching a total volume of 550 cc. Six months after the procedure, endoscopy was performed to remove the balloon. The balloon was deflated entirely, and it was extracted using a specialized instrument during the endoscopic procedure. LSG was performed using a laparoscopic endostapler with standard vertical stomach transection. After both procedures, patients were admitted to the surgical department for treatment, follow-up, and observation. Follow-ups were organized at 2 weeks, 3-months, 6-months and 12-months after the procedures.

Statistical Analysis

The IBM SPSS version 20.0 software was used for the statistical analysis of the data. The Kolmogorov-Smirnov test was used to assess whether the variables had a normal distribution. To compare paired groups, the Student's t-test was used for normally distributed variables, and the Mann-Whitney U test was used for parameters without a normal distribution. Multivariate cross-tabulations were assessed using either the chi-square test or the Fisher Exact test. Pre- and postoperative recovery scores within the same group were analyzed using the Paired-Samples t-Test. Results were considered statistically significant when $p<0.05$.

RESULTS

The study included 106 patients. While 65 patients underwent LSG, 41 underwent the IGB procedure. Among them, 61 were female (57.5%), and 45 were male (42.5%). The mean age of patients who underwent LSG surgery was 42.17±7.70 years. The mean preoperative body weight and BMI of patients undergoing LSG surgery were 122.75±11.03 kg and 43.98±4.19 kg/m^2, respectively. The mean age of patients who underwent the IGB procedure was 44.24±9.40 years. The mean preoperative body weight and BMI of patients who underwent the IGB procedure were 122.75±11.03 kg and 43.98±4.19 kg/m^2, respectively. Patients undergoing LSG had preoperative comorbidities of hypertension (51/65, 78.5%), DM (33/65, 50.8%), dyslipidemia (43/65, 66.2%), and OSAS (13/65, 20%). Patients who underwent IGB had preprocedural comorbidities of hypertension (33/41, 80.5%), DM (20/41, 48.8%), dyslipidemia (27/41, 65.9%), and OSAS (9/41, 22%). The mean length of hospital stay was 3.31±0.80 (days) in the LSG group and 1.12±0.40 (days) in the IGB group. The mean operation time was recorded as 63.92±7.07 minutes in the LSG group and 21.66±4.39 minutes in the IGB group (Table 1). Short- and long-term complications of LSG and IGB were analyzed and documented during hospital stay and follow-up (Table 2). Conservative treatment was applied to 3 patients who experienced bleeding in the early postoperative period after LSG. No new surgical intervention was needed. Following the IGB procedure, one patient experienced intolerance to medical treatment, leading to premature removal of the gastric balloon before its scheduled duration. During the post-procedure follow-up, 10 patients (15.4%) in the LSG group

and 8 patients (19.5%) patients in the IGB group experienced gastroesophageal reflux (GER) symptoms. In the LSG group, 22 patients (33.8%) were diagnosed with esophagitis during the control endoscopy, whereas in the IGB group, only 2 patients (4.9%) patients were diagnosed with esophagitis. No mortality was noted among the participants. Improvements in the comorbidities of the patients at 12-month follow-up after the procedures are presented in Table 3. Statistically significant improvements in hypertension, DM, and dyslipidemia were observed after LSG compared with IGB ($p<0.05$). The comparison of patients' QoL scores between the LSG and IGB groups before and 12 months after the procedure, according to the results of the standardized QoL measurement questionnaire, is presented in Table 4. Despite a greater increase in QoL observed in the LSG group compared with the IGB group, there was no statistically significant difference between them ($p>0.05$). Moreover, the LSG and IGB groups were separately evaluated for their effects on QoL. The results demonstrated that both procedures led to improvements in QOL, as illustrated in Table 5.

Finally, the 12-month pre-procedure and post-procedure changes in body weight, BMI changes and weight loss rates of the participants were compared, as presented in Table 6.

DISCUSSION

Table 1. Demographic and clinical characteristics of the patients

	LSG, n=65 n (%)	IGB, n=41 n (%)	p
Age (Years)	42.17±7.70	44.24±9.40	0.360
Gender			
Female	38 (58.5)	23 (56.1)	0.810
Male	27 (41.5)	18 (43.9)	
Weight before the procedure (kg)	122.75±11.03	118.44±11.84	0.069
BMI before the procedure (kg/m^2)	43.98±4.19	43.32±3.69	0.078
Hypertension			
Yes	51 (78.5)	33 (80.5)	0.802
No	14 (21.5)	8 (19.5)	
Diabetes			
Yes	33 (50.8)	20 (48.8)	0.842
No	32 (49.2)	21 (51.2)	
Dyslipidemia			
Yes	43 (66.2)	27 (65.9)	0.975
No	22 (33.8)	14 (34.1)	
OSAS			
Yes	13 (20)	9 (22)	0.809
No	52 (80)	32 (78)	
Duration of hospital stay (days)	3.31±0.80	1.12±0.40	**<0.001**
Duration of procedure (minutes)	63.92±7.07	21.66±4.39	**<0.001**

LSG: Laparoscopic sleeve gastrectomy, IGB: Intragastric balloon, BMI: Body mass index, OSAS: Obstructive sleep apnea syndrome (Statistically significant p values are written in bold)

Table 2. Comparison of complications

	LSG n (%)	IGB n (%)	p
Pain			
Yes	15 (23.1)	5 (12.2)	0.207
No	50 (76.9)	36 (87.8)	
Bleeding			0.282
Yes	3 (4.6)	0 (0)	
No	62 (95.4)	41 (100)	
Esophagitis			
Yes	22 (33.8)	2 (4.9)	**<0.001**
No	43 (66.2)	39 (95.1)	
GER Symptoms			
Yes	10 (15.4)	8 (19.5)	0.581
No	55 (84.6)	33 (80.5)	
Intolerance			
Yes	0 (0)	1 (2.4)	0.387
No	65 (100)	40 (97.6)	

GER: Gastroesophageal reflux, LSG: Laparoscopic sleeve gastrectomy, IGB: Intragastric balloon

Table 3. Comorbidity assessment 12 months after LSG and IGB

	LSG n (%)	IGB n (%)	p
Hypertension			**0.001**
Improved	38 (74.5)	13 (39.4)	
Not improved	13 (25.5)	20 (60.6)	
Total	51 (100)	33 (100)	
Diabetes			**0.007**
Improved	24 (72.7)	7 (35)	
Not improved	9 (27.3)	13 (65)	
Total	33 (100)	20 (100)	
Dyslipidemia			**0.028**
Improved	29 (67.4)	11 (40.7)	
Not improved	14 (32.6)	16 (59.3)	
Total	43 (100)	27 (100)	
OSAS			0.609
Improved	11 (84.6)	6 (66.7)	
Not improved	2 (15.4)	3 (33.3)	
Total	13 (100)	9 (100)	

OSAS: Obstructive sleep apnea syndrome, LSG: Laparoscopic sleeve gastrectomy, IGB: Intragastric balloon

Obesity is a global public health problem with its increasing prevalence, affecting individuals of all ages (17,18). Numerous surgical and non-surgical interventions exist to address this condition, with new ones continually emerging alongside advancements in medical science (19-21). Bariatric surgery is the most effective treatment method for obesity (22). LSG is the most common bariatric procedure (23). However, surgical methods are invasive and generally lead to irreversible changes in body anatomy and physiology. Given this

awareness, IGB, despite being a relatively recent technique, has emerged as a noteworthy option for patients who prefer to avoid surgical interventions. In our study, in which we compared the LSG and IGB methods, the IGB application was attractive for patients given its shorter hospital stay and procedure duration. Furthermore, the fact that IGB does not require general anesthesia is another factor that simplifies the procedure. Complications that may occur following bariatric treatment procedures include pain, bleeding, GER symptoms, esophagitis, and intolerance. Control endoscopy should be particularly conducted in patients with symptoms of GER, such as chronic cough, epigastric pain, and regurgitation, to determine whether concurrent esophagitis exists. When evaluating the two procedures investigated in our study for complications, the esophagitis after LSG was significantly higher. According to the findings of a study published by Lim et al. (24) in 2020, some patients required revision surgery due to the occurrence of esophagitis that was resistant to medical treatment following LSG. Similarly, previous studies have indicated an increase in both the severity and prevalence of esophagitis following LSG (25). Although LSG tends to cause bleeding and pain to a greater extent than IGB, the observed differences were not statistically significant. However, a higher proportion of patients experienced GER symptoms with IGB than with LSG. Moreover, there is a risk of intolerance to IGB, which, if it occurs, may lead to incomplete treatment for the patient. Hypertension, DM, dyslipidemia, and obstructive sleep apnea syndrome are among the most prevalent obesity-related comorbidities. Upon analyzing the 12-month results of LSG and IGB, it became evident that LSG was notably better, particularly regarding improvements in comorbidities such as hypertension, DM, and dyslipidemia. Proportionally better outcomes were observed with LSG regarding improvement in OSAS. Nonetheless, as a minimally invasive method, IGB alone was also able to achieve significant reductions in comorbidities. One of the most comprehensive studies on this subject to date is a retrospective study conducted by Genco et al. (26) in Italy, which included 2515 patients. According to the study, the rate of improvement in comorbidities was 44.8% in patients who underwent IGB. Several studies have highlighted the beneficial effect of weight loss on comorbidities and associated mortality (27-32). In our study, both LSG and IGB were found to improve the QoL of the participants positively. Based on the patients' QoL scores before the procedure, the increase in LSG was higher than that of IGB at the 12-month follow-up, although not statistically significant. Pre-procedure QoL scores were higher in the IGB group. From this perspective, patients undergoing LSG initially have a lower QoL, and this factor should be considered when selecting the appropriate method for individual patients. Upon analysis of patients for weight loss and reduction in BMI, although both procedures proved to be viable options, our study revealed that LSG was more effective than IGB. Moreover, despite studies suggesting that IGB is suitable for patients with a BMI of 30-40 kg/m^2, the initial mean BMI for the IGB group in our study was above 40 kg/m^2, yet effective results were achieved (33).

Table 4. Comparison of the LSG and IGB groups in terms of quality of life

	LSG n=65	IGB n=41	p
Pre-procedure quality of life score	67.22±8.38	71.32±7.66	**0.021**
Quality of life score at 12-months post-procedure	84.12±5.31	85.51±5.10	0.340
Changes in quality of life scores	16.91±10.52	14.20±9.62	0.220

LSG: Laparoscopic sleeve gastrectomy, IGB: Intragastric balloon

Table 5. Evaluation of quality of life improvements within the groups

	Preprocedure quality of life score	Quality of life score at 12-months after the procedure	p
LSG	67.22±8.38	84.12±5.31	**<0.001**
IGB	71.32±7.66	85.51±5.10	**<0.001**

LSG: Laparoscopic sleeve gastrectomy, IGB: Intragastric balloon

Table 6. Comparison of the LSG and IGB methods in terms of their results

	LSG n=65	IGB n=41	p
BMI change (kg/m2)	11.12±5.02	8.12±5.41	**0.002**
Body weight change (kg)	37.11±12.89	27.51±13.87	**0.001**
Loss of excess weight (%)	59.86±6.36	45.27±6.02	**<0.001**

LSG: Laparoscopic sleeve gastrectomy, IGB: Intragastric balloon

Study Limitations

The retrospective nature, single-center design, and the absence of longer follow-up results were the limitations of this study.

CONCLUSION

Weight loss plays an important role in the successful management of obesity and its associated comorbidities. The method chosen to achieve weight loss should be both appropriate and effective while ensuring safety. LSG, which is a surgical intervention, is more effective in improving comorbidities and weight loss. On the other hand, IGB, which is a minimally invasive approach, is associated with fewer complications, shorter hospitalization and procedure durations, easier applicability, and reversibility.

Ethics

Ethics Committee Approval: The study was approved by the Selçuk University of Medical Sciences local ethics committee (approval number: 2024/171, date: 12.3.2024)

Informed Consent: Informed consent was optained.

Footnotes

Authorship Contributions

Concept: F.T., S.Y., Design: F.T., S.Y., Supervision: S.Y., Resources: F.T., S.Y., Material: F.T., S.Y., Data Collection or Processing: F.T., Analysis or Interpretation: F.T., S.Y., Literature Search: F.T., Writing: F.T., S.Y., Critical Review: S.Y.

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REFERENCES

1. Jiang SZ, Lu W, Zong XF, Ruan HY, Liu YJE. Obesity and hypertension. Exp Ther Med. 2016; 12: 2395-9.
2. Haththotuwa RN, Wijeyaratne CN, Senarath U. Chapter 1 - Worldwide epidemic of obesity. In: Mahmood TA, Arulkumaran S, Chervenak FA, editors. Obesity and Obstetrics. 2nd ed. Elsevier; 2020. P. 3-8. Available from https://www.sciencedirect.com/science/article/abs/pii/B9780128179215000011?via%3Dihub.
3. Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al. Definitions, Classification, and Epidemiology of Obesity.
4. Verma S, Hussain ME. Obesity and diabetes: An update. Diabetes Metab Syndr. 2017; 11: 73-9.
5. Vekic J, Zeljkovic A, Stefanovic A, Jelic-Ivanovic Z, Spasojevic-Kalimanovska V. Obesity and dyslipidemia. Metabolism. 2019; 92: 71-81.
6. Klop B, Elte JWF, Castro Cabezas M. Dyslipidemia in obesity: mechanisms and potential targets. Nutrients. 2013; 5: 1218-40.
7. Seravalle G, Grassi G. Obesity and hypertension. Pharmacol Res. 2017; 122: 1-7.
8. Tuomilehto H, Seppä J, Uusitupa M. Obesity and obstructive sleep apnea–clinical significance of weight loss. Sleep Med Rev. 2013; 17: 321-9.
9. Jehan S, Zizi F, Pandi-Perumal SR, McFarlane SI, Jean-Louis G, Myers AK. Energy imbalance: obesity, associated comorbidities, prevention, management and public health implications. Adv Obes Weight Manag Control. 2020; 10: 146-61.
10. Specchia ML, Veneziano MA, Cadeddu C, Ferriero AM, Mancuso A, Ianuale C, et al. Economic impact of adult obesity on health systems: a systematic review. Eur J Public Health. 2015; 25: 255-62.
11. Tremmel M, Gerdtham U-G, Nilsson PM, Saha S. Economic burden of obesity: a systematic literature review. Int J Environ Res Public Health. 2017; 14: 435.
12. Gloy VL, Briel M, Bhatt DL, Kashyap SR, Schauer PR, Mingrone G, et al. Bariatric surgery versus non-surgical treatment for obesity: a systematic review and meta-analysis of randomised controlled trials. BMJ 2013; 347: 5934.
13. Gambioli R, Lepore E, Biondo FG, Bertolani L, Unfer V. Risks and limits of bariatric surgery: old solutions and a new potential option. Eur Rev Med Pharmacol Sci 2023; 27: 5831-40.
14. Arterburn DE, Telem DA, Kushner RF, Courcoulas AP. Benefits and risks of bariatric surgery in adults: a review. JAMA. 2020; 324: 879-87.
15. Neto MG, Silva LB, Grecco E, de Quadros LG, Teixeira A, Souza T, et al. Brazilian Intragastric Balloon Consensus Statement (BIBC): practical guidelines based on experience of over 40,000 cases. Surg Obes Relat Dis 2018; 14: 151-9.
16. Gleysteen JJ. A history of intragastric balloons. Surg Obes Relat Dis. 2016; 12: 430-5.
17. Wyatt SB, Winters KP, Dubbert PM. Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. Am J Med Sci. 2006; 331: 166-74.
18. Chan RSM, Woo J. Prevention of overweight and obesity: how effective is the current public health approach. Int J Environ Res Public Health. 2010; 7: 765-83.
19. Kral JG, Näslund E. Surgical treatment of obesity. Int J Environ Res Public Health 2010; 7: 765-83. Available from https://doi.org/10.1038/ncpendmet0563.
20. Wirth A, Wabitsch M, Hauner H. The prevention and treatment of obesity. Dtsch Arztebl Int. 2014; 111: 705-13.
21. Cardel MI, Atkinson MA, Taveras EM, Holm J-C, Kelly AS. Obesity treatment among adolescents: a review of current evidence and future directions. JAMA Pediatr. 2020; 174: 609-17.
22. Angrisani L, Santonicola A, Iovino P, Formisano G, Buchwald H, Scopinaro N. Bariatric surgery worldwide 2013. Obes Surg. 2015; 25: 1822-32.
23. Chung AY, Thompson R, Overby DW, Duke MC, Farrell TM. Sleeve gastrectomy: surgical tips. J Laparoendosc Adv Surg Tech A. 2018; 28: 930-7.
24. Lim CH, Lee PC, Lim E, Eng A, Chan WH, Tan HC, et al. Resolution of erosive esophagitis after conversion from vertical sleeve gastrectomy to Roux-en-Y gastric bypass. Obes Surg. 2020; 30: 4751-9.
25. Tsai Y-N, Tai C-M, Tu H-P, Chen J-H, Chen C-Y, Kuo C-H. Factors associated with increased severity of erosive esophagitis 1 year after laparoscopic sleeve gastrectomy. Obes Surg. 2022; 32: 3891-9.
26. Genco A, Bruni T, Doldi S, Forestieri P, Marino M, Busetto L, et al. BioEnterics intragastric balloon: the Italian experience with 2,515 patients. Obes Surg. 2005; 15: 1161-4.
27. Sarkhosh K, Switzer NJ, El-Hadi M, Birch DW, Shi X, Karmali S. The impact of bariatric surgery on obstructive sleep apnea: a systematic review. Obes Surg. 2013; 23: 414-23.
28. Ryan DH, Yockey SR. Weight loss and improvement in comorbidity: differences at 5%, 10%, 15%, and over. Curr Obes Rep. 2017; 6: 187-194.
29. Wing RR, Lang W, Wadden TA, Safford M, Knowler WC, Bertoni AG, et al. Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. Diabetes Care 2011; 34: 1481-6.
30. Cohen JB. Hypertension in obesity and the impact of weight loss. Curr Cardiol Rep. 2017; 19: 98.
31. Hamman RF, Wing RR, Edelstein SL, Lachin JM, Bray GA, Delahanty L, et al. Effect of weight loss with lifestyle intervention on risk of diabetes. Diabetes Care 2006; 29: 2102-7.
32. Hasan B, Nayfeh T, Alzuabi M, Wang Z, Kuchkuntla AR, Prokop LJ, et al. Weight loss and serum lipids in overweight and obese adults: a systematic review and meta-analysis. J Clin Endocrinol Metab. 2020; 105: 673.
33. Brill JV. Reimbursement for endoscopic bariatric therapies. Gastrointest Endosc Clin N Am. 2017; 27: 343-351.