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ORIGINAL CONTRIBUTIONS

Metabolic Effects of Sleeve Gastrectomy with Transit Bipartition in Obese Females with Type 2 Diabetes Mellitus: Results After 1-Year Follow-up

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Abstract

Purpose To present the early metabolic effects of sleeve gastrectomy with transit bipartition (SG + TB) procedure in female obese patients with type 2 diabetes mellitus (T2DM).

Methods This prospective clinical study was carried out between January 2016 and June 2017. Inclusion criteria were female participants under 60 years old with T2DM, body mass index ≥ 40 kg/m^2 and HbA1c level ≥ 8%. All patients underwent to SG + TB procedure. Primary outcomes were the glycemic control variables, and the secondary outcomes were weight loss and dyslipidemia levels up to the last follow-up point.

Results A total of 35 female participants with an average age of 48.8 ± 6.0 years old and a mean preoperative BMI of 42.0 ± 1.3 kg/m^2 were included during the study period. Diabetic remission was achieved in 88.6% of patients (n = 31) on the third month without any antidiabetic medications. The mean postoperative BMI of patients was 24.8 ± 1.6 kg/m^2, and dyslipidemia levels were significiantly lower at the last follow-up point of all patients.

Conclusions SG + TB procedure may be a potent therapeutic option for the treatment of obese patients with T2DM.

Keywords Obesity · Type 2 diabetes mellitus · Metabolic surgery · Transit bipartition · Sleeve gastrectomy

Introduction

Recently, obesity and type 2 diabetes mellitus (T2DM) has become a public health crisis. It has been reported that majority of diabetic patients are overweight (body mass index (BMI), 25 to 29.9 kg/m^2) or obese (BMI > 30 kg/m^2) [1–3]. Glycemic control is usually poor in these obese patients with T2DM despite of lifestyle changes and optimal treatment with either oral or injectable medications [4]. In the last several decades, treatment of T2DM in obese population has evolved from traditional medications to surgical options in terms of metabolic surgery.

In 2007, the first Diabetes Surgery Summit (DSS-I) reached a consensus that "metabolic surgery could be considered as a tool to achieve better T2DM control, even in patients with class I obesity" [5]. Since then, several studies have steadily reported better glycemic control and decreased cardiovascular risk factors with metabolic surgery and also put metabolic surgery into the T2DM treatment algorithms [6–9]. In 2016, the second DSS-II guidelines suggested that, metabolic surgery should be considered as an potent therapeutic option to treat T2DM in patients with class 1 obesity, if patients are poorly controlled despite optimal medical treatment, particularly in the presence of other major comorbidities [10]. And also in this conference, a consensus has been reached that metabolic surgery is the most cost-effective treatment for type 2 diabetes when associated to obesity.

Currently, several metabolic surgery techniques have been performed as an effective treatment option for T2DM patients with BMI > 30 kg/m^2 [9]. Most of the bariatric techniques were proposed to be restrictive and/or promote malabsorption, differently affecting metabolic variables. Gastric bypass (usually Roux-en-Y gastric bypass) and laparoscopic sleeve gastrectomy have been the most commonly investigated metabolic procedures and have formed the majority of the evidence base for obesity and related comorbidities in the literature. In the last decade, the ileal transposition with diverted sleeve gastrectomy

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as well as sleeve gastrectomy with transit bipartition (SG + TB) has become more accepted and frequently performed procedures in several metabolic surgery centers [11–14].

Expected outcomes after a metabolic procedure include long-term remission of hyperglicemia and/or improvement in other obesity-related comorbidities such as hypertension and hyperlipidemia which in turn decrease mostly cardiovascular risks [15]. In this study, we aimed to present the early results of patients who have undergone SG + TB procedure in order to obtain glycemic control and other metabolic changes of obese females with T2DM. To best of our knowledge, this is the first study investigating the metabolic effects of SG + TB in a female obese and diabetic population.

Materials and Methods

Patients and Study Design

Patients' selection, clinical management, and surgical procedures were performed at Numune Training and Research Hospital in Adana, Turkey. The study was approved by the Institutional Ethics Committee (No: 14/194). This study was applied in coherence with the novel metabolic surgery guidelines and principles of the Declaration of Helsinki and Good Clinical Practices. Written consent was obtained from all patients before the surgery regarding the surgical complications and postoperative rehabilitation period. The diagnosis of T2DM was determined according to the criteria of the American Diabetes Association [16].

We included only female participants because of the small sample size and to minimize the effects of heterogenity. This study included participants with BMI ≥ 40 kg/m^2 diagnosed with T2DM in accordance with the restrictions of the government ministry of health regarding metabolic surgery indications. Other inclusion criteria were ≤ 60 years old, T2D for ≥ 2 and ≤ 10 years, and glycated hemoglobin (HbA1c) level ≥ 8. All patients were under insulin therapy supervised by an endocrinologist.

The patients with C-peptide levels < 2.0 ng/ml, ICA autoantibody positivity, cancer, chronic renal disease, alcohol or drug abuse, severe eating problems, under psychiatric therapy, and smoke consumer were excluded. In addition, five participants were excluded from the study as three of them declined to participate the follow-up period and two of them because of other reasons. Laboratory datas (fasting blood samples for glucose, HbA1c, and lipids) were collected prospectively before surgery (baseline), and at 3, 6, and at the last follow-up point after surgery. Demographic variables (BMI, age, anti-diabetic medications, follow-up time, length of hospital stay) were recorded. All of the patients were evaluated at regular intervals, and an examination were completed upon arrival to every appointment.

The primary outcome measures were glycemic control variables (HbA1c and fasting glucose levels). The secondary outcome measures were weight loss and dyslipidemia variables (cholesterol, triglyceride levels) from baseline to the last follow-up point. Complete remission of T2DM was defined as HbA1c level $< 6.5\%$ without any pharmacotherapy whereas improvement was defined as still required some oral antidiabetics to achieve normoglycemic levels (≤ 126 mg/dl).

Surgical Technique

SG + TB procedure was described firstly by Santoro in 2012 [17] designing a shortcut to the ileum while maintaining access to the duodenum. Shortly, in this laparoscopic procedure, after obtaining pneumoperitoneum using a Veress needle, three 12-mm trocars (1 in the midline 3 to 5 cm above the umbilicus and 2 others in the upper left and right quadrant) and three 5-mm trocars (1 in the epigastrium for the liver retractor and 2 at each lateral flank) are positioned. After a 36 French bougie is passed to the stomach, a typical sleeve gastrectomy is performed initially using laparoscopic linear cutting stapler starting at the gastric greater curvature at a point located 4 to 5 cm from the pylorus up to 0.5 cm from the angle of His. After the SG, the ileocecal valve is found and the point at the ileum 80 cm from the ileocecal valve is marked with a single stitch. Thereafter, the point at 260 cm from the ileocecal valve is located, and a latero-lateral gastro-ileoanastomoses were performed which is 3-to 4 cm in wide in an antecolic position using a linear stapler. The residual defect of the gastro-ileoanastomosis is closed with a 3–0 absorbable extra mucosal running suture. In the second part of the operation, the small bowel cranial to the gastroileal anastomosis is transected and anastomosed to the ileum at 80 cm from ileocecal valve (previously located) using a 45-mm white cartridge (Fig. 1). Mesenteric defects are closed with a nonabsorbable suture to prevent internal hernias. All operations were performed by one surgeon (TB) between January 2016 and June 2017.

Statistical Analysis

Mean, standard deviation, median, minimum, maximum value frequency, and percentage were used for descriptive statistics. The distribution of variables was checked with Kolmogorov–Smirnov test. Paired sample t test and Wilcoxon test were used for the repeated measurement analysis. The values were considered to be statistically significant when $p < 0.05$. SPSS 22.0 was used for statistical analyses.

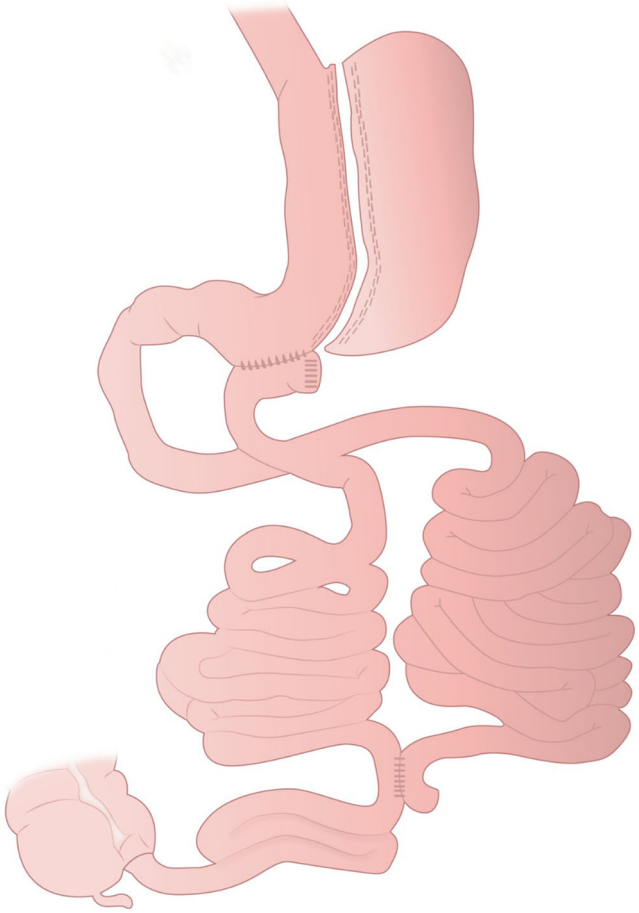

Fig. 1 Schematic demonstration of sleeve gastrectomy with transit bipartition

Results

This study included 35 female participants with an average age of 48.8 ± 6.0 years old and a mean preoperative BMI of 42.0 ± 1.3 kg/m^2. The mean duration of T2DM was 6.1 ± 2.2 years and all patients were under insulin therapy. The mean HbA1c (%) levels of the patients was 9.1 ± 1.0. The mean fasting C-peptide levels was 3.1 ± 0.8 ng/ml. The mean total cholesterol and triglyceride values were 222.2 ± 38.7 mg/dl and 179.0 ± 25.9 mg/dl respectively. The 60% (*n* 21) of patients were administering lipid lowering drugs at baseline. The patient's preoperative demographic characteristics are shown in Table 1.

All operations were performed laparoscopically by one surgeon and the average length of hospital stay was 3.9 ± 1.1 days. There was no preoperative complication regarding bleeding, necrosis, early leak, internal herniation, or any other intestinal injuries. In the postoperative period, four patients suffered from temporary nausea and/or vomitting and they were medicated with drugs. One patient had subileus and she was managed non-operatively. One patient underwent laparoscopic cholecystectomy at postoperative seventh month.

Table 1. Preoperative demographic characteristics of the patients

	Min-max	Median	Mean ± sd./*n* %
Age	37.0–60.0	48.0	48.8 ± 6.0
BMI (kg/m^2)	40.0–44.5	41.7	42.0 ± 1.3
T2DM duration (year)	2.0–10.0	6.0	6.1 ± 2.2
Fasting blood glucose (mg/dl)	137.0–320.0	168.0	187.5 ± 46.8
HbA1c (%)	8.0–11.9	9.0	9.1 ± 1.0
C-peptide (mg/dl)	2.0–5.3	3.2	3.1 ± 0.8
Total cholesterol (mg/dl)	165.0–310.0	213.0	222.2 ± 38.7
Triglyceride (mg/dl)	128.0–230.0	179.0	179.0 ± 25.9
Hospital stay (day)	3.0–8.0	4.0	3.9 ± 1.1
Follow-up time (month)	12.0–22.0	14.0	14.3 ± 2.8

The average follow-up time was 14.3 ± 2.8 months after surgery.

In the postsurgical assessment of the glycemic changes, 31 patients (88.6%) went into complete remission on the third month without any insulin or oral antidiabetics and four patients (11. 4%) were much improved on the third month but these patients still required some oral antidiabetics to achieve normoglycemic levels (≤ 126 mg/dl). Among these without complete remission, one patient had to restart insulin on the fourth month because of gastro-ileostomy anastomosis stenosis. After endoscopic balloon dilatations were performed, glycemic control was obtained rapidly in this patient without any medication. The remaining three patients are still under oral medication. Hypertriglyceridemia as well as hypercholesterolemia were improved in all patients after the surgery. Fifty-five percent of patients who were under hyperlipidemia treatment did not require any antihyperlipidemic drug at their last follow-up point. Metabolic changes of patients after surgery are shown in Table 2. No nutritional supplementation and/or multivitamin tablets were needed since vitamin and mineral deficiency, malnutrition, and anemia were not observed in any patient at their last follow-up points.

Discussion

T2DM is a chronic and progressive disease affecting millions of patients in worldwide. It is clear that uncontrolled T2DM increases the risk of long-term micro and macrovascular complications despite best medical care. It is well documented that majority of patients with T2DM are obese or have increased body fat that cannot be determined by traditional BMI calculations [3, 18]. Recently, metabolic surgery (MS) has been widely offered to eligible patients as a treatment tool in many centers because of its well-known results in weight loss and glycemic control as well as other metabolic effects such as on lipid profile [19, 20].

Table 2. Metabolic changes of patients after surgery

	Min-max	Median	Mean ± sd.	*p**	*p***
Weight (kg)					
Baseline	100.0–145.0	118.0	117.6 ± 10.5		
Last follow-up	60.0–84.0	69.0	69.5 ± 7.1	*0.000*[w]	
HbA1c (%)					
Baseline	8.0–11.9	9.0	9.1 ± 1.0		
3rd month	5.6–7.3	6.2	6.3 ± 0.4	*0.00*[w]	
6th month	5.1–6.4	5.7	5.7 ± 0.3	*0.000*[w]	*0.000*[w]
Last follow-up	4.3–5.9	5.2	5.2 ± 0.4	*0.000*[w]	*0.000*[w]
Fasting blood glucose (mg/dl)					
Baseline	137–320	168.0	187.5 ± 46.8		
3rd month	86–125	103.0	104.6 ± 9.2	*0.000*[w]	
6th month	85–115	95.0	95.6 ± 7.9	*0.000*[w]	*0.000*[w]
Last follow-up	76–110	92.0	89.8 ± 7.9	*0.000*[w]	*0.000*[w]
Triglyceride (mg/dl)					
Baseline	128–230.0	179.0	179.0 ± 25.9		
Last follow-up	90–142.0	125.0	122.6 ± 11.5	*0.000*[w]	
Total cholesterol (mg/dl)					
Baseline	165–310	213.0	222.2 ± 38.7		
Last follow-up	125–190	156.0	159.1 ± 16.1	*0.000*[w]	

[P] Paired sample *t* test; [w] Wilcoxon test

*p**Difference with preop; *p*****Difference with previous measurement

Triglyceride (mg/dl): normal range between 0 and 150 mg/dl

Total cholesterol (mg/dl): normal range between 0 and 200 mg/dl

The potential underlying mechanism of better metabolic outcomes following MS has been demonstrated in previous studies. It has been shown that some incretins such as glucagon-like peptide-1 (GLP1) and glucose-dependent insulinotropic polypeptide (GIP) play a major role regarding with metabolic changes after a MS [21–23]. And also, it has been reported that several metabolically active proteins such as fibroblast growth factor 19 (FGF19) are associated with glycemic control and decrease in atherosclerosis [23, 24].

Different MS techniques such as Roux-en-Y Gastric Bypass (RYGB), biliopancreatic diversion (BPD), mini gastric bypass, and sleeve gastrectomy have been emerged by surgeons in order to achieve glycemic control and improvement on lipid profile in obese patients with T2DM. All these procedures are proposed to be restrictive and/or promote malabsorption that may result in malnutrition signs (anemia, vitamin E and/or mineral deficiency, hypoalbuminemia). In 2012, Santoro et al. reported sleeve gastrectomy with transit bipartition (SG + TB) technique which was designed to minimize mechanical restriction and malabsorption aiming at adaptive and neuroendocrine goals [17]. In their study, the authors stated that SG + TB procedure to be functionally restrictive which means reduction in the rate of gastric emptying and intestinal transit. In this new procedure, distal gut function is increased because of fast transport of food to the ileum through the gastroileal anastomosis. In addition, proximal gut activity is decreased in this procedure since a great portion of food is switched directly to the ileum. In their study, the authors reported that complete diabetes remission was achieved in 86% of the patients with T2DM while 14% were much improved but still needed some oral anti-diabetic medications. When compared with the results published by Santoro et al., the complete diabetic remission was higher in the present study as well as the rate of patients requiring oral medications were lower (88.6% and 11.4% respectively). The more successful outcomes of the present study may be related to its small number of patients and including a homogeneous population such as only female patients and BMI ≥ 40 kg/m^2.

Mingrone and colleagues conducted a prospective randomized trial comparing RYGB and biliopancreatic diversion (BPD) with medical therapy for the treatment of T2DM [25]. In this trial, it has been reported that diabetes remission had occurred in no patients in the medical-therapy group vs 75% in the RYGB group and 95% in the BPD group at 2 years. Of note, the authors revealed that preoperative BMI and weight loss did not predict the improvement in hyperglycemia after these procedures in their trial. Many studies reported that the best DM remission is observed in biliopancreatic derivation (BPD) in approximately

90% of patients, however may induce severe malnutrition [26–28]. In the present study, T2DM remission rate was similar to BPD outcomes. Since the malapsorptive component is much minimized in SG + TB procedure, malnutrition signs did not occur in any patients in the present study.

In a systematic review that evaluated the impact of metabolic surgery on cardiovascular risk factors, the authors found that improvement/solution of hyperlipidemia occurred in 65% of subjects at a follow-up of 57.8 months [29]. Similar results have been found in studies with different surgical techniques [25, 30]. In the present study, 55% of patients who were under hyperlipidemia treatment did not require any antihyperlipidemic drug at their last follow-up point.

Leak and bleeding are the most common early complications of SG associated with high pressure in the gastric remnant that may result in significant morbidity and mortality. In addition, SG as well as other by-pass procedures such as RYGB and mini-gastric bypass have the potential of ulcerations in the long term. Because of the low pressure due to gastric drainage through gastro-ileoanastomosis, all these early and long-term complications are expected to be decreased in SG + TB procedure [17]. Besides all these advantages, endoscopic interventions can still be applied after a SG + TB procedure for treating possible duodenal and choledochal pathologies which may occur in the future. In this study population, leak and/or bleeding were not seen in any patients in the perioperative period. At the last follow-up points, no patients suffered from any ulcer symptoms.

This clinical study has several limitations. First of all, this study was limited inclusion to females diagnosed with T2DM and a BMI ≥ 40 kg/m^2. The patients BMI ≤ 40 kg/m^2 could not be involved to study population as the metabolic surgery indications used in our clinic was determined according to the government ministry of health policy. Secondly, fasting levels of FGF19 and proinsulin as well as the GIP and GLP1 responses of patients at baseline and after the surgery were not measured. Another limitation was that we did not report the validated measures of health-related quality of life. Although the present study has been conducted in only female patients with T2DM, the findings were interesting and may be reproducible in diabetic obese males.

In conclusion, the results of the present study support that SG + TB procedure may be a safe and effective metabolic procedure for the treatment of obesity and T2DM. The attractive findings of this study should be examined in larger diabetic populations.

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Compliance with Ethical Standards

Conflict of Interest The author declares that he has no conflict of interest.

References

1. Wang Y, Rimm EB, Stampfer MJ, et al. Comparison of abdominal adiposity and overall obesity in predicting risk of type 2 diabetes among men. Am J Clin Nutr. 2005;81:555–63.
2. Huxley R, James WP, Barzi F, et al. Ethnic comparisons of the cross-sectional relationships between measures of body size with diabetes and hypertension. Obes Rev. 2008;9(Suppl.1):53–61.
3. Bays HE, Chapman R, Grandy S. The relationship of body mass index to diabetes mellitus, hypertension and dyslipidaemia: comparison of data from two national surveys. Int J Clin Pract. 2007;61:737–47.
4. Liebl A, Mata M, Eschwege E. Evaluation of risk factors for development of complications in type II diabetes in Europe. Diabetologia. 2002;45:S23–8.
5. Rubino F, Kaplan LM, Schauer PR, et al. The diabetes surgery summit consensus conference. Ann Surg. 2010;251(3):399–405.
6. Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes—3-year outcomes. N Engl J Med. 2014;370(21):2002–13.
7. Ikramuddin S, Korner J, Lee W-J, et al. Roux-en-Y gastric bypass vs intensive medical management for the control of type 2 diabetes, hypertension, and hyperlipidemia: the diabetes surgery study randomized clinical trial Roux-en-Y gastric bypass and diabetes. JAMA. 2013;309(21):2240–9.
8. Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial. Lancet. 2015;386(9997):964–73.
9. Rubino F, Nathan D, Eckel RH, et al. Metabolic surgery in the treatment algorithm for type 2 diabetes: a joint statement by international diabetes organizations. Surg Obes Relat Dis. 2016;12:1144–62.
10. Cohen RV, Shikora S, Petry T, et al. The diabetes surgery summit II guidelines: a disease-based clinical recommendation. Obes Surg. 2016;26(8):1989–9.
11. Santoro S. From bariatric to pure metabolic surgery: new concepts on the rise. Ann Surg. 2015;262:79–80.
12. Arslan E, Sipahi M, Banli O. Early results of laparoscopic sleeve gastrectomy with loop bipartition. Surg Laparosc Endosc Percutan Tech. 2018; https://doi.org/10.1097/SLE.0000000000000541.
13. Yormaz S, Yılmaz H, Ece I, et al. Laparoscopic ileal interposition with diverted sleeve gastrectomy versus laparoscopic transit bipartition with sleeve gastrectomy for better glycemic outcomes in T2DM patients. Obes Surg. 2018;28(1):77–86.
14. Celik A, Ugale S, Ofluoglu H, et al. Technical feasibility and safety profile of laparoscopic diverted sleeve gastrectomy with ileal transposition (DSIT). Obes Surg. 2015;25(7):1184–90.
15. Yan Y, Sha Y, Yao G, et al. Roux-en-Y gastric bypass versus medical treatment for type 2 diabetes mellitus in obese patients: a systematic review and meta-analysis of randomized controlled trials. Medicine (Baltimore). 2016;95(17):e3462.
16. Members of the expert committee on the diagnosis and classification of diabetes mellitus. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care.
17. Santoro S, Castro LC, Velhote MCP, et al. Sleeve gastrectomy with transit bipartition. A potent intervention for metabolic syndrome and obesity. Ann Surg. 2012;256(1):104–10.
18. American Diabetes Association. Data from the National Diabetes Statistics Report, 2014. Available at: http://www.diabetes.org/diabetes-basics/statistics/. Accessed June 10, 2014.
19. Sjöström L, Lindroos A-K, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. N Engl J Med. 2004;351:2683–93.

20. Dixon JB, Zimmet P, Alberti KG, et al. International diabetes federation taskforce on epidemiology and prevention. Bariatric surgery: an IDF statement for obese type 2 diabetes [review]. Arq Bras Endocrinol Metabol. 2011;55(6):367–82.
21. Mingrone G, Nolfe G, Gissey GC, et al. Circadian rhythms of GIP and GLP1 in glucose-tolerant and in type 2 diabetic patients after biliopancreatic diversion. Diabetologia. 2009;52(5):873–81.
22. Griffo E, Cotugno M, Nosso G, et al. Effects of sleeve gastrectomy and gastric bypass on postprandial lipid profile in obese type 2diabetic patients: a 2-year follow-up. Obes Surg. 2016;26(6):1247–5.
23. Azevedo FR, Santoro S, Correa-Giannella ML, et al. A prospective randomized controlled trial of the metabolic effects of sleeve gastrectomy with transit bipartition. Obes Surg. 2018 Apr 27;28:3012–9. https://doi.org/10.1007/s11695-018-3239-3.
24. Jørgensen NB, Dirksen C, Bojsen-Møller KN, et al. Improvements in glucose metabolism early after gastric bypass surgery are not explained by increases in total bile acids and fibroblast growth factor 19 concentrations. J Clin Endocrinol Metab. 2015;100(3):E396–406.
25. Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric surgery versus conventional medical therapy for type 2 diabetes. N Engl J Med. 2012;366(17):1577–85.
26. Lebel S, Dion G, Marceau S, et al. Clinical outcomes of duodenal switch with a 200-cm common channel: a matched, controlled trial. Surg Obes Relat Dis. 2016;12(5):1014–20.
27. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery and endoluminal procedures: IFSO worldwide survey 2014. Obes Surg. 2017;27:2279–89. https://doi.org/10.1007/s11695-017-2666-x.
28. H B, Estok R, Fahrbach K, et al. Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis. Am J Med. 2009;122(3):248–56.
29. Vest AR, Heneghan HM, Agarwal S, et al. Bariatric surgery and cardiovascular outcomes: a systematic review. Heart. 2012;98(24):1763–77.
30. 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(8):694–700.