

Factors Predicting Weight Loss after "Sleeve Gastrectomy with Loop Duodenojejunal Bypass" Surgery for Obesity

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Background: Laparoscopic sleeve gastrectomy with loop duodenojejunal bypass (SG LDJB) is a loop modification of biliopancreatic diversion with duodenal switch. The aim of this study was to analyze weight loss response and factors predicting weight loss outcomes after SG LDJB.

Methods: This was a retrospective study analyzing SG LDJB surgeries performed between May 2013 and December 2017 in 126 Indians suffering from obesity. The collected data was analyzed to understand weight loss efficacy and the factors predicting weight loss. Surgery was considered successful when percentage excess weight loss (%EWL) was $\geq 50\%$ or percentage total weight loss (%TWL) was $\geq 25\%$.

Results: %EWL was 95.77% and 83.84% and %TWL was 34.64% and 30.32% at the 1-year and 3-year follow-up, respectively. %EWL $\geq 50\%$ was 99.04% and 96.47% and %TWL $\geq 25\%$ was 91.35% and 75.29% at the 1-year and 3-year follow-up, respectively. Patient age and sex did not independently predict %EWL or %TWL. Preoperative body mass index (BMI), weight, and excess weight negatively predicted %EWL and positively predicted %TWL at the 1-year and 3-year follow-up. Multiple regression analysis showed that these parameters were independent predictors of %EWL and %TWL at 1 year, while preoperative weight and excess weight also independently predicted %EWL at the 3-year follow-up. In diabetic patients, %EWL was significantly lower at the 3-year follow-up and %TWL was significantly lower at the 1-year and 3-year follow-up.

Conclusion: SG LDJB was an effective bariatric surgery to treat obesity. Preoperative BMI, weight, excess weight, and the presence of diabetes were the significant factors associated with the weight loss outcomes.

Key words: Bariatric surgery, Obesity, Weight loss, Diabetes, Metabolic surgery

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INTRODUCTION

Obesity is considered a serious health and socioeconomic problem worldwide.¹ Obesity leads to the development of co-morbid conditions such as type 2 diabetes, hypertension, hyperlipidemia, and coronary artery disease.² Lifestyle modifications such as diet and exercise are the basic treatment modalities to obviate obesity. Weight loss with lifestyle modifications can be unsuccessful in those with severe obesity, hormonal imbalances, metabolic disor-

ders, or genetic problems. Pharmacotherapy has been found to be ineffective in the long run.¹

Surgical intervention has proven to be superior compared to lifestyle modifications and medical treatment in dealing with patients suffering from severe obesity.³ Bariatric surgery is the most effective technique for reducing body fat. The physiologically induced metabolic changes, hormonal changes, alterations in intestinal microflora, and modifications in nerve signaling contribute to the loss of body fat after bariatric surgery.¹

Laparoscopic biliopancreatic diversion with duodenal switch (BPD DS) is the most effective bariatric surgery for long-term weight loss and remission from diabetes.⁴ However, risk of severe malabsorption is very high in BPD DS since a significant length of the small intestine is bypassed.⁵ The gold standard bariatric surgery, laparoscopic Roux-en-Y gastric bypass (RYGB), is associated with complications such as at-risk gastric remnant, marginal ulcers, internal hernias, and dumping syndrome.⁶ Laparoscopic sleeve gastrectomy with loop duodenojejunal bypass (SG LDJB) is a novel bariatric surgery found effective in terms of weight loss and diabetes remission.⁷ A “long common channel” reduces the risk of malabsorption. Technically, it is a loop modification of BPD DS but with more proximal anastomosis to minimize malabsorption. Literature is not available on the factors predicting weight loss response after SG LDJB. This study aimed to analyze weight loss response and various factors predicting weight loss outcomes after SG LDJB.

METHODS

This was a retrospective study carried out in 126 patients between May 2013 and December 2017 conducted at Dr. Amar Bariatric & Metabolic Center, Hyderabad, India. Patients who underwent SG LDJB surgery for obesity were included in the study. Our study complied with the ethical principles for medical research involving human subjects in accordance with the Declaration of Helsinki.⁸ Institutional Review Board of Ethical Research approved this study (IRB No. ABMC/AH/2020/002) and written informed consent was obtained from all patients included in this study. All clinical and follow-up data were documented in a master data sheet. After performing sleeve gastrectomy (SG), the first part of the duodenum was disconnected and anastomosed to the jejunum, 200 to 250 cm distal to the duodenojejunal flexure (Fig. 1).

This study analyzed parameters including preoperative body mass index (BMI), weight, excess BMI, and excess weight (based on a BMI reference point of 25 kg/m²) and calculated percentage excess weight loss (%EWL), percentage excess BMI loss (%EBMIL), percentage total weight loss (%TWL) and percentage total BMI loss (%TBMIL) at 1-year and 3-year follow-up intervals. For example, %EWL at 1-year = (weight loss at 1 year/preoperative excess weight) ×

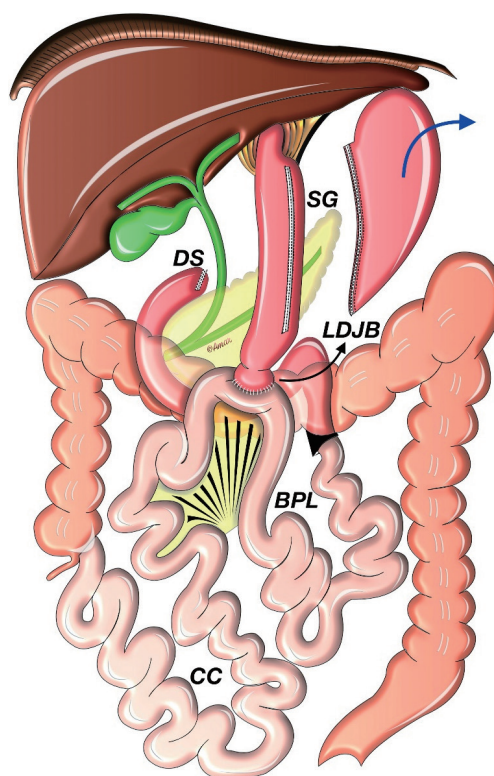


Figure 1. Pictorial diagram of “sleeve gastrectomy with loop duodenojejunal bypass”: sleeve gastrectomy (SG), duodenal stump (DS), loop duodenojejunal bypass (LDJB), biliopancreatic limb (BPL), and common channel (CC).

100 and %EBMIL at 1 year = (BMI loss at 1 year/preoperative excess BMI) × 100. Similarly, %TWL at 1 year = (weight loss at 1 year/preoperative weight) × 100 and %TBMIL at 1-year = (BMI loss at 1 year/preoperative BMI) × 100. Since %EWL and %EBMIL (and %TWL and %TBMIL) calculations yielded exactly the same values, both were used interchangeably. A %EWL (%EBMIL) above 100 did not indicate that the patient lost more than 100% of excess fat; it indicated that the patient’s BMI ended up below 25 kg/m².

The objective of this study was to analyze the weight loss efficacy of SG LDJB and to study the effect of age, sex, preoperative BMI, weight, excess weight, and diabetes status on %EWL and %TWL at the 1-year and 3-year follow-up. Weight loss parameters at the 1-year and 3-year follow-up after surgery were collected and analyzed with respect to age (< 50 years vs. ≥ 50 years), sex (male vs. female), preoperative BMI (< 40 kg/m² vs. ≥ 40 kg/m²), and preoperative diabetes status (diabetes vs. no diabetes). Simple linear regression analysis was performed to determine the impact of various factors on %EWL and %TWL at the 1-year and 3-year follow-up after sur-

gery. These factors were further analyzed by multiple regression analysis. Since the majority of patients had a BMI < 50 kg/m², a %EWL ≥ 50% was considered a successful weight loss outcome. Total weight loss (%TWL) ≥ 25% was alternatively used to define successful weight loss outcome. Those who fell below these reference points were considered to have inadequate weight loss. Those who achieved successful weight loss at the 1-year follow-up but fell below these reference points at the 3-year follow-up were considered to have weight regain. Patients who regained weight were included with those patients who had inadequate weight loss at the 3-year follow-up. Binary logistic regression was conducted to analyze the impact of various factors on the success rate after surgery.

For this study, diabetes was considered under remission when glycosylated hemoglobin (HbA_{1c}) was < 6.5% with a complete stoppage of insulin or oral hypoglycemic agents.⁹ Statistical analysis was performed using IBM SPSS version 23 (IBM Corp., Armonk, NY, USA). All *P*-values < 0.05 in various statistical tests were considered statistically significant.

RESULTS

Between May 2013 and December 2017, SG LDJB was performed on 126 individuals suffering from obesity. Out of 126 patients, 91 were males and 35 were females. Demographic data and perioperative parameters are depicted in Table 1. The mean BMI and weight at different time intervals are depicted in Tables 1 and 2. The mean preoperative excess weight was 44.88 ± 15.22 kg and mean excess BMI was 15.92 ± 5.74 kg/m² (based on the BMI reference point of 25 kg/m²). In this study, 78 of 126 patients (61.90%) were suffering from diabetes.

BMI loss, weight loss, %EWL, and %TWL at the 1-year and 3-year follow-up intervals are shown in Table 2. Overall BMI loss and weight loss were significant at the 1-year and 3-year follow-up intervals compared to preoperative BMI and weight, respectively. There was an increase in BMI and weight from 1-year to 3-year follow-up, which was statistically significant.

Variances in %EWL and %TWL in the different groups are summarized in Table 2. Simple linear regression and multiple regression analyses at the 1-year and 3-year follow-up intervals are shown in Table 3. There was no significant difference in %EWL and %TWL

Table 1. Demographic and perioperative data

Variable	Value (n = 126)
Age (yr)	40.79 ± 10.82
Age (< 50: ≥ 50, yr)	98:28 (77.78:22.22)
Sex (male:female)	91:35 (72.22:27.78)
BMI (kg/m ²)	40.92 ± 5.74
BMI (< 40: ≥ 40, kg/m ²)	60:66 (47.62:52.38)
Weight (kg)	116.26 ± 15.96
Diabetes:no diabetes	78:48 (61.90:38.10)
Duration of diabetes (yr)	4.85 ± 4.38
Duration of surgery (min)	188.65 ± 65.71
Intraoperative blood loss (mL)	36.4 ± 22.26
Major perioperative complications*	2 (1.59)

Values are presented as mean ± standard deviation or number (%).

*Leakage from upper end of sleeve requiring laparoscopic drainage, and portal vein thrombosis requiring long-term anticoagulation; both cases resolved without complications.

BMI, body mass index.

between patients aged < 50 years vs. ≥ 50 years at the 1-year and 3-year follow-up. Simple linear regression analysis showed that there was no significant correlation between age and %EWL. Age was found to be inversely proportional to %TWL at the 1-year follow-up, but not at the 3-year follow-up. Multiple regression analysis showed that patient age was not an independent predictor of weight loss outcomes. %EWL was higher in males vs. females but was significant only at the 1-year follow-up. There was no significant difference in %TWL between males and females. Multiple regression analysis showed that sex was not an independent predictor of weight loss outcomes (Table 3).

%EWL was higher in patients with a preoperative BMI < 40 kg/m² vs. ≥ 40 kg/m². However, %TWL was higher when preoperative BMI was ≥ 40 kg/m² vs. < 40 kg/m². Simple linear regression showed that preoperative BMI, weight, and excess weight negatively predicted %EWL and positively predicted %TWL. Multiple regression analysis showed that these factors were independent predictors of %EWL and %TWL at the 1-year follow-up, while preoperative weight and excess weight were also independent predictors of %EWL at the 3-year follow-up (Table 3). %EWL was higher in non-diabetic patients vs. diabetic patients but was significant only at the 3-year follow-up. %TWL was significantly higher in non-diabetic patients compared to diabetic patients at the 1-year and 3-year follow-up. Multiple regression analysis confirmed these findings.

Weight loss success rate and inadequate weight loss at the 1-year

Table 2. Weight loss parameters

Variable	1-Year follow-up			3-Year follow-up		
	n	Mean±SD	P	n	Mean±SD	P
Weight	104	75.44±11.08	<0.001*	85	79.18±12.12	<0.001 [†]
BMI (kg/m ²)	104	26.78±3.74	<0.001*	85	28.38±4.16	<0.001 [†]
Weight Loss (kg)	104	40.45±10.13	-	85	35.02±11.25	<0.001 [†]
BMI loss (kg/m ²)	104	14.39±3.66	-	85	12.6±4.09	<0.001 [†]
%Excess weight loss	104	95.77±25.26	-	85	83.84±24.65	<0.001 [†]
Subgroup						
Age (< 50 yr)	77	96.35±25.38	0.694 [‡]	60	82.88±23.06	0.580 [‡]
Age (≥ 50 yr)	27	94.12±25.3		25	86.15±28.5	
Male	75	98.88±27.35	0.014 [‡]	60	85.11±24.78	0.465 [‡]
Female	29	87.74±16.68		25	80.79±24.58	
BMI (< 40 kg/m ²)	49	111.97±24.82	<0.001 [†]	43	95.33±26.22	<0.001 [†]
BMI (≥ 40 kg/m ²)	55	81.35±14.82		42	72.08±16.14	
Diabetes	77	95.26±26.65	0.696 [‡]	73	80.81±22.67	0.005 [‡]
No diabetes	27	97.25±21.19		12	102.28±29.09	
%Total weight loss	104	34.64±5.88	-	85	30.32±7.6	<0.001 [†]
Subgroup						
Age (< 50 yr)	77	35.28±5.63	0.064 [‡]	60	30.14±8.06	0.739 [‡]
Age (≥ 50 yr)	27	32.84±6.32		25	30.75±6.49	
Male	75	34.07±5.93	0.109 [‡]	60	29.32±7.57	0.059 [‡]
Female	29	36.13±5.57		25	32.73±7.26	
BMI (< 40 kg/m ²)	49	32.7±5.4	0.001 [†]	43	28.2±8.15	0.009 [†]
BMI (≥ 40 kg/m ²)	55	36.37±5.79		42	32.49±6.39	
Diabetes	77	33.64±5.5	0.003 [‡]	73	29.05±6.85	<0.001 [†]
No diabetes	27	37.49±6.1		12	38.07±7.62	

*Paired samples t-test (preoperative to 1-year); [†]Paired samples t-test (1-year to 3-year); [‡]Independent samples t-test. SD, standard deviation; BMI, body mass index.

Table 3. Significance on regression analysis

Significance*	Simple linear regression				Multiple regression analysis				Binary logistic regression			
	%EWL		%TWL		%EWL		%TWL		%EWL ≥ 50		%TWL ≥ 25	
Predictor	1 Year	3 Years	1 Year	3 Years	1 Year	3 Years	1 Year	3 Years	1 Year	3 Years	1 Year	3 Years
Age	0.456	0.713	0.013	0.555	0.161	0.221	0.114	0.581	0.997	0.551	0.159	0.541
Sex [†]	-	-	-	-	0.973	0.763	0.566	0.672	0.999	0.998	0.784	0.863
Preoperative BMI	<0.001	<0.001	<0.001	<0.001	<0.001	0.121	0.015	0.386	0.997	0.215	0.064	0.262
Preoperative weight	<0.001	<0.001	0.001	0.004	<0.001	0.049	0.045	0.820	0.996	0.410	0.050	0.337
Preoperative EW	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	0.031	0.662	0.996	0.255	0.062	0.334
Diabetes status [‡]	-	-	-	-	0.428	<0.001	0.030	<0.001	0.997	0.482	0.658	0.208

Variables included in multiple regression analysis: age, sex, preoperative BMI, preoperative weight, preoperative EW, diabetes status.

*P-value in various tests; [†]Male vs. female; [‡]Diabetes vs. no diabetes.

%EWL, percentage excess weight loss (with 25 BMI reference point); %TWL, percentage total weight loss; BMI, body mass index; EW, excess weight.

and 3-year follow-up are documented in Table 4. Those patients who regained weight at the 3-year follow-up after achieving successful weight loss at the 1-year follow-up are also documented in Table 4. Binary logistic regression showed that none of the preop-

erative factors influenced success rate (Table 3).

Percentage of diabetes remission, improvement with HbA_{1c} < 6.5% taken as cut-off, use of insulin and oral hypoglycemic agents are depicted in Table 5. None of the diabetic patients had di-

Table 4. Weight loss success rate

Parameter	1 Year	3 Years
Based on %EWL \geq 50 reference point		
Successful weight loss (%EWL \geq 50)	99.04 (103/104)	96.47 (82/85)
Inadequate weight loss (%EWL $<$ 50)	0.96 (1/104)	3.53 (3/85)
Weight regain at the 3-year follow-up*	-	2.38 (2/84) [†]
Based on %TWL \geq 25% reference point		
Successful weight loss (%TWL \geq 25)	91.35 (95/104)	75.29 (64/85)
Inadequate weight loss (%TWL $<$ 25)	8.65 (9/104)	24.71 (21/85)
Weight regain at the 3-year follow-up	-	18.18 (14/77) [‡]

Values are presented as percent (number).

*Included in corresponding inadequate weight loss subgroup; [†]Out of 103 patients who had successful weight loss (%EWL \geq 50) at 1 year, 84 were available at the 3-year follow-up; [‡]Out of 95 patients who had successful weight loss (%TWL \geq 25) at 1 year, 77 were available at the 3-year follow-up.

%EWL, percentage excess weight loss; %TWL, percentage total weight loss.

abetes deterioration. Even though some patients who achieved remission had recurrence of diabetes later, they were still in the diabetes improvement category when compared to their preoperative diabetes status. None of our patients developed protein energy malnutrition after SG LDJB. None of the patients required revision in the form of adjusting the length of the biliopancreatic limb for weight regain or nutritional complications.

DISCUSSION

Bariatric surgery is an effective remedy to treat obesity. Weight loss after bariatric surgery is mainly due to physiological and hormonal changes including a reduction in ghrelin, anti-incretins, and an increase in distal ileal hormones such as glucagon-like peptide 1 and peptide YY, which reset fat mass to a lower limit. The same physiological changes are responsible for diabetes remission.¹⁰

SG LDJB is a novel metabolic surgery carried out with the objective to reduce malabsorption while maintaining surgery efficacy.¹¹ Endoscopic surveillance of the gastric sleeve is possible after this surgery and there is no at-risk gastric remnant. Anastomosing in a loop fashion rather than in the Roux-en-Y fashion reduces the number of anastomoses and mesenteric gaps, which probably translates into a reduced risk of internal hernias.¹¹

In our study, the mean %EWL and %TWL were greatest at the 1-year follow-up. These were relatively lower at the 3-year follow-up, but still %EWL was \geq 50% in $>$ 95% of patients and %TWL was \geq 25% in $>$ 75% of patients, indicating that the weight loss re-

Table 5. Diabetes parameters

Parameter	Preoperative	1 Year	3 Years
Response with HbA1c $<$ 6.5% cut-off			
Remission (%)	-	90.91 (70/77)	90.41 (66/73)
Improvement (%)	-	9.09 (07/77)	9.59 (07/73)
Recurrence (%)	-	-	4.48* (03/67) [†]
Usage of insulin	30.77 (24/78)	0 (0/77)	0 (0/73)
Usage of oral hypoglycemic agents	84.62 (66/78)	6.49 (5/77)	6.85 (5/73)

Values are presented as percent (number).

*Patients with recurrence are in the improvement category compared to preoperative status; [†]Sixty-seven of 70 patients who achieved remission at 1 year were available at the 3-year follow-up.

HbA1c, glycosylated hemoglobin.

sponse was durable with SG LDJB. Similarly, mean BMI loss and mean weight loss were greatest at the 1-year follow-up. In a study by Maciejewski et al.,¹² patients who underwent RYGB, laparoscopic adjustable gastric banding (LAGB), or SG lost 30.9%, 13%, and 23.4% of their baseline weight, respectively, at the 1-year follow-up. At 4 years, patients who underwent RYGB, LAGB, or SG lost 27.5%, 10.65, and 17.8% of their base-line weight, respectively.¹²

In our study, the proportion of inadequate weight loss with %EWL $<$ 50% was $<$ 1% at the 1-year and $<$ 5% at the 3-year follow-up. When %TWL $<$ 25% was taken into consideration, inadequate weight loss was $<$ 10% at the 1-year and $<$ 25% at the 3-year follow-up. This indicated that even though there was weight regain and an increase in BMI after 1-year, overall weight loss was maintained over a period of time after SG LDJB. Inadequate weight loss and weight regain are mainly related to a failure to maintain post-operative lifestyle modifications. Lifestyle modifications, regular follow-ups with the surgeon and dietician, and attending support group meetings may help patients to maintain post-surgery weight loss.

According to Ballantyne², younger patients had greater %EWL than older patients following RYGB and vertical banded gastroplasty bariatric procedures. In our study, age did not alter %EWL but younger patients had better %TWL at the 1-year follow-up. However, patient age and sex were not found to be independent predictors of weight loss outcomes after SG LDJB.

In our study, it was found that preoperative BMI negatively predicted %EWL, indicating that lower BMI patients had higher %EWL. However, preoperative BMI positively predicted %TWL, indicating that higher BMI patients had higher %TWL. Patients with mild

and severe obesity (BMI < 40 kg/m²) have better %EWL after this surgery compared to those with morbid obesity (BMI ≥ 40 kg/m²). These results are similar to the study by Ochner et al.,¹³ which showed that it was preferable to perform bariatric surgery when obesity was still in the initial stages as achieving a significant reduction in weight was easier in early stages of obesity. In this study, patients with a preoperative BMI of 35 to 49.9 kg/m² continued to lose weight, while individuals with a BMI ≥ 50 kg/m² regained significant weight, from 1 to 3 years after surgery.¹³

Our study showed that the presence of diabetes negatively predicted %EWL at the 3-year follow-up and %TWL at 1 and 3 years, indicating that non-diabetic patients responded well after SG LDJB. Sillén and Andersson¹⁴ showed that the presence of diabetes reduces %EWL after RYGB surgery.

Our study showed that the success rate after surgery was high at the 1-year follow-up and remained high even at the 3-year follow-up. Even though some preoperative factors predicted a weight loss response, they failed to influence success rate. It is probable that the high success rate after SG LDJB might have masked the influence of various factors. Diabetes remission reached a maximum at the 1-year follow-up in our patients with > 90% patients with HbA1c levels < 6.5%, even in the absence of taking any medications at the 1-year follow-up. This study showed that patients achieved significant glycemic control after SG LDJB without using any medications. Even at the 3-year follow-up, remission was > 90%, indicating that diabetes remission was durable after SG LDJB.

Significant weight loss after SG LDJB was perhaps more related to physiological and hormonal changes. The longer biliopancreatic limb may also contribute to an increase in weight loss.¹⁵ Increasing the length of the biliopancreatic limb can increase protein energy malnutrition. In most of our SG LDJB patients, biliopancreatic limb length was 250 cm and protein energy malnutrition was not observed. Preservation of the pylorus in SG LDJB probably played a role in preventing protein energy malnutrition. Since the pylorus controls gastric emptying, a longer length of the intestine could be bypassed without adverse malabsorptive outcomes.¹⁶ Detailed discussion of nutritional deficiencies after SG LDJB was beyond the scope of this article.

One drawback of this study was that there might have been bias while selecting different bariatric procedures for obesity and diabe-

tes. While SG is preferred in teenagers with mild obesity and females planning for future pregnancy, SG LDJB is preferred in all other patients with BMI < 50 kg/m² and single anastomosis duodenoileal bypass with sleeve was preferred in those with a BMI ≥ 50 kg/m². SG LDJB was preferentially offered to diabetic patients with BMI < 50 kg/m². Another drawback with this surgery was that the second part of the duodenum was excluded, obviating endoscopic access to the biliary tract. Furthermore, SG LDJB surgery is technically complex with a long learning curve. The results indicate that SG LDJB appears to be a promising surgery with durable %EWL and %TWL. Long-term data are required to evaluate the exact efficacy of this novel surgery.

The study showed that SG LDJB is a physiological and efficacious bariatric procedure in terms of weight loss response. Preoperative BMI, weight, excess weight, and presence of diabetes significantly predicted weight loss outcomes after SG LDJB.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Study concept and design: AV; acquisition of data: AV; analysis and interpretation of data: all authors; drafting of the manuscript: AV; critical revision of the manuscript: all authors; statistical analysis: all authors; administrative, technical, or material support: CK; and study supervision: AV.

REFERENCES

1. Szczuko M, Komorniak N, Hoffmann M, Walczak J, Jaroszek A, Kowalewski B, et al. Body weight reduction and biochemical parameters of the patients after RYGB and SG bariatric procedures in 12-month observation. *Obes Surg* 2017;27:940-7.
2. Ballantyne GH. Measuring outcomes following bariatric surgery: weight loss parameters, improvement in co-morbid conditions, change in quality of life and patient satisfaction. *Obes Surg* 2003;13:954-64.
3. Capristo E, Panunzi S, De Gaetano A, Raffaelli M, Guidone C,

- Iaconelli A, et al. Intensive lifestyle modifications with or without liraglutide 3mg vs. sleeve gastrectomy: a three-arm non-randomised, controlled, pilot study. *Diabetes Metab* 2018;44:235-42.
4. Copăescu C. Laparoscopic biliopancreatic diversion with duodenal switch: the most effective operation for type 2 diabetes mellitus. *How I do it? Chirurgia (Bucur)* 2018;113:704-11.
 5. Homan J, Betzel B, Aarts EO, Dogan K, van Laarhoven KJ, Janssen IM, et al. Vitamin and mineral deficiencies after biliopancreatic diversion and biliopancreatic diversion with duodenal switch: the rule rather than the exception. *Obes Surg* 2015;25:1626-32.
 6. Huang CK, Tai CM, Chang PC, Malapan K, Tsai CC, Yolsuriyanwong K. Loop duodenojejunal bypass with sleeve gastrectomy: comparative study with Roux-en-Y gastric bypass in type 2 diabetic patients with a BMI <35 kg/m², first year results. *Obes Surg* 2016;26:2291-301.
 7. Nor Hanipah Z, Hsin MC, Liu CC, Huang CK. Laparoscopic loop duodenaljejunal bypass with sleeve gastrectomy in type 2 diabetic patients. *Surg Obes Relat Dis* 2019;15:696-702.
 8. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 2013;310:2191-4.
 9. Lean ME, Leslie WS, Barnes AC, Brosnahan N, Thom G, McCombie L, et al. Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. *Lancet* 2018;391:541-51.
 10. Kim KS, Sandoval DA. Endocrine function after bariatric surgery. *Compr Physiol* 2017;7:783-98.
 11. Huang CK, Goel R, Tai CM, Yen YC, Gohil VD, Chen XY. Novel metabolic surgery for type II diabetes mellitus: loop duodenojejunal bypass with sleeve gastrectomy. *Surg Laparosc Endosc Percutan Tech* 2013;23:481-5.
 12. Maciejewski ML, Arterburn DE, Van Scoyoc L, Smith VA, Yancy WS Jr, Weidenbacher HJ, et al. Bariatric surgery and long-term durability of weight loss. *JAMA Surg* 2016;151:1046-55.
 13. Ochner CN, Jochner MC, Caruso EA, Teixeira J, Xavier Pi-Sunyer F. Effect of preoperative body mass index on weight loss after obesity surgery. *Surg Obes Relat Dis* 2013;9:423-7.
 14. Sillén L, Andersson E. Patient factors predicting weight loss after Roux-en-Y gastric bypass. *J Obes* 2017;2017:3278751.
 15. Jia D, Tan H, Faramand A, Fang F. One anastomosis gastric bypass versus Roux-en-Y gastric bypass for obesity: a systematic review and meta-analysis of randomized clinical trials. *Obes Surg* 2020;30:1211-8.
 16. Roslin M, Tugertimur B, Zarabi S, Cottam D. Is there a better design for a bariatric procedure? The case for a single anastomosis duodenal switch. *Obes Surg* 2018;28:4077-86.