Ulus Cerrahi Derg 2015; 31: 202-6
DOI: 10.5152/UCD.2015.2993

The effect of laparoscopic sleeve gastrectomy on morbid obesity and obesity-related comorbidities: A cohort study

Süleyman Çetinkünar[1], Hasan Erdem[1], Recep Aktimur[2], Mehmet Aziret[3], Sabri Özdaş[4], Banu Yürekli[5], Fahri Yetişir[6]

ABSTRACT

Objective: Bariatric surgery with multidisciplinary management is a more effective method to treat morbid obesity and obesity-related comorbidities compared with nonsurgical treatments. Laparoscopic sleeve gastrectomy (LSG) was initially performed as the first stage of biliopancreatic diversion with duodenal switch in the super-obese population. In the past few years, however, LSG has been performed as a definitive procedure because of its promising early and midterm results. The aim of this study is to evaluate the efficacy of our initial LSG series of 73 patients on excess weight loss (EWL) and resolution of obesity-related comorbidities in short-term follow-up.

Material and Methods: From March 2013 to May 2014, 78 morbid obese patients with an average body mass index (BMI) of 46.3 kg/m^2 underwent LSG. There is a 9-month follow-up period on average. Five patients were excluded from the study, because they could not be contacted. Comorbidities, preintervention BMI, glucose, HbA1c, and lipid profiles were recorded at 1, 6, and 12 months postintervention.

Results: After the surgery, the percent EWL was 58%. The mean serum glucose level, HbA1c level, LDL-cholesterol level, triglyceride level, insulin, and insulin resistance decreased significantly and the mean HDL-cholesterol level increased.

Conclusion: For the resolution of comorbidities, LSG may be used as an effective bariatric and metabolic surgery.

Keywords: Sleeve gastrectomy, bariatric surgery, morbid obesity

INTRODUCTION

Recently, obesity has become one of the most important public health problems worldwide in all age groups (1). The body mass index (BMI) in men and women increased by 0.4-0.5 kg/m^2 per decade (2). Morbid obesity (BMI≥40 kg/m^2) is a strong risk factor for several diseases [type 2 diabetes mellitus (T2DM), hypertension, steatohepatitis, pulmonary dysfunction, cardiovascular disease, and malignant tumors] and premature death (2).

Although prevention is the long-term solution for this vital public health problem, prevention may not always succeed. Furthermore, several conservative methods, including modification of lifestyle and medical treatment, are far from the desirable success in the long-term weight reduction (3, 4). Intragastric device application may be a supplemental therapy or may be used as a bridge to more durable, definitive procedures for weight loss. Ganesh et al. also stated that eligible patients (BMI ≥ 32.5 kg/m^2) should be encouraged to undergo bariatric surgery rather than Bioenteric Intragastric Balloon (BIB) to achieve long-term reliable weight loss. They found that although temporary weight loss can be achieved, mandatory removal of the BIB at 6 months results in regain of the lost weight in majority of patients (5).

Bariatric surgery in multimodal management modalities (lifestyle change, diet regulation, physical activity) has proven to be the treatment of choice for morbid obesity. This surgery is suggested for patients with BMI above 40 kg/m^2 or higher than 35 kg/m^2 when associated with comorbid disease (6).
Sjöström demonstrated that bariatric surgery for morbid obese adult patients may be the most actual treatment for continuous long-term weight loss and the resolution of obesity-related illnesses (7). Recently, the most applied bariatric surgeries are laparoscopic sleeve gastrectomy (LSG), mini-gastric bypass (MGB), Roux-en-Y gastric bypass (RYGB), and duodenal switch (DS). Laparoscopic sleeve gastrectomy may have results similar to those of MGB, RYGB, and DS, without the malabsorption problem (8, 9).

Lorry Hess introduced sleeve gastrectomy into the spectrum of bariatric surgery as a part of DS for the first time in 1988 (10). Gagner performed LSG as a first-step procedure in super-obese patients before DS or biliopancreatic diversion and published the results of this method in 1999 (11). Recently, several studies revealed that LSG might be even used as a single restrictive bariatric method for morbid obesity, with a satisfactory weight loss and improvement of metabolic disorders such as T2DM, dyslipidemia, and oth-

[1]Clinic of General Surgery, Adana Numune Training and Research Hospital, Adana, Turkey

[2]Clinic of General Surgery, Samsun Training and Research Hospital, Samsun, Turkey

[3]Clinic of General Surgery, Kars State Hospital, Kars, Turkey

[4]Clinic of General Surgery, Adıyaman Training and Research Hospital, Adıyaman, Turkey

[5]Department of Endocrinology, Ege University Faculty of Medicine, İzmir, Turkey

[6]Clinic of General Surgery, Atatürk Training and Research Hospital, Ankara, Turkey

Address for Correspondenc

Süleyman Çetinkünar
e-mail: slmcetin@gmail.com

Received: 17.11.2014
Accepted: 18.01.2015
Available Online Date: 09.04.2015

ers (12, 13). Until today, bariatric surgery can be roughly divided into restrictive procedures, malabsorptive procedures, or a combination of both. Laparoscopic sleeve gastrectomy does not include any digestive anastomosis and there are less complications after LSG compared with after RYGB (14). Thus, LSG has a widespread use among surgeons and a valuable bariatric procedure, with acceptable results even when used as a single procedure. The most irritating complication of LSG is the leak of the long stapler line, occurring in 1%-7% of patients (15).

Even with its widespread use, data for LSG's long-term weight loss are not uniform. Some authors report a weight regain after LSG (14). On the other hand, weight regain has been found after all bariatric operations (14).

For instance, depending on the mode of surgery and study design, the diabetes remission rate varied from 45% to 97%. Laparoscopic sleeve gastrectomy seems to be as efficient as RYGB in the treatment of diabetes and other comorbidities in morbid obese patients (16).

The aim of the present cohort study is to evaluate the efficacy of our initial LSG series of 73 morbid obese patients to induce weight loss and improvement of diabetes, hypertension, and hyperlipidemia in a short-term follow-up.

MATERIALS AND METHODS

Patient Selection

After the local ethics committee approval (Adana Numune Training and Research Hospital, ANEAH.EK.2013/82), from March 2013 to May 2014, 73 consecutive patients were included in the study. The patients aged between 18 and 60 years with BMI ≥40 kg/m^2 were admitted to our clinic for weight reduction, and then they underwent LSG. All patients were evaluated by a multidisciplinary approach for bariatric intervention and were informed of the risks and benefits of the LSG procedure. Written informed consent was obtained from all of the patients. The exclusion criteria were active *Helicobacter pylori* infection, active gastric ulcer, previous gastric resection or fundoplication, alcohol or drug abuse, psychiatric disorders, sweet eaters, and adult patients who were not allowed to undergo surgery by first-degree relatives. All sleeve gastrectomy operations were performed by the same surgical team laparoscopically. Patient's demographic characteristics, comorbidities, preintervention BMI, glucose, HbA1c, and lipid profile were recorded 1, 6, and 12 months postoperatively and compared within time.

Laparoscopic Sleeve Gastrectomy Technique

After the preoperative multidisciplinary team evaluation and approval, all patients underwent an upper-GI endoscopy, and the patients who had normal gastric mucosa were chosen for the surgery. Deep venous thrombosis prophylaxis with subcutaneous LMWH was given to all patients 12 h before and 10 days after the surgery, and elastic stockings are used in the perioperative period. Patients are positioned with both legs apart in the reverse Trendelenburg position. The surgeon is positioned in between the legs of the patient,

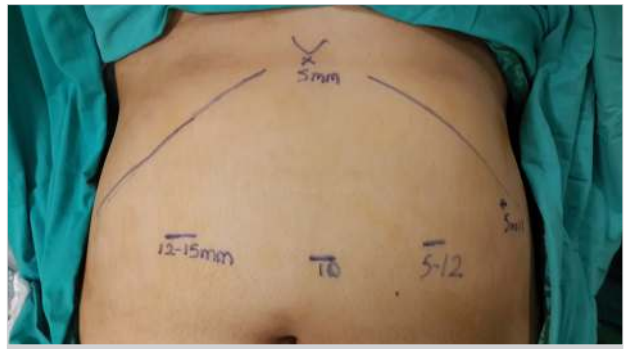

Figure 1. Port sites of sleeve gastrectomy procedure in our patients

with a camera assistant at left side and a first assistant on the right side of the surgeon. All operations were performed using four or five trocars (Figure 1). Because the body posture was affected negatively by obesity, a xiphoid is accepted as the landmark rather than an umbilicus. The first trocar is directly introduced 18-20 cm inferior to the xiphoid and patient's left side of the midline. To avoid iatrogenic injury, our first trocar insertion technique consisted of approaches applied step-wise. After the incision, a 10-mm trocar was inserted till it touched the anterior sheath of the rectus abdominis muscle. With continuous pressure, as it passed, the first "tic" was heard. The trocar was not loosened and was allowed to spring up with the abdominal wall. Then, a tightly holding trocar was pushed again till the second "tic" was heard, and the trocar was bluntly inserted into intra-abdominal space. A 30° scope was introduced, the abdomen was explored, and other trocars were applied with direct vision. The second trocar for liver retractor (5 mm) was inserted just below the xiphoid from the patient's left side. The third and fourth trocar (12-15 mm) for the surgeon's left and right hands were inserted symmetrically from the patient's left and right midclavicular line just about 2-3 cm higher from the level of the camera trocar. For operations using five trocars, the fifth trocar for the first assistant was inserted from the patient's left anterior axillary line just below the costal arc. With use of a bipolar vessel sealing device or harmonic scalpel, gastroepiploic arcade preserving dissection of a greater curvature was continued superiorly to the HIS angle of the stomach and inferiorly to 2–4-cm distance from the pylorus. Whole fundus and posterior attachment of the stomach are dissected and the left crus was visualized. After preparing the stomach, 39 Fr gastric tube placement was requested from the anaesthesiologist. The tube was placed in the lesser curvature. All staplers were applied from the 12–15-mm port on the patient's right side. Endo GIA™ 60 mm Articulating Medium/Thick Reload with Tri-Staple™ Technology, Purple were used to create vertical gastrectomy, with the preservation of the HIS angle just about 1 cm from the transection line. In all stapler usage, before firing the stapler, 15 s were waited for grasping of the tissues. If any hemorrhage occurs from the stapled line, it was controlled with endoclips or bipolar electro cautery. Buttress material, fibrin glue, or reinforcement sutures were not used. The resected specimen was removed from the patient's right side using a 12–15-mm trocar, which was used to apply staplers.

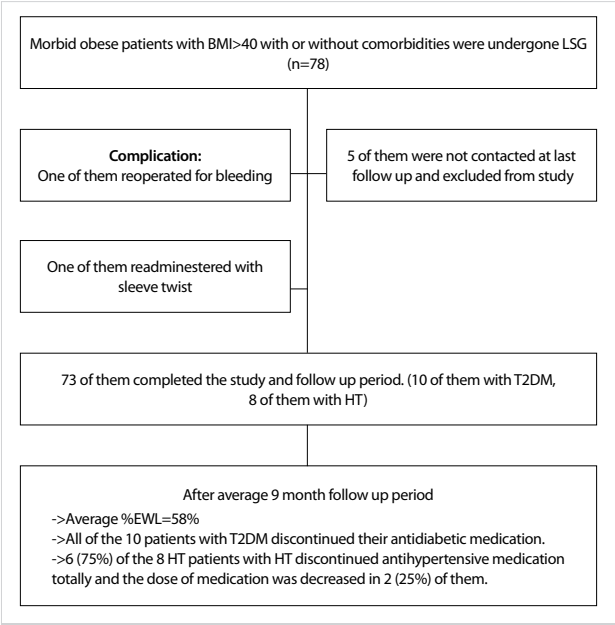

Figure 2. Flow chart

All patients were early mobilized at postoperative 8-12 h. After the confirmation of the absence of leakage on oral contrast radiograms on postoperative day 3, they were allowed to take a high-protein liquid diet, which was continued for first 2 weeks. After this, an 800-1200-kcal normal diet was initiated under the control of the clinic dietitian.

Statistical Analysis

Continuous data are presented as mean±standard deviation (SD) and the range (minimum-maximum). Dichotomous and categorical data are presented as numbers with percentages. For the comparison of pre- and postintervention data, the Student t-test for paired samples was used for normally distributed continuous data and Wilcoxon signed rank test was used for abnormally distributed continuous data. A two-tailed p-value of <0.05 was considered statistically significant. Statistical analyses were performed using the Statistical Package for the Social Sciences version 16.00 (SPSS, Inc., Chicago, IL, USA).

RESULTS

From March 2013 to May 2014, 78 consecutive patients aged between 18 and 60 years underwent LSG at our institution for the treatment of morbid obesity (Figure 2). None of the patients had undergone a previous bariatric surgery. The mean follow-up period was 9 months (range: 3-16 months). We could not reach 5/78 patients, and they were thus excluded from study. The mean age of patients was 34.1±8.2 years, and 12 (16%) of them were males and 61 (83.6%) were females. All operations were performed laparoscopically and none was converted to laparotomy. No intraoperative complications were observed. The mean duration of surgery was 70±38 min. In the postoperative period, only two patients required follow-up in the intensive care unit, and the remaining patients were followed up in the general surgery service. The mean length of stay in the hospital was 4.9±1.4 days. Only one (1.3%) patient was reoperated because of intra-abdominal hemorrhage from the posterior esophagogastric junction. Hemostasis was achieved with bipolar cautery and Surgicel and discharged without any problems at postoperative 7th day. Two patients were presented with decreased hemoglobin in the postoperative period and were managed with packed red blood cells and discharged after a few days of close observation. Only one (1.3%) patient required readmission for dehydration and electrolyte disturbances caused by intractable nausea and vomiting, and concentric stenosis at the incisura angularis was seen on endoscopy and treated with an endoscopic self-expandable biodegradable stent.

Table 1. Pre- and postoperative features of the 73 patients

	Preoperative	Postoperative (mean, 9 months after operation)	p
LDL	130.3±33.6	123.0±33.2	0.041
HDL	44.3±9.2	48.1±11.2	0.004
Cholesterol	196.0±44.6	184.3±40.3	0.002
Triglyceride	138 (52.5-585)	109.1 (50.7-585.4)	<0.001
Fasting blood glucose	99.6±16.7	91.9±27.3	0.014
HbA1c	5.7±0.7	5.2±0.5	<0.001
Insulin	20.4 (66-77)	7.9 (2.93-71.4)	<0.001
Insulin resistance	4.8 (1.5-22.6)	1.7 (0.4-20.9)	<0.001
BMI (mean±SD) kg/m^2	46.3±5.5	32.8±4.8	<0.001

LDL: low density lipoprotein; HDL: high density lipoprotein; BMI: body mass index

Laparoscopic sleeve gastrectomy induced a significant (p<0.001) weight loss. The median BMI decreased from 46.3 to 32.8 kg/m^2 at the mean follow-up of 9 months. The %EWL at the 9 month follow-up was 58%. Diabetes significantly improved after surgery. During the preoperative evaluation, 10 patients (14%) had T2DM, all of whom discontinued their antidiabetic medication after surgery. Hypertension was present in eight patients (10%), all of whom were taking antihypertensive medications. Six (75%) of these eight patients completely discontinued antihypertensive medication, and the dose of medication was decreased in two (25%) of them.

In this study, after the surgery, the mean serum glucose level, HbA1c level, LDL-cholesterol level, triglyceride level, Insulin, and insulin resistance decreased significantly and the mean HDL-cholesterol level increased (Table 1). The mean HbA1c level of 10 T2DM patients decreased from 6.86 to 5.6.

DISCUSSION

We found in this study that %EWL was 58%. T2DM, dyslipidemia and regulation of hypertension were improved at the 9 month follow-up period after LSG. All the diabetic patients (n=10) and 6/8 hypertensive patients were free of their medication at the end of the follow-up period.

Recently, accumulating evidence has demonstrated that bariatric surgery is a more effective method to produce greater

and sustained body weight reduction (%EWL 50% to 75%) compared with nonsurgical treatments (17).

Some studies show that LSG is successful in resolving T2DM and improving hypertension, hyperlipidemia, cardiorespiratory disease, obesity-related severe psychological problems, sleep apnea, and others (10, 11). Pham et al. (16) reported that SG and RYGB might be more efficient than GB to improve T2DM 1 year after the intervention. In their study, LSG seems to be at least as efficient as RYGB in the treatment of diabetes and other comorbidities. Major long-term nutritional deficiencies have not been described with LSG. If LSG is performed by an experienced surgical team, it is a simple bariatric surgical method with very low complication rate (18). The effects of LSG are based on three principles: gastric volume reduction, decrease of the ghrelin hormone concentration, and acceleration of gastric emptying (19). Zhou et al. (17) hypothesized that weight loss may be attributed not only to the restriction of the gastric capacity but also to the extreme changes in hormone secretion (ghrelin and obestatin), leading to great decreases in appetite and food consumption. However, there are controversial results about the hormone changes after surgery. Different surgeries of morbid obesity achieve different influences, for example, plasma obestatin concentrations were shown to be significantly increased in patients after LSG but without any alteration after gastric banding.

There are some variations in the LSG operation technique that may potentially affect its outcomes. The remaining volume of the stomach that is calibrated by orogastric bougie (with diameter from 32 Fr to 50 Fr) is important. A smaller diameter (32-42 Fr) of calibrating bougie has a better effect on weight loss in LSG patients (11, 20). We also used 39 Fr orogastric calibrating bougie in all patients during LSG and obtained a satisfactory result of 58% EWL at the mean follow-up duration of 9 months. There is currently no standard for defining bariatric surgery success or failure. Usually, a cut-off value for EWL of ≥50% has been used to state success and EWL of ≤25% is accepted as failure (1).

Some bariatric surgeons commonly use over-sewing sutures to reinforce the staple line in LSG in order to lower the risks of hemorrhage and leaks (21, 22). Kasalicky et al. (10) state that over-sewing can be omitted during LSG without increasing the number of postoperative complications. We did not use over-sewing sutures in our LSG operation. We can say that a carefully performed staple line in LSG without over sewing is feasible and safe. Although the use of over-sewing sutures in LSG does not provide an extra-contribution, it will cause the loss of time and money unnecessarily, as Kasalicky mentioned (10). In our technique, we used tri-stapler and waited 15-20 s after closing the stapling device to manage regular stapling and avoid bleeding. The staple line is carefully inspected before the end of the procedure, and any bleeding from the margin of the staple line is controlled with endoclips, bipolar electrocautery, or single stitches.

Short-and mid-term evidence on the effectiveness of LSG is hopeful. Laparoscopic sleeve gastrectomy is a multipurpose operation that has the advantage of convertibility to alternative surgical solutions. Surgical strategies to minimize the risk of potentially life-threatening staple-line leak after LSG are of critical importance. In a systematic review of 88 studies representing 8,920 patients, Gagner et al. (23) found that absorbable polymer membrane staple-line reinforcement was associated with a significantly lower leak rate than over-sewing and no reinforcement.

After the operation, the improving effect of LSG on T2DM within a short time may be explained by the hindgut hypothesis. Poorly predigested food, which is directly transiting from the sleeve to the distal bowel, improves glucose metabolism by stimulating intestinal cells to secrete glucagonlike peptide 1 (GLP1) and/or other incretions. According to some other studies, insulin secretion is also improved following the improvement of the glucose tolerance (24). Basso speculates the gastric hypothesis on the LSG mechanism of action that decreased HCl production may innervate antrum to produce gastrin releasing peptide that is responsible for early phase secretion of GLP1 (25).

Until today, an increasing number of authors confirm that LSG is a feasible and safe bariatric surgical method with an acceptable learning curve and low morbidity and mortality. There are some advantages of LSG such as the lack of nutrient malabsorption or dumping syndrome and the possibility of postoperative endoscopic examination of the whole residual stomach or cholangiography of bile ducts (18).

Recently, some modifications of the surgical technique have been introduced for better restriction; one of them is using a narrow diameter of calibrating bougie (32 Fr-38 Fr) and the other one is a short beginning resection line (3-4 cm from the pylorus) (10). In our study, we could get satisfactory results in the short-term follow-up with a 39 Fr orogastric calibrating bougie and 3-cm beginning resection line.

A major limitation of our study is that there is no control group. Prospective randomized studies with long term follow-ups in large series of patients are warranted in order to define the exact efficacy of LSG on morbid obesity, obesity-related comorbidities, and quality of life.

CONCLUSION

Bariatric surgery using a multimodal approach is a single chance of management for morbid obesity and obesity-related comorbidities. Laparoscopic sleeve gastrectomy can be accepted as a standalone bariatric and metabolic surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Adana Numune Training and Research Hospital.

Informed Consent: Written informed consent was obtained from patients diagnosed as morbidly obese and have sleeve gastrectomy who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - S.Ç., H.E.; Design - S.Ç., H.E., F.Y.; Supervision - S.Ç., H.E.; Funding - S.Ç., R.A.; Materials - M.A., S.Ö.; Data

Collection and/or Processing - B.Y., R.A., S.Ö., M.A.; Analysis and/or Interpretation - B.Y., R.A., F.Y.; Literature Review - S.Ö., M.A.; Writer - S.Ç.; Critical Review - F.Y., B.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Park JY, Song D, Kim YJ. Clinical experience of weight loss surgery in morbidly obese Korean adolescents. Yonsei Med J 2014; 55: 1366-1372. [CrossRef]
2. Raziel A, Sakran N, Szold A, Teshuva O, Krakovsky M, Rabau O, et al. Mid-term follow-up after laparoscopic sleeve gastrectomy in obese adolescents. Isr Med Assoc J 2014; 16: 37-41.
3. Adams TD, Gress RE, Smith SC, Halverson RC, Simper SC, Rosamond WD, et al. Long-term mortality after gastric bypass surgery. N Engl J Med 2007; 357: 753-761. [CrossRef]
4. Sjostrom L, Narbro K, Sjostrom CD, Karason K, Larsson B, Wedel H, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med 2007; 357: 741-752. [CrossRef]
5. Ganesh R, Rao AD, Baladas HG, Leese T. The Bioenteric Intragastric Balloon (BIB) as a treatment for obesity: poor results in Asian patients. Singapore Med J 2007; 48: 227-231.
6. Dixon JB, Zimmet P, Alberti KG, Rubino F; International Diabetes Federation Taskforce on Epidemiology and Prevention. Bariatric surgery: an IDF statement for obese Type 2 diabetes. Diabet Med 2011; 28: 628-642. [CrossRef]
7. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med 2013; 273: 219-234. [CrossRef]
8. Moy J, Pomp A, Dakin G, Parikh M, Gagner M. Laparoscopic sleeve gastrectomy for morbid obesity. Am J Surg 2008; 196: 56-59. [CrossRef]
9. Gagner M, Gumbs AA, Milone L, Yung E, Goldenberg L, Pomp A. Laparoscopic sleeve gastrectomy for the super-super-obese (body mass index >60 kg/m(2)). Surg Today 2008; 38: 399-403. [CrossRef]
10. Kasalicky M, Dolezel R, Vernerova E, Haluzik M. Laparoscopic sleeve gastrectomy without over-sewing of the staple line is effective and safe. Wideochir Inne Tech Malo Inwazyjne 2014; 9: 46-52. [CrossRef]
11. Kasalicky M, Michalsky D, Housova J, Haluzik M, Housa D, Haluzikova D, et al. Laparoscopic sleeve gastrectomy without an over-sewing of the staple line. Obes Surg 2008; 18: 1257-1262. [CrossRef]
12. Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve gastrectomy for morbid obesity. Obes Surg 2007; 17: 962-969. [CrossRef]
13. Nocca D, Guillaume F, Noel P, Picot MC, Aggarwal R, El Kamel M, 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. [CrossRef]
14. 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. [CrossRef]
15. Hutter MM, Schirmer BD, Jones DB, Ko CY, Cohen ME, Merkow RP, et al. First report from the American College of Surgeons Bariatric Surgery Center Network: laparoscopic sleeve gastrectomy has morbidity and effectiveness positioned between the band and the bypass. Ann Surg 2011; 254: 410-422. [CrossRef]
16. Pham S, Gancel A, Scotte M, Houivet E, Huet E, Lefebvre H, et al. Comparison of the effectiveness of four bariatric surgery procedures in obese patients with type 2 diabetes: a retrospective study. J Obes 2014; 2014: 638203. [CrossRef]
17. Zhou D, Jiang X, Ding W, Zhang D, Yang L, Zhen C, 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. [CrossRef]
18. Basso N, Casella G, Rizzello M, Abbatini F, Soricelli E, Alessandri G, et al. Laparoscopic sleeve gastrectomy as first stage or definitive intent in 300 consecutive cases. Surg Endosc 2011; 25: 444-449. [CrossRef]
19. Hady HR, Dadan J, Gołaszewski P, Safiejko K. Impact of laparoscopic sleeve gastrectomy on body mass index, ghrelin, insulin and lipid levels in 100 obese patients. Wideochir Inne Tech Malo-inwazyjne 2012; 7: 251-259. [CrossRef]
20. Kasalický M, Michalský D, Housová J, Haluzík M. Laparoscopic gastric tubulization--sleeve gastrectomy--another option for bariatric food intake restriction in morbidly obese subjects. Rozhl Chir 2007; 86: 601-606.
21. Chen B, Kiriakopoulos A, Tsakayannis D, Wachtel MS, Linos D, Frezza EE. Reinforcement does not necessarily reduce the rate of staple line leaks after sleeve gastrectomy. A review of the literature and clinical experiences. Obes Surg 2009; 19: 166-172. [CrossRef]
22. Szewczyk T, Janczak P, Duszewski M, Modzelewski B. Technical problems in laparoscopic sleeve gastrectomy. Videosurgery Miniinv 2009; 4: 95-101.
23. Gagner M, Buchwald JN. Comparison of laparoscopic sleeve gastrectomy leak rates in four staple-line reinforcement options: a systematic review. Surg Obes Relat Dis 2014; 10: 713-723. [CrossRef]
24. Bužga M, Holéczy P, Svagera Z, Svorc P, Zavadilová V. Effects of sleeve gastrectomy on parameters of lipid and glucose metabolism in obese women - 6 months after operation. Wideochir Inne Tech Malo Inwazyjne 2013; 8: 22-28. [CrossRef]
25. Basso N, Capoccia D, Rizzello M, Abbatini F, Mariani P, Maglio C, et al. First-phase insulin secretion, insulin sensitivity, ghrelin, GLP-1, and PYY changes 72 h after sleeve gastrectomy in obese diabetic patients: the gastric hypothesis. Surg Endosc 2011; 25: 3540-3550. [CrossRef]