THE MEDICAL BULLETIN OF
SISLI ETFAL HOSPITAL

DOI: 10.14744/SEMB.2019.17999
Med Bull Sisli Etfal Hosp 2020;54(1):36–40

Original Research

The Effects of Laparoscopic Sleeve Gastrectomy on Glucose Metabolism in Patients with a Body Mass Index below 35 kg/m^2

Burçin Batman, Hasan Altun

Department of General Surgery, Istinye University Faculty of Medicine, Istanbul, Turkey

Abstract

Objectives: The prevalence of obesity and its associated comorbidities are increasing all over the world. Laparoscopic sleeve gastrectomy has become the most common bariatric surgery in the world today, especially in the treatment of Type 2 diabetes mellitus, which is one of the effective surgical methods. The present study aims to investigate the effects on glucose metabolism in patients following laparoscopic sleeve gastrectomy.

Methods: In this study, the files of 174 patients who had laparoscopic sleeve gastrectomy with a body mass index between 30-35kg/m2 between March 2013 and September 2019 were analyzed retrospectively. Patients were evaluated by a multidisciplinary team in the preoperative period. Patients who met the criteria for laparoscopic sleeve gastrectomy were operated according to American Metabolic and Bariatric Surgeons criteria. Demographic data, body mass index, insulin, glycosylated hemoglobin (HbA1c), glucose, homeostasis model insulin resistance (HOMA-IR) values were recorded. The patients were followed up with visits to the outpatient clinic scheduled for 1-3-6 and 12 months postoperatively.

Results: The mean age of the 174 patients who underwent laparoscopic sleeve gastrectomy was 39.57±9.40, and the mean body mass index was 32.70±2.65. 149 patients (85.6%) were female. The mean hospital stay was 3.1±0.7 days. When glucose, HbA1c, HOMAR-IR and insulin values of the patients were examined, it was observed that the decrease was statistically significant at 12 months follow-up. There was a significant decrease in body mass index compared to the preoperative period.

Conclusion: Laparoscopic sleeve gastrectomy is an effective surgery on glucose metabolism in patients with a body mass index of 30-35kg/m^2.

Keywords: Bariatric surgery; glucose metabolism; laparoscopic sleeve gastrectomy.

Please cite this article as "Batman B, Altun H. The Effects of Laparoscopic Sleeve Gastrectomy on Glucose Metabolism in Patients with a Body Mass Index below 35 kg/m^2. Med Bull Sisli Etfal Hosp 2020;54(1):36–40".

According to the data of the World Health Organization about the increase in obesity, it was reported that 422 million adults suffered from diabetes in 2014, most of them being Type 2 diabetes mellitus (T2DM).[1] In addition to lifestyle changes and antidiabetic drugs, American Diabetes Association (ADA) has added bariatric and metabolic surgery to diabetes treatment.[2] Indeed, it is seen that bariatric surgery is superior to medical treatment in achieving diabetes remission.[3-7] Today, Laparoscopic Sleeve Gastrectomy (LSG) has taken its place as the most common bariatric surgery for obesity and associated comorbidities in the United States and Asia-Pacific region with its easy ap-

Address for correspondence: Burçin Batman, MD. Genel Cerrahi Bolumu Istinye Universitesi Tip Fakultesi, Istanbul, Turkey
Phone: +90 532 471 52 55 **E-mail:** drburcinbatman@yahoo.com

Submitted Date: October 22, 2019 **Accepted Date:** November 20, 2019 **Available Online Date:** March 24, 2020

plicability and low complication rates.[8] While LSG can be used as a treatment option in patients diagnosed as T2DM or metabolic syndrome with body mass indices (BMIs) between 30-35kg/m^2 and, this value has regressed to 27.5kg/m^2 in USA citizens of Asian descent.[2]

LSG is not only a restrictive surgery but also shows its metabolic effect by making serious changes in hormone levels, such as serum ghrelin, peptide YY (PYY), glucagon-like-peptide-1 (GLP-1) and glucose- independent peptide (GIP).[9, 10]

In this study, we aimed to investigate the effects of LSG on glucose metabolism in patients with BMIs ranging between 30-35 kg/m^2.

Methods

The files of patients, whose BMIs were between 30-35kg/m^2 and underwent LSG surgery in our center between March 2013 and September 2019, were examined retrospectively in this study. All patients were evaluated according to the American Clinical Endocrinologists Association (AACE), the Obesity Association (TOS) and the American Metabolic and Bariatric Surgeons Association (ASMBS) guidelines.[11] Approval was obtained for this study from the ethics committee of our hospital on 08.09.2019.

All patients were evaluated preoperatively by a multidisciplinary team consisting of a cardiologist, endocrinologist, dietician, psychologist, chest diseases and anesthesiologist. Abdominal ultrasonography and gastroscopy were also performed in patients deemed to be necessary. Biochemical tests, echocardiography, chest radiography and electrocardiography were routinely performed before the surgery. Demographic data, BMI, insulin, glycosylated hemoglobin (HbA1c), glucose, homeostasis model insulin resistance (HOMA-IR) values were recorded. The patients were followed up at the outpatient clinic visits planned at postoperative 1, 3, 6 and 12 months and thereafter. The surgical technique we used for LSG was described in our previous article.[12]

Statistical Analysis

In the statistical analysis of all data, IBM SPSS (Statistical Package for the Social Sciences) Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. was used. In descriptive statistics of the data, mean and standard deviation values were calculated using parametric and median values with nonparametric tests. The distribution of variables was checked using the Kolmogorov-Smirnov test. Values not showing normal distribution were calculated by the Friedman test. The results were evaluated within a 95% confidence interval, and $p<0.05$ was set as the level of statistical significance.

Results

Between March 2013 and September 2019, 174 patients with BMIs 30-35 kg/m^2 underwent LSG. Patients undergoing other bariatric surgeries and revision surgery were not included in this study. The mean age of the patients was 39.57±9.40 and 149 patients (85.6%) were women. The mean BMI was 32.70±2.65 kg/m^2. Demographic data and preoperative biochemical parameters are summarized in Table 1. All cases were completed laparoscopically without reversal. The mean hospital stay was 3.1±0.7 days. Any early or late mortality was not detected.

Compared with preoperative mean fasting plasma glucose value (FBG (105.40±31.42 mg/dL) postoperatively mean FBG values regressed to 92.40±26.36 mg/dL at the 3rd, to 90.37±11.33 mg/dL at the 6th and 92.96±17.69 mg/dL at the 12th months with a statistically significant difference between preoperative, and postoperative values ($p<0.0001$).

The mean HbA1c value was 5.55±0.86% in the preoperative period, and regressed postoperatively to 5.14±0.50% at the 3rd, to t4.99±0.56 at the 6th and 5.26±0.79 % at 12th months with a statistically significant difference between preoperative value ($p<0.0001$).

Compared to preoperative mean fasting blood insulin level (17.40±9.69), statistically significant decrease in nearly more than half of the baseline level was observed in the 3rd postoperative month (7.50±4.89). While mean fasting blood insulin levels value at postoperative 6th and 12th month were 7.71±6.05 i and 8.30±12.39, respectively ($p<0.0001$).

When the HOMA-IR levels were analyzed, a statistically significant and faster decrease was observed in the postoperative 3rd month (1.76±1.37) when compared with baseline values (4.50±2.70). HOMA-IR levels were 1.73±1.26, and 1.97±2.62 at 6, and 12th postoperative months, respectively ($p=0.002$).

Table 1. Demographic data and preoperative values

Parameters	**LSG n=174 (mean±SD)**
Gender (female/male)	149/25
Age (years)	39.57±9.40
BMI (kg/m^2)	32.70±2.65
Fasting blood glucose (mg/dl)	105.40±31.42
HbA1c	5.52±0.87
Insulin (µU/l)	17.40±9.69
HOMA-IR	4.50±2.70
Body weight (kg)	91.16±11.19
Height (cm)	166.81±7.85

*BMI: Body mass index; *HbA1c glycosylated hemoglobin; *HOMA-IR homeostasis model insulin resistance; *LSG Laparoscopic sleeve gastrostomy; *SD: Standard deviation.

The mean BMI value of the patients in the preoperative period was 32.70±2.65, while BMI values at 3rd, 8th, and 12th months were 26.43±1.73 a, 24.14±2.14 and 23.28±2.71, respectively. These findings were also statistically significant (p<0.0001).

Discussion

Obesity and associated comorbidities are increasing worldwide and becoming a global epidemic. Obesity is currently thought to affect at least 400 million adults, and BMIs of 30% of the US population will be higher than 30kg/m^2 in 2030.[13,14] Moreover, it causes many comorbidities, mainly T2DM.[15,16] Efficacy and permanence of bariatric surgery in T2DM treatment related to weight loss and obesity have been proven.[17] In our study, it has been shown that there is a significant positive change in glucose metabolism following LSG in patients with BMIs ranging between 30-35 kg/m^2 during at least 12 months of follow-up.

While mean FBG value was 105.40±31.42 mg/dL in the preoperative period, it decreased statistically significantly to 92.96±17.69 mg/dL at postoperative 12th month (p<0.0001).

Diabetes is a serious chronic disease that occurs when the pancreas does not produce enough insulin or the body cannot use the insulin, it produces effectively (insulin resistance). Insulin resistance is a precursor to diabetes and begins with hyperinsulinemia in the early period and progresses with disruption in β cells and the absence of insulin. The high-fat diet that causes obesity is known as the main precursor to insulin resistance. Therefore, the prevalence of obesity and T2DM increases all together.[18,19]

In LSG, 70-80% of the greater curvature of the stomach is removed. Thus, the amount of food taken is restricted and with the resection of the fundus, the amount of ghrelin decreases, and hormonal effect emerges with the loss of appetite.[9] In fact, it is still not fully understood how bariatric surgery provides remission of diabetes. Especially when compared to Roux-en-Y gastric bypass (RNYB), LSG that ensures remission of diabetes without touching the intestines makes the event even more complicated.[20-23] Although this phenomenon suggests that stomach can be a key factor in improving glucose homeostasis, the concept of "stomach-diabetes" has been introduced.[24,25] Although it has not been clarified yet, it is suggested that the shortening of the food contact time with the gastric mucosa may be the mechanism behind the development of glycemic control following bariatric surgery.[26]

LSG reduces ghrelin hormone levels, and at the same time, it increases the production of incretins, such as GLP-1, GIP which act together and enhances the release of glucose-dependent insulin from pancreatic β cells.[27] There is no response to GLP-1 secretion and GIP in diabetic individuals.

Thus, LSG has been observed to be at least as effective as RNYB on remission of diabetes with these hormonal effects. In addition, in a recent meta-analysis, LSG and RNYB have been shown to be effective on T2DM.[27] LSG effectively reduces glucose, insulin and HbA1c levels, and an improvement in insulin resistance is observed with improved glucose metabolism.[17,28] In our study, our results are consistent with the literature.

The mean HbA1c value was 5.55±0.86% in the preoperative period, which decreased to 5.26±0.79% at postoperative 12 months with a statistically significant reduction compared to the baseline value (p<0.0001). Similarly, preoperative mean fasting insulin level (17.40±9.69) and HOMA-IR (4.50±2.70) statistically significantly decreased to 8.30±12.39 and 1.97±2, respectively, at the end of the 12th postoperative month.

Although the length of hospital stay after LSG varies between clinics, the mean hospital stay was 3.1±0.7 days in our clinic. The differences between hospitalization times are also affected by comorbid diseases, such as the age of patients, chronic obstructive pulmonary diseases, hypertension and diabetes. Our results were also compatible with the literature data.[29]

The weak points of our study were the limited number of patients and the absence of a comparison group because only one surgical method was applied to all patients. In this study, postoperative 12-month results of patients were evaluated. More valuable information can be obtained by long-term evaluation of these patients and also increasing the number of patients.

Conclusion

With the available results, LSG is currently applied as one of the most effective, and easily applicable surgical treatment options in patients with BMIs ranging between 30-35kg/m^2 as BMI due to its positive effects on glucose metabolism, especially insulin resistance.

Disclosures

Ethics Committee Approval: The Ethics Committee of Liv Hospital Ulus provided the ethics committee approval for this study (09.08.2019-2019/24).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – B.B.; Design – H.A.; Supervision – H.A.; Materials – B.B.; Data collection &/or processing – B.B.; Analysis and/or interpretation – H.A.; Literature search – B.B.; Writing – B.B.; Critical review – H.A.

References

1. Diabetes Mellitus – epidemiology. 2. Diabetes Mellitus – prevention and control. 3. Diabetes, Gestational. 4. Chronic Disease. 5. Public Health. I. World Health Organization; NLM classification: WK 810.
2. American Diabetes Association. 7. Obesity Management for the Treatment of Type 2 Diabetes: Standards of Medical Care in Diabetes-2018. Diabetes Care 2018;41:S65–72. [CrossRef]
3. Buchwald H, Estok R, Fahrbach K, Banel D, Jensen MD, Pories WJ, et al. Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis. Am J Med 2009;122:248–56.e5. [CrossRef]
4. Haruta H, Kasama K, Ohta M, Sasaki A, Yamamoto H, Miyazaki Y, et al. Long-Term Outcomes of Bariatric and Metabolic Surgery in Japan: Results of a Multi-Institutional Survey. Obes Surg 2017r;27:754–62. [CrossRef]
5. Dicker D, Yahalom R, Comaneshter DS, Vinker S. Long-Term Outcomes of Three Types of Bariatric Surgery on Obesity and Type 2 Diabetes Control and Remission. Obes Surg 2016;26:1814–20.
6. Ribaric G, Buchwald JN, McGlennon TW. Diabetes and weight in comparative studies of bariatric surgery vs conventional medical therapy: a systematic review and meta-analysis. Obes Surg 2014;24:437–55. [CrossRef]
7. Schauer PR, Bhatt DL, Kirwan JP, Wolski K, Aminian A, Brethauer SA, et al; STAMPEDE Investigators. Bariatric Surgery versus Intensive Medical Therapy for Diabetes - 5-Year Outcomes. N Engl J Med 2017;376:641–51. [CrossRef]
8. Melissas J, Stavroulakis K, Tzikoulis V, Peristeri A, Papadakis JA, Pazouki A, et al. Sleeve Gastrectomy vs Roux-en-Y Gastric Bypass. Data from IFSO-European Chapter Center of Excellence Program. Obes Surg 2017;27:847–55. [CrossRef]
9. Langer FB, Reza Hoda MA, Bohdjalian A, Felberbauer FX, Zacherl J, Wenzl E, et al. Sleeve gastrectomy and gastric banding: effects on plasma ghrelin levels. Obes Surg 2005;15:1024–9. [CrossRef]
10. Peterli R, Wölnerhanssen B, Peters T, Devaux N, Kern B, Christoffel-Courtin C, et al. Improvement in glucose metabolism after bariatric surgery: comparison of laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy: a prospective randomized trial. Ann Surg 2009;250:234–41. [CrossRef]
11. Mechanick JI, Youdim A, Jones DB, Garvey WT, Hurley DL, McMahon MM, et al; American Association of Clinical Endocrinologists; Obesity Society; American Society for Metabolic & Bariatric Surgery. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient--2013 update: cosponsored by American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery. Obesity (Silver Spring) 2013;21 Suppl 1:S1–27. [CrossRef]
12. Batman B, Altun H, Simsek B, Aslan E, Namli Koc S. The Effect of Laparoscopic Sleeve Gastrectomy on Nonalcoholic Fatty Liver Disease. Surg Laparosc Endosc Percutan Tech 2019;29:509–12.
13. Müller MJ, Mast M, Langnäse K. WHO warns of obesity epidemic. Are we becoming a society of obese persons?. [Article in German]. MMW Fortschr Med 2001;143:28–32.
14. Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, et al. A potential decline in life expectancy in the United States in the 21st century. N Engl J Med 2005;352:1138–45. [CrossRef]
15. Steinbrook R. Surgery for severe obesity. N Engl J Med 2004;350:1075–9. [CrossRef]
16. Özdoğan E, Özdoğan O, Güldal Altunoğlu E, Köksal AR. Relationship of blood lipid levels with Hba1c and obesity in patients with type 2 diabetes mellitus. Med Bull Sisli Etfal Hosp 2015;49:248–54. [CrossRef]
17. Mihmanli M, Isil RG, Bozkurt E, Demir U, Kaya C, Bostanci O, et al. Postoperative effects of laparoscopic sleeve gastrectomy in morbid obese patients with type 2 diabetes. Springerplus 2016;5:497. [CrossRef]
18. Goodpaster BH, Sparks LM. Metabolic Flexibility in Health and Disease. Cell Metab 2017;25:1027–36. [CrossRef]
19. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27:1047–53. [CrossRef]
20. Keidar A, Hershkop KJ, Marko L, Schweiger C, Hecht L, Bartov N, et al. Roux-en-Y gastric bypass vs sleeve gastrectomy for obese patients with type 2 diabetes: a randomised trial. Diabetologia 2013;56:1914–8. [CrossRef]
21. 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;21:738–43. [CrossRef]
22. Murphy R, Clarke MG, Evennett NJ, John Robinson S, Lee Humphreys M, Hammodat H, et al. Laparoscopic Sleeve Gastrectomy Versus Banded Roux-en-Y Gastric Bypass for Diabetes and Obesity: a Prospective Randomised Double-Blind Trial. Obes Surg 2018;28:293–302. [CrossRef]
23. Rubino F, Forgione A, Cummings DE, Vix M, Gnuli D, Mingrone G, et al. The mechanism of diabetes control after gastrointestinal bypass surgery reveals a role of the proximal small intestine in the pathophysiology of type 2 diabetes. Ann Surg 2006;244:741–9. [CrossRef]
24. Zhu J, Gupta R, Safwa M. The Mechanism of Metabolic Surgery: Gastric Center Hypothesis. Obes Surg 2016;26:1639–41. [CrossRef]
25. Kim DJ, Paik KY, Kim MK, Kim E, Kim W. Three-year result of ef-

ficacy for type 2 diabetes mellitus control between laparoscopic duodenojejunal bypass compared with laparoscopic Roux-en-Y gastric bypass. Ann Surg Treat Res 2017;93:260–5. [CrossRef]

26. Oberbach A, Schlichting N, Heinrich M, Kullnick Y, Retschlag U, Lehmann S, et al. Gastric mucosal devitalization reduces adiposity and improves lipid and glucose metabolism in obese rats. Gastrointest Endosc 2018;87:288–99.e6. [CrossRef]
27. Li J, Lai D, Wu D. Laparoscopic Roux-en-Y Gastric Bypass Versus Laparoscopic Sleeve Gastrectomy to Treat Morbid Obesity-Related Comorbidities: a Systematic Review and Meta-analysis. Obes Surg 2016;26:429–42. [CrossRef]
28. Schauer PR, Kashyap SR, Wolski K, Brethauer SA, Kirwan JP, Pothier CE, et al. Bariatric surgery versus intensive medical therapy in obese patients with diabetes. N Engl J Med 2012;366:1567–76.
29. Fletcher R, Deal R, Kubasiak J, Torquati A, Omotosho P. Predictors of Increased Length of Hospital Stay Following Laparoscopic Sleeve Gastrectomy from the National Surgical Quality Improvement Program. J Gastrointest Surg 2018;22:274–8. [CrossRef]