The role of antral resection in sleeve gastrectomy. An observational comparative study

M. CLEMENTI[1], S. CARANDINA[2], V. ZULIAN[2], S. GUADAGNI[1], G. CIANCA[1], A. SALVATORELLI[1], A. GRASSO[1], F. SISTA[1]

[1]Dipartimento di Scienze Cliniche Applicate e Biotecnologie, Ospedale Civile San Salvatore, University of L'Aquila, L'Aquila, Italy
[2]ELSAN, Surgical Obesity Center (CCO), Clinique Saint Michel, Toulon, France

Abstract. – OBJECTIVE: The role of antral resection (AR) in laparoscopic sleeve gastrectomy (LSG) is still a greatly debated topic in the literature. The aim of this study was to evaluate the results and complications of AR in LSG.

PATIENTS AND METHODS: In this observational comparative study, 101 patients who underwent LSG were divided into two groups based on the extent of antral resection: 1 cm from the pylorus (1-DP group), or 6 cm from the pylorus (6-DP group). The %EWL (%Excess weight loss), resolution of T2D (Type 2 Diabetes Mellitus) and GLP-1 were investigated 48 hours before surgery and 3, 6 and 12 months after LSG. Postoperative complications in the first 30 days after surgery were also compared between the two groups using the Clavien-Dindo (CD) score.

RESULTS: A significant difference in %EWL was observed at 3 and 6 months in favor of the 1-DP group (38.9% and 57.8%, respectively) compared to the 6-DP group (31.4% and 49.7%, respectively). No difference in T2D resolution was observed between two groups during the follow-up period, with similar changes in GLP-1. Statistically significant differences were found between 1-DP and 6-DP group for the reintervention rate (CD III, 7.7% and 1.9%, respectively; $p = 0.02$) and life-threatening complications requiring intensive care unit management (CD IV, 3.8% and 0%, respectively, $p = 0.03$).

CONCLUSIONS: In LSG, sparing the antrum is associated with a significant reduction in the rate of postoperative complications, but the metabolic and weight results are comparable to those for antrum resection.

Key Words:
Obesity, Sleeve gastrectomy, Antral resection, Metabolic surgery, Diabetes mellitus type 2.

Introduction

Over the last decade, LSG has become the most frequently performed bariatric procedure worldwide[1-3]. Although metabolic and weight loss results have been reported by many authors, the mechanism of T2D resolution after LSG is still not well understood. Various studies[4-7] have shown that LSG is associated with diabetes improvement independent of the amount of weight loss or caloric restriction, suggesting that hormonal mechanisms could be involved. It has been proposed that removal of the gastric antrum and the resulting rapid gastric emptying lead to hormonal changes, highlighting the role of the stomach in the regulation of glucose metabolism[8-10]. The optimal distance from the pylorus to the beginning of LSG resection is crucial for deciding whether to resect or preserve the antrum. Currently, there is no consensus in the literature regarding the usefulness of antral resection[11-13]. The disagreement concerns the results in terms of T2D resolution and weight loss, as well as the rate of postoperative complications. Furthermore, only few studies have analyzed the metabolic and hormonal variations associated with antral resection in LSG.

The aim of this study was to evaluate the role of the gastric antrum in LSG in terms of weight loss and metabolic effects and whether its resection leads to an increase in postoperative morbidity. In this study, we analyzed two groups of patients in which the gastric antrum was resected or preserved.

Patients and Methods

Study Design and Assessment

This observational retrospective comparative study included patients with obesity who were admitted to two different centers of reference for the surgical treatment of obesity between December 2016 and July 2019. In accordance with the

Corresponding Author: Marco Clementi, MD; e-mail: marco.clementi@univaq.it

National Institutes of Health, all patients with a body mass index (BMI) >35 kg/m^2 and T2D were included in the study. The exclusion criteria were documented psychiatric disorders, alcohol or substance abuse, major diseases, such as cancer or autoimmune diseases, corticosteroid therapy, T2D duration <10 years[14,15] and HbA1c >6.5%. A multidisciplinary team consisting of a surgeon, a physician/endocrinologist, a psychiatrist, and a clinical nutritionist extensively evaluated all patients preoperatively. The study was approved by the University Internal Reviewer Board with protocol No. 55934. The study has been reviewed and approved by Thai Clinical Trials Registry (TCTR) Committee on 28 June 2021 (identification No. TCTR20210628001). Written informed-consent was obtained from all patients.

These patients underwent LSG and were assigned to two surgical intervention groups based on the amount of antrum spared. In the first group (1-DP group), patients underwent gastric resection starting 1 cm from the pylorus (LSG with antrectomy); while in the second group (6-DP group), patients underwent gastrectomy starting 6 cm from the pylorus (LSG without antrectomy). All patient received a low-calorie, high-protein diet for 2 weeks preceding the intervention.

The following four parameters were assessed: (1) weight loss results expressed as the change in BMI and percentage of excess weight loss (%EWL), where the ideal weight was calculated according to the Metropolitan Life Insurance Table for Medium Frame[16]; (2) postoperative complications in the first 30 days after surgery, classified based on the Clavien-Dindo classification system for grading of severity of complications[17]; (3) remission of T2D, defined as a plasma glucose level (PGL) <100 mg/dl and HbA1c <6.5% without medication; and (4) change in plasma glucagon-like peptide 1 (GLP-1) basal concentration.

The investigation was conducted by a bariatric surgeon on our team 48 h before surgery and 3, 6 and 12 months after LSG.

The endpoints of the study were to evaluate whether antrectomy affected glucose metabolism and weight loss and whether it leads to an increase in postoperative morbidity.

Surgical Technique and Postoperative Management

All the operations were performed with a standard technique with a four-ports technique using an ultrasonic dissector (Ultracision; Ethicon EndoSurgery, Cincinnati, OH, USA) and endostapler (Echelon 60 mm; Ethicon EndoSurgery, Cincinnati, OH, USA) charged with linear green and blue GIA reloads[10,18,19]. The resected stomach was extracted from the abdomen in a plastic bag (Endobag; Ethicon EndoSurgery, Cincinnati, OH, USA). In all cases, the gastric transection was performed using a 36-Fr gastric Bougie pushed toward and along the lesser curvature. The gastric dissection was started 1 cm from the pylorus for the 1-DP group and 6 cm from the pylorus for the 6-DP group, measured using a tape measure, and ending 1 cm lateral to the esophagogastric junction. The stapler line was not reinforced in any patients. A Jackson-Pratt drain was placed along the suture.

On postoperative day 2, all patients were checked for upper gastrointestinal transit. If no leakage was detected, a liquid diet was started on postoperative day 3, and patients were discharged on postoperative day 5 after successfully eating mashed foods.

Laboratory Analysis

Blood samples were taken to measure PGL, and HbA1c for comparison between the groups. The HbA1c level were determined by a direct turbidimetric inhibition immunoassay (Thermo-Fisher Scientific, Waltham, Massachusetts). The results are reported as % HbA1c. PGL was measured using the glucose oxidase method (YSI 2300 STAT Plus; YSI, Yellow Springs, OH, USA). GLP-1 was measured using a radioimmunoassay kit (Phoenix Pharmaceuticals, Mannheim, Germany) containing ^{125}I-labeled human and antibody human 3-36.

Statistical Analysis

This observational study was designed to evaluate whether antral resection is superior to preservation in terms of metabolic results and postoperative morbidity after LSG. The sample was calculated based on a statistical sample power of 1-β = 0.90, a type II error of 0.10 and a correlation between follow-up measurements of 0.700 using a two-tailed test. A *p*-value <0.05 was considered statistically significant. Data are presented as median (range) if not stated otherwise. The normality of distribution of the data was checked by the Shapiro-Wilk test. When parameters were not normally distributed, Kruskal-Wallis analysis of variance was performed. Categorical variables were expressed as a percentage. Comparisons were made using the chi-square test and Fisher's exact test.

Table I. Characteristic of the patients.

	Groups			
	1-DP Group n:52	6-DP Group n:51	Total n:103	*p*-value
Age, mean ± SD	42.8 ± 11.3	41.5 ± 12.5	41.6 ± 11.8	*p* = NS
BMI, mean ± SD	44.9 ± 6.8	45.3 ± 6.1	45.2 ± 6.4	*p* = NS
Sex, n (%) Female	33 (63.5%)	31 (60.8%)	64 (62.1%)	*p* = NS
Duration of diabetes (months)	54 ± 16	52 ± 26	53 ± 21	*p* = NS
HbAc1% ± SD	8.1 ± 1.5	8.3 ± 1.3	8.2 ± 1.4	*p* = NS
PGL ± SD (mg/dl)	167 ± 62	179 ± 51	172 ± 55	*p* = NS

BMI: body mass index, SD: standard deviation, HbAc1: glycated hemoglobin, PGL: Plasma Glucose Level.

Results

From a retrospective analysis of our database, 109 patients who met the inclusion criteria and were included in the study. In six of the enrolled patients, the follow-up data were largely incomplete and consequently were excluded from the study. For the included patients the rate of follow-up available data was 100% for both groups at 3 and 6 months and 92.8% and 98% at 12 months for the 1-DP group and 6-DP group, respectively. Eventually 52 patients were enrolled in the 1-DP group and 51 in the 6-DP group. Patients' demographic characteristics are presented in Table I. No statistical difference was found between the two groups in terms of age, preoperative BMI, sex and diabetic characteristics. The preoperative values of A1C and PGL, were comparable in both groups (Table I).

All of the conversion procedures were performed laparoscopically. None of the patients were converted to laparotomy, and the mortality rate was 0%. The operative time was comparable for both groups (68 ± 35 min *vs.* 75 ± 40 min). As shown in Table II, there was a significant difference in the length of hospital stay between the groups (7 ± 8.5 days *vs.* 4 ± 3.5 days; $p = 0.04$). Postoperative morbidity was 19.2% (n = 10) and 3.9% (n = 2) for the 1-DP group and 6-DP group, respectively ($p = 0.03$). The leakage rate was 3.8% (n = 2) and 0% (n = 0) for the 1-DP group and 6-DP group, respectively ($p = 0.03$) and postoperative ileus rate was significantly higher in the 1-DP group (Table II). No differences in minor complications were reported (Table II). Statistically significant differences were found in the reintervention rate between 1-DP and 6-DP group (Clavien-Dindo III, 7.7% and 1.9%, respectively; $p = 0.02$) and

Table II. Perioperative management and complications.

	Groups			
	1-DP Group n: 52	6-DP Group n: 51	Total n: 103	*p*-value
Mean operative time (min)	68 min ± 35	75 min ±40	71 min ±41	*p* = 0.7
Length of Hospital stay (Days)	7D ± 8.5 (3-20)	4D ± 3.5 (3-8)	6D ± 5.5 (3-20)	*p* =0.04
Mortality	–	–	–	–
Leakage	2 (3.8%)	–	2 (1.9%)	*p* = 0.03
Cardio-respiratory complications	1 (1.9%)	–	1 (1%)	*p* = 0.6
Staple line bleeding	2 (3.8%)	1 (2%)	3 (2.9%)	*p* = 1
Iileus	2 (3.8%)	–	2 (1.9%)	*p* = 0.03
Wound complication	3 (2.9%)	1 (1%)	4 (1.9%)	*p* = 0.6
Postoperative morbidity	10 (19.2%)	2 (3.9%)	12 (11.6%)	*p* = 0.002
CD – I	4 (7.7%)	3 (5.9%)	7 (6.8%)	*p* = 0.7
CD – II	1 (1.9%)	1 (2%)	2 (1.9%)	*p* = 1
CD – III	4 (7.7%)	1 (1.9%)	5 (4.8%)	*p* = 0.02
CD – IV	2 (3.8%)	–	2 (1.9%)	*p* = 0.03
CD – V	–	–	–	–

CD I-V: Clavien-Dindo Classification.

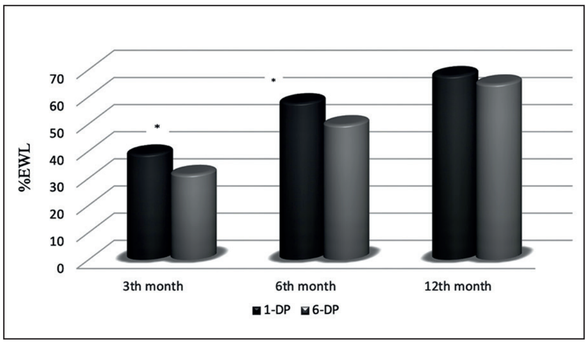

Figure 1. EWL changes after SG (*Statistically significant difference between each group using Kruskal Wallis test).

life-threatening complications requiring intensive care unit management (Clavien-Dindo IV, 3.8% and 0%, respectively, $p = 0.03$).

The overall %EWL at the 3rd, 6th and 12th month was 35.7%, 53.4% and 65.5%, respectively. A statistically significant difference in favor of the 1-DP group was found at 3 and 6 months (Figure 1).

The mean preoperative HbA1c level was 8.2 ± 1.4%, with no significant difference between the two groups (Table III). No difference in the rate of diabetes remission was observed during the follow-up period. The T2D remission rate at 3, 6 and 12 months was 26.9%, 48.1% and 59.6% for the 6-DP group and 23.5%, 47.1% and 64.7% for the 1-DP group, respectively, with an overall resolution of 62.1% at 12 months (p=0.80) (Table III).

Basal plasma GLP-1 concentrations were similar in both groups preoperatively and increased significantly after surgery, but there were no differences between the two groups during the follow-up period (Figure 2).

Discussion

Literature concerning the role of antrectomy in diabetes remission and weight loss following LSG is contradictory[11-13,18-21]. According to many, antral resection, by changing the gastric emptying reflex, would induce an alteration of gastric motility which could play a role in the treatment of morbid obesity[21]. This is supported by the "Hindgut Theory" relationship between gastric emptying, increased incretin GLP-1 secretion and increased systemic sensitivity to insulin[10,22,23]. Indeed, antral resection has been reported to increase GLP-1 secretion if initiated >1cm from the pylorus, as resection <1 cm has the opposite effect due to sub-occlusion[24], in agreement with the increase in the postoperative ileum observed in the DP-1 group of our study. Others, however, suggest that gastric emptying is attributable to food bolus reception and subsequent propulsive activity of the gastric fundus, suggesting that antral resection would not alter either receptive relaxation or the accommodation reflex of the gastric wall[25,26]. Indeed, a previous report failed to demonstrate changes in GLP-1 levels in either of these groups[12]. This is also in agreement with our study, despite the lack of significant improvement in diabetes or GLP-1 incretin levels, most likely attributable to the absence of non-diabetic patients in our study compared to the former study[12].

If one considers weight loss, the results change, at 12 months follow up, patients with antral resection exhibited a significant increase in %EWL compared to patients in the antral preservation, which was not apparent at 24 months and is consistent with the current literature[20,24]. We hypothesize that this results from an earlier sense of satiety in patients with antral resection, with lack difference at 24 months attributable to gastric emptying reflex adaptation[12,24], potentially caused by GLP-1 and Ghrelin incretins[20]. In contrast, a recent meta-analysis[11] of 7 studies, concluded that patients with antral resection do not exhibit significant weight loss prior to 24 months, with early changes in weight attributed to a less important weight gain compared to patients with antral conservation.

Table III. Resolution of T2D during the Follow up period (%HbA1c level).

	Pre-op	3th month	6th month	12th month)
1-DP Group	–	14 pts-26.9%	25 pts-48.1%	31 pts-59.6%
n:52	(8.1 ± 1.5)	(7.4 ± 1.4)	(6.6 ± 1.7)	(5.9 ± 1.9)
6-DP Group	–	12 pts-23.5%	49 pts-24.0%	33 pts-64.7%
n:51	(8.3 ± 1.3)	(7.5 ± 1.2)	(6.8 ± 1.5)	(6.1 ± 1.6)
Overall	–	26 pts-25.2%	74 pts-71.8%	64 pts-62.1%
N:103	(8.2 ± 1.4)	(7.5±1.1)	(6.7 ± 1.7)	(6.0 ± 1.7)
p value	p = NS	p = NS	p = NS	p = NS

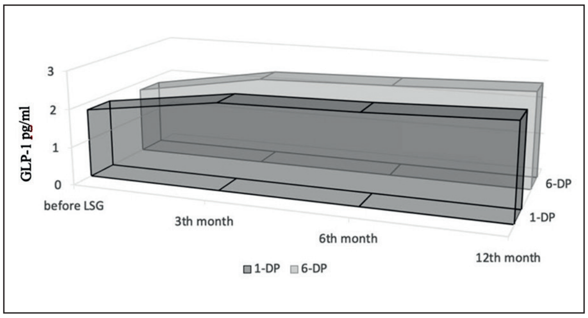

Figure 2. GLP-1 changes.

These differences may be explained by antral resection initiated at 1 cm from the pylorus with more extensive antrectomy in our study compared to initiation at 2 to 3 cm from the pylorus in the meta-analysis report[11].

Specific postoperative morbidity following antrectomy in the 1-DP group consisted of 3 fistulas, 2 obstructions to gastric emptying with postoperative ileus and 2 cases of bleeding from the staple line, which were not detected in the antral preservation group, but no statistically significant difference was calculated.

Overall postoperative morbidity was significantly higher (p = 0.002) following antrectomy in comparison to the antral preservation group. Staple line vicinity to the pylorus increased the risk of reduced gastric emptying, potentially linked to altered gastric kinetics, was ameliorated by prokinetic drugs without surgery but increased the length of hospitalization. Bleeding complications, following LSG, have been reported in up to 5% of patients[27,28], and originate in the majority of cases within the staple line, making staple depth choice, with respect to tissue thickness, of paramount importance. In our study, the incidence of bleeding complications was 2.9%. This is in agreement with the current literature and did not differ between groups. However, we agree that bleeding complications increase following antrectomy due to the elevated thickness of the antrum wall compared to other stomach areas, which increases the difficulty of achieving hemostasis[11,20,29].

The highest percentage of fistulas was observed in the DP-1 group. It has been reported that antral preservation, with section initiated 6 cm from the pylorus, reduces the incidence of leakage by lowering endoluminal pressure during gastric emptying[21]. This would help to explain the lowest leakage rate and subsequent abdominal sepsis observed in the DP-6 group.

Limitations of our study include: i) the small study population, which impeded statistical analyses and solid conclusions, particularly regarding postoperative complications, and ii) the absence of gastric emptying analyses which may help to explain differences in metabolic responses and late complications in the groups analyzed[30-31].

Conclusions

In conclusion, the increase in grade III and IV complications detected in the DP-1 group proports a potentially significant increase in postoperative antral resection risk that is not offset by either improved metabolic response and/or greater weight loss. For this reason, it is our opinion that antrum preservation during LSG is a more preferable approach. However, we support the call for future studies to better evaluate these procedures in larger cohorts.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Acknowledgements

This study was written in memory of the late professor Alessio Agnifili who drove us in the begin of our professional lives as researchers.

Funding

This research received no specific grants from any funding agency in the public, commercial, or not-for-profit sectors.

References

1) Arikh M, Gagner M, Heacock L. Laparoscopic sleeve gastrectomy: does bougie size affect mean %EWL? Short-term outcomes. Surg Obes Relat Dis 2008; 4: 528-533.
2) Carandina S, Zulian V, Nedelcu A, Sista F, Danan M, Nedelcu M. Laparoscopic sleeve gastrectomy follow-up: use of connected devices in the postoperative period. Surg Obes Relat Dis 2019; 15: 1058-1065.
3) Rosenthal RJ, Diaz AA, Arvidsson D, Baker RS, Basso N, Bellanger D, Boza C, El Mourad H, France M, Gagner M, Galvao-Neto M, Higa KD, Himpens J, Hutchinson CM, Jacobs M, Jorgensen JO, Jossart G, Lakdawala M, Nguyen NT, Nocca D, Prager G, Pomp A, Ramos AC, Rosenthal RJ, Shah S, Vix M, Wittgrove A, Zundel N.

International Sleeve Gastrectomy Expert Panel Consensus Statement: best practice guidelines based on experience of >12,000 cases. Surg Obes Relat Dis 2012; 8: 8-19.

4) Sista F, Abruzzese V, Clementi M, Guadagni S, Montana L, Carandina S. Resolution of type 2 diabetes after sleeve gastrectomy: a 2-step hypothesis. Surg Obes Relat Dis 2018; 14: 284-290.

5) Sista F, Abruzzese V, Guadagni S, Carandina S, Clementi M. High Resected Gastric Volume and poorly controlled DM2 in laparoscopic sleeve gastrectomy. Ann Med Surg (Lond) 2018; 36: 142-147.

6) Yip S, Signal M, Smith G, Beban G, Booth M, Babor R, Chase JG, Murphy R. Lower glycemic fluctuations early after bariatric surgery partially explained by caloric restriction. Obes Surg 2014; 24: 62-70.

7) Plourde CE, Grenier-Larouche T, Caron-Dorval D, Biron S, Marceau S, Lebel S, Biertho L, Tchernof A, Richard D, Carpentier AC. Biliopancreatic diversion with duodenal switch improves insulin sensitivity and secretion through caloric restriction. Obesity 2014; 22: 1838-1846.

8) Peterli R, Wölnerhanssen B, Peters T, Devaux N, Kern B, Christoffel-Courtin C, Drewe J, von Flüe M, Beglinger C. 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: 234-241.

9) Anderson B, Switzer NJ, Almamar A, Shi X, Birch DW, Karmali S. The impact of laparoscopic sleeve gastrectomy on plasma ghrelin levels: a systematic review. Obes Surg 2013; 23: 1476-1480.

10) Sista F, Abruzzese V, Clementi M, Carandina S, Cecilia M, Amicucci G. The effect of sleeve gastrectomy on GLP-1 secretion and gastric emptying: a prospective study. Surg Obes Relat Dis 2017; 13: 7-14.

11) McGlone ER, Gupta AK, Reddy M, Khan OA. Antral resection versus antral preservation during laparoscopic sleeve gastrectomy for severe obesity: Systematic review and meta-analysis. Surg Obes Relat Dis 2018; 14: 857-864.

12) Vives M, Molina A, Danús M, Rebenaque E, Blanco S, París M, Sánchez A, Sabench F, Del Castillo D. Analysis of gastric physiology after laparoscopic sleeve gastrectomy (LSG) with or without antral preservation in relation to metabolic response: a randomised study. Obes Surg 2017; 27: 2836-2844.

13) Abdallah E, El Nakeeb A, Youssef T, Abdallah H, Ellatif MA, Lotfy A, Youssef M, Elganash A, Moatamed A, Morshed M, Farid M. Impact of extent of antral resection on surgical outcomes of sleeve gastrectomy for morbid obesity (a prospective randomized study). Obes Surg 2014; 24: 1587-1594.

14) Basso N, Capoccia D, Rizzello M, Abbatini F, Mariani P, Maglio C, Coccia F, Borgonuovo G, De Luca ML, Asprino R, Alessandri G, Casella G, Leonetti F. 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.

15) Laville M, Disse E. Bariatric surgery for diabetes treatment: why should we go rapidly to surgery. Diabetes Metab 2009; 35: 562-563.

16) Metropolitan Life Insurance Co. New weight standards for men and women. Statistical Bulletin of the Metropolitan Life Insurance Company 1959; 40: 1-4.

17) Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004; 240: 205-213.

18) Omarov T, Samadov E, Coskun AK, Unlu A. Comparison of Weight Loss in Sleeve Gastrectomy Patients with and Without Antrectomy: a Prospective Randomized Study. Obes Surg 2020; 30: 446-450.

19) Sista F, Pessia B, Abruzzese V, Cecilia EM, Schietroma M, Carlei F, Amicucci G. Twelve years of gastric GIST A retrospective study of laparoscopic and open approach. Ann Ital Chir 2015; 86: 349-356.

20) ElGeidie A, ElHemaly M, Hamdy E, El Sorogy M, AbdelGawad M, GadElHak N. The effect of residual gastric antrum size on the outcome of laparoscopic sleeve gastrectomy: a prospective randomized trial. Surg Obes Relat Dis 2015; 11: 997-1003.

21) Michalsky D, Dvorak P, Belacek J, Kasalicky M. Radical resection of the pyloric antrum and its effect on gastric emptying after sleeve gastrectomy. Obes Surg 2013; 23: 567-573.

22) A. Maleckas, L. Venclauskas, V. Wallenius, H. Lönroth, L. Fändriks. Surgery in the treatment of type 2 diabetes mellitus. Scand J Surg 2015; 104: 40-47.

23) Sista F, Abruzzese V, Clementi M, Carandina S, Amicucci G. Effect of Resected Gastric Volume on Ghrelin and GLP-1 Plasma Levels: a Prospective Study. J Gastrointest Surg 2016; 20: 1931-1941.

24) Gagner M. Faster gastric emptying after laparoscopic sleeve gastrectomy. Obes Surg 2010; 20: 964-965.

25) Parker HE, Adriaenssens A, Rogers G, Richards P, Koepsell H, Reimann F, Gribble FM. Predominant role of active versus facilitative glucose transport for glucagon-like peptide-1 secretion. Diabetologia 2012; 55: 2445-2455.

26) Milone L, Strong V, Gagner M. Laparoscopic sleeve gastrectomy is superior to endoscopic intragastric balloon as a first stage procedure for super-obese patients (BMI > or =50). Obes Surg 2005; 15: 612–617.

27) Janik MR, Walędziak M, Brągoszewski J, Kwiatkowski A, Paśnik K. Prediction model for hemor-

rhagic complications after laparoscopic sleeve gastrectomy: development of SLEEVE BLEED calculator. Obes Surg 2017; 27: 968-972.

28) Sarkhosh K, Birch DW, Sharma A, Karmali S. Complications associated with laparoscopic sleeve gastrectomy for morbid obesity: a surgeon's guide. Can J Surg 2013; 56: 347-352.

29) Sabench Pereferrer F, Molina López A, Vives Espelta M, Raga Carceller E, Blanco Blasco S, Buils Vilalta F, París Sans M, Piñana Campón ML, Hernández González M, Sánchez Marín A, Del Castillo Déjardin D. Weight Loss Analysis According to Different Formulas after Sleeve Gastrectomy with or Without Antral Preservation: a Randomised Study. Obes Surg 2017; 27: 1254-1260.

30) Schietroma M, De Vita F, Carlei F, Leardi S, Pessia B, Amicucci G. Laparoscopic floppy nissen fundoplication: 11-year follow-up. Surg Laparosc Endosc Percutan Tech 2013; 23: 281-285.

31) Schietroma M, Piccione F, Clementi M, Cecilia EM, Sista F, Pessia B, Carlei F, Guadagni S, Amicucci G. Short- and Long-Term, 11-22 Years, Results after Laparoscopic Nissen Fundoplication in Obese versus Nonobese Patients. J Obes 2017; 2017: 7589408.