

# Laparoscopic sleeve gastrectomy: short and mid-term outcome

<sup>1,2</sup>Vlad Dudric, <sup>1</sup>Nicolae Constantea, <sup>3</sup>Dana Crișan, <sup>1</sup>Dan Axente, <sup>1</sup>Horațiu Silaghi, <sup>4</sup>Dan Miclăuș, <sup>4</sup>Antonia M. Ghișa, <sup>2</sup>Adrian Maghiar

<sup>1</sup> Department of Surgery, “Iuliu Hatieganu” University of Medicine and Pharmacy, Cluj-Napoca, Romania; <sup>2</sup> University of Medicine and Pharmacy, Oradea, Romania; <sup>3</sup> Department of Internal Medicine, “Iuliu Hatieganu” University of Medicine and Pharmacy, Cluj-Napoca, Romania; <sup>4</sup> Department of Surgery, Municipal Hospital of Cluj-Napoca, Cluj-Napoca, Romania; <sup>5</sup> “Iuliu Hatieganu” University of Medicine and Pharmacy, Cluj-Napoca, Romania

**Abstract.** Background: The laparoscopic sleeve gastrectomy (LSG) is a relatively simple surgical procedure with lower risks of complications and without disrupting the normal path of digestion and absorption. Although LSG has rapidly become one of the most popular bariatric procedures, the published results are contradictory regarding several aspects: details of the surgical technique, perioperative complications and their treatment. Material and methods: This prospective study included 95 patients who underwent LSG, carried out between 2010 and 2014 at the Municipal Hospital of Cluj-Napoca. Results: Average preoperative weight was  $144 \pm 24$  kg (101-240) with an average BMI of  $48.5 \pm 7.2$  (36-68). In 91 patients, LSG was performed as the primary bariatric technique, and 4 patients had a history of bariatric surgery. All patients (100%) were evaluated 6 months postoperatively, 82 (86%) after one year, and 62 (65%) patients after two years. Excess body mass index loss (EBMIL) was 52.61% after 6 months, 71.47% after one year, and 69.94% 2 years postoperatively. There were leak-related postoperative complications in 3 (3.1%) patients, one female patient developed pulmonary embolism, and gastric stenosis occurred in three patients (3.1%). Conclusion: Laparoscopic sleeve gastrectomy is an efficient bariatric procedure with low complication rates and good medium and long-term results in terms of weight loss.

**Key Words:** laparoscopic sleeve gastrectomy, excess body mass index loss, leak, gastric stenosis

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**Corresponding Author:** D. Axente, email: d\_axente@yahoo.com

## Introduction

In recent years, with the increasing prevalence of obesity among the world population, the incidence of morbid obesity has grown exponentially (Berghöfer et al 2008; Gallus et al 2015). Current guidelines based on published results recommend bariatric surgery as the only treatment that can provide sustainable weight loss over time (Fried et al 2014; Sjöström 2013). Bariatric surgery has undergone many transformations in recent decades from open surgery to well-defined laparoscopic techniques that have proven their effectiveness, such as the laparoscopic Roux-en-Y gastric bypass (LRYGB) or the laparoscopic biliopancreatic diversion (LBD). Although effective, they have a steep learning curve and involve a relatively high rate of complications (Picot et al 2009). For these reasons, there was an urgent need for the development of minimally invasive bariatric surgery techniques with lower degree of difficulty and fewer complications. Laparoscopic sleeve gastrectomy (LSG) is one of the recently introduced surgical procedures.

LSG is a relatively simple surgical procedure with lower complication rates and without major impact on the normal path of digestion and absorption. Performed initially by Gagner et al (2009; 2010) in superobese patients as the first stage of LBD and proving good results in terms of weight loss and resolution

of comorbidities, LSG was soon used as an independent bariatric surgical procedure (Ren et al 2000).

Initially, the effectiveness of the procedure was attributed solely to gastric volume reduction through the longitudinal resection of the stomach, the surgical intervention being classified as purely restrictive technique. Subsequent studies have shown the more complex mechanisms of action of LSG (Benaiges et al 2015; Ryan et al 2014).

Although the technique has been rapidly adopted, especially in Europe, with an increase in popularity greater than any other bariatric procedure, there is an inconsistency in published results regarding several respects: surgical details (distance for gastric resection, calibration tube size, the use of “hardening” methods for mechanical suture, etc.), postoperative complications and their treatment (Arias et al 2009; Fuks et al 2009).

The aim of this study is to evaluate the efficacy of LSG in patients with morbid obesity, regardless of BMI, by analyzing operative parameters, immediate and remote complications and assessing whether our results are consistent with literature.

## Material and method

**Patient selection.** This prospective study included 95 patients who underwent LSG and was conducted between 2010 and 2014 at the Municipal Hospital in Cluj-Napoca. Inclusion criteria

were those set out by the National Institutes of Health (NIH) in 1991: age between 18 and 60, a BMI greater than 40 without comorbidities or a BMI between 35 and 39 in association with major comorbidities (type 2 diabetes mellitus, high blood pressure, sleep apnea, respiratory dysfunction, etc.) (1991). Patients were considered eligible for surgery only after unsuccessfully trying nonsurgical treatment methods.

Exclusion criteria were as follows: severe disease with major surgery-related and anesthesia-related risks, patients addicted to drugs or alcohol, those with psychiatric disorders, patients who did not accept or understand the implications of bariatric surgery. All patients had to sign their informed consent to participate in the study, which was approved by the Ethics Committee of the Municipal Clinical Hospital. A database was created in 2010, which is still being filled in with information.

Preoperative evaluation. Patients were assessed by a multidisciplinary team consisting of a surgeon, anesthesiologist, cardiologist, gastroenterologist, radiologist, nutritionist, and psychologist. All patients underwent general clinical examination, which included measuring the following parameters: weight, height, waist circumference, hip circumference, blood pressure. Laboratory tests included complete blood count, blood sugar levels, serum lipid profile, glycated hemoglobin (HbA1c) in patients with diabetes, contrast radiography, gastroscopy, EKG, and an echocardiogram.

Surgical technique. All surgical interventions were performed by the same surgical team. The pneumoperitoneum was achieved by inserting the first automatically retractable 12 mm trocar, in addition to the introduction of other three or four trocars. After the identification of the pylorus, the dissection of the greater curvature was commenced approximately 6 cm cranially to the gastroesophageal junction using 5 or 10 mm LigaSure Atlas® forceps. Posterior stomach adhesions were cut for better exposure. Stomach resection was performed along the greater curvature using Endo GIA® staplers calibrated on a Faucher tube sized 32-36 Fr. Stapler type was chosen after assessing gastric antrum wall thickness, the first stapler was green (4.8 mm) or blue (3.5 mm), and the rest were blue. After tube retraction, we were overseeing the mechanical suture line. Suture tightness was tested intraoperatively by administration of 150 mL of methylene blue on nasogastric tube. At the end of all interventions a drainage tube was placed in the left lateral gastric region and maintained for 24-48 hours after surgery. The nasogastric tube was maintained 24 hours postoperatively. No bladder catheterization was performed.

Postoperatively, patients were transferred to the intensive care unit for 24 hours. Analgesics and antiemetics were administered to all patients, and anticoagulation therapy was continued by administering low-molecular-weight heparin and early mobilization 6-8 hours postoperatively. Proton pump inhibitors (PPIs) were administered throughout the duration of hospitalization and continued for 6 weeks postoperatively, and specific treatment for bacterial eradication was recommended in *Helicobacter pylori*-positive patients. Clear fluids were given the second day after surgery.

Postoperative evaluation. Radiographic examination was performed on the third day using orally administered water-soluble contrast agent (GASTROGRAFIN®). Patients were discharged on the fourth-fifth postoperative day if there were no

complications. Patients were reassessed 1 month, 3 months, and 6 months postoperatively, and then annually. The following parameters were measured during each reevaluation: weight, waist circumference, hip circumference, blood pressure. The following tests were repeated during the 6-month and the annual assessment: laboratory tests, contrast radiography, abdominal ultrasound, echocardiography, EKG. Pulmonary function tests were repeated in patients with preoperatively modified values. In some selected cases, upper gastrointestinal endoscopy was also repeated. Weight loss was confirmed by calculating the percentage of excess BMI loss (%EBMIL), considered to be the most appropriate calculation method. The method is suitable for patients with a BMI greater than 50 who are likely to achieve an ideal BMI of 25. The %EBMIL is calculated by reporting the difference between BMI at admission and at the time of reassessment to the difference between BMI at admission and the ideal BMI (25). This calculation method was chosen as most patients in research studies had a BMI below 50.

Statistical analysis was performed using MedCalc Statistical Software program version 16.8.4 (MedCalc Software bvba, Ostend, Belgium; <https://www.medcalc.org>; 2016). The Kolmogorov-Smirnov test was used to check the normal distribution of continuous variables. The Mann-Whitney test was employed to assess the difference between groups. The correlation between two continuous variables was checked using Spearman's rank correlation coefficient. A *p* value of <0.05 was considered statistically significant.

## Results

A total of 95 patients were included in the study, of which 60 women and 35 men with a mean age of  $41.8 \pm 11.2$  years, who underwent LSG between 2010 and 2014.

Average preoperative weight was  $144 \pm 24$  kg (101-240) with an average BMI of  $48.5 \pm 7.2$  (36-68). LSG was performed as the primary bariatric procedure in 91 patients, and 4 patients had a history of bariatric surgery (Laparoscopic Adjustable Gastric Banding – LAGB). High blood pressure (hypertension) was present in 48 patients (50%), 30 were preoperatively diagnosed with type 2 diabetes (31.5%), 39 (41%) with hypercholesterolemia, 53 (55.7%) with hypertriglyceridemia, 4 (4.2%) with sleep apnea, 48 (50.52%) with gastritis, 34 (35.7%) with esophagitis. Gallstones were diagnosed preoperatively in 5 (5.2%) patients. Twenty (21%) patients had undergone previous surgery in the lower abdomen, 5 (5.2%) in the upper abdomen, and the remaining 70 (73.6%) had no surgical history.

Duration of surgical intervention was greater in the first 33 cases and mean operative time dropped from 150 (120; 180) minutes to 80 (70; 90) minutes. There was a statistically significant increase in operative time in cases with concomitant surgery: 3 patients with adjustable gastric band suppression - 205 (102; 247) minutes, 1 patient with laparoscopic retrograde cholecystectomy (LRC).

Bleeding was the most common intraoperative complication, present in 10 (10.5%) patients. Small lesions in the liver capsule occurred in 9 (9.4%) patients and required electrocoagulation. The most common postoperative complication was bleeding, present in 9 (9.4%) patients. There was no postoperative death and average length of hospitalization was  $8.3 \pm 3.6$  days (2-16).

Leak occurring along the mechanical suture (in the gastroesophageal junction) complicated the postoperative evolution in 3 (3.1%) patients. They underwent a second laparoscopic surgical intervention for drainage. In 2 patients, the surgical treatment was accompanied by the endoscopic placement of prosthesis for a period 4 weeks. In one female patient, leak closed spontaneously 14 days after laparoscopic drainage. There was no association between the size of the calibration tube and the appearance of leak ( $p = 0.9$ ).

Pulmonary embolism was caused in one patient in the first 48 hours postoperatively.

Patient assessment was performed 6 months postoperatively in 95 patients (100%), after one year in 82 (86%) patients, and after two years in 62 (65%) patients. EBMIL was 52.61% 6 months postoperatively, 71.47% after one year, and 69.94% after 2 years. There was a direct correlation between the size of the calibration tube and EBMIL, without statistical significance ( $r = 0.148$ ;  $p = 0.1$ ).

Three patients (3.1%) with gastric stenosis had suggestive symptoms and were diagnosed by contrast x-ray imaging. Stenosis was observed in the gastric angle in all cases.

After 6 months, gallstones occurred in 39% of patients and mean EBMIL was  $55.6 \pm 15.1$ . After 1 year, 46 (48%) patients were diagnosed with gallstones, with a mean EBMIL of  $73 \pm 11$ , of which 5 were symptomatic and underwent laparoscopic cholecystectomy. After 2 years, 43 (45.2%) patients had gallstones and laparoscopic cholecystectomy was performed in 14 symptomatic patients. Patients with gallstones diagnosed postoperatively showed an average weight loss of  $49 \pm 9.3$  kg during postoperative follow-up. Altogether, 6.1% patients became symptomatic and required laparoscopic cholecystectomy. Only 5 patients complied with the therapeutic indications based on ursodeoxycholic acid.

## Discussions

Duration of surgical intervention decreased with the accumulation of surgical experience, without any correlation with patient BMI. The presence of concurrent surgical procedures led to a significant increase in operative time, which is why we do not recommend them to be performed by surgical teams with insufficient experience.

The most common intraoperative complication was bleeding in 10 (10.5%) patients, mostly occurring during the dissection of the greater curvature of the gastroepiploic arteries or more rarely, of the short gastric arteries, the main reason being the size of the omentum and the fatty infiltration of the gastrocolic ligament. In all cases, bleeding was controlled by coagulation with Ligasure forceps by applying hemostatic clips or sutures. There was no need for transfusion or conversion to open surgery. The mechanical suture was reinforced in all cases by continuous sling suturing that also supports hemostasis. Although there are studies that do not recommend the continuous sling suture for the reinforcement of mechanical suture, we preferred this method mainly for its hemostatic effect, which did not bring any changes in the rate of occurrence of postoperative leak (Aurora *et al* 2012; Burgos *et al* 2009).

The most important complication was anastomotic leak in 3 cases (3.1%). In all three cases, leak was located in the gastroesophageal junction and occurred 7-9 days postoperatively.

There was no correlation between the incidence of leak and patient associated pathology. Some studies correlate the risk of postoperative leak with the use of a small calibration tube (Aurora *et al* 2012; Sakran *et al* 2013). Patients in this study indicated no such association ( $p = 0.9$ ). Certain aspects of the surgical technique have been changed for the interventions performed after the last patient with leak. We minimized the dissection in the gastroesophageal junction, just enough to allow the adequate mobilization of the stomach to apply the last stapler. Stomach traction was no longer performed when applying staplers, achieving a mechanical suture that was "molded" on the calibration tube to a lesser extent.

In all cases, mechanical sutures were checked intraoperatively by introducing about 150 ml of methylene blue in the stomach. The test was negative in all cases, including in patients with postoperative leak. Contrast radiography was performed in all patients 2-3 days after surgery and the test was negative in all cases. There are authors who do not recommend these early postoperative leak testing methods as routine procedures based on the fact that most leaks occur later postoperatively (Dallal *et al* 2007; Goitein *et al* 2009). Although in our study none of the methods detected leak, we recommend their use mainly to identify mechanical suture defects that can be fixed in short periods of time, and not only for leaks occurring in the remote postoperative period.

Leak treatment methods vary depending on the time of diagnosis and the severity of the case. Several studies have reported successful treatment using non-surgical methods (Casella *et al* 2009; Csendes *et al* 2010). Based on the severity criterion, all patients in this study underwent surgery. Leak was relatively easily identified intraoperatively in two cases. In one case, upper gastrointestinal endoscopy was performed simultaneously with the surgical procedure. Spontaneous closure of leak occurred postoperatively in only one case, while for the others a self-extending stent was used for 4 weeks. This combination has recently proven a success rate of over 80% in the largest series of patients that it was chosen for (Puli *et al* 2012).

Obesity is a risk factor for deep vein thrombosis and pulmonary embolism, which is why patients undergoing bariatric surgery are at a high risk of developing such complications (Stein *et al* 2005). Despite prophylaxis applied by most bariatric surgery services, data published in the literature show that deep vein thrombosis and pulmonary embolism occur in between 0% and 3.5% patients (Magee *et al* 2010; Stein and Matta, 2013). The female patient with pulmonary embolism in our study received anticoagulant prophylaxis both preoperatively and postoperatively. After being diagnosed using computed tomography angiography, the patient was treated with anticoagulants at therapeutic doses and monitored in the ICU showing favorable evolution. Gallstones are one of the most common complications associated with rapid weight loss. The incidence of gallstones varies in published studies, especially that of symptomatic gallstones. Recent studies associate a higher risk of developing gallstones in patients with a weight loss greater than 25%, with no differences between bariatric techniques (Li *et al* 2009a; Li *et al* 2009b). The systematic administration of ursodeoxycholic acid postoperatively decreases the risk for gallstones (Stokes *et al* 2014). In our study, patient compliance to treatment with ursodeoxycholic acid was very low, with only 5 patients adhering

to the indications of administration, which is why we can not assess its effect on the prevention of gallstones.

Gastric stenosis is a rare complication of LSG. Published studies showed that it might be caused by the use of a small calibration tube and the application of reinforcement materials for mechanical sutures (Burgos *et al* 2013). Endoscopic dilation showed good results in two patients. The transformation of LSG into LRYGB was tried in one patient at another unit resulting in postoperative complications (anastomotic leak) eventually leading to total gastrectomy with esophageal anastomosis on the Roux-Y loop.

The patients in the present study were heterogeneous in terms of weight, BMI ranged from 36 to 68, with an average value of 48.54. The 6, 12, 24-month postoperative weight loss was comparable with data in the literature (Bellanger and Greenway, 2011; Gagner *et al* 2013; Vidal *et al* 2013). Recent studies have suggested that postoperative weight loss is determined by the size of the new stomach formed after surgery and by the size of the calibration tube, most authors recommending the use of an Fr 32 to an Fr 36 tube (Atkins *et al* 2012). This correlation was present in our patients, but without statistical significance. Two patients have undergone other bariatric surgical procedures due to insufficient weight loss 3 years postoperatively (EBMIL 24% and 35%).

## Conclusions

Laparoscopic sleeve gastrectomy is an effective bariatric procedure with low risks of complications and good short and medium-term results in terms of weight loss. The technique is easy to perform by a team with rich experience in laparoscopic surgery with minimal complications. Perioperative complications of LSG can be successfully treated if diagnosed early. The main complication of LSG is the presence of leak along the line of the mechanical suture, requiring emergency treatment, usually surgery, long-term hospitalization and relatively high costs until complete recovery. Other less frequent complications, such as pulmonary embolism, may complicate the postoperative course and can be life-threatening, requiring careful postoperative monitoring and emergency intervention using the appropriate treatment.

It is necessary to assess long-term postoperative results to better define the surgical technique.

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- Dana Crişan, Department of Internal Medicine, “Iuliu Hatieganu” University of Medicine and Pharmacy, 11 Tabacarilor Street, 400139, Cluj-Napoca, Cluj, Romania, email: crisan.dc@gmail.com
- Dan Axente, Department of Surgery, “Iuliu Hatieganu” University of Medicine and Pharmacy, 11 Tabacarilor Street, 400139, Cluj-Napoca, Cluj, Romania, email: d\_axente@yahoo.com
- Horaşiu Silaghi, Department of Surgery, “Iuliu Hatieganu” University of Medicine and Pharmacy, 11 Tabacarilor Street, 400139, Cluj-Napoca, Cluj, Romania, email: hsilaghi@yahoo.com
- Dan Miclăuş, Department of Surgery, Municipal Hospital of Cluj-Napoca, 11 Tabacarilor Street, 400139, Cluj-Napoca, Cluj, Romania, email: miclausdan@gmail.com
- Antonia-Maria Ghişă, “Iuliu Hatieganu” University of Medicine and Pharmacy, 8 Victor Babes Street, 400012, Cluj-Napoca, Cluj, Romania, email: antonia.ghisa@gmail.com
- Adrian Maghiar, University of Medicine and Pharmacy, 10 Piaţa 1 Decembrie Street, 410068, Oradea, Bihor, Romania, Romania, email: amaghiar@gmail.com

## Authors

- Vlad Dudric, Department of Surgery, “Iuliu Hatieganu” University of Medicine and Pharmacy, 11 Tabacarilor Street, 400139, Cluj-Napoca, Cluj, Romania, email: dudricvlad@gmail.com
- Nicolae Constantea, Department of Surgery, “Iuliu Hatieganu” University of Medicine and Pharmacy, 11 Tabacarilor Street, 400139, Cluj-Napoca, Cluj, Romania, email: nicuconstantea@yahoo.com

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