original article

Five-year outcomes for laparoscopic sleeve gastrectomy from a single center in Turkey

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BACKGROUND: There are no long- term results for laparoscopic sleeve gastrectomy (LSG) from Turkey.

OBJECTIVES: Assess the outcomes of LSG at 5 years.

DESIGN: Retrospective.

SETTING: Training and research hospital.

PATIENTS AND METHODS: The study included patients with LSG performed from August 2012 to December 2013. The data was prospectively collected with the aim of providing 5-year outcomes.

MAIN OUTCOME MEASURES: Changes in percentage excessive weight loss (%EWI) and BMI. Changes in the pharmacological treatment status of patients with type 2 diabetes mellitus and hypertension.

SAMPLE SIZE AND CHARACTERISTICS: 120 patients (89 female) completed follow up; mean age 37 years(range, 19-63 years), mean preoperative BMI 48.3 kg/m^2 (range 40-80.4 kg/m^2).

RESULTS: After a mean 5.6-year follow-up, the mean (SD) postoperative weight loss was 43.5 (11.8) kg and the mean (SD) BMI loss was 16.1 (4.4). The mean %EWL value was 62.9% (range, 30-101%). Most patients (87.5%, n=105) achieved satisfactory %EWL values. The major complication rate was 6.6%. After surgery, 74.2% of patients taking medication for hypertension were able to stop treatment, while 12.9% reduced the dose, of patients that took medication for diabetes, all had a dosage reduction.

CONCLUSIONS: We showed that LSG is an acceptable bariatric procedure, but in the long-term there may be weight gain and frequent reflux symptoms. We think renewed weight gain can be partially prevented by close clinical follow-up. There is a need for long-term randomized controlled studies with long-term follow-up to clearly define the indications for LSG.

LIMITATIONS: Retrospective, incomplete clinical visits, GERD symptoms not objectively assessed.

CONFLICT OF INTEREST: None.

Obesity is a significant public health problem that also creates a serious burden on the world economy. The increasing prevalence may reduce duration of life because obesity is accompanied by multiple comorbidities that negatively affect health in the long term.[1] The only evidence-based treatment choice for obesity and related comorbidities that is accepted is bariatric surgery. In the past, roux en-y gastric bypass and adjustable gastric band were the most commonly used techniques, but laparoscopic sleeve gastrectomy has gained increasing popularity. According to latest data of the American Society for Metabolic and Bariatric Surgery, the most commonly performed bariatric procedures are laparoscopic sleeve gastrectomy (LSG) (54%), followed by gastric bypass (23%), revisional surgery (14%) and gastric band (6%).[2]

Sleeve gastrectomy (SG) was first defined in 1990 as a part of the duodenal switch procedure with formation of a narrow stomach tube along the small curvature of the stomach.[3] Later, researchers proposed that LSG reduced the risk profile of the duodenal switch procedure in high-risk patients.[4] Additionally, LSG was accepted as a rapid single bariatric surgical procedure due to simplicity and efficacy.[5] Technical details of LSG are simpler than laparoscopic roux en-y gastric bypass or biliopancreatic diversion with duodenal switch, so it has lower complication rates. Other advantages include secure intestinal passage postoperatively, in addition to the choice to transfer to laparoscopic roux en-y gastric bypass or biliopancreatic diversion with duodenal switch surgery in cases with insufficient weight loss.

Contrary to the opinion that LSG is only a restrictive procedure, strong metabolic effects have been demonstrated. These effects are probably due to rapid stomach emptying of solid food and a probable reduction in ghrelin levels after resection of the gastric fundus.[6,7] Though there is still no consensus, in recent times LSG has been clearly observed to obtain nearly equivalent short-term outcomes to roux en-Y gastric bypass.[8] To date, long-term studies of LSG are rare. The aim of this study was to assess the long-term outcomes of a 5-year LSG by emphasizing weight loss, modification of comorbidities and complications.

PATIENTS AND METHODS

The study included patients with LSG performed from August 2012 to December 2013 at the Bakırköy Dr.SadiKonuk Training and Research Hospital in Istanbul and data was prospectively-collected with the aim of providing 5-year outcomes. The study was permitted by the local ethics committee (2018-35). Inclusion criteria were age 18 to 65 years, initial body mass index (BMI) of at least 40 kg/m^2 or BMI of 35 kg/m^2 in the presence of additional comorbidities related to obesity and failure of conservative treatment for at least 2 years. Patients were assessed by a multidisciplinary team comprising a surgeon, endocrinologist, anesthesiologist and psychiatrist. Preoperative assessment included abdominal ultrasound, gastroscopy, and if clinically necessary, cardiac sonography and respiratory function tests. Patients with gallstones on abdominal ultrasound or hiatal hernia identified on gastroscopy were assessed for preoperative cholecystectomy and cruces repair.

Patients who did not attend follow-up clinical check-ups were reached by telephone or through social media. To measure the efficacy of the procedure, we calculated the percentage of excessive weight loss (%EWL) and variation in body mass index (BMI). Data are presented as mean and standard deviation (SD), and median and interquartile range (IQR). The %EWL was calculated according to the method described by Montero et al.[9] The presence of gastroesophageal reflux disease (GERD) was assessed by typical symptoms according to the latest guidelines and/or proton pump inhibitor (PPI) treatment.[10] Questions related to typical symptoms (like postprandial stomach acidity, regurgitation, chronic cough) were asked. The pharmacological treatment status of the two main comorbidities related to obesity of type 2 diabetes and hypertension were recorded with questions like "did it stop after surgery (improvement), did the dose or number of medications used reduce (remission), or were there no changes?"

Surgical technique

Each procedure was completed with laparoscopy with five trocars. A 36F bougie was used to calibrate the volume of the remnant stomach. Linear gastrectomy began 2 cm proximal of the pylorus and continued until the gastroesophageal junction. According to the intraoperative decision of the surgeon, endoscopic clips were used to ensure hemostasis of the stapler line.

RESULTS

During the study period from August 2012 to December 2013 , LSG was performed on 144 consecutive patients. Twenty-four patients without appropriate clinical visits could not be reached at old telephone numbers or addresses, so follow-up was completed for 120 patients (including 31 males) (83.3%). The mean follow-up duration was 5.6 (5.3-6.2) years. The mean (SD) age of the 120 patients at the time of surgery was 37.8 (9.9) years, and ranged from 19-63 years. Mean (SD) preoperative BMI was 48.3 (6.8) kg/m^2 (range, 40-80.4) with a mean

weight of 132.3 (20.0) kg (range, 90-186) (**Table 1**).

Mean duration of surgery was 75 minutes (range, 45-125 minutes) and hospital stay was 5.5 days (range, 3-41 days). The most common early complication was rhabdomyolysis, which affected 13 patients (10.8%). Patients with rhabdomyolysis in the early period due to clinical suspicion and laboratory tests (creatine kinase is routinely assessed at the start of our LSG program), were successfully treated with intravenous fluids and forced diuresis. We did not observe any case with renal failure due to rhabdomyolysis. Hemorrhage occurred in a total of 6 (5%) patients, with one patient requiring emergency surgical intervention. For 7 (5.8%) patients with a leak during the early postoperative period, two did not respond to drainage and surgical treatment accompanied by endoscopic and interventional radiology and one patient developed pulmonary embolism in the early postoperative period died. The major complication rate in our series was 6.6% (Clavien-Dindo complication classification ≥ grade 3).

At the end of the follow-up period, the mean (SD) postoperative weight loss was 43.5 (11.8) kg (**Figure 1**) and the mean (SD) BMI loss was 16.1 (4.4) (**Figure 2**). The mean %EWL value was 62.9% (range, 30-101%). Most patients (87.5%, n=105) achieved satisfactory %EWL valuesaccording to the Reinhold criteria mentioned in Himpens. Two patients died due to sepsis after leakage. In one patient, pulmonary embolism developed at home after discharge and the patient died due to respiratory arrest (**Table 2**).

In 5% of patients (n=6) revision surgery was performed due to insufficient weight loss. Two patients with treatment refractory GERD symptoms and uncontrollable leak secondary to stenosis had laparascopic roux en-Y gastric bypass added. Two patients had mini gastric bypass performed due to renewed weight gain or unsuccessful weight loss and two patients had a re-sleeve performed due to observation of theresidual fundus on upper gastrointestinal series.

Before surgery hypertension was present in 31 patients. After sleeve gastrectomy, 74.2% (n=23) did not require pharmacologic treatment for hypertension, while 12.9% (n=4) had reduced dosages. There was no change in treatment of 12.9% (n=4) of hypertension patients. In our series 27 patients had type 2 diabetes. After LSG, 74% (n=20) did not use any medication for diabetes, while 25.9% (n=7) reduced the dose of medication (**Table 3**). Before surgery 18 patients (6.6%) had hiatal failure present on gastroscopy, with only 4 patients (3.3%) complaining of reflux. These cases had simultaneous crurorapy performed. After LSG, 30 cases (25%) were identified as having GERD requiring medical treatment. On follow-up, 12 cases (10%) developed de novo GERD.

DISCUSSION

We have shared the outcomes for a mean 5.6-year follow-up of 120 patients who underwent LSG and pres-

Table 1. Preoperative demographic and clinical data.

Gender (male/female)	31/89
Age (years)	37.8 (9.9), 19.0-63.0
Body mass index (kg/m^2)	48.3 (6.8), 40.0-80.4
Weight (kg)	132.3 (20.0), 90.0-186.0

Data are mean (standard deviation), and range.

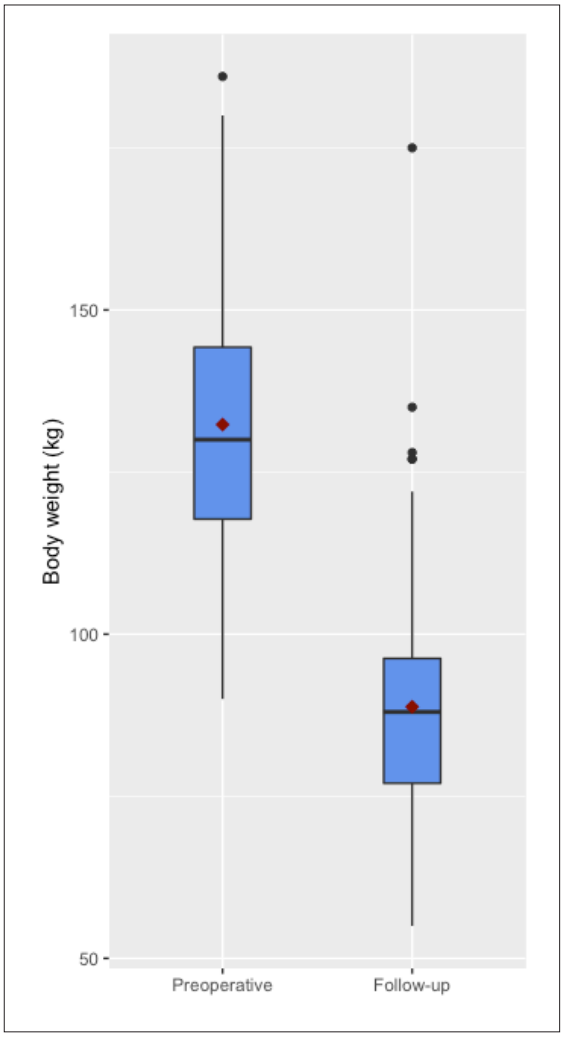

Figure 1. Change in body weight (kg) (median, IQR, outliers; red dot: mean).

Table 2. Postoperative follow-up parameters.

Variable	Value
Complications (n)	
Rhabdomyolysis	13 (10.8)
Hemorrhage	6 (5.0)
Leak	7 (5.8)
Weight loss	
Body mass index (kg/m^2)	32.1 (23-55)
%EWL	62.9 (30-101)
Mortality (n)	3

Data are number (%) or mean (range).

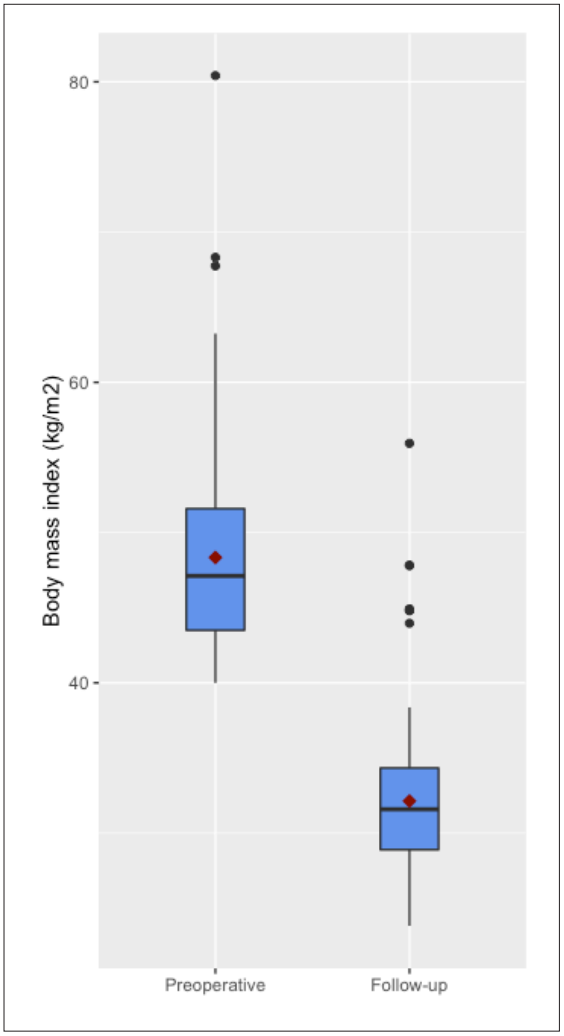

Figure 2. Change in body mass index (kg/m^2) (median, IQR, outliers; red dot: mean).

Table 3. Treatment of comorbid diseases after surgery.

Comorbidity	Preoperative	Postoperative
Type 2 diabetes mellitus		
Present	27 (22.5)	0
Absent	93 (77.5)	20 (74.0)
Reduced	-	7 (25.9)
Hypertension		
Present	31 (25.8)	4 (12.9)
Absent	89(74.2)	23 (74.2)
Reduced	-	4 (12.9)

Data are number (%).

ent changes in weight loss and BMI and %EWL values. We also report improvement and remission rates for comorbidities, and accompanying complications during follow-up and revision surgery rates. Our results are consistent with recent studies that have shown that LSG leads to effective weight loss, improvement or remission of comorbidities and relatively few early postoperative complication rates.[11-13] Buchwald and Oien in 2013 reported clear improvements in LSG performance throughout the world, while the performance of laparoscopic Roux-en-Y gastric bypass, biliopancreatic diversion and adjustable gastric band has not improved.[5] The greater use of LSG on a global scale can be largely linked to promising initial outcomes; however, the question still remains about whether these outcomes remain good in the long term.

Himpens et al reported that 75% of LSG patients regained weight in 3 to 6 years and %EWL outcomes were 77% against 53%.[15] Similar results were reported by Braghetto et al.[16] for 5-year follow-up outcomes. Long-term series are rare to date.[16,17] Our study shows the outcomes up to 5 years from a single-center organization. Permanent weight loss after bariatric surgery is an important aim of bariatric surgery and generally is the most important outcome parameter measuring success of the procedure.

Juodeikis et al reported 8-year mean %EWL value of 54.8% in a systematic review,[18] while Brethauer et al showed %EWL values varied from 33% to 85% after LSG in a systematic review.[19] In 2014, Abd Ellatif et al reported %EWL value of 61% at the end of the 5th year.[20] Our results for weight loss (%EWL 62.9%) are consistent with other reports. Our reoperation rate (5%) was lower than longer studies, such as Arman et al which reported as 31.7%.[21]

Rhabdomyolysis is a morbid and potentially mortal complication of bariatric surgery. Patients with muscle pain after bariatric surgery are at significant risk of rhabdomyolysis, which can cause renal injury and require emergency treatment. Male patients, patients with high BMI or long operations are defined as being at high risk of rhabdomyolysis. Lagandre et al reported a rhabdomyolysis rate of 26.5% after bariatric surgery in their study.[22] In our series 13 cases (10.8%) had a rhabdomyolysis diagnosis.

Remission or improvement in type 2 diabetes and hypertension patients have been reported in many short-term studies after LSG; however, few long-term outcomes have been reported. A study reporting the long-term outcomes after LSG in a systematic review stated diabetes and hypertension improved by 77.8% and 68%, respectively. As shown in **Table 3**, our results related to diabetes and hypertension treatment are similar to the outcomes stated by Juodeikis et al.[19] Increased gastric emptying and reduced gastric acid secretion after LSG cause incomplete digestion of food.[6,7,23] Increased stomach emptying is associated with improved weight loss and type 2 diabetes mellitus due to high levels of glucagon-like peptide-1 levels, which is a glucose-regulating-insulin increasing material.[24] This beneficial effect of stomach emptying reduces over time as the remnant stomach regains compliance allowing more frequent digestion of larger volumes.[6] Long-term renewed weight gain may be triggered by diet factors alone, like changes in nutritional behavior with orientation toward food containing very high calories. Diet problems can be identified and treated with frequent clinic visits targeting patient education and motivation. This topic has been shown for previous restrictive procedures, especially for adjustable gastric band.[25,26] Continuous support and monitoring of loss is known to play an important role in regaining weight. As a result, based on our clinical experience we believe continuous clinical follow-up is required.

There is a general concern that the remnant stomach may enlarge over time, instead of regaining normal compliance. Dilation of the stomach allows the patient to consume larger amounts of food; as a result, there is weight regain. In our series, "neofundus" formation was observed with postoperative barium upper GI tests due to recurrent weight gain. In fact, in our series two patients benefited from the success of a resleeve procedure for "fundus regeneration" recommended by Baltasar et al.[27] Neofundus may be due to leaving too much fundus during the operation to avoid fistulas. The critical point during sleeve gastrectomy is the angle of His. At this point, if the surgeon decides to move away from the left crus due to safety reasons, this may result in a conical sleeve tube rather than a cylindrical shape. Following the Laplace law (along with relatively distal down-flow stenosis) thi may result in proximal dilatation and "neofundus" formation. This neofundus problem may be important both for renewed weight gain and causing GERD.[14]

In our study, in the preoperative period only 3.3% (n=4) of patients complained of GERD symptoms, while after LSG 25% (n=30) had GERD symptoms requiring medical treatment. Of these 10% were de novo GERD. Rawlins et al reported a rate of new onset GERD of 16%.[28] This is consistent with other published reports stating that LSG may be refluxogenic.[29] In our study three patients died due to minimally invasive interventions (endoscopy and interventional radiology) after pulmonary embolism and leak due to intra-abdominal sepsis that could not be controlled by surgical intervention.

There are some limitations to this study. Communication with patients who did not complete clinical visits was made with social media or via telephone. Interviews by telephone or social media were assessed with caution due to a tendency of patients to downplay their weight. We did not perform invasive tests related to GERD and our outcomes are only based on symptoms and pharmacotherapy. We did not objectively assess the severity and incidence of GERD symptoms. Additionally, for effective analysis of comorbidities, we considered changes to prescribed treatment made by other clinicians.

In conclusion, we showed that LSG can be a reliable and effective bariatric procedure acceptable to patients. However, long-term follow-up appears to be associated with weight gain and frequent reflux symptoms. We think renewed weight gain can be partially prevented by close clinical follow-up. There is a need for long-term follow-up of large randomized controlled studies to define the indications for LSG.

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