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Laparoscopic Sleeve Gastrectomy: Outcomes

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Indications for Sleeve Gastrectomy

There are a wide variety of circumstances in which LSG (Fig. 1) has been used, and this can make outcome assessment difficult when reviewing the literature. These can be categorized according to anatomical limitations, the patient's overall risk profile, and specific medical considerations that make other bariatric procedures suboptimal. Additionally, preference for this operation among lower-risk patients and revisional patients is increasing as many surgeons and patients find this operation meeting their criteria from a risk/benefit standpoint.

Anatomical considerations include super obesity (BMI > 60 kg/m^2) in which there is massive hepatomegaly, a foreshortened small bowel mesentery, and bulky visceral fat and omentum. This combination of intraoperative findings results in severely limited working space or tension on the gastrojejunal anastomosis and severe torque on the laparoscopic instrumentation and may be prohibitive for proceeding with laparoscopic gastric bypass. Multiple prior abdominal surgeries, particularly prior small bowel resections, can also limit the surgeon's ability to complete a bypass procedure safely. In patients with massive abdominal wall hernias with loss of domain, it is challenging to complete a gastric bypass as they frequently have had abdominal sepsis and open abdomen in the past. The decision to proceed with LSG in these settings is often made intraoperatively based on the limitations encountered at the time of surgery.

Patients who are very high-risk surgical candidates due to advanced age, severe cardiopulmonary disease, pre- or post-organ transplant status, poor functional status, or inability to ambulate due to joint paint or a very high body mass index are potential candidates for LSG [1]. Depending on the initial BMI, some of these patients will require a second-stage operation (gastric bypass or duodenal switch) after their weight loss from the LSG plateaus.

There are also specific medical circumstances in which LSG has been used, even if the patient is not at particularly high risk for general anesthesia. These include patients with Crohn's disease, the need for chronic antiinflammatory medication use, or the need for reliable absorption of specific medication such as immunosuppressants after organ transplantation. Unlike laparoscopic Roux-en-Y gastric bypass (LRYGB), LSG allows continued endoscopic access to the common bile duct for patients with biliary disease or liver transplants.

LSG as a revisional procedure has also been reported and is discussed in Chap. 17. This is mostly described after failed laparoscopic adjustable gastric bands (LAGB), particularly if there have been a complication (e.g., esophageal dilation, chronic prolapse, or paraesophageal hernia) related to the band. Most of the reported studies include small numbers of patients with limited follow-up. Converting an uncomplicated LAGB to LSG for failed weight loss has been reported [2–4], but the best revision procedure after failed restrictive procedure is still debated. Foletto et al. [5] performed 41 band removals and simultaneous LSG, and 16 patients had interval LSG after the band was removed. The mean preoperative body mass index (BMI) was 45.7 ± 10.8 kg/m^2 and decreased to 39 ± 8.5 kg/m^2 with a mean excess BMI loss of 41.6 % ± 24.4 % after 2 years. The postoperative complications included perigastric hematoma ($n = 3$, 5.7 %), staple-line leakage ($n = 3$, 5.7 %), mid-gastric stenosis ($n = 1$), and death due to septic shock ($n = 1$). Two patients required DS for insufficient weight loss after LSG.

The American Society for Metabolic and Bariatric Surgery's (ASMBS) 2011 updated position statement on LSG [6] recognizes this operation as a primary bariatric procedure and as a first-stage procedure in high-risk patients as part of a planned staged approach.

The ASMBS also recognizes that as with any bariatric procedure, long-term weight regain can occur and can be managed effectively with re-intervention. Reoperations for failed weight loss after LSG are necessary in 6.8 % (range, 0.7–25 %) of cases with patients receiving LSG as a stand-alone procedure and in 9.6–28.5 % of cases with

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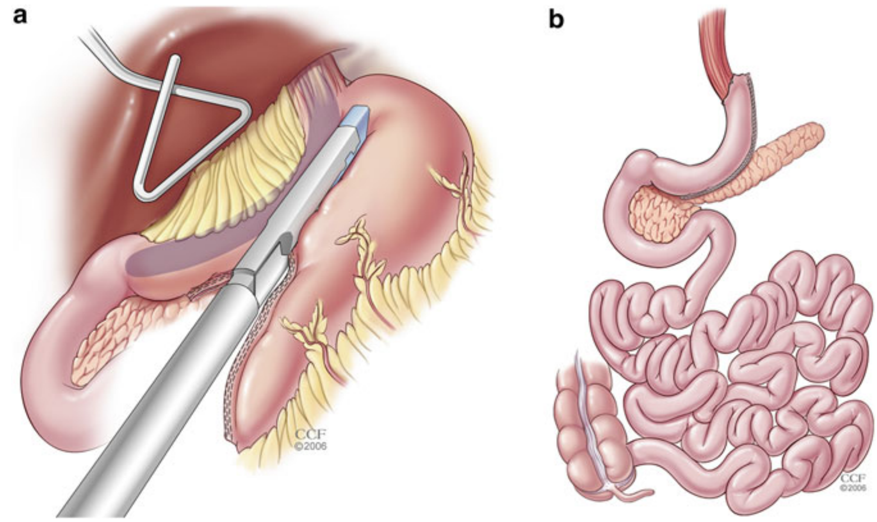


Fig. 1. (a, b). Vertical sleeve gastrectomy. Reprinted with the permission of the Cleveland Clinic Center for Medical Art and Photography.

patients undergoing LSG as a planned first-stage procedure [7], but the updated statement does not address LSG as a revisional procedure.

Outcomes Compared to Other Bariatric Procedures

Several studies have provided direct comparisons to widely accepted procedures such as LAGB and LRYGB (Table 1). Kehagias [8] randomized 60 patients with body mass index <50 (kg/m^2) to LRYGB and LSG with 3 years follow-up. The results revealed a significantly better weight loss after sleeve in the first year. At 3 years, percent excess weight loss (% EWL) was 62 % after LRYGB and 68 % after LSG ($P=0.13$), and both procedures were equally effective in the amelioration of comorbidities. Karamanakos et al. [9] performed a double-blind study comparing LSG and LRYGB that demonstrated better weight loss at 6 months (55.5 % ± 7.6 % vs. 50.2 % ± 6.5 %, $p=0.04$) and at 12 months (69.7 % ± 14.6 % vs. 60.5 % ± 10.7 %, $p=0.05$) in the LSG group. A randomized controlled trial by Himpens and colleagues [10] compared LAGB and LSG and found significantly better weight loss at 3 years after LSG (48 % vs. 66 % EWL, respectively).

Carlin et al. [11] reported data from the Michigan Bariatric Surgery Collaborative regarding the risks and benefits of LSG compared to LAGB and LRYGB. The study included 2,949 LSG patients and compared outcomes to 2,949 LAGB and 2,949 LRYGB patients who were matched for 23 baseline characteristics. Excess weight loss, complications, comorbidity remission, and QOL were assessed at 30 days, 1, 2, and 3 years postoperatively. The complication rates, weight loss, and comorbidity improvement for LSG were intermediate between LAGB and LRYGB in this large study (Figs. 2 and 3).

Durability

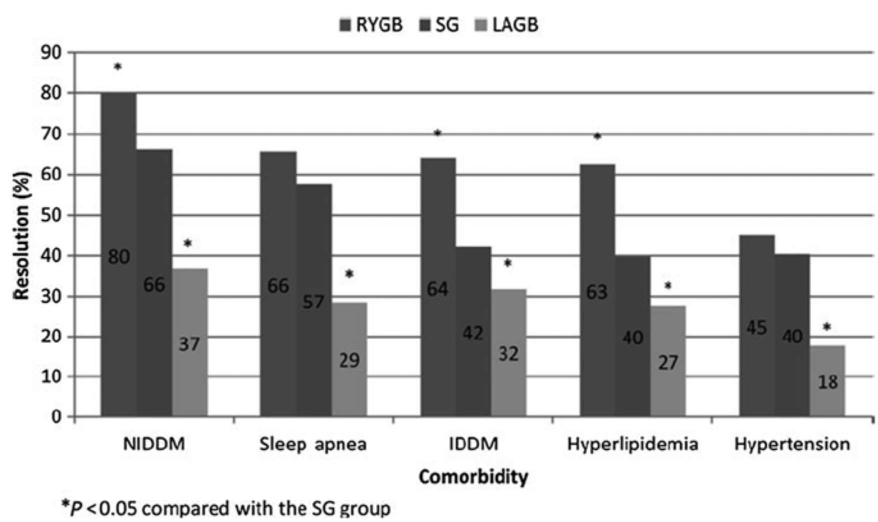
A comprehensive literature review of LSG shows a mean % EWL after LSG ranging from 47 to 83 % at 2 years and 66 % at 3 years. The reported overall mean % EWL after LSG was 55 % with average follow-up less than 3 years [6] and % EWL ranging from 48 to 69 % with follow-up more than 5 years (Table 2). Most of the earlier reports using LSG included high-risk patients with a planned second-stage gastric bypass or duodenal switch. Some of these patients had sufficient weight loss and those with reduction in comorbidities with the sleeve alone did not undergo the second-stage operation for personal or insurance reasons. Eid et al. [12] reported outcomes for 74 patients who did not undergo their planned second-stage operation. Long-term follow-up data was available for 69 patients (93 % follow-up). Mean patient age at the time of surgery was 50 years and the mean preoperative BMI was 66 ± 7 kg/m^2 (range, 43–90). Most patients had significant comorbid conditions a mean of nine (range, 2–17) per patient. The high-risk status of this patient population was demonstrated by the fact that 54 % were classified as ASA IV by the American Society of Anesthesiology, and the remaining 46 % were classified as ASA III status before surgery. The mean length of follow-up was 73 months (range, 38–95 months). Mean % EWL at 38–60 months, 61–72 months, 73–84 months, and 85–95 months was 51 %, 52 %, 43 %, and 46 %, respectively, with an overall % EWL of 48 % for the entire group. These patients provide evidence

TABLE 1. Randomized trials evaluating sleeve gastrectomy to other bariatric procedures

Author	Procedure (*n*)	Mean preop BMI	Follow-up	Weight loss	Conclusion
Woelnerhanssen et al. [11]	LSG (11) LRYGB (12)	LSG 45 LRYGB 47	12 months	LSG 28 % TBW LRYGB 35 % TBW	No differences in weight loss, insulin sensitivity, or effects on adipokines (adiponectin, leptin)
Kehagias et al. [8]	LSG (30) LRYGB (30)	LSG 46 LRYGB 45	36 months	LSG 68 % EWL LRYGB 62 % EWL	No differences in weight loss. LSG and LRYGB are equally safe and effective in the amelioration of comorbidities. LSG is associated with fewer postoperative metabolic deficiencies
Lee et al. [13]	LSG (30) Mini-GB (30)	LSG 30 LRYGB 30	12 months	LSG 76 % EWL Mini-GB 94 % EWL*	GB patients more likely to achieve remission of T2DM (HbA1c <6.5 %, 93 % vs. 47 %, $p=0.02$)
Karamanakos et al. [9]	LSG (16)	LSG 45	12 months	LSG 69 % EWL	Greater weight loss with SG at 1 year PYY levels increased similarly after either procedure
	LRYGB (16)	LRYGB 46		LRYGB 60 % EWL**	Greater ghrelin reduction and appetite suppression after SG compared with LRYGB
Himpens et al. [10]	LSG (40) LAGB (40)	LSG 39 LAGB 37	36 months	LSG 66 % EWL LAGB 48 % EWL**	Weight loss and loss of feeling of hunger after 1 year and 3 years are better after SG than LAGB. GERD is more frequent at 1 year after SG and at 3 years after GB
Peterli et al. [29]	LSG (14) LRYGB (13)	LSG 46 LRYGB 47	3 months	LSG 39 % EBMIL LRYGB 43 % EBMIL*	Both procedures markedly improved glucose homeostasis; insulin, GLP-1, and PYY levels increased similarly after either procedure

From the updated statement of the ASMBS
*P = not significant, **$P<0.05$
BMI body mass index, *LSG* laparoscopic sleeve gastrectomy, *LRYGB* laparoscopic Roux-en-Y gastric bypass, *LAGB* laparoscopic adjustable gastric band, *EWL* excess weight loss, *EBMIL* excess body mass index loss, *Mini-GB* Mini-gastric bypass

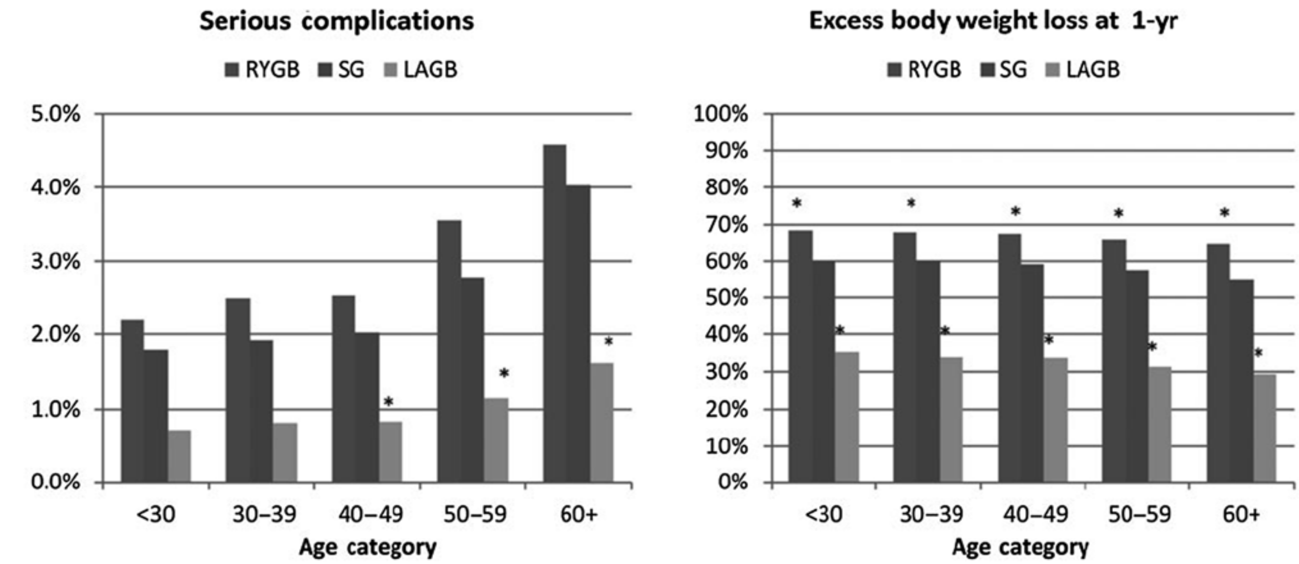
FIG. 2. Comorbidity resolution of LSG compared to LAGB and LRYGB (From Carlin et al. Ann Surg May 2013 with permission).



regarding the effectiveness and durability of LSG for severe obesity, even in high-risk patients.

Sarela et al. [13] reported 8–9-year follow-up data for LSG as a definitive bariatric procedure for 13 out of 20 patients. Of the remainder, 4 patients underwent revision surgery and 3 were lost to follow-up after 2 years. The small number of patients in that series did not permit statistically meaningful comparison at additional intervals. For the entire cohort, the median % EWL was 68 % (range, 18–85 %) at 8 or 9 years.

D'Hondt et al. [14] had 83 patients (81.4 %) who were eligible for long-term follow-up evaluation. Their mean



	n	n	n	n	n		n	n	n	n	n
RYGB	252	712	890	781	314	RYGB	83	206	297	268	113
SG	269	710	840	813	317	SG	67	200	424	286	112
LAGB	290	725	807	752	375	LAGB	72	214	244	257	116

* $P<0.05$ compared with the SG group

Fig. 3. Complications and weight loss of LSG compared to LAGB and LRYGB (from Carlin et al. Ann Surg May 2013 with permission).

Table 2. Sleeve gastrectomy durability

Author	Patient (n)	Preoperative BMI (kg/m²)	Follow-up duration (years)	% EWL (%)
Himpens et al. [10]	41	39	6	53
Bohdjalian et al. [31]	26	48	5	55
Sarela et al. [13]	20	46	8–9	69
D'Hondt et al. [14]	23	39	6	56
Eid et al. [12]	69	66	6–8	48

Adapted from the updated ASMBS position statement on sleeve gastrectomy [3] with modification

initial body mass index (BMI) was 39.3 kg/m^2. No major complications occurred. At a median follow-up point of 49 months (range, 17–80 months), the mean % EWL was 72.3 % ± 29.3 %. For the 23 patients who reached the 6-year follow-up point, the mean % EWL was 55.9 % ± 25.55 %. The overall success rate (% EWL > 50 %) was 85.7 % after 4 years, 64.3 % after 5 years, and 54.5 % after 6 years. The % EWL reported by the surgeons in a survey at the Third International Summit for LSG 4 and 5 years was 57.3 % and 60.0 %, respectively [15].

Comorbidity Reduction

Diabetes is currently a major public health problem in both developed and developing countries. Like obesity, type 2 diabetes mellitus (T2DM) is a chronic disease, with increasing prevalence. T2DM is challenging to control with current therapies that include diets, drug therapy, and behavioral modification, especially in obese patients. Bariatric surgery has become a powerful tool in the management of these closely related disease processes.

Schauer et al. [16] published a randomized controlled, single-center trial, evaluating the efficacy of intensive medical therapy (IMT) alone versus medical therapy plus LRYGB versus IMT plus LSG in 150 patients with a BMI of 27–43 and an uncontrolled type 2 diabetes. Ninety-one percent of patients completed 36 months of follow-up. The proportion of patients achieving the primary end point (glycated hemoglobin level of 6.0 % or less at 36 months) was 5 % in the medical-therapy group versus 38 % in the gastric-bypass group ($P<0.001$) and 24 % in the sleeve-gastrectomy group ($P=0.01$). The use of glucose-lowering medications, including insulin, was lower in the surgical groups than in the medical group. Patients in the surgical groups had greater total weight loss, with reductions of 24.5 ± 9.1 % in the gastric-bypass group and 21.1 ± 8.9 % in the sleeve-gastrectomy group, as compared with a reduction of 4.2 ± 8.3 % in the medical-therapy group ($P<0.001$ for both comparisons).

Lee et al. [17] evaluated in RCT the effects of mini-gastric bypass versus LSG for type 2 diabetes mellitus on lower BMI patients (mean BMI, 31.0 ± 2.9 kg/m^2) with diabetes. Of the 60 patients enrolled, all completed the 12-month follow-up. Remission of T2DM was achieved by 28 (93 %) in the gastric-bypass group and 14 (47 %) in the sleeve-gastrectomy group ($P=0.02$). In this study, preoperative C-peptide levels directly correlated with remission of diabetes.

Vidal et al. [18] performed a 12-month prospective study including 39 LSG patients and 52 LRYGB patients who matched for duration and severity of T2DM. Diabetes remission was 84.6 % for both the LSG and the LRYGB patients, and there were comparable remission rates of metabolic syndrome (62 % and 67 %, respectively (NS)) 1 year after surgery. Neither weight loss nor decrease in waist circumference was associated with T2DM remission after LSG or LRYGB.

Shorter duration of T2DM and lower presurgical fasting plasma glucose or HbA1c were associated with T2DM remission. Rosenthal et al. [19] performed a retrospective review of 30 diabetic patients whom had undergone LSG. Diabetes remission at 6 months was 63 %. Patients with diabetes <5 years were found to have an 87.5 % chance of DM resolution, while those >5 years only had 35.7 % remission ($P=0.004$).

Kehagias'[9] randomized trial showed an overall prevalence of obesity-related comorbidities of 72 % (43 out of 60 patients). In the LRYGB group, 23 of the 30 patients had at least one comorbidity compared to 20 of the 30 patients who were randomized to LSG. At 3 years postoperatively, a significant improvement or resolution of comorbidities was recorded. Dyslipidemia improved at a higher rate after LRYGB and hypertension resolved at a higher rate following LSG. The rest of the studied comorbidities resolved or improved equally between groups. Sarkhosh [20] did a systematic review evaluating the impact of sleeve gastrectomy on hypertension, and LSG resulted in resolution of hypertension in 58 % of patients. On average, 75 % of patients experienced resolution or improvement of their hypertension.

A systematic review by Chiu [21] studied the effect of LSG on gastroesophageal reflux disease (GERD) and included 15 studies. Two reports analyzed GERD as a primary outcome, and 13 included GERD as a secondary study outcome. Of the 15 studies, 4 showed an increase in GERD after SG, 7 found reduced GERD prevalence after LSG, 3 included only the postoperative prevalence of GERD, and 1 did not include data on prevalence of GERD. The evidence of the effect of SG on GERD did not consolidate to a consensus.

A previous systematic review of the sleeve gastrectomy in literature revealed >60 % rates of remission or improvement in many other obesity-related comorbidities including gastroesophageal reflux, degenerative joint pain, sleep apnea, leg edema, hypertension, and hyperlipidemia [22].

Complications

One of the potential advantages of LSG is a lower complication rate compared to duodenal switch and RYGB. The effective use of LSG as a first-stage procedure in high-risk patients has provided evidence for its safety and utility in this patient population [1]. Several recent publications have evaluated the safety profile of sleeve gastrectomy in high-risk patients as well as in average-risk bariatric patients.

Although most of the data available suggest that morbidity related to LSG is lower than in LRYGB, results vary according to different studies. Results confirm that morbidity is significantly lower in patients undergoing LSG, in a nonrandomized, retrospective comparison of patients who underwent LSG ($n=216$), LAGB ($n=271$), LRYGB ($n=303$), and DS ($n=56$). Lee [23] and colleagues reported the major complication rates for these procedures as 4.6 %, 4.8 %, 10.6 %, and 39.3 % respectively ($P<0.03$). The reoperation rate for LSG was the lowest of the four procedures (2.8 %). Reoperation rates for the other procedures increased with the complexity of the operation (LAGB (4.8 %), LRYGB (8.6 %), and DS (32.1 %)). One potential weakness of this nonrandomized study is that patient selection bias may have affected the results for the different procedures.

Brethauer et al. [22] who performed a systematic review of sleeve gastrectomy outcomes reported that the complication rate among the 36 studies (2,570 patients) ranged from 0 to 23.8 %. Studies with >100 patients reported a major postoperative complication rate from 0 to 14 %. The overall 30-day mortality rate was 0.19 %. The overall rate of major complication rates were low including leaks (2.2 %), bleeding requiring reoperation or transfusion (1.2 %), and strictures requiring endoscopic or surgical intervention (0.6 %). The analysis of weight loss and complications varied depending on the patient group studied. The differences between complication rates for patient undergoing sleeve gastrectomy as a risk-reduction strategy and those undergoing LSG as a primary procedure are highlighted in Table 3.

Gastric leak and hemorrhage are the most important challenges after LSG . The long staple line of the LSG in conjunction with an increased intraluminal pressure offers a possible explanation. Shi's [24] systematic review reported the rate of major complications after LSG, such as staple-line leakage and internal bleeding (1.17 % ± 1.86 %, 3.57 % ± 5.15 %, respectively). Leaks were more common in the proximal staple line close to the gastroesophageal junction (1.6 % of cases) than at the distal staple line 0.5 % [6]. Intraluminal bleeding occurred in 2.0 % of cases and the mortality rate was 1 %.

Parikh et al. [25] analyzed the effect of various surgical techniques for LSG on the leak rate by systematically reviewing the literature and conducting a meta-analysis focusing on the relationship between leak rate and bougie size, and distance from the pylorus, and the use of buttressing material on the staple line. Hundred and ninety-eight leaks in 8,922 patients (2.2 %) were identified. The general estimating equation (GEE) model was used to calculate the odds ratio (OR) for leak and revealed that the risk of leak decreased with bougie ≥40 Fr (OR =0.53, 95 % CI=[0.37–0.77]; $P=0.0009$). Buttressing did not influence leak. There was no difference in % EWL between bougie <40 Fr and bougie ≥ 40 Fr up to 36 months (mean % EWL 70.1; $P=0.273$), and distance from the pylorus did not affect leak or % EWL.

TABLE 3. Outcomes of sleeve gastrectomy in high-risk/staged patients versus primary procedure

	High-risk patients/staged approach	Primary procedure	All patients
Number of studies[a] (number of patients)	13 (821)	24 (1,749)	36 (2,570)
Preoperative BMI range (mean) kg/m^2	49.1–69.0 (60.0)	37.2–54.5 (46.6)	37.2–69.0 (51.2)
Postoperative BMI range (mean) kg/m^2	36.4–53.0 (44.9)	26.0–39.8 (32.2)	26.0–53.0 (37.1)
Follow-up	4 months–5 years	3 months–3 years	3 months–5 years
% Excess weight loss range (mean)	33.0–61.4 % (46.6 %)	36.0–85.0 % (60.7 %)	33.0–85.0 % (55.4 %)
Complication rate	0–23.8 % (9.4 %)	0–21.7 % (6.2 %)	0–23.8 %
All studies (mean)			
Studies with $n>100$	3.3–15.3 %	0–14.1 %	0–14.1 %
Leaks	8/686 (1.2 %)	45/1,681 (2.7 %) $^+$	53/2,367 (2.2 %)
Bleeding	11/686 (1.6 %)	17/1,681 (1.0 %)	28/2,367 (1.2 %)
Strictures	6/686 (0.9 %)	9/1,681 (0.5 %)	15/2,367 (0.6 %)
Mortality	2/821 (0.24 %)	3/1,749 (0.17 %)	5/2,570 (0.19 %)

Adapted from Brethauer et al. [22]
[a]One study had clearly defined patients in both groups; + $p=0.02$ compared to high risk group

Dapri [26] and Albanopoulos [27] compared techniques of reinforcing the staple line in LSG with suturing versus buttressing or neither. There was no significant difference in leak rates between groups. However, buttressing statistically reduced blood loss during stomach sectioning as well as overall blood loss.

Management of LSG leak patients mainly depend on their clinical condition and this is discussed in Chap. 16. Patients presenting with hemodynamic instability and uncontrolled sepsis require immediate operative management. Stable patients can be managed with percutaneous drainage, endoscopic therapy including stenting, and nutritional support. The type and duration of therapy must be individualized to allow closure of fistulas and to avoid recurrent episodes of sepsis or leak.

Mechanisms of Action

The evidence suggests that LSG effects gut hormone secretion and satiety pathways in addition to creating gastric restriction. One of the first gut hormones evaluated with LSG was ghrelin. Since ghrelin is primarily produced in the fundus of the stomach (completely resected during LSG), it is logical that ghrelin would decrease after LSG. Karamanakos et al. [9] showed that LSG suppressed fasting and postprandial ghrelin levels and attributed this decrease in ghrelin to improved postoperative satiety and greater weight loss at 1 year compared to LRYGB. The LRYGB group in this study had an initial decrease in ghrelin levels after surgery, but these levels returned to normal levels within 3 months.

Lee et al. [28] studied the treatment of patients with a low body mass index and type 2 diabetes mellitus between the two groups. LRYGB is reportedly more effective than LSG; they conclude that both procedures have strong hindgut effects after surgery, but LRYGB has a significant duodenal exclusion effect on cholecystokinin. The LSG group had lower acylated ghrelin and des-acylated ghrelin levels but greater concentrations of resistin than the LRYGB group.

In addition to evaluations of ghrelin, there are now several small studies demonstrating that gastric emptying is increased after sleeve gastrectomy. The loss of a large reservoir in the gastric fundus and body and preservation of the antral pump provide a reasonable explanation for this finding. A secondary effect of earlier distal bowel stimulation with nutrients after meals due to increased gastric emptying time may be similar to the effects seen after gastric bypass. Several mechanistic studies have demonstrated early and exaggerated postprandial peak levels of Peptide YY_{3-36} and GLP-1 after LSG. GLP-1 is an incretin that stimulates insulin production and releases from pancreatic islet cells, and the increased PYY_{3-36} results in satiety and reduced food intake. Karamanakos et al. [9] have independently shown that the sleeve gastrectomy does have the effect of increasing the transit time of chyme despite an intact pylorus as measured by increased postprandial PYY levels.

Peterli et al. [29] performed a randomized prospective trial with 13 LRYGB and 14 LSG patients to investigate the potential mechanism of LSG focusing on foregut and hindgut mechanisms. They found marked improvement in glucose homeostasis 1 week after surgery in both groups. This improvement was associated with early, exaggerated increases in GLP-1 secretion at 1 week, 3 months, and 1 year postoperatively in both groups. In addition to changes in GLP-1, PYY_{3-36} increased significantly and ghrelin was suppressed in both groups. It is unclear whether PYY_{3-36} has a direct effect on glucose homeostasis or if its effects are exhibited via appetite reduction and concomitant weight loss. Preoperatively, some patients had a blunted PYY_{3-36} and GLP-1 response suggesting some "resistance" to these gut hormones in obese patients. These findings suggest that the LSG should not be viewed merely as a restrictive procedure but also as a procedure that has neurohormonal and incretin effects.

Ramon et al. [30] compared the effects of LRYGB and LSG on glucose metabolism and levels of gastrointestinal hormones such as ghrelin, leptin, GLP-1, peptide YY (PYY), and pancreatic polypeptide (PP) in morbid obese patients. This prospective, randomized study confirmed that the postprandial response of ghrelin, GLP-1, and PYY was maintained in patients undergoing LSG for 12 months after surgery and was similar to the LRYGB group results.

Adipokines are cytokines produced by adipose cell and closely linked to obesity and insulin resistance. To date, it is unclear whether the different anatomical changes of the various bariatric procedures have different effects on hormones of adipocyte origin. A prospective, randomized study by Woelnerhanssen et al. [11] compared the 1-year results of LRYGB and LSG for weight loss, metabolic control, and fasting adipokine levels. The authors confirmed a close association of specific adipokines with obesity and with the changes observed with weight loss after two different bariatric surgical procedures. The concentrations of circulating leptin levels decreased by almost 50 % as early as 1 week postoperatively and continued to decrease until 12 months postoperatively and adiponectin increased progressively. No differences were found between the LRYGB and LSG groups regarding adipokine changes.

Conclusion

The current evidence regarding sleeve gastrectomy demonstrates that it can be used safely as a primary procedure or as part of a staged approach for high-risk bariatric patients. Published early postoperative complication rates are acceptably low, and there are few long-term complications or reoperations reported after this procedure. Early and medium-term weight loss is better than laparoscopic adjustable gastric banding and is comparable to or slightly less than gastric bypass in most studies. There are growing numbers of long-term studies supporting the durability of LSG, but some patients will have weight regain that can be managed with a bypass procedure. Mechanistic studies suggest some neurohumoral effects of sleeve gastrectomy that may contribute to rapid weight loss and improved glucose metabolism.

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