Sleeve Gastrectomy

Stacy A. Brethauer, MD

KEYWORDS
• Bariatric • Sleeve gastrectomy • Vertical gastrectomy

HISTORY

Sleeve gastrectomy (SG) was originally performed as the restrictive component of the duodenal switch procedure. This partial vertical gastrectomy served to reduce gastric capacity and initiate short-term weight loss while the malabsorptive component of the operation (biliopancreatic diversion) provided the long-term weight loss. Some patients, however, could not undergo the intestinal bypass, and early investigations found that substantial weight loss occurred with the SG alone. The sleeve then developed into a risk management strategy for very large or high-risk patients who would not tolerate a longer or higher-risk procedure.1

In this staged approach, patients’ medical conditions improved in the 1 or 2 years after SG, and many subsequently underwent a second-stage bypass procedure (gastric bypass or duodenal switch). In a study by Cottam and colleagues,2 126 high-risk super-obese patients with a mean preoperative body mass index (BMI) of 65.3 kg/m2 underwent laparoscopic SG (LSG) as a first-stage procedure. The mean excess weight loss at 1 year was 43% and significant reductions were seen in the number of comorbidities and American Society of Anesthesiologists classification before the second-stage gastric bypass procedure. In the past 10 years, SG has increasingly been used as a stand-alone primary bariatric procedure and has gained popularity among patients and bariatric surgeons. Rapid growth has been seen in the number of SGs performed in the past 5 years, and it currently accounts for more than 5% of all bariatric operations performed worldwide.3

TECHNIQUE

LSG involves a vertical gastrectomy that results in a narrow, tubular stomach. The concept of SG is simple, but some components of the operation, if performed incorrectly, can result in serious complications. Five ports are placed across the upper abdomen identical to placement for a gastric bypass. If exposure is difficult because of a large amount of perigastric fat or a large liver, a sixth port can be placed in the left...
upper quadrant for the assistant (Fig. 1). The operating surgeon stands to the patient’s right side and uses a footboard and tapes the patient to the operating table for placement in a steep reverse Trendelenburg position during the procedure. The first step of the procedure is to divide the vascular attachments of the gastroepiploic arcade and the short gastric vessels. This dissection is performed with ultrasonic shears, and is started along the greater curvature and extended proximally to the angle of His and distally to within 4 cm of the pylorus. The stomach and fundus must be fully immobilized during the dissection. The filmy posterior attachments should be divided so the entire posterior surface of the stomach can be seen. After the short gastric vessels are divided at the upper pole of the spleen, the attachments between the fundus and the left crus of the diaphragm must also be taken down. This technique is important to

Fig. 1. Port placement for laparoscopic sleeve gastrectomy. The surgeon stands to the patient’s right. The two middle ports are 12 mm and the lateral ports are 5 mm. (Reprinted from Cleveland Clinic Center for Medical Art & Photography © 2006–2011; with permission. All Rights Reserved.)
avoid leaving a large pouch of fundus at the top of the stomach and ensure that the
gastroesophageal junction can be identified and avoided during the final staple firing.

Once this dissection is complete, the first stapler is placed tangentially across the
antrum. The authors use green loads for the first two staple firings because of the
increased thickness of the stomach in this area. The assistant should flatten the stomach
with lateral retraction and the anesthesiologist should remove the temperature probe
and orogastric tubes before the first staple firing. The angle of the first firing is deter-
mined by the patient’s anatomy, but care should be taken to not use an angle that will
narrow the lumen at the incisura. The authors fire the first staple load before placing
the calibration tube and then close the stapler for the next firing, which helps guide
the calibration tube distally into the antrum (Fig. 2). The authors use a diagnostic gastro-
scope (Olympus GIF-H180J, 9.9-mm outer diameter, Olympus, Center Valley, Pennsyl-
vania) to calibrate the sleeve lumen and place the lighted tip of the scope into the antrum
under laparoscopic guidance (no insufflation is used to place the endoscope initially).

If any concern exists that the lumen is too narrow at the incisura, the stapler is
moved laterally before firing. This part of the procedure requires close attention,
because a lumen that is too narrow at the incisura can result in severe dysphagia
and food intolerance from stricture formation or, more commonly, kinking of the
stomach in this area. Once the surgeon is satisfied with the lumen size, the stapler
is fired. Blue loads of the stapler are then fired proximally along the calibration tube.
Because the staple line is oversewn with an imbricating suture, several millimeters
of lumen are left between the calibration tube (30 French gastroscope) and the staple
line (ie, the calibration tube is not hugged tightly with the stapler). Care should be taken
to create a straight staple line and avoid anterior or posterior “spiraling” of the staple
line, which can also cause mechanical problems with the sleeve and can be avoided
through good lateral retraction of the stomach by the assistant.

The position of the final staple firing is critical to avoid a leak. Leaving a significant
portion of fundus will not be optimal in terms of weight loss or gastroesophageal reflux
disease (GERD) in the long term, but care must be taken not to impinge on the gastro-
esophageal junction or esophagus during the final staple firing. Approximately 1 cm of
gastric serosa should be seen to the left of the stapler cartridge before the stapler is
fired. Mobilizing a large fat pad off of this area early in the case can help identify
and avoid the gastroesophageal junction.

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Fig. 2. The linear stapler is used to perform a vertical sleeve gastrectomy starting 4 cm from
the pylorus. This technique is performed with a calibration tube in place (A). The resected
gastric body and fundus are removed in a laparoscopic specimen bag (B). (Reprinted from
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The entire staple line is then oversewn with a continuous, imbricating suture. Caution must be taken not to imbricate too much tissue at the incisura, because this may also cause an obstruction in this area. If concern exists about the lumen size, a nonimbricating locking suture is placed in this area. After the suture line is completed, the endoscope is used to perform a leak test and evaluate the lumen for hemostasis and patency. Other methods of leak testing, such as the methylene blue dye test, can also be used, but the endoscopic view offers some reassurance that the lumen is uniform in size without obstruction. The omentum is then sewn to the entire suture line to provide another potential barrier if a leak occurs. Sewing the omentum or the gastrocolic fat back up to the distal sleeve may also anchor the sleeve and prevent kinking at the incisura. A closed-suction drain is placed under the omentum with its tip above the spleen. The 12-mm port sites are closed with a suture passer and the resected stomach is placed in a specimen bag and removed from the abdomen. **Fig. 3** shows the completed sleeve gastrectomy.

**OUTCOMES**

**Weight Loss**

The weight loss outcomes after SG have varied according to the population studied. Initial reports of SG used this operation to downstage high-risk medical patients...
or super-obese patients before a staged bypass procedure.\textsuperscript{1,2,4–14} Because many of these patients subsequently underwent a planned second-stage procedure, most of the early reports of SG did not provide follow-up beyond 1 or 2 years. As more experience was gained with this operation, many surgeons found it to be an effective primary bariatric procedure for patients with a lower BMI, and the more recent literature reflect this shift.\textsuperscript{5,15–37} With this increasing experience over the past 5 years, longer-term outcome data are now emerging.

A systematic review of 36 studies recently evaluated overall weight loss after SG, and also assessed weight loss for the staged and primary patient groups.\textsuperscript{38} The mean preoperative BMI for all patients included in the systematic review was 51.2 kg/m\textsuperscript{2}, and decreased to 37.1 kg/m\textsuperscript{2} during the reported follow-up periods, which were predominantly 3 years or less. The mean excess weight loss (EWL) after SG was reported in 24 studies (\(n = 1662\)) and ranged from 33\% to 85\%, with an overall mean EWL of 55.4\%. The mean preoperative BMI was 60.0 kg/m\textsuperscript{2} (range, 49.1–69.0 kg/m\textsuperscript{2}) for the staged/high-risk patient group, and 46.6 kg/m\textsuperscript{2} (range, 37.2–54.5 kg/m\textsuperscript{2}) for the patients undergoing SG as a primary procedure. The reduction in BMI and the EWL reported after SG in these two groups is shown in Table 1.

Several studies compare SG with other bariatric procedures. In a randomized, controlled trial comparing LSG and laparoscopic adjustable gastric banding, Himpens and colleagues\textsuperscript{22} reported greater EWL (66\% vs 48\%; \(P = .025\)), greater loss of hunger (46.7\% of patients vs 2.9\%), and greater loss of craving for sweets

Table 1

<table>
<thead>
<tr>
<th>Outcomes of sleeve gastrectomy in high-risk/staged patients versus primary procedure</th>
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<tbody>
<tr>
<td>Number of studies\textsuperscript{a} (number of patients)</td>
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<tr>
<td>Preoperative BMI range (mean) kg/m\textsuperscript{2}</td>
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<tr>
<td>Postoperative BMI range (mean) kg/m\textsuperscript{2}</td>
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<tr>
<td>Follow-up</td>
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<tr>
<td>Percent excess weight loss range (mean)</td>
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<tr>
<td>IVW mean = 46.6% (43.8%–49.5%)</td>
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<tr>
<td>Complication rate all studies (mean)</td>
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<td>Studies with (n&gt;100)</td>
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<tr>
<td>Leaks\textsuperscript{b}</td>
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<td>Bleeding\textsuperscript{b}</td>
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<tr>
<td>Strictures\textsuperscript{b}</td>
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<tr>
<td>Mortality</td>
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Abbreviation: IVW, inverse variance weighted.
\textsuperscript{a} One study included clearly defined patients in both groups.
\textsuperscript{b} Includes studies with detailed complication data only.
\textsuperscript{*} \(P = .02\) compared with high-risk group.
\textsuperscript{d} \(P\) not significant compared with high-risk groups.

(23.3% of patients vs 2.9%) in patients treated with LSG at 3 years. Two patients in that trial (5%) experienced insufficient weight loss 3 years after LSG and underwent a duodenal switch.

Another small randomized trial also showed superior weight loss and decreased ghrelin levels 6 months after LSG compared with laparoscopic adjustable gastric banding.39

Several studies have compared LSG and Roux-en-Y gastric bypass (RYGB). In a prospective, double-blind study with 16 patients in each group, Karamanakos and colleagues23 reported better weight loss with LSG at 1 year compared with RYGB (EWL, 69.7% vs 60.5%, respectively; \( P = .05 \)). The authors attributed this difference to more pronounced changes in specific gut hormones after the sleeve, resulting in decreased hunger. In a nonrandomized study, Vidal and colleagues37 matched patients who were treated with LSG \((n = 39)\) and RYGB \((n = 52)\) for duration and severity of diabetes and, 1 year after surgery, found that weight loss was similar for the groups (31% of initial weight).

Despite being widely adopted in the past 5 years, the long-term durability of SG has remained a concern. Weiner and colleagues14 published the first 5-year weight loss data in 2007, reporting their weight loss outcomes related to the calibration of the sleeve as their practice evolved. In their early experience, no calibration tube was used and they subsequently used a 40 French and then a 32 French Bougie to create a tighter sleeve. They also measured the volume of the resected stomach and the sleeve volume intraoperatively. After 2 years, patients who had tube calibration of their sleeve had better weight loss than those who underwent the uncalibrated procedures. They also reported that a volume of the resected stomach less than 500 mL predicted weight loss failure or weight regain. Overall, BMI decreased from 60.7 to 45.0 kg/m². A trend has been seen in the literature toward using smaller calibration tubes as more primary procedures are performed, and Weiner’s study presents compelling data that long-term weight loss success is related to the calibration of the sleeve. Similar findings related to calibration were reported with the Magenstrasse and Mill procedure (a nonresectional form of the vertical sleeve procedure), in which weight regain was noted with larger calibration tubes early in the investigators’ experience, prompting the use of smaller calibration tubes over time to achieve durable weight loss.40

Since the publication of the systematic review in 2009,38 several important studies have been published that report longer-term follow-up (Table 2). Himpens and colleagues41 reported long-term weight loss data on 41 patients who underwent SG intended as a primary procedure. These patients were not part of the randomized trial comparing LSG and adjustable banding. The median preoperative BMI in this study

<table>
<thead>
<tr>
<th>Author</th>
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<th>Preoperative BMI</th>
<th>Follow-Up</th>
<th>Weight Loss</th>
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<tr>
<td>Johnston et al</td>
<td>16</td>
<td>46</td>
<td>5 y</td>
<td>61% EWL</td>
</tr>
<tr>
<td>(M+M procedure)</td>
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<tr>
<td>Weiner et al</td>
<td>8</td>
<td>62</td>
<td>5 y</td>
<td>–17 BMI</td>
</tr>
<tr>
<td>Himpens et al</td>
<td>41</td>
<td>39</td>
<td>6 y</td>
<td>53% EWL</td>
</tr>
<tr>
<td>Bohdjalian et al</td>
<td>26</td>
<td>48</td>
<td>5 y</td>
<td>55% EWL</td>
</tr>
<tr>
<td>Eid et al</td>
<td>69</td>
<td>66</td>
<td>6 y</td>
<td>52% EWL</td>
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Abbreviations: BMI, body mass index; EBMI, excess body mass index; EWL, excess weight loss; M+M, Magenstrasse and Mill.
was 39 kg/m². At 3 years after surgery, the mean EWL overall was 72.8%, and after the sixth year of follow-up the mean EWL overall was 57.3%. Eleven patients underwent a second-stage duodenal switch procedure and improved their EWL to 70.8% at 6 years (mean BMI 27 kg/m²). The stand-alone LSG patient group (n = 30) had a 53% EWL and a mean BMI of 31 kg/m² at 6 years. This report shows that some patients regain weight long-term after LSG when it is used as a primary procedure, and that weight loss can be improved with a second-stage procedure in selected patients. Despite these issues, patient acceptance of the LSG procedure remained good at 6+ years in this study.

Another report of long-term outcomes after LSG was recently published by Bohdajilian and colleagues.42 The authors provide 5-year weight loss data for 26 patients who underwent LSG. Mean BMI before surgery was 48.2 kg/m² and one-third of the patients were super-obese (BMI>50 kg/m²). Mean EWL at 5 years was 55%. Four patients (15%) underwent a second-stage gastric bypass for weight regain (n = 3) and GERD (n = 1).

### Comorbidity Improvement

Diabetes remission has been reported to different degrees after all of the currently performed bariatric procedures. A recent systematic review by Gill and colleagues43 evaluated the rates of diabetes improvement after SG and found 28 studies that met their inclusion criteria. The patient population included 673 patients with a mean preoperative BMI of 47.4 kg/m². In this analysis, LSG resulted in diabetes remission in 66.2% of patients. Of those studies that reported improvement and remission of diabetes, 97% of patients had either improvement or remission. The mean hemoglobin A1c (HbA1c) decreased from 7.9 to 6.2 in the 11 studies that included this measure of glucose control.

A randomized, controlled trial by Lee and colleagues44 from Taiwan compared gastric bypass (n = 30) and SG (n = 30) for the treatment of type 2 diabetes (remission defined as fasting glucose <126 mg/dL and HbA1c <6.5% off glycemic therapy). LSG resulted in remission of diabetes in 47% of patients at 1 year and was associated with an average 3% reduction in HbA1c levels. Gastric bypass, however, had more powerful effects on weight loss, waist circumference, the remission rate of type 2 diabetes (93%), and improvements in the metabolic syndrome in this study. In an analysis of patients undergoing LSG and RYGB who were matched for severity and duration of diabetes, Vidal and colleagues37 found that both groups had 84% remission of diabetes and comparable rates of resolution of the metabolic syndrome at 1 year (62% for SG; 67% for RYGB).

Improvement in other major obesity-related comorbidities after LSG are shown in Fig. 4. In addition to improvements in the components of the metabolic syndrome, significant improvement or resolution of sleep apnea, joint pain, depression, and leg edema have been reported.2,10,12,14,24,27

### MECHANISMS OF ACTION

The mechanisms of action through which SG produces early satiety, hunger control, and improvement in metabolic parameters are still controversial. Initially thought to be a purely restrictive operation, some studies reporting changes in gut hormones and the metabolic effects of this procedure have challenged that concept. Ghrelin, an orexigenic hormone produced primarily in the gastric fundus, is significantly decreased after SG39 and this decrease has been shown to persist 5 years after the procedure.42 Although ghrelin may affect changes in hunger, satiety, and even
glucose metabolism after SG, it is unlikely the only mechanism that contributes to the long-term effects of this procedure.

Rapid nutrient transit to the distal bowel is one of the mechanisms responsible for early satiety and improvements in glucose metabolism after gastric bypass. These effects are mediated by gut hormones (PYY3-36 and GLP-1) produced in the L cells located in the distal bowel. Evidence shows that nutrient transit is also increased after SG. Melissas and colleagues26,45 showed increased gastric emptying after SG, and this rapid transit of solid food to the distal bowel may have similar effects on the L cell mass as the gastric bypass. In a small randomized trial comparing RYGB and LSG, Karamanakos and colleagues23 showed similar increases in fasting and post-prandial PYY3-36 after these two procedures. Weight loss was greater at 12 months after LSG in this study (69.7% vs 60.5%; $P < 0.05$), however, and the investigators attributed this to the lower ghrelin levels and decreased appetite seen after LSG compared with RYGB. Although further studies are needed to define the mechanisms of weight loss and diabetes remission after LSG, early evidence suggests that this operation has metabolic effects beyond weight loss.

### COMPLICATIONS

Leaks are the most concerning complication after SG. The most common site of a leak is near the angle of His or at the gastroesophageal junction. This complication may be from placement of the final staple line across the gastroesophageal junction or distal esophagus with resultant staple line disruption. Another potential factor that can contribute to a proximal leak is mid-sleeve stenosis. This complication can be from a truly stenotic lumen or, more commonly, twisting or kinking of the sleeve at the incisura that causes a functional obstruction. This relative downstream obstruction in the setting of a proximal leak can lead to a persistent fistula that does not resolve with conservative management (Fig. 5).Leaks occur less than 2% of the time in most published series, and the leak rates associated with primary and staged SG are shown in Table 1. The higher leak rate reported among primary procedures performed in

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**Fig. 4.** Improvement and remission rates of major comorbidities after sleeve gastrectomy. HLIPID, hyperlipidemia; HTN, hypertension; OSA, obstructive sleep apnea; T2DM, type 2 diabetes mellitus. *(Data from Brethauer SA, Hammel JP, Schauer PR. Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. Surg Obes Relat Dis 2009;5:469–75.)*
patients with lower BMIs may be related to some of the authors reporting their early experience with this procedure (several multicenter studies in this group included lower case volumes with higher complication rates).

A high index of suspicion and early identification of leaks after LSG are critical to achieving an acceptable outcome after this complication. Unexplained tachycardia, fevers, abdominal pain, or persistent hiccups after the procedure should alert surgeons to investigate for a leak. The authors perform routine upper gastrointestinal contrast studies the morning after the procedure to evaluate for leaks before starting the patient on clear liquids. This approach, however, should be at the discretion of the surgeon, and no compelling evidence shows that routine imaging is warranted. If the surgeon becomes concerned about a leak and a drain was left in place at the time of surgery, the drain fluid can be sent for an amylase level. If the fluid amylase level is much higher than normal serum levels (in the 1000s), this suggests that saliva is entering the drain. Regardless of the drain amylase level, early imaging is warranted if clinical suspicion of a leak exists. Upper gastrointestinal contrast studies are often ordered first, but CT scans can provide more information about fluid collections in the left upper quadrant (Fig. 6).

The management of the leak depends on the patient’s clinical condition. The surgeon managing this complication must have a clear treatment strategy or algorithm based on the patient’s status, the duration of the leak, and the resources available. If the leak presents as a well-defined abscess several days or weeks after surgery and the patient is clinically stable, percutaneous image-guided drainage, antibiotics, and nutritional support with parenteral nutrition or a nasojejunal tube is appropriate. If drainage is adequate, endoluminal therapies can be used to facilitate closure of the leak. This process often includes placement of endoscopic clips, fibrin glue, or bioabsorbable fistula plugs, and endoluminal stenting across the leak. Stenting has been shown to be effective in small series of selected cases, but results can be variable depending on the size and duration of the leak. Although placement of self-expanding, covered, or partially covered stents (Polyflex or Wallflex stents,

Fig. 5. Upper gastrointestinal contrast study showing extravasation of contrast from the upper stomach into the left subphrenic space (A). Stenosis of the mid portion of the sleeve is present where the barium tablet is lodged (B).
Boston Scientific, Natick, Massachusetts) may be beneficial, the current stent technology is not ideal for this anatomy that involves two different lumen diameters with curvature of the gastric lumen (Fig. 7). Before attempts at stenting, the extraluminal collection must be adequately addressed in all cases and surgical placement of drains

![CT scan of a postoperative leak after sleeve gastrectomy resulting in a left upper quadrant abscess.](image)

**Fig. 6.** CT scan of a postoperative leak after sleeve gastrectomy resulting in a left upper quadrant abscess.

![Endoscopic placement of fibrin glue and clips across a small leak at the gastroesophageal junction after sleeve gastrectomy (A) followed by placement of a stent across the leak (B). Follow-up contrast study after stenting shows a small persistent leak of contrast refluxing up around the stent (C).](image)

**Fig. 7.** Endoscopic placement of fibrin glue and clips across a small leak at the gastroesophageal junction after sleeve gastrectomy (A) followed by placement of a stent across the leak (B). Follow-up contrast study after stenting shows a small persistent leak of contrast refluxing up around the stent (C).
with washout of the infected field is often warranted to promote closure of the leak. Because successful outcomes after stenting often occur in carefully selected patients, evidence is currently insufficient to make any broad claims that stenting accelerates or promotes closure of leaks for all patients. Nevertheless, stenting may be a useful therapeutic adjunct in some patients and is associated with little risk. One advantage of stent placement in these patients is that it may allow patients to resume oral intake while the leak heals.

Patients who are manifesting signs of sepsis or are unstable should be managed operatively with laparoscopy or laparotomy. Drainage and washout of the infected collection and wide drainage of the area is the primary goal of the operation. Primary closure of the defect can be performed if discovered early, but the surrounding inflammatory reaction typically prohibits effective closure of the hole. Closed suction or sump drains should be placed and the omentum can be sewn over the defect to help contain the contamination. If the patient is stable during the case, a feeding jejunostomy should be placed for long-term enteral access.

A chronic fistula after LSG is a challenging problem. If a leak or gastrocutaneous fistula persists for months despite adequate surgical drainage, endoluminal therapy, and nutritional support, reoperation may be the only solution. The patient’s gastrointestinal anatomy should be evaluated for a distal obstruction or stricture that would also jeopardize any revisional procedure. Several surgical options have been reported for these chronic fistulas, including resection of the proximal stomach with the fistula and creation of a Roux-en-Y esophagojejunostomy, bringing a Roux limb up and creating a gastrojejunal anastomosis directly on the leak site, placing a jejunal patch over the leak site, or placing a T tube into the leak site. Evidence is insufficient to support one approach over another, and the type of salvage procedure should be determined by the patient’s anatomy and the surgeon’s judgment and experience.

Bleeding complications requiring transfusion or reoperation occur less than 2% of the time after LSG. Common sites of bleeding include the sleeve staple line, short gastric vessels, the spleen, and omental vessels that have been divided during the dissection of the greater curvature. Some evidence suggests that the use of staple-line buttressing can decrease intraoperative and postoperative blood loss after LSG, but these studies include small numbers of patients and do not provide definitive evidence that staple-line reinforcement is superior to oversewing or no reinforcement in terms of preventing postoperative complications.

Strictures requiring endoscopic dilation or surgical revision occur less than 1% of the time after SG. The most common site of luminal narrowing is at the incisura. Although true strictures can occur, this problem after LSG is typically not a true mucosal or luminal stricture as much as it is an angulation or kinking of the stomach in this area (Fig. 8). This functional obstruction presents as persistent dysphagia to solids and liquids, with nausea and vomiting. When creating the SG initially, this complication can be prevented through avoiding sharp angulation of the staple line and allowing for adequate lumen size as the stapler approaches the incisura. Treatment includes symptom control with antiemetics and repeated endoscopic balloon dilations of the area. Laparoscopic seromyotomy has been reported to treat long strictures that are refractory to dilation and conversion to gastric bypass is occasionally necessary to alleviate the obstruction.

GERD remains a concern after SG, and the onset of severe refractory GERD after LSG may be an indication to revise the procedure to gastric bypass. Often early improvement of GERD symptoms occurs after LSG, but late onset of GERD symptoms has been reported after LSG. In the report by Himpens and colleagues with 6-year follow-up, the overall incidence of new-onset GERD (defined as symptoms
requiring proton pump inhibitor use) was 26%. The investigators attribute some of the new-onset GERD symptoms to the appearance of a neofundus (dilated pouch of fundus at the proximal sleeve) that occasionally requires reoperation. In patients in whom this dilated fundus was resected, GERD symptoms improved. Additionally, after 5 years of follow-up in the study by Bohdjalian and colleagues,42 31% of patients were taking chronic acid suppression medication for GERD. This long-term complication must be evaluated further with objective testing, but the possibility of new or recurrent GERD symptoms should be considered when discussing this procedure with patients.

The overall 30-day mortality rate in the published literature (n = 2570 patients) includes five deaths, for an overall mortality rate of 0.19%.38 The mortality rates for the staged/high-risk and primary groups are shown in Table 1.

**SUMMARY**

LSG is an accepted bariatric procedure that can be used for many different patient populations. It has been effectively used as part of a staged risk-management strategy for high-risk patients and has gained popularity as a primary bariatric procedure. The evidence supporting the safety and efficacy of SG continues to increase and long-term data are emerging that report excess weight loss greater than 50%. A second-stage gastric bypass or duodenal switch promotes further weight loss in selected patients with weight regain or inadequate weight loss after LSG. Attractive features of LSG are rapid weight loss, comorbidity reduction, and avoidance of long-term complications of bypass procedures or implantable devices. Concerns remain regarding the risks of leak after LSG, the long-term incidence of GERD symptoms, and weight loss durability beyond 5 years. Management of leaks after LSG is a formidable challenge for the bariatric surgeon, and early diagnosis followed by a multidisciplinary treatment strategy is key. The precise mechanism of sustained weight loss and diabetes remission after SG is unclear, but early evidence suggests that this is a metabolic procedure that affects nutrient transit, gut hormones, and the enteroinsular axis in a favorable way.
REFERENCES

1. Regan JP, Inabnet WB, Gagner M, et al. Early experience with two-stage laparo-
scopic Roux-en-Y gastric bypass as an alternative in the super-super obese
2. Cottam D, Qureshi FG, Mattar SG, et al. Laparoscopic sleeve gastrectomy as an
initial weight-loss procedure for high-risk patients with morbid obesity. Surg En-
4. Almogy G, Crookes PF, Anthone GJ. Longitudinal gastrectomy as a treatment for
6. Milone L, Strong V, Gagner M. Laparoscopic sleeve gastrectomy is superior to
endoscopic intragastric balloon as a first stage procedure for super-obese
by Roux-en-Y gastric bypass for morbibly obese patients: a risk reduction
bougie size affect mean %EWL? Short-term outcomes. Surg Obes Relat Dis
2008;4:528–33.
gastrectomy (first stage of biliopancreatic diversion with duodenal switch) on
improves candidacy in morbidly obese patients awaiting transplantation. Surg
Obes Relat Dis 2008;4:159–64.
two different techniques for laparoscopic sleeve gastrectomy. Obes Surg 2007;
17:1435–41.
 gastrectomy as an isolated bariatric procedure: intermediate-term results from
16. Fuks D, Verhaeghe P, Brehant O, et al. Results of laparoscopic sleeve gastrec-
tomy: a prospective study in 135 patients with morbidity obesity. Surgery 2009;