The National Shift to Sleeve Gastrectomy: Long-Term Disappointment and Recidivism or Patient Preference?

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22.1 Introduction

Obesity has reached a world-wide epidemic and more than a third of the United States adult population is obese. Since 2012, laparoscopic sleeve gastrectomy (SG) has been accepted as a primary procedure by the American Society of Metabolic and Bariatric Surgery (ASMBS) and accepted by all major insurers. Currently, SG is being performed with increasing frequency, bypassing laparoscopic Roux-en-Y gastric bypass (GB) as the most commonly performed bariatric procedure in the United States. The long-term outcomes studies of SG among patients of advanced obesity are limited. This chapter will analyze the available data of SG compared to GB in regards to weight recidivism and its effects on diabetes mellitus (DM) and GERD resolution by analyzing evidence in the following 6 categories: comparative outcomes, special populations, weight loss outcomes, weight regain/lack of treatment effect, GERD complications, and patient and surgeon preference/resource utilization.

22.2 Search Strategy

We conducted our search using the following search terms from in PubMed: sleeve gastrectomy long-term follow up; sleeve gastrectomy and super morbid obesity, GERD or Barrett's Esophagus, diabetes resolution; sleeve gastrectomy/bariatric surgery in special populations, inflammatory bowel disease, immunosuppression, prior abdominal surgery; sleeve gastrectomy compared to gastric bypass long-term follow

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Table 22.1 PICO Terms

P (Patients)	I (Intervention)	C (Comparator)	O (Outcomes)
Patients with severe/ morbid obesity, type 2 diabetes, GERD, morbidity after bariatric surgery	Sleeve gastrectomy	Roux-en-Y gastric bypass	Weight loss, lack of treatment effect, type 2 diabetes remission, GERD resolution/ progression, and cost

up, patient preference and bariatric surgery, sleeve gastrectomy, morbidity, readmission, operative time, and cost (Table 22.1). The results were narrowed by the following criteria: English language and published within the last 5 years.

22.3 Results

In order to better characterize the available literature, we summarized the results in 6 sub-categories.

22.3.1 Comparative Outcomes Between Sleeve Gastrectomy and Gastric Bypass (Table 22.2)

Mixed evidence exists in comparing the outcomes of these 2 procedures, however both SG and GB are superior to medication alone for inducing remission of type 2 DM, especially in the non-severely obese population. In the STAMPEDE trial, Schauer et al. randomized 150 patients who had type 2 diabetes to receive either intensive medical therapy alone or intensive medical therapy plus GB or SG. 90% of the patients completed 5 year follow up. They found that patients who underwent surgery had a greater mean percentage reduction from baseline in HgbA1c (2.1% vs. 0.3% $p = 0.003$). At 5 years, changes from baseline body weight were superior in post bariatric surgery patients compared to medical therapy (−23%, −19%, and −5% in GB, SG, and medical therapy, respectively). Changes in TG levels were superior in the bariatric surgery group (−40%, −29%, and −8%), HDL level (32%, 30%, and 7%), use of insulin (−35%, −34%, and −13%), and quality-of-life (general health score increases of 17, 16, and 0.3) [1].

Another study further substantiates SG in its effects in DM. Nedelcu et al. looked at the effect of SG on type 2 DM at 5 years. In 52 patients with diabetes, the mean duration was 10.8 ±10.8 years before operation. The preoperative HgbA1c was 8 ± 2% in 45 patients; >/=9% in 17 patients (38%). Prolonged DM remission at 5 years was found in 9 patients (17%). No patient who required insulin preoperatively went into remission. Improvement of diabetes was found in 27 patients (52%) at 5 years [2].

Several studies compared the rate of DM remission/improvement between SG and GB, and most studies demonstrated that GB was superior both in the short and

Table 22.2 Comparative outcomes

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Schauer et al. [1]	150 Randomized to intensive medical therapy or bariatric surgery plus medical therapy at 5 years	Weight change Triglycerides Use of insulin Quality of life All comparisons showed bariatric (SG/GB) superior compared to medical therapy ($p < 0.05$)	−23% −40% −35% 17	−19% −29% −34% 16	High
Nedelcu et al. [2]	52 retrospective	Type 2 DM after SG at 5 years	Remission 17%. None in patients who required insulin preoperatively. Improvement in 52%.		Low
Dang et al. [3]	207 retrospective	Type 2 DM remission at 1 year	38.1%	57.7% (OR 6.58, 95% CI 2.79–15.5)	Low
Sha et al. [4]	Meta-analysis of RCTs of 296 patients	DM remission in non-severely obese patients (BMI < 35)	DM remission rate and %EWL were of no difference between GB and SG	High	High
Salminen et al. [5]	Randomization of 240 to SG or GB	Complete or partial DM remission after 5 years follow up	37% (15/41)	51% (24/40) ($p = 0.99$)	Moderate
Celio et al. [6]	50,987 Retrospective	Co-morbidity resolution at 1 year: Diabetes mellitus (DM), hypertension (HTN), gastroesophageal reflux disease (GERD), hyperlipidemia (HL), and obstructive sleep apnea (OSA)	DM 50.8% HTN 34.5% GERD 32.5% HL 32.5% OSA 40.6%	DM 61.6% ($p < 0.001$) HTN 43.1% ($p < 0.001$) GERD 53.9% ($p < 0.001$) HL 39.7% ($p < 0.001$) OSA 42.8% ($p = 0.058$)	Low

(continued)

Table 22.2 (continued)

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Lager et al. [7]	714 retrospective	Total weight (TW) and excess weight loss (EWL), hemoglobin A1c (HgbA1c) in all patients, HgbA1c in diabetics, and total cholesterol (TC) at 4 years	TW 18.6% EWL 38.5% HgbA1c decrease 0.45 to 0.73% DM HgbA1c decrease 0.45% (±0.15%) TC increase 12.7 ± 3.6 mg/dL	TW 25.6% ($p < 0.0001$) EWL 57.6% ($p < 0.0001$) HbA1c decrease 0.91–1.12% ($p = 0.004$) DM HgbA1c decrease 1.28% (±0.21%) ($p = 0.002$) TC decrease 0.3 ± 5.4 mg/dL ($p = 0.01$)	Low

long-term. Dang et al. conducted a retrospective review of 207 diabetic patients who underwent SG or GB and reported their 1 year remission rates to be 38.1% and 57.7% for SG and GB, respectively. GB was associated with higher odds ratio of DM remission (OR 6.58, 95% CI 2.79–15.5) [3].

In patients who are non-severely obese, SG may be equivalent in comparison to GB in regards to DM remission. Sha et al. performed a meta-analysis of RCTs evaluating GB vs SG for type 2 DM in non-severely obese patients (BMI < 35). At mid-term follow up, in the 296 patients included, DM remission rate and %EWL were of no difference between GB and SG. GB was associated with lower BMI, waist circumference, LDL, and higher HDL; however HgbA1c, fasting plasma glucose, total cholesterol, and TG were not significantly different [4]. There was no significance difference in DM remission between GB and SG in another study. Salminen et al. randomized 240 patients to SG or GB and followed them for 5 years. Complete or partial remission of type 2 DM was seen in 37% (n = 15/41) after sleeve gastrectomy and 51% (n = 24/40) after gastric bypass ($P = 0.99$) [5].

However, when evaluating obesity-related comorbidities resolution, several studies demonstrated GB superiority compared to SG, especially in advanced obesity at medium-term follow up. Celio et al. found that in 50,987 class 5 obesity patients (BMI >/=50), at 1 years compared to SG, GB patients had increased resolution of all measured co-morbidities: DM (61.6 vs 50.8%, $p < 0.001$), hypertension (43.1 vs 34.5%, $p < 0.001$), GERD (53.9 vs 32.5%, $p < 0.001$), hyperlipidemia (39.7 vs. 32.5%, $p < 0.001$), and obstructive sleep apnea (42.8 vs. 40.6%, $p = 0.058$) [6].

Lager et al. found that in 714 patients, at 4 years follow-up, GB patients lost 34.4 kg of total weight, 25.7% of total weight, and 57.6% EWL as compared to SG patients who lost 26.7 kg, 18.6%, and 38.5% ($p < 0.0001$ for all measures). In GB patients, HgbA1c decreases were consistent over time with range of 0.91 to 1.12%

at 4 years. On the other hand, in SG patients, improvements in HgbA1c decreased over time from a reduction of 0.73% at 1 year to 0.45% at 4 years (p = 0.004). Among patients with DM, HgbA1c improvements at 4 years were 1.28% (±0.21%) vs. 0.45% (±0.15%) for GB vs SG patients (p = 0.002). Total cholesterol decreased in the GB patients at 4 years by 0.3 ± 5.4 mg/dL, but increased in SG patients by 12.7 ± 3.6 mg/dL (p = 0.01). There was only a significant difference at 3 years in systolic blood pressure in favor of GB (12.6 vs 6.5 mmHg, p = 0.001) [7].

22.3.2 Special Populations (Table 22.3)

In special populations, i.e. patients with immunosuppression, inflammatory bowel disease (IBD), and prior abdominal operations, SG appears to be safer. Hefler et al. utilized the MBSAQIP data to study the effects of chronic corticosteroid and immunosuppressant after bariatric surgery. 430,936 patients were included, of these 7214 (1.7%) were chronically immunosuppressed. Their analyses found statistically higher odds of 30-day major complication rates (OR 1.39, 95% CI 1.25–1.55;

Table 22.3 Special populations

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Hefler et al. [8]	430,936 MBSAQIP retrospective	7214 (1.7%) chronically immunosuppressed	30-day major complication OR 1.39, 95% CI 1.25–1.55 (p < 0.001) Bleed OR 1.49, 95% CI 1.24–1.8 (p < 0.001) Anastomotic leak OR 1.38, 95% CI 1.02–1.87 (p = 0.037)		Low
Major et al. [9]	Retrospective 2413 Group 1 no prior abdominal surgery, Group 2 at least 1 abdominal surgery.	Operation time. Intra-operative adverse events. Length of stay.	Group 2 prolonged median operation time for GB (p = 0.012). Such correlation was not found in SG patients (p = 0.396). Group 1 and 2 similar intraoperative adverse events and post operative complications. Group 2 longer length of stay (p = 0.034). Readmissions were similar.		Low
Heshmati et al. [10]	Retrospective 1 year follow up of 54 patients (SG N = 35, GB N = 19)	Increased severity of IBD post-op Post-op complication	4% 3%	37.5% (p = 0.016) 26% (p = 0.02)	Low

p < 0.001), bleed (OR 1.49, 95% CI 1.24–1.8; p < 0.001) and anastomotic leak (OR 1.38, 95% CI 1.02–1.87; p = 0.037) amongst the immunosuppressed. Their secondary analysis found higher rates of 30-day major complications for immunosuppressed patients undergoing GB (9.6% vs 5%; p < 0.001) [8].

Major et al. conducted a retrospective analysis of 2413 patients and evaluated if previous abdominal surgery affected the course and outcomes after bariatric surgery. Group 1 had no history of abdominal surgery and group 2 patients had undergone at least 1 abdominal surgery. Group 2 had a significantly prolonged median operation time for GB (p = 0.012). Such correlation was not found in SG patients (p = 0.396). Group 1 and 2 had similar intraoperative adverse events and postoperative complications. Group 2 had a longer median length of stay (p = 0.034), while readmissions were similar [9].

In a retrospective study conducted by Heshmati et al., examined 54 Crohn's Disease (CD, N = 31) or ulcerative colitis (UC, N = 23) patients and followed them for 1 year. 19 patients underwent GB and 35 underwent SG. There was a significant difference in the proportion of patients who had worsened CD after GB compared with SG (37.5% vs. 4%; p = 0.016). In addition, there was a greater rate of postoperative complication after GB vs SG (26% vs. 3%; p = 0.02). GB was associated with a greater number of patients with an increased requirement of IBD-medications. SG resulted in less weight loss however had a lower rate of severe complications. SG may be a safer surgery in this patient population [10].

22.3.3 **Weight Loss Outcomes** (Table 22.4)

Laparoscopic sleeve gastrectomy is well established as a primary bariatric surgery with durable long-term weight loss. Arman et al. analyzed 110 consecutive SG patients with >11-year follow up and looked at progression of weight, satisfaction, evolution of co-morbidities, and GERD. For the 47 patients who maintained the sleeve construction, the excess body mass index loss (EBMIL) was 62.5% vs 81.7% (p = 0.015) for the 16 patients who underwent conversion procedure. None of the 7 patients preoperatively suffering from GERD had remission after SG. Patient satisfaction score remains good despite unfavorable GERD outcomes [11]. In addition, Noel et al. found that for 116 patients with long-term follow up (8 years), the mean EWL was 67% and that 70.7% of patients had >50% EWL. Comorbidity resolution were: hypertension, 59.4%; diabetes 43.4%; OSA 72.4% [12].

However, when compared to GB, some studies have showed inferiority of SG. Sharples et al. performed a systematic review and meta-analysis of randomized controlled trials comparing long-term outcomes of GB and SG. GB demonstrated greater %EWL compared with SG (65.7% vs 57.3%, P < 0.0001). Resolution of HL was more common after GB (69.6% vs. 55.2%, p = 0.0443). Remission of GERD was more common after GB (60.4% vs. 25%, p = 0.002) [13]. In addition, Ahmed et al. conducted a longitudinal long-term (7 years) study comparing weight change and comorbidities in patients who underwent SG vs. GB. At year 7, mean weight loss was 23.6% for SG and 30.4% for GB, P = 0.001) [14].

Table 22.4 Weight loss outcomes

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Arman et al. [11]	110 prospective SG patients	Weight, satisfaction, evolution of GERD with 11+ years follow up	N = 47 EBMIL 62.5% 0/7 cured from GERD. Patient satisfaction equivalent vs GB.	Conversion N = 16 EBMIL 81.7% ($p = 0.015$)	Low
Noel et al. [12]	116 Retrospective	Mean EWL, >50% EWL, and comorbidity resolution: HTN, DM, and OSA at 8 years after SG	Mean EWL 67%, >50% EWL 70.7%, HTN 59.4% DM 43.4% OSA 72.4%		Low
Sharples et al. [13]	Systematic review and meta-analysis of 5 RCTs	EWL at 5 years.	57.3%	65.7% ($p < 0.0001$)	High
Ahmed et al. [14]	116 (SG = 59) (GB = 57) Retrospective	Mean WL after 7 years	23.6%	30.4% ($p = 0.001$)	Low

22.3.4 Weight Regain/Lack of Treatment Effect (Table 22.5)

The lack of treatment effect seems to higher in SG compared to GB. Morton et al. found that at 12 months, weight loss results followed a normal bell-curve distribution for laparoscopic adjusted gastric band (LAGB), SG, and GB. However, at 24 and 36 months, percent excess weight loss (%EWL), both LAGB and SG appeared to follow a flatter distribution. At 1 year, the odds ratio of a lack of a successful treatment of SG compared to GB was 6.305 (2.125–19.08; $P = 0.0004$) and at 3 years, the OR for SG compared to GB was 32.4 (7.31–43.4; $P < 0.0001$) [15].

The lack of treatment effect phenomenon is further exemplified in advanced obesity and GBB may be superior in weight loss in this population. Ece et al. performed a retrospective analysis of 186 SG patients with follow up for 41.2 ± 7.3 months after SG. 83 patients (50.9%) were class 4 (BMI 40–49), 52 (31.9%) were of the class 5 obesity (BMI 50–59), and 28 (17.2%) were also class 5+ obese, with BMI >/= 60. The mean %TWL at 12, 24, 36, and 41.2 months was 34.7, 34.4, 31.4, and 29.6%, respectively. The most heavy group of patients (class 5+) experienced significantly lower %EWL (48.6) compared to class 4 and class 5 obese groups (65.6 and 59.8) at 41.2 months [16].

Table 22.5 Weight regain

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Morton et al. [15]	1331 SG (N = 243) GB (N = 963) Prospective	Weight loss failure at 1 and 3 years odds ratio (OR)	1 year OR: 6.305 3 years OR: 32.4	1 year: 1 (p = 0.0004) 3 years: 1 (p = 0.0001)	Moderate
Ece et al. [16]	186 retrospective	TWL for morbidly obese (MO, BMI 40–49), super-obese (SO, BMI 50–59), super-super obese (SSO, BMI >/= 60), and %EWL at 12, 24, 36, and 41.2 months (Mos) after SG.	SSO TWL at 12 Mos 34.7%, 24 Mos 34.4%, 36 Mos 31.4%, 41.2 Mos 29.6%. SSO EWL at 41.2 Mos 48.6% SO EWL 65.6% MO EWL 59.8%		Low
Jain et al. [17]	4932 SG (N = 1699), GB (N = 3236) Retrospective	EWL in BMI 45 to 55 at 5 years	BMI >/=45 EWL 56.5% BMI >/=55 EWL 53.5%	BMI >/=45 EWL 66.6 (p < 0.001) BMI >/=55 EWL 63.8% (p < 0.001)	Low
Guan et al. [18]	Meta-analysis, 32 studies: 3 RCTs, 29 observational studies with 6665 patients.	Revision rate after SG after >/= 3 years.	>/= 3 years 10.4% >10 years 22.6%		High
Toolabi et al. [19]	120, GB (N = 64) and SG (N = 56), prospective	WL, EWL and weight regain (WR) after 5 years.	WL 24.6% EWL 61.9% WR 32%	WL 30.4% (p = 0.005) EWL 79.4% (p = 0.001) WR 9.3% (p = 0.004)	Low
Sepulvada et al. [20]	148 SG retrospective	Weight loss failure (%EWL < 50) after 7 years	33.3% fail at 5 years and 50% fail at 7 years.		Low
Bhandari et al. [21]	306, GB (N = 154) and SG (N = 152) retrospective	EWL and weight loss failure (%EWL < 50) after 6 years	EWL 50% WL failure 46.9%	EWL 61% (p = 0.0001) WL failure 11.5% (no p value)	Low

Jain et al. conducted a retrospective review of 4935 patients who underwent SG (N = 1699) or GB (N = 3236) with follow-up up to 5 years and found that patients in the BMI 45 to 55, there a significant higher %EWL in GB vs. SG [17].

Lack of treatment effect in SG is associated with conversions to GB. Guan et al. found that in mid-long-term outcomes (>/=3 years) after SG the overall revision rate was 10.4%. In patients with >10 years follow-up, the rate increased to 22.6%. Lack of effect of treatment was the most common indication for revision [18].

The higher lack of effect of SG compared to GB is further represented in the following observational studies. Toolabi et al. performed a prospective study on 120 patients who underwent GB (N = 64) and SG (N = 56). At 5 years, %WL (30.4 ± 1.3% vs 24.6 ± 1.3%, P = 0.005), and %EWL (79.4 ± 3.6% vs. 61.9 ± 3.5%, P = 0.001) were significantly higher in GB vs. SG respectively. Weight regain occurred in 9.3% in GB and 32% in SG (P = 0.004) [19]. This is based on the definition proposed by Baig et al.: 1. 25% increase in lost weight from the first 1 year postop, OR 2. weight regain more than 10 kg from weight at 1 year after surgery [22].

Sepulvada et al. performed a 7 year retrospective study of 148 SG patients. They found that up to one third of patients experience lack of treatment effect at the fifth year and 50% endure treatment failure in the seventh year. Lack of effect was defined as %EWL <50% [20]. Bhandari et al. performed a retrospective review on 154 GB and 152 SG patients. After 6 years the %EWL for SG was 50% and GB 61% (p = 0.0001). The lack of treatment effect (%EWL <50) for SG was 46.9% and GB 11.5% [21].

22.3.5 **GERD Complications** (Table 22.6)

Studies consistently demonstrate the association of SG with GERD development/progression and its inferiority in inducing remission of GERD compared to GB. This has potential correlation with development of pre-cancerous lesions, reason for conversion to GB, and/or weight-loss treatment lack of effect.

Peterli et al. found that in 217 patients randomized to SG and GB, GERD remission was observed more frequently after GB (60.4%) than after SG (25%). GERD worsened more often after SG (31.8%) than GB (6.3%) [23]. In addition, Chuffart et al. found that after 6 years follow-up in 41 SG patients, de novo GERD occurred in 22%, persistent GERD in 22%, and 5% required conversion to GB due to reflux [24].

In a multicenter study by Sebastianelli et al., systematic endoscopy was conducted at least 5 years after SG, the prevalence of Barrett's Esophagus (BE) in 90 patients was 18.8%. Lack of treatment effect was significantly associated with BE (p < 0.01). 36.8% of patients experienced weight loss failure and among patients with BE, it was 70.6% (P < 0.01). GERD symptoms were present in 21% of patients before surgery and rose to 76% at the time of follow up (p < 0.01). Half of the patients in this study complained of de novo GERD that were mild in 12 (18%) and severe in the remaining 56 (82%). The use of PPIs increased from 22% (20 patients) to 52% (46 patients) at the follow-up (p < 0.0001). Esophagitis on endoscopy at

Table 22.6 GERD complications

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Peterli et al. [23]	217 randomization to SG and GB	GERD remission/progression after 5 years	Remission 25% Progression 31.8%	60.4% 6.3%	Moderate
Chuffart et al. [24]	41 after SG retrospective	GERD after 6 years	De novo GERD 22% Persistent GERD 22% GERD requiring conversion to GB 5%		Low
Sebastianelli et al. [25]	90 after SG retrospective	Prevalence of Barrett's esophagus (BE), WL failure association with BE, GERD progression, PPI use, and esophagitis after at least 5 years.	Prevalence of BE 18.8%, WL failure 70.6% in patients with BE. GERD before SG 21% to 76% at follow up ($p < 0.01$). PPI use 22% before SG to 52% at follow up ($p < 0.0001$). Esophagitis 10% before SG to 41% 5 years post op.		Low
Genco et al. [26]	110 prospective	Visual analogue scale (VAS) of GERD, PPI consumption, and endoscopy before SG and after with mean 58 months	After surgery vs before: VAS score 3 vs 1.8 ($p = 0.018$) GERD symptoms 68.1% vs 33.6% ($p < 0.0001$) PPI intake 57.2% vs. 19.1% ($p < 0.0001$). Endoscopy upward migration Z-line 73.6%, biliary-like reflux 74.5%. New non-dysplastic BE 17.2%.		Moderate
Sorcicelli et al. [27]	144 prospective	GERD symptoms, PPI intake, pre and post SG endoscopy with mean follow up 66 months. Diagnosis of GERD post SG was not reliable based on symptoms.	GERD 70.2% PPI 63.9% Post op endoscopy 72.9% pathological findings: EE 59.8%, non-dysplastic BE 13.1%.		Low

increased from 10% (9 patients) pre-operatively, to 41% (37 patients) 5 years post-operatively [25].

Genco et al. examined 162 patients who underwent preoperative visual analogue scale (VAS) evaluation of GERD symptoms, recording of PI consumption, and upper endoscopy. 110 patients (69.1%) participated in follow up at a mean of 58 months. VAS score, GERD symptoms, and PPI intake significantly increased compared to before surgery (3 vs. 1.8, p = 0.018; 68.1% vs. 33.6%, P < 0.0001; 57.2% vs. 19.1%, p < 0.0001). On endoscopy, an upward migration of the Z-line was found in 73.6% and a biliary-like esophageal reflux was found in 74.5%. A significant increase in incidence and severity of EE was discovered. Non-dysplastic BE was newly diagnosed in 19 patients (17.2%) [26].

A GERD diagnosis after SG is often based on symptoms and PPI consumption as objective tests are performed less often. Sorcicelli et al. conducted a prospective study of 144 patients with a mean follow-up of 66 months and found that GERD symptoms and PPI intake was present in 70.2% and 63.9% of patients, respectively. Post-operative upper endoscopy revealed pathological esophageal findings in 105 of 144 patients (72.9%), significantly increased compared to preoperative endoscopy. Erosive esophagitis was found in 86 patients post-operatively (59.8%). Nondysplastic BE was found in 13.1% (19 patients). After a logistic regression analysis, it was discovered that the probability of suffering from GERD symptoms did not change significantly among different degrees of EE or in case of BE diagnosis (OR 0.4–1.29). Even after adjustment based on PPI usage, the results were similar. The authors conclude that the diagnosis of GERD post SG was not reliable based on symptoms [27].

22.3.6 Patient and Surgeon Preference/Resource Utilization (Table 22.7)

Several reasons may persuade patients and/or surgeons to pursue SG over GB; these reasons include: decreased overall morbidity/mortality, easier and quicker operation, and lower cost. Young et al. performed a retrospective analysis of the American College of Surgeons NSQIP data of 24,117 patients who underwent SG or GB. They found that SG had a shorter mean operative time (101 vs. 133 min, p < 0.01), a lower rate of deep wound infections (0.06% vs. 0.20%, p = 0.05), lower serious morbidity rate (3.8% vs. 5.8%, p < 0.01), and a 30-day reoperation rate (1.6% vs. 2.5%, p < 0.01) [28].

In addition, Alizadeh et al. retrospectively reviewed MBSAQIP data of 29,588 patients and found that SG was associated with significantly shorter operative time compared to GB (78 ± 39 *vs* 122 ± 54 min, $P < 0.01$), lower overall morbidity (2.3% *vs* 4.4%, AOR 0.53, CI 0.46–0.60, $P < 0.01$), lower serious morbidity (1.5% *vs* 2.3%, AOR 0.64, CI 0.53–0.76, p < 0.01), lower 30-day reoperation (1.2% *vs* 2.3%, AOR 0.52, CI 0.43–0.63, p < 0.01), and lower 30-day readmission (4.2% *vs* 6.6%,

Table 22.7 Patient and surgeon preference/resource utilization

Study	Patients	Outcome classification	Sleeve gastrectomy	Gastric bypass	Quality of evidence
Young et al. [28]	24,117 retrospective NSQIP	Operative time Deep wound infection Serious morbidity 30-day reoperation	101 min 0.06% 3.8% 1.6%	133 min ($p < 0.01$) 0.20% ($p = 0.05$) 5.8% ($p < 0.01$) 2.5% ($p < 0.01$)	Low
Alizadeh et al. [29]	29,588 retrospective MBSAQIP	Operative time Overall morbidity Serious morbidity 30-day reoperation 30-day readmission	79 min 2.3% 1.5% 1.2% 4.2%	122 min ($p < 0.01$) 4.4% (AOR 0.53 CI 0.46–0.60, $P < 0.01$) 2.3% (AOR 0.64, CI 0.53–0.76, $p < 0.01$) 2.3% (AOR 0.52, CI 0.43–0.63, $p < 0.01$) 6.6% (AOR 0.62, CI 0.55–0.69, $P < 0.01$)	Moderate
Berger et al. [30]	Retrospective review of MBSAQIP of 130,007 patients (LAGB N = 7378; SG N = 80,646; GB N = 41,983)	30-day readmission rates	2.8% OR 1.89 (95% CI 1.52–2.33)	4.9% OR 3.06 (95% CI 2.46–3.81)	Moderate

AOR 0.62, CI 0.55–0.69, $P < 0.01$). The authors conclude that, SG's popularity may in part be related to its improved perioperative safety profile [29].

Lastly, Berger et al. evaluated the national readmission rates of 130,007 patients from the MBSAQIP data. Of those, 7378 were laparoscopic adjusted gastric banding (LAGB) (5.7%), 80,646 were SG (62%), and 41,983 were GB (32.3%). The overall 30-day readmission rate was 4.4% and the most common causes were nausea, vomiting, electrolyte, and nutrition depletion. LAGB had the lowest rate of 1.4%, followed by SG (2.8%), and then GB (4.9%). When compared with LABG, SG had a readmission odds ratio (OR) of 1.89; 95% CI 1.52–2.33 and GB had the highest, with an OR of 3.06; 95% CI 2.46–3.81 [30].

22.4 Recommendations Based on the Data

22.4.1 Comparative Outcomes Between Sleeve Gastrectomy and Gastric Bypass

SG has a moderate effect on DM in the medium term, especially in the non-severely obese patients. In addition, when compared to medical therapy alone, the addition of bariatric surgery, whether it may be sleeve gastrectomy or gastric bypass, is superior in inducing type 2 DM remission and/or cure in short and medium-term. This is supported by high quality of evidence. However, when in studies comparing GB to SG, GB almost unanimously demonstrate higher efficacy for inducing DM improvement or remission in the short and medium-term. This is supported by moderate quality of evidence (QoE).

Either SG or GB plus medical therapy is more effective than medical therapy alone for the management of type 2 diabetes and hypertriglyceridemia. QoE high.

For the non-severely obese patients, compared to GB, SG may have equivalent efficacy in inducing DM remission. QoE high.

When comparing resolution of obesity-related comorbidities (DM, HTN, GERD, HL, and OSA), GB is superior to SG at short and medium-term but may or may not be superior at long-term. QoE moderate.

22.4.2 Special Populations

Although both SG and GB are nearly equivalent in overall morbidity and mortality, certain patient factors may disproportionately increase the risk of GB due to the need for multiple anastomoses and bowel manipulation. Literature review demonstrated increased risk in patients with inflammatory bowel disease, with immunosuppression, and those with multiple intra-abdominal surgeries. All of the evidence are retrospective, therefore the quality of evidence is low.

SG may be safer in special populations: inflammatory bowel disease, immunosuppressed, and patients with prior abdominal operation. QoE low.

22.4.3 Weight Loss Outcomes

Centers have established with long-term follow up that sleeve gastrectomy is durable in maintaining weight loss, therefore its long-term efficacy should not be discredited. The quality of evidence is moderate. However, when compared to GB, some studies have demonstrated inferiority in weight loss of SG in medium and long-term. The quality of evidence is also high in this aspect.

SG has durable weight-loss efficacy in the long-term. QoE moderate.

When discussing SG and GB long-term weight loss outcomes, patients should be informed that GB is superior and has less lack of treatment effect. QoE high.

22.4.4 Weight Regain/Lack of Treatment Effect

When compared to SG, literature demonstrates less lack of treatment effect of GB and higher weight-loss potential. This is most common reason for conversion of SG to GB. The quality of evidence ranges from moderate to high. There is also suggestion that SG is inferior in weight loss in class 5 obesity (BMI > 50) when compared to GB. In addition, when comparing resolution of co-morbidities at short and medium-term, GB is superior and SG's effects are variable in the long-term, especially in class 5 obesity. The above evidence ranges from moderate to low as they are mainly observational.

Long-term weight loss outcomes for SG is variable across studies and may be worse especially for Class 5+ obesity (BMI=/>60). QoE low.

Weight regain or lack of treatment effect is significantly higher after SG compared to GB after medium and long-term follow up. QoE moderate.

In Class 5 obesity (BMI > 50), weight loss potential is significantly larger after GB compared to SG. QoE moderate.

Revisional rates after SG increased with long-term follow up. QoE moderate.

22.4.5 GERD Complications

SG is associated with development of de novo GERD and the progression of disease in medium follow up. It has been associated with the sole or main reason for conversion to GB. When compared to GB, SG induces more GERD progression and less GERD remission. In-turn, this is associated with development of Barrett's Esophagus which has ramification in not just disease progression but also lack of effect in weight loss after medium follow up. These statements are supported by moderate to low quality evidence.

In comparing GERD remission or progression after medium-term follow up, GB is superior. SG has direct correlation to de novo GERD development, subjective and objective worsening, and increased PPI intake. Therefore, in bariatric patients with symptomatic GERD, GB should be recommended. QoE moderate.

Barret's esophagus is correlated with weight loss failure. QoE low.

22.4.6 Patient and Surgeon Preference/Resource Utilization

Several reasons may persuade patients and/or surgeons to pursue SG rather than GB. Supported by moderate quality of evidence, these reasons include: lower morbidity, readmission, operative duration, and overall cost.

Surgeon/patient preference for SG may be due to: lower operative time, morbidity, readmission, and overall cost. QoE moderate.

22.5 Personal View of the Data

While the sleeve gastrectomy has grown tremendously over the past decade, further delineation of its appropriate utilization needs to be determined. The safety profile of the sleeve gastrectomy is superior to the gastric bypass while the benefits of the gastric bypass exceeds sleeve gastrectomy. Future investigation should be undertaken to determine if sleeve gastrectomy benefits may be enhanced by standardization and/or adjuvant pharmaceutical intervention.

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