Bariatric Surgery
Overview of Procedures and Outcomes

Alexandra Kovar, MD[a], Dan E. Azagury, MD[b,*]

KEYWORDS

• Bariatric surgery • Outcomes • Weight loss • Comorbidities

KEY POINTS

- Bariatric surgery is currently the most effective and enduring weight loss therapy available and is extremly safe with morbidity and mortality rates on par with hernia repairs and appendectomies.
- The types of bariatric surgery procedures have evolved over the past 20 years with laparoscopic sleeve gastrectomy accouting for 60% of all procedures in the United States while the gastric band is now rarely offered at all.
- Gastric bypass surgery, the gold standard in terms of long-term efficacy, reduces diabetes-related mortality by 92% over 7 years.
- The long-lasting remission of type 2 diabetes after bariatric surgery has been demonstrated in observational studies covering greater than 10,000 patients as well as in multiple randomized control trials.
- The new 2022 ASMBS/IFSO guidelines emphasize the benefit of bariatric surgery on diabetes and recommends bariatric surgery in all patients with T2DM with a BMI greater than 30 kg/m^2.

INTRODUCTION

Bariatric surgery has been demonstrated to be the single most effective weight loss therapy available.[1] These therapies are now very well standardized, and the evidence demonstrating their efficacy is overwhelming. The overall effect on mortality alone has been studied in multiple large landmark trials: The Swedish Obese Subjects Study is a prospective controlled trial including 2000 surgical and 2000 matched, "conventional obesity treatment," control patients. The follow-up period is now upward of 24 years. The initial study in 2007, though incorporating older procedures, demonstrated an overall reduction in mortality after bariatric surgery with an adjusted odds ratio of 0.71 compared to the control group. After an additional 13 years of follow-up, a

[a] Department of Surgery, Stanford University, Palo Alto, CA, USA; [b] Section of Bariatric and Minimally Invasive Surgery, Stanford University School of Medicine, Stanford University, 300 Pasteur Drive, H3680A, Stanford, CA 94305-5655, USA
* Corresponding author.
E-mail address: dazagury@stanford.edu

Endocrinol Metab Clin N Am 54 (2025) 121–133
https://doi.org/10.1016/j.ecl.2024.10.003 **endo.theclinics.com**

second analyzation of the same matched cohorts (bariatric surgery vs "conventional obesity treatment") showed persistence of this mortality benefit, including a lower risk of death from cardiovascular disease and cancer.[2] The average weight change in the control group was less than $\pm$ 2% over the study period. In contrast, the average total weight loss 10 years after gastric bypass was 25%.[3] At the 20 year follow-up mark, there was an average reduction in body mass index (BMI) by 7 points demonstrating a long-lasting weight loss affect.[2]

Another long-term study published in the New England Journal of Medicine studied mortality among 7925 gastric bypass patients and 7925 carefully matched patients with severe obesity. Over the 7 year follow-up, mortality decreased 40% in the surgical group, and diabetes-related deaths were reduced by 92%.[4] A smaller study of 1000 surgical patients and 5700 controls demonstrated similar benefits over 5 years with a reduction in the risk of death of 89%.[5] A more recent study analyzed the effect of surgery on 6100 patients with type 2 diabetes undergoing gastric bypass surgery and 6100 matched controls. Over 3.5 years, the overall mortality risk decreased by 58%, and the risk of myocardial infarction was cut in half.[6] These findings were also confirmed among the US veteran's population in 2500 patients (74% men) who underwent bariatric surgery were matched to 7462 control patients. Over the 14 year follow-up, overall mortality decreased after 1 to 5 years (hazard ratio [HR], 0.45) and 5 to 14 years (HR, 0.47).[7]

Additionally, advancements in minimally invasive surgery and overall surgical experience have led to a significant decrease in perioperative mortality and the benefits of bariatric surgery on life expectancy are therefore likely to be even more positive today. The most recent data demonstrated a 30 day mortality of 0.07% in accredited centers, representing less than 1 in 1400 surgeries.[8] Lastly, bariatric surgery has been shown to have comparable morbidity and mortality risks to other commonly performed procedures like cholecystectomy, hernia repairs, appendectomy, and hip arthroplasty.[9]

CURRENT SURGICAL BARIATRIC PROCEDURES

The type of bariatric procedures performed in the United States has evolved over the past 5 years (**Table 1**).[10] The laparoscopic gastric banding (LGB) was a very popular procedure, but during the last decade, it is now in steep decline nearly becoming obsolete and one of the 2 manufacturers for the US market has halted production of the device. The sleeve gastrectomy (SG) now constitutes more than half of all procedures performed. Even if it is no longer the most common procedure performed, the Roux-en-Y gastric bypass (RYGB) remains the gold standard of bariatric procedures with proven long-term efficacy.

The guidelines for bariatric surgery have been recently updated for the first time since the 1991 National Institutes of Health guidelines. The American Society for Metabolic and Bariatric Surgery and International Federation for the Study of Obesity recommend surgery for patients with a BMI of 35 kg/m^2 or greater regardless of presence, absence, or severity of comorbidities or a BMI of 30 kg/m^2 or greater with a high-risk comorbid conditions such as life-threatening cardiopulmonary problems severe diabetes mellitus; or obesity-induced physical problems interfering with lifestyle.[11] Additionally, in Asian patient populations, given the higher risk of cardiovascular disease at a lower BMI compared to non-Asian patients, the recommendation is to consider bariatric surgery at a BMI of $\geq$25 kg/m^2.[11] Patients must have failed attempts at diet and exercise, be motivated and well informed, and free of significant psychological disease. In addition, the expected benefits of operation must outweigh the risks.[12,13] The LGB is also Food and Drug Administration (FDA)-approved for patients

Table 1
Estimate of bariatric surgery procedures in the United States

	2018		2019		2020		2021		2022	
	n	%	n	%	n	%	n	%	n	%
Sleeve	154,976	61.4	152,413	59.5	122,056	61.4	152,866	58.1	160,609	57.4
RYGB	42,945	17.0	45,744	17.9	41,280	20.8	56,527	21.5	62,097	22.2
Band	2660	1.1	2375	0.9	2393	1.2	1121	0.4	2500	0.9
BPD-DS	2123	0.8	2272	0.9	3555	1.8	5525	2.1	6096	2.2
Revision	38,971	15.4	42,881	16.8	22,022	11.1	31,021	11.8	30,894	11.0
SADI	—	—	—	—	488	0.2	1025	0.4	1567	0.6
OAGB	—	—	—	—	1338	0.7	1149	0.4	1057	0.4
Other	5847	2.3	6060	2.4	1221	0.6	7339	2.8	6189	2.2
ESG	—	—	—	—	1500	0.8	2200	0.8	4600	1.6
Balloons	5042	2.0	4655	1.8	2800	1.4	4100	1.6	4358	1.6
Total	*252,564*		*256,000*		*198,651*		*262,893*		*279,967*	

Courtesy of ASMBS – American Society for Metabolic and Bariatric Surgery.

with a BMI of 30 to 40 with one or more obesity-related medical conditions, such as high blood pressure, heart disease, diabetes, or sleep apnea.

Minimally Invasive Roux-en-Y Gastric Bypass

RYGB was first described by EE Mason in the mid-1960s[14] and is now performed laparoscopically and robotically. A small proximal gastric pouch is created (approximately 15–20 cc). The small bowel is then divided approximately 40 to 60 cm from the ligament of Treitz. The distal portion is then brought up and anastomosed to the neo-stomach (Roux limb). The proximal portion is then reconnected to the distal Roux limb, approximately 150 cm from the stomach, creating a functional nonabsorptive bypass as the bile is not in contact with ingested food in this proximal portion (**Fig. 1**). The one anastomosis gastric bypass is a newer technique aiming to reduce the complexity of the operation with a single anastomosis; however, its adoption is low and we do not have good data on the short-term and long-term outcomes regarding weight loss, comorbidity remission, and safety.

Weight loss results

RYGB not only procedues the best weight loss results among the most common procedures but also demonstrates maintenance over time.[15] Average percent of excess body weight lost (EWL) at 1 year is approximately 68%,[16] average EWL after 5 year follow-up ranges from 57% to 79.5%.[17] In a review of 10 year outcomes after gastric bypass, weighted mean excess weight loss at greater than or equal to 10 years was 61.4% ± 13.5[18]; total body weight loss (TWL) ranges from 20% to 31.5%.[19,20] On average, RYGB patients lost over 15 BMI points at 1 year.[21]

Resolution of comorbidities

Improvement in hypertension after gastric bypass has been reported in approximately 87% of patients with complete remission in 61% to 81%.[16,22] A systematic review with follow up greater than 2 years showed a remission rate of 38%,[23] and in a recent study of over 1000 patients, remission was maintained at 6 years in 42% of patients.[24] Similarly improvement in hyperlipidemia was seen in 94% of patients, with resolution in 63% to 91%, 60% at greater than 2 years and maintained remission of 71% at

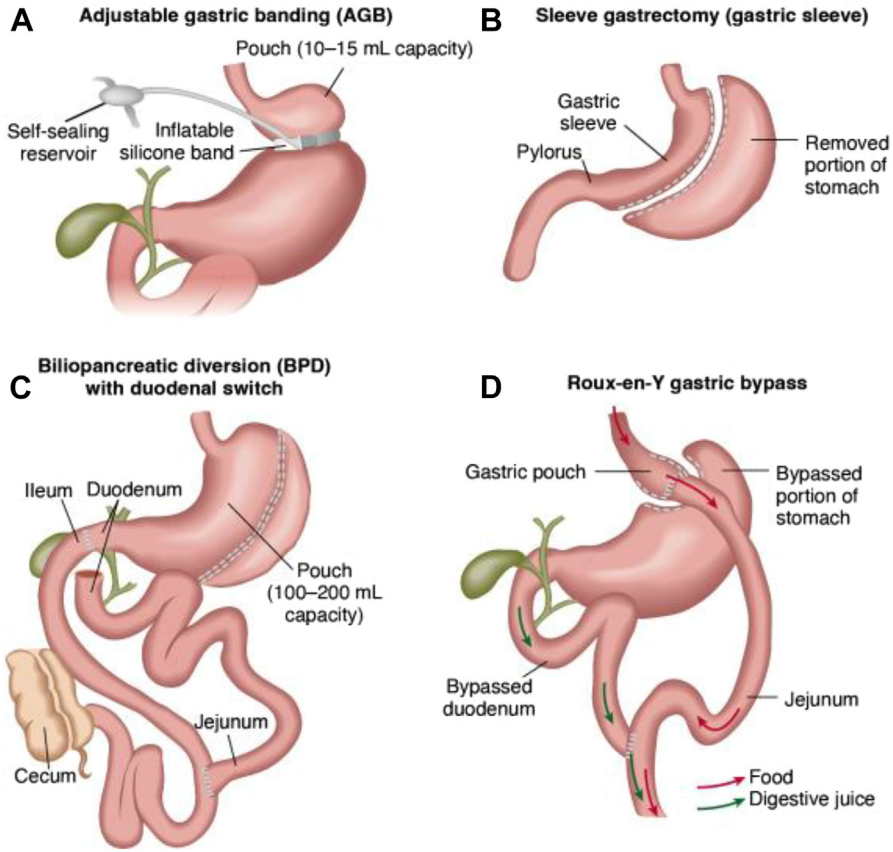

Fig. 1. Bariatric surgical procedures. (*A*) Adjustable gastric banding (AGB) uses a band to create a gastric pouch. (*B*) Sleeve gastrectomy involves creating a sleeve-shaped stomach by removing about 75% of the stomach. (*C*) Biliopancreatic diversion (BPD) with duodenal switch procedure creates an anastomosis between the stomach and intestine. (*D*) Roux-en-Y gastric bypass procedure involves constructing a gastric pouch whose outlet is a Y-shaped limb of the small intestine. (Mariann M. Harding, Lewis's Adult Health Nursing I & II with Integrated Pathophysiology and Geriatric Nursing, Fifth South Asia Edition, 2025. Elsevier Inc.).

6 years.[16,22–24] Obstructive sleep apnea (OSA) improved in 95% of patients after RYGB and resolved in 80%.[16]

Morbidity and mortality

Short-term mortality rates after bariatric surgery have been constantly decreasing. For RYGB, the short-term mortality rate has been reduced by one-third between 2007 and 2012, according to a large French study of over 133,000 patients.[25] Current 30 day mortality is reported to be between 0.07% and 0.38%,[8,21,22,26,27] with reports from US-accredited centers ranging between 0.07% and 0.14%.[8,21] Chang and colleagues[22] reported an overall complication rate between 12% and 21% and reoperations rates of 2.56% to 5.34%.

Minimally Invasive Sleeve Gastrectomy

The SG was originally described as the first step preceding biliopancreatic diversion with duodenal switch (BPD-DS) in patients with severe obesity (BMI >50 kg/m^2). It

is now the most commonly performed procedure in the United States and worldwide (see **Table 1**). The BPD-DS was scheduled approximately 1 year later, but the significant weight loss observed during the interval led to the adoption of this procedure as a stand-alone one.[28] A gastric conduit of approximately 100 cc is created along the lesser curve of the stomach utilizing laparoscopic and robotic techniques. The remnant stomach, including the fundus, is thereafter resected.

Weight loss results

Average weight loss 1 year after SG has been reported to be comparable and sometimes superior to that of RYGB, with a EWL of 69% at 1 year in a blinded randomized control trial.[29] However, long-term maintenance of weight loss has not yet been demonstrated to be as good as for RYGB. A recent study showed a 76.8%, 69.7%, and 56.1% EWL at 1 year, 3 year, and 5 year follow-ups, respectively.[30] Other studies with 5 year follow-up found EWL after SG to be between 49% and 70.3%.[19] TWL in one study with 13 year follow-up after SG was 33.4%, 29.7%, 28.3%, and 26.6% at 1, 2, 5, and 10 years.[31]

Resolution of comorbidities

Remission of hypertension after SG was greater than 82% in a recent systematic review with reported ranges 68% to 92%.[22] Another systematic review with follow-up greater than 2 years showed a remission rate of 38%.[23] Yet other studies evaluating remission 5 years postoperatively, remission rates were described as 27.8% to 100%.[19] Hypertriglyceridemia completely resolved at 1 year in 72% of patients,[30] and overall dyslipidemia resolution rate was 82% in a recent review.[22] At 5 years, the Swiss Multicenter Bypass or Sleeve Study (SM-BOSS) showed complete remission of dyslipidemia after SG in 42.6% of patients.[32] OSA resolution was 90% in that same review and another study demonstrated a maintained resolution rate of 73% 5 years after SG.[33]

Morbidity and mortality

Similarly to RYGB, the mortality rate of SG has been improving since its inception, with a similar 3 fold decrease between 2007 and 2012 in a large French study (0.36%–0.11%).[25] SM-BOSS demonstrated an early (less than 30 days postoperatively) complication rate of 0.9%, a late complication rate of 14.9%, and no deaths.[32]

Laparoscopic Adjustable Gastric Banding

Laparoscopic adjustable gastric banding (LAGB) is an inert inflatable band placed around the proximal portion of the stomach. It is inflated using a subcutaneous port offering the opportunity of adjusting of the degree of restriction. LAGB gained fast and wide popularity in Europe and Australia in the mid and late 1990s and in the United States a decade later after its FDA approval in 2001. It has demonstrated very low perioperative mortality and morbidity, but the advent of the SG has made the LAGB much less attractive with less than 1% of procedures currently in the United States versus more than one-third only 10 years ago (see **Table 1**). Additionally, the device is being produced at a much lower rate due to various companies no longer continuing production.

Weight loss results

One of the reasons for the decreasing number of LAGB procedures performed is the significant variability in weight-loss results. Variability in weight loss is significantly greater than the other bariatric procedures and requires close follow-up for iterative adjustments. At 1 year, EWL loss ranges from 29% to 49% with an average of

42%.[16] In the American College of Surgeons Bariatric Surgery Center Network report (>12,000 LAGB patients), the average BMI lost at 1 year was 7 kg/m^2.[21] Over time EWL has been reported to be between 44% and 59% in follow-up greater than 5 years and 42% at 12+ years.[34–36]

Resolution of comorbidities

One year after LAGB, hyperlipidemia improved in 59% of patients, hypercholesterolemia in 78% and hypertriglyceridemia in 77%. Hypertension resolved in 43% and improved in 71%. Obstructive apnea syndrome improved in 95% and resolved in 68% of LAGB patients.[16] At 2 years or more, remission of hypertension was 17.4% and 22.7% for hyperlipidemia.[23] OSA remission ranged between 71% (observational studies) and 94% (randomized control trials).[22]

Morbidity and mortality

The perioperative morbidity and mortality rates of the LAGB have been consistently very low with a 30 day mortality at or below 0.05%, including no deaths in over 1200 cases in the Longitudinal Assessment of Bariatric Surgery (LABS) Consortium study.[21,37] Short-term (30 day) reoperation rates are also low (0.92%).[21] The Achilles heel of this procedure (and a significant cause for its decreasing use) has emerged over time: The removal (reoperation) rate is significant and ranges from 25% to greater than 50% in long-term studies.[34,35] Grounds for removal include inadequate weight loss, gastro-esophageal reflux, and dysphagia with or without slippage and erosion.

Biliopancreatic Diversion with Duodenal Switch and Single Anastomosis Duodeno-ileal Bypass

The biliopancreatic diversion (BPD) procedure was created in the 1970s in Italy by Dr Scopinaro, which included a partial gastrectomy with duodenal stump, 250 cm gastro-ileal Roux limb, and a 50 cm common channel.[38] This was fine-tuned over multiple iterations by DeMeester[39] and Hess and others[40] in the 1980s to a vertical SG with a suprapapillary duodenojejunostomy (or duodenal switch) and a longer common channel with the hopes of minimizing risk of marginal ulceration and improve the side effects of malabsorption with a longer common channel. After the advent of laparoscopy, given the difficulty of the new skill, the BPD-DS became a 2 staged procedure.[41] The first step involved creating the gastric sleeve, typically over a 48 Fr dilator, followed by a second step where a 150 cm duodeno-ileal roux limb was created followed by an ileoileostomy with a common channel measuring 100 cm.[41]

In 2010, Dr Sanchez-Pernaute[42] described the single anastomosis duodeno-ileal bypass with sleeve gastrectomy as an attempt to simplify the BPD-DS to a single anastomosis. He describes a vertical SG over a 54 French bougie followed by duodeno-ileal anastomosis leaving a 200 cm common channel.[42] Mitzman and colleagues[43] expanded on this technique in 2016 by creating a slimmer SG over a 42 French bougie and a longer common channel measuring 300 cm to reduce the risk of short gut syndrome (**Fig. 2**).

Both the BPD-DS and SADI are performed laparoscopically and robotically. They are typically reserved for higher BMI patients given the complexity of the procedure and risk for malnutrition. However, with over 160,000 sleeve gastrectomies being performed annually, the BPD-DS and SADI are potential options for revisional surgery for patients who failed to have adequate weight loss.

Weight loss results

Average EWL after BPD-DS in a study evaluating 10 year outcomes was 73.4%.[44] A study that followed patients after BPD-DS for up to 20 years showed a similar degree

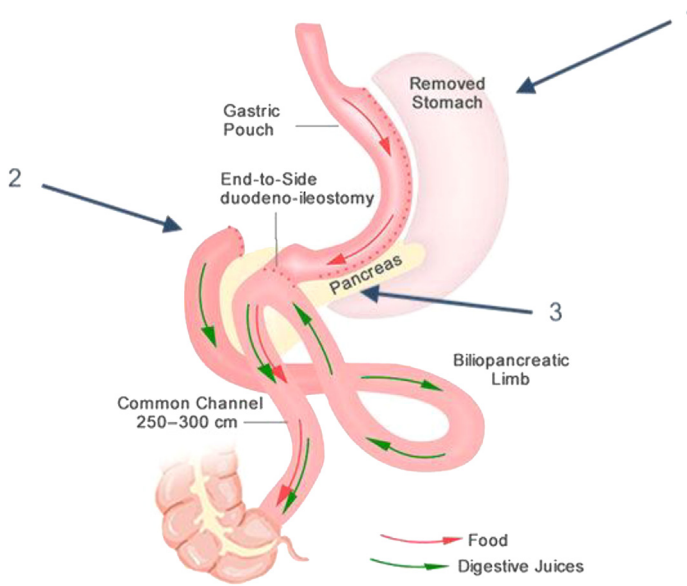

Fig. 2. Laparoscopic single anastomosis duodeno-ileal bypass with sleeve gastrectomy. (*With permission from* ASMBS - American Society for Metabolic and Bariatric Surgery.)

of EWL (70.9%), but also showed this weight loss was maintained over the 20 year study period.[45] TWL is reported as 33.9%.[19]

Patients who undergo the SADI will experience similar rates of EWL around 69% to 80%, depending on the study.[46,47] One systematic review demonstrated 80.4% EWL 10 years post-SADI demonstrating excellent longer term maintenance.[48] TWL was noted to be 39.2% after 3 years and 34.4% at 10 years.[48]

Resolution of comorbidities

In a study comparing remission rates for diabetes, hypertension, OSA, and dyslipidemia between patients undergoing BPD-DS and patients undergoing SADI, there were no statistically significant differences.[47] Remission rates as high as 96% for diabetes, 92.3% for hypertension, 90.7% for OSA, and 80% for dyslipidemia have been described.[45,47] These improvements in comorbidities have been show to persist for over 10 years in multiple studies.[45]

Morbidity and mortality

The 30 day mortality rate is described as 0.57% to 2% for BDP-DS and 0.44% for SADI.[49–51] Early complications, including anastomotic leak, bleeding, and bowel obstruction, are higher in BPD-DS compared to SADI (20.9% vs 1.6%).[52] Long-term complications are similarly elevated in BPD-DS compared to SADI (32.2% vs 10.8%) with the most common complication being diarrhea (7%) and malnutrition (5%) after BPD-DS and sleeve stricture (4%) after SADI.[52] In a systematic review evaluating the efficacy and safety of SADI, they found rates of malnutrition to be 6.3%. Other late complications after SADI included new or worsening gastroesophageal reflux disease (GERD) (3.6%), internal hernia (0.5%), chronic diarrhea (3.3%), and a reoperation rate of 6.4%.[48]

DIABETES REMISSION AFTER BARIATRIC SURGERY

The impact of a bariatric procedure on diabetes was not expected and is truly remarkable. RYGB reduces 3 year diabetes associated mortality by 58% in type 2 diabetes mellitus (T2DM). Similarly cardiovascular-related mortality is reduced by 59% and the risk of myocardial infarction in half.[6]

Furthermore, bariatric surgery has provided patients with a potential for long-lasting and complete remission of T2DM and has offered the medical community a novel understanding of this complex disease.[53]

Even if LAGB has demonstrated very positive outcomes in patients with T2DM, the mechanisms of action and timeline for resolution are different from those of RYGB or even SG. In the case of RYGB or SG, improvement or resolution of diabetes is witnessed within days of the procedure. In LAGB patients, resolution of diabetes is more dependent on weight loss. Remission rates of T2DM after LAGB range from 28.6% to 73% of patients, and improvement was seen in 80% of patients.[16,22,23]

The mechanisms behind the effect of SG on T2DM are yet to be fully understood, and its efficacy on the disease seems to lie between LAGB and RYGB.[54] Improvement or resolution of diabetes was greater than 60% within the first 30 days.[21] T2DM remission rates of 79% to 85% have been reported at 1 year[22,33] and 42% (29%–56%) at 5 years.[55,56]

The substantial effect of RYGB on T2DM was described 20 years ago. Pories and colleagues[57] published an article entitled, "Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus." The study described a series of 146 T2DM patients having undergone an RYGB with 83% of them showing remission of their diabetes.

Since this initial publication, multiple observational studies analyzing over 10,000 patients have confirmed these findings. A retrospective cohort in the United Kingdom identified 569 surgical patients with T2DM and matched them to 1881 patients with diabetes. Remission was defined as absence of medication and a hemoglobin A1c (HbA1c) level below 6.0%. In the bariatric surgery group, 94.5 diabetes mellitus remissions were found per 1000 person-years compared to 4.9 in control patients. The remission rate in the RYGB group was 43 times that of the control group.[54]

Two recent reviews included over 60,000 patients reported remission rates between 66.7% and 70.9% at 2 years or more. At less than 2 years, the resolution rate was 81.6%.[23,58] The LABS consortium published their 3 year results (>2400 patients), and the T2DM remission rate was 67.5%.[59] Very long-term remission rates remain high with 58% at 10 years.[15]

This overwhelming evidence paved the way 2 prospective randomized control trials. The Surgical Treatment and Medications Potentially Eradicate Diabetes Efficiently (STAMPEDE) trial published their 3 year results recently in the New England Journal of Medicine: 150 patients with obesity and uncontrolled T2DM were randomized to receive either intensive medical therapy alone or intensive medical therapy plus RYGB or SG with a goal of obtaining an HbA1c of 6.0% or less. This was achieved in 5% of the medical group patients and 38% in the RYGB group. Of note, 35% of the patients in the RYGB group achieved the primary endpoint without any medication, and 65% of the patients in this same group achieved an HbA1c less than 7%. Patients in the medical group were taking more than 5 diabetes medications versus an average of 1.4 in the RYGB group.[60] The 5 year results of another, similar, randomized controlled trial were published in *Lancet*. Sixty patients were randomized to receive medical treatment, either RYGB or BPD. The primary endpoint was HbA1c less than 6.5% without active pharmacologic treatment for 1 year. This endpoint was achieved

and maintained at 5 years in 50% of the 38 surgical patients (37% in the RYGB group) and in none of the 15 medically treated patients. Five major complications of diabetes (including one fatal myocardial infarction) occurred in the medical group compared with one complication in the surgical group.[61]

A recent systematic review and meta-analysis of articles published between 2013 and 2023 describes the 5 year DM remission rates as 47% (36%–59%) after RYGB.[56] The 2018 Swedish study, SM-BOSS, comparing outcomes between SG and RYGB demonstrated complete remission of diabetes in 61.5% of patients in the sleeve cohort and 67.9% in the RYGB cohort.[32] Even higher rates of diabetes remission, upward of 80% to 90%, are seen after BPD-DS and SADI when compared to RYGB; but keep in mind that this surgical option is typically reserved for the very high BMI, given the higher rates of malnutrition and side effects associated with that.[47,62]

Other endocrine effects of bariatric surgery have been demonstrated including improvement in low testosterone syndrome with a doubling of testosterone at 1 year following gastric bypass surgery.[63] Finally, enhancement in female fertility and birth events was also seen in a meta-analysis following bariatric surgery.[64]

CLINICS CARE POINTS

- Bariatric surgery is the most effective weight loss treatment with long-lasting results.
- The SM-BOSS study demonstrated diabetes remission rates >60% after Sleeve Gastrectomy and RYGB.
- Bariatric surgery results in the improvement, and potentially remission, of other metabolic co-morbidities including hypertension, dyslipidemia, and obstructive sleep apnea.
- Bariatric surgery is extraordinarily safe with similar risk profiles to common procedures such as appendectomy, cholecystectomy, hernia repair, and hip replacement.

DISCLOSURE

The authors have nothing to disclose.

REFERENCES

1. Quality AFHRA. Pharmacological and surgical treatment of obesity: evidence report/technology assessment, No. 103 2005. p. 1–280.
2. Carlsson LMS, Carlsson B, Jacobson P, et al. Life expectancy after bariatric surgery or usual care in patients with or without baseline type 2 diabetes in Swedish Obese Subjects. Int J Obes 2005;47(10):931–8.
3. Sjöström L, Narbro K, Sjöström CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med 2007;357(8):741–52.
4. Adams TD, Gress RE, Smith SC, et al. Long-term mortality after gastric bypass surgery. N Engl J Med 2007;357(8):753–61.
5. Christou NV, Sampalis JS, Liberman M, et al. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. Ann Surg 2004; 240(3):416–23, discussion423–4.
6. MD BRE, MD VL, PhD SFN, et al. ArticlesCardiovascular disease and mortality in patients with type 2 diabetes after bariatric surgery in Sweden: a nationwide,

matched, observational cohort study. Lancet Diabetes Endocrinol 2015;3(11):847–54.
7. Arterburn DE, Olsen MK, Smith VA, et al. Association between bariatric surgery and long-term survival. JAMA, J Am Med Assoc 2015;313(1):62.
8. Morton JM, Garg T, Nguyen N. Does hospital accreditation impact bariatric surgery safety? Ann Surg 2014;260(3):504–9.
9. Clapp B, Abi Mosleh K, Glasgow AE, et al. Bariatric surgery is as safe as other common operations: an analysis of the ACS-NSQIP. Surg Obes Relat Dis 2024;20(6):515–25.
10. ASMBS estimates of bariatric procedures. Available at: https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers. Accessed June 4, 2015.
11. Eisenberg D, Shikora SA, Aarts E, et al. 2022 American society of metabolic and bariatric surgery (ASMBS) and international federation for the surgery of obesity and metabolic disorders (IFSO) indications for metabolic and bariatric surgery. Obes Surg 2023;33(1):3–14.
12. NIH conference. Gastrointestinal surgery for severe obesity. Consensus Development Conference Panel. Ann Intern Med 1991;115:956–61.
13. FDA approved obesity treatment devices. Available at: http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/ObesityDevices/ucm350134.htm. Accessed December 11, 2015.
14. Mason EE, Ito C. Gastric bypass. Ann Surg 1969;170(3):329–39.
15. Obeid NR, Malick W, Concors SJ, et al. Long-term outcomes after Roux-en-Y gastric bypass: 10- to 13-year data. SOARD 2015;1–10. https://doi.org/10.1016/j.soard.2015.04.011.
16. Buchwald H,MD, Avidor PY, Braunwald ME, et al. 2004 JAMA Bariatric surg review Buchwald. JAMA, J Am Med Assoc 2004;1–15.
17. Thaher O, Wollenhaupt F, Croner RS, et al. Evaluation of the effect of sleeve gastrectomy versus Roux-en-Y gastric bypass in patients with morbid obesity: multicenter comparative study. Langenbeck's Arch Surg 2024;409(1):156.
18. Hsieh T, Zurita L, Grover H, et al. 10-Year outcomes of the vertical transected gastric bypass for obesity: a systematic review. Obes Surg 2013;24(3):456–61.
19. Salte OBK, Olbers T, Risstad H, et al. Ten-year outcomes following roux-en-Y gastric bypass vs duodenal switch for high body mass index: a randomized clinical trial. JAMA Netw Open 2024;7(6):e2414340.
20. Jawhar N, Abi Mosleh K, Bartosiak KZ, et al. Comprehensive outcomes after Roux-en-Y gastric bypass with a near-complete 15-year follow-up. Surgery 2024;S0039-6060(24):00181–8.
21. Hutter MM, Schirmer BD, Jones DB, et al. First report from the American College of Surgeons bariatric surgery center Network. Ann Surg 2011;254(3):410–22.
22. Chang S-H, Stoll CRT, Song J, et al. The effectiveness and risks of bariatric surgery. JAMA Surg 2014;149(3):275.
23. Puzziferri N, Roshek TB III, Mayo HG, et al. Long-term follow-up after bariatric surgery. JAMA, J Am Med Assoc 2014;312(9):934.
24. Adams TD, Davidson LE, Litwin SE, et al. Health benefits of gastric bypass surgery after 6 years. JAMA, J Am Med Assoc 2012;308(11):1122–31.
25. MD AL, PhD EAM, PhD FHM, et al. Reduction in early mortality outcomes after bariatric surgery in France between 2007 and 2012: a nationwide study of 133,000 obese patients. Surgery 2015;1–8. https://doi.org/10.1016/j.surg.2015.08.005.
26. Buchwald H, Estok R, Fahrbach K, et al. Trends in mortality in bariatric surgery: a systematic review and meta-analysis. Surgery 2007;142(4):621–35.

27. Carter J, Elliott S, Kaplan J, et al. Predictors of hospital stay following laparoscopic gastric bypass: analysis of 9,593 patients from the National Surgical Quality Improvement Program. SOARD 2015;11(2):288–94.
28. Marceau P, Biron S, Marceau S, et al. Biliopancreatic diversion-duodenal switch: independent contributions of sleeve resection and duodenal exclusion. Obes Surg 2014;24(11):1843–9.
29. Karamanakos SN, Vagenas K, Kalfarentzos F, et al. Weight loss, appetite suppression, and changes in fasting and postprandial ghrelin and peptide-YY levels after Roux-en-Y gastric bypass and sleeve gastrectomy: a prospective, double blind study. Ann Surg 2008;247(3):401–7.
30. Golomb I, Ben David M, Glass A, et al. Long-term metabolic effects of laparoscopic sleeve gastrectomy. JAMA Surg 2015;150(11):1051–7.
31. Chang DM, Lee WJ, Chen JC, et al. Thirteen-year experience of laparoscopic sleeve gastrectomy: surgical risk, weight loss, and revision procedures. Obes Surg 2018;28(10):2991–7.
32. Peterli R, Wölnerhanssen BK, Peters T, et al. Effect of laparoscopic sleeve gastrectomy vs laparoscopic roux-en-Y gastric bypass on weight loss in patients with morbid obesity: the SM-BOSS randomized clinical trial. JAMA 2018;319(3):255–65.
33. Lemanu DP, Singh PP, Rahman H, et al. Five-year results after laparoscopic sleeve gastrectomy: a prospective study. SOARD 2015;11(3):518–24.
34. Nieuwenhove Y, Ceelen W, Stockman A, et al. Long-term results of a prospective study on laparoscopic adjustable gastric banding for morbid obesity. Obes Surg 2010;21(5):582–7.
35. Himpens J, Cadiere GB, Bazi M, et al. Long-term outcomes of laparoscopic adjustable gastric banding. Arch Surg 2011;146(7):802–7.
36. O'Brien PE, McPhail T, Chaston TB, et al. Systematic review of medium-term weight loss after bariatric operations. Obes Surg 2006;16(8):1032–40.
37. Flum DR, Belle SH, King WC, et al, Longitudinal Assessment of Bariatric Surgery (LABS) Consortium. Perioperative safety in the longitudinal assessment of bariatric surgery. N Engl J Med 2009;361(5):445–54.
38. Scopinaro N, Gianetta E, Civalleri D, et al. Bilio-pancreatic bypass for obesity: II. Initial experience in man. Br J Surg 1979;66(9):618–20.
39. DeMeester TR, Fuchs KH, Ball CS, et al. Experimental and clinical results with proximal end-to-end duodenojejunostomy for pathologic duodenogastric reflux. Ann Surg 1987;206(4):414–26.
40. Hess DS, Hess DW. Biliopancreatic diversion with a duodenal switch. Obes Surg 1998;8(3):267–82.
41. Silecchia G, Rizzello M, Casella G, et al. Two-stage laparoscopic biliopancreatic diversion with duodenal switch as treatment of high-risk super-obese patients: analysis of complications. Surg Endosc 2009;23(5):1032–7.
42. Sánchez-Pernaute A, Herrera MAR, Pérez-Aguirre ME, et al. Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S). One to three-year follow-up. Obes Surg 2010;20(12):1720–6.
43. Mitzman B, Cottam D, Goriparthi R, et al. Stomach intestinal pylorus sparing (SIPS) surgery for morbid obesity: retrospective analyses of our preliminary experience. Obes Surg 2016;26(9):2098–104.
44. Topart P, Becouarn G, Delarue J. Weight loss and nutritional outcomes 10 Years after biliopancreatic diversion with duodenal switch. Obes Surg 2017;27(7):1645–50.

45. Marceau P, Biron S, Marceau S, et al. Long-term metabolic outcomes 5 to 20 Years after biliopancreatic diversion. Obes Surg 2015;25(9):1584–93.
46. Sánchez-Pernaute A, Herrera MÁR, Ferré NP, et al. Long-term results of single-anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S). Obes Surg 2022;32(3):682–9.
47. Gebellí JP, Lazzara C, de Gordejuela AGR, et al. Duodenal switch vs. Single-anastomosis duodenal switch (SADI-S) for the treatment of grade IV obesity: 5-year outcomes of a multicenter prospective cohort comparative study. Obes Surg 2022;32(12):3839–46.
48. Esparham A, Roohi S, Ahmadyar S, et al. The efficacy and safety of laparoscopic single-anastomosis duodeno-ileostomy with sleeve gastrectomy (SADI-S) in mid- and long-term follow-up: a systematic review. Obes Surg 2023;33(12):4070–9.
49. Bolckmans R, Himpens J. Long-term (>10 yrs) outcome of the laparoscopic biliopancreatic diversion with duodenal switch. Ann Surg 2016;264(6):1029–37.
50. Hess DS, Hess DW, Oakley RS. The biliopancreatic diversion with the duodenal switch: results beyond 10 years. Obes Surg 2005;15(3):408–16.
51. Yashkov Y, Bordan N, Torres A, et al. SADI-S 250 vs roux-en-Y duodenal switch (RY-DS): results of 5-year observational study. Obes Surg 2021;31(2):570–9.
52. Surve A, Zaveri H, Cottam D, et al. A retrospective comparison of biliopancreatic diversion with duodenal switch with single anastomosis duodenal switch (SIPS-stomach intestinal pylorus sparing surgery) at a single institution with two year follow-up. Surg Obes Relat Dis 2017;13(3):415–22.
53. Rubino F, Schauer PR, Kaplan LM, et al. Metabolic surgery to treat type 2 diabetes: clinical outcomes and mechanisms of action. Annu Rev Med 2010;61(1):393–411.
54. Yska JP, van Roon EN, de Boer A, et al. Remission of type 2 diabetes mellitus in patients after different types of bariatric surgery. JAMA Surg 2015;1. https://doi.org/10.1001/jamasurg.2015.2398.
55. Boza C, Daroch D, Barros D, et al. Long-term outcomes of laparoscopic sleeve gastrectomy as a primary bariatric procedure. SOARD 2014;10(6):1129–33.
56. Kim JC, Kim MG, Park JK, et al. Outcomes and adverse events after bariatric surgery: an updated systematic review and meta-analysis, 2013-2023. J Metab Bariatr Surg 2023;12(2):76–88.
57. Pories WJ, Swanson MS, MacDonald KG, et al. Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus. Ann Surg 1995;222(3):339–50, discussion350–2.
58. Buchwald H, Estok R, Fahrbach K, et al. Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis. AJM 2009;122(3):248–56.e5.
59. Courcoulas AP. Weight change and health outcomes at 3 Years after bariatric surgery among individuals with severe obesity. JAMA, J Am Med Assoc 2013. https://doi.org/10.1001/jama.2013.280928.
60. Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes — 3-year outcomes. N Engl J Med 2014;370(21):2002–13.
61. MD PGM, PhD SP, De Gaetano PhD A, et al. Bariatric–metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial. Lancet 2015;386(9997):964–73.

62. Verhoeff K, Mocanu V, Zalasky A, et al. Evaluation of metabolic outcomes following SADI-S: a systematic review and meta-analysis. Obes Surg 2022; 32(4):1049–63.
63. Woodard G, Ahmed S, Podelski V, et al. Effect of Roux-en-Y gastric bypass on testosterone and prostate-specific antigen. Br J Surg 2012;99(5):693–8.
64. Maggard MA, Yermilov I, Li Z, et al. Pregnancy and fertility following bariatric surgery: a systematic review. JAMA 2008;300(19):2286–96.