

7.01.47	Bariatric Surgery		
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Section:	7.0 Surgery	Page:	Page 1 of 101

Policy Statement

Initial Bariatric Procedure

- I. Bariatric surgery for the treatment of adult or adolescents with obesity may be considered **medically necessary** when **all** of the following criteria are met:
 - A. Documentation of **either** of the following:
 1. A body mass index (BMI) greater than or equal to 35 kg/m² or for adolescents 140% of the 95th percentile for age and sex (whichever is lower)
 2. A BMI greater than or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) or for adolescents 120% of the 95th percentile for age and sex (whichever is lower) with **at least one** clinically significant obesity-related disease, including but not limited to:
 - a. Type 1 or 2 diabetes mellitus
 - b. [Clinically significant obstructive sleep apnea](#) ; or [obesity hypoventilation syndrome](#)
 - c. Coronary artery disease, with documentation of atherosclerotic heart disease as evidenced by **any** of the following:
 - i. Stress study
 - ii. Coronary angiography
 - iii. History of heart failure
 - iv. History of myocardial infarction
 - v. Prior coronary artery bypass
 - vi. Prior percutaneous coronary intervention (PCI)
 - d. Hypertension (blood pressure greater than 140 mmHg systolic and/or 90 mmHg diastolic in spite of the concurrent use of at least 3 anti-hypertensive drugs, one of which may be a diuretic)
 - e. Painful or activity-limiting osteoarthritis involving the lower extremities, with radiographic documentation of joint space narrowing, osteophytes, subluxation, or subchondral sclerosis
 - f. Hyperlipidemia (LDL cholesterol of 160 mg/dL or higher), uncontrolled by diet and medical therapy
 - g. Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett's esophagus, or esophagitis and failing maximal medical therapy (e.g., proton pump inhibitors, H2 blockers, and/or prokinetic agents titrated to maximal recommended dosages)
 - h. Idiopathic intracranial hypertension
 - i. Nonalcoholic steatohepatitis
 - j. Blount disease
 - k. Slipped capital femoral epiphysis
 - B. The individual has failed weight loss to a BMI less than required for approval (e.g., for adults, 30 kg/m² or 27.5 kg/m² for Asian individuals) at the time of surgery by conservative measures for at least 6 months (may be done at the same time as pharmacologic treatment, despite **one** of the following:
 1. Documentation of participation in a structured provider-supervised weight-loss program including an exercise and nutrition program with at least 3 visits including weight measurement
 2. Serially-charted documentation, including notes from three clinician-directed follow-up visits including weight measurement, of participation in another managed weight-loss program including dietary control and exercise (commercial, dietician, or diabetes management programs)

- C. The individual has been evaluated for, and has received, maximal therapy for any secondary (e.g., endocrine) causes of obesity, has been evaluated for and treated for any pulmonary, gastrointestinal (including GERD), neoplastic, and cardiac co- morbidities which may impact surgery, and has been medically cleared for surgery, as documented in the Pre-Operative Checklist
- D. The individual has received a comprehensive psychosocial-behavioral evaluation signed by a [qualified mental health professional](#) clearing the individual for surgery, as documented in the Psychosocial-Behavioral Checklist
- E. The individual has undergone educational counseling or a formal class giving a comprehensive understanding of the available bariatric surgery procedures, of how the individual's life will be changed after surgery, the morbidity and mortality associated with this surgery, and the commitment required to make the lifestyle changes necessary to maintain the health improvements achieved through surgery
- F. No tobacco smoking for at least 6 weeks prior to surgery
- G. No ongoing alcohol or drug abuse or treatment within the past year
- H. The bariatric surgery is performed by properly credentialed surgeons, and preferably at Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) accredited hospitals that follow the American Society for Metabolic and Bariatric Surgery (ASMBS) guidelines, including a multidisciplinary program experienced in obesity surgery that can provide **all** of the following:
 - 1. Nutritional counseling
 - 2. Exercise counseling
 - 3. Long-term monitoring including **both** of the following:
 - a. Psychosocial counseling
 - b. Support group meetings

Revision Bariatric Surgery for Complications

- II. The first (or a subsequent) revision surgery to address perioperative or late complications of a bariatric procedure may be considered **medically necessary**, provided that these complications include, but are not limited to at least **one** of the following:
 - A. Band slippage or herniation that cannot be corrected with manipulation or adjustment
 - B. Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett's esophagus, or esophagitis and failing maximal medical therapy
 - C. Nonabsorption resulting in hypoglycemia or malnutrition
 - D. Obstruction, stricture, erosion, or fistula
 - E. Staple-line failure or leakage
 - F. Dilation of the gastric pouch or dilation proximal to an adjustable gastric band (documented by upper gastrointestinal examination or endoscopy) if the initial procedure was successful in inducing weight loss prior to pouch dilation
 - G. Weight loss of 20% or more below ideal body weight

Revision Bariatric Surgery for Inadequate Weight Loss

- III. Revision of a primary or a subsequent bariatric procedure that has failed due to inadequate weight loss may be considered **medically necessary** when **all** of the following are met:
 - A. **All** initial primary bariatric surgery qualification criteria have been satisfied (see Initial Bariatric Procedure above)
 - B. Two years have elapsed since prior bariatric surgery
 - C. Inadequate weight loss resulted from initial procedure; less than 50% expected weight loss and/or weight remains greater than 40% over ideal body weight (normal body weight BMI parameter = 18.5-24.9)
 - D. Ineffective weight loss attempts within the year prior to revision surgery, including but not limited to compliance with previous post operative nutrition plan and exercise program is documented

Bariatric Surgery in Preadolescent Children

- IV. Bariatric surgery is considered **investigational** for the treatment of obesity in preadolescent children.

Concomitant Hiatal Hernia Repair With Bariatric Surgery

- V. [Repair of a hiatal hernia](#) at the time of bariatric surgery may be considered **medically necessary** for individuals who have a preoperatively diagnosed hiatal hernia with indications for surgical repair.
- VI. [Repair of a hiatal hernia](#) that is diagnosed at the time of bariatric surgery, or repair of a preoperatively diagnosed hiatal hernia in individuals who do not have indications for surgical repair, is considered **investigational**.

Other Bariatric Surgery Procedures

- VII. **Any** of the following bariatric surgery procedures are considered **investigational** for the treatment of obesity in adults who have failed weight loss by conservative measures:
 - A. Vertical-banded gastroplasty
 - B. Gastric bypass using a Billroth II type of anastomosis (mini-gastric bypass)
 - C. Biliopancreatic diversion without duodenal switch
 - D. Long-limb gastric bypass procedure (i.e., greater than 150 cm)
 - E. Single anastomosis duodenoileal bypass with sleeve gastrectomy
 - F. Two-stage bariatric surgery procedures (e.g., sleeve gastrectomy as initial procedure followed by biliopancreatic diversion at a later time)
 - G. Laparoscopic gastric plication
 - H. Endoscopic procedures as a primary bariatric procedure or as a revision procedure (i.e., to treat weight gain after bariatric surgery to remedy large gastric stoma or large gastric pouches) including but not limited to:
 1. Insertion of the StomaphyX™ device
 2. Insertion of a gastric balloon
 3. Endoscopic gastroplasty
 4. Use of an endoscopically placed duodenojejunal sleeve
 5. Laparoscopic gastric plication
 6. Aspiration therapy device

Bariatric Surgery Contraindications

- VIII. Bariatric surgery is considered **investigational** for **any** of the following:
 - A. Individuals with a body mass index less than or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) at the time of surgery
 - B. Individuals who are pregnant
 - C. Individuals with typical major surgery contraindications (active infection, uncontrolled bleeding diathesis, device allergies, etc.)
 - D. Individuals with ongoing, current (within 6 weeks) use of tobacco products or with history of recent (within 1 year) alcohol or drug abuse
 - E. Individuals with an untreated or uncontrolled DSM-5 psychiatric disorder limiting compliance with medical and dietary post-surgical requirements
 - F. Individuals unwilling to comply with post-surgical medical and dietary requirements and required follow-up appointments

NOTE: Refer to [Appendix A](#) to see the policy statement changes (if any) from the previous version.

Policy Guidelines

Centers for Disease Control and Prevention (CDC) definitions of Overweight and Obesity: Defining Adult Overweight & Obesity | Overweight & Obesity | CDC

Weight that is higher than what is considered healthy for a given height is described as overweight or obesity. Body Mass Index (BMI) is a screening tool for overweight and obesity.

BMI is a person's weight in kilograms divided by the square of height in meters. A high BMI can indicate high body fatness.

To calculate BMI, see the Adult BMI Calculator or determine BMI by finding your height and weight in this BMI Index Chart.

- If your BMI is less than 18.5, it falls within the underweight range.
- If your BMI is 18.5 to <25, it falls within the healthy weight range.
- If your BMI is 25.0 to <30, it falls within the overweight range.
- If your BMI is 30.0 or higher, it falls within the obesity range.

Obesity is frequently subdivided into categories:

- Class 1: BMI of 30 to < 35
- Class 2: BMI of 35 to < 40
- Class 3: BMI of 40 or higher. Class 3 obesity is sometimes categorized as "severe" obesity.

Bariatric Surgery Selection Criteria

Class III obesity, formerly known as morbid obesity, is defined as a body mass index (BMI) 40 kg/m² or more or a BMI 35 kg/m² or more with at least 1 clinically significant obesity-related disease such as diabetes, obstructive sleep apnea, coronary artery disease, or hypertension for which these complications or diseases are not controlled by best practice medical management. However, no evidence-based guidance has been identified that explicitly defines thresholds for determining the clinical significance of obesity-related disease that would qualify individuals for bariatric surgery.

Additionally, a 2022 joint statement by the American Society for Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) recommends metabolic and bariatric surgery in individuals with a BMI greater than or equal to 35 kg/m², regardless of the presence, absence, or severity of comorbidities. This recommendation is based on nonrandomized, single-arm, single-center clinical studies described in detail in the Rationale section and briefly in the Background section; these include Gloy et al (2013), Puzifferri et al (2014), and the Swedish Obese Subjects (SOS) (Sjostrom et al 1999, Sjostrom et al 2004, Sjostrom et al 2007, Sjostrom et al 2012) trials. However, as these studies did not separately evaluate outcomes in individuals without comorbidities, evidence of the net health outcome in individuals without comorbidities is inconclusive.

The medical necessity criteria in this document govern the appropriate use of bariatric surgery, which is a surgical procedure performed for the treatment of obesity. Bariatric surgery in adults with obesity may include the following bariatric surgery procedures when criteria are met:

- Open gastric bypass using a Roux-en-Y anastomosis (for patients with prior abdominal surgery only)
- Laparoscopic gastric bypass using a Roux-en-Y anastomosis
- Laparoscopic adjustable gastric banding
- Sleeve gastrectomy
- Open or laparoscopic biliopancreatic bypass (i.e., Scopinaro procedure) with duodenal switch

While there are limited evidence on which to assess the long-term impacts of bariatric surgery for patients younger than age 18 years, severely obese (class III obesity, BMI ≥ 40 kg/m² or 140% of the 95th percentile for age and sex, whichever is lower) adolescents with commonly present though not required comorbidities, or who have a BMI of 35 kg/m² or greater (class II obesity or 120% of the 95th percentile for age and sex, whichever is lower) with clinically significant disease (including, but not limited to, type 2 diabetes [T2D], idiopathic intracranial hypertension, nonalcoholic steatohepatitis, Blount disease, slipped capital femoral epiphysis, gastroesophageal reflux disease, obstructive sleep apnea [apnea-hypopnea index >5], cardiovascular disease risks [HTN, hyperlipidemia, insulin resistance], depressed health-related quality of life) may be considered for bariatric surgery according to the American Academy of Pediatrics (Armstrong et al, 2019 and Hampl et al, 2023). U.S. Food and Drug Administration (FDA) premarket approval for the LAP-BAND® System indicates it is intended for severely obese adults. (The clinical study submitted to FDA for approval of the LAP-BAND was restricted to adults ages 18 to 55 years.)

Bariatric Procedure Considerations

Vertical-banded gastroplasty (VBG) is a purely restrictive procedure that is largely not performed in the U.S. and has been replaced by laparoscopic adjustable gastric banding (LAGB) or sleeve gastrectomy (SG). Weight loss with VBG is substantial, but there are high rates of revisions and reoperations due to staple line disruption, perforation, band erosion or disruption, and stenosis at the band site. Overall rates of revisions and reoperations at up to 10 years may be as high as 50% (Balsiger et al, 2000, PMID11307094; Miller et al, 2007, PMID17116427). Vertical-banded gastroplasty is not included on the list of endorsed procedures by the American Society for Metabolic and Bariatric Surgery (<https://asmbs.org/resources/endorsed-procedures-and-devices>. Accessed January 3, 2023).

Clinicians performing bariatric surgery must have appropriate clinical training and experience and have satisfactory outcomes as assessed by quality assurance monitoring. Bariatric surgery must be performed in a manner consistent with established standards of care.

Appropriate Use Criteria

Appropriate use criteria are intended to assist patients and clinicians, but are not intended to diminish the acknowledged difficulty or uncertainty of clinical decision making and cannot act as substitutes for sound clinical judgment and practice experience.

Recommendations From Qualified Mental Health Professionals

The minimal credentials for qualified mental health professionals who work with adults presenting with a desire for bariatric surgery include a master's degree or its equivalent or a more advanced degree (e.g., Ph.D., M.D., Ed.D., D.Sc., D.S.W., Psy.D., LCSW, or MFT) in a clinical behavioral science field with established competence in the assessment of adults who desire bariatric surgery. At least one of the professionals must be capable of adequately evaluating comorbid psychiatric conditions.

Bariatric Surgery In Children And Adolescents

The evidence for bariatric surgery in patients younger than age 18 years consists primarily of studies of adolescents, with a lack of evidence for younger children. Guidelines for bariatric surgery in adolescents are not uniform, with variability in weight-based criteria, ranging from a BMI of 35 kg/m² with comorbidities to a BMI of 50 kg/m². Most guidelines use weight-based criteria that parallel those for adults.

In addition to the weight-based criteria, there is greater emphasis on issues of developmental maturity, psychosocial status, and informed consent for adolescent patients. All guidelines mention these issues, but recommendations are not uniform. The following are examples from U.S. guidelines published since 2013 that address issues of maturity and psychosocial status.

Adolescence begins with the onset of physiologically normal puberty and ends when an adult identity and behavior are accepted. This period of development corresponds roughly to the period between the ages of 10 and 19 years, which is consistent with the World Health Organization's definition of adolescence. There are no set ages, as the onset of both puberty and adulthood vary significantly, but at a minimum, patients should be post-pubertal (more commonly after age 13). For adolescent patients, greater consideration should be given to psychosocial and informed consent issues

Clinically Significant OSA in Adults

Clinically significant OSA includes either of the following:

- An Apnea/Hypopnea Index (AHI), Respiratory Disturbance Index (RDI), or Respiratory Event Index (REI) of at least 15 events per hour
- An AHI, RDI, or REI of at least 5 events per hour in a patient with excessive daytime sleepiness (as determined by standard sleep questionnaires such as the Epworth Sleepiness Scale >10 or the Berlin Questionnaire with a score of at least 2 in Category 2) or hypertension

Clinically Significant OSA in Children and Adolescents

The presentation of OSA in children may differ from that of adults. Children frequently exhibit behavioral problems or hyperactivity rather than daytime sleepiness. Although the definition of severe OSA in children is not well established, an AHI or RDI greater than 1.5 events per hour is considered abnormal (an AHI or RDI greater than or equal to 10 events per hour may be considered severe). In addition, the first-line treatment in children is usually adenotonsillectomy. Continuous positive airway pressure (CPAP) is an option for children who are not candidates for surgery or who have an inadequate response to surgery.

Obesity-Hypoventilation Syndrome Defined as daytime alveolar hypoventilation (awake arterial PCO₂>45 mm Hg or serum bicarbonate ≥27) among patients with body mass index ≥30 kg/m² in the absence of other causes of hypoventilation.

Endocrine Society

The 2017 Endocrine Society Clinical Practice Guideline on Pediatric Obesity suggest bariatric surgery only under the following conditions (Styne et al, 2017):

- The child has attained Tanner 4 or 5 pubertal development and final or near-final adult height, the patient has a BMI of >40 kg/m² or has a BMI of >35 kg/m² and significant, extreme comorbidities
- Extreme obesity and comorbidities persist despite compliance with a formal program of lifestyle modification, with or without pharmacotherapy
- Psychological evaluation confirms the stability and competence of the family unit, psychological distress due to impaired QOL from obesity may be present, but the patient does not have an underlying untreated psychiatric illness
- The patient demonstrates the ability to adhere to the principles of healthy dietary and activity habits (Styne et al, 2017)
- The patient has access to an experienced surgeon in a pediatric bariatric surgery center of excellence providing the necessary infrastructure for patient care, including a team capable of long-term follow-up of the metabolic and psychosocial needs of the patient and family."

Bariatric Procedure Guidelines

The choice of procedure in adolescents may also differ from adults, but there is a lack of consensus in guidelines or expert opinion as to the preferred procedure(s) for adolescents. The following factors should be considered in the choice of bariatric surgery in adolescents (Aikenhead et al, 2011; PMID: 25586970):

- As in adults, laparoscopic gastric bypass is the most common procedure in adolescents.
- Devices used for LAGB do not have FDA approval in the United States for individuals younger than age 18 years.

- Some guidelines for bariatric surgery in adolescents do not recommend biliopancreatic diversions (BPD) because of the greater frequency of nutritional deficiencies on long-term follow-up, but other guidelines do not specify that BPD not be done in adolescents.

In 2018, the American Society for Metabolic and Bariatric Surgery (ASMBS) published an updated guideline on pediatric metabolic and bariatric surgery (Pratt et al, 2018). With regard to choice of procedure, the guideline stated:

- "Vertical sleeve gastrectomy has become the most used and most recommended operation in adolescents with severe obesity for several reasons, near-equivalent weight loss to RYGB in adolescents, fewer reoperations, better iron absorption, and near-equivalent effect on comorbidities as RYGB in adolescents. However, given the more extensive long-term data available for RYGB, we can recommend the use of either RYGB or VSG in adolescents."

Hiatal Hernia Repair Guidelines

In 2018, the ASMBS and the American Hernia Society published a consensus guideline on bariatric surgery and hernia surgery (Menzo et al, 2018). The guideline contained the following conclusions and summary recommendations:

- "There is a significant link between obesity and hernia formation both after abdominal surgery and de novo. There is also evidence that abdominal wall hernia can more commonly present with obstruction or strangulation in patients with obesity."
- "There is a higher risk for complications and recurrence after hernia repair in patients with obesity."
- "In patients with severe obesity and ventral hernia, and both being amenable to laparoscopic repair, combined hernia repair and metabolic/bariatric surgery may be safe and associated with good short-term outcomes and low risk of infection. There is a relative lack of evidence, however, about the use of synthetic mesh in this setting."
- "In patients with severe obesity and abdominal wall hernia that is not amenable to laparoscopic repair, a staged approach is recommended. Weight loss prior to hernia repair is likely to improve hernia repair outcomes. Metabolic/bariatric surgery appears to provide far more significant and rapid weight loss than other modalities and would be a good option for selected patients with severe obesity and large, symptomatic abdominal wall hernia."

The Society of American Gastrointestinal and Endoscopic Surgeons issued evidence-based guidelines for the management of hiatal hernia (Kohn et al, 2013). The Society noted that the general methodologic quality of available studies is low. Recommendations for indications for repair are as follows:

- "Repair of a type I hernia [sliding hiatal hernias, where the gastroesophageal junction migrates above the diaphragm] in the absence of reflux disease is not necessary" (moderate-quality evidence, strong recommendation).
- "All symptomatic paraesophageal hiatal hernias should be repaired [high-quality evidence, strong recommendation], particularly those with acute obstructive symptoms or which have undergone volvulus."
- "Routine elective repair of completely asymptomatic paraesophageal hernias may not always be indicated. Consideration for surgery should include the patient's age and comorbidities" (moderate-quality evidence, weak recommendation).

Coding

Hiatal hernia repair performed at the time of bariatric surgery would not be reported with the hiatal hernia repair code. There is no code for this specific surgery, therefore, it should be reported with code 43289 - Unlisted laparoscopy procedure, esophagus.

Description

Bariatric surgery is a treatment for class III obesity in patients who fail to lose weight with conservative measures. There are numerous gastric and intestinal surgical techniques available. While these techniques have heterogeneous mechanisms of action, the result is a smaller gastric pouch that leads to restricted eating. However, these surgeries may lead to malabsorption of nutrients or eventually to metabolic changes.

Related Policies

- Gastric Electrical Stimulation
- Transesophageal Endoscopic Therapies for Gastroesophageal Reflux Disease

Benefit Application

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates (e.g., Federal Employee Program [FEP]) prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.

Regulatory Status

Forms of bariatric surgery performed without specific implantable devices are surgical procedures and, as such, are not subject to regulation by the FDA.

Table 1 shows forms of bariatric surgery with implantable devices approved by the FDA through the premarket approval process.

Table 1. FDA Approved Bariatric Surgery Devices

Device	Manufacturer	PMA Date	Labeled Indications
Obalon™ intragastric balloon system	Obalon Therapeutics, Inc.	Sept 2016	For use in obese adults (BMI, 30 to 40 kg/m ²) who have failed weight reduction with diet and exercise, and have no contraindications. Maximum placement time is 6 mo. Balloon is encased in a capsule. The capsule is swallowed and begins to dissolve after exposure to fluids in the stomach. After verification of capsule placement in the stomach, the balloon is filled with a gas mixture. Up to 3 balloons can be used during the 6 mo treatment period.
AspireAssist System®	Aspire Bariatrics	Jun 2016	For long-term use in conjunction with lifestyle therapy and continuous medical monitoring in obese adults >22 y, with a BMI of 35.0 to 55.0 kg/m ² and no contraindications to the procedure who have failed to achieve and maintain weight loss with nonsurgical weight loss therapy.
ORBERA® intragastric balloon system	Apollo Endosurgery	Aug 2015	For use in obese adults (BMI, 30 to 40 kg/m ²) who have failed weight reduction with diet and exercise, and have no contraindications. Maximum placement time is 6 mo. Balloon placed endoscopically and inflated with saline.

Device	Manufacturer	PMA Date	Labeled Indications
LAP-BAND Adjustable Gastric Banding System	Apollo Endosurgery (original applicant: Allergan)	Apr 2010	For use in weight reduction for severely obese adults with BMI of at least 40 kg/m ² or a BMI of at least 30 kg/m ² with ≥ 1 severe comorbid conditions who have failed more conservative weight-reduction alternatives (e.g., supervised diet, exercise, behavior modification programs).
REALIZE Adjustable Gastric Band	Ethicon Endosurgery	Nov 2007	For use in weight reduction for morbidly obese patients and for individuals with BMI of at least 40 kg/m ² , or a BMI of at least 35 kg/m ² with ≥ 1 comorbid conditions, or those who are ≥ 45.4 kg over their estimated ideal weight. Indicated for use only in morbidly obese adults who have failed more conservative weight-reduction alternatives (e.g., supervised diet, exercise, behavior modification programs).

BMI: body mass index; FDA: U.S. Food and Drug Administration; PMA: premarket approval.

In February 2017, the FDA issued a letter to health care providers discussing the potential risks with liquid-filled intragastric balloons in response to reports of 2 types of adverse events related to the balloons. Several dozen reports concerned spontaneous overinflation of the balloons, which caused pain, swelling, and vomiting. The second set of adverse event reports indicated that acute pancreatitis developed in several patients due to compression of gastrointestinal structures. These reports involved both ReShape (no longer marketed in the U.S.) and ORBERA brands. The adverse events may require premature removal of the balloons.

In August 2017, the FDA issued a second letter to health care providers informing them of 5 unanticipated deaths occurring from 2016 through the time of the letter, due to intragastric balloons. The FDA recommended close monitoring of patients receiving these devices. In June 2018, the FDA reported that, since 2016, a total of 12 deaths occurred in patients with liquid-filled intragastric balloons worldwide; 7 of these deaths were in patients in the U.S.

In April 2020, the FDA provided an update on risks and continued to recommend that healthcare providers "instruct patients about the symptoms of life-threatening complications such as balloon deflation, gastrointestinal obstruction, and gastric and esophageal perforation and monitor patients closely during the entire duration of treatment for potential complications, including acute pancreatitis, spontaneous hyperinflation, and other potentially life-threatening complications."

Rationale

Background

Bariatric Surgery

Bariatric surgery is performed to treat class III (clinically severe) obesity. Class III obesity, formerly referred to as morbid obesity, is defined as a body mass index (BMI) greater than 40 kg/m² or a BMI greater than 35 kg/m² with associated complications including, but not limited to, diabetes, hypertension, or obstructive sleep apnea (OSA). Class III obesity results in a very high risk for weight-related complications, such as diabetes, hypertension, OSA, and various types of cancers (for men: colon, rectal, prostate; for women: breast, uterine, ovarian), and a shortened lifespan. A man with class III obesity at age 20 can expect to live 13 fewer years than his counterpart with a normal BMI, which equates to a 22% reduction in life expectancy.

Per the Centers for Disease Control and Prevention (CDC), obesity is also frequently classified into the categories of Class 1: BMI of 30 to < 35 kg/m²; Class 2: BMI of 35 to < 40 kg/m²; and Class 3: BMI of 40 kg/m² or higher. Class 3 obesity is sometimes categorized as "severe" obesity.¹

The first treatment of class III obesity is dietary and lifestyle changes. Although this strategy may be effective in some patients, only a few individuals with class III obesity can reduce and control weight through diet and exercise. Most patients find it difficult to comply with these lifestyle modifications on a long-term basis. When conservative measures fail, some patients may consider surgical approaches.

Resolution (cure) or improvement of type 2 diabetes after bariatric surgery and observations that glycemic control may improve immediately after surgery before a significant amount of weight is lost have promoted interest in a surgical approach to the treatment of type 2 diabetes. The various surgical procedures have different effects, and gastrointestinal rearrangement seems to confer additional antidiabetic benefits independent of weight loss and caloric restriction. The precise mechanisms are not clear, and multiple mechanisms may be involved. Gastrointestinal peptides, e.g., glucagon-like peptide-1, glucose-dependent insulinotropic peptide, and peptide YY, are secreted in response to contact with unabsorbed nutrients and by vagally mediated parasympathetic neural mechanisms. Glucagon-like peptide-1 is secreted by the L cells of the distal ileum in response to ingested nutrients and acts on pancreatic islets to augment glucose-dependent insulin secretion. It also slows gastric emptying, which delays digestion, blunts postprandial glycemia, and acts on the central nervous system to induce satiety and decrease food intake. Other effects may improve insulin sensitivity. Glucose-dependent insulinotropic peptide acts on pancreatic beta cells to increase insulin secretion through the same mechanisms as glucagon-like peptide-1, although it is less potent. Peptide YY is also secreted by the L cells of the distal intestine and increases satiety and delays gastric emptying.

Types of Bariatric Surgery Procedures

Open Gastric Bypass

The original gastric bypass surgeries were based on the observation that postgastrectomy patients tended to lose weight. The current procedure (CPT code 43846) involves both a restrictive and a malabsorptive component, with the horizontal or vertical partition of the stomach performed in association with a Roux-en-Y procedure (i.e., a gastrojejunal). Thus, the flow of food bypasses the duodenum and proximal small bowel. The procedure may also be associated with an unpleasant "dumping syndrome," in which a large osmotic load delivered directly to the jejunum from the stomach produces abdominal pain and/or vomiting. The dumping syndrome may further reduce intake, particularly in "sweets eaters." Surgical complications include leakage and operative margin ulceration at the anastomotic site. Because the normal flow of food is disrupted, there are more metabolic complications than with other gastric restrictive procedures, including iron deficiency anemia, vitamin B12 deficiency, and hypocalcemia, all of which can be corrected by oral supplementation. Another concern is the ability to evaluate the "blind" bypassed portion of the stomach. Gastric bypass may be performed with either an open or laparoscopic technique.

Note: In 2005, CPT code 43846 was revised to indicate that the short limb must be 150 cm or less, compared with the previous 100 cm. This change reflects the common practice in which the alimentary (i.e., jejunal limb) of a gastric bypass has been lengthened to 150 cm. This length also serves to distinguish a standard gastric bypass with a very long, or very, very long gastric bypass, as discussed further here.

Laparoscopic Gastric Bypass

CPT code 43644 was introduced in 2005 and described the same procedure as open gastric bypass (CPT code 43846), but performed laparoscopically.

Adjustable Gastric Banding

Adjustable gastric banding (CPT code 43770) involves placing a gastric band around the exterior of the stomach. The band is attached to a reservoir implanted subcutaneously in the rectus sheath. Injecting the reservoir with saline will alter the diameter of the gastric band; therefore, the rate-limiting stoma in the stomach can be progressively narrowed to induce greater weight loss, or

expanded if complications develop. Because the stomach is not entered, the surgery and any revisions, if necessary, are relatively simple.

Complications include slippage of the external band or band erosion through the gastric wall. Adjustable gastric banding has been widely used in Europe. Two banding devices are approved by the U.S. Food and Drug Administration (FDA) for marketing in the United States. The first to receive the FDA approval was the LAP-BAND® (original applicant, Allergan, BioEnterics, Carpinteria, CA; now Apollo Endosurgery, Austin, TX). The labeled indications for this device are as follows:

"The LAP-BAND system is indicated for use in weight reduction for severely obese patients with a BMI of at least 40 or a BMI of at least 35 with 1 or more severe comorbid conditions, or those who are 100 lb or more over their estimated ideal weight according to the 1983 Metropolitan Life Insurance Tables (use the midpoint for medium frame). It is indicated for use only in severely obese adult patients who have failed more conservative weight-reduction alternatives, such as supervised diet, exercise, and behavior modification programs. Patients who elect to have this surgery must make the commitment to accept significant changes in their eating habits for the rest of their lives."

In 2011, the FDA-labeled indications for LAP-BAND were expanded to include patients with a BMI from 30 to 34 kg/m² with at least 1 obesity-related comorbid condition.

The second adjustable gastric banding device approved by the FDA through the premarket approval process is the REALIZE® model (Ethicon Endo-Surgery, Cincinnati, OH). Labeled indications for this device are:

"The [REALIZE] device is indicated for weight reduction for morbidly obese patients and is indicated for individuals with a BMI of at least 40 kg/m², or a BMI of at least 35 kg/m² with 1 or more comorbid conditions. The Band is indicated for use only in morbidly obese adult patients who have failed more conservative weight-reduction alternatives, such as supervised diet, exercise, and behavior modification programs."

Sleeve Gastrectomy

A sleeve gastrectomy (SG; CPT code 43775) is an alternative approach to gastrectomy that can be performed on its own or in combination with malabsorptive procedures (most commonly biliopancreatic diversion [BPD] with duodenal switch [DS]). In this procedure, the greater curvature of the stomach is resected from the angle of His to the distal antrum, resulting in a stomach remnant shaped like a tube or sleeve. The pyloric sphincter is preserved, resulting in a more physiologic transit of food from the stomach to the duodenum and avoiding the dumping syndrome (overly rapid transport of food through the stomach into intestines) seen with distal gastrectomy. This procedure is relatively simple to perform and can be done as an open or laparoscopic procedure. Some surgeons have proposed the SG as the first in a 2-stage procedure for very high-risk patients. Weight loss following SG may improve a patient's overall medical status and, thus, reduce the risk of a subsequent more extensive malabsorptive procedure (e.g., BPD).

Biliopancreatic Diversion

The BPD procedure (also known as the Scopinaro procedure; CPT code 43847), developed and used extensively in Italy, was designed to address drawbacks of the original intestinal bypass procedures that have been abandoned due to unacceptable metabolic complications. Many complications were thought to be related to bacterial overgrowth and toxin production in the blind, bypassed segment. In contrast, BPD consists of a subtotal gastrectomy and diversion of the biliopancreatic juices into the distal ileum by a long Roux-en-Y procedure. The procedure consists of the following components:

- A distal gastrectomy induces temporary early satiety and/or the dumping syndrome in the early postoperative period, both of which limit food intake.
- A 200-cm long "alimentary tract" consists of 200 cm of ileum connecting the stomach to a common distal segment.

- A 300- to 400-cm “biliary tract” connects the duodenum, jejunum, and remaining ileum to the common distal segment.
- A 50- to 100-cm “common tract” is where food from the alimentary tract mixes with biliopancreatic juices from the biliary tract. Food digestion and absorption, particularly of fats and starches, are therefore limited to this small segment of bowel, creating selective malabsorption. The length of the common segment will influence the degree of malabsorption.

Because of the high incidence of cholelithiasis associated with the procedure, patients typically undergo an associated cholecystectomy.

Many potential metabolic complications are related to BPD, including, most prominently, iron deficiency anemia, protein malnutrition, hypocalcemia, and bone demineralization. Protein malnutrition may require treatment with total parenteral nutrition. Also, several case reports have noted liver failure resulting in death or liver transplant.

Biliopancreatic Diversion With Duodenal Switch

CPT code 43845, which specifically identifies the duodenal switch (DS) procedure, was introduced in 2005. The DS procedure is a variant of the BPD previously described. In this procedure, instead of performing a distal gastrectomy, a SG is performed along the vertical axis of the stomach. This approach preserves the pylorus and initial segment of the duodenum, which is then anastomosed to a segment of the ileum, similar to the BPD, to create the alimentary limb. Preservation of the pyloric sphincter is intended to ameliorate the dumping syndrome and decrease the incidence of ulcers at the duodeno-ileal by providing a more physiologic transfer of stomach contents to the duodenum. The SG also decreases the volume of the stomach and decreases the parietal cell mass. However, the basic principle of the procedure is similar to that of the BPD, i.e., producing selective malabsorption by limiting the food digestion and absorption to a short common ileal segment.

Vertical-Banded Gastroplasty

Vertical-banded gastroplasty (VBG; CPT code 43842) was formerly 1 of the most common gastric restrictive procedures performed in the United States but has now been replaced by other restrictive procedures due to high rates of revisions and reoperations. In this procedure, the stomach is segmented along its vertical axis. In order to create a durable reinforced and rate-limiting stoma at the distal end of the pouch, a plug of the stomach is removed, and a propylene collar is placed through this hole and then stapled to itself. Because the normal flow of food is preserved, metabolic complications are uncommon. Complications include esophageal reflux, dilation, or obstruction of the stoma, with the latter 2 requiring reoperation. Dilation of the stoma is a common reason for weight regain. Vertical-banded gastroplasty may be performed using an open or laparoscopic approach.

Long-Limb Gastric Bypass (i.e., >150 cm)

Variations of gastric bypass procedures have been described, consisting primarily of long-limb Roux-en-Y procedures (CPT code 43847), which vary in the length of the alimentary and common limbs. For example, the stomach may be divided with a long segment of the jejunum (instead of ileum) anastomosed to the proximal gastric stump, creating the alimentary limb. The remaining pancreaticobiliary limb, consisting of stomach remnant, duodenum, and length of proximal jejunum, is then anastomosed to the ileum, creating a common limb of variable length in which the ingested food mixes with the pancreaticobiliary juices. While the long alimentary limb permits absorption of most nutrients, the short common limb primarily limits absorption of fats. The stomach may be bypassed in a variety of ways (e.g., resection or stapling along the horizontal or vertical axis). Unlike the traditional gastric bypass, which is a gastric restrictive procedure, these very long-limb Roux-en-Y gastric bypasses combine gastric restriction with some element of malabsorptive procedure, depending on the location of the anastomoses. Note that CPT code for gastric bypass (43846) explicitly describes a short limb (<150 cm) Roux-en-Y gastroenterostomy, and thus would not apply to long-limb gastric bypass.

Laparoscopic Malabsorptive Procedure

CPT code 43645 was introduced in 2005, to specifically describe a laparoscopic malabsorptive procedure. However, the code does not specifically describe any specific malabsorptive procedure.

Laparoscopic Gastric Plication

Laparoscopic gastric plication is a bariatric procedure that involves laparoscopic placement of sutures over the greater curvature (laparoscopic greater curvature plication) or anterior gastric region (laparoscopic anterior curvature plication) to create a tube-like stomach. To achieve gastric restriction the procedure requires 2 main steps, mobilization of the greater curvature of the stomach and suture plication of the stomach. CPT code 43843 Gastric restrictive procedure, without gastric bypass, for morbid obesity; other than vertical-banded gastroplasty is commonly used for this procedure.

Weight Loss Outcomes

There is no uniform standard for reporting results of weight loss or for describing a successful procedure. Common methods of reporting the amount of body weight loss are the percent of ideal body weight achieved or percent of excess body weight (EBW) loss, with the latter most commonly reported. Excess body weight is defined as actual weight minus "ideal weight" and "ideal weight" and is based on 1983 Metropolitan Life Insurance height-weight tables for "medium frame."

These 2 reporting methods are generally preferred over the absolute amount of weight loss because these methods reflect the ultimate goal of surgery: to reduce weight to a range that minimizes obesity-related morbidity. Obviously, an increasing degree of obesity will require a greater amount of weight loss to achieve these target goals. There are different definitions of successful outcomes, but a successful procedure is often considered one in which at least 50% of EBW is lost, or when the patient returns to within 30% of ideal body weight. The results may also be expressed as the percentage of patients losing at least 50% of EBW. Table 2 summarizes the variations in reporting weight loss outcomes.

Table 2. Weight Loss Outcomes

Outcome Measure	Definition	Clinical Significance
Decrease in weight	Absolute difference in weight pre- and posttreatment	Unclear relation to outcomes, especially in class III obesity
Decrease in BMI	Absolute difference in BMI pre- and posttreatment	May be clinically significant if change in BMI clearly leads to change in risk category
Percent EBW loss	Amount of weight loss divided by EBW	Has anchor to help frame clinical significance; unclear threshold for clinical significance
Percent patients losing >50% of EBW	No. patients losing >50% EBW divided by total patients	Additional advantage of framing on per patient basis. Threshold for significance (>50%) arbitrary.
Percent ideal body weight	Final weight divided by ideal body weight	Has anchor to help frame clinical significance; unclear threshold for clinical significance

BMI: body mass index; EBW: excess body weight.

Durability of Weight Loss

Weight change (i.e., gain or loss) at yearly intervals is often reported. Weight loss at 1 year is considered the minimum length of time for evaluating these procedures; weight loss at 3 to 5 years is considered an intermediate time period for evaluating weight loss; and weight loss at 5 to 10 years or more is considered to represent long-term weight loss following bariatric surgery.

Short-Term Complications (Operative and Perioperative Complications <30 Days)

In general, the incidence of operative and perioperative complications is increased in obese patients, particularly in thromboembolism and wound healing. Other perioperative complications include

anastomotic leaks, bleeding, bowel obstruction, and cardiopulmonary complications (e.g., pneumonia, myocardial infarction).

Reoperation Rate

Reoperation may be required to “take down” or revise the original procedure. Reoperation may be particularly common in VBG due to pouch dilation.

Long-Term Complications (Metabolic Adverse Events, Nutritional Deficiencies)

Metabolic adverse events are of particular concern in malabsorptive procedures. Other long-term complications include anastomotic ulcers, esophagitis, and procedure-specific complications such as band erosion or migration for gastric banding surgeries.

Improved Health Outcomes in Terms of Weight-Related Comorbidities

Aside from psychosocial concerns, which may be considerable, one motivation for bariatric surgery is to decrease the incidence of complications of obesity, such as diabetes, cardiovascular risk factors (i.e., increased cholesterol, hypertension), OSA, or arthritis. Unfortunately, these final health outcomes are not consistently reported.

Literature Review

Evidence reviews assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life, and ability to function including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms. To assess whether the evidence is sufficient to draw conclusions about the net health outcome of technology, 2 domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent 1 or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

Promotion of greater diversity and inclusion in clinical research of historically marginalized groups (e.g., People of Color [African-American, Asian, Black, Latino and Native American]; LGBTQIA (Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual); Women; and People with Disabilities [Physical and Invisible]) allows policy populations to be more reflective of and findings more applicable to our diverse members. While we also strive to use inclusive language related to these groups in our policies, use of gender-specific nouns (e.g., women, men, sisters, etc.) will continue when reflective of language used in publications describing study populations.

The following overview section is a summary of the key literature to date.

Overview: Bariatric Surgery in Adults With Class III Obesity

There is a vast literature on bariatric surgery for adults with class III obesity. This literature is characterized by a preponderance of single-arm clinical series from individual institutions. These types of studies can be used to determine the amount of weight loss expected from surgery, the durability of the weight loss, and the rate of adverse events. However, these studies are not adequate for determining the comparative efficacy of bariatric surgery versus conservative treatment, or the comparative efficacy of different bariatric surgery techniques. Some comparative trials, including

randomized and nonrandomized designs, compare bariatric surgery with conservative therapy and/or compare outcomes of different bariatric surgery procedures. RCTs of bariatric surgery have been performed but are limited and insufficient to draw conclusions about comparisons of bariatric surgery and conservative treatments for weight loss.² RCTs are difficult in bariatric surgery because many experts consider it inappropriate or unethical to randomize patients to bariatric surgery. Also, most patients and clinicians have strong preferences for treatment, which result in a select population that might agree to randomization and, therefore, limited generalizability. As a result, the emphasis for this evidence review is on comparative nonrandomized trials of bariatric surgery and nonsurgical therapy or of different types of bariatric surgery procedures.

Swedish Obese Subjects Trial

The Swedish Obese Subjects (SOS) trial is the most influential study of bariatric surgery versus conservative treatment. The SOS trial started in 1987 with a registry containing a detailed questionnaire and clinical data on obese patients with a body mass index (BMI) greater than 34 kg/m² at 480 primary health care centers in Sweden. From this registry, patients who met eligibility criteria were recruited and offered bariatric surgery. Thus, SOS patients self-selected into treatment, and there were baseline differences between groups, primarily reflecting more excess weight and a higher incidence of comorbidities in the surgery group. A total of 2010 people chose surgery, and 2037 people chose conservative care. Each surgical patient was matched on 18 clinical variables with a patient from the registry who received nonsurgical treatment (usual care). Each surgeon chose the surgical procedure offered. Most procedures were vertical-banded gastroplasty (VBG; >70%), with gastric bypass (6%) and gastric banding (23%) procedures performed as well. Usual care in the SOS trial was the local practice of the primary care center and usually did not include pharmacologic treatment. Patients were followed at regular intervals with repeat questionnaires and physical examinations for at least 10 years.

Many publications from this trial have reported on methods, weight loss, and clinical outcomes.^{3,4,5,6} The following general conclusions can be drawn from the SOS study:

- Weight loss was greater with bariatric surgery than with conservative treatment. At 10 years of follow-up, weight loss in the surgery group was 16% of total body weight compared with a weight gain of 1.6% in the conservative treatment group.
- There was significant improvement in glucose control for diabetics and reduced incidence of new cases of diabetes.
- The effect on other cardiovascular risk factors (e.g., hypertension, lipidemia) was also positive, but less marked than that seen for diabetes.
- Mortality was reduced by 29% after a mean follow-up of 10.9 years.
- Quality of life improved in the 2- to 10-year follow-up period, with the degree of improvement in quality of life correlating with the amount of weight loss.

Longitudinal Assessment of Bariatric Surgery Consortium

The Longitudinal Assessment of Bariatric Surgery Consortium study is a large prospective, longitudinal, noncomparative study of patients who underwent Roux-en-Y gastric bypass (RYGB) or laparoscopic adjustable gastric banding (LAGB) with follow-up through 3 years post-procedure.⁷ The study enrolled 2458 subjects, with a median BMI of 45.9 kg/m² (interquartile range [IQR], 41.7 to 51.5 kg/m²). For their first bariatric surgical procedure, 1738 participants underwent RYGB, 610 LAGB, and 110 other procedures. At 3-year follow-up, for 1533 RYGB patients with available data, the percentage of baseline weight lost was 31.5% (IQR, 24.6% to 38.4%). For the 439 LAGB patients with available data at 3 years, the percentage of baseline weight loss was 15.9% (IQR, 7.9% to 23.0%). At 3 years post-surgery, 67.5% and 28.5% of RYGB and LAGB patients, respectively, had at least partial diabetes remission. Dyslipidemia was in remission in 61.9% and 27.1% of RYGB and LAGB patients, respectively. Subsequent bariatric procedures (revision or reversal) were required in 0.3% (95% confidence interval [CI], 0.1% to 0.9%) of the RYGB patients and in 17.5% (95% CI, 13.8% to 21.9%) of LAGB patients.

National Patient-Centered Clinical Research Network - Bariatric Study

The National Patient-Centered Clinical Research Network (PCORnet) Bariatric Study is a large retrospective, comparative study of 65,093 patients aged 20 to 79 years who underwent RYGB (n=32,208), LAGB (n=29,693), or sleeve gastrectomy (SG) (n=3192) with follow-up through 5 years post-procedure.⁸ Mean estimated percent total weight loss (%TWL) was calculated at 1, 3, and 5 years in addition to 30-day rates of major adverse events. Study results are summarized in Table 3. This study demonstrates that RYGB is associated with a greater weight loss than SG (p<.001) and that LAGB is associated with the lowest amount of weight loss as observed in a large and diverse patient cohort.

Table 3. National Patient-Centered Clinical Research Network - Bariatric Study Results

Group (n ^a)	Mean TWL, % (95% CI)			MAE Rate,% (95% CI)
	1 Year	3 Years	5 Years	30 Days
RYGB (19,029; 9225; 3676)	-31.2 (-31.3 to -31.1)	-29.0 (-29.2 to -28.8)	-25.5 (-25.9 to -25.1)	5.0 (NR)
LAGB (1681; 943; 337)	-13.7 (-14.0 to -13.3)	-12.7 (-13.5 to -12.0)	-11.7 (-13.1 to -10.2)	2.9 (NR)
SG (14,929; 5304; 1088)	-25.2 (-25.4 to -25.1)	-21.0 (-21.3 to -20.7)	-18.8 (-19.6 to -18.0)	2.6 (NR)

CI: confidence interval; LAGB: laparoscopic adjustable gastric banding; MAE: major adverse event; NR: not reported; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy; TWL: total weight loss.

^a Number of patients evaluated at 1, 3, and 5 years, respectively.

Systematic Reviews

Numerous systematic reviews have compared the efficacy of bariatric surgery with conservative therapy or compared different types of bariatric surgery techniques, some of which are older and/or do not extend across the full range of available studies.^{9,10,11,12} Trials included in select systematic reviews can be compared in Appendix Table A1.

Cosentino et al (2021) performed a network meta-analysis of 43 RCTs comparing the efficacy of bariatric surgery versus medical therapy, as well as comparing different types of bariatric surgery techniques.¹³ Most included trials were 1 year in duration but a few extended to 5 years. Results demonstrated that surgery reduced BMI more effectively than medical therapy (mean difference [MD], -6.632 kg/m²; 95% CI, -8.29 to -4.97), but increased risk for severe adverse events (odds ratio [OR], 3.06; 95% CI, 1.09 to 8.57). When comparing different procedures to medical therapy, duodenal switch (DS) and bilio-pancreatic diversion (BPD) appeared to be more effective than other procedures, whereas greater curvature plication, LAGB, and laparoscopic vertical banded gastroplasty (LVBG) produced a smaller weight loss than other interventions. When comparing different types of bariatric surgery techniques on BMI change, RYGB was superior to LAGB (MD, -4.26; 95% CI, -6.02 to -2.50; n=2 studies) and LVGB (MD, -3.05; 95% CI, -5.88 to -0.21; n=2 studies); the difference between RYGB and SG (n=12 studies), BPD (n=2 studies), gastric plication (n=3 studies), and one anastomosis/gastric bypass (OAGB; n=2 studies) did not reach statistical significance. Roux-en-Y gastric bypass was inferior to DS for BMI change (MD, 7.55; 95% CI, 6.35 to 8.75; 2 studies).

Park et al (2019) conducted a systematic review with a network meta-analysis evaluating the comparative efficacy of various bariatric surgery techniques against standard-of-care in the treatment of morbid obesity and diabetes.¹⁴ The literature search was conducted through February 2018, identifying 45 RCTs for inclusion on RYGB (2 studies vs. control), SG (3 studies vs. control), LAGB (5 studies vs. control), and BPD with DS (BPD-DS; 3 studies vs. RYGB). Based on 33 trials, superior efficacy for percent excess weight loss (EWL) compared to standard-of-care was seen for BPD-DS (MD, 38.2%; 95% CI, 7.3 to 69.1), RYGB (MD, 32.1%; 95% CI, 3.1 to 61.1), and SG (MD, 32.5%; 95% CI, 5.5 to 59.5) at 6 months post-procedure. LAGB was not superior to standard-of-care (MD, -0.2%; 95% CI, -19.6 to 19.2). At 3 years post-procedure, superior efficacy for percent EWL compared to standard-of-care was seen for RYGB (MD, 45%; 95% CI, 21.8 to 68.2) and SG (MD, 39.2%; 95% CI, 15.2 to 63.3). BPD-DS (relative risk [RR], 7.51; 95% CI, 1.91 to 29.54), RYGB (RR, 7.51; 95% CI, 1.98 to 28.46), and SG (RR,

6.69; 95% CI, 1.75 to 25.57) were all superior to standard-of-care with respect to remission rates at 3 to 5 years post-procedure and remission rates were not significantly different among procedures. SG was found to have a relatively lower risk of adverse events compared to RYGB.

Kang et al (2017) conducted a systematic review with a network meta-analysis that compared the 3 most common types of bariatric surgery techniques: RYGB, SG, and LAGB.¹⁵ The literature search, conducted through July 2016, identified 11 RCTs for inclusion (8 RYGB vs. SG; 2 RYGB vs. LAGB; 1 SG vs. LAGB). Quality of the trials was assessed using the Jadad score, based on allocation concealment, blinding, intention-to-treat analysis, power calculation, and funding. Most trials had a Jadad score of 3 (scale range, 1 to 5). A meta-analysis for the outcome of BMI reduction (6 trials) showed that there was no difference between SG and RYGB (0.7; 95% CI, -1.6 to 3.1). A meta-analysis of RYGB and LAGB (2 trials) and a single trial of SG and LAGB showed that LAGB was not as effective as RYGB or SG (5.8; 95% CI, 2.3 to 9.1; and 5.1; 95% CI, 0.9 to 8.9; respectively). Meta-analyses for the outcome of percent EWL showed the same pattern, no difference comparing SG and RYGB (5 trials; -4.0; 95% CI, -14.0 to 8.2), and both SG and RYGB more effective than LAGB (2 trials; 22.0; 95% CI, 6.5 to 34.0; 1 trial; 26.0; 95% CI, 6.4 to 41.0; respectively).

Colquitt et al (2014) updated 2003 and 2009 Cochrane reviews of bariatric surgery for obesity.¹⁶ The authors identified 22 randomized trials that compared bariatric surgery with nonsurgical obesity management or that compared different bariatric surgery procedures (N=1798 participants; sample size range, 15 to 250 participants). All 7 RCTs comparing surgery with nonsurgical interventions found benefits of surgery on measures of weight change at 1- to 2-year follow-ups. However, reviewers noted that adverse event rates and reoperation rates were poorly reported across trials, and long-term follow-up (beyond 1 to 2 years) was limited. Gloy et al (2013) conducted a systematic review and meta-analysis of RCTs comparing current bariatric surgery techniques with nonsurgical treatment for patients with a BMI of 30 kg/m² or more.¹⁷ Eleven studies (N=796 patients) were included. Overall, patients after bariatric surgery lost more body weight than patients after nonsurgical treatment (MD, -26 kg; 95% CI, -31 to -21; p<.001). Remission of type 2 diabetes (T2D) was more likely for bariatric surgery patients than for nonsurgical patients (RR of T2D remission, 22.1; 95% CI, 3.2 to 154.3; p<.002); similarly, remission of metabolic syndrome was more likely for bariatric surgery patients (RR, 2.4; 95% CI, 1.6 to 3.6; p<.001). After bariatric surgery, 21 (8%) of 261 patients required reoperations (5/124 after LAGB, 4/69 after RYGB, 1/49 after SG, 1/19 after BPD). Similar to the Colquitt et al (2014) meta-analysis, no studies reported longer-term follow-up (>2 years) and heterogeneity between studies were high. Chang et al (2014) published a systematic review and meta-analysis of RCTs and observational studies to evaluate the effectiveness and risks of bariatric surgery.¹⁸ Reviewers included 164 studies (37 RCTs, 127 observational studies), with a total of 161756 patients. Mean pre-surgery BMI was 45.62 kg/m² and, among the studies that provided information about obesity-related comorbidities, 26% of patients had T2D, 47% had hypertension, 28% had dyslipidemia, 7% had cardiovascular disease, and 25% had obstructive sleep apnea (OSA). Perioperative complications were relatively low, with a perioperative mortality rate in RCTs of 0.08% (95% CI, 0.01 to 0.24) and in observational studies of 0.22% (95% CI, 0.14 to 0.31). Complication rates were 17% (95% CI, 11 to 23) for RCTs and 10% for observational studies (95% CI, 7 to 13). At 1-year follow-up, mean change in BMI was -13.53 kg/m² (95% CI, -15.51 to -11.55) in RCTs and -11.79 kg/m² (95% CI, -13.89 to -9.69) in observational studies. Decreases in BMI were generally sustained over 2 to 4 years of follow-up among studies reporting this outcome. Puzifferri et al (2014) conducted a systematic review of studies of bariatric surgery reporting follow-up beyond 2 years, which included 29 studies (N=7971 patients).¹⁹ At follow-up, which ranged from 2 to 5 years post-procedure, the mean sample size-weighted percentage of EWL was higher for gastric bypass (65.7%) than for gastric banding (45.0%). Reviewers noted that few studies reported sufficient long-term results to minimize bias. Many systematic reviews have reported improvements in specific obesity-related comorbidities following bariatric surgery. These reviews have relied primarily on the results of observational studies and included the outcomes of hypertension, T2D, hyperlipidemia, cardiovascular events, quality of life, cancer, knee pain, and liver disease.^{20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39}

Liu et al (2021) performed a network meta-analysis of 35 RCTs (N=2198) to compare the effects of bariatric surgery versus lifestyle/medical interventions on dyslipidemia and insulin resistance in patients who are overweight with or without T2D.⁴⁰ Compared with lifestyle/medical interventions, the Homeostasis Model Assessment for Insulin Resistance (HOMA-IR; a product of fasting circulating insulin and glucose concentrations divided by 22.5) was significantly lower with RYGB (MD, -3.93; 95% credible interval [CrI], -6.20 to -2.17), single anastomosis (mini-) gastric bypass (SAGB) (MD, -4.45; 95% CrI, -9.04 to -0.34), and SG (MD, -4.32; 95% CrI, -6.74 to -2.22). Compared with lifestyle/medical interventions, a statistically significant difference in the reduction of low-density lipoprotein cholesterol was only reached with RYGB (MD, -0.51; 95% CrI, -0.85 to -0.16) and DS (MD, -0.90; 95% CrI, -1.66 to -0.16).

Wiggins et al (2020) analyzed large-scale population studies to evaluate the association between bariatric surgery and long-term mortality and the incidence of new-onset obesity-related disease at a national level.⁴¹ The analysis included 18 national or regional administrative database cohort studies involving patients who had undergone any bariatric procedure compared to an appropriate control group with a minimum follow-up of 18 months. Overall, 1,539,904 patients were included: 269,818 receiving a bariatric procedure and 1,270,086 controls. Results revealed that bariatric surgery was associated with a significant improvement in all-cause mortality (pooled odds ratio [POR], 0.62; 95% CI, 0.55 to 0.69; $p < .001$), cardiovascular mortality (POR, 0.5; 95% CI, 0.35 to 0.71; $p < .001$), T2D incidence (POR, 0.39; 95% CI, 0.18 to 0.83; $p = .01$), hypertension (POR, 0.36; 95% CI, 0.32 to 0.4; $p < .001$), dyslipidemia (POR, 0.33; 95% CI, 0.14 to 0.8; $p = .01$), and ischemic heart disease (POR, 0.46; 95% CI, 0.29 to 0.73; $p = .001$). Limitations of this analysis included inability to account for unmeasured variables, which may have not been equally distributed between patient groups due to the nonrandomized design of included studies; heterogeneity between studies regarding the nature of the control group utilized; and unexamined potential adverse effects related to bariatric surgery due to a lack of data.

Section Summary: Bariatric Surgery in Adults With Class III Obesity

There is a lack of large-scale RCTs with long-term follow-up comparing bariatric surgery with nonsurgical treatment for the general population of patients with class III obesity. Evidence from nonrandomized comparative studies and case series and meta-analyses of existing RCTs has consistently reported that bariatric surgery results in substantially greater weight loss than nonsurgical therapy. Data from the largest comparative study (the SOS study) has reported that bariatric surgery is associated with improvements in mortality, diabetes, cardiovascular risk factors, and quality of life.

Evidence for Specific Types of Bariatric Surgery Procedures

Gastric Bypass for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of gastric bypass is to provide a treatment option that is an alternative to or an improvement on existing therapies, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest are individuals who are adults with class III obesity.

Interventions

The therapy being considered is gastric bypass. The procedure involves both a restrictive and a malabsorptive component, with the horizontal or vertical partition of the stomach performed in association with a Roux-en-Y procedure (i.e., a gastrojejunol); thus, food bypasses the duodenum and proximal small bowel.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are overall survival (OS), change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity.

Negative outcomes can include surgical complications, including leakage and operative margin ulceration at the, and metabolic complications, including iron deficiency anemia, vitamin B12 deficiency, and hypocalcemia.

The existing literature evaluating gastric bypass as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 10 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Cui et al (2021) published a systematic review of 7 RCTs comparing long-term outcomes of RYGB (n=239) versus medical therapy (n=238) in obese patients with T2D.⁴² Results demonstrated a higher likelihood of T2D remission with RYGB versus medical therapy at 1 year (RR, 18.01; 95% CI, 4.53 to 71.70), 3 years (RR, 29.58; 95% CI, 5.92 to 147.82), and 5 years (RR, 16.92; 95% CI, 4.15 to 69.00). The probability of achieving American Diabetes Association (ADA) treatment goals was also more likely with RYGB versus medical therapy at 1 year (RR, 3.99; 95% CI, 1.01 to 15.82), 3 years (RR, 3.16; 95% CI, 1.33 to 7.49), and 5 years (RR, 6.18; 95% CI, 1.69 to 22.68).

Yan et al (2016) published a systematic review of RCTs comparing gastric bypass with medical treatment in obese patients (i.e., BMI ≥ 30 kg/m²) who had T2D.⁴³ The primary study outcome was remission of T2D, which was reported in 5 of the 6 studies. A pooled analysis found a significantly higher remission rate after gastric bypass than after medical treatment (OR, 76.37; 95% CI, 20.70 to 271.73; p<.001). Also, a pooled analysis found a significantly lower final BMI in the gastric bypass group than in the medical treatment group (MD, -6.54 kg/m²; 95% CI, -9.28 to -3.80 kg/m²; p<.001). A 2005 TEC Assessment focused on laparoscopic gastric bypass, which intends to reproduce the open procedure via minimally invasive techniques.⁴⁴ This technically complex surgery requires a dedicated team and a relatively high degree of skill and experience in laparoscopic technique. This Assessment reviewed 7 comparative trials of the open gastric bypass and laparoscopic gastric bypass, including 3 RCTs. Also, 18 large clinical series of laparoscopic gastric bypass were included.

The Assessment concluded that weight loss at 1 year was similar for laparoscopic and open gastric bypass approaches. Longer follow-up periods were less well-reported but appeared to be similar for both approaches. While comparisons of complication rates were less certain, some patterns were evident and consistent across the data examined. The profile of adverse events differed between the 2 approaches, with each having advantages and disadvantages. Laparoscopic gastric bypass offered a less invasive procedure associated with decreased hospital stay and earlier return to usual activities. Mortality might be lower with the laparoscopic approach, although both procedures had mortality rates less than 1%. Postoperative wound infections and incisional hernias were also less frequent with laparoscopic gastric bypass. However, anastomotic problems, gastrointestinal tract bleeding, and bowel obstruction appeared to be higher with the laparoscopic approach, though not markedly higher. Given these data, the overall benefit-risk profile for these 2 approaches appeared to be similar.

Observational Studies

Arterburn et al (2021) published a retrospective, matched cohort study to investigate weight loss among patients with severe obesity undergoing RYGB, SG, or nonsurgical treatment.⁴⁵ Among 17,258 RYGB, 13,900 SG, and 87,965 nonsurgical patients, the 5-year follow-up rate was 72.0%, 70.9%, and 64.5%, respectively. At 1, 5, and 10 years, RYGB patients had a %TWL of -28.35% (95% CI, -28.53 to -28.18), -21.74% (95% CI, -22.02 to -21.45), and -20.18% (95% CI, -21.00 to -19.34), respectively; at the same time points, nonsurgical patients had a %TWL of -0.22% (95% CI, -0.35 to -0.09), -2.24% (95% CI, -2.46 to -2.02), and -4.78% (95% CI, -5.51 to -4.04), respectively. At 1 and 5 years, SG patients had a %TWL of -22.98% (95% CI, -23.19 to -22.76) and -15.99% (95% CI, -16.58 to -15.40), respectively. Wadden et al (2019) reported on end-of-trial results from the Look AHEAD: Action for Health in Diabetes (Look AHEAD) trial, which evaluated outcomes in patients with T2D and obesity who had self-selected to receive bariatric surgery after failing an assigned intensive lifestyle intervention (ILI) or a diabetes support and education (DSE) control therapy.⁴⁶ Patients who received bariatric surgery were significantly more likely to be female ($p < .001$), younger ($p < .001$), and have higher BMI at randomization ($p < .001$). Patients underwent 127 RYGB, 58 LAGB, and 11 SG procedures, respectively. End-of-trial assessments were completed at 4.3 years post-surgery compared to 9.6 years post-randomization for the DSE and ILI participants. Patients undergoing RYGB, LAGB, or SG surgical procedures lost a mean of $22.4\% \pm 1.0\%$, $13.0\% \pm 1.5\%$, and $16.2\% \pm 3.3\%$ of baseline weight, respectively. Twelve patients (6.1%) receiving bariatric surgery were randomized with a BMI < 35 kg/m². The mean BMI was 37.0 ± 5.1 , 37.1 ± 5.3 , and 42.1 ± 5.8 for DSE, ILI, and surgery groups, respectively ($p < .001$). Overall, surgically-treated patients lost a mean of 19.3% of baseline weight, compared with 5.8% and 3.3% for the ILI and DSE participants. Full diabetes remission was achieved by 7.6% of bariatric surgery participants compared to 1.1% of ILI and 1.1% of DSE participants. Full remission was significantly more common in surgically treated participants in ILI (RR 6.72; 95% CI, 3.35 to 13.48; $p < .001$) or DSE (RR 7.07; 95% CI, 3.49 to 14.30; $p < .001$) groups. Significantly greater reductions in waist circumference ($p < .001$), triglyceride levels (ILI: $p = .03$; DSE: $p = .02$), and hemoglobin A1c (HbA1c) levels ($p < .001$) were observed in surgically-treated patients compared to ILI or DSE groups. The study was limited by heterogeneity in baseline characteristics and choice of surgical procedure. Results were not stratified by surgery type or BMI range.

Section Summary: Gastric Bypass for Adults with Class III Obesity

Gastric bypass has been extensively studied. TEC Assessments and other systematic reviews have found that gastric bypass improved health outcomes, including weight loss and remission of T2D. A TEC Assessment also found similar weight loss with open and laparoscopic gastric bypass.

Laparoscopic Adjustable Gastric Banding for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of LAGB is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is LAGB.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating LAGB as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 2 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

A 2006 TEC Assessment updated the evidence on LAGB and compared outcomes with gastric bypass.⁴⁷ This Assessment concluded that, for patients considering bariatric surgery, there was sufficient evidence to permit an informed choice between gastric bypass and LAGB. An informed patient might reasonably choose open gastric bypass or LAGB as the preferred procedure. Preoperative counseling should include education on the comparative risks and benefits (e.g., extent of weight loss and frequency and timing of potential complications) of the 2 procedures to optimize choice based on preferences and shared decision making.

Weight loss outcomes from the studies reviewed in the Assessment confirmed that weight loss at 1 year was lower for LAGB than for open gastric bypass. The percentage of EWL at 1 year was approximately 40%, compared with 60% or higher for open gastric bypass. At time points beyond 1 year, some comparative studies have reported that the difference in weight loss between LAGB and open gastric bypass narrows, but other studies did not. Weight loss outcomes from the 9 single-arm series with the most complete follow-up did not support the hypothesis that the difference in weight loss shrinks after 1 to 2 years of follow-up. It appears more likely from the current data that attrition bias might have accounted for the diminution of the difference in weight loss over time, particularly when patients with bands removed or deflated were excluded from analysis.

These studies also confirmed that short-term (perioperative) complications are very low with LAGB and lower than with open gastric bypass or LAGB. Death was extremely rare, and serious perioperative complications probably occurred at rates less than 1%. The reported rates of long-term adverse events vary considerably. In the comparative trials, reoperations were reported in approximately 25% of patients, while, in the single-arm studies, the composite rate for reoperations were approximately 50% lower (11.9%). The rates of other long-term complications were also highly variable; e.g., the range of rates for band slippage was 1% to 36%, and the range for port access problems was 2% to 20%. These data on long-term complications remain suboptimal. The reporting of long-term complications in these trials was not systematic or consistent. While impossible to determine the precise rates of long-term complications from these data, it is likely that complications have been underreported in many studies due to incomplete follow-up and lack of systematic surveillance. A publication by Ibrahim et al (2017) reviewed 25,042 Medicare beneficiaries who underwent LAGB surgery; 18.5% (n=4636) patients underwent 1 or more reoperation(s). Reoperation was prompted by the need for band removal (41.8%), band and port replacement (28.6%), and other requirements.⁴⁸ The rates of long-term complications reported in some studies raise concern about the impact of these events on the overall benefit-risk profile for LAGB.

In comparing LAGB with open gastric bypass, there are tradeoffs in terms of risks and benefits. LAGB is a less invasive procedure associated with fewer procedural complications, decreased hospital stay and earlier return to usual activities. However, benefits defined by the amount of weight lost are lower for LAGB. The patterns of long-term complications also differ between the 2 procedures. For LAGB, longer-term adverse events related to the presence of a foreign body in the abdomen will occur and result in reoperations and removal of the band in a minority of patients. Patients who have their bands removed can later be offered an alternative bariatric surgery procedure, such as gastric bypass.

A systematic review by Chakravarty et al. (2012)⁴⁹, comparing LAGB with other bariatric surgery procedures drew conclusions similar to the TEC Assessment. Reviewers included 5 RCTs. The RCTs found that patients using LAGB lost weight, but less weight than with other procedures (e.g., gastric bypass or SG). However, the short-term complication rate was lower with LAGB, and no difference was found in quality of life after LAGB versus other procedures.

Prospective Studies

Dixon et al (2018) published a prospective, industry-sponsored study of morbidly obese patients who underwent implantation of the adjustable gastric banding system (LAP-BAND)⁵⁰. Between 2009 and 2013, 652 patients with a mean BMI of 45.4 kg/m² were treated at 17 participating centers in the United States and Canada. At 5 years, the explant rate was 8.74% (95% CI, 6.6 to 10.9). Excluding explants, 100 (15.3%) reoperations were necessary during the follow-up period. A mean weight loss of 18.7% was achieved by 2 years and maintained through 5-year follow-up. The study was limited by the lack of control group.

Section Summary: Laparoscopic Adjustable Gastric Banding for Adults with Class III Obesity

Systematic reviews of the literature have concluded that LAGB is a reasonable alternative to gastric bypass. There is less weight loss with LAGB; however, the procedure is associated with fewer serious adverse events.

Sleeve Gastrectomy for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of SG is to provide a treatment option that is an alternative to or an improvement of existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is SG, an alternative approach to gastrectomy that can be performed on its own or in combination with malabsorptive procedures. In this procedure, the greater curvature of the stomach is resected from the angle of His to the distal antrum, resulting in a stomach remnant shaped like a tube or sleeve. This procedure can be done as an open or laparoscopic procedure.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating SG as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence**Systematic Reviews**

Sleeve gastrectomy may be performed as a stand-alone procedure or in combination with a malabsorptive procedure, such as the BPD with BPD-DS. It has also been proposed as the first step in a 2-stage procedure, with gastric bypass or BPD as the second stage.

Numerous recent systematic reviews have compared SG and RYGB with regard to effects on weight, comorbidities, and complications.^{51,52,53,54,55,56,}

Lee et al (2021) performed a meta-analysis evaluating long-term (5 years) outcomes of laparoscopic RYGB versus SG (Table 4).⁵⁷ A total of 33 studies (N=2475) were included. Results demonstrated that RYGB resulted in a significantly greater decrease of BMI compared to SG at 1 and 3 years post-surgery; results at 5 years did not reach statistical significance (Table 5). A similar trend was seen for the resolution of dyslipidemia. Furthermore, neither RYGB nor SG was superior for the remission of T2D and hypertension at 5 years.

Gu et al (2020) completed a meta-analysis of the medium- and long-term effects of laparoscopic SG and RYGB (Table 4).⁵¹ The evaluation included 9038 patients from 28 studies. Overall, 5 year follow-

up results revealed that laparoscopic RYGB was associated with an improvement in percentage of EWL and remission of T2D, hypertension, and dyslipidemia as compared to laparoscopic SG. Han et al (2020) also published a systematic review and meta-analysis involving 18 studies (N=2917) that compared weight loss and comorbidity resolution between laparoscopic SG and RYGB (Table 4).⁵² Results from this analysis revealed no significant difference in EWL or T2D resolution between the 2 procedures. Laparoscopic RYGB was found to be superior to SG with regard to dyslipidemia, hypertension, and gastroesophageal reflux disease (GERD) management; however, patients who underwent laparoscopic SG experienced fewer postoperative complications and reoperation rates. Sharples et al (2020) performed a systematic review and meta-analysis evaluating long-term (5 years) outcomes of RYGB and SG (Table 4).⁵³ Overall, both RYGB and SG resulted in sustained weight loss and comorbidity control with RYGB associated with a greater percent EWL, improved dyslipidemia outcomes, and a reduced incidence of GERD (Table 5).

Shenoy et al (2020) published a systematic review and meta-analysis of 9 studies that compared laparoscopic SG (LSG) and RYGB in 2240 elderly (>55 years) patients.⁵⁴ Results revealed no significant differences between the 2 bariatric procedures with regard to the rate of early complications (3.6% LSG vs. 5.8% RYGB; $p=.15$) and mortality (0.1% vs. 0.8%; $p=.27$). Additionally, there was no difference in EWL between the procedures at 1 year (Table 5); however, the authors recommended SG for high-risk elderly patients due to the reduced mortality and complication rates with this procedure. Another systematic review and meta-analysis by Xu et al (2020) involving 19 studies also concluded that SG was the preferable option for obese patients 60 years and older as it was found to be non inferior to RYGB with regard to efficacy, but overall had an improved safety profile.⁵⁸

Osland et al (2017) published a systematic review and meta-analysis of RCTs comparing laparoscopic vertical SG with RYGB (Table 4).⁵⁹ The literature search, conducted from 2000 to November 2015, identified 9 RCTs for inclusion (N=865 patients). Four trials were included in meta-analyses comparing percent EWL between the 2 groups. Results at both 6- and 12-month follow-ups showed that the procedures are comparable (Table 5). Osland et al (2020) recently published a continuation of their work that focused exclusively on long-term (5 year) weight outcomes of laparoscopic vertical SG versus RYGB.⁶⁰ This systematic review and meta-analysis included 5 studies (SG=520; RYGB=508) and results revealed that a statistically significant BMI loss was seen with both SG: -11.37 kg/m² (range, -6.3 to -15.7) and RYGB: -12.6 kg/m² (range, -9.5 to -15.4) at 5 years. However, differences in reporting parameters limit the ability to reliably compare outcomes using statistical methods and the results may have been impacted by large dropout rates and per protocol analyses of the 2 largest included studies.

A systematic review by Juodeikis and Brimas (2017) summarized evidence on long-term results after SG (Table 4).⁶¹ Reviewers included an RCT and 19 retrospective studies, with a total of 2713 patients who received SG. Mean preoperative BMI was 46.9 kg/m². Mean duration of follow-up ranged from 5 to 11 years, and mean proportion of patients followed for 5 years was 68.5%. Seventeen studies (N=1501 patients) reported 5-year follow-up data. At 5 years, resolution of T2D, arterial hypertension, dyslipidemia, OSA, GERD, and degenerative joint diseases also improved in most patients (Table 5). Two studies reported weight loss after 7 and 8 years; percent EWL rates were 56.6% and 54.8%, respectively.

In a meta-analysis of 21 randomized and nonrandomized studies (N=18,766 patients) comparing SG with laparoscopic RYGB for morbid obesity, Zhang et al. (2015) reported no significant difference in percent EWL from 0.5- to 1.5-year follow-ups (Tables 4 and 5).⁶² However, after 1.5 years, RYGB was associated with higher percent EWL (2-year MD, 5.77; 95% CI, 4.29 to 7.25; $p<.05$). Adverse events were more frequent following RYGB (OR for major complication, 1.29; 95% CI, 1.22 to 3.22; $p<.01$). Trastulli et al (2013) conducted a systematic review of 15 RCTs (N=1191 patients) that compared SG with other bariatric procedures (Table 4).⁶³ Summary statistics were provided; meta-analyses were not conducted (Table 5). Reviewers reported mean complication rates with SG of 12.1% (range, 10% to

13.2%) compared with 20.9% with LAGB (range, 10% to 26.4%). Percent EWL ranged from 49% to 81% with SG and from 62.1% to 94.4% with LAGB.

Brethauer et al (2009) reviewed 36 studies (N=2570 patients) in a systematic review of SG as a staged and primary procedure, the largest trials coming from European centers (Table 4).⁶⁴ Thirteen studies (n=821 patients) reported on high-risk patients having a staged approach and 24 studies (n=1749 patients) on SG as the primary procedure. Mean percent EWL, reported in 24 studies (n=1662 patients), was 55.4% overall. Mean postoperative BMI, reported in 26 studies (n=1940 patients), decreased from a baseline of 51.2 to 37.1 kg/m². Other studies reported weight loss in terms of BMI decrease, the percentage of BMI lost, or percentage of total weight lost; all had significant reductions from baseline. Rates of major postoperative complications ranged from 0% to 23.8% for all studies and from 0% to 15.3% in studies with more than 100 patients. Leaks (2.2%), bleeding episodes requiring reoperation (1.2%), and postoperative strictures requiring endoscopic or surgical intervention (0.6%) were reported in the 33 studies (n=2570 patients). All extracted studies reported mortality data, with 5 deaths within 30 days of surgery (overall mortality rate, 0.19%; 2 in the high-risk/staged group, 3 in the primary procedure group).

Table 4. Systematic Review Characteristics for Sleeve Gastrectomy

Study	Dates	Studies	Participants	Design	Duration
Lee et al (2021) ⁵⁷	Through Jan 2019	33	SG=1252; RYGB=1223	RCTs	1 to 5 y
Gu et al. (2020) ⁵¹	Through Jan 2019	28	SG=4597; RYGB=4441	7 RCTs; 6 prospective; 15 retrospective	3 to 7 y
Han et al. (2020) ⁵²	Through Jan 2020	18	2917	9 RCTs; 9 nonrandomized studies of interventions	1 to 82.2 mo
Sharples et al (2020) ⁵³ ,	Through Dec 2018	5	729	RCTs	5 y
Shenoy et al (2020) ⁵⁴ ,	1991 to 2019	9	SG=683; RYGB=1557	RCTs; observational studies	Minimum follow-up: 1 y
Osland et al (2017) ⁵⁹ ,	2000 to Nov 2017	9	SG=437; RYGB=428	RCTs	3 mo to 5 y
Juodeikis et al. (2017) ⁶¹ ,	Through May 2016	20	1626	1 RCT; 19 retrospective	5 to 11 y
Zhang et al (2015) ⁶² ,	Through Oct 2013	21	18,766	8 RCTs; 13 nonrandomized comparative	1 to 5 y
Trastulli et al (2013) ⁶³ ,	Through Nov 2012	15	1191	RCTs	6 mo to 3 y
Brethauer et al (2009) ⁶⁴ ,	1996 to 2009	36	2570	2 RCTs; 1 cohort; 33 case series	3 mo to 5 y

RCT: randomized controlled trial; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy.

Table 5. Systematic Review Results for Sleeve Gastrectomy

Study	BMI mean difference (95% CI)	Comorbidities (95% CI)
Lee et al (2021) ⁵⁷	Mean difference SG vs RYGB: 1 y (16 trials): -1.25 kg/m ² (-2.01 to -0.49) 3 y (5 trials): -1.71 kg/m ² (-2.68 to -0.74) 5 y (4 trials): -1.46 kg/m ² (-3.15 to 0.23)	Remission, SG vs RYGB: T2D (1 y): RR, 0.86 (0.71 to 1.04) T2D (3 y): RR, 0.88 (0.72 to 1.07) T2D (5 y): RR, 0.79 (0.57 to 1.10) Hypertension (5 y): RR, 0.86 (0.68 to 1.10) Dyslipidemia (5 y): RR, 0.68 (0.46 to 1.23)
Gu et al (2020) ⁵¹	Percent EWL (95% CI) Weighted mean difference, RYGB and SG: 3 y (13 trials): -4.37 (-8.10 to -0.64) 5 y (9 trials): -2.20 (-3.83 to -0.57)	Comorbidities (95% CI) Remission, RYGB and SG: T2D (3 y): OR, 0.68 (0.48 to 0.95) T2D (5 y): OR, 0.63 (0.41 to 0.96) Hypertension (5 y): OR, 0.51 (0.38 to 0.68) Dyslipidemia (5 y): OR, 0.3 (0.19 to 0.48)
Han et al (2020) ⁵²	Mean difference, RYGB and SG: RCTs: -0.16 (-0.52 to 0.19)	Resolution, RYGB and SG: T2D: RR, 1.07 (0.89 to 1.28) Dyslipidemia: RR, 1.36 (1.17 to 1.59)

Study	BMI mean difference (95% CI)	Comorbidities (95% CI)
		Hypertension: RR, 1.23 (1.04 to 1.45) GERD symptoms: RR, 0.16 (0.06 to 0.44)
Sharples et al (2020)⁵³	5 y: RYGB: 65.7% SG: 57.3%	RYGB vs. SG at 5 y: T2D resolution: 37.4% vs. 27.5% Diabetes improvement: 77.5% vs. 74% Hypertension resolution: 60.1% vs. 48.4% Hypertension improvement: 86.4% vs. 76.6% Dyslipidemia resolution: 68.6% vs. 55.2% GERD remission: 60.4% vs. 25%
Shenoy et al (2020)⁵⁴	Mean difference, RYGB and SG: -7.79 (-23.96 to 8.38)	Resolution, RYGB and SG: T2D (5 studies): OR, 1.02 (0.63 to 1.66) Hypertension (4 studies): OR, 0.57 (0.35 to 0.93) Obstructive sleep apnea (2 studies): OR, 1.14 (0.55 to 2.34)
Osland et al (2017)⁵⁹	Mean difference, SG and RYGB: 6 mo (3 trials): 0.5 (-5.0 to 6.0) 12 mo (2 trials): 7.6 (-0.1 to 15.3)	NR
Juodeikis et al (2017)⁶¹	Mean rates for SG: 5 y (17 trials): 58.4% 7 y (2 trials): 56.6% 11 y (1 trial): 62.5%	Remission/improvement: T2D: 77.8% Hypertension: 68.0% Dyslipidemia: 65.9% Sleep apnea: 75.8%
Zhang et al (2015)⁶²	Mean difference, RYGB and SG: 6 mo (9 studies): 0.2 (-2.5 to 2.9) 12 mo (15 studies): 2.9 (-0.2 to 6.0) 4 y (3 studies): 2.7 (0.2 to 5.2)	Mean difference resolution, RYGB and SG: T2D (10 studies): 3.3 (2.0 to 5.5) Hypertension (10 studies): 1.3 (0.7 to 2.4) Dyslipidemia (5 studies): 1.1 (0.3 to 1.3) Sleep apnea (7 studies): 1.5 (0.8 to 2.6)
Trastulli et al (2013)⁶³	Mean by procedure: SG: 49% to 81% LGB: 62% to 94% LAGB: 29% to 48%	T2D: SG, 67% to 100% LGB, 80% to 100%
Brethauer et al (2009)⁶⁴	Mean rate overall for SG: 55% (range, 33% to 85%)	Remission/improvement: T2D: >70% Significant reductions also seen in hypertension, hyperlipidemia, and sleep apnea

BMI: body mass index; CI: confidence interval; EWL: excess body weight loss; GERD: gastroesophageal reflux disease; LAGB: laparoscopic adjustable gastric banding; LGB: laparoscopic gastric bypass; NR: not reported; OR: odds ratio; RCT: randomized controlled trial; RR: relative risk; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy; T2D: type 2 diabetes.

Randomized Controlled Trials

Hofso et al (2019) published the results of a single-center, triple-blind RCT comparing the efficacy of RYGB (n=54) versus SG (n=55) on diabetes remission and β -cell function in patients with obesity and T2D.⁶⁵ Inclusion criteria included previously verified BMI ≥ 35 kg/m² and current BMI ≥ 33.0 kg/m², HbA1c $\geq 6.5\%$ or use of antidiabetic medications with HbA1c $\geq 6.1\%$, and age ≥ 18 years. One-year follow-up was completed by 107 (98%) of 109 patients, with 1 patient in each group withdrawing after surgery. In the intention-to-treat population, diabetes remission rates were superior in the gastric bypass group than in the SG group (risk difference 27%; 95% CI, 10 to 44; RR 1.57, 95% CI, 1.14 to 2.16; p=.0054). Results were similar in the per-protocol population (risk difference 27%; 95% CI, 10 to 45; RR 1.57; 95% CI, 1.14 to 2.15; p=.0036). The 2 procedures had a similar beneficial effect on β -cell function. Peterli et al (2018) published a randomized study of adults with morbid obesity treated with either LSG or RYGB.⁶⁶ Two hundred five patients (mean age, 45.5 years; mean BMI, 43.9; 72% women) treated at 4 Swiss bariatric centers were randomly assigned to receive SG (n=101) or RYGB (n=104) with 5-year follow-up. Excess BMI loss was 61.6% for SG and 68.3% for RYGB (95% CI, -14.30 to -0.06; p=.22). Gastric reflux remission was seen in 25.0% of SG and 60.4% of RYGB patients. Reoperations or interventions were necessary for 16/101 (15.8%) in the SG group and 23/104 (22.1%) of the RYGB group.

The study was limited by the lack of analysis of diabetes remission information, and the results may not be generalizable.

Salminen et al (2018) published a randomized trial, Laparoscopic Gastric Bypass vs. Laparoscopic Sleeve Gastrectomy in the Treatment of Morbid Obesity (SLEEVEPASS), comparing 5-year outcomes of morbidly obese patients ($n=240$; mean age, 48 years; mean baseline BMI, 45.9; 69.6% women) who underwent either LSG ($n=121$) or RYGB ($n=119$).⁶⁷ Five-year estimated mean percentage excess BMI loss was 49% (95% CI, 45 to 52) for SG and 57% (95% CI, 53 to 61) for gastric bypass. For SG and RYGB, respectively, rates of remission of T2D were 37% ($n=15/41$) and 45% ($n=18/40$; $p>.99$). Medication for hypertension was discontinued in 20/68 (29%) SG patients and 37/73 (51%) RYGB patients ($p=.02$). Overall 5-year morbidity rate was 19% for SG and 26% for RYGB ($p=.19$), and there was no significant difference in quality of life between groups ($p=.85$). The study was limited by the following: (1) only a small number ($n=430$) of bariatric procedures were performed in Finland at trial initiation in 2008, meaning a learning curve could account for some earlier technical complications, (2) the study had a higher reoperation rate for SG than other trials reported, (3) approximately 20% of patients were lost to follow-up, and (4) there was a lack of reliable information for diabetes duration at baseline.

Wolnerhanssen et al (2021) pooled 5-year outcomes data from the 2018 studies by Peterli et al and Salminen et al.⁶⁸ Five-year follow-up was available for 199 of 228 patients after SG and 199 of 229 after RYGB. Patients who underwent SG had an estimated 7% greater excess BMI loss versus RYGB ($p<.001$). While remission rates for hypertension were better after RYGB versus SG (60.3% vs 44.9%; $p<.049$), between-group differences in rates of remission of T2D, OSA, or quality of life scores did not reach statistical significance. The rate of complications was higher after RYGB versus SG (37.2% vs 22.5%; $p=.001$), but there was no difference in mean Comprehensive Complication Index value (30.6 vs 31.0 points; $p=.859$).

An RCT comparing short-term outcomes of laparoscopic SG with gastric bypass was published in 2012.⁶⁹ Trialists compared 30-day outcomes for 117 patients randomized to gastric bypass with 121 patients randomized to LSG. The rate of major complications (no deaths in either group) was 9.4% in the gastric bypass group compared with 5.8% in the LSG group ($p=.29$). Minor complications were more common in the gastric bypass group than in the LSG group (17.1% vs 7.4%, $p=.02$), as were combined major and minor complications (26.5% vs 13.2%, $p=.01$).

Karamanakos et al (2008) carried out a double-blind RCT comparing outcomes of laparoscopic RYGB and LSG on body weight, appetite, fasting, and postprandial ghrelin and peptide YY (levels at 1, 3, 6, and 12 months after surgery).⁷⁰ Thirty-two patients were randomized, half to each procedure. The decrease in body weight and BMI were marked and comparable in each group. EWL was greater after LSG than laparoscopic RYGB at 6 months (55.5% vs. 50.2%; $p=.04$) and 12 months (69.7% vs. 60.5%; $p=.05$), all respectively. Fasting peptide YY levels increased after both surgical procedures. Appetite decreased in both groups but decreased more after LSG.

Himpens et al (2006) reported on a randomized trial comparing LAGB with isolated LSG in 80 patients and reported 3-year follow-up.⁷¹ Median baseline BMI was 37 kg/m² (range, 30 to 47) in the LAGB group and 39 kg/m² (range, 30 to 53) in the SG group. Outcomes of weight loss, feeling of hunger, sweet-eating, GERD, complications, and reoperations were recorded at 1- and 3-year follow-ups. Median decrease in BMI in the gastric bypass group was 15.5 kg/m² (range, 5 to 39) after 1 year and 18 kg/m² (range, 0 to 39) at 3 years after LAGB. One year after SG, decrease in BMI was 25 kg/m² (range, 0 to 45) and 27.5 kg/m² (range, 0 to 48) after 3 years. Median EWL in the LAGB group was 41.4% after 1 year and 48% at 3 years. Median EWL after SG was 58% and 66% at 1 and 3 years, respectively. More patients having SG than LAGB reported a loss of craving for sweets, but the difference was not statistically significant; GERD appeared de novo in more SG than LAGB patients at 1 year, and the relation reversed at 3 years; between-group differences were not statistically significant at either time point. Two SG patients required reoperation for complications. Seven late complications required reoperation after LAGB, including pouch dilations treated by band removal

(n=2) or conversion to RYGB (n=1), 1 gastric erosion treated by conversion to RYGB, and 3 system disconnections that required reconnection. Four patients had reoperations for lack of efficacy (2 LAGB patients underwent conversion to RYGB, 2 SG patients underwent conversion to DS). The trialists noted that the number of reoperations was significant in both groups and that the severity of complications was greater in the SG group.

Section Summary: Sleeve Gastrectomy for Adults with Class III Obesity

Systematic reviews of RCTs and observational studies, evaluating SG alone and comparing SG with RYGB, have found that SG results in substantial weight loss, comparable to RYGB and that this weight loss is durable for at least 5 years. A meta-analysis found that short-term weight loss was similar after SG or gastric bypass. Long-term weight loss was greater after gastric bypass, but SG is associated with fewer adverse events.

Biliopancreatic Diversion With Duodenal Switch for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of BPD-DS is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is BPD-DS. BPD may be performed with or without the DS procedure. In the BPD-DS, a SG is performed, preserving the pyloric sphincter. Preservation of the pyloric sphincter is intended to ameliorate dumping syndrome and to decrease the incidence of ulcers at the duodeno-ileal junction by providing a more physiologic transfer of stomach contents to the duodenum.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating BPD-DS as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 15 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.

- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Review

In an evidence-based review of literature, Farrell et al (2009) summarized data on BPD with or without DS, RYGB (proximal), and LAGB, and reported that at a mean 1-year follow-up, EWL for BPD with or without DS (outcomes with and without DS not reported separately) was 72% (4 studies; n=896 patients), 67% for RYGB (7 studies; n=1627 patients), and 42% for LAGB (11 studies; n=4456 patients).⁷² At mean follow-up of 5 years, EWL for BPD with or without DS was 73% (3 studies; n=174 patients), 58% for RYGB (3 studies; n=176 patients), and 55% for LAGB (5 studies; n=640 patients). Reviewers noted that “given the marked paucity of prospectively collected comparative data among the different bariatric operations, it remains impossible to make definitive recommendations for one procedure over another.”

Nonrandomized Comparative Studies

Skogar et al (2017) published results from a retrospective mail survey of patients undergoing BPD-DS (n=113) or RYGB (n=98) (Table 6).⁷³ Reduction in BMI was statistically larger in patients receiving BPD-DS compared with patients receiving RYGB. Both groups experienced significant reductions in diabetes and OSA. Significant reductions in dyslipidemia were only seen in the group receiving BPD-DS. The overall complication rate was lower for patients undergoing RYGB.

Strain et al (2007) published a comparative study of 72 patients who underwent RYGB (n=50) or BPD (n=22) (Table 6).⁷⁴ Choice of surgery was by the surgeon and/or patient, and the patient populations differed by age and time since surgery. Weight loss at 1 year was greater for BPD, with a reduction in BMI of 10.6 kg/m² (23.3 lb) for BPD compared with 7.5 kg/m² (16.5 lb) for RYGB (p<.001).

Prachand et al (2006) published the largest comparative study of 350 super-obese patients with a BMI greater than 22.7 kg (50 lb) who underwent RYGB (n=152) or Scopinaro BPD combined with the DeMeester BPD-DS (n=198) (Table 6).⁷⁵ In this retrospective study, the decision for surgery was made by the surgeon and/or patient. The BPD-DS patients differed from RYGB patients on baseline weight and BMI; mean weight was 167 kg (368 lb; range, 267 to 597 lb) in BPD-DS patients and 157 kg (346 lb; range, 240 to 505 lb) in the RYGB group, and mean BMI was 27 kg/m² (59 lb; range, 50 to 96 lb) in BPD-DS patients versus 26 kg/m² (56 lb; range, 50 to 84 lb) in the RYGB group. At 1 year, data were reported for 143 BPD-DS patients and 81 RYGB patients (Table 7). EWL was greater for BPD (64.1%) versus RYGB (55.9%; p<.01), and the reduction in BMI was also greater with BPD (10.7 kg/m² [23.6 lb]) versus RYGB (8.8 kg/m² [19.4 lb]; p<.001). Complications and data on the resolution of comorbidities were not reported.

Table 6. Nonrandomized Comparative Study Characteristics for Biliopancreatic Diversion with Duodenal Switch

Study	Country	Dates	Participants	Follow-Up
Skogar et al (2017) ⁷³	Sweden	2003-2012	BPD-DS: 113 RYGB: 98	4 y
Strain et al (2007) ⁷⁴	U.S.	2002-2005	BPD-DS: 22 RYGB: 50	BPD-DS: 19 mo RYGB: 15 mo
Prachand et al (2006) ⁷⁵	U.S.	2002-2005	BPD-DS: 198 RYGB: 152	3 y

BPD-DS: biliopancreatic diversion with duodenal switch; RYGB: Roux-en-Y gastric bypass.

Table 7. Nonrandomized Comparative Study Results for Biliopancreatic Diversion with Duodenal Switch

Study	Mean Reduction in BMI (SD)		Percent Achieving ≥50% EWL	Percent Achieving ≥50% EWL		
	Presurgery, kg/m ²	Postsurgery, kg/m ²		p ^a	1 Year	2 Years

Study	Mean Reduction in BMI (SD)		Percent Achieving $\geq 50\%$ EWL		
Skogar et al (2017)⁷³					
BPD-DS	56 (6.7)	31 (5.5)	<.01	NR	
RYGB	52 (4.0)	36 (7.1)		NR	
Strain et al (2007)⁷⁴					
BPD-DS	54 (11.9)	30 (6.1)	<.001	NR	
RYGB	48 (6.3)	31 (5.0)		NR	
		Change in BMI			
Prachand et al (2006)⁷⁵					
BPD-DS	59 (6.7)	27.8	<.01	83.9	89.2 84.2
RYGB	56 (6.8)	18.9		70.4 ^b	79.3 59.3 ^b

BMI: body mass index; BPD-DS: biliopancreatic diversion with duodenal switch; EWL: excess weight loss; NR: not reported; RYGB: Roux-en-Y gastric bypass; SD: standard deviation.

^a Between groups, difference in change.

^b $p < .05$.

Case Series

Strain et al (2017) reported on the nutrient status of 190 patients receiving BPD-DS after 9 years of follow-up.⁷⁶ At baseline, the patients had a mean age of 43 years and mean BMI of 53 kg/m². All patients reported taking some supplements. Deficiencies in protein, iron, and calcium developed by year 3 and continued through the study. Zinc deficiencies developed by year 5. Folate levels increased during the study, probably due to the efficacy of the supplement. The authors warned that interventions need to be implemented to improve nutrient status in patients receiving BPD-DS. The largest case series of this procedure is by Marceau et al (2009), who reported on their 15-year experience with DS in 1423 patients from 1992 to 2005.⁷⁷ Follow-up evaluations were available for 97% of patients. Survival rate was 92%. After a mean of 7 years (range, 2 to 15), 92% of patients with an initial BMI of 50 kg/m² or less obtained a BMI of 35 kg/m² or less, and 83% of patients with a BMI greater than 50 kg/m² achieved a BMI of less than 40 kg/m². Diabetes medication was discontinued in 92% and decreased in others. Use of continuous positive airway pressure was discontinued in 92% of patients, and the prevalence of cardiac risk index greater than 5 decreased by 86%. Operative mortality was 1%, the revision rate was 0.7%, and the reversal rate was 0.2%. Revision for failure to lose sufficient weight was needed in only 1.5% of patients. Severe anemia, vitamin deficiency, or bone damage were preventable or easily treated and without documented permanent damage.

Section Summary: Biliopancreatic Diversion with Duodenal Switch for Adults with Class III Obesity

Nonrandomized comparative studies have found significantly higher weight loss after BPD-DS compared with gastric bypass at 1 year. A large case series found sustained weight loss after 7 years.

Biliopancreatic Diversion without Duodenal Switch for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of BPD without DS is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity. The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is BPD without DS.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating BPD without DS as a treatment for class III obesity has varying lengths of follow-up, ranging to 9 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Review

The available evidence on BPD-DS was reviewed in the 2006 TEC Assessment, and BPD outcomes, with or without DS, were compared with those of gastric bypass.⁴⁷ One comparative trial and 7 single-arm series suggested that weight loss outcomes at 1 year were in the same range as for gastric bypass. While these data were not sufficient to distinguish small differences in weight loss between the 2 procedures, they did not support the hypothesis that BPD resulted in greater weight loss than open gastric bypass.

Randomized and Nonrandomized Studies

Complication rates have been poorly reported in these trials. The data have suggested that mortality is low (1%) and in the same range as for open gastric bypass. However, rates of other complications, especially long-term complications, cannot be determined from these data. Limited data have suggested that long-term nutritional and vitamin deficiencies occur at a high rate following BPD. Slater et al (2004) focused specifically on vitamin and calcium deficiencies following BPD.⁷⁸ The authors reported high rates of vitamin and calcium abnormalities in their population over a 4-year period. By year 4, 48% of patients had low calcium, and 63% had low levels of vitamin D. Other fat-soluble vitamins showed similar patterns of abnormalities. Low vitamin A was found in 69% of patients at 4 years, low vitamin K in 68%, and low zinc in 50%. Dolan et al (2004) reported similar data in a study that compared several technical variations of BPD.⁷⁹ The authors reported low calcium levels in 12% to 34% of patients, low vitamin D in 22.2% to 70.6%, low vitamin A in 53% to 67%, and low vitamin K in 44% to 59%. Also, this study reported high rates of iron deficiency (11% to 47%) and anemia (11% to 40%).

Skroubis et al (2006) randomized 130 patients with a BMI of 35 to 50 kg/m² to RYGB or BPD without DS using a variant of BPD that included RYGB in place of SG.⁸⁰ All patients were followed for at least 2 years. Weight loss outcomes were superior for the BPD group at every interval examined up to 2 years. EWL at 1 year was 73.7% for RYGB and 83.1% for BPD (p<.001); at 3 years, EWL was 72.6% for RYGB and 83.1% for BPD (p<.001). There were more early complications in the RYGB group, but this difference was not statistically significant (6 complications vs. 1, respectively; p=.12). Late

complications also did not differ significantly between the RYGB group (16 complications) and BPD groups (22 complications; $p=.46$).

Case Series

Numerous clinical series of BPD have been published but high-quality trials directly comparing outcomes of this procedure with gastric bypass are lacking. The largest experience with BPD (N=1217 patients) was reported by Scopinaro et al (1996), who developed the procedure.⁸¹ With a follow-up of up to 9 years, the authors reported a durable EWL of 75%, suggesting that weight loss is greater with this procedure than with gastric restrictive procedures. Also, most patients reported disappearance or improvement of complications such as OSA, hypertension, hypercholesterolemia, and diabetes. The authors considered protein malnutrition to be the most serious metabolic complication, occurring in almost 12% of patients and responsible for 3 deaths. This complication could require inpatient treatment with total parenteral nutrition. To address protein malnutrition, 4% of patients underwent reoperation to elongate the common limb (thus increasing protein absorption) or to have the operation reversed, restoring normal intestinal continuity. The authors also found that protein malnutrition was strongly related to ethnicity and, presumably, patient eating habits, with an increased incidence among those from southern Italy where the diet contains more starch and carbohydrates than the north. Peripheral neuropathy may occur in the early postoperative period due to excessive food limitation but may be effectively treated with large doses of thiamine. Bone demineralization, due to decreased calcium absorption, was seen in about 33% of patients during the first 4 postoperative years. All patients were encouraged to maintain an oral calcium intake of 2 g/d, with monthly vitamin D supplementation.

Section Summary: Biliopancreatic Diversion without Duodenal Switch for Adults with Class III Obesity

A TEC Assessment reviewed the available observational studies and concluded that weight loss was similar after BPD without the DS and gastric bypass. However, BPD without DS leads to complications, especially long-term nutritional and vitamin deficiencies.

Vertical-Banded Gastroplasty for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of VBG is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is VBG. In this procedure, the stomach is segmented along its vertical axis, a plug of the stomach is removed, and a propylene collar is placed through this hole and then stapled to itself. It can be performed using an open or laparoscopic approach.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. Negative outcomes associated with VBG include complications such as esophageal reflux, dilation, or obstruction of the stoma.

The existing literature evaluating VBG as a treatment for class III obesity has varying lengths of follow-up, ranging from 3 to 10 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 3 to 10 years of follow-up is considered necessary to demonstrate efficacy.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Hsieh et al (2014) conducted a systematic review of studies reporting greater than 10-year follow-up for VBG, which included 3 studies with extractable data.⁸² Mean EWL was 61.4% from baseline to follow-up in the 3 studies, but reviewers noted a lack of long-term evidence related to outcomes following VBG.

A number of nonrandomized, comparative studies of open gastric bypass versus VBG were included in the 2003 TEC Assessment (N=8 studies, total N=3470 patients).⁸³ All 8 studies reported greater amounts of weight loss with open gastric bypass. These studies reported a 44% to 70% improvement in TWL, a 28% to 43% improvement in the percent EWL, and 19% to 36% more patients with more than 50% EWL for those undergoing gastric bypass compared with VBG. Comparison of adverse events was difficult because the data did not permit rigorous assessment. Nevertheless, the data suggested that the mortality rate for both surgeries was low overall. Serious perioperative adverse events were also infrequently reported, but somewhat higher for gastric bypass. Long-term adverse events were inconsistently reported, although it appeared that revision rates were higher for VBG.

Randomized Controlled Trials

A small body of literature has compared outcomes between VBG and open gastric bypass. The most rigorous of these comparative trials, the Adelaide Study (1990), randomized 310 morbidly obese patients to gastric bypass, VBG, or horizontal gastroplasty.⁸⁴ The percentage of patients with greater than 50% EWL at 3-year follow-up was 67% for gastric bypass, 48% for VBG, and 17% for horizontal gastroplasty ($p < .001$). There were no demonstrable differences in adverse events across groups. A second, smaller RCT by Sugerman et al (1987) randomized 40 patients to a VBG or a gastric bypass procedure.⁸⁵ After 9 months, the gastric bypass patients had significantly greater weight loss that was maintained at 3-year follow-up. The gastric bypass patients lost approximately 64% of excess weight, whereas the gastroplasty patients lost 37% of excess weight.

Case Series

Relatively high rates of complications, revisions, and reoperations led to the abandonment of VBG as a bariatric surgery procedure in the United States. An example of these results is a large case series with long-term follow-up by MacLean et al (1990), who reported on 201 patients undergoing VBG followed for a minimum of 2 years.⁸⁶ Staple line perforation occurred in 48% of patients, and 36% underwent reoperation either to repair the perforation or to repair a stenosis at the rate-limiting orifice. However, the more than 50% of patients who maintained an intact staple line had a durable weight loss of 75% to 100% of excess weight.

Section Summary: Vertical-Banded Gastroplasty for Adults with Class III Obesity

A TEC Assessment identified 8 nonrandomized comparative studies evaluating VBG with gastric bypass. The Assessment found that weight loss was significantly greater with open gastric bypass than with VBG. Also, VBG has relatively high rates of complications, revisions, and reoperations.

Two-Stage Bariatric Surgery Procedures for Adults with Class III Obesity**Clinical Context and Therapy Purpose**

The purpose of 2-stage bariatric surgery procedures is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is 2-stage bariatric surgery. Bariatric surgeries performed in 2 stages have been proposed as a treatment option, particularly for patients with "super-obesity" defined as a BMI greater than 50 kg/m². The rationale for a 2-stage procedure is that the risk of an extensive surgery is prohibitive in patients who are extremely obese. Therefore, a procedure with low-risk (usually an SG) is performed first. After the patient loses some weight, thus lowering the surgical risk, a second more extensive procedure (e.g., BPD) is performed.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating 2-stage bariatric surgery as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1 to 5 years of follow-up is considered necessary to demonstrate efficacy.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Randomized Controlled Trial

Coffin et al (2017) published results on the use of intragastric balloon (IGB) prior to a laparoscopic gastric bypass in patients with super-obesity.⁸⁷ Patients with a BMI greater than 45 kg/m² were randomized to an IGB (n=55) or standard medical care (n=60) during the 6 months prior to a planned laparoscopic gastric bypass procedure. Five patients had the IGB removed earlier than 6 months due to complications (n=3) or patient request (n=2). Patients receiving IGBs during the first 6 months of the study experienced significantly more BMI reduction (2.8 kg/m²; range 1.7 to 6.2) than patients receiving standard care (0.4 kg/m²; range 0.3 to 2.2). Weight loss during months 6 through 12, after the laparoscopic gastric bypass procedure, was greater in the patients who received standard of care before the procedure. Duration of hospitalization after laparoscopic gastric bypass and quality of life did not differ between groups.

Case Series

Most of the evidence on 2-stage procedures consists of case series of patients undergoing SG as the initial procedure. Many do not report on the second-stage surgery. A minority of patients undergoing first-stage surgery proceed to second-stage surgery. Cottam et al (2006) reported on 126 patients with a mean BMI of 65 kg/m² who underwent LSG as the first phase of a planned 2-stage procedure.⁸⁸ The incidence of major perioperative complications for LSG was 13%. After 1 year, mean EWL was 46%. Thirty-six (29%) patients proceeded to the second-stage procedure, which was laparoscopic gastric bypass. The incidence of major complications following the second procedure was 8%.

In a similar study, Alexandrou et al (2012) reported on 41 patients who underwent SG as the first-stage of a planned 2-stage procedure.⁸⁹ After 1-year of follow-up, 12 (29%) patients achieved a BMI of less than 35 kg/m² and were ineligible for the second-stage procedure. Of the remaining 28 patients, 10 (24%) underwent the second-stage procedure. The remaining 18 (44%) patients were eligible for but had not undergone, the second-stage procedure at the last follow-up.

Patients who undergo 2-stage procedures are at risk for complications from both procedures. Silecchia et al (2009) described the complication rates in 87 patients who underwent a stage 1 SG followed by BPD in 27 patients.⁹⁰ For the first stage, 16.5% of patients had complications of bleeding, fistula, pulmonary embolism, acute renal failure, and abdominal abscess. For the 27 patients who underwent the second-stage BPD, 29.6% had major complications, including bleeding, duodeno-ileal stenosis, and rhabdomyolysis.

Section Summary: Two-Stage Bariatric Surgery Procedures for Adults with Class III Obesity

The evidence from an RCT and several case series does not support a 2-stage bariatric surgery procedure for improving outcomes in patients with extreme levels of obesity. There is no evidence to suggest that weight loss is improved or that complications are reduced by this approach. Most patients who receive SG as the initial procedure lose sufficient weight during the first year so that a second procedure is no longer indicated. Also, patients undergoing a 2-stage procedure are at risk for complications from both procedures; therefore, it is likely that overall complications are increased by this approach.

Laparoscopic Gastric Plication for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of laparoscopic gastric plication is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is laparoscopic gastric plication. Laparoscopic gastric plication is a bariatric procedure that involves laparoscopic placement of sutures over the greater curvature (laparoscopic greater curvature plication) or anterior gastric region (laparoscopic anterior curvature plication) to create a tube-like stomach. To achieve gastric restriction the procedure requires 2 main steps, mobilization of the greater curvature of the stomach and suture plication of the stomach.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating laparoscopic gastric plication as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 12 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Li et al (2021) reported on a systematic review of 18 studies (N=1329) comparing outcomes after laparoscopic SG versus laparoscopic greater curvature gastric plication.⁹¹ Results demonstrated that SG is superior to greater curvature gastric plication with regard to providing effective weight loss through 24 months; statistical significance was not reached at 36 months. The difference in the improvement of comorbidities such as T2D, hypertension, and OSA did not reach statistical significance between groups, nor did the risks of major complications or mortality.

Ji et al (2014) reported on a systematic review of 14 studies reporting outcomes after laparoscopic gastric plication.⁹² Reviewers included a nonrandomized matched cohort analysis, 10 uncontrolled case series, and 3 case reports. The nonrandomized cohort study was small (N=19). Only 3 studies identified included more than 100 patients. Mean preoperative BMI ranged from 31.2 to 44.5 kg/m². Mean percent EWL after the procedure was reported in 9 studies (n=1407 patients), and ranged from 31.8% to 74.4% at follow-up times ranging from 6 to 24 months. One study reported weight loss in terms of percent decrease in BMI, with a reported decrease at 6 and 12 months of 66.4% and 60.2%,

respectively. One study compared anterior plication with greater curvature plication and reported increased weight loss with greater curvature plication (percent EWL, 53.7% vs. 23.3%, respectively). Reporting of complications was heterogeneous across studies, but no deaths were reported, and the rate of major postoperative complications requiring reoperation ranged from 0% to 15.4% (average, 3.7%), most commonly due to gastric obstruction or gastric perforation. Surgical techniques were not standardized.

In a systematic review, Abdelbaki et al (2012) summarized outcomes from 7 studies of laparoscopic gastric plication, 2 of which enrolled more than 100 patients (N=307 patients).⁹³ All studies reported some incidence of nausea and vomiting, most of which were mild. Twenty (6.5%) patients were readmitted, of whom 14 (4.6%) patients required reoperation, most commonly for gastric obstruction (8/14 [57%]). Table 8 provides a comparison of the studies included in these systematic reviews. Tables 9 and 10 discuss characteristics and results, respectively.

Table 8. Comparison of Trials/Studies Included in SR & M-A

Study	Li et al (2021)	Ji et al (2014)	Abdelbaki et al (2021)
Abdelbaki et al (2014)	●		
Abdelnazer et al (2016)	●		
Abouzeid et al (2015)	●		
Atlas et al (2013)		●	
Brethauer et al (2011)		●	●
Buzga et al (2017)	●		
Casajoana et al (2017)	●		
Chouillard et al (2015)	●		
Fried et al (2012)		●	
Grubnik et al (2015)	●		
Hi et al (2012)		●	
Li et al (2018)	●		
Lopeznava et al (2020)	●		
Morshed et al (2011)	●		
Miu et al (2013)		●	
Nabil et al (2018)	●		
Neagoe et al (2019)	●		
Niazi et al (2013)		●	
Park et al (2017)	●		
Pujol Gebelli et al (2011)		●	●
Ramos et al (2010)		●	●
Sharma et al (2014)	●		
Skrekas et al (2011)		●	●
Shen et al (2013)	●	●	
Taha et al (2012)		●	
Talebpour et al (2007)			●
Talebpour et al (2017)	●	●	
Toprak et al (2015)	●		
Tsang et al (2012)		●	●
Verdi et al (2015)	●		
Watkins et al (2012)		●	●

M-A: meta-analysis; SR: systematic review.

Table 9. Systematic Review Characteristics for Laparoscopic Gastric Plication

Study	Dates	Studies	Participants	Design	Duration
Li et al (2021) ⁹¹	Dec 2020	18	1329	6 retrospective cohort; 7 prospective cohort; 5 RCTs	1 mo to 3 y
Ji et al (2014) ⁹²	Jun 2013	14	1450	1 matched cohort; 10 case series; 3 case reports	6 mo to 10 y
Abdelbaki et al (2012) ⁹³	NR	7	307	5 case series; 2 case reports	3 y

NR: not reported; RCT: randomized controlled trial.

Table 10. Systematic Review Results for Laparoscopic Gastric Plication

Study	% Excessive Weight Loss	Complications	Conclusions
Li et al (2021) ⁹¹	MD (95% CI) between SG and gastric plication: 6 mo: 5.37 (1.59 to 9.16) 12 mo: 13.23 (9.93 to 16.54) 24 mo: 19.62 (1.15 to 38.08) 36 mo: 24.63 (-1.94 to 51.21)	OR (95% CI) between SG and gastric plication: Bleeding: 1.37 (0.61 to 3.09) Stenosis: 0.57 (0.23 to 1.38) Leak: 1.58 (0.61 to 4.15) Mortality: 1.39 (0.09 to 22.55)	SG is superior to gastric plication with regard to providing effective weight loss in the short- and mid-term. The procedures are similar in terms of major complications.
Ji et al (2014) ⁹²	31.8 to 74.4	Rate % (range) 3.7 (0 to 15.4)	Favorable short-term efficacy and safety profile; long-term follow-up and prospective trials needed.
Abdelbaki et al (2012) ⁹³	6 mo: 51 to 54 12 mo: 53 to 67	8 (7 to 15.3)	Prospective randomized trials vs. gastric plication with established bariatric procedures needed.

CI: confidence interval; MD: mean difference; OR: odds ratio; SG: sleeve gastrectomy.

Randomized Controlled Trials

In addition to the studies included in the above-summarized systematic reviews, Sullivan et al (2017) published results from the randomized, subject and evaluator-blinded, parallel-group, multicenter clinical trial using an endoscopic suturing device (G-CATH EZ™ suture anchor delivery catheter) for primary weight loss (ESSENTIAL), a randomized sham-controlled trial evaluating the efficacy and safety of endoscopic gastric plication (Table 11).⁹⁴ Patients (N=332) were randomized 2:1 to the active or sham procedure. All patients were provided low-intensity lifestyle therapy (LT). The primary endpoint was total body weight loss (TBWL) at 12-month follow-up. The MD in TBWL for patients receiving the procedure compared with patients receiving the sham procedure was 3.6% (95% CI, 2.1 to 5.1). Significant differences between the active and sham groups were also reported in a change in weight from baseline, percent excess weight loss, BMI, and improvement in diabetes (Table 12). No significant differences were detected in improvements in hyperlipidemia or hypertension between the treatment groups.

Table 11. RCT Characteristics for Laparoscopic Gastric Plication

Interventions	Countries	Sites	Dates	Participants	Interventions	
					Active	Comparator
Sullivan et al (2017) ⁹⁴	U.S.	11	2013-2014	Patients 22 to 60 y, BMI \geq 30 kg/m ² , and \geq 1 obesity-related comorbidity, or BMI \geq 35 kg/m ² , and with or without obesity-related comorbidity Race (active, sham): White: 71%, 64.8% Indian: 0%, 0.9% Black: 28.1%, 31.5% Mixed: 0.9%, 2.8% Ethnicity (active, sham) Not Hispanic/Latino: 93.7%, 92.8% Hispanic/Latino: 6.3%, 7.2%	Endoscopic gastric plication (n=221)	Sham procedure (n=111)

BMI: body mass index; RCT: randomized controlled trial.

Table 12. RCT Results for Laparoscopic Gastric Plication

Study; Trial Name	BMI Reduction		Weight Loss ^a	
	Mean Change (SD) ^b	Difference (95% CI)	Mean (SD) ^b	Difference (95% CI)
Sullivan et al (2017); ⁹⁴ ESSENTIAL		1.2 (0.6 to 1.9)		3.6 (2.1 to 5.1)
Endoscopic gastric plication	1.7		4.9 (7.0)	
Sham	0.5		1.4 (5.6)	

BMI: body mass index; CI: confidence interval; ESSENTIAL: The randomized, subject and evaluator-blinded, parallel-group, multicenter clinical trial using an endoscopic suturing device (G-CATH EZ™ suture anchor delivery catheter) for primary weight loss; RCT: randomized controlled trial; SD: standard deviation.

^a For Sullivan et al (2017), percent total body weight loss at 12 months.

^b At 12-month follow-up.

Study relevance, design, and conduct limitations are summarized in Tables 13 and 14.

Table 13. Study Relevance Limitations

Study	Population ^a	Intervention ^b	Comparator ^c	Outcomes ^d	Duration of Follow-up ^e
Sullivan et al (2017); ⁹⁴ ESSENTIAL	4. Majority White, not Hispanic/Latino patients.	4. Low-intensity lifestyle therapy used with procedure.	2. Low-intensity lifestyle therapy used.		

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

^a Population key: 1. Intended use population unclear; 2. Study population is unclear; 3. Study population not representative of intended use; 4. Enrolled populations do not reflect relevant diversity; 5. Other.

^b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest (e.g., proposed as an adjunct but not tested as such); 5. Other.

^c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively; 5. Other.

^d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. Incomplete reporting of harms; 4. Not establish and validated measurements; 5. Clinically significant difference not prespecified; 6. Clinically significant difference not supported; 7. Other.

^e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms; 3. Other.

Table 14. Study Design and Conduct Limitations

Study	Allocation ^a	Blinding ^b	Selective Reporting ^c	Data Completeness ^d	Power ^e	Statistical ^f
Sullivan et al (2017); ⁹⁴ ESSENTIAL	5. Lead-in cohort of 34 subjects was not randomized but underwent the active treatment procedure for the purposes of investigator training.	1. Evaluator-blinded only.			4. Weight loss results were lower in both the active and sham control groups than estimated in the power analysis.	

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

^a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias; 5. Other.

^b Blinding key: 1. Participants or study staff not blinded; 2. Outcome assessors not blinded; 3. Outcome assessed by treating physician; 4. Other.

^c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication; 4. Other.

^d Data Completeness key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials); 7. Other.

^e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference; 4. Other.

^f Statistical key: 1. Analysis is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2.

Analysis is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated; 5. Other.

Observational Study

Pattanshetti et al (2013) published the results of a study that described the evolution of an LAGB plication procedure, a hybrid procedure involving both LAGB and greater curvature plication developed by the authors.⁹⁵ Eighty patients were included, with a baseline mean BMI of 38.05 kg/m². At 6, 12, 18, and 24 months postsurgery, mean percent EWL was 42.6%, 56.4%, 57.6%, and 65.8%, respectively. Five postoperative complications required reoperation.

Section Summary: Laparoscopic Gastric Plication for Adults with Class III Obesity

There is a shortage of comparative studies, especially RCTs, comparing the safety and efficacy of laparoscopic gastric plication with other bariatric surgery procedures. A 2021 systematic review demonstrated that SG is superior to greater curvature gastric plication with regard to providing effective weight loss through 24 months; statistical significance was not reached at 36 months. The difference in the improvement of comorbidities and risk of major complications or mortality did not reach statistical significance between groups. One RCT compared endoscopic gastric plication with a sham procedure, reporting 1-year follow-up results in favor of the intervention. Longer-term follow-up and additional comparative studies are needed.

Single Anastomosis Duodeno-ileal Bypass With Sleeve Gastrectomy for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is SADI-S.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating SADI-S as a treatment for class III obesity has varying lengths of follow-up, ranging from 3 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;

- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

No controlled trials of SADI-S were identified. Some case series have reported on weight loss and other clinical outcomes up to 5 years postsurgery.

Systematic Review

In 2018, Shoar et al published a systematic review of 12 studies, comprising 5 cohorts, 4 case series, and 3 case reports, that reviewed the efficacy and safety of SADI-S.⁹⁶ The studies included 581 patients who underwent SADI-S. These patients were between 18 and 71 years of age with a BMI between 33 to 71.5 kg/m². Of the total surgeries, 508 (87.4%) were primary and 73 (12.6%) were revisional. Follow-up was available between 6 and 60 months after the procedure. Results revealed the average percent EWL was 30% at 3 months, 55% at 6 months, 70% at 1 year, and 85% at 2 years. The comorbidity resolution rate was 74.1% for T2D, 96.3% for hypertension, 68.3% for dyslipidemia, 63.3% for OSA, and 87.5% for GERD. The most common complication was diarrhea (1.2%) and vitamin A, selenium, and iron deficiency were the most common nutritional deficiencies. There was also the possibility of protein malnutrition in up to 34% of patients when measured. The authors concluded that SADI-S was associated with a promising short-term weight loss outcome and comorbidity resolution rate; however, RCTs are warranted to compare this procedure to more commonly performed bariatric procedures.

Observational Studies

Torres et al (2017) published a retrospective chart review of patients from their center receiving bariatric procedures, evaluating outcomes at 3-year follow-up.⁹⁷ Outcomes were evaluated separately for patients with and without diabetes. For patients without diabetes, comparisons were made among patients who underwent RYGB (n=149) or SADI-S (n=106). For patients with diabetes, comparisons were made among patients who underwent RYGB (n=97), BPD-DS (n=77), or SADI-S (n=97). Among the patients without diabetes, significant differences favoring SADI-S over RYGB were found in: percent EWL; systolic blood pressure; total, high-density lipoprotein and low-density lipoprotein cholesterol; and insulin. Significant differences were not found in diastolic blood pressure or fasting glucose. Among the patients with T2D, remission rates using ADA criteria were: 55%, 70%, and 76% for patients receiving RYGB, BPD-DS, and SADI-S, respectively. Patients with diabetes who underwent BPD-DS or SADI-S achieved significantly lower total cholesterol and triglyceride levels compared with those undergoing RYGB after 3 years of follow-up.

Case Series

One larger series, by Sanchez-Pernaute et al (2015), reported on 97 patients with obesity and T2D who underwent SADI-S.⁹⁸ The authors reported that control of diabetes, defined as HbA1c levels less than 6.0%, was achieved by between 70% and 84% of patients at different time points. Remission rates were higher for patients on oral therapy than those on insulin and were higher in patients with a shorter duration of diabetes.

Section Summary: Single Anastomosis Duodeno-ileal Bypass With Sleeve Gastrectomy for Adults with Class III Obesity

A systematic review of 12 observational studies concluded that SADI-S was associated with promising weight loss and comorbidity resolution. No published controlled trials have evaluated SADI-S. A comparative chart review found that patients without diabetes experienced significantly better weight loss and lipid profiles with SADI-S than with RYGB and patients who had diabetes

experienced significantly higher rates of remission with SADI-S than with RYGB. Long-term safety and efficacy outcomes and comparative RCTs are still needed.

Duodenojejunal Sleeve for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of the duodenojejunal sleeve procedure is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is the duodenojejunal sleeve procedure.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating duodenojejunal sleeve as a treatment for class III obesity has varying lengths of follow-up, ranging from 3 to 6 months. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Review

The EndoBarrier (GI Dynamics) is a fluoropolymer sleeve that is reversibly fixated to the duodenal bulb and extends 80 cm into the small bowel, usually terminating in the proximal jejunum. A systematic review of the effect of EndoBarrier on weight loss and diabetes control outcomes was published in 2016.⁹⁹ It included 5 small RCTs (N=235 patients; range, 18 to 77 patients), with follow-up ranging from 12 to 24 weeks. Comparators were diet and/or other lifestyle modifications, and 2 studies had sham controls. All studies were judged to be at high-risk of bias using the Cochrane risk of bias tool. Combined results demonstrated that the EndoBarrier group had 12.6% greater EWL (95% CI, 9.0 to 16.2) than medical therapy. For diabetes control outcomes, trends toward greater

improvement in the EndoBarrier group were not statistically significant. MD in HbA1c level was -0.8% (95% CI, -1.8 to 0.3) and the RR of reducing or discontinuing diabetic medications was 3.28 (95% CI, 0.54 to 10.73).

Randomized Controlled Trial

The largest single trial was a multicenter RCT published in 2014; it included 77 patients with T2D and a BMI greater than 30 kg/m².¹⁰⁰ Patients were treated for 6 months with EndoBarrier or medical therapy. At 6 months, the EndoBarrier was removed, and patients were followed for an additional 6 months. Thirty-eight patients were randomized to the EndoBarrier group, and 31 (82%) of 38 completed 12 months of treatment. Thirty-nine patients were randomized to medical treatment, and 35 (90%) of 39 completed 12 months of treatment. At 6 months, the decrease in BMI was significantly greater in the EndoBarrier group than in the medical therapy group (3.3 kg/m² vs. 1.8 kg/m², $p < .05$), and at 12 months the difference in BMI was of marginal statistical significance (2.2 kg/m² vs. 1.3 kg/m², $p = .06$), respectively. HbA1c level was significantly lower in the EndoBarrier group at 6 months (7.0% vs. 7.9%, $p < .05$), but at 12 months the difference between groups did not differ significantly (7.3% vs. 8.0%, $p = .95$).

Observational Study

Obermayer et al (2021) evaluated outcomes after treatment with EndoBarrier in 10 patients with T2D and an average BMI of 43.3 kg/m².¹⁰¹ Results demonstrated that EndoBarrier reduced mean body weight from 121.2 ± 18.5 kg to 116.3 ± 18.2 kg ($p = .006$) 4 weeks after the start of therapy, and to 115.1 ± 21.4 kg ($p = .075$ vs. baseline) until explantation of the device after 36 weeks. There was an increase in weight to 117.2 ± 20.8 kg ($p = 0.117$ vs. baseline) 24 weeks after explanation.

Section Summary: Duodenojejunal Sleeve for Adults with Class III Obesity

A systematic review of evidence on a duodenojejunal sleeve included 5 RCTs and found significantly greater short-term weight loss (12 to 24 weeks) with duodenojejunal sleeves compared with medical therapy. There was no significant difference in symptom reduction associated with diabetes. However, all RCTs had small sample sizes and were judged by the systematic reviewers to be at high-risk of bias.

Intragastric Balloon Devices for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of IGB devices is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity. The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is IGB devices. IGB devices are placed in the stomach via endoscope or swallowing to act as space-occupying devices to induce satiety. As of 2017, 2 IGB devices have U.S. Food and Drug Administration (FDA) approval, each designed to stay in the stomach for no more than 6 months. Obalon is a swallowable 3-balloon system. The OBERA Intragastric Balloon System (previously marketed outside of the United States as BioEnterics) is a saline-inflated silicone single balloon system.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating IGB devices as a treatment for class III obesity has varying lengths of follow-up, ranging from 5 to 10 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Several systematic reviews of RCTs evaluating IGB devices for the treatment of obesity have been published; none was limited to FDA-approved devices.^{102,103,104,105,}

Kotinda et al (2020) published a systematic review and meta-analysis that evaluated the efficacy of IGB devices in comparison to sham or lifestyle interventions in overweight and obese adults.¹⁰⁵ Thirteen RCTs with 1523 patients were included. Results revealed that the mean percent EWL difference between the IGB and control groups was 17.98% (95% CI, 8.37 to 27.58; $p < .00001$), significantly favoring IGB. IGB was also significantly favored when evaluating the mean percent TWL difference between the groups: 4.40% (95% CI, 1.37 to 7.43; $p < .00001$). Similarly, the difference in actual weight loss and BMI loss was 6.12 kg and 2.13 kg/m², respectively. Overall, IGB was found to be more effective than lifestyle intervention alone for weight loss; however, the majority of included RCTs used 1 fluid-filled IGB and there was significant heterogeneity between the included studies. The systematic review by Tate et al (2017) focused on RCTs, published between 2006 and 2016.¹⁰⁶ Additional inclusion criteria were: sham, lifestyle modification, or pharmacologic agent as a comparator; at least 1 outcome of body weight change; and study duration of 3 or more months. Eight RCTs were included in the review, with 4 contributing to the meta-analysis. The meta-analysis included 777 patients and showed a significant improvement in percent TBWL with IGB compared with control (5.5%; 95% CI, 4.3 to 6.8). However, there was significant heterogeneity among the trials ($I^2=62%$), so interpretation of results is limited. The percent TBWL with IGB is lower than expected with RYGB (reported 27%) or with the most efficacious pharmacologic agent (reported 9%).

Saber et al (2017) identified 20 RCTs reporting weight loss outcomes after IGB implantation or a non-IGB control intervention.¹⁰² IGB was compared with sham in 15 trials, behavioral modification in 4 trials, and pharmacotherapy in 1 trial. In 17 trials, patients received LT in addition to other interventions. Studies were published between 1987 and 2015 and sample sizes varied from 21 to 326 participants. Outcomes were reported between 3 and 6 months. In a meta-analysis of 7 RCTs reporting BMI loss as an outcome, there was a significantly greater BMI loss in the IGB group than in the control group (mean effect size [ES], 1.59 kg/m²; 95% CI, -0.84 to 4.03; $p < .001$). Findings on other outcomes were similar. A meta-analysis of 4 studies reporting percent EWL favored the IGB group

(ES=14.25%; 95% CI, 2.09 to 26.4; p=.02). Also, a meta-analysis of 6 studies reporting absolute weight loss favored the IGB group (ES=4.6 kg; 95% CI, 1.6 to 7.6; p=.003).

Although the review was not limited to FDA approved devices, older devices were air-filled and newer devices, including the 2 approved by FDA in 2015, are fluid-filled. Sufficient data were available to conduct a sensitivity analysis of 3-month efficacy data. A meta-analysis of 4 studies did not find a significant difference in weight loss with air-filled IGB devices or a control intervention at 3 months (ES= 0.26; 95% CI, -0.12 to 0.64; p=.19). In contrast, a meta-analysis of 8 studies of fluid-filled devices found significantly better outcomes with the IGB than with control (ES=0.25; 95% CI, 0.05 to 0.45; p=.02).

Randomized Controlled Trials

Pivotal trials on FDA-approved devices have been published.

Courcoulas et al (2017) published a multicenter, pivotal RCT evaluating the Obera IGB in the United States (as noted, the device has been used in other countries).¹⁰⁷ A total of 317 patients were randomized and initiated 6 months of treatment with an IGB plus LT (n=137) or LT only (n=136). Patients were followed for an additional 6 months. Key eligibility criteria were age 18 to 65 years, baseline BMI between 30 and 40 kg/m², a history of obesity for at least 2 years, and having failed previous weight loss attempts. Nineteen patients in the IGB group and 121 in the control group completed the 6-month treatment period.

Coprimary effectiveness outcomes, assessed at 9 months, were mean percent EWL and difference in mean weight loss. Mean percent EWL at 9 months was 26.4% in the IGB group and 10.1% in the control group (difference, 16.2%; 95% CI, 12.3 to 20.2; p<.001). Mean weight loss at 9 months was -8.8 kg (-19.4 lb) in the IGB group and -3.2 kg (-7.1 lb) in the control group (p<.001). There were also significant between-group differences in mean weight loss and mean percent EWL at 6 and 12 months.

Most adverse events in the Obera pivotal trial were anticipated accommodative symptoms. A total of 139 (87%) patients reported nausea, 121 (76%) reported vomiting, and 92 (58%) reported abdominal pain. Fewer than 5% of these adverse events were serious; most were mild or moderate. Thirty patients in the device group had the IGB removed before month 6 because of an adverse event (n=15) or patient request (n=15). There were no deaths and 9 serious adverse events unrelated to device accommodation; among others, these included a case of gastric outlet obstruction and a case of gastric perforation with sepsis.

The Courcoulas et al (2017) pivotal trial was not blinded or sham-controlled; however, a double-blind sham-controlled randomized trial evaluating the BioEnterics IGB (now called the Obera device) was published by Genco et al (2006).¹⁰⁸ This crossover trial included 32 obese patients ages 25 to 50 years with a mean BMI of 47.3 kg/m². Patients received, in random order, 3 months of an IGB and 3 months of sham. (Both groups underwent upper gastrointestinal endoscopy, but no device was placed in the sham group.) Patients who initially received the IGB had a mean BMI reduction of 5.8 kg/m² after 3 months; after crossover to sham, these patients had a mean additional BMI reduction of 1.1 kg/m². Patients initially in the sham group had an initial mean BMI reduction of 0.4 kg/m²; after crossover to an active device, these patients had a mean BMI reduction of 5.1 kg/m². The between-group difference in BMI reductions was statistically significant (p<.001). Findings on other outcomes (mean percent EWL, mean weight loss) were similar.

Case Series

A case series of patients treated with an IGB with up to 60-month follow-up was published by Kotzampassi et al (2012).¹⁰⁹ A total of 500 patients were treated with the BioEnterics IGB. Twenty-six patients did not complete the initial 6 months of treatment, and another 77 patients did not comply with dietary restrictions and did not have satisfactory weight loss at 6 months. Among 352 patients

with data available, BMI was 44.5 kg/m² at baseline, 35.7 kg/m² at device removal, 38.8 kg/m² 12 months after device removal, and 40.1 kg/m² 24 months after device removal. Mean percent EWL was 43.9% at device removal, 27.7% 12 months after device removal, and 17% 24 months after device removal. Among the 195 patients with available 5-year data, mean baseline BMI was 43.3 kg/m², mean BMI at device removal was 33.8 kg/m², and mean BMI at 5 years was 40.1 kg/m². Mean percent EWL at 5 years was 13.0%. Overall, patients who initially complied with 6 months of IGB device use and lost weight slowly gained weight over time but weighed less at final follow-up than at baseline.

Section Summary: Intra-gastric Balloon Devices for Adults with Class III Obesity

Evidence includes RCTs, a case series with long-term follow-up on 1 of the devices, and systematic reviews on various IGB devices. RCTs have found significantly better weight loss outcomes with IGB devices compared with sham treatment or LT alone. One RCT followed patients for an additional 6 months after IGB removal and found sustained weight loss. A large case series with follow-up up to 5 years has suggested that patients regain weight over time. Additional long-term follow-up data are needed. There are some adverse events, and in a minority of cases, these adverse events can be severe. The FDA wrote 2 letters in 2017 to health care providers, 1 warning of spontaneous balloon inflation and pancreatitis and the other reporting 5 unanticipated deaths occurring in 2016 to 2017 following the IGB procedure. In June 2018, the FDA reported that, since 2016, a total of 12 deaths occurred in patients with liquid-filled intra-gastric balloons worldwide; 7 of these deaths were in patients in the U.S. Health care providers are encouraged to monitor patients receiving IGBs.

Aspiration Therapy Device for Adults with Class III Obesity

Clinical Context and Therapy Purpose

The purpose of the aspiration therapy (AT) device is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity.

Interventions

The therapy being considered is the AT device.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating AT device as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 2 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1 to 2 years of follow-up is considered necessary to demonstrate efficacy.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.

- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Randomized Controlled Trials

AT involves an FDA-approved device (AspireAssist) that allows patients to drain a portion of the stomach contents after meals via an implanted tube connected to an external skin port. One RCT has been published. The Pivotal Aspiration Therapy with Adjusted Lifestyle (PATHWAY) trial, by Thompson et al (2017), randomized 207 participants to 52 weeks of AspireAssist therapy plus lifestyle counseling (n=127) or lifestyle counseling alone (n=70).¹¹⁰ Participants were between 21 and 65 years of age, with a BMI ranging from 35 to 55 kg/m². Coprimary outcomes were mean EWL at 52 weeks and the proportion of patients with 25% or more EWL at 52 weeks. Investigators did a modified intention-to-treat analysis including all patients in the AspireAssist group who attempted tube placement (n=111) and all patients in the lifestyle counseling group who attended at least 1 therapy session (n=60). Mean EWL at 52 weeks was 31.5% in the AspireAssist group and 9.8% in the lifestyle counseling group. The difference between groups was 21.7% (95% CI, 15.3 to 28.1), which was greater than the 10% difference needed to meet the a priori definition of success. The proportion of patients with 25% or more EWL at 52 weeks was 58.6% in the AspireAssist group and 22% in the lifestyle counseling group (p<.001). Bulimia or binge eating disorder were exclusion criteria and, during the study, there was no evidence that patients developed bulimia or that devices were overused (i.e., used >3 times a day). Most of the adverse events (83.8%) in the AspireAssist group were associated with placement of a percutaneous endoscopic gastric tube. All 5 serious adverse events occurred in the AspireAssist group (mild peritonitis, severe abdominal pain and a case of product malfunction). Product malfunction was related to malfunction of the A-tube, typically occurring within the first week of implantation and seen in 90% of adverse events seen with the AspireAssist. The durability of a treatment effect beyond 1 year was not reported.

Thompson et al (2019) published 4-year outcomes from the PATHWAY trial.¹¹¹ AT patients were permitted to continue the study beyond 1 year up to a maximum of 5 years provided they maintained at least 10% TWL from baseline at each year end. Out of 82 AT patients who completed year 1, 58 continued in the next phase, 43 completed year 2, 22 completed year 3, and 15 completed year 4 in the trial. Of 58 AT participants continuing in the study, 43 withdrew before completion of year 4, with 25/43 meeting their weight loss goal or losing >10% of their baseline weight. Forty of 58 patients (69%) achieved at least 10% TWL at 4 years or at time of study withdrawal. Out of 60 patients treated in the LT control group, only 31 completed the full initial study year. Two serious adverse events were reported in years 2 to 4. One patient developed a secondary fistula superior to the A-tube fistula, which resolved following A-tube removal. The second patient experienced an A-tube malfunction, which was replaced. A total of 57 adverse events, including the 2 serious adverse events, were recorded. The adverse events with the greatest frequency were peristomal irritation (12 events), persistent fistulas (12 events), and peristomal granulation tissue (8 events). A total of 27 A-tubes required replacement over the 4 years of the study. Reasons for replacement include tube defects (~50%) and tube leaks (~30%). According to the study survival analysis, one can expect 50% of A-tubes to be replaced within approximately 3.5 years postgastrostomy. No clinically significant metabolic disorders were observed. No evidence for the development of any eating disorders was noted. Study results are summarized in Table 15. Study relevance, design, and conduct limitations are summarized in Tables 16 and 17.

Table 15. Results of PATHWAY Trial

		>25% EWL ¹	% TWL	ΔHbA1c ²	IWquality of life Total Score ^{2,3}
Thompson et al (2017); PATHWAY¹¹⁰.	Year 1, n	% [95% CI]	% (SD) [95% CI]	% (SD)	Mean (SD)
AT	mITT: 111 PP: 82	mITT: 56.8 [49.0 to 64.5] PP: 68.3 [NR]	mITT: 12.1 (9.6) [NR] PP: 14.2 (9.8) [12.1 to 16.4]	mITT: -0.36 (0.45) PP: NR	mITT: 6.2 (13.4) PP: NR
LT	mITT: 60 PP: 31	mITT: 22.0 [15.3 to 28.1] PP: 25.8 [NR]	mITT: 3.6 (6.0) [NR] PP: 4.9 (7.0) [NR]	mITT: -0.22 (0.27) PP: NR	mITT: 3.3 (10.0) PP: NR
Mean Difference [95% CI]		NR	8.6 [6.2 to 10.9] ²	-1.4 [-0.28 to 0.0] ²	2.9 (SD: 12.5) ²
P-Value		mITT: <.001 PP: <.001	NR	P=.05 ²	P=.03 ⁴
Thompson et al (2019); PATHWAY¹¹¹.	AT ⁵	>25% EWL ¹ % (SD)		% TWL % (SD) [95% CI]	
Year 1	82	68.3 (NR)		14.2 (9.8) [12.1 to 16.4]	
Year 2	43	72.1 (NR)		15.3 (8.8) [12.6 to 18.0]	
Year 3	22	63.6 (NR)		16.6 (10.5) [12.0 to 21.3]	
Year 4	15	73.3 (NR)		18.7 (11.7) [12.2 to 25.2]	

AT: aspiration therapy; CI: confidence interval; EWL: excess weight loss; HbA1c: hemoglobin A1c; IWquality of life: Impact of Weight of Quality of Life survey; LT: lifestyle therapy; mITT: modified intent-to-treat; NR: not reported; PATHWAY: Pivotal Aspiration Therapy with Adjusted Lifestyle; PP: per protocol; SD: standard deviation; TWL: total weight loss.

¹ Primary outcome measure.

² Based on the modified intent-to-treat analysis.

³ Improvement in quality-of-life measures is reflected by increasing IWquality of life scores.

⁴ Treatment differences in individual IWquality of life component scores did not reach statistical significance.

⁵ Based on the per-protocol analysis.

Table 16. Study Relevance

Study; Trial	Population ^a	Intervention ^b	Comparator ^c	Outcomes ^d	Follow-Up ^e
Thompson et al (2017; 2019); PATHWAY^{110,111}.	4. The majority of enrolled patients were white, non-Hispanic.		2: No active comparator for years 2 to 4.		

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

PATHWAY: Pivotal Aspiration Therapy with Adjusted Lifestyle.

^a Population key: 1. Intended use population unclear; 2. Study population is unclear; 3. Study population not representative of intended use; 4. Enrolled populations do not reflect relevant diversity; 5. Other.

^b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.

^c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.

^d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.

^e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 17. Study Design and Conduct Limitations

Study	Allocation ^a	Blinding ^b	Selective Reporting ^c	Data Completeness ^d	Power ^e	Statistical ^f
Thompson et al (2019); PATHWAY^{110,111}.		2: Blinding to outcome assessment unclear.		1: High loss to follow-up or missing data. High loss to pre- and post-enrollment	1: Study not powered beyond 1 y of follow-up.	2: Not all sensitivity analyses are statistically

Study	Allocation ^a	Blinding ^b	Selective Reporting ^c	Data Completeness ^d	Power ^e	Statistical ^f
		3: Blinding and identity of outcome assessors unclear.		withdrawals. 2: Multiple strategies utilized for handling of missing data. 5: Inappropriate exclusion of patients with TWL <10% during years 2-4 from analysis. 6: Modified intent to treat analysis not carried through.	Study underpowered for completers at 1 y. 3: Rationale for clinically important difference not provided.	significant for primary effectiveness outcome (at least 50% of participants achieving at least 25% EWL); unclear if analysis is appropriate for multiple observations per patient or extent of missing data.

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

EWL: excess weight loss; PATHWAY: Pivotal Aspiration Therapy with Adjusted Lifestyle; TWL: total weight loss.

^a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.

^b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.

^c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.

^d Data Completeness key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. No intent to treat analysis (per protocol for noninferiority trials).

^e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.

^f Statistical key: 1. Analysis is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Analysis is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Case Series

In addition to the RCT, a case series by Noren and Forssell (2016) evaluated AspireAssist use by 25 obese patients.¹¹² Patients had 1 year of AT and also participated in a cognitive-behavioral therapy weight loss program for the initial 3 months. Patients were instructed to aspirate 3 times a day after meals. Twenty (80%) patients completed the 1-year intervention period. Mean baseline weight was 107.4 kg. In a per-protocol analysis, the mean EWL was 54.5% at 12 months. Data on 15 (60%) patients were available at 24 months; mean EWL was 61.5%.

Section Summary: Aspiration Therapy Device for Adults with Class III Obesity

The evidence consists of an RCT with 4 years of follow-up and a small case series with up to 2 years of follow-up. The RCT found significantly greater weight loss (measured several ways) with AT compared with LT at 1 year. Forty of 58 patients (69%) achieved at least 10% TWL at 4 years or at time of study withdrawal; however, only 15/111 initial AT patients completed the study through 4 years. In addition to a high degree of missing data, the PATHWAY study noted a potentially high degree of adverse events related to A-tube malfunction, an element of the therapy which is expected to require replacement within approximately 3.5 years postgastrostomy in 50% of cases. The impact of this on health outcomes compared to existing surgical approaches is unknown. The case series followed only 15 patients more than 1 year; at 2 years, study completers had not regained weight and instead had lost additional excess weight. The total amount of data on AT remains limited and additional studies need to be conducted before conclusions can be drawn about the long-term effects of treatment on weight loss, metabolism, safety, and nutrition.

Revision Bariatric Surgery for Adults with Class III Obesity Who Failed Bariatric Surgery Clinical Context and Therapy Purpose

The purpose of revision bariatric surgery is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in adults with class III obesity and who failed bariatric surgery.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adults with class III obesity and failed bariatric surgery.

Interventions

The therapy being considered is revision bariatric surgery.

Comparators

Comparators of interest include standard medical care. Treatment for adults with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating revision bariatric surgery as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 3 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up of 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Matar et al (2021) published a systematic review of 556 patients (n=17 studies) who underwent RYGB for SG-related complications, including GERD (30.4% cases) and insufficient weight loss and weight regain (52% of cases).¹¹³ The mean BMI at the time of conversion ranged from 33.3 to 48.3 kg/m². The pooled baseline BMI at conversion was 38.5 kg/m² (95% CI, 36.49 to 40.6), at 6 months was down to 28.6 kg/m² (95% CI, 16.1 to 41.0), and after 1 year was up to 32.1 kg/m² (95% CI, 25.50 to 38.7). The pooled mean %TWL after completion of treatment was 25.2% (95% CI, 12.8 to 37.5) at 6 months and 22.8% (95% CI, 13.5 to 32.1) at 1 year. There was a 16.4% complication rate at 30 days, which decreased to 11.4% after 30 days. At 1-year post RYGB, the rate of resolution for common comorbidities was as follows: GERD, 79.7% (95% CI, 59.6 to 91.3); T2D, 57.7% (95% CI, 36.9 to 76.1); and hypertension, 49.4% (95% CI, 25.8 to 73.3).

Parmar et al (2020) published a systematic review of 1075 patients (n=17 studies) who underwent 1 anastomosis/mini gastric bypass (OAGB-MGB) as a revisional bariatric procedure after failure of a primary LAGB and SG.¹¹⁴ No RCTs were available on this topic and no meta-analyses were performed as part of this systematic review. The most commonly reported reason for revisional surgery was poor response (81%) followed by gastric band failure (35.9%), GERD (13.9%), intolerance (12.8%), staple line disruption (16.5%), pouch dilatation (17.9%), and stomal stenosis (10.3%). Results revealed that after the revisional OAGB-MGB, the mean percent EWL was 50.8% at 6 months, 65.2% at 1 year, 68.5% at 2 years, and 71.6% at 5 years. Resolution of comorbidities after OAGB-MGB was significant with 80.5% of patients with T2D, 63.7% of patients with hypertension, and 79.4% of patients with GERD reporting resolution. The overall readmission rate following OAGB-MGB was 4.73%, the mortality rate was 0.3%, and the leak rate was 1.54%. Although the authors concluded that OAGB-MGB is a safe and effective choice for revisional bariatric surgery, RCTs on this topic are needed as currently only retrospective cohort studies with heterogenous data are available.

Brethauer et al (2014) conducted a systematic review of reoperations after primary bariatric surgery for the American Society for Metabolic and Bariatric Surgery that included 175 studies, most of which were single-center retrospective reviews.¹¹⁵ The review is primarily descriptive, but made the following conclusions: "The current evidence regarding reoperative bariatric surgery includes a diverse group of patient populations and procedures. The majority of the studies are single institution case series reporting short- and medium-term outcomes after reoperative procedures. The reported outcomes after reoperative bariatric surgery are generally favorable and demonstrate that additional weight loss and co-morbidity reduction is achieved with additional therapy. The risks of reoperative bariatric surgery are higher than with primary bariatric surgery and the evidence highlights the need for careful patient selection and surgeon expertise."

Nonrandomized Studies

Petrucciani et al (2021) published a retrospective analysis of 215 patients who underwent revisional OAGB with a biliopancreatic limb of 150 cm after failing LAGB at a single center between 2010 and 2016.¹¹⁶ The indication for surgery was weight loss failure in 30.7% of cases and long-term complications in the remaining cases. The mean BMI at the time of OAGB was 42 kg/m². At 2 years after OAGB, 9.7% of patients were lost to follow-up, BMI was down to 28 ± 5.5 kg/m², %EWL was 88.2 ± 23.9, and %TWL was 38.7 ± 9.3. At 5 years after OAGB, 16.6% of patients were lost to follow-up, BMI was slightly up to 29.2 ± 5.8 kg/m², %EWL was 82.4 ± 25, and %TWL was 36.1 ± 10. Overall postoperative morbidity was 13.5% with a 5.9% rate of postoperative abscess with or without staple line leak. Treatment-resistant GERD occurred in 21.3% of patients; conversion to RYGB was required in 4.2% of cases.

Almalki et al (2018) published a retrospective analysis of patients diagnosed with failed restrictive procedure who underwent revision bariatric surgery.¹¹⁷ One hundred sixteen patients between 2001 and 2015 had revision RY gastric bypass (R-RYGB; n=35) or revision single anastomosis- (mini-) gastric bypass (R-SAGB; n=81); the primary indications for revisional procedures were weight regain (50.9%), inadequate weight loss (31%), and intolerance (18.1%). Major complications occurred in 12 (10%) patients without significant difference between groups (R-SAGB, n=9; R-RYGB, n=3). At 1 year after revision surgery, the R-SAGB group (76.8% EWL) showed better weight loss than R-RYGB (32.9% EWL; p=.001). In the 37.1% of patients available for follow-up at 5 years, R-SAGB had significantly lower hemoglobin levels than R-RYGB (8.2 ± 3.2 g/dl vs. 12.8 ± 0.5 g/dl; p=.03). The study was limited by its retrospective nature, relatively short follow-up time, and lack of consideration of data related to patient compliance.

Sudan et al (2015) reported on safety and efficacy outcomes for reoperative bariatric surgeries using data from a national registry, the Bariatric Outcomes Longitudinal Database.¹¹⁸ The Bariatric Outcomes Longitudinal Database was a large, multi-institutional bariatric surgery-specific database to which data were submitted from 2007 through 2012 by 1029 surgeons and 709 hospitals

participating in the Bariatric Surgery Centers of Excellence program. Surgeries were classified as primary or reoperative bariatric. Reoperations were further divided into corrective surgeries (when complications or incomplete treatment effect of a previous bariatric operation was addressed, but the initial operation was not changed) or conversions (when an index bariatric operation was changed to a different type of bariatric operation or a reversal restored original anatomy.) Of 449,473 bariatric operations in the database, 420,753 (93.6%) operations had no further reoperations (primary operations) while 28,270 (6.3%) underwent reoperations. Of the reoperations, 19,970 (69.5%) were corrective and 8,750 (30.5%) were conversions. The primary bariatric operations were RYGB (n=204,705 [49.1%]), LAGB (n=153,142 [36.5%]), SG (n=42,178 [10%]), and BPD-DS (n=4,260 [1%]), with the rest classified as miscellaneous. LAGB was the most common primary surgery among conversions (57.5% of conversions; most often [63.5%] to RYGB). Compared with primary operations, mean hospital length of stay was longer for corrections (2.04 days vs. 1.8 days, $p < .001$) and for conversions (2.86 days vs. 1.8 days, $p < .001$). Mean percent EWL at 1 year was 43.5% after primary operation, 39.3% after conversions, and 35.9% after corrective operations (statistical comparison not reported). One-year mortality was higher for conversions (0.31%) than for primary surgeries (0.17%; $p < .001$), with no statistically significant difference for corrections (0.24%) compared with primary surgeries (0.17%; $p = \text{not significant [NS]}$). One-year serious adverse event rates were higher for conversions (3.61%) than for primary operations (1.87%; $p < .001$), with no statistically significant difference for corrections (1.9%) compared with primary operations (1.87%; $p = \text{NS}$). The authors concluded that reoperation after primary bariatric surgery is relatively uncommon, but generally safe and efficacious when it occurs.

Endoscopic Revision Procedures

While bariatric surgery revision or correction can be conducted using standard surgical approaches, novel endoscopic procedures are being developed. Some procedures use devices also being evaluated for the endoscopic treatment of GERD (see Blue Shield of California Medical Policy: Transesophageal Endoscopic Therapies for Gastroesophageal Reflux Disease). The published data on the use of these devices for treatment of regained weight is limited. Published case series have reported results using a number of devices and procedures (including sclerosing injections) as a treatment for this condition. The largest series (2007) found involved 28 patients treated with a sclerosing agent (sodium morrhuate).¹¹⁹ Reported trials that used 1 of the suturing devices had fewer than 10 patients. For example, Herron et al (2008) reported on a feasibility study in animals.¹²⁰ Thompson et al (2006) reported on a pilot study with changes in anastomotic diameter and weight loss in 8 patients who regained weight and had dilated gastrojejunal anastomoses after RYGB.¹²¹ No comparative trials were identified; comparative trials are important because of the known association between an intervention and short-term weight loss.

The StomaphyX device, which has been used in this approach, was cleared by FDA through the 510(k) process. It was determined to be equivalent to the EndoCinch system, which has 510(k) marketing clearance for endoscopic suturing for gastrointestinal tract surgery. Eid et al (2014) reported on results from a single-center RCT that compared the StomaphyX device with a sham procedure for revisions in patients with prior weight loss after RYGB at least 2 years earlier.¹²² Enrollment was initially planned for 120 patients, but the trial was stopped prematurely after 1-year follow-up was completed by 45 patients in the StomaphyX group and 29 patients in the sham control group because preliminary analysis failed to achieve the primary efficacy endpoint in at least 50% of StomaphyX patients. The primary 12-month efficacy endpoint (reduction in pre-RYGB excess weight by $\geq 15\%$, excess BMI loss, and BMI $< 35 \text{ kg/m}^2$) was achieved by 10 (22.2%) of 45 in the StomaphyX group and 1 (3.4%) of 29 in the sham control group ($p < .01$).

A 2009 survey of American Society for Metabolic and Bariatric Surgery members (bariatric surgeons) indicated different risk tolerance and weight loss expectations for primary and revisional endoscopic procedures.⁶⁴ The surgeons were "willing to accept less weight loss and more risk for revisional endoluminal procedures than for primary endoluminal procedures." The durability of the procedures was a concern, and most surgeons were unwilling to consider the procedures until their efficacy has

been proven. A 2013 systematic review of studies reporting outcomes after endoluminal revision of primary bariatric surgery conducted by the American Society for Metabolic and Bariatric Surgery concluded: "The literature review shows the procedures on the whole to be well tolerated with limited efficacy. The majority of the literature is limited to small case series. Most of the reviewed devices are no longer commercially available."¹²³

Cohen et al (2019) conducted a systematic review evaluating the safety and efficacy of endoscopic gastroplasty for medically uncontrolled obesity.¹²⁴ Nine observational studies and a single RCT were identified by the authors. Follow-up duration in the majority of studies was limited to 6 to 12 months with several studies reporting high rates of loss to follow-up. Percent total body weight loss ranged from -15.1% to 19.5%. Reduction in BMI ranged from -1.69 to -7.5 kg/m². Serious adverse events ranged from 2% to 10%. The quality of the current evidence was graded very low to moderate, with limited long-term data on weight loss durability and procedure safety.

Section Summary: Revision Bariatric Surgery for Adults with Class III Obesity Who Failed Bariatric Surgery

For surgical revision of bariatric surgery after failed treatment, evidence from systematic reviews and nonrandomized studies suggests that revisions are associated with improvements in weight similar to those seen in primary surgery. However, the published scientific literature on the use of endoscopic devices and procedures in patients who regain weight after bariatric surgery is very limited.

Bariatric Surgery as a Treatment for Type 2 Diabetes for Adults with Diabetes Who Do Not Have Class III Obesity

Clinical Context and Therapy Purpose

The purpose of gastric bypass, SG, BPD, and adjustable gastric banding is to provide treatment options that are alternatives to or improvements on existing therapies, such as standard medical care, in patients who are diabetic and do not have class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are diabetic and do not have class III obesity.

Interventions

The therapy being considered is gastric bypass, SG, BPD, and adjustable gastric banding. Current indications for bariatric surgery view poorly or uncontrolled diabetes as a comorbidity whose presence supports the need for surgery in patients with a BMI of less than 35 kg/m².

Comparators

Comparators of interest include standard medical care. Treatment for patients who are diabetic includes blood sugar regulation and insulin therapy.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating gastric bypass, SG, BPD, and adjustable gastric banding as a treatment for diabetes has varying lengths of follow-up, ranging from 1 to 5 years.

While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

This section focuses on RCTs and systematic reviews of RCTs comparing bariatric surgery with medical therapy.

Review of Evidence

Type 2 Diabetes and Body Mass Index Less Than 35 kg/m²

Systematic Reviews

Wu et al (2016) published a meta-analysis of studies comparing bariatric surgery with nonsurgical interventions for patients who had T2D.¹²⁵ Eight RCTs with 619 patients were included. RCTs addressed RYGB (6 studies), LAGB (3 studies), LSG (1 study), and BPD (1 study). Mean BMI across studies was 29 kg/m² or higher; in 6 of 8 studies, mean BMI was 35 kg/m² or higher. One study had a 5-year follow-up, and the others had 1 to 3 years of follow-up. The study with a 5-year follow-up, by Mingrone et al (2015), was limited to patients with a BMI of at least 35 kg/m².¹²⁶ All 8 studies reported remission of T2D as an efficacy endpoint. A pooled analysis found a significantly higher rate of T2D remission in the bariatric surgery versus the nonsurgical treatment group (RR, 5.76; 95% CI, 3.15 to 10.55; p<.001). Another diabetes-related outcome (mean reduction in HbA1c levels) was significantly greater after bariatric surgery than nonsurgical treatment (MD, -1.29; 95% CI, -1.70 to -0.87). Also, there was a significantly greater reduction in BMI with bariatric surgery than with nonsurgical treatment (MD, -5.80; 95% CI, -6.95 to -4.64; p<.001).

Since the publication of the Wu et al (2016) meta-analysis, 5-year follow-up has been reported for the Schauer et al (2017) RCT, which is shown in Table 18. When the Wu et al (2016) meta-analysis was published, only 3-year findings of the Schauer et al (2017) study were available. The study included patients with T2D who had a BMI of 27 to 43 kg/m². The RCTs evaluating bariatric surgery in patients with T2D, including the 5-year follow-up of the Schauer et al (2017) study, are summarized in Table 18. Muller-Stich et al (2015) published a systematic review of RCTs and observational studies on bariatric surgery in patients with T2D and a BMI less than 35 kg/m².¹²⁷ Eleven comparative trials of medical therapy versus bariatric surgery were included, with 5 RCTs and 6 nonrandomized comparative studies identified. Follow-up was between 1 and 3 years. The primary outcome reported was remission of diabetes. On combined analysis, bariatric surgery was associated with a higher remission rate than medical therapy (OR, 14.1; 95% CI, 6.7 to 29.9; p<.001). On secondary outcomes, surgery was associated with a greater decrease in BMI (MD, -5.5 kg/m²; 95% CI, -6.7 to -4.3; p<.001), a lower HbA1c level (MD, -1.4%; 95% CI, -1.9 to -0.9; p<.001), lower rates of hypertension (OR, 0.25; 95% CI, 0.12 to 0.50; p<.001), and lower rates of dyslipidemia (OR, 0.21; 95% CI, 0.10 to 0.44; p<.001). Also, Rao et al (2015) published a meta-analysis of short-term outcomes for patients with T2D and a BMI of 35 kg/m² or less who underwent RYGB.¹²⁸ Nine articles were included (N=343 patients). After 12 months, patients with T2D had a significant decrease in BMI (weighted MD, -7.42; 95% CI, -8.87 to -5.97; p<.001) and improvements in HbA1c levels (weighted MD, -2.76; 95% CI, -3.41 to -2.11; p<.000). Reviewers reported that longer term follow-up would be needed.

Previously, a 2012 TEC Assessment evaluated bariatric surgery in diabetic patients with a BMI less than 35 kg/m².¹²⁹ The evidence consisted mainly of case series. The Assessment identified only observational studies. Based on the data, the Assessment concluded that gastric bypass met TEC criteria as a treatment for diabetes in patients with a BMI less than 35 kg/m² but that other procedures did not meet the TEC criteria for this indication:

- There were no randomized trials comparing bariatric surgery with medical treatment for diabetic subjects with a BMI less than 35 kg/m². There was only 1 randomized trial comparing 2 bariatric procedures. Therefore, studies were categorized by procedure type and presented as case series, regardless of the underlying study type.
- Nine studies reported diabetes remission rates and other outcomes in subjects undergoing gastric bypass. Diabetes remission rates varied between 48% and 100% at follow-up times of 1 year and beyond. One study was a randomized trial of gastric bypass versus SG; in it, diabetes remission associated with gastric bypass was 93% versus 47% for SG at 1 year.
- Two studies reported outcomes of SG. Diabetes remission rates were 55% and 47% at 1 year.
- One study reported outcomes of ileal interposition. The diabetes remission rate at a mean follow-up time of 39.1 months was 78.3%.
- Two studies reported outcomes of gastric banding. The outcomes reported were not considered to be rigorous, because the only measure of diabetes outcome was the withdrawal of diabetes medication. Reported remission rates were 27.5% and 50% at variable follow-up times.
- One study of BPD reported a remission rate of 67% for subjects with a BMI between 30 and 35 kg/m² and 27% for subjects with a BMI between 25 and 30 kg/m² at 12-month follow-up.
- One study reported outcomes of duodenojejunal exclusion. Subjects in this study had more severe diabetes than subjects enrolled in other studies; 100% were on insulin treatment, and the duration of diabetes was between 5 and 15 years. The diabetes remission rate was 17% at 6 months.

Summaries of various systematic reviews and meta-analyses on the use of bariatric or metabolic surgery in patients with a BMI <35 kg/m² are available, and report efficacy in achieving weight loss, glycemic control, T2D remission, and mitigation of various cardiovascular disease factors through 1 to 5 years of follow-up.^{130,131} However, current studies are limited by heterogeneity in applied surgical intervention and threshold definitions for T2D remission. Longer-term (>5 years) RCTs evaluating the use of metabolic surgery in lower BMI patients for the treatment of T2D are pending (NCT02328599). Observational studies evaluating patients undergoing bariatric surgery in patients with T2D with a follow-up to 3 or more years are shown in Table 19.

Table 18. Randomized Controlled Trials^a of Bariatric Surgery Procedures Comparing Patients Who Had Type 2 Diabetes With Controls

Study (Country)	N	BMI Range, kg/m ²	Patients With BMI ≤35 kg/m ²	Length of FU, years	Definition of Diabetes Remission	Diabetes Remission Rate, n/N (%)	P-Value
Simonson et al (2019)¹³² (US)	40	30 to 45	39% LAGB; 36% DWM	3	FBS <126 mg/dL AND HbA1c <6.5%	Surgery (LAGB) 13%	Control (DWM) 5% .601
Dixon et al (2008)⁵⁰ (US)	60	30 to 40	22%	2	% achieving FBS <126mg/dL HbA1c <6.2% (off meds)	Surgery (LAGB) 22/30 (93%)	Control (ILI/A1C-R) 4/30 (13%) <.001
						Surgery (RYGB)	Control (HILI/A1C-R)

Study (Country)	N	BMI Range, kg/m ²	Patients With BMI ≤35 kg/m ²	Length of FU, years	Definition of Diabetes Remission	Diabetes Remission Rate, n/N (%)		P-Value	
Ikramuddin et al (2015) ¹³³ , (U.S.)	120	30 to 40	59%	2	% achieving all 3 ADA goals: HbA1c <7.0% LDL <2.59 mmol/L SBP <130 mm Hg	26/60 (43%)	8/59 (14%)	<.001	
						Surgery (RYGB)	Control 1 (GCP/A1C-R)	Control 2 (GCP/A1C-S)	
Liang et al (2013) ¹³⁴ , (China)	108	>28 ^a		1	T2D remission ^b	28/31 (90%)	0%	0%	<.05
						Surgery (RYGB)	Surgery (LAGB)	Control (HILI/A1C-S)	
Courcoulas et al (2015) ¹³⁵ , (U.S.)	61	30 to 40	43%	3	Partial: HbA1c <6.5% Full: HbA1c <5.7% (off meds)	8/20 (40%) Full: 3/20 (15%)	6/21 (29%) Full: 1/21 (5%)	0%	.004
Courcoulas et al (2020) ¹³⁶ , (U.S.)				5	Partial: HbA1c <6.5% Full: HbA1c <5.7% (off meds)	6/20 (30%) Full: 1/20 (5%)	4/21 (19%) Full: 0	0%	.0208
						Completers			
Schauer et al (2017) ¹³⁷ , (U.S.)	150	27 to 43	37%	5 ^h	% HbA1c <6.0% (meds)	14/49 (29%)	Surgery (LSG) 11/49 (23%)	Control (ILI/A1C-S) 2/38 (5%)	.01 ^c /.03 ^d
						Intention-to-Treat			
						26.4%	20.4%	7.3%	.08 ^e /.17 ^f
						Surgery (RYGB)	Surgery (BPD)	Control (GCP/A1C-S)	
Mingrone et al (2015) ¹²⁶ , (Italy)	60	35+	0%	5	%HbA1c ≤6.5% (% meds x1 y)	8/19 (42%)	13/19 (68%)	0%	<.001
						Surgery (LAGB)	Control (ILI/A1C-R)		
Wentworth et al (2014) ¹³⁸ , (Australia)	51	25 to 30	100%	2	<125 mg/dL or 200 mg/dL 2-h OGTT (off meds x2 d)	12/23 (52%)	2/25 (8%)		.001
						Surgery (RYGB)	Control (HILI/A1C-S)		
Halperin et al (2014) ¹³⁹ , (U.S.)	43	30 to 42	30%	1	% HbA1c <6.5%	11/19 (58%)	3/19 (16%)		.03

ADA: American Diabetes Association; A1C-R: HbA1c reasonable goal of <7%; A1C-S: HbA1c stringent goal of <6.5%; BMI: body mass index; BPD: biliopancreatic diversion; DWM: diabetes and weight management; FBS: fasting blood sugar; FU: follow-up; GCP: good clinical practice; HbA1c: hemoglobin A1c; HILI: highly intensive lifestyle intervention; ILI: intensive lifestyle intervention; LAGB: laparoscopic adjustable gastric banding; LDL: low-density lipoprotein; LSG: laparoscopic sleeve gastrectomy; OGTT: Oral Glucose Tolerance Test; RYGB: Roux-en-Y gastric bypass; SBP: systolic blood pressure; T2D: type 2 diabetes.

^a All RCTs in this table are in the Wu et al (2016) meta-analysis; 7 of the 8 (except Mingrone et al) are in the Muller-Stich et al (2015) meta-analysis; the Rao et al (2015) meta-analysis and the TEC Assessment did not

include RCTs. No additional RCTs comparing bariatric surgery with nonsurgical treatment in patients who had T2D were identified.

^b Used as a secondary outcome. Primary outcome was change in left ventricular mass index.

^c Unadjusted (RYGB vs. control).

^d Unadjusted (LSG vs. control).

^e RYGB vs. control.

^f LSG vs. control.

^g WHO Asia-Pacific Obesity Classification.

^h Through February 2017.

Table 19. Observational Studies Assessing Bariatric Surgery in Patients With Type 2 Diabetes With Follow-Up \geq 3 Years

Study (Country) N	BMI Range, kg/m ²	Patients With BMI \leq 35 kg/m ²	Length of FU	Interv	Mean HbA1c	Mean BMI, kg/m ²	Diabetes Remission Rate	Base	FU	
Group 1										
Scopinaro et al (2014)⁸¹ (Italy)	20 treated; 27 matched diabetic controls	30 to 34.9	100%	3 y	RYGB	9.5%	7.0% ^a	32.9	26.0 ^a	5/20 (25%)
					Control	9.3%	7.7% ^a	33.0	32.6	
Lanzarini et al (2013)¹⁴⁰ (Chile)	31	30 to 35	100%	30 mo ^c	RYGB	7.9%	5.5% ^a	33.1	24.7 ^a	29/31 (94%)
Boza et al (2011)¹⁴¹ (Chile)	30	<35	100%	2 y	RYGB	8.1%	\approx 6.2% ^{a,b}	33.5	23.9 ^a	12 mo: 25/30 (83.3%) 2 y: 13/20 (65%)
DePaula et al (2012)¹⁴² (Brazil)	202	<35	100%	39 mo ^c	SG	8.7%	6.1% ^a	29.7	23.5 ^a	171/198 (86.4%)
Group 2										
Lee et al (2008)³⁵ and¹⁴³ (Taiwan)	544 bypass	32 to 77	NR	3 y	Bypass	6.2%	4.8%	41.3	28.0	NR
	116 LAGB		NR		LAGB	5.9%	5.2%	41.9	32.7	NR

Group 1 is defined as poor control optimal medical management (may include insulin). Group 2 is defined as adequate control with medication (may include insulin).

Base: baseline; BMI: body mass index; Bypass: mini-gastric bypass; FU: follow-up; HbA1c: hemoglobin A1c; Interv: intervention; LAGB; laparoscopic adjustable gastric banding; NR: not reported; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy.

^a $p < .05$ (follow-up vs baseline).

^b Estimated from figure.

^c Mean.

Section Summary: Bariatric Surgery as a Treatment for Type 2 Diabetes for Adults with Diabetes Who Do Not Have Class III Obesity

Systematic reviews of RCTs and observational studies have found that certain types of bariatric surgery are more efficacious than medical therapy as a treatment for T2D in obese patients, including those with a BMI between 30 and 34.9 kg/m². The greatest amount of evidence assesses gastric bypass, with some comparative studies on LAGB, LSG, and BPD. Systematic reviews have found significantly greater remission rates of diabetes, decrease in HbA1c levels, and decrease in BMI with bariatric surgery than with nonsurgical treatment. The efficacy of surgery is balanced against the short-term risks of the surgical procedure. Most RCTs in this population have 1 to 5 years of follow-up data.

Bariatric Surgery in Nondiabetic Patients With a Body Mass Index Less Than 35 kg/m²

Clinical Context and Therapy Purpose

The purpose of any bariatric surgery procedure is to provide a treatment option that is an alternative to or improvement on existing therapies, such as standard medical care, in patients who are not diabetic and do not have class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are not diabetic and do not have class III obesity.

Interventions

The therapy being considered is any bariatric surgery procedure.

Comparators

Comparators of interest include standard medical care for nondiabetic patients.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating any bariatric surgery procedure has varying lengths of follow-up, ranging from 1 to 3 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

A 2012 TEC Assessment evaluated LAGB in individuals without diabetes who had a BMI less than 35 kg/m².¹⁴⁴ This Assessment was prompted by FDA approval of LAP-BAND for this indication in 2011. The TEC Assessment concluded that LAGB did not meet TEC criteria in these patients and made the following summary statements:

- The evidence on LAGB for patients with lower BMIs is limited both in quantity and quality. There was only 1 small RCT, which had methodologic limitations, a nonrandomized comparative study based on registry data, and several case series. Using the GRADE evaluation, the quality of evidence on the comorbidity outcomes was judged to be low, and the quality of the evidence on the weight loss outcomes was judged to be moderate.
- The evidence was sufficient to determine that weight loss following LAGB was greater than with nonsurgical therapy.

- Direct data on improvement in weight-related comorbidities was lacking. The limited evidence was not sufficient to conclude that the amount of weight loss is large enough that improvements in weight-related comorbidities could be assumed.
- There were very few data on quality of life in this population of patients.
- The frequency and impact of long-term complications following LAGB were uncertain, and this uncertainty has been 1 of the main reasons why it is difficult to determine whether the benefit of LAGB outweighs the risk for this population. While the short-term safety of LAGB has been well-established, the long-term adverse events occur at a higher rate and are less well-defined.

Section Summary: Bariatric Surgery in Nondiabetic Patients With a Body Mass Index Less Than 35 kg/m²

There is limited evidence for bariatric surgery in patients who are not diabetic and do not have class III obesity. A few small RCTs and case series have reported a loss of weight and improvements in comorbidities for this population. However, the evidence does not permit conclusions on the long-term risk-benefit ratio of bariatric surgery in this population.

Bariatric Surgery in Class III Obese Adolescent Children

Clinical Context and Therapy Purpose

The purpose of gastric bypass, LAGB, or SG is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adolescent children with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are adolescent children with obesity. While guidelines for bariatric surgery in adolescents are not uniform, most use weight-based criteria that parallel those for adults.

Interventions

The therapy being considered is gastric bypass, LAGB, or SG.

Comparators

Comparators of interest include standard medical care. Treatment for adolescent children with class III obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating gastric bypass, LAGB, or SG as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 6 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.

- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Bariatric Surgery Techniques

Review of Evidence

Systematic Reviews

Qi et al (2017) published a systematic review and meta-analysis on the use of bariatric surgery for the treatment of adolescents with obesity (Table 20).¹⁴⁵ In a literature search conducted through July 2017, 49 studies were identified for inclusion. Study quality was assessed using the Newcastle-Ottawa Scale. Age of patients ranged from 14 to 20 years. BMI ranged from 34 to 63 kg/m². Overall results showed significant improvements in BMI as well as glycemic and lipid control with various bariatric surgery techniques. RYGP showed the largest improvements compared with other procedures, with LAGB and SG also showing improvements in this population.

In a systematic review of 23 studies, Black et al (2013) concluded that the available literature demonstrated a high rate of significant short-term weight loss after bariatric surgery (Table 21).¹⁴⁶ The literature search was conducted through January 2013. Quality assessment of the included studies was not discussed. Ages of patients at the time of surgery ranged from 5 to 23 years. A meta-analysis showed significant reductions in BMI. Meta-analyses were not conducted on the resolution of comorbidities due to heterogeneity in reporting. However, most cases of hypertension, OSA, T2D, and dyslipidemia were reported to have resolved at 1-year follow-up. Reviewers noted that complication and comorbidity rates were not well-defined.

Treadwell et al (2008) conducted a systematic review and meta-analysis of the published evidence on bariatric surgery in adolescents (Table 21).¹⁴⁷ Their analysis included English-language articles on currently performed procedures when data were separated by procedure, and there was a minimum 1-year follow-up for weight and BMI. Studies must have reported outcomes data for 3 or more patients ages 21 years or younger, representing at least 50% of pediatric patients enrolled at that center. Nineteen studies reported on between 11 and 68 patients who were 21 years or younger. Eight studies of LAGB (mean BMI, 45.8 kg/m²; median age range, 15.6 to 20 years); 6 studies on RYGB (mean BMI, 51.8 kg/m²; median age range, 16 to 17.6 years); 5 studies of other procedures (mean BMI, 48.8 kg/m²; median age range, 15.7 to 21 years) were included.

Meta-analyses of BMI at longest follow-up indicated sustained and clinically significant reductions for both LAGB and RYGB (Table 21). Comorbidity resolution was sparsely reported, but surgery appeared to resolve some medical conditions, including diabetes and hypertension; 2 studies of LAGB showed large rates of diabetes resolution but low patient enrollment, and only 1 study of RYGB reported relevant data. No in-hospital or postoperative deaths were reported in any LAGB study. The most frequently reported complications for LAGB were band slippage and micronutrient deficiency with sporadic cases of band erosion, port/tube dysfunction, hiatal hernia, wound infection, and pouch dilation. More severe complications were reported for RYGB, such as pulmonary embolism, shock, intestinal obstruction, postoperative bleeding, staple line leak, and severe malnutrition. No in-hospital deaths were reported; however, 1 patient died 9 months after the study with severe *Clostridium difficile* colitis; 3 others died of causes not likely to have been directly related to the bariatric surgeries. No LAGB studies reported data on the impact of surgery on growth and development. One study of RYGB reported pre- and postoperative heights and concluded that there was no evidence of growth retardation at an average follow-up of 6 years, but it could not be determined from the data whether expected growth was achieved.

Table 20. Systematic Review Characteristics for Bariatric Surgery for Adolescents With Obesity

Study	Dates	Studies	Participants	Design	Duration
Qi et al (2017) ¹⁴⁵	Jul 2017	49	RYGP: 1216 LAGB: 1028 LSG: 665 Other: 98	1 RCT 22 prospective 26 retrospective	12 to 120 mo
Black et al (2013) ¹⁴⁶	Jan 2013	23	RYGP: 256 LAGB: 271 LSG: 90 Other: 20	1 controlled 22 uncontrolled	6 to 120 mo
Treadwell et al (2008) ¹⁴⁷	Dec 2007	18	RYGB: 131 LAGB: 352 Other: 158	1 prospective 17 retrospective	0 to 22 y

LAGB: laparoscopic adjustable gastric banding; LSG: laparoscopic sleeve gastrectomy; RCT: randomized controlled trial; RYGP: Roux-en-Y gastric bypass.

Table 21. Systematic Review Results for Bariatric Surgery for Adolescents With Obesity

Study	BMI Reduction Mean Difference (95% CI)	Fasting Blood Insulin, mIU/L Mean Difference (95% CI)	Total Cholesterol, mg/dL Mean Difference (95% CI)
Qi et al (2017) ¹⁴⁵			
RYGP	18.5 (16.4 to 20.7)	24.8 (10.0 to 30.7)	29.4 (18.1 to 40.7)
LAGB	12.1 (11.0 to 13.3)	20.5 (16.4 to 24.6)	2.2 (-10.0 to 14.4)
LSG	16.0 (13.2 to 20.7)	18.4 (11.4 to 25.3)	13.6 (2.9 to 24.2)
Other	23.2 (15.6 to 30.7)	28.3 (5.7 to 50.9)	49.5 (29.9 to 69.2)
Black et al (2013) ¹⁴⁶			
RYGP	17.2 (14.3 to 20.1)	NR	NR
LAGB	10.5 (9.1 to 11.8)	NR	NR
LSG	14.5 (11.7 to 17.3)	NR	NR
Other	NR	NR	NR
Treadwell et al (2008) ¹⁴⁷			
RYGP	(17.8 to 22.3) ^a	NR	NR
LAGB	(10.6 to 13.7) ^a		

BMI: body mass index; CI: confidence interval; LAGB: laparoscopic adjustable gastric banding; LSG: laparoscopic sleeve gastrectomy; NR: not reported; RYGP: Roux-en-Y gastric bypass.

^a No point estimate provided; only 95% CIs given.

Observational Studies

Dumont et al (2018) published a retrospective study of obese adolescents who underwent LAGB.¹⁴⁸ Between 2006 and 2015, 97 consecutive teenagers (average age at surgery 17.2 ± 0.7 years; mean BMI of 44.9 ± 6.1 kg/m²) who had achieved full growth and sexual maturity and had previously failed a medical nutritional and dietary management program for at least 1 year were enrolled in the study. After a mean follow-up time of 56.0 ± 22.0 months, mean total weight loss was 20.0 ± 16.6% and mean excess weight loss was 46.6 ± 39.5%. Nineteen patients underwent band removal (mean 43.0 ± 28.0 months). No limitations to the study were reported.

One of the larger observational studies included in the systematic reviews was by Inge et al (2014), who reported results from the Teen-Longitudinal Assessment of Bariatric Surgery study, a prospective, multicenter observational study of bariatric surgery in patients ages 19 or younger.¹⁴⁹ The study enrolled 242 patients, with a mean age of 17.1 years and median BMI of 50.5 kg/m² (IQR, 45.2 to 58.2 kg/m²) at the time of surgery. All patients had at least 1 obesity-related comorbidity, most commonly dyslipidemia (74%), followed by OSA (57%), back and joint pain (46%), hypertension (45%), and fatty liver disease (37%). Gastric bypass, LAGB, and vertical SG were performed in 66.5%, 5.8%, and 27.7% of patients, respectively. Within 30 days of surgery, 20 major complications occurred in 19 (7.9%) patients, most of which were perioperative. The cohort is being followed to assess longer term outcomes.

Gastric Bypass

Comparative Studies

Olbers et al (2017) published results from the Adolescent Morbid Obesity Surgery (AMOS) study.¹⁵⁰ AMOS is a prospective, nonrandomized study of patients ages 13 to 18 years with severe obesity. Enrolled patients underwent RYGB (n=81) and were compared with 80 matched adolescent controls undergoing conservative treatment and 81 matched adult controls undergoing RYGB. The primary outcome was change in BMI after 5 years. Adolescents undergoing RYGB had a mean age of 16.5 years and mean BMI of 45.5 kg/m². At 5-year follow-up, adolescents receiving RYGB experienced a mean reduction in BMI of 13.1 kg/m² (95% CI, 11.8 to 14.5). Adolescents receiving conservative treatment experienced a mean increase in BMI of 3.3 kg/m² (95% CI, 1.1 to 4.8). Adult controls receiving RYGB experienced a reduction in BMI similar to the adolescents undergoing RYGB, 12.3 kg/m² (95% CI, 10.9 to 13.7). Adolescents undergoing RYGB also experienced significant improvements in glucose, insulin, cholesterol, and blood pressure levels compared with adolescents in the control group.

Laparoscopic Adjustable Gastric Banding

Systematic Reviews

Willcox and Brennan (2014) conducted a systematic review focusing on studies reporting biopsychosocial outcomes following LAGB in adolescents with obesity.¹⁵¹ The literature search, conducted through May 2013, identified 11 studies for inclusion. Significant weight loss was reported in all studies. Resolution of comorbidities was also reported, though the evidence was poor quality due to a limited discussion of comorbidity assessment criteria. Reporting of psychosocial outcomes was considered limited, with reviewers concluding that further research is needed to better understand the behavioral, emotional, and social factors experienced by adolescents undergoing LAGB.

Randomized Controlled Trials

In the only RCT identified in the systematic reviews, O'Brien et al (2010) reported on 50 adolescents between the ages of 14 and 18 years with a BMI 35 kg/m² or higher who received either a lifestyle intervention or LAGB.² Follow-up was 2 years. Twenty-four of 25 patients in the gastric banding group and 18 of 25 in the lifestyle group completed the study. Twenty-one (84%) in the gastric banding group and 3 (12%) in the lifestyle group lost more than 50% of excess weight. Overall, mean weight loss in the gastric banding group was 34.6 kg (95% CI, 30.2 to 39.0), representing an EWL of 78.8% (95% CI, 66.6 to 91.0). Mean losses in the lifestyle group were 3.0 kg (95% CI, 2.1 to 8.1), representing an EWL of 13.2% (95% CI, 2.6 to 21.0). The gastric banding group experienced improved quality of life with no perioperative adverse events; however, 8 (33%) surgeries were required in 7 patients for revisional procedures, either for proximal pouch dilatation or tubing injury during follow-up.

Case Series

There are many case series of bariatric surgery in adolescents, and these series have generally reported weight loss in the same range reported for adults. For example, Nadler et al (2008) reported on 73 patients ages 13 to 17 years who had undergone LAGB since 2001 at the authors' institution.¹⁵² Mean preoperative BMI was 48 kg/m². EWL at 6 months, 1 year, and 2 years postoperatively was 35%, 57%, and 61%, respectively. Six patients developed band slippage, and 3 developed symptomatic hiatal hernias. Nutritional complications included an asymptomatic iron deficiency in 13 patients, asymptomatic vitamin D deficiency in 4 patients, and mild subjective hair loss in 14. In the 21 patients who entered the authors' FDA-approved study and had reached 1-year follow-up, 51 comorbid conditions were identified, 35 of which completely resolved, 9 were improved, 5 were unchanged, and 2 were aggravated after 1 year.

Sleeve Gastrectomy

Manco et al (2017) published results from contemporaneous cohorts of adolescent patients with a BMI of 35 kg/m² or more and nonalcoholic steatohepatitis who chose between 3 treatment options.¹⁵³ Twenty patients chose to undergo LSG, 20 patients opted to ingest intragastric weight-

loss devices (IGWLD, either the BioEnterics IntraGastric Balloon System or Obalon Gastric Balloon) plus lifestyle interventions, and 53 patients chose lifestyle interventions alone. All patients in the LSG and IGWLD groups completed the study; 22 of the 53 in the lifestyle intervention group completed the study. After 1-year follow-up: patients undergoing LSG lost 21% body weight; patients treated with IGWLD lost 3% body weight, and patients receiving lifestyle interventions only gained 2% body weight. Nonalcoholic steatohepatitis reverted in 100% of patients receiving LSG and in 24% receiving IGWLD. Patients receiving lifestyle interventions alone did not improve significantly.

Alqahtani et al (2021) conducted a prospective, noncomparative, cohort study analyzing durability of weight loss and comorbidity resolution, growth velocity, and adverse events associated with LSG in children and adolescents with severe obesity over 10 years.¹⁵⁴ Children and adolescents with class II or III obesity underwent LSG between 2008 and 2021. Overall, 2504 children and adolescents were included, with a mean age \pm standard deviation (SD) 15.7 ± 3.7 years (range, 5 to 21 years) at the time of operation. In the 15- to 18-year age group specifically, there were 1517 children enrolled (61%). Mean \pm SD baseline BMI was 44.8 ± 12.6 kg/m², with a BMI z-score of 3.0 ± 0.5 , representing 165% above the 95th percentile for age and sex, on average. In the overall cohort in the short- (1 to 3 years, n=2051), medium- (4 to 6 years, n=1268), and long-term (7 to 10 years, n=632) follow-up, mean %EWL was $82.3\% \pm 20.5\%$, $76.3\% \pm 29.1\%$, and $71.1\% \pm 26.9\%$, respectively. At baseline, 263 patients (10.5%) were diagnosed with T2D, 227 (9.1%) were diagnosed with dyslipidemia, and 377 (15.1%) had hypertension. At long-term follow-up, complete comorbidity remission was observed in 74% of T2D cases, 59% of dyslipidemia cases, and 64% of hypertension cases. Mean height z-score change at short-, medium-, and long-term follow-up was 0.1 ± 0.5 , 0.1 ± 1.2 , and 0.0 ± 0.8 , respectively, representing no significant change in growth velocity at each follow-up stage ($p=.95$, $p=.21$, and $p=.40$, respectively). There were 27 (1%) reported adverse events within the first 90 days after operation, including 2 patients with a staple line leak, 22 patients with nausea and vomiting, and 3 patients with signs of metabolic neuropathy, with no procedure-related mortality. None of those patients with adverse events had long-standing sequelae or disability.

Section Summary: Bariatric Surgery in Class III Obese Adolescent Children

Gastric Bypass, Laparoscopic Adjustable Gastric Banding, or Sleeve Gastrectomy

Several systematic reviews and meta-analyses have been conducted on observational studies evaluating the use of bariatric surgery for the treatment of adolescents with obesity. There is an overlap of studies among the systematic reviews. The majority of evidence assesses the use of gastric bypass, SG, or LAGB. Two nonrandomized comparative studies were published after the systematic reviews. One compared RYGB with conservative treatment and with adults undergoing RYGB, and 1 compared LSG with gastric balloons and lifestyle interventions. The evidence on bariatric surgery in adolescents indicates that the percent EWL and change in BMI are approximately the same as that in adults. There are greater concerns for developmental maturity, psychosocial status, and informed consent in adolescents.

Bariatric Surgery Other Than Gastric Bypass, Laparoscopic Adjustable Gastric Banding, or Sleeve Gastrectomy

There is less evidence for the use of bariatric techniques other than gastric bypass, LAGB, and SG. Sample sizes are small for these other techniques and meta-analyses have shown wide CIs in the estimates.

Guideline recommendations for bariatric surgery in adolescents lack uniformity but generally correspond to the clinical selection criteria for adults and supplement these clinical selection criteria with greater attention to issues of maturity and psychosocial status.

Bariatric Surgery in Class III Obese Preadolescent Children

Clinical Context and Therapy Purpose

The purpose of bariatric surgery is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are preadolescent children with class III obesity.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who are preadolescent children with class III obesity.

Interventions

The therapy being considered is bariatric surgery.

Comparators

Comparators of interest include standard medical care. Treatment for preadolescent children with class III obesity includes low carbohydrate dieting and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating bariatric surgery as a treatment for class III obesity has varying lengths of follow-up, ranging from 1 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Alqahtani et al (2021), described above, included children as young as 5 years of age in their prospective, noncomparative cohort study analyzing durability of weight loss and comorbidity resolution, growth velocity, and adverse events associated with LSG in children and adolescents with severe obesity over 10 years.¹⁵⁴ In the 5- to 14-year age group, 801 (32%) children were included. The mean percent of 95th percentile at baseline for children in this age group was 177% ± 38%. The %EWL after LSG in children aged 5 to 14 years was not significantly different from the adolescent children (>14 years) as results were consistent across age groups. Additionally, the height z-score change did not differ in this age group, indicating no impact on change over 10 years of follow-up. Black et al (2013; described above) published a systematic review of 23 studies on bariatric surgery in children and adolescents.¹⁴⁶

Section Summary: Bariatric Surgery in Class III Obese Preadolescent Children

There are few published data, and no studies were identified that focused on bariatric surgery solely in preadolescent children. A recently published (Alqahtani et al [2021]) prospective noncomparative cohort study demonstrated substantial, long-lasting (follow-up of 10 years) weight loss and comorbidity resolution without safety concerns after LSG in children as young as 5 years of age. In the study of children and adolescents, 801/2504 (32%) children included were ages 5 to 14 years at the time of surgery. Additional comparative studies are needed to permit conclusions about the net health benefit of bariatric surgery in preadolescent children with class III obesity.

Hiatal Hernia Repair in Conjunction With Bariatric Surgery for Adults with Class III Obesity and a Preoperative Diagnosis of Hiatal Hernia**Clinical Context and Therapy Purpose**

The purpose of hiatal hernia repair with bariatric surgery is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients with class III obesity and a preoperative diagnosis of hiatal hernia.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals with class III obesity and a preoperative diagnosis of hiatal hernia.

Interventions

The therapy being considered is hiatal hernia repair with bariatric surgery.

Comparators

Comparators of interest include standard medical care. Treatment for patients with class III obesity and a preoperative diagnosis of hiatal hernia includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating hiatal hernia repair with bariatric surgery as a treatment for class III obesity and a preoperative diagnosis of hiatal hernia has varying lengths of follow-up, ranging from 1 to 3 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5 to 10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions, and appearance of long-term complications.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Consistent with a 'best available evidence approach,' within each category of study design, studies with larger sample sizes and longer durations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Hiatal hernia is associated with obesity, and existing hiatal hernias may be worsened with bariatric surgery. In some studies, the presence of a hiatal hernia has been associated with complications after LAGB.¹⁵⁵ Although other studies have reported no differences in perioperative complications after LAGB in patients with GERD and/or a hiatal hernia or those without GERD and/or hiatal hernia.¹⁵⁶ Hiatal hernias, either incidentally found at surgery or diagnosed preoperatively, are often repaired at the time of bariatric surgery. In 2013, the Society of American Gastrointestinal and Endoscopic Surgeons published guidelines on the management of hiatal hernia, recommending that, during RYGB, SG, and the placement of LAGBs, all detected hiatal hernias should be repaired (grade of recommendation: weak; evidence quality moderate).¹⁵⁷ There is limited evidence regarding whether repair of hiatal hernias at the time of bariatric surgery improves outcomes after surgery; it consists primarily of cohort studies comparing outcomes for patients who had a hiatal hernia and underwent repair during bariatric surgery with patients without a hiatal hernia.

Systematic Reviews

Chen et al (2021) published a systematic review of 18 studies that evaluated outcomes after hiatal hernia repair plus SG in obese patients (N=937).¹⁵⁸ Results demonstrated that patients who underwent hiatal hernia repair during SG had significant reductions in BMI (MD, -11.42 kg/m², 95% CI, -12.8 to -10.03), and the risk of GERD symptoms (OR, 0.20; 95% CI, 0.10 to 0.41) and esophagitis (OR, 0.12; 95% CI, 0.05 to 0.26). Hiatal hernia repair during SG was superior to SG alone for GERD remission (OR, 2.97; 95% CI, 1.78 to 4.95), but not de novo GERD (OR, 0.61; 95% CI, 0.24 to 1.53). The pooled recurrence rate for hiatal hernia after hiatal hernia repair plus SG was 11% (95% CI, 4 to 19).

Cohort Studies

Gulkarov et al (2008) reported on results of a prospective cohort study comparing outcomes for patients who underwent LAGB with or without concurrent hiatal hernia repair (n=1298 with LAGB alone; n=520 with concurrent hiatal hernia repair).¹⁵⁹ The authors reported that, initially, hiatal hernias were diagnosed based on preoperative esophagram and upper endoscopy, but this was discontinued after these studies were shown to have poor predictive value for small-to-medium size hernias; subsequent patients were diagnosed at the time of surgery. It was not specified how many patients were diagnosed with each method or how many of those had symptoms before gastric banding. Fewer patients who underwent concurrent hiatal hernia repair required reoperation for a complication (3.5% vs. 7.9% in the LAGB alone group; p<.001). Hiatal hernia repair added an average of 14 minutes to surgical time. Weight loss outcomes did not differ significantly between groups. Santonicola et al (2014) evaluated the effects of LSG with or without hiatal hernia repair on GERD in obese patients.¹⁶⁰ The study included 78 patients who underwent SG with concomitant hiatal hernia repair for a sliding hiatal hernia diagnosed intraoperatively, compared with 102 patients without a hiatal hernia who underwent SG only. The prevalence of typical GERD symptoms did not improve from baseline to follow-up in patients who underwent concomitant hiatal hernia repair (38.4% presurgery vs. 30.8% postsurgery, p=.3). However, those in the SG only group had a significant decrease in the prevalence of typical GERD symptoms (39.2% presurgery vs. 19.6% postsurgery, p=.003).

Reynoso et al (2011) reported on outcomes after primary and revisional LAGB in patients with a hiatal hernia treated at a single hospital system.¹⁶¹ Of 1 637 patients with a hiatal hernia undergoing primary gastric banding, 190 (11.6%) underwent concurrent hiatal hernia repair; of 181 patients undergoing revision gastric banding, 15 (8.3%) underwent concurrent hiatal hernia repair. For primary procedures, there were no significant differences in mortality, morbidity, length of stay, and 30-day readmission rates for patients who underwent LAGB with and without hiatal hernia repair. However, this compares patients with a hiatal hernia undergoing repair to patients without a hiatal hernia. The more relevant comparison would be comparing repair to no repair in patients who have a hiatal hernia.

Ardestani et al (2014) analyzed data from the Bariatric Outcomes Longitudinal Database registry to compare outcomes for patients with and without hiatal hernia repair at the time of LAGB.¹⁶² Of 41,611 patients who had LAGB from 2007 to 2010, 8120 (19.5%) had a concomitant hiatal hernia repair. Those with hiatal hernia repair were more likely to have GERD preoperatively (49% vs. 40% in the non-hiatal hernia repair group; $p < .001$). Perioperative outcomes were similar between groups. Of those with GERD preoperatively, rates of improvement in GERD symptoms did not differ significantly at 1 year, postprocedure (53% for hiatal hernia repair vs. 52% for non-hiatal hernia repair; $p = .4$). Although the hiatal hernia repair added minimal time (mean, 4 minutes) to surgery, the authors concluded that many repairs would have involved small hernias with limited clinical effect. In general, studies have reported that the addition of hiatal hernia repair at the time of bariatric surgery is safe and feasible. In a small case series of 21 patients, Frezza et al (2008) described the feasibility of crural repair at the time of LAGB for patients with a hiatal hernia.¹⁶³ Al-Haddad et al (2014) used data from the U.S. Nationwide Inpatient Sample to evaluate the surgical risk associated with hiatal hernia repair at the time of bariatric surgery.¹⁶⁴ For laparoscopic RYGB, there were 206,559 and 9060 patients who underwent the procedure alone or with concomitant hiatal hernia repair, respectively. For LAGB, 52,901 and 9893 patients, respectively, underwent the procedure alone or with hiatal hernia repair. The authors reported no evidence of increased risk of perioperative adverse events associated with the concomitant hiatal hernia repair. However, patients who underwent a concomitant hiatal hernia repair were less likely to have prolonged length of stay, with an average treatment effect of hiatal hernia repair of -0.124 (95% CI, -0.15 to -0.088) for prolonged length of stay for patients who underwent RYGB and an average treatment effect of hiatal hernia repair of -0.107 (95% CI, -0.159 to -0.0552) for prolonged length of stay for patients who underwent LAGB.

Section Summary: Hiatal Hernia Repair in Conjunction With Bariatric Surgery for Adults with Class III Obesity and a Preoperative Diagnosis of Hiatal Hernia

Hiatal hernia repair is frequently undertaken at the time of bariatric surgery. The evidence related to whether hiatal hernia repair improves outcomes after bariatric surgery is limited, particularly for hiatal hernias that are incidentally diagnosed at the time of surgery. For patients with a preoperative diagnosis of a hiatal hernia, symptoms related to a hernia, and indications for surgical repair, it is reasonable to undertake this procedure at the time of bariatric surgery. For other patients, it is uncertain whether repair of a hiatal hernia at the time of bariatric surgery improves outcomes. A systematic review found that hiatal hernia repair during SG was superior to SG alone for GERD remission, but not de novo GERD.

Supplemental Information

The purpose of the following information is to provide reference material. Inclusion does not imply endorsement or alignment with the evidence review conclusions.

Clinical Input From Physician Specialty Societies and Academic Medical Centers

While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

2008 Input

In response to the requests, input was received from 1 physician specialty society and 2 academic medical centers on the use of the REALIZE band while the policy was under review in 2008. All 3 responses supported the use of the REALIZE band as a surgical option for patients, as adopted into the policy in 2008.

In response to the requests, input was also received from 2 academic medical centers on the use of the new endoscopic placement of devices to remedy weight gain that occurs after bariatric surgery

while the policy was under review in 2008. Input from both centers agreed that this approach is considered investigational, as adopted in the policy in 2008.

Practice Guidelines and Position Statements

Guidelines or position statements will be considered for inclusion in 'Supplemental Information' if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American Association of Clinical Endocrinologists et al.

In 2020, the American Association of Clinical Endocrinologists (AACE) and the American College of Endocrinology jointly published a comprehensive diabetes type 2 management algorithm.¹⁶⁵ Updates were made in 2022 and recommendations for bariatric surgery are presented in Table 22.¹⁶⁶

Table 22. Recommendations for Bariatric Surgery in Diabetes

Recommendation	GOE	BEL
Persons with a BMI ≥ 35 kg/m ² and 1 or more severe obesity-related complications remediable by weight loss, including T2D, high risk for T2D (insulin resistance, prediabetes, and/or metabolic syndrome), poorly controlled hypertension, NAFLD/NASH, OSA, osteoarthritis of the knee or hip, and urinary stress incontinence, should be considered for a bariatric procedure	C	3
Persons with BMI 30 to 34.9 kg/m ² and T2D with inadequate glycemic control despite optimal lifestyle and medical therapy should be considered for a bariatric procedure	B	2

BEL: best evidence level; BMI: body mass index; GOE: grade of evidence; NAFLD: nonalcoholic fatty liver disease; NASH: nonalcoholic steatohepatitis; OSA: obstructive sleep apnea; T2D: type 2 diabetes.

In 2016, the AACE and the American College of Endocrinology jointly published comprehensive clinical guidelines on the medical care of patients with obesity.¹⁶⁷ The guidelines addressed 9 broad clinical questions with 123 recommendations. With regard to bariatric surgery, the following recommendations were added (Table 23).

Table 23. Recommendations for Bariatric Surgery Added in 2016

No.	Recommendation	GOE	BEL
35	Patients with obesity (BMI ≥ 30 kg/m ²) and diabetes who have failed to achieve targeted clinical outcomes following treatment with lifestyle therapy and weight-loss medications may be considered for bariatric surgery, preferably Roux-en-Y gastric bypass, sleeve gastrectomy, or biliopancreatic diversion."	B	1 ^a
121	"Patients with a BMI of ≥ 35 kg/m ² and 1 or more severe obesity-related complications, including type 2 diabetes, hypertension, obstructive sleep apnea, obesity-hypoventilation syndrome, Pickwickian syndrome, nonalcoholic fatty liver disease or nonalcoholic steatohepatitis, pseudotumor cerebri, gastroesophageal reflux disease, asthma, venous stasis disease, severe urinary incontinence, debilitating arthritis, or considerably impaired quality of life may also be considered for a bariatric surgery procedure. Patients with BMI of 30 to 34.9 kg/m ² with diabetes or metabolic syndrome may also be considered for a bariatric procedure, although current evidence is limited by the number of patients studied and lack of long-term data demonstrating net benefit.	A B C	1 2 3
	<ul style="list-style-type: none"> BMI ≥ 35 kg/m² and therapeutic target of weight control and improved biochemical markers of CVD risk. BMI ≥ 30 kg/m² and therapeutic target of weight control and improved biochemical markers of CVD risk. BMI ≥ 30 kg/m² and therapeutic target of glycemic control in type 2 diabetes and improved biochemical markers of CVD risk. 		
122	"Independent of BMI criteria, there is insufficient evidence for recommending a bariatric surgical procedure specifically for glycemic control alone, lipid lowering alone, or CVD risk reduction alone."	D	

No.	Recommendation	GOE	BEL
62	"Roux-en-Y gastric bypass should be considered as the bariatric surgery procedure of choice for patients with obesity and moderate to severe gastroesophageal reflux symptoms, hiatal hernia, esophagitis, or Barrett's esophagus." ^a "Intragastric balloon for weight loss may increase gastroesophageal reflux symptoms and should not be used for weight loss in patients with established gastroesophageal reflux."	Int	Int
		Strong	Strong

BEL: best evidence level; BMI: body mass index; CVD: cardiovascular disease; GOE: grade of evidence; Int: intermediate.

^a Downgraded due to study limitations.

In 2019, an update of the joint 2013 guidelines on support for bariatric surgery patients were published by the AACE, the Obesity Society, the American Society for Metabolic and Bariatric Surgery (ASMBS), Obesity Medicine Association, and American Society of Anesthesiologists.¹⁶⁸ Recommendations on the following questions are summarized below.

- "Which patients should be offered bariatric surgery?"
 - "Patients with a BMI [body mass index] ≥ 40 kg/m² without coexisting medical problems and for whom bariatric surgery would not be associated with excessive risk should be eligible for a bariatric procedure."
 - "Patients with a BMI ≥ 35 kg/m² and 1 or more severe obesity-related complications remediable by weight loss, including T2D [type 2 diabetes], high risk for T2D, poorly controlled hypertension, nonalcoholic fatty liver disease/nonalcoholic steatohepatitis, OSA [obstructive sleep apnea], osteoarthritis of the knee or hip, and urinary stress incontinence, should be considered for a bariatric procedure."
 - "Patients with the following comorbidities and BMI ≥ 35 kg/m² may also be considered for a bariatric procedure, though the strength of evidence is more variable; obesity-hypoventilation syndrome and Pickwickian syndrome after a careful evaluation of operative risk; idiopathic intracranial hypertension; GERD [gastroesophageal reflux disease]; severe venous stasis disease; impaired mobility due to obesity, and considerably impaired quality of life."
 - "Patients with BMI of 30 to 34.9 kg/m² with T2D with inadequate glycemic control despite optimal lifestyle and medical therapy should be considered for a bariatric procedure; current evidence is insufficient to support recommending a bariatric procedure in the absence of obesity."
 - "The BMI criterion for bariatric procedures should be adjusted for ethnicity (e.g., 18.5 to 22.9 kg/m² is normal range, 23 to 24.9 kg/m² overweight, and ≥ 25 kg/m² obesity for Asians)."
 - "Bariatric procedures should be considered to achieve optimal outcomes regarding health and quality of life when the amount of weight loss needed to prevent or treat clinically significant obesity-related complications cannot be obtained using only structured lifestyle change with medical therapy."
- "Which bariatric surgical procedure should be offered?"
 - "Selecting a bariatric procedure should be based on individualized goals of therapy (e.g., weight loss target and/or improvement in specific obesity-related complications), available local-regional expertise (obesity specialists, bariatric surgeon, and institution), patient preferences, personalized risk stratification, and other nuances as they become apparent. Notwithstanding technical surgical reasons, laparoscopic bariatric procedures should be preferred over open bariatric procedures due to lower early postoperative morbidity and mortality. Laparoscopic adjustable gastric banding, sleeve gastrectomy, RYGB [Roux-en-y gastric bypass], and LBPD/DS [laparoscopic biliopancreatic diversion/duodenal switch], or related procedures should be considered as primary bariatric and metabolic procedures performed in patients requiring weight loss and/or amelioration of obesity-related complications. Physicians must exercise caution when recommending BPD [biliopancreatic diversion], BPD with duodenal switch, or related procedures because of the greater associated nutritional risks related to the increased length of bypassed small intestine. Newer nonsurgical bariatric procedures may be

considered for selected patients who are expected to benefit from short-term (i.e., about 6 months) intervention with ongoing and durable structured lifestyle with/without medical therapy."

American College of Cardiology et al.

In 2013, the American College of Cardiology (ACC), American Heart Association (AHA), and the Obesity Society published joint guidelines on the management of obesity and overweight in adults.¹⁶⁹The guidelines made the following recommendations related to bariatric surgery:

- "Advise adults with a BMI 40kg/m² or BMI 35 kg/m² with obesity-related comorbid conditions who are motivated to lose weight and who have not responded to behavioral treatment with or without pharmacotherapy with sufficient weight loss to achieve targeted health outcome goals that bariatric surgery may be an appropriate option to improve health and offer referral to an experienced bariatric surgeon for consultation and evaluation. NHLBI [National heart, lung, and blood Institute] Grade A (Strong); AHA/ACC COR [class of recommendation]: IIa; AHA/ACC LOE [level of evidence]: A."
- "For individuals with a BMI <35 kg/m², there is insufficient evidence to recommend for or against undergoing bariatric surgical procedures. NHLBI Grade N (No Recommendation)."

American Society for Metabolic and Bariatric Surgery

In 2016, the ASMBS published a position statement on intragastric balloon therapy (the statement was also endorsed by the Society of American Gastrointestinal and Endoscopic Surgeons).¹⁷⁰ The statement did not include specific recommendations for or against using these devices. A summary of key recommendations is as follows:

There is level 1 data from RCTs [randomized controlled trials] on the "efficacy [and] safety of intragastric balloon therapy for obesity ... [and] lower-level evidence [suggesting] that weight loss can be maintained ... for some finite time into the future."

It is difficult to separate the effect from the intragastric "balloon alone from those of supervised diet and lifestyle changes...." This has been addressed in recent FDA [U.S. Food and Drug Administration] pivotal trials. "In general, any obesity treatment, including intragastric balloon therapy, would benefit from a multidisciplinary team...."

"...serious complications are rare. Early postoperative tolerance challenges ... can be managed with pharmacotherapy in the majority of patients...."

In 2017, the ASMBS published a position statement on sleeve gastrectomy.¹⁷¹ This updated statement provided the following conclusions:

- "Substantial long-term outcome data published in the peer-reviewed literature, including studies comparing outcomes of various surgical procedures, confirm that sleeve gastrectomy [SG] provides significant and durable weight loss, improvements in medical comorbidities, improved quality of life, and low complication and mortality rates for obesity treatment."
- "In terms of initial early weight loss and improvement of most weight-related comorbid conditions, SG and RYGB appear similar. The effect of SG on GERD, however, is less clear, because GERD improvement is less predictable and GERD may worsen or develop de novo."
- The ASMBS recognizes SG as an acceptable option for a primary bariatric procedure or as a first-stage procedure in high-risk patients as part of a planned staged approach."

Surgeons performing SG are encouraged to continue to prospectively collect and report outcome data in the peer-reviewed scientific literature.

In 2018, the ASMBS and the American Hernia Society published a consensus guideline on bariatric surgery and hernia surgery.¹⁷² The guideline contained the following conclusions and summary recommendations:

- "There is a significant link between obesity and hernia formation both after abdominal surgery and de novo. There is also evidence that abdominal wall hernia can more commonly present with obstruction or strangulation in patients with obesity."
- "There is a higher risk for complications and recurrence after hernia repair in patients with obesity."
- "In patients with severe obesity and ventral hernia, and both being amenable to laparoscopic repair, combined hernia repair and metabolic/bariatric surgery may be safe and associated with good short-term outcomes and low risk of infection. There is a relative lack of evidence, however, about the use of synthetic mesh in this setting."
- "In patients with severe obesity and abdominal wall hernia that is not amenable to laparoscopic repair, a staged approach is recommended. Weight loss prior to hernia repair is likely to improve hernia repair outcomes. Metabolic/bariatric surgery appears to provide far more significant and rapid weight loss than other modalities and would be a good option for selected patients with severe obesity and large, symptomatic abdominal wall hernia."

In 2020, ASMBS published an updated statement on single-anastomosis duodenal switch (SADI-S) "in response to numerous inquiries made...by patients, physicians, society members, hospitals, and others regarding [this procedure] as a treatment for obesity and metabolic diseases."¹⁷³ The following recommendations were endorsed regarding SADI-S for the primary treatment of obesity or metabolic disease:

- "SADI-S, a modification of classic Roux-en-Y duodenal switch, is an appropriate metabolic bariatric surgical procedure."
- "Publication of long-term safety and efficacy outcomes is still needed and is strongly encouraged, particularly with published details on sleeve gastrectomy size and common channel length."
- "There remain concerns about intestinal adaptation, nutritional issues, optimal limb lengths, and long-term weight loss/regain after this procedure. As such, ASMBS recommends a cautious approach to the adoption of this procedure, with attention to ASMBS-published guidelines on nutritional and metabolic support of bariatric patients, in particular for duodenal switch patients."

In 2022, ASMBS, along with the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), updated their guideline on indications for metabolic and bariatric surgery.¹⁷⁴ Historically, class III obesity was the threshold for bariatric surgery; however, ASMBS now recommends metabolic and bariatric surgery in individuals with a BMI greater than or equal to 35 kg/m², regardless of the presence, absence, or severity of comorbidities. Studies referenced by the guideline to support this recommendation generally demonstrated weight loss and remission in both T2D and hypertension in the bariatric surgery groups compared to the nonsurgical groups. However, there were no subgroup analyses performed on individuals without metabolic disorders, so it is difficult to determine if this benefit extends to all patient populations with BMI greater than or equal to 35 kg/m², regardless of the presence, absence, or severity of comorbidities. Additionally, only 1 systematic review referenced by the guidelines included RCTs, and heterogeneity of these RCTs was considered high; all other trials referenced were nonrandomized.

The ASMBS/IFSO guideline also states that metabolic and bariatric surgery can be considered for individuals with metabolic disease and class I obesity, defined as BMI of 30 to 34.9 kg/m², who do not achieve substantial or durable weight loss or comorbidity improvement with nonsurgical methods. Additionally, they state that BMI thresholds should be adjusted in the Asian population, as the prevalence of diabetes and cardiovascular disease is higher at a lower BMI than in the non-Asian population. Thus, a BMI greater than or equal to 25 kg/m² suggests clinical obesity, and individuals with BMI greater than or equal to 27.5 kg/m² should be offered bariatric surgery.

Importantly, these recommendation from the 2022 ASMBS/IFSO guideline do not appear to be informed by a separately conducted systematic review, include strength of evidence ratings, or include a description of management of conflict of interest.

Society of American Gastrointestinal and Endoscopic Surgeons

In 2013, the Society of American Gastrointestinal and Endoscopic Surgeons issued evidence-based guidelines on the management of a hiatal hernia, which included a recommendation about the repair of hiatal hernias incidentally detected at the time of bariatric surgery.¹⁵⁷ These guidelines stated: "During operations for Roux-en-Y gastric bypass, sleeve gastrectomy and the placement of adjustable gastric bands, all detected hiatal hernias should be repaired" (moderate quality evidence, weak recommendation).

International Federation for the Surgery of Obesity and Metabolic Disorders

In 2019, members of societies affiliated with the IFSO established an expert consensus statement on revisional bariatric surgery (RBS).¹⁷⁵ Consensus agreement was established for the following recommendation statements:

- "RYGB is an acceptable RBS option after gastric banding."
- "OAGB is an acceptable RBS option after gastric banding."
- "SADI-S is an acceptable RBS option after gastric banding."^a
- "RBS after gastric banding can be carried out in either 1 or 2-stage."
- "OAGB is an acceptable RBS option after SG."
- "BPD-DS is an acceptable RBS option after SG."
- "SADI-S is an acceptable RBS option after SG."
- "Prolongation of bilio-pancreatic limb is an acceptable RBS option after RYGB."
- "Prolongation of bilio-pancreatic limb is an acceptable RBS option after OAGB."^a

BPD-DS: bilio-pancreatic diversion duodenal switch; OAGB: one gastric bypass; RBS: revisional bariatric surgery; RYGB: Roux-en-Y gastric bypass; SADI: single anastomosis duodeno-ileal bypass with sleeve gastrectomy; SG: sleeve gastrectomy.

^a Consensus achieved in second round of voting.

In 2020, members of societies affiliated with the IFSO established a position statement on Single Anastomosis Duodenal-Ileal Bypass with Sleeve Gastrectomy/One Anastomosis Duodenal Switch (SADI-S/OADS).¹⁷⁶ The following recommendations were made based on available data:

- "SADI-S/OADS offers substantial weight loss that is maintained into the medium term."
- "SADI-S/OADS provides an improvement in metabolic health that is maintained into the medium term."
- "Nutritional deficiencies are emerging as long-term safety concerns for the SADI-S/OADS procedure and patients undergoing this procedure need to be aware of this, and counseled to stay in long-term multidisciplinary care."
- "Surgeons performing the SADI-/OADS, as well as other bariatric/metabolic procedures, are encouraged to participate in a national or international registry so that data may be more effectively identified."
- "IFSO supports the SADI-S/OADS as a recognized bariatric/metabolic procedure, but highly encourages RCT's in the near future."

Guidelines for Children and Adolescents

Childerhose et al (2017) conducted a systematic review of adolescent bariatric surgery recommendation documents published in the United States and provided recommendations based on their review.¹⁷⁷ The literature search was conducted from 1999 through 2013 and identified 16 recommendations for inclusion: 10 clinical practice guidelines, 4 position statements, and 2 consensus statements. Fifteen of the 16 publications recommended bariatric surgery for adolescents. The main

reasons for recommending bariatric surgery for adolescents included: (1) surgery is effective in producing short- and long-term weight loss; (2) surgery is appropriate when the patient does not respond to behavioral or medical interventions; (3) surgery is appropriate when serious comorbidities threaten the health of the patient; and (4) surgery can improve long-term health and/or emotional problems. Body mass index thresholds ranged from 35 kg/m² or more to 50 kg/m² or more, with lower thresholds usually requiring the presence of at least 1 serious comorbidity. The minimum age was specified in 10 publications, with most using physiologic maturity (Tanner stage IV and/or 95% of adult height based on bone age, corresponding to ≥ 13 years for females and to ≥ 15 years for males) rather than years.

American Academy of Pediatrics

In 2019, the American Academy of Pediatrics (AAP) published a report outlining the current evidence regarding adolescent bariatric surgery that provided recommendations for practitioners and policy makers.¹⁷⁸ Within this report, AAP listed indications for adolescent metabolic and bariatric surgery that reflected 2018 ASMBS recommendations. Additionally, the AAP report noted that generally accepted contraindications to bariatric surgery included: "a medically correctable cause of obesity, untreated or poorly controlled substance abuse, concurrent or planned pregnancy, current eating disorder, or inability to adhere to postoperative recommendations and mandatory lifestyle changes." In 2023, the AAP published their first evidence-based clinical practice guideline for the evaluation and treatment of children and adolescents (ages 2 to 18 years) with obesity.¹⁷⁹ The recommendations put forth in the guideline are based on evidence from RCTs and comparative effectiveness trials, along with high-quality longitudinal and epidemiologic studies gathered in a systematic review process described in their methodology. The AAP's recommendation related to bariatric surgery is below:

- "Pediatricians and other PHCPs [pediatric health care providers] should offer referral for adolescents 13 years and older with severe obesity (BMI $\geq 120\%$ of the 95th percentile for age and sex) for evaluation for metabolic and bariatric surgery to local or regional comprehensive multidisciplinary pediatric metabolic and bariatric surgery centers (Grade C Evidence Quality)."

They list indications for adolescent metabolic and bariatric surgery (Table 24) that align with the 2019 indications.

Table 24. Indications for Adolescent Metabolic and Bariatric Surgery

Weight Criteria	Comorbid Conditions
Class 2 obesity; BMI ≥ 35, or 120% of the 95th percentile for age and sex, whichever is lower	Clinically significant disease, including, but not limited to, OSA (AHI >5), T2D, IIH, NASH, Blount disease, SCFE, GERD, depressed health-related quality of life, and hypertension
Class 3 obesity; BMI ≥ 40, or 140% of the 95th percentile for age and sex, whichever is lower	Not required but commonly present

AHI: apnea-hypopnea index; BMI: body mass index; GERD: gastroesophageal reflux disease; IIH: idiopathic intracranial hypertension; NASH: non-alcoholic steatohepatitis; OSA: obstructive sleep apnea; SCFE: slipped capital femoral epiphysis; T2D: type 2 diabetes.

American Society for Metabolic and Bariatric Surgery

In 2012, the ASMBS best practice guidelines found that current evidence was insufficient to discriminate among specific bariatric procedures, but allowed that there was an increasing body of data showing safety and efficacy of Roux-en-Y gastric bypass and adjustable gastric band for the pediatric population.¹⁸⁰ Bariatric surgery was recommended for pediatric patients with morbid obesity and the following comorbidities:

- Strong indications: Type 2 diabetes, Moderate or severe obstructive sleep apnea (apnea-hypopnea index >15), Nonalcoholic steatohepatitis, Pseudotumor cerebri.
- Less strong indications: Cardiovascular disease, Metabolic syndrome.

The guidelines stated that depression and eating disorders should not be considered exclusion criteria for bariatric surgery. The guidelines also noted that depression should be monitored following the procedure and that eating disorders should be treated and the patient stabilized before the procedure.

In 2018, ASBMS published an update to the 2012 guideline.¹⁸¹ Summary of major changes in the guideline included:

- "Vertical sleeve gastrectomy has become the most used and most recommended operation in adolescents with severe obesity for several reasons, near-equivalent weight loss to RYGB in adolescents, fewer reoperations, better iron absorption, and near-equivalent effect on comorbidities as RYGB in adolescents. However, given the more extensive long-term data available for RYGB, we can recommend the use of either RYGB or VSG in adolescents. Long-term outcomes of GERD after vertical sleeve gastrectomy are still not well understood."
- "There are no data that the number of preoperative weight loss attempts correlated with success after metabolic/bariatric surgery. Compliance with a multidisciplinary preoperative program may improve outcomes after metabolic/bariatric surgery but prior attempts at weight loss should be removed as a barrier to definitive treatment for obesity."
- "The use of the most up to date definitions of childhood obesity are as follows: (1) BMI cut offs of 35 kg/m² or 120% of the 95th percentile with a comorbidity, or (2) BMI >40 kg/m² or 140% of the 95th percentile without a comorbidity (whichever is less). Requiring adolescents with a BMI >40 to have a comorbidity (as in the old guidelines) puts children at a significant disadvantage to attaining a healthy weight. Earlier surgical intervention (at a BMI <45 kg/m²) can allow adolescents to reach a normal weight and avoid lifelong medication therapy and end organ damage from comorbidities."
- "Certain comorbidities should be considered in adolescents, specifically the psychosocial burden of obesity, the orthopedic diseases specific to children, GERD, and cardiac risk factors. Given the poor outcomes of medical therapies for T2D in children, these comorbidities may be considered an indication for metabolic/bariatric surgery in younger adolescents or those with lower obesity percentiles."
- "Vitamin B deficiencies, especially B1 appear to be more common in adolescents both preoperatively and postoperatively; they should be screened for and treated. Prophylactic B1 for the first 6 months postoperatively is recommended as is education of patients and primary care providers on the signs and symptoms of common deficiencies."
- "Developmental delay, autism spectrum, or syndromic obesity should not be a contraindication to metabolic/bariatric surgery. Each patient and caregiver team will need to be assessed for the ability to make dietary and lifestyle changes required for surgery. Multidisciplinary teams should agree on the specific needs and abilities of the given patient and caregiver and these should be considered on a case-by-case basis with the assistance of the hospital ethics committee where appropriate."
- "Because metabolic/bariatric surgery results in better weight loss and resolution of comorbidities in adolescents at lower BMI's with fewer comorbidities, referrals should occur early, as soon as a child is recognized to suffer from severe obesity disease (BMI >120% of the 95th percentile or BMI of 35). Prior weight loss attempts, Tanner stage, and bone age should not be considered when referring patients to a metabolic/bariatric surgery program."
- "Unstable family environments, eating disorders, mental illness, or prior trauma should not be considered contraindications for metabolic/bariatric surgery in adolescents; however, these should be optimized and treated where possible before and surrounding any surgical intervention for obesity."

In 2022, the ASMBS updated their guideline on indications for metabolic and bariatric surgery.¹⁷⁴ They noted that prospective data demonstrated durable weight loss and maintained co-morbidity remission in patients as young as 5 years of age. Additionally, the ASMBS stated that metabolic and

bariatric surgery do not negatively impact pubertal development or linear growth, and therefore a specific Tanner stage and bone age should not be considered a requirement for surgery. Other statements supported 2018 recommendations, including that syndromic obesity, developmental delay, autism spectrum, or a history of trauma would not be considered a contraindication to bariatric surgery in children or adolescents.

Endocrine Society

In 2008, the Endocrine Society published recommendations on the prevention and treatment of pediatric obesity.¹⁸² In 2017, the Society sponsored an update of these guidelines by the Pediatric Endocrine Society and the European Society of Endocrinology.¹⁸³ These guidelines recommended the following:

"We suggest that bariatric surgery be considered only under the following conditions:

- The child has attained Tanner 4 or 5 pubertal development and final or near-final adult height.
- The child has a BMI > 40 kg/m² or has BMI above 35 kg/m² and significant, extreme comorbidities.
- Extreme obesity and comorbidities persist, despite compliance with a formal program of lifestyle modification, with or without a trial of pharmacotherapy.
- Psychological evaluation confirms the stability and competence of the family unit.
- There is access to an experienced surgeon in a pediatric bariatric surgery center of excellence that provides the necessary infrastructure for patient care, including a team capable of long-term follow-up of the metabolic and psychosocial needs of the patient and family.
- The patient demonstrates the ability to adhere to the principles of healthy dietary and activity habits.

We recommend against bariatric surgery for preadolescent children, for pregnant or breast-feeding adolescents (and those planning to become pregnant within 2 yr of surgery) and in any patient who has not mastered the principles of healthy dietary and activity habits and/or has an unresolved substance abuse, eating disorder, or untreated psychiatric disorder."

U.S. Preventive Services Task Force Recommendations

Not applicable.

Medicare National Coverage

The Centers for Medicare & Medicaid Services have published a national coverage decision on bariatric surgery.¹⁸⁴ The Centers determined that:

"...the evidence is adequate to conclude that open and laparoscopic Roux-en-Y gastric bypass (RYGBP), laparoscopic adjustable gastric banding (LAGB), and open and laparoscopic biliopancreatic diversion with duodenal switch (BPD/DS), are reasonable and necessary for Medicare beneficiaries who have a body mass index (BMI) ≥ 35 , have at least 1 co-morbidity related to obesity, and have been previously unsuccessful with medical treatment for obesity."

Ongoing and Unpublished Clinical Trials

Some currently ongoing and unpublished trials that might influence this review are listed in Table 25.

Table 25. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
<i>Ongoing</i>			
NCT01172899	The BASIC Trial. Morbid Obesity in Children and Adolescents: a Prospective Randomised Trial of Conservative Treatment Versus Surgery	60	Dec 2022 (active, not recruiting)
NCT02390973 ^a	Surgery Versus Best Medical Management for the Long Term Remission of Type 2 Diabetes and Related Diseases (REMISSION)	408	Mar 2024 (recruiting)

NCT No.	Trial Name	Planned Enrollment	Completion Date
NCT04174768	The Effect of Bariatric Surgery on Glucose Metabolism and Kidney Function	50	Nov 2021 (unknown)
NCT03891056	Metabolic Surgery for Patients with Type 2 DM and Grade 1 Obesity with Bad Metabolic Control (MSO1CT)	40	Jan 2022 (recruiting)
NCT02310178	Obesity Cohort: Medical Follow-Up of Severe or Morbid Obese Patients Undergoing Bariatric Surgery	750	May 2022 (recruiting)
NCT02328599	A Prospective Consortium Evaluating the Long-term Follow-up of Patients With Type 2 Diabetes Enrolled In a Randomized Controlled Trial Comparing Bariatric Surgery Versus Medical Management (ARMMS-T2D)	302	Jun 2024 (enrolling by invitation)
NCT04583683	Effects of Very Low Calorie Diet vs Metabolic Surgery on Weight Loss and Obesity Comorbidities: a Randomized Controlled Trial	218	Sep 2022 (active, not recruiting)
NCT03610256	Prospective Multicentric Randomized Trial Comparing the Efficacy and Safety of single anastomosis- Duodeno Ileal Bypass With Sleeve Gastrectomy (SADI-S) Versus Roux-en-Y Gastric Bypass (RYGB) (SADISLEEVE)	382	Oct 2023 (active, not recruiting)
NCT03517072	Determinants of the Long-Term Success of Bariatric Surgery	1000	Jan 2023 (unknown)
NCT03472157	Prospective Multicentric, Open Label, Randomized Clinical Trial of Superiority, With Two Arms, Comparing Bariatric Surgery to the Recommended Medical Treatment for NASH (NASHSURG)	100	Mar 2023 (recruiting)
NCT04506190	A Prospective Multicenter Study to Evaluate the Perioperative Outcomes of Laparoscopic and Robotic-Assisted Revisional Bariatric Surgery	100	Mar 2023 (active, not recruiting)
NCT04128995	Surgical or Medical Treatment for Pediatric Type 2 Diabetes	100	Sep 2025 (recruiting)
NCT03236142	The Single, 300 cm Loop, Duodenal Switch (SIPS) Results in Less Nutritional Deficiencies Than the Standard Duodenal Switch (DS) Operation: A Multicenter, Randomized Controlled Trial	110	Jan 2025 (recruiting)
NCT02692469	Laparoscopic single anastomosis- Duodenal-Jejunal Bypass With Sleeve Gastrectomy vs Laparoscopic Duodenal Switch as a Primary Bariatric Procedure. 5 Year Patient Follow	140	Apr 2026 (not yet recruiting)
NCT04165694	Single Anastomosis Duodenal Ileal Bypass (SADI) as a Second Stage for Sleeve Gastrectomy Weight Loss Failure	54	Dec 2030 (active, not recruiting)
<i>Unpublished</i>			
NCT02881684 ^a	Weight Reduction by Aspiration Therapy in Asian Patients with Morbid Obesity	15	Dec 2018 (unknown)
NCT02142257	Gastric Bypass Procedure and AspireAssist Aspiration Therapy System for the Treatment of Morbid Obesity, Observational Study over 5 Years	100	May 2020 (unknown)
NCT03493620	Multicenter Randomized Prospective Study With Sham Group to Evaluate the Efficacy and Results of Endoscopic Gastroplasty Using Overstitch in Patients With Class I and II Obesity	60	Aug 2020 (completed)
NCT03102697	Optimization and Follow-up of the Consecutive Use of Two Intra-gastric Balloons (Heliosphere Bag [®]) in the Treatment of Obesity: A Prospective Clinical Study	30	Dec 2020 (completed)

NCT: national clinical trial.

^a Denotes industry-sponsored or cosponsored trial.

Appendix 1

Table A1. Comparison of Studies Included in Systematic Reviews & Meta-analyses

Study	Gloy et al (2013) ¹⁷	Puzziferri et al (2014) ¹⁹	Colquitt et al (2014) ¹⁶	Kang et al (2017) ¹⁵	Park et al (2019) ¹⁴	Cosentino et al (2021) ¹³
Hall et al (1990)						

Study	Gloy et al (2013) ¹⁷ .	Puzziferri et al (2014) ¹⁹ .	Colquitt et al (2014) ¹⁶ .	Kang et al (2017) ¹⁵ .	Park et al (2019) ¹⁴ .	Cosentino et al (2021) ¹³ .
Pories et al (1995)		●				
Heindorff et al (1997)	●					
Mingrone et al (2002)	●					●
Lee et al (2004)						●
Langer et al (2005)					●	
Lee et al (2005)					●	
Olbers et al (2005)					●	
van Dielen et al (2005)		●			●	
O'Brien et al (2005)		●				
Ponce et al (2005)		●				
Suter et al (2005)		●				
Olbers et al (2006)						●
Himpens et al (2006)			●	●		●
O'Brien et al (2006)	●		●		●	●
Skroubis et al (2006)		●			●	●
van Mastrigt et al (2006)					●	
Kalfarentzos et al (2006)		●				
Basdevant et al (2007)		●				
Czupryniak et al (2007)		●				
Favretti et al (2007)		●				
Gravante et al (2007)		●				
Mathus-Vliegen et al (2007)		●				
Angrisani et al (2007)			●	●		
Sekhar et al (2007)		●				
Weiner et al (2007)		●				
Dixon et al (2008)	●		●		●	●
Karamanakos et al (2008)			●	●	●	●
Vagenas et al (2008)		●				
Yan et al (2008)		●				
Aasheim et al (2009)			●			
Angrisani et al (2009)					●	
Phillips et al (2009)		●				
Scozzari et al (2009)					●	●
Nguyen et al (2009)		●	●	●	●	●
Caiazzo et al (2010)		●				
Hauser et al (2010)		●				
Nogues et al (2010)			●			
O'Brien et al (2010)	●				●	
Reis et al (2010)	●					

Study	Gloy et al (2013) ¹⁷ .	Puzziferri et al (2014) ¹⁹ .	Colquitt et al (2014) ¹⁶ .	Kang et al (2017) ¹⁵ .	Park et al (2019) ¹⁴ .	Cosentino et al (2021) ¹³ .
Sovik et al (2010)					●	
Sultan et al (2010)		●				
Kehagias et al (2011)				●	●	●
Lee et al (2011)			●		●	
Ray and Ray (2011)		●				
Sovik et al (2011)		●				●
Van Nieuwenhove et al (2011)		●				
Adams et al (2012)		●				
Dixon et al (2012)	●					●
Hedberg et al (2012)			●			
Paluszkiwicz et al (2012)			●	●	●	
Praveen et al (2012)			●		●	
Peterli et al (2012)			●			
Mingrone et al (2012)	●	●		●	●	
Ramon et al (2012)				●		●
Schauer et al (2012)	●		●		●	
Courcoulas et al (2013)		●				
Darabi et al (2013)					●	●
Demerdash et al (2013)			●			
Kehagias et al (2013)		●				
Keidar et al (2013)			●	●		●
Liang et al (2013)	●		●			
Ikramuddin et al (2013)	●		●			
Peterli et al (2013)				●		
Sharma et al (2013)			●			
Vix et al (2013)			●	●		
MacLaughlin et al (2014)						●
Parikh et al (2014)						●
Gras-Miralles et al (2014)					●	
Courcoulas et al (2014)					●	
Schauer et al (2014)					●	
Vix et al (2014)						●
Zhang et al (2014)				●	●	
Courcoulas et al (2015)						●
Feigel-Guiller et al (2015)					●	
Mingrone et al (2015)					●	●
Risstad et al (2015)						●
Yang et al (2015)					●	
Cummings et al (2016)					●	●
Grubnik et al (2016)					●	●

Study	Gloy et al (2013) ¹⁷ .	Puzziferri et al (2014) ¹⁹ .	Colquitt et al (2014) ¹⁶ .	Kang et al (2017) ¹⁵ .	Park et al (2019) ¹⁴ .	Cosentino et al (2021) ¹³ .
Ikramuddin et al (2016)					●	
Pilone et al (2016)					●	
Tang et al (2016)					●	
Biter et al (2017)					●	●
Casajoana et al (2017)					●	●
Ignat et al (2017)					●	●
Kalinowski et al (2017)						●
Murphy et al (2017)						●
Peterli et al (2017)					●	
Schauer et al (2017)					●	
Risstad et al (2017)					●	
Seetharamaiah et al (2017)					●	●
Sullivan et al (2017)						●
Miller et al (2017)						●
Capristo et al (2018)						●
Ikramuddin et al (2018)					●	●
Murphy et al (2018)					●	
Talebpour et al (2018)					●	●
Peterli et al (2018)					●	●
Salminen et al (2018)					●	●
Schiavon et al (2018)						●
Shivakumar et al (2018)						●
Simonson et al (2018)						●
Robert et al (2019)						●

References

- Centers for Disease Control and Prevention. Overweight & Obesity. Last Reviewed: June 3, 2022; <https://www.cdc.gov/obesity/basics/adult-defining.html>. Accessed February 10, 2023.
- O'Brien PE, Sawyer SM, Laurie C, et al. Laparoscopic adjustable gastric banding in severely obese adolescents: a randomized trial. *JAMA*. Feb 10 2010;303(6):519-526. PMID 20145228
- Sjostrom L, Lindroos AK, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *N Engl J Med*. Dec 23 2004;351(26):2683-2693. PMID 15616203
- Scopinaro N, Papadia F, Marinari G, et al. Long-term control of type 2 diabetes mellitus and the other major components of the metabolic syndrome after biliopancreatic diversion in patients with BMI < 35 kg/m². *Obes Surg*. Feb 2007;17(2):185-192. PMID 17476869
- Sjostrom CD, Lissner L, Wedel H, et al. Reduction in incidence of diabetes, hypertension and lipid disturbances after intentional weight loss induced by bariatric surgery: the SOS Intervention Study. *Obes Res*. Sep 1999;7(5):477-484. PMID 10509605
- Sjostrom L, Narbro K, Sjostrom CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. *N Engl J Med*. Aug 23 2007;357(8):741-752. PMID 17715408
- Courcoulas AP, Christian NJ, Belle SH, et al. Weight change and health outcomes at 3 years after bariatric surgery among individuals with severe obesity. *JAMA*. Dec 11 2013;310(22):2416-2425. PMID 24189773

8. Arterburn D, Wellman R, Emiliano A, et al. Comparative Effectiveness and Safety of Bariatric Procedures for Weight Loss: A PCORnet Cohort Study. *Ann Intern Med.* Dec 04 2018; 169(11): 741-750. PMID 30383139
9. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA.* Oct 13 2004;292(14):1724-1737. PMID 15479938
10. Maggard MA, Shugarman LR, Suttorp M, et al. Meta-analysis: surgical treatment of obesity. *Ann Intern Med.* Apr 5 2005;142(7):547-559. PMID 15809466
11. Gomes-Rocha SR, Costa-Pinho AM, Pais-Neto CC, et al. Roux-en-Y Gastric Bypass Vs Sleeve Gastrectomy in Super Obesity: a Systematic Review and Meta-Analysis. *Obes Surg.* Jan 2022; 32(1): 170-185. PMID 34642872
12. Currie AC, Askari A, Fangueiro A, et al. Network Meta-Analysis of Metabolic Surgery Procedures for the Treatment of Obesity and Diabetes. *Obes Surg.* Oct 2021; 31(10): 4528-4541. PMID 34363144
13. Cosentino C, Marchetti C, Monami M, et al. Efficacy and effects of bariatric surgery in the treatment of obesity: Network meta-analysis of randomized controlled trials. *Nutr Metab Cardiovasc Dis.* Sep 22 2021; 31(10): 2815-2824. PMID 34348877
14. Park CH, Nam SJ, Choi HS, et al. Comparative Efficacy of Bariatric Surgery in the Treatment of Morbid Obesity and Diabetes Mellitus: a Systematic Review and Network Meta-Analysis. *Obes Surg.* Jul 2019; 29(7): 2180-2190. PMID 31037599
15. Kang JH, Le QA. Effectiveness of bariatric surgical procedures: A systematic review and network meta-analysis of randomized controlled trials. *Medicine (Baltimore).* Nov 2017; 96(46): e8632. PMID 29145284
16. Colquitt JL, Pickett K, Loveman E, et al. Surgery for weight loss in adults. *Cochrane Database Syst Rev.* 2014;8:CD003641. PMID 25105982
17. Gloy VL, Briel M, Bhatt DL, et al. Bariatric surgery versus non-surgical treatment for obesity: a systematic review and meta-analysis of randomised controlled trials. *BMJ.* Oct 22 2013;347:f5934. PMID 24149519
18. Chang SH, Stoll CR, Song J, et al. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. *JAMA Surg.* Mar 2014;149(3):275-287. PMID 24352617
19. Puzifferri N, Roshek TB, 3rd, Mayo HG, et al. Long-term follow-up after bariatric surgery: a systematic review. *JAMA.* Sep 3 2014;312(9):934-942. PMID 25182102
20. Wilhelm SM, Young J, Kale-Pradhan PB. Effect of bariatric surgery on hypertension: a meta-analysis. *Ann Pharmacother.* Jun 2014;48(6):674-682. PMID 24662112
21. Ricci C, Gaeta M, Rausa E, et al. Early impact of bariatric surgery on type II diabetes, hypertension, and hyperlipidemia: a systematic review, meta-analysis and meta-regression on 6,587 patients. *Obes Surg.* Apr 2014;24(4):522-528. PMID 24214202
22. Cuspidi C, Rescaldani M, Tadic M, et al. Effects of bariatric surgery on cardiac structure and function: a systematic review and meta-analysis. *Am J Hypertens.* Feb 2014;27(2):146-156. PMID 24321879
23. Kwok CS, Pradhan A, Khan MA, et al. Bariatric surgery and its impact on cardiovascular disease and mortality: a systematic review and meta-analysis. *Int J Cardiol.* Apr 15 2014;173(1):20-28. PMID 24636546
24. Afshar S, Kelly SB, Seymour K, et al. The effects of bariatric surgery on colorectal cancer risk: systematic review and meta-analysis. *Obes Surg.* Oct 2014;24(10):1793-1799. PMID 25015708
25. Andersen JR, Aasprang A, Karlsen TI, et al. Health-related quality of life after bariatric surgery: a systematic review of prospective long-term studies. *Surg Obes Relat Dis.* Mar-Apr 2015; 11(2): 466-73. PMID 25820082
26. Arterburn DE, Olsen MK, Smith VA, et al. Association between bariatric surgery and long-term survival. *JAMA.* Jan 6 2015;313(1):62-70. PMID 25562267
27. Bower G, Toma T, Harling L, et al. Bariatric Surgery and Non-Alcoholic Fatty Liver Disease: a Systematic Review of Liver Biochemistry and Histology. *Obes Surg.* Dec 2015; 25(12): 2280-9. PMID 25917981

28. Cheung D, Switzer NJ, Ehmann D, et al. The impact of bariatric surgery on diabetic retinopathy: a systematic review and meta-analysis. *Obes Surg.* Sep 2015;25(9):1604-1609. PMID 25515499
29. Driscoll S, Gregory DM, Fardy JM, et al. Long-term health-related quality of life in bariatric surgery patients: A systematic review and meta-analysis. *Obesity (Silver Spring).* Jan 2016; 24(1): 60-70. PMID 26638116
30. Groen VA, van de Graaf VA, Scholtes VA, et al. Effects of bariatric surgery for knee complaints in (morbidly) obese adult patients: a systematic review. *Obes Rev.* Feb 2015;16(2):161-170. PMID 25487972
31. Hachem A, Brennan L. Quality of Life Outcomes of Bariatric Surgery: A Systematic Review. *Obes Surg.* Feb 2016; 26(2): 395-409. PMID 26494369
32. Lindekilde N, Gladstone BP, Lubeck M, et al. The impact of bariatric surgery on quality of life: a systematic review and meta-analysis. *Obes Rev.* Aug 2015; 16(8): 639-51. PMID 26094664
33. Lopes EC, Heineck I, Athaydes G, et al. Is Bariatric Surgery Effective in Reducing Comorbidities and Drug Costs? A Systematic Review and Meta-Analysis. *Obes Surg.* Sep 2015; 25(9): 1741-9. PMID 26112137
34. Ricci C, Gaeta M, Rausa E, et al. Long-term effects of bariatric surgery on type II diabetes, hypertension and hyperlipidemia: a meta-analysis and meta-regression study with 5-year follow-up. *Obes Surg.* Mar 2015;25(3):397-405. PMID 25240392
35. Yang XW, Li PZ, Zhu LY, et al. Effects of bariatric surgery on incidence of obesity-related cancers: a meta-analysis. *Med Sci Monit.* May 11 2015; 21: 1350-7. PMID 25961664
36. Madadi F, Jawad R, Mousati I, et al. Remission of Type 2 Diabetes and Sleeve Gastrectomy in Morbid Obesity: a Comparative Systematic Review and Meta-analysis. *Obes Surg.* Dec 2019; 29(12): 4066-4076. PMID 31655953
37. Yan G, Wang J, Zhang J, et al. Long-term outcomes of macrovascular diseases and metabolic indicators of bariatric surgery for severe obesity type 2 diabetes patients with a meta-analysis. *PLoS One.* 2019; 14(12): e0224828. PMID 31794559
38. Castellana M, Procino F, Biacchi E, et al. Roux-en-Y Gastric Bypass vs Sleeve Gastrectomy for Remission of Type 2 Diabetes. *J Clin Endocrinol Metab.* Mar 08 2021; 106(3): 922-933. PMID 33051679
39. Carmona MN, Santos-Sousa H, Lindeza L, et al. Comparative Effectiveness of Bariatric Surgeries in Patients with Type 2 Diabetes Mellitus and BMI \geq 25 kg/m²: a Systematic Review and Network Meta-Analysis. *Obes Surg.* Dec 2021; 31(12): 5312-5321. PMID 34611827
40. Liu DF, Ma ZY, Zhang CS, et al. The effects of bariatric surgery on dyslipidemia and insulin resistance in overweight patients with or without type 2 diabetes: a systematic review and network meta-analysis. *Surg Obes Relat Dis.* Sep 2021; 17(9): 1655-1672. PMID 34229937
41. Wiggins T, Guidozi N, Welbourn R, et al. Association of bariatric surgery with all-cause mortality and incidence of obesity-related disease at a population level: A systematic review and meta-analysis. *PLoS Med.* Jul 2020; 17(7): e1003206. PMID 32722673
42. Cui BB, Wang GH, Li PZ, et al. Long-term outcomes of Roux-en-Y gastric bypass versus medical therapy for patients with type 2 diabetes: a meta-analysis of randomized controlled trials. *Surg Obes Relat Dis.* Jul 2021; 17(7): 1334-1343. PMID 33863632
43. Yan Y, Sha Y, Yao G, et al. Roux-en-Y Gastric Bypass Versus Medical Treatment for Type 2 Diabetes Mellitus in Obese Patients: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Medicine (Baltimore).* Apr 2016; 95(17): e3462. PMID 27124041
44. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Laparoscopic gastric bypass surgery for morbid obesity. *TEC Assessment.* 2005;Vol:Tab 15.
45. Arterburn DE, Johnson E, Coleman KJ, et al. Weight Outcomes of Sleeve Gastrectomy and Gastric Bypass Compared to Nonsurgical Treatment. *Ann Surg.* Dec 01 2021; 274(6): e1269-e1276. PMID 32187033
46. Wadden TA, Chao AM, Bahnson JL, et al. End-of-Trial Health Outcomes in Look AHEAD Participants who Elected to have Bariatric Surgery. *Obesity (Silver Spring).* Apr 2019; 27(4): 581-590. PMID 30900413

47. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Laparoscopic adjustable gastric banding for morbid obesity. TEC Assessment. 2006;Vol 21:Tab 13.
48. Ibrahim AM, Thumma JR, Dimick JB. Reoperation and Medicare Expenditures After Laparoscopic Gastric Band Surgery. *JAMA Surg.* Sep 01 2017; 152(9): 835-842. PMID 28514487
49. Chakravarty PD, McLaughlin E, Whittaker D, et al. Comparison of laparoscopic adjustable gastric banding (LAGB) with other bariatric procedures; a systematic review of the randomised controlled trials. *Surgeon.* Jun 2012;10(3):172-182. PMID 22405735
50. Dixon JB, O'Brien PE, Playfair J, et al. Adjustable gastric banding and conventional therapy for type 2 diabetes: a randomized controlled trial. *JAMA.* Jan 23 2008;299(3):316-323. PMID 18212316
51. Gu L, Huang X, Li S, et al. A meta-analysis of the medium- and long-term effects of laparoscopic sleeve gastrectomy and laparoscopic Roux-en-Y gastric bypass. *BMC Surg.* Feb 12 2020; 20(1): 30. PMID 32050953
52. Han Y, Jia Y, Wang H, et al. Comparative analysis of weight loss and resolution of comorbidities between laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass: A systematic review and meta-analysis based on 18 studies. *Int J Surg.* Apr 2020; 76: 101-110. PMID 32151750
53. Sharples AJ, Mahawar K. Systematic Review and Meta-Analysis of Randomised Controlled Trials Comparing Long-Term Outcomes of Roux-En-Y Gastric Bypass and Sleeve Gastrectomy. *Obes Surg.* Feb 2020; 30(2): 664-672. PMID 31724116
54. Shenoy SS, Gilliam A, Mehanna A, et al. Laparoscopic Sleeve Gastrectomy Versus Laparoscopic Roux-en-Y Gastric Bypass in Elderly Bariatric Patients: Safety and Efficacy-a Systematic Review and Meta-analysis. *Obes Surg.* Nov 2020; 30(11): 4467-4473. PMID 32594469
55. Borgeraas H, Hofsvø D, Hertel JK, et al. Comparison of the effect of Roux-en-Y gastric bypass and sleeve gastrectomy on remission of type 2 diabetes: A systematic review and meta-analysis of randomized controlled trials. *Obes Rev.* Jun 2020; 21(6): e13011. PMID 32162437
56. Zhao H, Jiao L. Comparative analysis for the effect of Roux-en-Y gastric bypass vs sleeve gastrectomy in patients with morbid obesity: Evidence from 11 randomized clinical trials (meta-analysis). *Int J Surg.* Dec 2019; 72: 216-223. PMID 31756544
57. Lee Y, Doumouras AG, Yu J, et al. Laparoscopic Sleeve Gastrectomy Versus Laparoscopic Roux-en-Y Gastric Bypass: A Systematic Review and Meta-analysis of Weight Loss, Comorbidities, and Biochemical Outcomes From Randomized Controlled Trials. *Ann Surg.* Jan 01 2021; 273(1): 66-74. PMID 31693504
58. Xu C, Yan T, Liu H, et al. Comparative Safety and Effectiveness of Roux-en-Y Gastric Bypass and Sleeve Gastrectomy in Obese Elder Patients: a Systematic Review and Meta-analysis. *Obes Surg.* Sep 2020; 30(9): 3408-3416. PMID 32277330
59. Osland E, Yunus RM, Khan S, et al. Weight Loss Outcomes in Laparoscopic Vertical Sleeve Gastrectomy (LVSG) Versus Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) Procedures: A Meta-Analysis and Systematic Review of Randomized Controlled Trials. *Surg Laparosc Endosc Percutan Tech.* Feb 2017; 27(1): 8-18. PMID 28145963
60. Osland EJ, Yunus RM, Khan S, et al. Five-Year Weight Loss Outcomes in Laparoscopic Vertical Sleeve Gastrectomy (LVSG) Versus Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) Procedures: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Surg Laparosc Endosc Percutan Tech.* Dec 2020; 30(6): 542-553. PMID 32658120
61. Juodeikis Z, Brimas G. Long-term results after sleeve gastrectomy: A systematic review. *Surg Obes Relat Dis.* Apr 2017; 13(4): 693-699. PMID 27876332
62. Zhang Y, Wang J, Sun X, et al. Laparoscopic sleeve gastrectomy versus laparoscopic Roux-en-Y gastric bypass for morbid obesity and related comorbidities: a meta-analysis of 21 studies. *Obes Surg.* Jan 2015;25(1):19-26. PMID 25092167
63. Trastulli S, Desiderio J, Guarino S, et al. Laparoscopic sleeve gastrectomy compared with other bariatric surgical procedures: a systematic review of randomized trials. *Surg Obes Relat Dis.* Sep-Oct 2013;9(5):816-829. PMID 23993246

64. Brethauer SA, Hammel JP, Schauer PR. Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. *Surg Obes Relat Dis*. Jul-Aug 2009;5(4):469-475. PMID 19632646
65. Hofsø D, Fatima F, Borgeraas H, et al. Gastric bypass versus sleeve gastrectomy in patients with type 2 diabetes (Oseberg): a single-centre, triple-blind, randomised controlled trial. *Lancet Diabetes Endocrinol*. Dec 2019; 7(12): 912-924. PMID 31678062
66. 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*. Jan 16 2018; 319(3): 255-265. PMID 29340679
67. Salminen P, Helmiö M, Ovaska J, et al. Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss at 5 Years Among Patients With Morbid Obesity: The SLEEVEPASS Randomized Clinical Trial. *JAMA*. Jan 16 2018; 319(3): 241-254. PMID 29340676
68. Wölnerhanssen BK, Peterli R, Hurme S, et al. Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy: 5-year outcomes of merged data from two randomized clinical trials (SLEEVEPASS and SM-BOSS). *Br J Surg*. Jan 27 2021; 108(1): 49-57. PMID 33640917
69. Helmiö M, Victorzon M, Ovaska J, et al. SLEEVEPASS: a randomized prospective multicenter study comparing laparoscopic sleeve gastrectomy and gastric bypass in the treatment of morbid obesity: preliminary results. *Surg Endosc*. Sep 2012;26(9):2521-2526. PMID 22476829
70. 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*. Mar 2008;247(3):401-407. PMID 18376181
71. Himpens J, Dapri G, Cadiere GB. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: results after 1 and 3 years. *Obes Surg*. Nov 2006;16(11):1450-1456. PMID 17132410
72. Farrell TM, Haggerty SP, Overby DW, et al. Clinical application of laparoscopic bariatric surgery: an evidence- based review. *Surg Endosc*. May 2009;23(5):930-949. PMID 19125308
73. Skogar ML, Sundbom M. Duodenal Switch Is Superior to Gastric Bypass in Patients with Super Obesity when Evaluated with the Bariatric Analysis and Reporting Outcome System (BAROS). *Obes Surg*. Sep 2017; 27(9): 2308-2316. PMID 28439748
74. Strain GW, Gagner M, Inabnet WB, et al. Comparison of effects of gastric bypass and biliopancreatic diversion with duodenal switch on weight loss and body composition 1-2 years after surgery. *Surg Obes Relat Dis*. Jan- Feb 2007;3(1):31-36. PMID 17116424
75. Prachand VN, Davee RT, Alverdy JC. Duodenal switch provides superior weight loss in the super-obese (BMI > or =50 kg/m²) compared with gastric bypass. *Ann Surg*. Oct 2006;244(4):611-619. PMID 16998370
76. Strain GW, Torghabeh MH, Gagner M, et al. Nutrient Status 9 Years After Biliopancreatic Diversion with Duodenal Switch (BPD/DS): an Observational Study. *Obes Surg*. Jul 2017; 27(7): 1709-1718. PMID 28155056
77. Marceau P, Biron S, Hould FS, et al. Duodenal switch improved standard biliopancreatic diversion: a retrospective study. *Surg Obes Relat Dis*. Jan-Feb 2009;5(1):43-47. PMID 18440876
78. Slater GH, Ren CJ, Siegel N, et al. Serum fat-soluble vitamin deficiency and abnormal calcium metabolism after malabsorptive bariatric surgery. *J Gastrointest Surg*. Jan 2004;8(1):48-55; discussion 54-45. PMID 14746835
79. Dolan K, Hatzifotis M, Newbury L, et al. A clinical and nutritional comparison of biliopancreatic diversion with and without duodenal switch. *Ann Surg*. Jul 2004;240(1):51-56. PMID 15213618
80. Skroubis G, Anesidis S, Kehagias I, et al. Roux-en-Y gastric bypass versus a variant of biliopancreatic diversion in a non-superobese population: prospective comparison of the efficacy and the incidence of metabolic deficiencies. *Obes Surg*. Apr 2006;16(4):488-495. PMID 16608616

81. Scopinaro N, Adami GF, Papadia FS, et al. Effects of gastric bypass on type 2 diabetes in patients with BMI 30 to 35. *Obes Surg*. Jul 2014;24(7):1036-1043. PMID 24647849
82. Hsieh T, Zurita L, Grover H, et al. 10-year outcomes of the vertical transected gastric bypass for obesity: a systematic review. *Obes Surg*. Mar 2014;24(3):456-461. PMID 24379176
83. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). TEC Special Report: The relationship between weight loss and changes in morbidity following bariatric surgery for morbid obesity. *TEC Assessments*. 2003;Vol 18:Tab 18.
84. Hall JC, Watts JM, O'Brien PE, et al. Gastric surgery for morbid obesity. The Adelaide Study. *Ann Surg*. Apr 1990;211(4):419-427. PMID 2181950
85. Sugerma HJ, Starkey JV, Birkenhauer R. A randomized prospective trial of gastric bypass versus vertical banded gastroplasty for morbid obesity and their effects on sweets versus non-sweets eaters. *Ann Surg*. Jun 1987;205(6):613-624. PMID 3296971
86. MacLean LD, Rhode BM, Forse RA. Late results of vertical banded gastroplasty for morbid and super obesity. *Surgery*. Jan 1990;107(1):20-27. PMID 2296754
87. Coffin B, Maunoury V, Pattou F, et al. Impact of Intra-gastric Balloon Before Laparoscopic Gastric Bypass on Patients with Super Obesity: a Randomized Multicenter Study. *Obes Surg*. Apr 2017; 27(4): 902-909. PMID 27664095
88. 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 Endosc*. Jun 2006;20(6):859-863. PMID 16738970
89. Alexandrou A, Felekouras E, Giannopoulos A, et al. What is the actual fate of super-morbid-obese patients who undergo laparoscopic sleeve gastrectomy as the first step of a two-stage weight-reduction operative strategy? *Obes Surg*. Jul 26 2012;22(10):1623-1628. PMID 22833137
90. 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*. May 2009;23(5):1032-1037. PMID 18814005
91. Li H, Wang J, Wang W, et al. Comparison Between Laparoscopic Sleeve Gastrectomy and Laparoscopic Greater Curvature Plication Treatments for Obesity: an Updated Systematic Review and Meta-Analysis. *Obes Surg*. Sep 2021; 31(9): 4142-4158. PMID 34227019
92. Ji Y, Wang Y, Zhu J, et al. A systematic review of gastric plication for the treatment of obesity. *Surg Obes Relat Dis*. Nov-Dec 2014;10(6):1226-1232. PMID 24582413
93. Abdelbaki TN, Huang CK, Ramos A, et al. Gastric plication for morbid obesity: a systematic review. *Obes Surg*. Oct 2012;22(10):1633-1639. PMID 22960951
94. Sullivan S, Swain JM, Woodman G, et al. Randomized sham-controlled trial evaluating efficacy and safety of endoscopic gastric plication for primary obesity: The ESSENTIAL trial. *Obesity (Silver Spring)*. Feb 2017; 25(2): 294-301. PMID 28000425
95. Pattanshetti S, Tai CM, Yen YC, et al. Laparoscopic adjustable gastric banded plication: evolution of procedure and 2-year results. *Obes Surg*. Nov 2013;23(11):1934-1938. PMID 24013809
96. Shoar S, Poliakin L, Rubenstein R, et al. Single Anastomosis Duodeno-Ileal Switch (SADIS): A Systematic Review of Efficacy and Safety. *Obes Surg*. Jan 2018; 28(1): 104-113. PMID 28823074
97. Torres A, Rubio MA, Ramos-Leví AM, et al. Cardiovascular Risk Factors After Single Anastomosis Duodeno-Ileal Bypass with Sleeve Gastrectomy (SADI-S): a New Effective Therapeutic Approach?. *Curr Atheroscler Rep*. Nov 07 2017; 19(12): 58. PMID 29116413
98. Sanchez-Pernaute A, Rubio MA, Cabrerizo L, et al. Single-anastomosis duodenoileal bypass with sleeve gastrectomy (SADI-S) for obese diabetic patients. *Surg Obes Relat Dis*. Sep-Oct 2015; 11(5): 1092-8. PMID 26048517
99. Rohde U, Hedback N, Gluud LL, et al. Effect of the EndoBarrier Gastrointestinal Liner on obesity and type 2 diabetes: a systematic review and meta-analysis. *Diabetes Obes Metab*. Mar 2016; 18(3): 300-5. PMID 26537317
100. Koehestanie P, de Jonge C, Berends FJ, et al. The effect of the endoscopic duodenal-jejunal bypass liner on obesity and type 2 diabetes mellitus, a multicenter randomized controlled trial. *Ann Surg*. Dec 2014;260(6):984-992. PMID 25072436

101. Obermayer A, Tripolt NJ, Aziz F, et al. EndoBarrier™ Implantation Rapidly Improves Insulin Sensitivity in Obese Individuals with Type 2 Diabetes Mellitus. *Biomolecules*. Apr 14 2021; 11(4). PMID 33919949
102. Saber AA, Shoar S, Almadani MW, et al. Efficacy of First-Time Intra-gastric Balloon in Weight Loss: a Systematic Review and Meta-analysis of Randomized Controlled Trials. *Obes Surg*. Feb 2017; 27(2): 277-287. PMID 27465936
103. Moura D, Oliveira J, De Moura EG, et al. Effectiveness of intra-gastric balloon for obesity: A systematic review and meta-analysis based on randomized control trials. *Surg Obes Relat Dis*. Feb 2016; 12(2): 420-9. PMID 26968503
104. Zheng Y, Wang M, He S, et al. Short-term effects of intra-gastric balloon in association with conservative therapy on weight loss: a meta-analysis. *J Transl Med*. Jul 29 2015; 13: 246. PMID 26219459
105. Kotinda APST, de Moura DTH, Ribeiro IB, et al. Efficacy of Intra-gastric Balloons for Weight Loss in Overweight and Obese Adults: a Systematic Review and Meta-analysis of Randomized Controlled Trials. *Obes Surg*. Jul 2020; 30(7): 2743-2753. PMID 32300945
106. Tate CM, Geliebter A. Intra-gastric Balloon Treatment for Obesity: Review of Recent Studies. *Adv Ther*. Aug 2017; 34(8): 1859-1875. PMID 28707286
107. Courcoulas A, Abu Dayyeh BK, Eaton L, et al. Intra-gastric balloon as an adjunct to lifestyle intervention: a randomized controlled trial. *Int J Obes (Lond)*. Mar 2017; 41(3): 427-433. PMID 28017964
108. Genco A, Cipriano M, Bacci V, et al. BioEnterics Intra-gastric Balloon (BIB): a short-term, double-blind, randomised, controlled, crossover study on weight reduction in morbidly obese patients. *Int J Obes (Lond)*. Jan 2006;30(1):129-133. PMID 16189503
109. Kotzampassi K, Grosomanidis V, Papakostas P, et al. 500 intra-gastric balloons: what happens 5 years thereafter? *Obes Surg*. Jun 2012;22(6):896-903. PMID 22287051
110. Thompson CC, Abu Dayyeh BK, Kushner R, et al. Percutaneous Gastrostomy Device for the Treatment of Class II and Class III Obesity: Results of a Randomized Controlled Trial. *Am J Gastroenterol*. Mar 2017; 112(3): 447-457. PMID 27922026
111. Thompson CC, Abu Dayyeh BK, Kushnir V, et al. Aspiration therapy for the treatment of obesity: 4-year results of a multicenter randomized controlled trial. *Surg Obes Relat Dis*. Aug 2019; 15(8): 1348-1354. PMID 31302000
112. Noren E, Forssell H. Aspiration therapy for obesity; a safe and effective treatment. *BMC Obes*. 2016; 3: 56. PMID 28035287
113. Matar R, Monzer N, Jaruvongvanich V, et al. Indications and Outcomes of Conversion of Sleeve Gastrectomy to Roux-en-Y Gastric Bypass: a Systematic Review and a Meta-analysis. *Obes Surg*. Sep 2021; 31(9): 3936-3946. PMID 34218416
114. Parmar CD, Gan J, Stier C, et al. One Anastomosis/Mini Gastric Bypass (OAGB-MGB) as revisional bariatric surgery after failed primary adjustable gastric band (LAGB) and sleeve gastrectomy (SG): A systematic review of 1075 patients. *Int J Surg*. Sep 2020; 81: 32-38. PMID 32738545
115. Brethauer SA, Kothari S, Sudan R, et al. Systematic review on reoperative bariatric surgery: American Society for Metabolic and Bariatric Surgery Revision Task Force. *Surg Obes Relat Dis*. Sep-Oct 2014;10(5):952-972. PMID 24776071
116. Petrucciani N, Martini F, Benois M, et al. Revisional One Anastomosis Gastric Bypass with a 150-cm Biliopancreatic Limb After Failure of Adjustable Gastric Banding: Mid-Term Outcomes and Comparison Between One- and Two-Stage Approaches. *Obes Surg*. Dec 2021; 31(12): 5330-5341. PMID 34609712
117. Almalki OM, Lee WJ, Chen JC, et al. Revisional Gastric Bypass for Failed Restrictive Procedures: Comparison of Single-Anastomosis (Mini-) and Roux-en-Y Gastric Bypass. *Obes Surg*. Apr 2018; 28(4): 970-975. PMID 29101719
118. Sudan R, Nguyen NT, Hutter MM, et al. Morbidity, mortality, and weight loss outcomes after reoperative bariatric surgery in the USA. *J Gastrointest Surg*. Jan 2015;19(1):171-178; discussion 178-179. PMID 25186073

119. Catalano MF, Rudic G, Anderson AJ, et al. Weight gain after bariatric surgery as a result of a large gastric stoma: endotherapy with sodium morrhuate may prevent the need for surgical revision. *Gastrointest Endosc.* Aug 2007;66(2):240-245. PMID 17331511
120. Herron DM, Birkett DH, Thompson CC, et al. Gastric bypass pouch and stoma reduction using a transoral endoscopic anchor placement system: a feasibility study. *Surg Endosc.* Apr 2008;22(4):1093-1099. PMID 18027049
121. Thompson CC, Slattery J, Bundga ME, et al. Peroral endoscopic reduction of dilated gastrojejunal anastomosis after Roux-en-Y gastric bypass: a possible new option for patients with weight regain. *Surg Endosc.* Nov 2006;20(11):1744-1748. PMID 17024527
122. Eid GM, McCloskey CA, Eagleton JK, et al. StomaphyX vs a sham procedure for revisional surgery to reduce regained weight in Roux-en-Y gastric bypass patients: a randomized clinical trial. *JAMA Surg.* Apr 2014;149(4):372-379. PMID 24554030
123. Dakin GF, Eid G, Mikami D, et al. Endoluminal revision of gastric bypass for weight regain--a systematic review. *Surg Obes Relat Dis.* May-Jun 2013;9(3):335-342. PMID 23561960
124. Cohen RV, Oliveira da Costa MV, Charry L, et al. Endoscopic gastroplasty to treat medically uncontrolled obesity needs more quality data: A systematic review. *Surg Obes Relat Dis.* Jul 2019; 15(7): 1219-1224. PMID 31130406
125. Wu GZ, Cai B, Yu F, et al. Meta-analysis of bariatric surgery versus non-surgical treatment for type 2 diabetes mellitus. *Oncotarget.* Dec 27 2016; 7(52): 87511-87522. PMID 27626180
126. Mingrone G, Panunzi S, De Gaetano 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.* Sep 05 2015; 386(9997): 964-73. PMID 26369473
127. Muller-Stich BP, Senft JD, Warschkow R, et al. Surgical versus medical treatment of type 2 diabetes mellitus in nonseverely obese patients: a systematic review and meta-analysis. *Ann Surg.* Mar 2015;261(3):421-429. PMID 25405560
128. Rao WS, Shan CX, Zhang W, et al. A meta-analysis of short-term outcomes of patients with type 2 diabetes mellitus and BMI \leq 35 kg/m² undergoing Roux-en-Y gastric bypass. *World J Surg.* Jan 2015;39(1):223-230. PMID 25159119
129. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Bariatric Surgery In Patients With Diabetes And Body Mass Index Less Than 35 kg/m² TEC Assessments. 2012;Volume 27:Tab 2.
130. Cummings DE, Cohen RV. Bariatric/Metabolic Surgery to Treat Type 2 Diabetes in Patients With a BMI 35 kg/m². *Diabetes Care.* Jun 2016; 39(6): 924-33. PMID 27222550
131. Cummings DE, Rubino F. Metabolic surgery for the treatment of type 2 diabetes in obese individuals. *Diabetologia.* Feb 2018; 61(2): 257-264. PMID 29224190
132. Simonson DC, Vernon A, Foster K, et al. Adjustable gastric band surgery or medical management in patients with type 2 diabetes and obesity: three-year results of a randomized trial. *Surg Obes Relat Dis.* Dec 2019; 15(12): 2052-2059. PMID 31931977
133. Ikramuddin S, Billington CJ, Lee WJ, et al. Roux-en-Y gastric bypass for diabetes (the Diabetes Surgery Study): 2-year outcomes of a 5-year, randomised, controlled trial. *Lancet Diabetes Endocrinol.* Jun 2015; 3(6): 413-422. PMID 25979364
134. Liang Z, Wu Q, Chen B, et al. Effect of laparoscopic Roux-en-Y gastric bypass surgery on type 2 diabetes mellitus with hypertension: a randomized controlled trial. *Diabetes Res Clin Pract.* Jul 2013;101(1):50-56. PMID 23706413
135. Courcoulas AP, Belle SH, Neiberg RH, et al. Three-Year Outcomes of Bariatric Surgery vs Lifestyle Intervention for Type 2 Diabetes Mellitus Treatment: A Randomized Clinical Trial. *JAMA Surg.* Oct 2015; 150(10): 931-40. PMID 26132586
136. Courcoulas AP, Gallagher JW, Neiberg RH, et al. Bariatric Surgery vs Lifestyle Intervention for Diabetes Treatment: 5-Year Outcomes From a Randomized Trial. *J Clin Endocrinol Metab.* Mar 01 2020; 105(3): 866-76. PMID 31917447
137. Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric Surgery versus Intensive Medical Therapy for Diabetes - 5-Year Outcomes. *N Engl J Med.* Feb 16 2017; 376(7): 641-651. PMID 28199805

138. Wentworth JM, Playfair J, Laurie C, et al. Multidisciplinary diabetes care with and without bariatric surgery in overweight people: a randomised controlled trial. *Lancet Diabetes Endocrinol.* Jul 2014;2(7):545-552. PMID 24731535
139. Halperin F, Ding SA, Simonson DC, et al. Roux-en-Y gastric bypass surgery or lifestyle with intensive medical management in patients with type 2 diabetes: feasibility and 1-year results of a randomized clinical trial. *JAMA Surg.* Jul 2014;149(7):716-726. PMID 24899464
140. Lanzarini E, Csendes A, Gutierrez L, et al. Type 2 diabetes mellitus in patients with mild obesity: preliminary results of surgical treatment. *Obes Surg.* Feb 2013;23(2):234-240. PMID 23054574
141. Boza C, Munoz R, Salinas J, et al. Safety and efficacy of Roux-en-Y gastric bypass to treat type 2 diabetes mellitus in non-severely obese patients. *Obes Surg.* Sep 2011;21(9):1330-1336. PMID 21744283
142. DePaula AL, Stival AR, DePaula CC, et al. Surgical treatment of type 2 diabetes in patients with BMI below 35: mid-term outcomes of the laparoscopic ileal interposition associated with a sleeve gastrectomy in 202 consecutive cases. *J Gastrointest Surg.* May 2012;16(5):967-976. PMID 22350720
143. Lee WJ, Wang W, Lee YC, et al. Effect of laparoscopic mini-gastric bypass for type 2 diabetes mellitus: comparison of BMI>35 and <35 kg/m2. *J Gastrointest Surg.* May 2008;12(5):945-952. PMID 17940829
144. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Laparoscopic adjustable gastric banding in patients with body mass index less than 35 kg/m2 with weight-related comorbidity. *TEC Assessments.* 2012;Volume 27:Tab 3.
145. Qi L, Guo Y, Liu CQ, et al. Effects of bariatric surgery on glycemic and lipid metabolism, surgical complication and quality of life in adolescents with obesity: a systematic review and meta-analysis. *Surg Obes Relat Dis.* Dec 2017; 13(12): 2037-2055. PMID 29079384
146. Black JA, White B, Viner RM, et al. Bariatric surgery for obese children and adolescents: a systematic review and meta-analysis. *Obes Rev.* Aug 2013;14(8):634-644. PMID 23577666
147. Treadwell JR, Sun F, Schoelles K. Systematic review and meta-analysis of bariatric surgery for pediatric obesity. *Ann Surg.* Nov 2008;248(5):763-776. PMID 18948803
148. Dumont PN, Blanchet MC, Gignoux B, et al. Medium- to Long-Term Outcomes of Gastric Banding in Adolescents: a Single-Center Study of 97 Consecutive Patients. *Obes Surg.* Jan 2018; 28(1): 285-289. PMID 29103071
149. Inge TH, Zeller MH, Jenkins TM, et al. Perioperative outcomes of adolescents undergoing bariatric surgery: the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study. *JAMA Pediatr.* Jan 2014;168(1):47-53. PMID 24189578
150. Olbers T, Beamish AJ, Gronowitz E, et al. Laparoscopic Roux-en-Y gastric bypass in adolescents with severe obesity (AMOS): a prospective, 5-year, Swedish nationwide study. *Lancet Diabetes Endocrinol.* Mar 2017; 5(3): 174-183. PMID 28065734
151. Willcox K, Brennan L. Biopsychosocial outcomes of laparoscopic adjustable gastric banding in adolescents: a systematic review of the literature. *Obes Surg.* Sep 2014;24(9):1510-1519. PMID 24849913
152. Nadler EP, Youn HA, Ren CJ, et al. An update on 73 US obese pediatric patients treated with laparoscopic adjustable gastric banding: comorbidity resolution and compliance data. *J Pediatr Surg.* Jan 2008;43(1):141-146. PMID 18206472
153. Manco M, Mosca A, De Peppo F, et al. The Benefit of Sleeve Gastrectomy in Obese Adolescents on Nonalcoholic Steatohepatitis and Hepatic Fibrosis. *J Pediatr.* Jan 2017; 180: 31-37.e2. PMID 27697327
154. Alqahtani AR, Elahmedi M, Abdurabu HY, et al. Ten-Year Outcomes of Children and Adolescents Who Underwent Sleeve Gastrectomy: Weight Loss, Comorbidity Resolution, Adverse Events, and Growth Velocity. *J Am Coll Surg.* Dec 2021; 233(6): 657-664. PMID 34563670
155. Greenstein RJ, Nissan A, Jaffin B. Esophageal anatomy and function in laparoscopic gastric restrictive bariatric surgery: implications for patient selection. *Obes Surg.* Apr 1998;8(2):199-206. PMID 9730394

156. Pilone V, Vitiello A, Hasani A, et al. Laparoscopic adjustable gastric banding outcomes in patients with gastroesophageal reflux disease or hiatal hernia. *Obes Surg*. Feb 2015;25(2):290-294. PMID 25030091
157. Kohn GP, Price RR, DeMeester SR, et al. Guidelines for the management of hiatal hernia. *Surg Endosc*. Dec 2013;27(12):4409-4428. PMID 24018762
158. Chen W, Feng J, Wang C, et al. Effect of Concomitant Laparoscopic Sleeve Gastrectomy and Hiatal Hernia Repair on Gastroesophageal Reflux Disease in Patients with Obesity: a Systematic Review and Meta-analysis. *Obes Surg*. Sep 2021; 31(9): 3905-3918. PMID 34254259
159. Gulkarov I, Wetterau M, Ren CJ, et al. Hiatal hernia repair at the initial laparoscopic adjustable gastric band operation reduces the need for reoperation. *Surg Endosc*. Apr 2008;22(4):1035-1041. PMID 18080712
160. Santonicola A, Angrisani L, Cutolo P, et al. The effect of laparoscopic sleeve gastrectomy with or without hiatal hernia repair on gastroesophageal reflux disease in obese patients. *Surg Obes Relat Dis*. Mar-Apr 2014;10(2):250-255. PMID 24355324
161. Reynoso JF, Goede MR, Tiwari MM, et al. Primary and revisional laparoscopic adjustable gastric band placement in patients with hiatal hernia. *Surg Obes Relat Dis*. May-Jun 2011;7(3):290-294. PMID 21130046
162. Ardestani A, Tavakkoli A. Hiatal hernia repair and gastroesophageal reflux disease in gastric banding patients: analysis of a national database. *Surg Obes Relat Dis*. May-Jun 2014;10(3):438-443. PMID 24680760
163. Frezza EE, Barton A, Wachtel MS. Crural repair permits morbidly obese patients with not large hiatal hernia to choose laparoscopic adjustable banding as a bariatric surgical treatment. *Obes Surg*. May 2008;18(5):583-588. PMID 18317857
164. al-Haddad BJ, Dorman RB, Rasmus NF, et al. Hiatal hernia repair in laparoscopic adjustable gastric banding and laparoscopic Roux-en-Y gastric bypass: a national database analysis. *Obes Surg*. Mar 2014;24(3):377-384. PMID 24307434
165. Garber AJ, Handelsman Y, Grunberger G, et al. CONSENSUS STATEMENT BY THE AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS AND AMERICAN COLLEGE OF ENDOCRINOLOGY ON THE COMPREHENSIVE TYPE 2 DIABETES MANAGEMENT ALGORITHM - 2020 EXECUTIVE SUMMARY. *Endocr Pract*. Jan 2020; 26(1): 107-139. PMID 32022600
166. Blonde L, Umpierrez GE, Reddy SS, et al. American Association of Clinical Endocrinology Clinical Practice Guideline: Developing a Diabetes Mellitus Comprehensive Care Plan-2022 Update. *Endocr Pract*. Oct 2022; 28(10): 923-1049. PMID 35963508
167. Garvey WT, Mechanick JI, Brett EM, et al. AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS AND AMERICAN COLLEGE OF ENDOCRINOLOGY COMPREHENSIVE CLINICAL PRACTICE GUIDELINES FOR MEDICAL CARE OF PATIENTS WITH OBESITYEXECUTIVE SUMMARYComplete Guidelines available at <https://www.aace.com/publications/guidelines>. *Endocr Pract*. Jul 2016; 22(7): 842-84. PMID 27472012
168. Mechanick JI, Apovian C, Brethauer S, et al. CLINICAL PRACTICE GUIDELINES FOR THE PERIOPERATIVE NUTRITION, METABOLIC, AND NONSURGICAL SUPPORT OF PATIENTS UNDERGOING BARIATRIC PROCEDURES - 2019 UPDATE: COSPONSORED BY AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS/AMERICAN COLLEGE OF ENDOCRINOLOGY, THE OBESITY SOCIETY, AMERICAN SOCIETY FOR METABOLIC BARIATRIC SURGERY, OBESITY MEDICINE ASSOCIATION, AND AMERICAN SOCIETY OF ANESTHESIOLOGISTS - EXECUTIVE SUMMARY. *Endocr Pract*. Dec 2019; 25(12): 1346-1359. PMID 31682518
169. Jensen MD, Ryan DH, Apovian CM, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation*. Jun 24 2014; 129(25 Suppl 2): S102-38. PMID 24222017
170. Ali MR, Moustarah F, Kim JJ. American Society for Metabolic and Bariatric Surgery position statement on intragastric balloon therapy endorsed by the Society of American

- Gastrointestinal and Endoscopic Surgeons. *Surg Obes Relat Dis*. Mar-Apr 2016; 12(3): 462-467. PMID 27056407
171. Ali M, El Chaar M, Ghiassi S, et al. American Society for Metabolic and Bariatric Surgery updated position statement on sleeve gastrectomy as a bariatric procedure. *Surg Obes Relat Dis*. Oct 2017; 13(10): 1652-1657. PMID 29054173
 172. Menzo EL, Hinojosa M, Carbonell A, et al. American Society for Metabolic and Bariatric Surgery and American Hernia Society consensus guideline on bariatric surgery and hernia surgery. *Surg Obes Relat Dis*. Sep 2018; 14(9): 1221-1232. PMID 30154033
 173. Kallies K, Rogers AM. American Society for Metabolic and Bariatric Surgery updated statement on single-anastomosis duodenal switch. *Surg Obes Relat Dis*. Jul 2020; 16(7): 825-830. PMID 32371036
 174. Eisenberg D, Shikora SA, Aarts E, et al. 2022 American Society for Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO): Indications for Metabolic and Bariatric Surgery. *Surg Obes Relat Dis*. Dec 2022; 18(12): 1345-1356. PMID 36280539
 175. Mahawar KK, Himpens JM, Shikora SA, et al. The first consensus statement on revisional bariatric surgery using a modified Delphi approach. *Surg Endosc*. Apr 2020; 34(4): 1648-1657. PMID 31218425
 176. Brown WA, de Leon Ballesteros GP, Ooi G, et al. Single Anastomosis Duodenal-Ileal Bypass with Sleeve Gastrectomy/One Anastomosis Duodenal Switch (SADI-S/OADS) IFSO Position Statement-Update 2020. *Obes Surg*. Jan 2021; 31(1): 3-25. PMID 33409979
 177. Childerhose JE, Alsamawi A, Mehta T, et al. Adolescent bariatric surgery: a systematic review of recommendation documents. *Surg Obes Relat Dis*. Oct 2017; 13(10): 1768-1779. PMID 28958402
 178. Armstrong SC, Bolling CF, Michalsky MP, et al. Pediatric Metabolic and Bariatric Surgery: Evidence, Barriers, and Best Practices. *Pediatrics*. Dec 2019; 144(6). PMID 31656225
 179. Hampl SE, Hassink SG, Skinner AC, et al. Clinical Practice Guideline for the Evaluation and Treatment of Children and Adolescents With Obesity. *Pediatrics*. Jan 09 2023. PMID 36622115
 180. Michalsky M, Reichard K, Inge T, et al. ASMBS pediatric committee best practice guidelines. *Surg Obes Relat Dis*. Jan-Feb 2012;8(1):1-7. PMID 22030146
 181. Pratt JSA, Browne A, Browne NT, et al. ASMBS pediatric metabolic and bariatric surgery guidelines, 2018. *Surg Obes Relat Dis*. Jul 2018; 14(7): 882-901. PMID 30077361
 182. August GP, Caprio S, Fennoy I, et al. Prevention and treatment of pediatric obesity: an Endocrine Society clinical practice guideline based on expert opinion. *J Clin Endocrinol Metab*. Dec 2008;93(12):4576-4599. PMID 18782869
 183. Styne DM, Arslanian SA, Connor EL, et al. Pediatric Obesity-Assessment, Treatment, and Prevention: An Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab*. Mar 01 2017; 102(3): 709-757. PMID 28359099
 184. Centers for Medicare and Medicaid Services (CMS). Decision Memo for Bariatric Surgery for the Treatment of Morbid Obesity (CAG-00250R). 2006; <https://www.cms.gov/medicare-coverage-database/details/nca-decision-memo.aspx?NCAId=160>. Accessed January 3, 2023.

Documentation for Clinical Review

Please provide the following documentation:

Initial Bariatric Procedure in Adults with Obesity:

- History and physical and/or consultation notes including prior weight loss attempts and responses, and comorbidities (if needed):
 - A body mass index (BMI) greater than 35.0 kg/m² or for adolescents 140% of the 95th percentile for age and sex (whichever is lower)

OR

- If BMI is greater than or equal to or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) and less than 35.0 kg/m²) or for adolescents 120% of the 95th percentile for age and sex (whichever is lower), documentation of **at least one** of the following comorbidities, including, but not limited to:
 - Coronary artery disease: Submit documentation of **at least one** of the following:
 - Stress study
 - Coronary angiography
 - Heart failure
 - History of prior myocardial infarction
 - Prior coronary artery bypass
 - Prior percutaneous coronary intervention
 - Diabetes: Submit documentation from primary care provider or endocrinologist of the diagnosis and treatment
 - Hypertension: Submit documentation showing a blood pressure of greater than 140 mm Hg systolic and/or 90 mmHg diastolic in spite of concurrent use of at least 3 anti-hypertensive drugs, one of which may be a diuretic
 - Obstructive sleep apnea (OSA): Submit documentation of clinically significant OSA such as an official sleep study report interpreted by a sleep disorders specialist MD or Doctor of Osteopathic (DO) medicine showing an Apnea Hypopnea Index (AHI) of at least 15 events per hour, or at least 5 events per hour in addition to excessive daytime sleepiness or hypertension; or obesity hypoventilation syndrome as shown by an awake arterial blood gas or serum bicarbonate level
 - Osteoarthritis: Submit documentation that includes radiographic reports confirming the diagnosis
 - Hyperlipidemia: Submit documentation of an LDL cholesterol of 160 mg/dl or higher despite dieting and medical treatment
 - GastroEsophageal Reflux Disease (GERD): Submit documentation showing endoscopic findings or an ambulatory pH monitoring report that supports the diagnosis and failure of maximal medical therapy
 - Idiopathic intracranial hypertension: Submit documentation showing laboratory or imaging findings that supports diagnosis
 - Nonalcoholic steatohepatitis: Submit documentation showing laboratory, imaging or pathology findings that confirms diagnosis
 - Blount disease: Submit documentation showing history, physical or imaging findings that supports diagnosis
 - Slipped capital femoral epiphysis: Submit documentation showing imaging findings that supports diagnosis
- Description of medically supervised non-surgical weight-reduction program, initial weight, end weight, duration (start and end dates)) and any pharmacologic agents used (including intolerance if applicable)
- Documented failure of weight reduction to a BMI less than 30 kg/m² (27.5 kg/m² for Asian individuals) by conservative measures for 3 of the past 6 months
- Medical records that include current height, weight, and body mass index (BMI), surgery requested, and any other recommendations
- Documented educational counseling/class
- Signed Psychosocial-behavioral checklist
- Signed Pre-operative checklist

Revision Bariatric Surgical Requests for Complications:

- Documentation of the problem needing correction (history and physical and/or consultation notes including: prior surgery and complications as applicable, indication for surgery, and treatment plan), which may include, but are not limited to:
 - Staple-line failure or leakage

- Obstruction, stricture, erosion, or fistula
- Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett's esophagus, or esophagitis and failing maximal medical therapy
- Pouch enlargement documented by endoscopy and prior successful weight loss
- Nonabsorption resulting in hypoglycemia or malnutrition
- Weight loss of 20% or more below ideal body weight
- Band slippage or herniation that cannot be corrected with manipulation or adjustment

Revision Bariatric Surgical Requests for Inadequate Weight Loss:

- Documentation requested for Initial Bariatric Procedure in Adults with Morbid Obesity
- Post-surgical weight loss history (including pre- and post-surgical BMI), nutrition and exercise compliance
- Operative report(s) (if applicable)
- Documentation at least 2 years have passed since the initial procedure
- Inadequate weight loss resulted from initial procedure; less than 50% expected weight loss and/or weight remains greater than 40% over ideal body weight (normal body weight BMI parameter = 18.5-24.9)

Bariatric Surgery in Adolescents:

- Documentation requested for Initial Bariatric Procedure in Adults with Obesity
- Documentation of psychological counseling
- Documentation of informed consent
- Documentation that any device used for bariatric surgery is in accordance with the FDA-approved indication for use

Concomitant Hiatal Hernia Repair:

- Documentation of preoperatively-diagnosed hiatal hernia with indications for surgical repair

Coding

This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy.

The following codes are included below for informational purposes. Inclusion or exclusion of a code(s) does not constitute or imply member coverage or provider reimbursement policy. Policy Statements are intended to provide member coverage information and may include the use of some codes for clarity. The Policy Guidelines section may also provide additional information for how to interpret the Policy Statements and to provide coding guidance in some cases.

Type	Code	Description
CPT®	43290	Esophagogastroduodenoscopy, flexible, transoral; with deployment of intragastric bariatric balloon (Code effective 1/1/2023)
	43291	Esophagogastroduodenoscopy, flexible, transoral; with removal of intragastric bariatric balloon(s) (Code effective 1/1/2023)
	43632	Gastrectomy, partial, distal; with gastrojejunostomy
	43644	Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and Roux-en-Y gastroenterostomy (roux limb 150 cm or less)
	43645	Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and small intestine reconstruction to limit absorption
	43659	Unlisted laparoscopy procedure, stomach

Type	Code	Description
	43770	Laparoscopy, surgical, gastric restrictive procedure; placement of adjustable gastric restrictive device (e.g., gastric band and subcutaneous port components)
	43771	Laparoscopy, surgical, gastric restrictive procedure; revision of adjustable gastric restrictive device component only
	43772	Laparoscopy, surgical, gastric restrictive procedure; removal of adjustable gastric restrictive device component only
	43773	Laparoscopy, surgical, gastric restrictive procedure; removal and replacement of adjustable gastric restrictive device component only
	43774	Laparoscopy, surgical, gastric restrictive procedure; removal of adjustable gastric restrictive device and subcutaneous port components
	43775	Laparoscopy, surgical, gastric restrictive procedure; longitudinal gastrectomy (i.e., sleeve gastrectomy)
	43842	Gastric restrictive procedure, without gastric bypass, for morbid obesity; vertical-banded gastroplasty
	43843	Gastric restrictive procedure, without gastric bypass, for morbid obesity; other than vertical-banded gastroplasty
	43845	Gastric restrictive procedure with partial gastrectomy, pylorus-preserving duodenoileostomy and ileoileostomy (50 to 100 cm common channel) to limit absorption (biliopancreatic diversion with duodenal switch)
	43846	Gastric restrictive procedure, with gastric bypass for morbid obesity; with short limb (150 cm or less) Roux-en-Y gastroenterostomy
	43847	Gastric restrictive procedure, with gastric bypass for morbid obesity; with small intestine reconstruction to limit absorption
	43848	Revision, open, of gastric restrictive procedure for morbid obesity, other than adjustable gastric restrictive device (separate procedure)
	43860	Revision of gastrojejunal anastomosis (gastrojejunostomy) with reconstruction, with or without partial gastrectomy or intestine resection; without vagotomy
	43865	Revision of gastrojejunal anastomosis (gastrojejunostomy) with reconstruction, with or without partial gastrectomy or intestine resection; with vagotomy
	43886	Gastric restrictive procedure, open; revision of subcutaneous port component only
	43887	Gastric restrictive procedure, open; removal of subcutaneous port component only
	43888	Gastric restrictive procedure, open; removal and replacement of subcutaneous port component only
	43999	Unlisted procedure, stomach
HCPCS	C9784	Gastric restrictive procedure, endoscopic sleeve gastroplasty, with esophagogastroduodenoscopy and intraluminal tube insertion, if performed, including all system and tissue anchoring components (Code effective 7/1/2023)
	C9785	Endoscopic outlet reduction, gastric pouch application, with endoscopy and intraluminal tube insertion, if performed, including all system and tissue anchoring components (Code effective 7/1/2023)

Policy History

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

Effective Date	Action
04/14/1970	New Policy Adoption
02/26/1997	Policy Review
11/10/1999	Administrative Review External Review of policy
04/17/2000	Administrative Review Deleted Metropolitan Tables
01/22/2001	Administrative Review Morbid Obesity definition
02/13/2002	BCBSA Medical Policy adoption Open and Laparoscopic adjustable silicone gastric banding
04/17/2002	Administrative Review Distal Gastric Bypass with Duodenal Switch clarification
08/01/2002	Coding Update
09/01/2003	Policy Revision Updated
12/01/2003	Policy Revision Updated
02/01/2004	Policy Revision Updated Duodenal Switch
06/01/2004	Policy Revision Coding update Laparoscopic Gastric Banding CTAF update
01/01/2005	Policy Revision Coding update
09/01/2005	Policy Revision External review and recommendations for revision to policy statement: Duodenal Switch
12/01/2005	Policy Statement Revision
03/01/2006	Policy Revision Policy Statement Revision for Duodenal Switch and Lap Gastric Bypass Coding update
06/01/2006	Policy Name Change
12/07/2006	BCBSA Medical Policy adoption
03/12/2007	Policy Review CTAF review
03/24/2008	Coding Update
07/08/2008	Policy Revision Added lap banding adjustment, rationale, references Coding update
09/25/2009	Policy Title Revision Criteria revised
02/05/2010	Policy revision with position change Coding update
08/06/2010	Policy revision with position change
09/13/2010	Documentation required for clinical review update
11/04/2010	Policy revision for clarification of criteria
11/12/2010	Policy revision for clarification of criteria

Effective Date	Action
04/01/2011	Policy revision for clarification of criteria
06/28/2013	Coding update
04/30/2015	Policy revision with position change effective 6/30/2015
06/30/2015	Policy revision with position change
07/31/2015	Policy clarification update
06/01/2016	Policy revision without position change
05/01/2017	Policy revision without position change
12/01/2017	Policy revision without position change
04/01/2018	Policy revision without position change
11/01/2018	Policy statement clarification
04/01/2019	Policy revision without position change
05/01/2020	Annual Review. Policy statement, guidelines and literature updated.
04/01/2021	Annual Review. No change to policy statement. Policy guidelines and literature updated.
02/01/2022	Coding update.
05/01/2022	Annual review. No change to policy statement. Literature review updated.
01/01/2023	Annual review. Policy statement and guidelines updated.
02/01/2023	Policy statement updated. Coding update.
05/01/2023	Policy statement, guidelines and literature updated.
08/01/2023	Policy statement and guidelines updated. Coding update.
10/01/2023	Policy statement updated.

Definitions of Decision Determinations

Medically Necessary: Services that are Medically Necessary include only those which have been established as safe and effective, are furnished under generally accepted professional standards to treat illness, injury or medical condition, and which, as determined by Blue Shield, are: (a) consistent with Blue Shield medical policy; (b) consistent with the symptoms or diagnosis; (c) not furnished primarily for the convenience of the patient, the attending Physician or other provider; (d) furnished at the most appropriate level which can be provided safely and effectively to the patient; and (e) not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of the Member's illness, injury, or disease.

Investigational/Experimental: A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

Split Evaluation: Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

Prior Authorization Requirements and Feedback (as applicable to your plan)

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member's health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member's eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department at (800) 541-6652, or the Transplant Case Management Department at (800) 637-2066 ext. 3507708 or visit the provider portal at www.blueshieldca.com/provider.

We are interested in receiving feedback relative to developing, adopting, and reviewing criteria for medical policy. Any licensed practitioner who is contracted with Blue Shield of California or Blue Shield of California Promise Health Plan is welcome to provide comments, suggestions, or concerns. Our internal policy committees will receive and take your comments into consideration.

For utilization and medical policy feedback, please send comments to: MedPolicy@blueshieldca.com

Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.

Appendix A

POLICY STATEMENT	
BEFORE Red font: Verbiage removed	AFTER
<p>Bariatric Surgery 7.01.47</p> <p>Policy Statement: Initial Bariatric Procedure</p> <ol style="list-style-type: none"> I. Bariatric surgery for the treatment of adult or adolescents with obesity may be considered medically necessary when all of the following criteria are met: <ol style="list-style-type: none"> A. Documentation of either of the following: <ol style="list-style-type: none"> 1. A body mass index (BMI) greater than or equal to 35 kg/m² or for adolescents 140% of the 95th percentile for age and sex (whichever is lower) 2. A BMI greater than or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) or for adolescents 120% of the 95th percentile for age and sex (whichever is lower) with at least one clinically significant obesity-related disease, including but not limited to: <ol style="list-style-type: none"> a. Type 1 or 2 diabetes mellitus b. <u>Clinically significant obstructive sleep apnea</u> ; or <u>obesity hypoventilation syndrome</u> c. Coronary artery disease, with documentation of atherosclerotic heart disease as evidenced by any of the following: <ol style="list-style-type: none"> i. Stress study ii. Coronary angiography iii. History of heart failure iv. History of myocardial infarction v. Prior coronary artery bypass vi. Prior percutaneous coronary intervention (PCI) d. Hypertension (blood pressure greater than 140 mmHg systolic and/or 90 mmHg diastolic in spite of the concurrent use of at least 3 anti-hypertensive drugs, one of which may be a diuretic) e. Painful or activity-limiting osteoarthritis involving the lower extremities, with radiographic documentation of 	<p>Bariatric Surgery 7.01.47</p> <p>Policy Statement: Initial Bariatric Procedure</p> <ol style="list-style-type: none"> I. Bariatric surgery for the treatment of adult or adolescents with obesity may be considered medically necessary when all of the following criteria are met: <ol style="list-style-type: none"> A. Documentation of either of the following: <ol style="list-style-type: none"> 1. A body mass index (BMI) greater than or equal to 35 kg/m² or for adolescents 140% of the 95th percentile for age and sex (whichever is lower) 2. A BMI greater than or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) or for adolescents 120% of the 95th percentile for age and sex (whichever is lower) with at least one clinically significant obesity-related disease, including but not limited to: <ol style="list-style-type: none"> a. Type 1 or 2 diabetes mellitus b. <u>Clinically significant obstructive sleep apnea</u> ; or <u>obesity hypoventilation syndrome</u> c. Coronary artery disease, with documentation of atherosclerotic heart disease as evidenced by any of the following: <ol style="list-style-type: none"> i. Stress study ii. Coronary angiography iii. History of heart failure iv. History of myocardial infarction v. Prior coronary artery bypass vi. Prior percutaneous coronary intervention (PCI) d. Hypertension (blood pressure greater than 140 mmHg systolic and/or 90 mmHg diastolic in spite of the concurrent use of at least 3 anti-hypertensive drugs, one of which may be a diuretic) e. Painful or activity-limiting osteoarthritis involving the lower extremities, with radiographic documentation of

POLICY STATEMENT

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<p>joint space narrowing, osteophytes, subluxation, or subchondral sclerosis</p> <ul style="list-style-type: none"> f. Hyperlipidemia (LDL cholesterol of 160 mg/dL or higher), uncontrolled by diet and medical therapy g. Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy (e.g., proton pump inhibitors, H2 blockers, and/or prokinetic agents titrated to maximal recommended dosages) h. Idiopathic intracranial hypertension i. Nonalcoholic steatohepatitis j. Blount disease k. Slipped capital femoral epiphysis <p>B. The individual has failed weight loss to a BMI less than required for approval (e.g., for adults, 30 kg/m² or 27.5 kg/m² for Asian individuals) at the time of surgery by conservative measures for at least 6 months (may be done at the same time as pharmacologic treatment, despite one of the following:</p> <ul style="list-style-type: none"> 1. Documentation of participation in a structured provider-supervised weight-loss program including an exercise and nutrition program with at least 3 visits including weight measurement 2. Serially-charted documentation, including notes from three clinician-directed follow-up visits including weight measurement, of participation in another managed weight-loss program including dietary control and exercise (commercial, dietician, or diabetes management programs) <p>C. Failed prescription pharmacologic treatment (including but not limited to documented intolerance of at least 2 different agents) of at least one year by not achieving weight loss below a BMI of 30 kg/m² (27.5 kg/m² for Asian individuals) or failing to maintain weight loss below 30 kg/m² (27.5 kg/m² for Asian individuals) despite ongoing treatment</p> <p>D. The individual has been evaluated for, and has received, maximal therapy for any secondary (e.g., endocrine) causes of</p>	<p>joint space narrowing, osteophytes, subluxation, or subchondral sclerosis</p> <ul style="list-style-type: none"> f. Hyperlipidemia (LDL cholesterol of 160 mg/dL or higher), uncontrolled by diet and medical therapy g. Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy (e.g., proton pump inhibitors, H2 blockers, and/or prokinetic agents titrated to maximal recommended dosages) h. Idiopathic intracranial hypertension i. Nonalcoholic steatohepatitis j. Blount disease k. Slipped capital femoral epiphysis <p>B. The individual has failed weight loss to a BMI less than required for approval (e.g., for adults, 30 kg/m² or 27.5 kg/m² for Asian individuals) at the time of surgery by conservative measures for at least 6 months (may be done at the same time as pharmacologic treatment, despite one of the following:</p> <ul style="list-style-type: none"> 1. Documentation of participation in a structured provider-supervised weight-loss program including an exercise and nutrition program with at least 3 visits including weight measurement 2. Serially-charted documentation, including notes from three clinician-directed follow-up visits including weight measurement, of participation in another managed weight-loss program including dietary control and exercise (commercial, dietician, or diabetes management programs) <p>C. The individual has been evaluated for, and has received, maximal therapy for any secondary (e.g., endocrine) causes of</p>

POLICY STATEMENT

BEFORE Red font: Verbiage removed	AFTER
<p>obesity, has been evaluated for and treated for any pulmonary, gastrointestinal (including GERD), neoplastic, and cardiac co-morbidities which may impact surgery, and has been medically cleared for surgery, as documented in the Pre-Operative Checklist</p> <p>E. The individual has received a comprehensive psychosocial-behavioral evaluation signed by a qualified mental health professional clearing the individual for surgery, as documented in the Psychosocial-Behavioral Checklist</p> <p>F. The individual has undergone educational counseling or a formal class giving a comprehensive understanding of the available bariatric surgery procedures, of how the individual's life will be changed after surgery, the morbidity and mortality associated with this surgery, and the commitment required to make the lifestyle changes necessary to maintain the health improvements achieved through surgery</p> <p>G. No tobacco smoking for at least 6 weeks prior to surgery</p> <p>H. No ongoing alcohol or drug abuse or treatment within the past year</p> <p>I. The bariatric surgery is performed by properly credentialed surgeons, and preferably at Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) accredited hospitals that follow the American Society for Metabolic and Bariatric Surgery (ASMBS) guidelines, including a multidisciplinary program experienced in obesity surgery that can provide all of the following:</p> <ol style="list-style-type: none"> 1. Nutritional counseling 2. Exercise counseling 3. Long-term monitoring including both of the following: <ol style="list-style-type: none"> a. Psychosocial counseling b. Support group meetings 	<p>obesity, has been evaluated for and treated for any pulmonary, gastrointestinal (including GERD), neoplastic, and cardiac co-morbidities which may impact surgery, and has been medically cleared for surgery, as documented in the Pre-Operative Checklist</p> <p>D. The individual has received a comprehensive psychosocial-behavioral evaluation signed by a qualified mental health professional clearing the individual for surgery, as documented in the Psychosocial-Behavioral Checklist</p> <p>E. The individual has undergone educational counseling or a formal class giving a comprehensive understanding of the available bariatric surgery procedures, of how the individual's life will be changed after surgery, the morbidity and mortality associated with this surgery, and the commitment required to make the lifestyle changes necessary to maintain the health improvements achieved through surgery</p> <p>F. No tobacco smoking for at least 6 weeks prior to surgery</p> <p>G. No ongoing alcohol or drug abuse or treatment within the past year</p> <p>H. The bariatric surgery is performed by properly credentialed surgeons, and preferably at Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) accredited hospitals that follow the American Society for Metabolic and Bariatric Surgery (ASMBS) guidelines, including a multidisciplinary program experienced in obesity surgery that can provide all of the following:</p> <ol style="list-style-type: none"> 1. Nutritional counseling 2. Exercise counseling 3. Long-term monitoring including both of the following: <ol style="list-style-type: none"> a. Psychosocial counseling b. Support group meetings
<p>Revision Bariatric Surgery for Complications</p> <p>II. The first (or a subsequent) revision surgery to address perioperative or late complications of a bariatric procedure may be considered</p>	<p>Revision Bariatric Surgery for Complications</p> <p>II. The first (or a subsequent) revision surgery to address perioperative or late complications of a bariatric procedure may be considered</p>

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<p>medically necessary, provided that these complications include, but are not limited to at least one of the following:</p> <ul style="list-style-type: none"> A. Band slippage or herniation that cannot be corrected with manipulation or adjustment B. Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy C. Nonabsorption resulting in hypoglycemia or malnutrition D. Obstruction, stricture, erosion, or fistula E. Staple-line failure or leakage F. Dilatation of the gastric pouch or dilation proximal to an adjustable gastric band (documented by upper gastrointestinal examination or endoscopy) if the initial procedure was successful in inducing weight loss prior to pouch dilation G. Weight loss of 20% or more below ideal body weight <p>Revision Bariatric Surgery for Inadequate Weight Loss</p> <p>III. Revision of a primary or a subsequent bariatric procedure that has failed due to inadequate weight loss may be considered medically necessary when all of the following are met:</p> <ul style="list-style-type: none"> A. All initial primary bariatric surgery qualification criteria have been satisfied (see Initial Bariatric Procedure above) B. Two years have elapsed since prior bariatric surgery C. Inadequate weight loss resulted from initial procedure; less than 50% expected weight loss and/or weight remains greater than 40% over ideal body weight (normal body weight BMI parameter = 18.5-24.9) D. Ineffective weight loss attempts within the year prior to revision surgery, including but not limited to compliance with previous post operative nutrition plan and exercise program is documented <p>Bariatric Surgery in Preadolescent Children</p> <p>IV. Bariatric surgery is considered investigational for the treatment of obesity in preadolescent children.</p>	<p>medically necessary, provided that these complications include, but are not limited to at least one of the following:</p> <ul style="list-style-type: none"> A. Band slippage or herniation that cannot be corrected with manipulation or adjustment B. Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy C. Nonabsorption resulting in hypoglycemia or malnutrition D. Obstruction, stricture, erosion, or fistula E. Staple-line failure or leakage F. Dilatation of the gastric pouch or dilation proximal to an adjustable gastric band (documented by upper gastrointestinal examination or endoscopy) if the initial procedure was successful in inducing weight loss prior to pouch dilation G. Weight loss of 20% or more below ideal body weight <p>Revision Bariatric Surgery for Inadequate Weight Loss</p> <p>III. Revision of a primary or a subsequent bariatric procedure that has failed due to inadequate weight loss may be considered medically necessary when all of the following are met:</p> <ul style="list-style-type: none"> A. All initial primary bariatric surgery qualification criteria have been satisfied (see Initial Bariatric Procedure above) B. Two years have elapsed since prior bariatric surgery C. Inadequate weight loss resulted from initial procedure; less than 50% expected weight loss and/or weight remains greater than 40% over ideal body weight (normal body weight BMI parameter = 18.5-24.9) D. Ineffective weight loss attempts within the year prior to revision surgery, including but not limited to compliance with previous post operative nutrition plan and exercise program is documented <p>Bariatric Surgery in Preadolescent Children</p> <p>IV. Bariatric surgery is considered investigational for the treatment of obesity in preadolescent children.</p>

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<p>Concomitant Hiatal Hernia Repair With Bariatric Surgery</p> <p>V. Repair of a hiatal hernia at the time of bariatric surgery may be considered medically necessary for individuals who have a preoperatively diagnosed hiatal hernia with indications for surgical repair.</p> <p>VI. Repair of a hiatal hernia that is diagnosed at the time of bariatric surgery, or repair of a preoperatively diagnosed hiatal hernia in individuals who do not have indications for surgical repair, is considered investigational.</p> <p>Other Bariatric Surgery Procedures</p> <p>VII. Any of the following bariatric surgery procedures are considered investigational for the treatment of obesity in adults who have failed weight loss by conservative measures:</p> <ol style="list-style-type: none"> A. Vertical-banded gastroplasty B. Gastric bypass using a Billroth II type of anastomosis (mini-gastric bypass) C. Biliopancreatic diversion without duodenal switch D. Long-limb gastric bypass procedure (i.e., greater than 150 cm) E. Single anastomosis duodenoileal bypass with sleeve gastrectomy F. Two-stage bariatric surgery procedures (e.g., sleeve gastrectomy as initial procedure followed by biliopancreatic diversion at a later time) G. Laparoscopic gastric plication H. Endoscopic procedures as a primary bariatric procedure or as a revision procedure (i.e., to treat weight gain after bariatric surgery to remedy large gastric stoma or large gastric pouches) including but not limited to: <ol style="list-style-type: none"> 1. Insertion of the StomaphyX™ device 2. Insertion of a gastric balloon 3. Endoscopic gastroplasty 4. Use of an endoscopically placed duodenojejunal sleeve 5. Laparoscopic gastric plication 	<p>Concomitant Hiatal Hernia Repair With Bariatric Surgery</p> <p>V. Repair of a hiatal hernia at the time of bariatric surgery may be considered medically necessary for individuals who have a preoperatively diagnosed hiatal hernia with indications for surgical repair.</p> <p>VI. Repair of a hiatal hernia that is diagnosed at the time of bariatric surgery, or repair of a preoperatively diagnosed hiatal hernia in individuals who do not have indications for surgical repair, is considered investigational.</p> <p>Other Bariatric Surgery Procedures</p> <p>VII. Any of the following bariatric surgery procedures are considered investigational for the treatment of obesity in adults who have failed weight loss by conservative measures:</p> <ol style="list-style-type: none"> A. Vertical-banded gastroplasty B. Gastric bypass using a Billroth II type of anastomosis (mini-gastric bypass) C. Biliopancreatic diversion without duodenal switch D. Long-limb gastric bypass procedure (i.e., greater than 150 cm) E. Single anastomosis duodenoileal bypass with sleeve gastrectomy F. Two-stage bariatric surgery procedures (e.g., sleeve gastrectomy as initial procedure followed by biliopancreatic diversion at a later time) G. Laparoscopic gastric plication H. Endoscopic procedures as a primary bariatric procedure or as a revision procedure (i.e., to treat weight gain after bariatric surgery to remedy large gastric stoma or large gastric pouches) including but not limited to: <ol style="list-style-type: none"> 1. Insertion of the StomaphyX™ device 2. Insertion of a gastric balloon 3. Endoscopic gastroplasty 4. Use of an endoscopically placed duodenojejunal sleeve 5. Laparoscopic gastric plication

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<p>6. Aspiration therapy device</p> <p>Bariatric Surgery Contraindications</p> <p>VIII. Bariatric surgery is considered investigational for any of the following:</p> <ul style="list-style-type: none"> A. Individuals with a body mass index less than or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) at the time of surgery B. Individuals who are pregnant C. Individuals with typical major surgery contraindications (active infection, uncontrolled bleeding diathesis, device allergies, etc.) D. Individuals with ongoing, current (within 6 weeks) use of tobacco products or with history of recent (within 1 year) alcohol or drug abuse E. Individuals with an untreated or uncontrolled DSM-5 psychiatric disorder limiting compliance with medical and dietary post-surgical requirements F. Individuals unwilling to comply with post-surgical medical and dietary requirements and required follow-up appointments 	<p>6. Aspiration therapy device</p> <p>Bariatric Surgery Contraindications</p> <p>VIII. Bariatric surgery is considered investigational for any of the following:</p> <ul style="list-style-type: none"> A. Individuals with a body mass index less than or equal to 30 kg/m² (27.5 kg/m² for Asian individuals) at the time of surgery B. Individuals who are pregnant C. Individuals with typical major surgery contraindications (active infection, uncontrolled bleeding diathesis, device allergies, etc.) D. Individuals with ongoing, current (within 6 weeks) use of tobacco products or with history of recent (within 1 year) alcohol or drug abuse E. Individuals with an untreated or uncontrolled DSM-5 psychiatric disorder limiting compliance with medical and dietary post-surgical requirements F. Individuals unwilling to comply with post-surgical medical and dietary requirements and required follow-up appointments