

2. Overview of Bariatric Operations

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A. Overview of Bariatric Surgery

Overweight, obesity, and morbid obesity, defined as body mass indices greater than or equal to 25, 30, and 40 kg/m², respectively, constitute a burgeoning global epidemic. Approximately 30% of Americans are obese, of whom over 5 million suffer from morbid obesity. For the latter cohort, bariatric surgery is the only effective means to achieve significant weight loss with improvement or resolution of comorbid diseases. The field of bariatric surgery began over 50 years ago and has grown steadily and, over the last decade, explosively, with over 100,000 procedures performed annually in the United States.

The purpose of this chapter is to present the reader with a framework for understanding the numerous described bariatric surgical procedures along with their historical development. The evolution of these operations has not been a linear process, as previously abandoned procedures have been modified and re-introduced. As newer technologies emerge, this framework will permit the reader to compare their function, advantages, and limits of use to existing procedures.

Bariatric operations are classified as purely malabsorptive, purely restrictive, or combined malabsorptive-restrictive (Fig. 2.1). An additional category, entitled “miscellaneous,” contains the procedures that do not fit into the three standard classes. Note that no distinction between “laparoscopic” or “open” procedures is made, since these are merely approaches to perform a given procedure. The advantages of a laparoscopic approach (less pain, faster recovery, and fewer wound-related complications) are well established and require no further discussion here. The bariatric surgeon requires a thorough understanding of the recognized operations and, based on his or her ability, may perform them utilizing a laparoscope or a laparotomy.

B. Purely malabsorptive procedures

Purely malabsorptive procedures were initially popular in the 1960s and 1970s. Because of the risk of vitamin and protein deficiencies as well as diarrheal issues, these procedures are no longer performed as primary bariatric surgery in the United States.

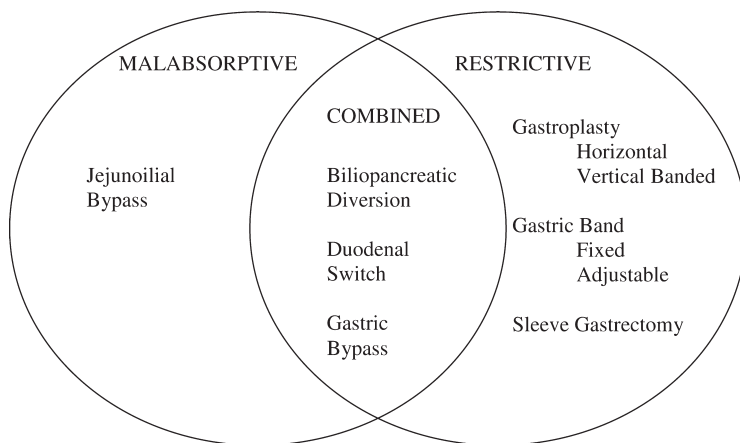


Figure 2.1. Venn diagram of the recognized bariatric operations.

1. Jejunioileal bypass

- a. Development. The first surgical procedure performed on a large scale to treat obesity was the jejunioileal bypass (JIB). Early animal studies began at the University of Minnesota in 1953 and led to the first published clinical series by Kremen in 1954, who performed an end-to-end jejunioileostomy with drainage of the bypassed bowel into the colon. Severe complications and early failures led to the development of the classic 14-4 end-to-side jejunioileostomy.
- b. Technique. The proximal jejunum is divided 14 inches (35.5 cm) from the ligament of Treitz and anastomosed to the terminal ileum 4 inches (10 cm) proximal to the ileocecal valve (Fig. 2.2).
- c. Outcome. Approximately 25,000 patients have undergone a JIB. Patients achieved roughly 50% of excess body weight loss (EBWL). Malabsorptive side effects were significant, with severe electrolyte, nutrient and vitamin deficiencies; protein-energy malnutrition with alopecia and liver failure; renal oxalate urolithiasis from intestinal binding of dietary calcium by fatty acids; polyarthropathy by circulating immune complexes from bacterial proliferation and absorption in the bypassed limb; and socially impairing profuse and foul-smelling diarrhea from malabsorption of fat.
- d. Current status. This operation has been abandoned since the early 1980s and most of the patients are thought to have been reversed or revised to other procedures. Our knowledge of intestinal malabsorption and, in particular, bypass enteritis has been significantly advanced from this procedure. Today, all bariatric procedures have intestinal limbs through which pass either food or bile so as to avoid the blind loop.

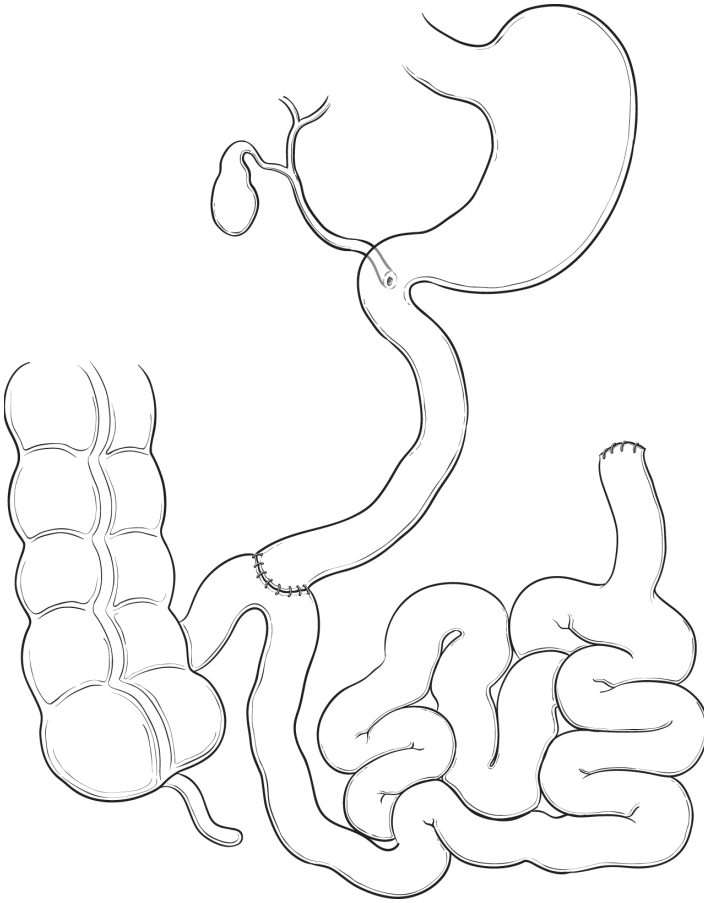


Figure 2.2. Jejunoileal bypass.

C. Combined Restrictive–Malabsorptive Procedures

1. Biliopancreatic diversion

- a. Development. Scopinaro first described this procedure in 1979, which was designed to enhance the benefits of a malabsorptive procedure while minimizing the profile of side effects. Although the procedure involves a hemigastrectomy, leaving a 250- to 500-ml pouch, the restriction of this procedure is limited as the stomach stretches, and the long-term weight loss and comorbidity resolution is attributed to the

significant malabsorption. Distal gastrectomy is essential so as not to leave an intact antrum leading to uninhibited gastrin secretion with marginal ulcer formation, otherwise known as the “retained antrum syndrome.” Adequate pouch size is similarly essential in order to counteract protein and macronutrient malabsorption by increasing intake. Scopinaro hypothesized that direct contact of undigested food with the ileal mucosa is thought to cause early satiety and, in the initial postoperative period, mild discomfort and vomiting; a state referred to as the “post-cibal syndrome.”

- b. Technique. Distal gastrectomy including the pylorus is performed, leaving a 250- to 500-ml proximal gastric pouch. The ileum is divided 250 cm proximal to the ileocecal valve and the distal stump is anastomosed to the gastric pouch. The proximal stump (biliopancreatic limb) is anastomosed to the distal ileum 50 cm from the ileocecal valve (Fig. 2.3).
- c. Outcome. Two large series of patients with 15-year follow-up demonstrated approximately 71% EBWL regardless of preoperative BMI and comorbidity resolution that was equal or superior to results following gastric bypass. Morbidity occurs in 30%, including protein-energy malnutrition in 12.6%, ulcers in 8.3%, and a perioperative mortality of 1.3%.
- d. Current status. The BPD achieves excellent weight loss and comorbidity resolution even in the superobese; however, mortality and long-term morbidity rates that exceed other bariatric procedures have tempered the enthusiasm for this procedure in North America. Most surgeons who advocated a preference for the BPD have migrated in favor of the duodenal switch (see the following).

2. Duodenal switch

- a. Development. DeMeester first described this surgery in 1987 to treat bile reflux; however, Hess and Hess are credited with the first series of the duodenal switch (DS) to treat obesity in 1988. The DS has been lauded as a safer alternative to the BPD, with less malabsorption (and hence fewer malabsorptive sequelae), greater restriction, less marginal ulceration, less dumping, and lower perioperative mortality.
- b. Technique. A sleeve gastrectomy is performed leaving a 200-ml gastric reservoir with the pylorus included in the alimentary limb. The duodenum is divided just distal to the pylorus and anastomosed to the ileum 250 cm proximal to the ileocecal valve. The biliopancreatic limb is then anastomosed to the ileum 100 cm from the ileocecal valve (Fig. 2.4).
- c. Outcome. The 100-cm common channel of the DS has led to significantly fewer malabsorptive complications, such as fewer bowel movements per day and lower incidence of iron, calcium, and vitamin A deficiency when compared with BPD. Percent EWL is approximately 73% at 4 years, which is roughly equivalent to BPD.
- d. Current status. Most surgeons who once advocated for BPD have migrated to the DS camp. Overall this represents a minority of North American bariatric surgeons. Since the weight loss in the superobese (BMI > 50) exceeds that found in Roux-en-Y gastric bypass, some

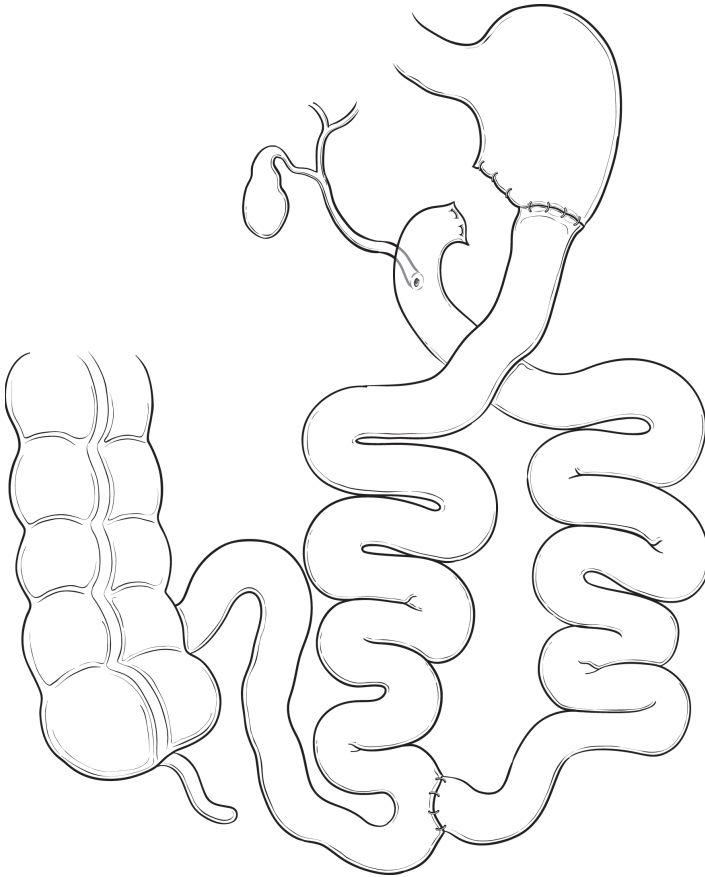


Figure 2.3. Biliopancreatic diversion.

surgeons have advocated for this technique in this group of patients either as a single- or two-staged procedure. Others have performed DS as a secondary procedure following other failed bariatric operations.

3. Gastric bypass

- a. Development. Mason and Ito are credited with the first gastric bypass (GBP) for morbid obesity in 1966. Their operation included a horizontal gastric pouch with a 100- to 150-ml reservoir anastomosed to a loop of jejunum. This operation has evolved over the last four decades into what is considered the gold standard bariatric procedure to which all other procedures are compared. The fundamental modifications

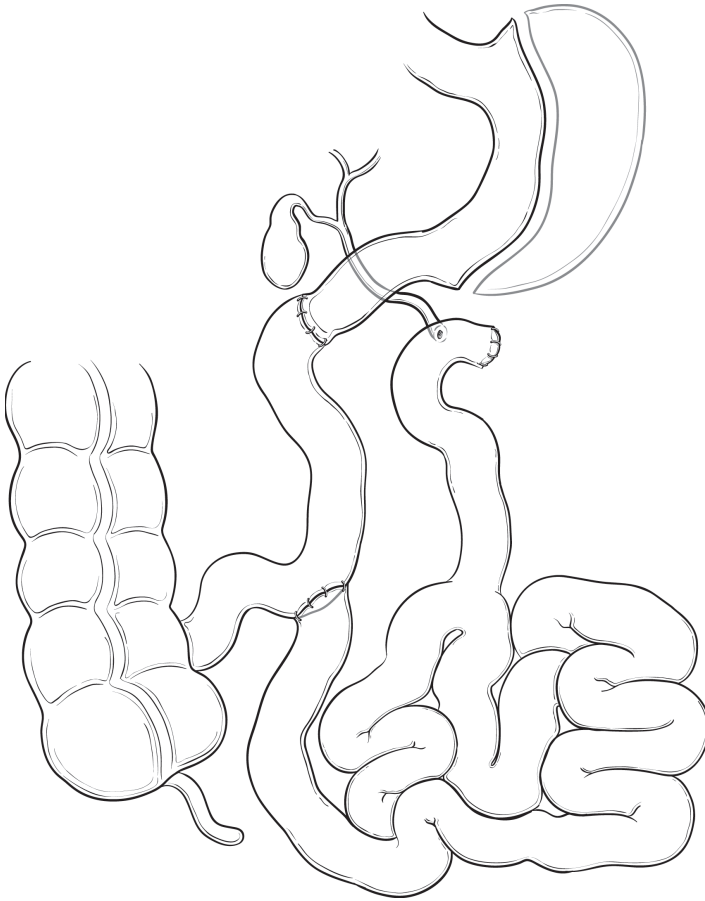


Figure 2.4. Duodenal switch.

included a Roux-en-Y drainage, vertical pouch based on the less-distensible lesser curvature, isolated gastric pouch (divided from the gastric remnant) with less than 30-ml volume and a 10- to 15-mm anastomosis. Brolin randomized superobese patients (BMI > 50) to 75 vs. 150 cm alimentary (Roux) limb lengths and found significantly improved excess weight loss at 2 years (50% vs. 64%, respectively).

- b. Technique. The gastric pouch is created by creating a 15- to 30-ml pouch based on the lesser curve by stapling either “free-hand” or around a 32–34 French gastric lavage tube or Baker balloon. Care is taken to avoid injury to the left gastric artery, which supplies the pouch, and to exclude the fundus by not dividing the stomach to the left of the angle of His. The proximal jejunum is divided and the distal stump (alimentary

limb) is brought antecolic, retrocolic antegastric, or retrocolic retrogastric and anastomosed to the gastric pouch to create a 10- to 12-mm diameter stoma. The proximal stump of jejunum (biliopancreatic limb) is anastomosed to the alimentary limb either 75 to 100 cm distal to the gastrojejunostomy (BMI < 50) or 150 cm (BMI ≥ 50) (Fig. 2.5).

- c. Outcome. Similar to the BPD and DS, the GBP results in dramatic metabolic and weight changes but with fewer malabsorptive sequelae. Excess body weight loss varies from 60% to 75% for 10 years and 50% at 14 years. Reported rates for comorbidity resolution are diabetes (80%), hypertension (70%), hypercholesterolemia (65%), gastroesophageal reflux disease (75%), and obstructive sleep apnea syndrome (75%). Thirty-day perioperative mortality is 0.5%. Potential vitamin and mineral deficiencies from malabsorption requiring lifelong monitoring include iron, calcium, folic acid, and vitamin B₁₂. The most severe complications include leaks (0–3%), internal herniation with or without strangulated bowel obstruction (2–5%), and perforated marginal ulcer (1%). Less severe complications include anastomotic stenosis (5–10%). Perioperative (30-day) mortality rates are 0.2% to 1% in most recent published series; however, larger regional surveys have reported up to 2%.
- d. Current status. The GBP is the most commonly performed bariatric surgery, accounting for 85% of procedures in the United States and 65% worldwide. This is due to its excellent and durable results with low morbidity and mortality rates.

D. Purely Restrictive Procedures

1. Gastropasty

- a. Development. The gastropasty procedures were an attempt to create a safer more physiologic procedure without intestinal anastomoses where leaks may occur. The stapled gastropasties in which a partial partition was made by either horizontally or vertically placed staples to create a restrictive gastric pouch. However, the staple lines tended to break down with complete loss of restriction. Various modifications were described without success until Mason's series on vertical banded gastropasties (VBGs) in 1982. This procedure utilized a restrictive pouch based on the lesser curvature with multiple staple lines and a stoma reinforced with prosthetic mesh.
- b. Technique. A 32-French bougie is placed via the mouth and advanced along the lesser curve. An EEA stapler anvil is passed full thickness through the stomach from the lesser sac approximately 5 cm distal to the gastroesophageal junction. Several applications of a TA-90 or similar stapler are fired vertically to the left of the bougie across the angle of His. The stoma is then reinforced with a band of prosthetic material (Fig. 2.6).

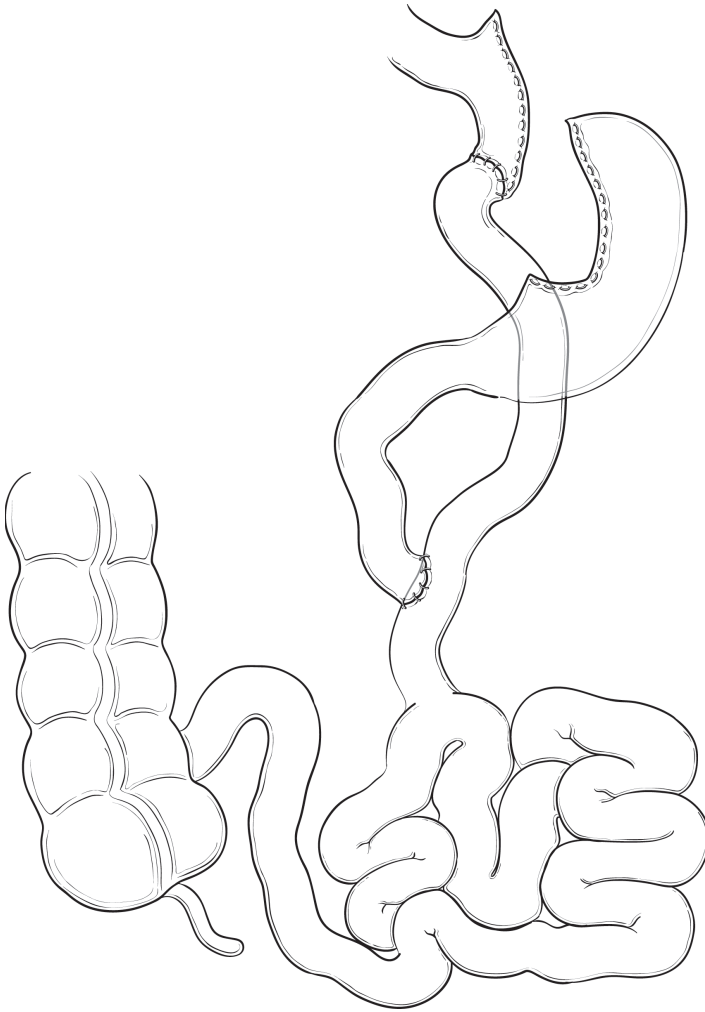


Figure 2.5. Roux-en-Y gastric bypass.

- c. Outcome. Morbidity and perioperative mortality rates were low (10% and 0.25%) and patients achieved 35% to 60% EBWL during the first year, but many patients regain significant weight over the long term. Staple-line dehiscences with marginal ulcerations as well as stomal stenoses with reflux were commonly encountered.
- d. Current status. The gastroplasty procedures have been largely abandoned given their long-term failures and high rates of requiring revisional procedures.

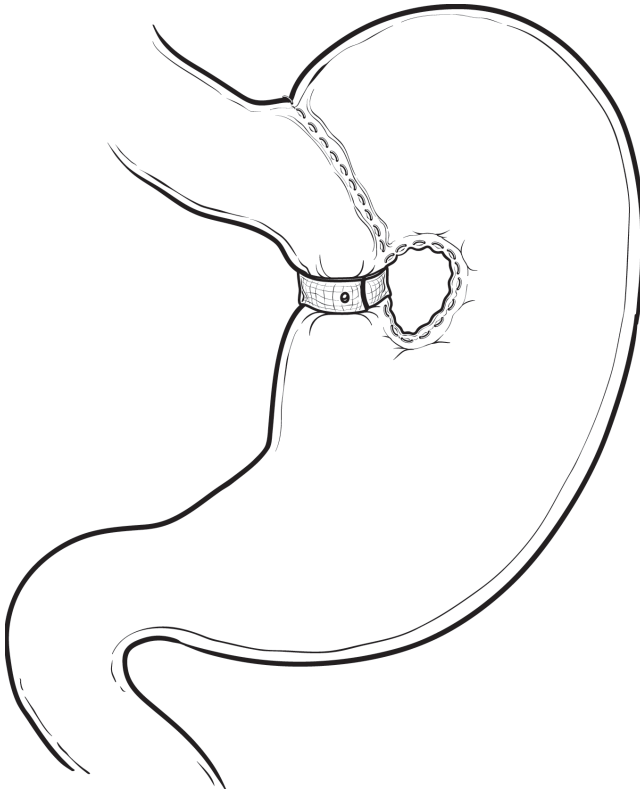


Figure 2.6. Vertical banded gastroplasty.

2. Gastric banding

- a. Development. Gastric banding procedures are the least invasive, have the lowest propensity for vitamin and nutrient deficiencies, and have the lowest morbidity and mortality among bariatric operations. With the advent of the adjustable band using a subcutaneous port, this procedure has become the most commonly performed bariatric operation in Australia and parts of Europe. Nonadjustable prosthetic material wrapped around the proximal stomach over a Nissen fundoplication was first described by Wilkinson in 1981, and 2 years later Bo described the first placement of a gastric band. Kuzmak introduced the adjustable gastric band (AGB) connected to a Port-A-Cath-type self-sealing reservoir placed in the subcutaneum in 1990. Currently performed on an outpatient basis or 24-hour stay, these bands induce satiety by exerting

a constant, gentle pressure on the proximal gastric wall that leads to a dramatic reduction in appetite and food intake. In order to be effective, the procedure requires regular outpatient adjustments and a patient who is highly disciplined in avoiding energy-dense liquids. Initial rates of complications such as posterior gastric prolapses and erosions reported with the perigastric technique through the lesser sac have been markedly reduced using the pars flaccida technique.

- b. Technique. Minimal dissection is the key as the gastrophrenic ligament is dissected sufficiently to safely pass a blunt instrument posterior to the fundus. The pars flaccida of the gastrohepatic ligament is divided to expose the right crus. A small window through the phrenoesophageal ligament along the right crus is made to pass a blunt instrument through the retrogastric tissue to create a tunnel just large enough to pass the band. The tubing is passed through the buckle, where it is fastened and anterior gastrogastic sutures are placed to create an anterior tunnel to prevent anterior prolapses. The tubing is externalized where it is connected to the subcutaneously placed port (Fig. 2.7).

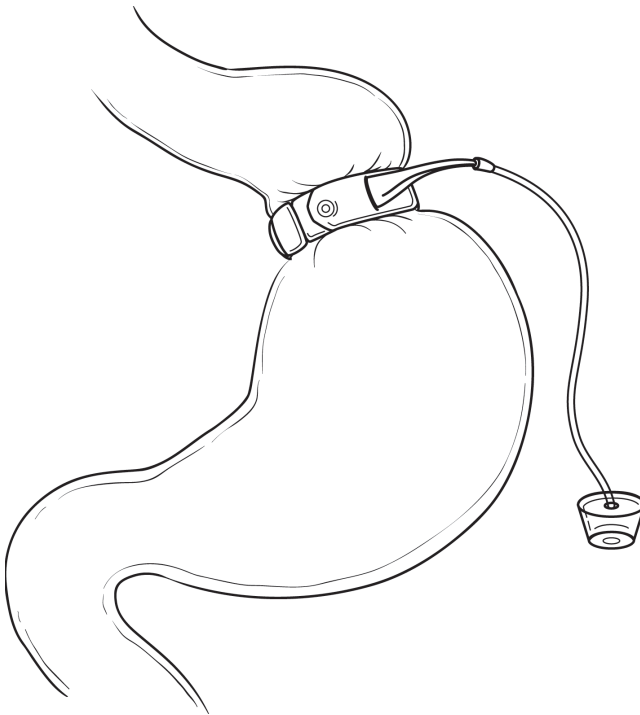


Figure 2.7. Gastric band—adjustable.

- c. Outcome. Weight loss following AGB is gradual, reaching 50–60% EWL by 3 years, which remains stable over periods up to 7 years. The US experience, however, has been more variable, with higher failure rates and band explantations. Resolution of medical comorbidities is good but generally does not attain the superior results of the GBP, BPD, or DS. The most severe complications include gastric prolapse, or “band slippage,” in up to 5%, and band erosion in 0% to 1%. However, tube breakages, leaks, and port problems requiring surgical correction occur in 10% to 15%. Perioperative mortality is 0.05%.
- d. Current status. The AGB is the preferred procedure in Australia and parts of Europe, accounting for 30% of bariatric surgeries worldwide and 15% in the United States. Long-term data demonstrate that this procedure is effective and durable. The AGB is a good option for the motivated patient willing to comply with a postoperative adjustment schedule of every 4 to 6 weeks in the initial year and who understands that the weight loss is gradual over 3 years.

3. Sleeve gastrectomy

- a. Development. The sleeve gastrectomy (SG), in which a narrow tubular stomach is created based on the lesser curvature with resection of greater curvature gastric remnant, is the first part of the DS procedure, as previously described. Due to presumed increased morbidity and mortality with superobese patients undergoing RYGB or DS, Regan proposed a staged procedure in which an SG is performed first and then converted to a DS or GBP after a period of initial weight loss. This “initial weight loss” turned out to be substantial, with 50% to 60% EWL over 12 months and, combined with a favorable safety profile, the SG has lately been proposed as a definitive stand-alone bariatric procedure.
- b. Technique. The greater omentum and gastrocolic ligament are separated from the greater curvature of the stomach beginning at a point 2 to 3 cm from the pylorus and extending proximally to include division of the gastrosplenic ligament with the short gastric vessels. A 32- or 34-French bougie is advanced along the lesser curvature and the stomach is divided with linear staplers around the bougie from a point on the greater curvature 2 to 3 cm from the pylorus to the angle of His.
- c. Outcome. In a meta-analysis of 15 studies, 12-month %EWL was 51 (45–81) with 9% complications, including bleeding and staple-line leaks and a perioperative mortality of 0.6%. Many of these studies included primarily higher risk patients with greater BMIs.
- d. Current status. The SG has been touted as both an initial stage of another bariatric procedure, such as a DS or GBP, as well as a stand-alone operation. Recent reports of using the SG as a definitive procedure demonstrate impressive weight loss and comorbidity improvement with low morbidity and mortality for high-risk patients at 12 months but long-term effects are currently unknown.

E. Miscellaneous Procedures

1. Jaw wiring

Maxillomandibular fixation (MMF) is a temporary method to prevent over-feeding using orthodontic devices with wires. Although this procedure was more popular in the last century, it is still offered by some practitioners. The wires need to be removed for several days every 4 to 6 weeks to prevent stiffness and they are rarely left in place beyond 6 months. They have been shown to induce a moderate degree of weight loss in some patients the weight usually returns once it is removed. Wire cutters need to be carried at all times in case of emergencies such as vomiting or choking. With the established safety, effectiveness, and durability of other bariatric procedures for even the larger, higher-risk patient, there is little benefit to be obtained by MMF.

2. Intra-gastric balloon

Endoscopic placement of an intra-gastric balloon filled with 400 to 700 ml of fluid has seen resurgence in popularity in recent years. Like MMF, it is a temporary procedure with a strict recommendation to remove it within 6 months. Weight loss during this period has been reported up to 33% EWL, with complete weight regain following deflation if a definitive bariatric procedure does not ensue. Patients at high risk for a definitive surgery may improve their risk profile with an initial substantial weight loss, but complications such as obstruction, gastric perforation, and death have been reported. The intra-gastric balloon is at present only investigational in the United States.

3. Implanted gastric pacemaker

Electrical impulses to induce gastroparesis and anorexia serve as the impetus for the implanted gastric pacemaker (IGP). Cigaina reported these results in animal studies in which an implanted pacemaker that stimulated the lesser curvature of the stomach between the gastroesophageal junction and pylorus. Clinical trials are few but the largest experience comes from Europe, where morbidly obese patients underwent placement of the IGP. At 1- and 2-year follow-up, % EWL was 20 and 25, respectively, with minimal morbidity. At this time, the IGP is solely experimental.

F. Summary

After half a century of growth and development, bariatric surgery is still an array of procedures in evolution. The application of the laparoscope along with improvements in safety and a dramatic reduction in morbidity and mortality has made these procedures more acceptable to patients. Despite their popularity, the large volume of bariatric operations performed has not kept pace with the epidemic rise in obesity rates worldwide.

The armamentarium of procedures to treat obesity attests to the lack of a single ideal surgical remedy. As further refinements are made and new technologies become available, we will undoubtedly see even greater and more durable weight loss, better outcomes for comorbidities, and enhanced safety profiles. This brief overview of existing procedures will hopefully provide the reader a framework in which to evaluate current treatments and integrate future ones.

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