Bariatric Surgery: Current Concepts and Future Directions

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The increasing use of bariatric procedures in the treatment of morbidly obese patients means that aesthetic plastic surgeons can expect to care for more and more patients who have undergone bariatric surgery. It is important for aesthetic surgeons to understand the procedures, outcomes, and possible complications to recognize the signs and symptoms of any potential problems. Candidates for bariatric surgery must have a body mass index (BMI) of at least 40 kg/m² or a BMI of 35 kg/m² with at least one comorbidity, plus demonstrated failure of nonsurgical means of weight control to control weight and no significant psychiatric disorders. Surgical procedures can be categorized as restrictive or malabsorptive and include adjustable gastric band, Roux-en-Y gastric bypass, and biliopancreatic diversion with or without duodenal switch. There are no definitive criteria for choosing any single procedure, although in general restrictive procedures may be more appropriate for those patients with lower BMIs and malabsorptive procedures for those with higher BMIs. Results of bariatric surgery are impressive and include not only significant and sustained weight loss but also improvement or resolution of major comorbid conditions. Significant complications include anastomotic leak, marginal ulceration, and internal herniation, as well as wound infection, incisional hernia, hemorrhage, deep venous thrombosis, and pulmonary embolus. Innovative procedures now under study include gastrointestinal neuromodulation, sleeve gastrectomy, intragastrointestinal balloons, intraluminal sleeves, and other endoscopic procedures. (Aesthetic Surg J 2008;28:79–84.)
BARIATRIC SURGICAL PROCEDURES

The primary goal of bariatric surgery is to induce sufficient weight loss to ameliorate obesity-related comorbidities such as diabetes, heart disease, hypertension, and obstructive sleep apnea.\(^6\)\(^7\) To qualify for surgery, candidates must meet strict criteria established by the National Institutes of Health in 1991.\(^8\) Candidates for surgery must have a body mass index (BMI) of 40 kg/m\(^2\) or greater without any obesity-related comorbidities or a BMI of 35 kg/m\(^2\) of greater with at least one comorbidity. Additionally, they must demonstrate repeated failure to control weight after reasonable attempts at nonsurgical modalities and be free of significant psychiatric disorders. A multidisciplinary team, usually consisting of an internist, surgeon, nutritionist, and behavioral therapist, should also evaluate patients.

The current weight loss procedures can be categorized by mechanism of action: gastric restriction or intestinal malabsorption. Restrictive procedures limit the size of the stomach and therefore reduce food intake, such as the adjustable gastric band. Malabsorptive procedures reduce the nutrient-absorptive capacity of the small intestine by segregating the food from the digestive enzymes and bile. Mixing and absorption are limited to the distal ileum. As a result, calories, especially from fatty foods, are poorly digested and excreted. The jejunoileal and jejunocolonic bypasses are two purely malabsorptive procedures. However, they are not performed anymore because of complications and will not be discussed further. The Roux-en-Y gastric bypass and biliopancreatic diversion with or without duodenal switch contain elements of various degrees of both restriction and malabsorption. All of the currently performed bariatric procedures can be performed either open or laparoscopically.

Adjustable Gastric Band

In this procedure, an adjustable silicone band is placed around the upper stomach, creating a 15- to 20-mL pouch and thereby limiting food intake (Figure 1).\(^9\) Around 40% to 60% of excess weight can be lost with the gastric band.\(^10\)\(^11\) Because the method of weight loss is purely restrictive, there is less concern for anemia and vitamin deficiencies than is seen with some of the other bariatric procedures. The 30-day mortality rate is 0.1%.\(^10\)\(^12\) The most common complications reported include band slippage, erosion into the stomach, or pouch dilation. The risk of band erosion is 1% to 2%, whereas the risk for slippage is 2% to 4%.\(^10\)

Roux-en-Y Gastric Bypass

This is the most common weight loss procedure performed in the United States and is mainly a restrictive procedure with some malabsorption (Figure 2). The stomach is divided, creating a 15- to 30-mL pouch. The rest of the stomach is excluded from the alimentary tract. The pouch is connected to the jejunum via a Roux-en-Y gastrojejunostomy. The cause of the weight loss achieved is believed to be multifactorial. The limited capacity of the small gastric pouch leads to early satiety and reduced calorie intake. In addition, the consumption of sugars provokes a dumping syndrome, characterized by flushing, light-headedness, and cramping abdominal pain, as the sugars pass directly into the jejunum. This often leads patients to avoid concentrated sweets altogether. Ghrelin, a gastrointestinal hormone produced in the fundus of the stomach, is suppressed, leading to increased satiety and early meal termination.\(^13\) Patients can lose more than 50% of their excess weight.\(^4\)\(^14\)\(^15\) The operative mortality rate ranges from 0.3% to 1.6%.\(^4\)\(^16\) The 30-day mortality rate is less than 1%.\(^13\) Serious complications include deep venous thrombosis, pulmonary embolism, hemorrhage, and gastrointestinal leak. Long-term complications can include anemia, as well as vitamin and mineral deficiencies. Serum levels of iron, folate, and vitamin B\(_{12}\) should be monitored closely because many patients require life-long supplementation.\(^17\)\(^20\)

Biliopancreatic Diversion

This operation is both restrictive and malabsorptive. However, this procedure is far more malabsorptive than the gastric bypass (Figure 3). It involves a partial gastrectomy, with the gastric remnant anastomosed to the distal ileum. The proximal ileum is also anastomosed to the terminal ileum, creating a common channel approximately 50 to 100 cm from the ileocecal valve. Nutrient absorption only occurs in this common channel because this is the first place along the intestinal tract where food is mixed with bile and digestive enzymes. The partial gastrectomy is believed to initiate weight loss by limiting food intake whereas the intestinal bypass is believed to maintain weight loss because of malabsorption. Excess weight loss has been reported as high as 72%.\(^21\) The operative 30-day mortality rate for the biliopancreatic diversion is reported to be 1.1%.\(^22\) The most serious complications include malnutrition and severe vitamin deficiency.\(^23\) Bone demineralization has been reported in 15% of patients.\(^21\) Malnutrition

Figure 1. Adjustable gastric band.
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and vitamin deficiencies can be limited by extending the length of the common channel. Ulceration of the ileum at the gastroileal anastomosis is another complication that can occur as a result of exposure of the ileum to gastric acid.

A variant of the biliopancreatic diversion, the biliopancreatic diversion with duodenal switch (Figure 4), leaves the first part of the duodenum intact, thereby decreasing the incidence of stomal ulceration and dumping. This procedure involves a sleeve gastrectomy, leaving intact the antrum, pylorus, and first part of the duodenum. The distal ileum is anastomosed to the duodenum whereas the proximal ileum is anastomosed to the terminal ileum, creating a common channel approximately 50 to 100 cm from the ileocecal valve. Complications are similar to the standard biliopancreatic diversion. Long-term follow-up with vitamin and protein surveillance is critical.

OUTCOMES

The results of bariatric surgery are impressive. The benefits far exceed the commonly recognized significant and sustained weight loss. Many studies have demonstrated the improvement and even resolution of most of the major comorbid conditions. Christou et al have shown reduced 5-year mortality rates and health care costs for patients who have undergone surgery when compared with a matched cohort of patients who did not have surgery. Patients were also less likely to have development of cancer, cardiovascular disease, endocrinologic disorders, infectious diseases, musculoskeletal disorders, and respiratory conditions. Similar findings have been reported by others. Interestingly, the time frame for resolution of the obesity-related comorbidities can be variable. For example, diabetes resolves immediately after gastric bypass and biliopancreatic diversion surgery even before weight loss ensues. However, its improvement is more gradual and weight loss related with the adjustable gastric band procedure. The resolution of other comorbidities, such as hypertension, hyperlipidemia, and obstructive sleep apnea occur within months of surgery as weight loss progresses. The likelihood of condition improvement can also vary from procedure to procedure. For example, the resolution of diabetes and improvement in hyperlipidemia are more prevalent after malabsorptive procedures (biliopancreatic diversion and gastric bypass) in contrast to purely restrictive procedures (gastric banding). This is in contrast to the resolution of hypertension and obstructive sleep apnea, which appears to be less dependent of the procedure performed.

CHOICE OF OPERATIVE PROCEDURE

As a new patient is being evaluated for surgery, the choice of which bariatric procedure to recommend is not straightforward. There are no definitive criteria for choosing one

Figure 2. Roux-en-Y gastric bypass.

Figure 3. Biliopancreatic diversion.
procedure over another. For the most part, the decision is made by the patient after a discussion of risks versus benefits of the various procedures. Some choose safety over efficacy and others efficacy over safety. In some instances it is the surgeon’s choice on the basis of his or her own opinion and experience. Generally speaking, the restrictive procedures may be best suited for the lower BMIs and the malabsorptive procedures for the higher BMIs. In our practice, we recommend the gastric bypass to patients who eat sweets to take advantage of the dumping syndrome that occurs. We also recommend gastric bypass for patients who have a higher BMI and those with conditions such as type II diabetes or hyperlipidemia, because the gastric bypass is likely to be more effective at treating these diseases. We prefer to recommend the adjustable gastric band for patients who are young, have lower BMIs, and are interested in getting pregnant in the near future.

**COMPLICATIONS**

Some complications are universal to any surgical procedure such as wound infections, incisional hernias, hemorrhage, deep venous thromboses, and pulmonary emboli. With regard to bariatric surgery, there are complications that are specific for each operation. Some have been mentioned above, such as band slippage and erosion for the adjustable gastric band and nutritional deficiencies after gastric bypass or biliopancreatic diversion with or without duodenal switch. Three complications of gastric bypass in particular warrant more in-depth discussion. They include the anastomotic leak, marginal ulcer, and internal hernia.

One of the most feared complications of bariatric surgery is the anastomotic leak. It occurs in 1% to 2% of patients. Fever, tachycardia, severe abdominal or back pain, excessive fluid requirements, and anxiety are some of the signs and symptoms. Prompt exploration to repair the leak is required. If the diagnosis of leak is missed, peritonitis, shock, and multiple organ dysfunction may quickly ensue. This complication is one of the most common causes for death or long-term morbidity.

Marginal ulceration after gastric bypass or the standard biliopancreatic diversion represents mucosal erosion on the intestinal side of the anastomosis with the gastric

![Figure 4. Biliopancreatic diversion with duodenal switch.](image)

![Figure 5. Likelihood of comorbid condition improvement by procedure. (Data from Buchwald et al.25)](image)
pouch. Patients can present with epigastric pain, burning sensation, and nausea and vomiting. The small intestine, unlike the stomach, has no natural defense against acid erosion. Normally, the small gastric pouch produces only a minimal amount of acid, but in some cases, the pouch can produce enough acid to cause ulceration. The incidence of marginal ulcers after gastric bypass is 3% to 5%, whereas the incidence after biliopancreatic diversion is 2% to 10% and is less than 2% with a duodenal switch. To decrease the risk of ulceration, patients are usually placed on histamine receptor blockers.

Internal herniation is an uncommon but potentially life-threatening complication of anastomotic bariatric surgery. The incidence is 2% to 5%. It is caused by migration of the bowel into abnormal spaces created at the time of surgery, leading to intestinal obstruction. These abnormal spaces tend to enlarge with weight loss. There are three distinct areas for internal herniation: (1) through the mesocolon (retrocolic roux limb only), (2) through the divided mesenteric leaves of the enteroenterostomy, or (3) migration of the biliopancreatic limb under the roux limb (Petersen hernia). Patients may present with bloating, cramping, abdominal pain, nausea, or vomiting. A high index of suspicion is warranted because presentation and radiographic findings are nonspecific. Prompt exploration with reduction of the bowel from the hernia site and closure of the space is the treatment.

For the plastic surgeon seeing patients in consultation for body contouring or in follow-up after body-contouring procedures, the recognition of complications related to the bariatric procedure would be similar to other abdominal operations. Any patient who complains of food intolerance, abdominal pain, persistent or bilious vomiting, new-onset or worsening heartburn, or any other symptom that seems suspicious should be referred back to the bariatric surgeon.

THE FUTURE

Despite the many benefits of bariatric surgery, some patients do not want the current operative procedures because of either the fear of complications, the need for adjustments requiring needle puncture, or the desire not to have their anatomy altered. This creates a large unmet need that has been the driving force for the development of new and novel procedures. Several are currently under development, including gastrointestinal neuro-modulation (stimulating or blocking nervous pathways with an electrical pulse generator), sleeve gastrectomy, intragastric balloons, and intraluminal sleeves, and other endoscopic procedures.

Implantable gastric stimulation is one example of neuro-modulation. Bipolar leads are implanted laparoscopically into the seromuscular layer of the stomach wall along the lesser curvature. The leads are connected to an electrical pulse generator that is positioned subcutaneously along the abdominal wall. The exact mechanism by which gastric stimulation leads to weight loss is still under investigation. Some possible mechanisms for the decrease in appetite include fundic expansion, vagal nerve stimulation, decrease in gastric emptying, and alterations in gut hormone activity. Weight loss has thus far been inconsistent, with reports as high as 30%. Although the procedure has been shown to be extremely safe, further research is necessary to better refine this technology.

Sleeve gastrectomy is another evolving option for weight loss. This procedure can be used as a primary procedure or as the first stage of a staged approach for extremely large patients or those at high risk. In this operation, the greater curvature of the stomach is excised, leaving behind a tubular section along the lesser curvature (Figure 6). The exact mechanism for weight loss is not currently known, but it may be a decrease in calorie intake and appetite as a result of the gastric restriction. Weight loss averages 40% to 50% of excess. There is, however, some concern that the remaining narrow stomach tube may dilate over time, causing a failure to lose weight. Before sleeve gastrectomy can be considered a “mainstream” bariatric procedure, more data with long-term follow-up need to be collected.

Natural orifice transluminal endoscopic surgery is a new and evolving concept for minimally invasive surgery. The application of endoluminal techniques to bariatric surgery is in its nascent stage of development. Investigators are developing instruments and procedures to limit oral intake or mimic the gastric bypass. These procedures include the implantation of intragastric balloons and intestinal sleeves and even methods to perform a gastric partitioning and gastrojejunostomy. However, the efficacy, durability, and safety of these novel procedures need to be established.
CONCLUSION
The prevalence of obesity is rapidly increasing among adults and even children. The health consequences and costs are enormous. Nonsurgical treatments are usually inadequate for achieving meaningful, as well as sustained, weight loss. Surgical approaches are currently safe and effective options for long-term weight loss, as well as to ameliorate obesity-related comorbidities and improve life expectancy. Perioperative and long-term complications may occur that require early recognition to avoid morbidity. New and innovative techniques are on the horizon and are currently being investigated.

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The authors have no disclosures with respect to this article.

REFERENCES

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