



# Perioperative management of the bariatric surgery patient: Focus on cardiac and anesthesia considerations

BIPAN CHAND, MD; DAVID GUGLIOTTI, MD; PHILIP SCHAUER, MD; AND KAREN STECKNER, MD

**T**he obesity epidemic and the limited efficacy of dietary therapy to treat obesity have resulted in a surge in the volume of bariatric surgery. Obesity-related comorbidities are numerous and present a variety of preoperative, intraoperative, and postoperative challenges in obese patients undergoing any type of surgery and in those specifically referred for bariatric surgery. At the same time, the outcomes of bariatric surgery are increasingly good in terms of excess weight loss, reductions in comorbidities, increased life span, and overall medical costs.

Using a case for illustrative purposes, this article examines clinical considerations in the management of obese surgical patients as well as patients undergoing gastric bypass surgery.

## ■ OVERVIEW OF BARIATRIC SURGERIES

A variety of surgical options (**Figure 1**) have been developed to treat the morbidly obese patient (ie, with a body mass index [BMI] > 35 kg/m<sup>2</sup>).

### Restrictive procedures

The simplest concept is gastric restriction, which involves the creation of a small gastric pouch to cause early satiety; a small outlet to the pouch is also created to prolong satiety.

---

From the Departments of General Surgery (B.C. and P.S.), General Internal Medicine (D.G.), and General Anesthesiology (K.S.), Cleveland Clinic Foundation, Cleveland, OH.

**Address:** Philip Schauer, MD, Department of General Surgery, Cleveland Clinic Foundation, 9500 Euclid Avenue, A80, Cleveland, OH 44195; schaup@ccf.org.

**Disclosure:** Dr. Chand reported that he is a consultant for the Ethicon Endo-Surgery, Gore, and Sanofi-Aventis corporations. Dr. Schauer reported that he has received grant support from the US Surgical, Stryker, Ethicon, Inamed, Gore, and Baxter corporations. Drs. Gugliotti and Steckner reported that they have no financial relationships that pose a potential conflict of interest with this article.

**Vertical-banded gastroplasty**, the first major restrictive procedure, was the most commonly performed bariatric operation in the United States until about 10 years ago. Initial weight loss can be substantial with vertical-banded gastroplasty, but because of high weight regain caused by maladaptive eating behavior, the popularity of this operation has decreased dramatically. The procedure consists of the creation of a small gastric pouch or reservoir based on a vertical staple line, which is reinforced by a fixed band. The pouch and its outlet must be small enough to sufficiently restrict intake yet not so small as to cause obstruction. Because the fixed band is not adjustable, it often limits the patient's ability to consume solid food, which most often results in reliance on high-calorie "junk" food.

**Adjustable laparoscopic gastric banding** is an alternative restrictive operation that has for the most part replaced vertical-banded gastroplasty. Adjustable gastric banding was introduced outside the United States in the early 1990s. It offers an improvement over fixed vertical-banded gastroplasty in that the silicone collar employed is adjustable postoperatively, allowing for titration of diet to maximize weight loss and minimize side effects (ie, vomiting, reflux) and potential weight regain.

The benefits of restrictive procedures are their technical simplicity and their avoidance of protein-calorie malabsorption or vitamin or mineral deficiencies. Their disadvantages include less weight loss relative to other procedures and a higher rate of late failures owing to pouch or anastomosis dilation or to maladaptive eating behaviors.

### Malabsorptive procedures

Malabsorptive procedures rely on bypass of a portion of the small intestine to cause malabsorption. Their relative benefits are sustained weight loss that is less reliant on dietary compliance compared with restrictive procedures. Their drawbacks are relative techni-



The **gastric bypass** (Roux-en-Y procedure) constitutes the vast majority of US bariatric surgeries today. The small intestine is reconfigured into a Y, consisting of two limbs and a common channel. The pancreo-biliary limb is proximal small bowel, attached to the stomach and the duodenum. The Roux limb (food limb) is attached to the gastric pouch.



**Vertical-banded gastroplasty** is an outdated restrictive procedure that decreases the size of the stomach, usually by division or partitioning, to create early satiety. A small reservoir is created based on a vertical staple line reinforced by a fixed band.



**Adjustable laparoscopic banding** employs an adjustable silicone collar, allowing for titration of diet and weight loss.



**Jejunioileal bypass** is a malabsorptive procedure that short-circuits the small intestine. It is no longer performed because of a high rate of metabolic complications such as vitamin and protein deficiency, kidney stones, and liver failure.



**Biliopancreatic diversion** involves a limited gastrectomy. The remaining pouch is connected directly to the final segment of the small intestine, bypassing the duodenum and the jejunum.



**Biliopancreatic diversion with duodenal switch** also involves a limited gastrectomy, but the remaining stomach remains attached to the duodenum. Continuity of the gastric lesser curve is maintained, and the duodenal switch maintains continuity of the gastro-duodeno-jejunal axis.

**FIGURE 1.** Bariatric surgery options include gastric bypass (Roux-en-Y), which constitutes the vast majority of bariatric surgeries performed in the United States; vertical-banded gastroplasty, which has fallen out of favor due to maladaptive eating behavior; adjustable laparoscopic banding, which has replaced vertical-banded gastroplasty; jejunioileal bypass, the initial malabsorptive procedure; and biliopancreatic diversion with or without duodenal switch, which are second-generation malabsorptive procedures.

cal complexity and a heightened risk of malnutrition and vitamin deficiencies, along with a resultant need for close follow-up.

**Jejunioleal bypass.** The first malabsorptive procedure, the jejunioleal bypass, was introduced in the 1950s but has been abandoned because of unacceptable rates of morbidity, which include gas-bloat syndrome, steatorrhea, metabolic imbalances, hepatic fibrosis and failure, and nephrolithiasis. The procedure did, however, result in substantial weight loss even in the face of high caloric intake.

**Biliopancreatic diversion.** Jejunioleal bypass has been replaced somewhat by biliopancreatic diversion with or without duodenal switch, which is a less extreme malabsorptive procedure. Biliopancreatic diversion involves some gastric volume reduction as well. In the procedure, a horizontal partial gastrectomy is performed, but with the creation of a reduced intestinal bypass compared with jejunioleal bypass, such that an “alimentary” common channel of approximately 50 cm is constructed. This biliopancreatic diversion/duodenal switch procedure carries a much lower risk of malnutrition sequelae compared with jejunioleal bypass. Protein malabsorption, however, is still a risk, occurring in approximately 7% of patients.

### Gastric bypass

One of the most commonly performed bariatric surgeries is the gastric bypass procedure (Roux-en-Y gastric bypass), which represents about 80% of bariatric operations performed by American surgeons. It is principally a restrictive procedure, involving creation of a small pouch and bypass of a small portion of the foregut, although this bypass rarely leads to protein malnutrition.

### Effectiveness correlates with invasiveness

The effectiveness of the various bariatric procedures generally correlates with their invasiveness. The percentage of excess weight lost is about 40% with restrictive procedures, 65% to 70% with gastric bypass, and 80% to 85% with malabsorptive procedures.<sup>1</sup>

### ■ CASE STUDY:

#### EVALUATION PRIOR TO BARIATRIC SURGERY

A 53-year-old woman with morbid obesity (BMI of 45.97 kg/m<sup>2</sup>) is referred for evaluation prior to bariatric surgery (Roux-en-Y gastric bypass). She has classic risk factors for coronary disease, including a 30-pack-year history of smoking, hyperlipidemia, obstructive sleep apnea, uncontrolled hypertension despite pharmacotherapy (losartan 50 mg/day and hydrochlorothiazide 25 mg/day), and borderline type 2 diabetes mellitus (elevated blood glucose levels in

the past 2 to 3 years; rarely > 200 mg/dL). She also has hypersomnolence, depression, gastroesophageal reflux disease, and stress incontinence.

At presentation, her laboratory evaluation is normal, her fasting blood glucose is 129 mg/dL, and her blood pressure is 152/88 mm Hg. Her hypersomnolence is being treated with methylphenidate 10 mg twice daily, her sleep apnea with nighttime continuous positive airway pressure, and her dyslipidemia with ezetimibe 10 mg/day. Other than obesity, her physical examination is unremarkable. She has trace lower extremity edema but normal cardiac and pulmonary examinations.

### Determining cardiac status

Establishing physical exertional status is valuable. Exercise tolerance is a predictor of surgical outcomes in general. In one study, symptom-limited stair climbing predicted postoperative cardiopulmonary complications after high-risk surgery.<sup>2</sup>

The patient denies having chest pain with exertion. She has no history of cardiac disease, myocardial infarction, stroke, arrhythmias, or heart failure. She reports being able to walk about one or two blocks on level ground but experienced shortness of breath but no chest pain when climbing two flights of stairs (10 steps each) and “panting” after three flights of stairs. She reports having had an episode of chest squeezing while climbing an observation tower, which resolved with rest. Resting electrocardiography (ECG) is normal.

### What role for stress testing and imaging studies?

Given that this patient has had some vague symptoms that may or may not have been related to cardiac disease, mounting evidence suggests that proceeding to surgery with appropriate risk stratification and medications (ie, beta-blocker) may be acceptable.

An ECG exercise stress test probably has limited value in the obese patient because of the difficulty in getting adequate tracing, particularly in women, and because the ability to exercise is compromised.

The types of stress echocardiography are exercise stress echocardiography, dobutamine stress echocardiography, transesophageal dobutamine stress echocardiography, and contrast-enhanced stress echocardiography. Exercising to an adequate heart rate is essential to maximize the sensitivity of exercise stress echocardiography. Preliminary investigation suggests that contrast-enhanced stress echocardiography or transesophageal dobutamine stress echocardiography may be superior to the other types of stress echocardiography testing for obese patients. Obtaining appropriate echocardiography windows and high-quality two-dimensional images may be problematic when

performing transthoracic stress echocardiography.

Photon scatter and attenuation artifacts are problems with single-photon emission computed tomography (SPECT) using thallium or technetium 99m. Positron emission tomography (PET) may provide better visualization of the myocardium and less attenuation than SPECT imaging.

Several investigators have studied the accuracy of thallium scanning in obese patients. Hansen et al<sup>3</sup> stratified 567 patients who underwent thallium SPECT into two groups: a low-risk group or patients who had had catheterization within 60 days of stress testing (without an intervening event or procedure). Of the 216 patients with a BMI greater than 30 kg/m<sup>2</sup>, 91 had coronary artery disease diagnosed based on the findings from catheterization. The accuracy of thallium 201 scanning was found to be significantly diminished in patients with a BMI greater than 30 kg/m<sup>2</sup>.

Freedman et al<sup>4</sup> compared thallium 201 SPECT scanning to PET scanning in 161 patients, 81 of whom were normal weight and 80 who were overweight (BMI > 27 kg/m<sup>2</sup>). The results were compared with angiographic findings in 75 patients; concordance and discordance were calculated for territories of three major arteries. They found concordance between the two types of nuclear tests in 75% (367/483) of arterial territories. More defects on thallium scanning were found in all territories except for the left circumflex artery, and there were differences among the incidences of defects between SPECT and PET, which were significant in the left anterior descending artery for women and in the right coronary artery for men and women. A significant difference in the right coronary artery territory was observed between obese patients and nonobese patients, which would be expected since obese patients have larger abdomens. PET had greater specificity (84%) compared with SPECT (64%) for the subset of 75 patients who underwent angiography.

#### Case continued

Our patient undergoes a stress echocardiogram, and she is able to exercise at 90% of her maximum predicted heart rate and at 5.5 metabolic equivalents with negative findings for ischemia. She is cleared for surgery with the addition of a beta-blocker.

#### ■ ARRIVAL IN THE OPERATING ROOM: WHAT ARE THE CONCERNS?

Maintaining glycemic control and hemodynamic stability during this patient's operation will require an armamentarium of medications and monitoring equipment. The biggest concern for the anesthesiologist will

be managing her airway. It is reassuring to know from preoperative testing that the patient is free of coronary artery disease, but she has a number of other worrisome issues, such as diabetes and sleep apnea, which may increase the risk of a difficult intubation. Obstructive sleep apnea can increase the sensitivity to sedative medications; thus, doses of benzodiazepines are minimized and the patient is offered vocal reassurance just before the anesthetic is started. In patients with sleep apnea, the use of anesthetic agents with a short duration of action is preferred so that their action can be terminated upon completion of surgery. A number of clinical factors can be used to predict ventilation and tracheal intubation difficulty: primarily neck circumference, visualization of oropharyngeal structures (Mallampati score), thyromental distance, and dental configuration. Based on this patient's clinical presentation, ventilation and intubation should not be overly difficult and most anesthesiologists would elect to induce general anesthesia for this patient, and secure the airway with the patient asleep. Another option is to intubate the patient while awake, with the aid of a fiberoptic bronchoscope, and then to induce general anesthesia.

For blood pressure control, the use of short-acting beta-blockers and antihypertensive drugs is preferred rather than deeper levels of anesthesia. Monitors such as the bispectral index can indicate an adequate level of sedation. Anesthesia can be maintained with anesthesia vapors such as sevoflurane, desflurane, and opioid infusions, thereby minimizing postoperative sedation.

Most bariatric surgeries, perhaps more than 90%, can be performed laparoscopically. The preoperative prediction of a successful laparoscopic outcome is based on the patient's BMI, with higher BMIs being more challenging laparoscopically as a result of difficult insufflation of the abdomen. Laparoscopic procedures are more difficult to perform in patients who have truncal obesity or who have had previous abdominal surgery, but they can be successful even in these types of patients.

#### Issues in airway management

Brodsky et al<sup>5</sup> studied 100 morbidly obese patients and found that only 1 could not be intubated and 12 had "problematic" intubations. Optimal positioning of the patient, and consideration of an algorithm for difficult airway management such as the American Society of Anesthesiologists' Practice Guidelines for Management of the Difficult Airway,<sup>6</sup> will help to achieve safe and rapid airway management. Additional personnel, as well as equipment such as fiberoptic bronchoscopes on a well-stocked airway cart, laryngeal mask airways, and alternatives to conventional laryngoscopy (eg,

Bullard scope, GlideScope), will be key resources for difficult airway management.

The head-up or reverse Trendelenburg position can improve oxygen reservoirs in patients who are given oxygen before the anesthetic is started, and will delay the time to desaturation due to consumption of oxygen in the functional residual capacity. Desaturation is normally much faster in a morbidly obese patient; one who is preoxygenated with 100% oxygen will desaturate within 4 minutes, whereas a normal-weight patient has a 10-minute margin of safety. For example, a morbidly obese patient who is critically ill and returns to the operating room with abdominal sepsis will have increased oxygen consumption and will experience hypoxemia very quickly after induction of general anesthesia.

#### Hemodynamics of laparoscopic surgery

Even when done laparoscopically, bariatric surgery is a stressful surgery. Cardiac output is usually well preserved but systemic vascular resistance can be increased; tachycardia, bradycardia, and hypertension are common, depending on the levels of surgical stimulation and the adrenergic state of the patient. Five percent to 10% of our patients will become hypotensive for a brief period after institution of the pneumoperitoneum and steep reverse-Trendelenburg (head-up) positioning.<sup>7</sup> This hypotension appears to be related to preoperative hypovolemia (fasting, bowel prep, and antihypertensive medications) and responds quickly to treatment with intravenous fluid boluses of 500 to 1,000 mL.

#### Postoperative analgesia

Balanced multimodal postoperative analgesia (ie, local anesthetics in the wound, nonsteroidal anti-inflammatory drugs, and modest doses of opioids) will help minimize respiratory depression after surgery. We consider epidural analgesia if the patient is scheduled for an open procedure; however, there is an increased risk for epidural hematoma in patients receiving low-molecular-weight heparins. The risks and benefits of neuraxial pain relief are weighed, using information from guidelines on regional anesthesia in the anticoagulated patient issued by the American Society of Regional Anesthesia and Pain Medicine.<sup>8</sup>

#### ■ POSTOPERATIVE COMPLICATIONS OF BARIATRIC SURGERY

Because comorbidities are common in obese patients, the risk of postoperative complications is relatively high.

##### Intestinal leak

The International Bariatric Surgery Registry<sup>9</sup> includes more than 10,000 patients and provides data on com-

plications. The most frequent complication is intestinal leak. Of the staple lines that can result in a leak, the gastrojejunostomy is the most vulnerable. Such a leak can potentially result in severe peritonitis and is the most common cause of surgically related mortality in patients undergoing bariatric surgery.

Early diagnosis of an intestinal leak is challenging because symptoms are often masked in obese patients. This requires the surgeon and team managing the patient to have a high index of suspicion of an underlying leak.

##### Pulmonary embolism/deep vein thrombosis

The second most common cause of mortality related to bariatric surgery is pulmonary embolism (PE).<sup>9</sup> The combined incidence of deep vein thrombosis (DVT) and PE following bariatric surgery is 2%.<sup>10</sup> In patients with a low risk of bleeding, pharmacologic prophylaxis of DVT may be a useful adjunct to mechanical prophylaxis. The data to support the choice of therapy and appropriate dosing for DVT prophylaxis in bariatric surgery are limited, with no randomized controlled trials completed. Success has been reported using enoxaparin and heparin prophylaxis.

Higher than standard doses of enoxaparin may be required for prophylaxis in obese patients undergoing bariatric surgery. A retrospective analysis of 481 patients who underwent Roux-en-Y gastric bypass<sup>11</sup> indicated that 40 mg of enoxaparin twice daily may be superior to 30 mg of enoxaparin twice daily in reducing the incidence of postoperative symptomatic DVT/PE without an increase in bleeding complications. The trend in practice is toward use of 40 mg of enoxaparin twice daily, but the timing of administration is debatable. Because most patients are at highest risk at the time of induction, preoperative dosing is reasonable.

Weight-based dosing of unfractionated heparin aimed at keeping Factor anti-Xa levels at 0.11 to 0.25 units/mL has been studied in 700 patients after gastric bypass.<sup>12</sup> There were no cases of DVT and three cases of nonfatal PE. Bleeding requiring cessation of unfractionated heparin occurred in 16 cases (2.3%) and bleeding requiring transfusion occurred in 7 (1.0%). The authors concluded that weight-based dosing is an improvement over fixed dosing, although the trial was not randomized and contained no control arm.

##### Other complications

Other common complications are cardiopulmonary complications (1% to 5% incidence), respiratory compromise (1% to 2%), wound complications (1% to 2%), bowel obstructions (1% to 2%), strictures (3% to 8%), and perioperative bleeding (0.3%).<sup>1</sup>

It behooves not just the surgeon but the entire team

managing the patient to be aware of these complications, anticipate them, and act before they become severe.

### ■ OUTCOMES OF BARIATRIC SURGERY

Buchwald et al<sup>13</sup> collected data on outcomes of bariatric surgery in a meta-analysis of 22,094 patients. The average excess weight loss for all types of procedures was 61.2%. When stratified by type of surgery, the average excess weight loss was:

- 47.5% for gastric banding
- 61.6% for gastric bypass
- 68.2% for gastroplasty
- 70.1% for biliopancreatic diversion/duodenal switch.

Overall, each type of surgery was safe, with the more complex surgeries carrying a greater risk of morbidity and mortality. Mortality ranged from a low of 0.1% for restrictive procedures to 1.1% for biliopancreatic diversion/duodenal switch.

### Effect on comorbidities

Importantly, the reductions in comorbidities are also quite impressive. In this same meta-analysis, diabetes resolved in 76.8% of cases, lipid profiles improved in 70.0%, hypertension resolved in 61.7%, and obstructive sleep apnea resolved in 85.7%.<sup>13</sup>

### Effect on life span

Evidence suggests that bariatric surgery also increases life span. In a study comparing survival between 62,781 morbidly obese patients who had undergone gastric bypass and 3,328 morbidly obese patients who had not, the 15-year survival rate using Cox regression analysis for patients younger than 40 years was 13.8% for those

who underwent surgery vs 3.0% for those who did not.<sup>14</sup>

### Effect on overall health costs

Studies are beginning to emerge that suggest that bariatric surgery yields savings in overall health care expenditures over time. Typical are the results of a retrospective study by Potteiger et al<sup>15</sup> in 51 consecutive patients with obesity-related hypertension and diabetes who underwent bariatric surgery. The average number of medications taken by these patients fell to from 2.44 preoperatively to 0.56 at 9 months after surgery, and the total monthly cost of their diabetic and antihypertensive medications declined 77% over the same period.

### ■ SUMMARY

Obesity is a major public health problem in developed nations worldwide. Currently, the only treatment for severe obesity (BMI  $\geq 35$  kg/m<sup>2</sup> with comorbidity) that provides long-term weight loss is bariatric surgery. Restrictive, malabsorptive, and combination procedures have been developed. Each type of procedure has its merits and unique set of risks and complications. Weight loss after bariatric surgery is accompanied by predictable improvement or resolution of obesity-related comorbidities and improved quality of life and life expectancy.

Candidates for bariatric surgery are often at high risk for complications because of obesity-related comorbidities. Therefore, careful patient selection for bariatric surgery, together with well-designed strategies for preventing and managing complications, are keys to success. Close monitoring for nutritional deficiencies and short- and long-term complications is required to completely assess outcomes of these procedures.

### ■ REFERENCES

- Schauer PR, Schirmer BD. The surgical management of obesity. In: Brunicaudi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Pollock RE, eds. *Schwartz's Principles of Surgery*. 8th ed. New York: McGraw-Hill; 2004:997-1016.
- Girish M, Trayner E, Dammann O, et al. Symptom-limited stair climbing as a predictor of postoperative cardiopulmonary complications after high-risk surgery. *Chest* 2001; 120:1147-1151.
- Hansen C, Woodhouse S, Kramer M. Effect of patient obesity on the accuracy of thallium-201 myocardial perfusion imaging. *Am J Cardiol* 2000; 85:749-752.
- Freedman N, Schechter D, Klein M, Marciano R, Rozenman Y, Chisin R. SPECT attenuation artifacts in normal and overweight persons: insights from a retrospective comparison of Rb-82 positron emission tomography and Tl-201 SPECT myocardial perfusion imaging. *Clin Nucl Med* 2000; 25:1019-1023.
- Brodsky JB, Lemmens HJM, Brock-Utne JG, et al. Morbid obesity and tracheal intubation. *Anesth Analg* 2002; 94:732-736.
- American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology* 2003; 98:1269-1277.
- Nguyen NT, Wolfe BM. The physiologic effects of pneumoperitoneum in the morbidly obese. *Ann Surg* 2005; 241:219-226.
- Horlocker TT, Wedel DJ, Benzon H, et al. Regional anesthesia in the anticoagulated patient: defining the risks (the second ASRA Consensus Conference on Neuraxial Anesthesia and Anticoagulation). *Reg Anesth Pain Med* 2003; 28:172-197.
- American Society for Bariatric Surgery. Rationale for the surgical treatment of morbid obesity, 2001. [www.asbs/html/rationale/rationale.html](http://www.asbs/html/rationale/rationale.html).
- Schauer PR, Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. *Ann Surg* 2000; 232:515-529.
- Scholten DJ, Hoedema RM, Scholten SE. A comparison of two different prophylactic dose regimens of low molecular weight heparin in bariatric surgery. *Obes Surg* 2002; 12:19-24.
- Shepherd ME, Rosborough TK, Schwartz ML. Heparin thromboprophylaxis in gastric bypass surgery. *Obes Surg* 2003; 13:249-253.
- Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004; 292:1724-1737.
- Flum DR, Dellinger EP. Impact of gastric bypass operation on survival: a population-based analysis. *J Am Coll Surg* 2004; 199:543-551.
- Potteiger CE, Paragi PR, Inverso NA, et al. Bariatric surgery: shedding the monetary weight of prescription costs in the managed care arena. *Obes Surg* 2004; 14:725-730.