The morbid obesity epidemic continues to spread throughout industrialized nations. It is a condition with a heterogeneous etiology, including genetic, psychosocial, and environmental factors. Prevention methods have currently been unable to halt the further spread of this disease. Obesity has been linked to increased healthcare costs, common physiologic derangements, reduced quality of life, and increased overall mortality. More than one third of adults and almost 17% of children in the United States are obese.

Medical therapy that can cause sustained significant weight loss may be years away. Bariatric surgery, when combined with a multi-disciplinary team, continues to be the only proven method to achieve sustained weight loss in most patients. Bariatric procedures modify gastrointestinal anatomy and, in some cases, enteric hormone release to reduce caloric intake, reduce absorption, and alter metabolism to achieve weight loss. Currently, the three most common bariatric operations in the United States are Roux-en-Y gastric bypass,
adjustable gastric band, and the vertical sleeve gastrectomy (Boxes 1, 2, and 3). The sleeve gastrectomy is part of a duodenal switch with biliopancreatic diversion. It has been used in patients at higher risk as a first-staged weight loss procedure, where the plan is to induce a significant weight loss and then offer patients a revision to a gastric bypass or duodenal switch with biliopancreatic diversion when they have achieved a safer weight. It is also now used as a primary bariatric operation with weight loss results that are better than adjustable gastric band but without the intestinal malabsorption issues seen after gastric bypass. Duodenal switch with biliopancreatic diversion has never been a popular weight loss surgery because of the significant malnutrition that accompanies this procedure (Box 4). All four of these operations can be performed laparoscopically in most patients.

**PREOPERATIVE EVALUATION**

The National Institutes of Health Consensus Development Conference Statement for Gastrointestinal Surgery for Severe Obesity was issued in 1991 and is still regarded as the starting point for criteria to accept patients in a surgical weight loss program. Patients are considered morbidly obese and candidates for surgery if they have a body mass index (BMI) of at least 35 kg/m², with an obesity-related comorbidity or greater than 40 kg/m². Recommendations are that patients should have tried dieting in the past before surgical therapy is considered as a treatment option (Box 5).

In evaluation of a potential patient for bariatric surgery, a multidisciplinary team should be used. This team should include a dietitian and mental health professional, whose purpose is to obtain dietary and behavioral eating history, discuss postoperative dietary expectations, and decide whether the patient is appropriate for bariatric surgery. Support for the surgery from family members and friends is helpful. If the team believes that the patient is not appropriate for surgery, then consideration should be given to nonoperative medical management with appropriate counseling and surgery should be reconsidered or denied indefinitely.

Patients with severe end organ disease, such as end-stage heart failure or respiratory failure, are at higher risk for morbidity and mortality. Surgery is not necessarily contraindicated for these patients, but weight loss alone may not significantly correct end-stage heart or lung disease. Patients with cirrhosis may be at higher risk

---

**BOX 1: Gastric bypass**

**Advantages**
- Proven weight loss over 5 years
- Better weight loss than restrictive-only operations
- Proven improvement in medical comorbidities
- Mortality rate less than 1% at most centers

**Disadvantages**
- Malabsorption
- Marginal ulcer
- Stomal stenosis
- Inability to easily access distal stomach
- Internal hernia
- Small bowel obstruction
- Iron deficiency anemia
- Calcium and vitamin B₁₂ deficiency

---

**BOX 2: Adjustable gastric band**

**Advantages**
- Reversible
- Least invasive (no stapling of the stomach)
- Lowest risk of death
- No malabsorption

**Disadvantages**
- Erosion
- Esophageal dilation
- Breakage
- Port problems
- Slippage or prolapse
- May worsen GERD
- Failure to lose weight
- Lower average weight loss

---

**BOX 3: Sleeve gastrectomy**

**Advantages**
- Better weight loss than with adjustable gastric band
- Proven improvement in medical comorbidities
- Easier to perform than gastric bypass, especially if BMI is high
- No intestinal malabsorption
- No risk of marginal ulcers
- Preserved pylorus means less risk of dumping
- Ability to convert to gastric bypass or DS-BPD
- Mortality rate less than 1% at most centers

**Disadvantages**
- Not reversible
- Large portion of stomach removed
- A proximal leak is difficult to treat
- Stricture (incisura angularis)

---

**BOX 4: Duodenal switch with biliopancreatic diversion**

**Advantages**
- Excellent weight loss
- Proven improvement in medical comorbidities
- Preserved pylorus means less risk of dumping
- Less risk of marginal ulcers

**Disadvantages**
- Increased risk of protein malabsorption
- Increased risk of fat-soluble vitamin malabsorption (A, D, E, and K)
- Iron deficiency anemia
- Diarrhea and excess gas more common
- Internal hernia
- Higher complication rate
- Higher risk of osteoporosis

**BMI, Body mass index; DS-BPD, duodenal switch with biliopancreatic diversion.**
for surgery but certainly may benefit from weight loss. Patients who are morbidly obese may be rejected for heart, lung, liver, or kidney transplant and, therefore, may benefit from bariatric surgery-induced weight loss. Patients who are nonambulating or bedridden should also be considered at high risk for postoperative complications.

Currently, patients with type 2 diabetes with a BMI of 30 to 35 kg/m² are being studied for whether they would benefit from bariatric surgery. The U.S. Food and Drug Administration (FDA) has approved the adjustable gastric band for this subgroup of patients.

**Preparation of the Patient in the Operating Room**

On the morning of surgery, the patient is injected subcutaneously with low molecular-weight heparin to prevent venous thromboembolic complications. A peripheral intravenous (IV) line is placed, and an appropriate antibiotic is administered intravenously. The patient is placed on the operating room table in the supine position with a footboard. Appropriate padding of the patient is important because these particular patients are at increased risk for compression-related injuries. Sequential compression devices are placed on the lower extremities if they fit. General anesthesia is performed, and then a urinary catheter is inserted. The anesthetist inserts, applies suction to, and then immediately removes the oral-gastric tube before starting the operation. Esophageal temperature probes are not recommended because these can migrate into the stomach during stapling. The operating surgeon stands on the patient’s right side, and the assistant on the left (Figure 1). Entering the abdomen in morbidly obese patients is safe with direct vision with a device that allows visualization of the abdominal wall layers sequentially with a 0-degree laparoscope inserted inside of it. Initial access in each procedure is through a left upper quadrant 12-mm incision.

**Techniques**

**Laparoscopic Antecolic Antegastric Roux-en-Y Gastric Bypass Operative Technique**

The abdomen is then insufflated with carbon dioxide to a pressure of 15 mm Hg, a 45-degree angled laparoscope is inserted, and an additional four ports are placed (a 5-mm trocar at the right subcostal margin, a 5-mm inferior to the left upper quadrant 12-mm trocar, a 12-mm trocar in the right upper quadrant, and a 12-mm trocar in the upper abdominal midline). The omentum and transverse colon are retracted cephalad until the transverse colon mesentery is visualized. Anterior retraction of the mesentery allows visualization of the jejunal at the ligament of Trietz. The jejunal is then transected with a linear stapler loaded with a 60-mm–length cartridge containing variable staple sizes from 2.0 to 3.0 mm for medium-thickness tissue, approximately 40 cm to 75 cm distal to the ligament of Trietz. A long enough section of mesentery is usually found here so that the Roux limb can be placed in the antecolic antegastric position and safely reach the gastric pouch without any significant tension. The mesentery is divided with a linear stapler loaded with a 2.0-mm staple cartridge, and then the ultrasonic shears are used to extend this division as much as necessary so that the proximal Roux limb is able to safely reach the gastric pouch. A stay suture is placed on the proximal Roux limb, and then the bowel is run approximately 60 to 100 cm distal to the stapled off end. A stay suture is placed here to mark where the stapled side-to-side jejunoojejunostomy will be constructed with the end of the biliopancreatic limb. The anastomosis is performed with a linear stapler loaded with a 60-mm–length cartridge containing variable staple sizes from 2.0 to 3.0 mm that is inserted through small enterotomies made with the ultrasonic shears below the stay suture (Figure 2). The enterotomy opening is then closed with firing of a similar linear stapler that has been placed under two stay sutures at each end of the opening (Figure 3). An unzipping stitch is placed in the crotch of the stapled anastomosis, and an antiobstruction stitch is placed to keep the Roux limb from kinking at the jejunoojejunostomy. The mesenteric defect is then closed with a running suture. Clips or sutures are placed on the staple line if there is any bleeding. The greater omentum is divided in half with an ultrasonic dissector or vessel-sealing device along its entire length up to the border of the transverse colon.

Next, the patient is placed into steep reverse Trendelenburg’s position. The legs and feet are then checked to ensure they are still straight and on the footboard. The left lateral segment of the liver is retracted with a Nathanson’s retractor through a subxiphoid 4-mm puncture, which is then held in position with a movable arm that attaches to the operating room table (Iron Intern with Nathanson’s liver retractors, Automated Medical Products Corp., Edison, NJ). The procedure then begins with dissecting the peritoneal attachments at the angle of His to expose the left crus, followed by the bare area of the gastrohepatic omentum to enter the lesser sac. Division of the neurovascular bundle on the lesser curvature side of the stomach just distal to the left gastric vein is done with a linear stapler with a

---

**BOX 5: Patient requirements for bariatric surgery**

1. Patients with a BMI of 40 kg/m² or greater are potential candidates for bariatric surgery.
2. Patients with a BMI of 35 to 40 kg/m² with significant obesity-related comorbidity are also potential candidates for bariatric surgery.
3. Patients with a history of dieting.
4. Patients with no recent substance abuse.
5. Patients should be evaluated by a multidisciplinary team that includes a dietitian and psychologic evaluation before surgery.

*BMI, Body mass index.*
A linear stapler is used to create the jejunojejunostomy. (Illustration used with permission from Cameron JL, Sandone C: Atlas of gastrointestinal surgery, ed 2, vol II, Shelton, CT, in press, PMPH-USA.)

Closure of jejunojejunostomy opening. (Illustration used with permission from Cameron JL, Sandone C: Atlas of gastrointestinal surgery, ed 2, vol II, Shelton, CT, in press, PMPH-USA.)

FIGURE 2

FIGURE 3

A linear stapler is used to create the jejunojejunostomy. Next, a linear stapler loaded with a 60-mm–length cartridge containing variable staple sizes from 3.0 to 4.0 mm is first used to divide the stomach, followed by successive firings of a linear stapler containing 60-mm–length cartridges with variable staple sizes from 2.0 to 3.0 mm. The first gastric staple transection is started on the lesser curve side just below the left gastric vein and is then followed by sequential stapling until completion at the angle of His so that the proximal gastric pouch created is 15 to 20 mL in size (Figure 4). It is important to retract the posterior fundus downward and bring the stapler around the tissue at the angle of His to avoid making a large fundal pouch. This is prevented by entering the open space of the lesser sac after the first stapled division of the stomach and then dissecting through to the angle of His with an articulating dissector instrument that can then lock in place after forming a right angle. The articulating dissector can then be used to retract the fundus inferiorly while stapling sequentially to the angle of His. The stomach staple lines on both sides should be inspected for adequate staple formation, bleeding, and ischemia. Bleeding staple lines are usually easily taken care of with a clip or direct suture ligation.

The Roux limb is brought up antecolic antegastric with care to avoid a twist in the mesentery. The Roux limb is then sutured to the gastric pouch staple line approximately where the first and second gastric staple lines intersect. A small enterotomy is made below the stay suture in the Roux limb and a similar size gastrostomy in the pouch to place the linear stapler loaded with a 45-mm–length cartridge containing variable staple sizes from 3.0 to 4.0 mm to create the gastrojejunalostomy where only the first 30-mm of the staple cartridge are used (Figure 5). A stay suture is placed on the lesser curve (right) side of the opening; it is then used to retract the posterior part of the anastomosis to the left and anterior, thereby exposing the entire posterior side. A running 2-0 suture is then placed starting posterior on the left side and continuously run to the stay suture on the right side, which it is tied too (Figure 6). The anesthesia team carefully passes a 32F blunt round-end bougie from the mouth and then through the gastrojejunal anastomosis and into the Roux limb. A stay suture is placed at the halfway point of the opening between the end stay sutures. This stay suture and the stay suture on the left (angle of His side) are used to elevate the tissue so that the linear stapler loaded with a 60-mm–length cartridge containing variable staple sizes from 3.0 to 4.0 mm can be used to close the openings. The stapler is brought down on top of the bougie while retracting the tissue to be transected. This firing then closes most of the opening,
Laparoscopic surgery for Morbid Obesity

and the small remaining defect on the right side is easily closed with a 2-0 suture (Figure 7). Alternatively, the entire opening could be closed with a running 2-0 suture. The gastrojejunal anastomosis is then completed by running a 2-0 suture to cover the entire anterior and lateral sides in a second layer. The resultant anastomosis is approximately 12 mm in diameter and has been completely encircled by multiple continuous running 2-0 suture. An air leak test can be performed if desired to test the gastrojejunal anastomosis.

The operating room table is taken out of steep reverse Trendelenburg’s position, and the mesenteric defect is then closed between the Roux limb mesentery and the transverse mesocolon, up to the transverse colon with running 2-0 suture. This is to help prevent an internal hernia through Peterson’s defect. The remaining jejunojejunalostomy mesenteric defect is then closed with a running suture. A drain is placed in the left upper quadrant by the anastomosis, and the trocars are removed with direct vision. Long-acting local anesthetic is placed in the wound, and the sites are closed with an absorbable subcuticular suture and glue (Figure 8).

Laparoscopic Adjustable Gastric Band

The 45-degree angled viewing laparoscope is inserted, and an additional three trocars (a 12-mm trocar in the upper abdominal midline and two right upper quadrant 5-mm trocars) are placed with direct vision. The angle of His attachments are taken down with blunt dissection, and the gastrohepatic omentum in the bare area is divided with a hook electrocautery. The right crus is identified. After the hook cautery is used to divide peritoneal tissue, an articulating dissector is then placed from the right crus side to the angle of His, with gentle rotating side-to-side motion as it is advanced forward; it is then
flexed into a right angle and locked. The 12-mm left upper quadrant trocar is removed, and a 15-mm trocar is placed. The adjustable band is placed into the abdomen through the 15-mm trocar. The band tubing is then placed through the opening in the articulating dissector and then brought over to the right crus side (Figure 9). The tubing is removed from the dissector and then placed through the buckle of the band. The buckle is then locked. Next, one to four interrupted 2-0 nonabsorbable sutures are placed from the fundus to the proximal stomach (superior to the band). It is easier to work closer to the angle of His side of the stomach and then sew towards the patient’s right side (Figure 10). The buckle of the band should not be covered because of increased risk of erosion. The anterior fundal wrap over the band should be without tension. The tubing of the band is grasped and removed through the left upper quadrant trocar site. The trocars are then removed. A subcutaneous pocket is formed on the anterior side of the fascia, and the port is connected to the band tubing and then secured to the fascia. It is important to check the tubing and ensure it has no kinks as it enters the fascia. The site is irrigated, and then all the trocar sites are closed with subcuticular suture and glue (Figure 11).

Laparoscopic Vertical Sleeve Gastrectomy

Laparoscopic vertical sleeve gastrectomy was initially used as a first-stage operation in patients at high risk or in patients whose super morbid obesity made a laparoscopic-only approach difficult. After 12 to 24 months of weight loss, a second-stage operation could be used in those who were still at a high BMI and wanted to be revised to a laparoscopic Roux-en-Y gastric bypass or a laparoscopic duodenal switch with biliopancreatic diversion. This staged approach is designed to reduce operative risk by improving comorbidities and reducing the technical challenges associated with super morbidly obese patients. Recent data has shown that sleeve gastrectomy is an effective operation for weight loss, resulting in 40% to 60% excess body weight loss as the primary treatment alone. It is easier to perform and has less complications then a Roux-en-Y gastric bypass or duodenal switch with biliopancreatic diversion. It does not involve a large foreign body that can be at risk to erode or slip as with an adjustable gastric band. It also avoids the intestinal malabsorption and small bowel obstruction risks seen with gastric bypass or duodenal switch with biliopancreatic diversion.

As previously described, entry to the abdominal cavity starts with a 12-mm trocar placed with direct vision through a left upper quadrant incision. The abdomen is then insufflated with carbon dioxide to a pressure of 15 mm Hg, a 45-degree angled laparoscope is inserted and an additional three ports (a 5-mm trocar at the right subcostal margin, a 15-mm trocar in the right upper quadrant, and a 12-mm trocar just to the left of the upper abdominal midline) and a subxi-phoid liver retractor are placed with direct vision. The operation starts with division of the stomach’s greater curvature blood supply with a vessel-sealing device to divide the gastrocolic and gastroplenic
**FIGURE 9** The band tubing attached to the articulating dissector is then brought around the posterior stomach, from patient's left to right side. (Illustration used with permission from Cameron JL, Sandone C: Atlas of gastrointestinal surgery, ed 2, vol II, Shelton, CT, in press, PMPH-USA.)

**FIGURE 10** An anterior gastric wrap is performed with interrupted nonabsorbable sutures. (Illustration used with permission from Cameron JL, Sandone C: Atlas of gastrointestinal surgery, ed 2, vol II, Shelton, CT, in press, PMPH-USA.)
ligaments close to the stomach (Figure 12). A stay suture is placed 6 to 7 cm from the pylorus-duodenal junction. A 40F bougie is inserted transorally and brought down alongside the lesser curve until it lays against the stomach wall to the patient's right of the stay suture. Next, a narrow gastric tube is created with a linear cutting stapler starting on the patient's right side of the stay suture and sequentially stapling towards the angle of His alongside a 40F bougie. The surgeons should confirm that the bougie is on the lesser curve side of the stapler.

The stomach is first divided with two firings of the linear stapler loaded with 60-mm–length cartridges containing variable staple sizes from 4.0 to 5.0 mm for extra thick tissue. The stomach is continued to be divided with a linear stapler loaded with 60-mm–length cartridges containing variable staple sizes from 3.0 to 4.0 mm. The stomach is divided next to the bougie all the way up to the angle of His where the lateral stomach is separated (Figure 13). Care is taken not to leave any fundus behind and not to apply the stapler too close to the gastroesophageal junction. Hemostasis of the gastric staple line can be secured with running sutures or clips. The resected stomach is extracted intact through the 15-mm trocar site, after widening the fascial opening with a clamp device. If the surgeon desires, the staple line can be evaluated with an underwater leak test either with an orogastric tube or an endoscope. A drain is placed in the left upper quadrant and brought out through the 5-mm trocar site. The ports are removed with direct vision after first closing the 15-mm port site suture passing device. Long-acting local anesthetic is placed in the wounds, and the sites are closed with subcuticular sutures (Figure 14).

**Laparoscopic Biliopancreatic Diversion With Duodenal Switch**

The laparoscopic duodenal switch with biliopancreatic diversion (DS-BPD) is primarily a malabsorptive operation that involves preservation of the gastric pylorus and creation of a short, 100-cm ileal “common channel,” where food and biliopancreatic enzymes are allowed to mix. Because of the potential for malabsorption-related nutritional deficiencies and the complexity of the operation, DS-BPD is the least common bariatric operation performed in the United States when compared with gastric bypass, sleeve gastrectomy, and adjustable gastric banding.
Laparoscopic Gastric Plication

Laparoscopic gastric greater curvature plication is an emerging restrictive bariatric procedure that successfully reduces the gastric volume with plication of the gastric greater curvature. Its main advantages are the reversibility of the technique, no staple line needed, and no foreign body. Currently, it is under investigational protocol at several institutions in the United States. The procedure consists of separating the greater omentum and attachments of the spleen from the greater curvature of the stomach. The anesthesiologist places a bougie into the stomach or a flexible endoscope may be used in its place. The surgeon then starts inverting the stomach 2 cm from the angle of His on the greater curvature side with either running or interrupted sutures to approximately 5 to 6 cm from the pylorus. A second row of sutures are usually placed to further fold the stomach inward and create more restriction. Current studies have shown short-term efficacy in weight reduction. However, further studies are needed to determine long-term efficacy and safety because the rates of complications may increase over time along with weight regain. Acute gastric perforation, leak at the suture line, obstruction, and intussusception are all possible complications.

As previously described, entry to the abdominal cavity starts with a 12-mm trocar placed with direct vision through a left upper quadrant incision. The abdomen is then insufflated with carbon dioxide to a pressure of 15 mm Hg, a 45-degree angled laparoscope is inserted, and an additional four ports (a 5-mm trocar at the right subcostal margin, a 5-mm inferior to the left upper quadrant 12-mm trocar, a 15-mm trocar in the right upper quadrant, and a 12-mm trocar in the upper abdominal) and a subxiphoid liver retractor are placed with direct vision. The operating surgeon stands on the patient’s left side for the small intestinal part of the operation, and the assistant on the right. The left-sided ports are the surgeon’s operating ports for the ileoileostomy part of the procedure. The operating room table is then placed flat, and the omentum and transverse colon are retracted cephalad. The cecum and ileocecal valve are then identified, and the ileum is measured back 100 cm proximal to the cecum. A stay suture is placed, and then another 150 cm of ileum is measured proximal from the suture. This is where the ileum is transected with a linear stapler loaded with a 60-mm–length cartridge containing variable staple sizes from 2.0 to 3.0 mm. The mesentery is divided with ultrasonic shears, and a stay suture is placed on the distal transected bowel to mark the Roux end that will connect to the duodenum. The proximal divided bowel is the biliopancreatic limb, which is brought down to the previous stay suture marking the ileum at 100 cm from the cecum. A stapled side-to-side ileoileostomy is then constructed. Care should be taken to avoid a twist or misalignment of the bowel at this point. The anastomosis is performed as the previously described enteroenterostomy in the gastric bypass section.

Next, the patient is placed in steep reverse Trendelenburg’s position, and a liver retractor is placed in the subxiphoid position to retract the left lateral segment of the liver. As previously described, a sleeve gastrectomy is then performed, with a 48F instead of a 40F bougie, and then it is removed after completion. Attention is then turned toward the duodenum, which is freed from its lateral attachments, with great care taken to not injure any of the structures in the hepatoduodenal ligament. The duodenum is divided approximately 2 to 4 cm distal to the pylorus with a linear stapler loaded with a 60-mm–length cartridge containing variable staple sizes from 3.0 to 4.0 mm (Figure 15). The omentum is split, and the Roux limb is brought antecolic up to the proximal duodenal end. Two stay sutures are placed for a side-to-side anastomosis. Under the inferior stay suture, both ends are opened and a linear stapler loaded with a 45-mm–length cartridge containing variable staple sizes from 3.0 to 4.0 mm is placed for 2.5 to 3 cm and fired (Figure 16). A 40F bougie is placed through the anastomosis. The opening is now closed with a running suture. Multiple seromuscular interrupted sutures are placed circumferentially. The mesenteric defect is then closed between the Roux limb mesentery and the transverse mesocolon, up to the transverse colon. A drain is left by the stomach, and another drain is left by the ileoinal anastomosis. The trocars are removed, and local anesthetic is injected, followed by a subcuticular closure of the trocar sites (Figure 17).

POSTOPERATIVE MANAGEMENT

Most patients are transferred after routine monitoring in the recovery room. Patients with moderate to severe obstructive sleep apnea are prescribed (CPAP [continuous positive airway pressure]) during...
sleep, if they are able to tolerate it or use it routinely at home. Low molecular-weight heparin is continued during hospitalization for most patients, and some patients who are at higher risk for venous thromboembolism may be treated at home for an entire month after surgery. The patient is usually in a chair or ambulating within the first 12 hours. Pain is managed with a patient-controlled analgesia delivery device for the first evening, and the patient is encouraged to use the incentive spirometer while awake.

Patients for adjustable gastric band are given a liquid diet the following morning and then discharged to home. Patients for gastric bypass and duodenal switch are started on a limited liquid diet on postoperative day 1, and then the quantity of liquids is advanced as tolerated on day 2 with discharge planned that day. Patients for sleeve gastrectomy are given a nonsugar liquid diet on postoperative day 1.
and usually advanced over the course of the day, with an aim to discharge that day or the following morning. Patients after all four operations remain on a nonsugar noncarbonated liquid diet that includes protein drinks for the first week after surgery. They are then advanced to a puree diet that still includes protein drinks for the following 3 weeks, at which time they start to introduce solid foods. Selective upper gastrointestinal series radiography is used in patients who have a sustained heart rate over 120 bpm, respiratory distress, fever, increasing abdominal pain or chest pain. The drain is removed before discharge.

Follow-up is in 2 weeks for all patients. Patients are highly encouraged to go to monthly support group meeting and see the dietitian on a routine basis, along with a mental health professional if needed or requested.

Patients for adjustable gastric band are evaluated for their first fill at the 6-week postoperative appointment. Patients who, despite making healthy food choices, have stopped losing weight, who report no "restriction" with solid foods, and who are consistently hungry in between meals get a fill. Patients are then asked to follow-up in 2 months. Band position and tightness can be assessed with fluoroscopy if necessary in patients who, despite repeated fills, continue to have no restriction. Patients who report continued vomiting, abdominal pain, or severe gastroesophageal reflux disease (GERD)—like symptoms should also be evaluated with an upper gastrointestinal fluoroscopic study.

All patients are placed on a multivitamin and calcium after surgery. Menstruating women are placed on iron to prevent anemia. Patients for gastric bypass are recommended to take vitamin B12, and patients for duodenal switch with biliopancreatic diversion are advised to take supplements that include the fat-soluble vitamins A, D, E, and K. Patients who have not had their gallbladder previously are advised to take supplements that include the fat-soluble vitamins A, E, and K. Patients for duodenal switch with biliopancreatic diversion are advised to take supplements that include the fat-soluble vitamins A, E, and K tested after surgery.

Patients who are not taking in enough protein by diet history may need prealbumin checked along with nutritional counseling. Patients for DS-BPD may also need the additional vitamins A, E, and K tested after surgery.

**OUTCOMES AND COMPLICATIONS**

Buchwald and colleagues conducted a meta-analysis of the bariatric literature in 2003. They found that mean excess weight losses for adjustable gastric band, Roux-en-Y gastric bypass, and biliopancreatic diversion with or without duodenal switch were 48%, 62%, and 70%, respectively. Mortality rates were 0.1%, 0.5%, and 1.1%, respectively, for the three operations. Type II diabetes was found overall to be completely resolved in 77% of patients and improved in an additional 9% of patients. Hyperlipidemia, hypertension, and obstructive sleep apnea were improved in 70%, 79%, and 84%, respectively. Schauer and associates showed in a randomized prospective trial that obese patients with uncontrolled type II diabetes had significant improvement in glycemic control after both Roux-en-Y gastric bypass and sleeve gastrectomy compared with medical therapy alone. The mean glycated hemoglobin was 9.2% before the study; after 12 months, the mean decreased to 7.5% in the medical therapy alone group, 6.4% in the gastric bypass group ($P < 0.001$), and 6.6% in the sleeve gastrectomy group ($P = 0.003$). Patient weight loss was only $-5.4$ kg in the medical therapy group as compared with the gastric bypass and sleeve gastrectomy groups ($-29.4$ kg and $-25.1$ kg, respectively; $P < 0.001$) at 12 months follow-up. In a large retrospective cohort study comparing bariatric surgery patients matched with morbidly obese patients who did not undergo surgery, Adams and colleagues found a 40% reduction in mortality rate after 7.1 years with the surgery group. The significant decrease in the long-term mortality rate was attributed to a decrease in coronary artery disease, type II diabetes, and cancer-related deaths.

Pulmonary embolism and sepsis from an anastomotic leak are the two leading causes of death in the postoperative period after bariatric surgery. Both complications are less than 1% at most bariatric surgery centers that are part of the American College of Surgeons Bariatric Surgery Center Network Accreditation program. Perioperative measures to reduce the risk include: chemoprophylaxis, sequential compression devices (if they can safely fit the patient’s lower extremity), and early ambulation. Some centers go beyond the routine in-hospital prophylaxis by placing patients who may be at higher risk for venous thromboembolism on low molecular-weight heparin anywhere from 10 days to a month after discharge from the hospital. These patients may include those who have a history of pulmonary embolism or deep venous thrombosis, poor ambulation, severe venous stasis disease, and possibly a BMI of more than 70 kg/m². Inferior vena cava filters are also used in some select patients who may be at higher risk for death from pulmonary embolism. It is unclear to date whether these extra measures used to prevent venous thromboembolism (VTE) are helpful because no randomized trials specifically address the morbid obese patient population that undergoes bariatric surgery.

Prevention of a leak is one of the primary ways to decrease mortality after bariatric surgery. The most common area for a leak to occur after gastric bypass is at the gastrojejunostomy. However, a leak may also occur at the distal stomach staple line or the jejunojunostomy. There are several ways of performing the upper anastomosis of a GBP or DS-BPD that include circular stapler, linear stapler, hand-sown, and a combination of stapling with an outer layer of suturing. This may account for variation in the reported rates of a leak, stomal stenosis, and marginal ulcer. At Johns Hopkins, the laparoscopic Roux-en-Y gastric bypass leak rate is less than 0.3% with the previously described technique that has an inner stapled layer and essentially an outer layer consisting of multiple running sutures.

Box 6 shows the published complication rate after laparoscopic gastric bypass. The authors have used an anecolic antegastric technique for more than 7 years, which has reduced the internal hernia rates to less than 2%. The authors continue to close the defect between the transverse mesocolon and the Roux limb mesentery up to the transverse colon along with the enterostomy defect in both the gastric bypass and the DS-BPD operations. Stomal stenosis after gastric bypass most commonly occurs between 2 to 6 weeks after surgery but occasionally may be seen later in conjunction with a marginal ulcer. Greater than 90% of these patients respond to balloon dilation; however, late-occurring strictures are less likely to heal and may require revision of the gastrojejunostomy with or without a truncal vagotomy. A marginal ulcer after gastric bypass can occur on the jejunal side of the gastrojejunal anastomosis, and again, greater than 90% heal with proton pump inhibitor therapy. Patients should

**BOX 6: Complications for 251 cases**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomal stenosis:</td>
<td>10 (4%)</td>
</tr>
<tr>
<td>Marginal ulcer:</td>
<td>11 (4%)</td>
</tr>
<tr>
<td>Symptomatic gallstones:</td>
<td>8 (3%)</td>
</tr>
<tr>
<td>Internal hernia:</td>
<td>4 (2%)</td>
</tr>
<tr>
<td>Postoperative bleeding:</td>
<td>5 (2%)</td>
</tr>
<tr>
<td>Stroke (minor):</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Trocar hernia:</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Deep venous thrombosis:</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Pulmonary emboli:</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Wound infection:</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Leaks:</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Death:</td>
<td>1 (0.4%)</td>
</tr>
</tbody>
</table>
Flexible endoscopic suturing devices have also been used to create a gastric sleeve along the lesser curvature of the stomach. This approach has been noted in India, and South America with adequate short-term results. The most common complication reported in ~1% of cases and requires removal of the band.

Infection of the band system is also seen in ~1% of cases and again requires removal. GERD symptoms that develop when inflating the band with saline solution to increase restriction may require removal of the some or all of the fluid. Patients who have an obvious hiatal hernia at the time of surgery may benefit from a crural repair at the time of gastric band placement.

**ENDOSCOPIC APPROACHES TO THE MANAGEMENT OF OBESITY**

Transoral endoluminal interventions performed entirely through the gastrointestinal tract with flexible endoscopy offer the potential for an ambulatory weight loss procedure without any incisions on the abdominal wall. The restrictive procedures include intragastric balloon treatment, endoluminal sutured gastroplasty, and transoral stapled gastroplasty. The malabsorptive procedures include duodenojejunal bypass sleeve and gastroduodenojunal bypass sleeve. Other procedures that have been performed with varying degrees of short-term success include intragastric injection of botulinum toxin type A and gastric electrical stimulation.

The most widely studied of these therapies is the intragastric balloon. Although this device is currently not FDA approved for use in the United States, it has been used in Europe, Canada, Mexico, India, and South America with adequate short-term results. The most common complication is nausea and vomiting, but more serious complications, such as gastric erosions, ulcerations, and bowel obstructions, have been noted. There are ongoing trials looking at the use of flexible endoscopically guided staplers or suture devices to create a gastric sleeve along the lesser curvature of the stomach. Flexible endoscopic suturing devices have also been used to reduce the size of the stoma and gastric pouch in patients who have had weight regain after gastric bypass. Unfortunately, long-term weight loss has not been proven with these devices.

Malabsorptive procedures, such as the duodenojejunal bypass sleeve, use a prosthetic barrier device that intraluminally bypasses the necessary areas of absorption in the duodenum and the upper part of the jejunal. A gastroduodenojunal bypass sleeve has also shown promise in very short-term results with regards to weight loss and glycemic control. Long-term results and safety profile studies are needed with these devices.

Endoscopic therapy for weight loss is in its infancy; newer therapies are constantly being introduced and tested. If appropriate efficacy and safety profiles can be established, these products may be introduced into the clinical mainstream practice.

**COMMENTS**

Bariatric surgery continues to be the only effective means of producing weight loss in most patients. It has been shown to reduce or even eliminate comorbidities associated with a high BMI. Mortality and leak rates less than 1% have been published by several leading surgical centers committed to bariatric surgery. Laparoscopic techniques have been shown in randomized prospective studies over open approaches to significantly reduce perioperative wound complications and incisional hernias. Appropriate attention to the risks and benefits of the procedure along with the individual patient’s medical risks requires consultation and joint decision making between the physician and the patient. Center of excellence certification programs are collecting outcome data that will not only help to document in the future the beneficial long-term effects of bariatric surgery but will also define acceptable outcomes and complication rates.

**SUGGESTED READINGS**


