Surgery for Severe Obesity: Patient Selection, Surgical Options, and Aftercare

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Obesity continues to be a public health problem of growing magnitude in the United States. Between the late 1970s and 2004, the prevalence of obesity among adults more than doubled, with an increase from 15% to 33%.[1] In the same period, the prevalence of overweight among children of different age groups rose from between 5% and 6.5% to between 14% and 19%.[1] Globally, the problem is equally alarming. According to estimates by the World Health Organization and the International Obesity Task Force, nearly 1.7 billion people are overweight worldwide,[2,3] exceeding the number of those who are undernourished.[4] Although obesity is mainly concentrated in the developed world, it is beginning to affect the developing countries[5] and is predicted to contribute significantly to a worldwide pandemic of diabetes by the year 2030.[6,7]

Obesity is strongly associated with a number of metabolic derangements and medical conditions, including type 2 diabetes mellitus, coronary artery disease, and obstructive sleep apnea,[8] and is now considered the second leading cause of preventable death in the United States.[9] An estimated $92.6 billion is spent each year in prevention and treatment of overweight and obesity in the United States, accounting for more than 9% of total medical expenditures.[1,10]

The nonsurgical treatments for obesity have failed to produce clinically significant[11] and sustainable[12,13] weight loss, especially in severely obese patients. At this time, surgery is the only effective long-term treatment option available for these individuals. The development of a minimally invasive laparascopic approach to bariatric surgery along with the rising prevalence of obesity has led to a dramatic increase in the number of bariatric procedures being performed in the United States. From 1998 to 2004, the total number of bariatric operations increased ninefold, from 13,386 to 121,055 (**Table**).[14] Given these trends, physicians are likely to encounter patients who may be candidates for bariatric surgery or patients who have already undergone a weight loss operation. Thus, physicians should be familiar with the factors that are used to select patients for bariatric surgery, the types of bariatric surgical procedures performed in the United States, and the potential complications associated with each procedure.

TAKE HOME POINTS

- Surgery is currently indicated in patients with a body mass index (BMI) of 40 kg/m^2 or greater, or in patients with a BMI of 35 kg/m^2 or greater with obesity-related life-threatening or life-altering illnesses (eg, severe diabetes, obstructive sleep apnea, cardiomyopathy, joint disease).
- Factors considered in selection of an appropriate candidate for weight loss surgery include age, patient motivation, nutritional behavior, psychosocial issues, and medical comorbidities.
- Roux-en-Y gastric bypass is the most frequently performed bariatric surgery procedure and is considered the gold standard for surgical treatment of morbid obesity in the United States.
- Many of the comorbidities associated with obesity are either resolved or improved within a short span of time after surgery, including diabetes, hyperlipidemia, hypertension, and obstructive sleep apnea.
- Lifelong follow-up is required after bariatric surgery with review of the patient's weight loss, eating pattern, and new symptoms and monitoring of levels of essential vitamins and minerals, including vitamin B_1, vitamin B_{12}, vitamin D, folic acid, iron, and calcium.

DEFINITIONS OF OVERWEIGHT AND OBESITY

Body mass index (BMI) is the most commonly used measure of overweight and obesity. The National Institutes of Health (NIH) defines overweight as a BMI between 25 and 29.9 kg/m^2 and obesity as a BMI of

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Table. Types of Bariatric Surgical Procedures Performed in the United States During 1998–2002

Procedure Type	No. of Procedures (%)					*P* Value for Trend*
	1998	1999	2000	2001	2002	
Gastric bypass	10,675 (79.9)	20,421 (89.5)	27,497 (88.5)	48,507 (85.4)	63,538 (88.0)	0.27
Gastroplasty†	3295 (24.7)	2097 (9.2)	4357 (14.0)	6247 (11.0)	5369 (7.4)	0.01
Malabsorptive‡	990 (7.4)	1277 (5.6)	3684 (11.9)	4732 (8.3)	7495 (10.4)	0.54
Gastrectomy§	258 (1.9)	721 (3.2)	495 (1.6)	2186 (3.8)	3082 (4.3)	0.30
Other	43 (0.3)	31 (0.1)	70 (0.2)	303 (0.5)	1446 (1.9)	0.13
Total number of procedures‖	13,365	22,809	31,082	56,781	72,177	< 0.001

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*In the proportion of total procedures.

†Includes vertical banded gastroplasty and adjustable gastric banding.

‡Includes duodenal switch, biliopancreatic diversion, and isolated intestinal bypass.

§Includes sleeve gastrectomy and any isolated partial gastrectomy.

‖The numbers in the columns do not add up to the total number of procedures because they are survey-weighted estimates.

30 kg/m^2 or greater.[15] In addition, there are 3 classes of obesity: class I, which is a BMI of 30.0 to 34.9 kg/m^2; class II, which is a BMI of 35 to 39.9 kg/m^2; and class III, which is a BMI of 40 kg/m^2 or greater.[15] Class III obesity is referred to as extreme, severe, or morbid obesity. In addition to BMI, physicians are advised to use waist circumference when assessing health risks in a patient who is obese, as this measure is strongly associated with abdominal fat and is a predictor of disease risk.[15] A waist circumference exceeding 40 inches in men and 35 inches in women is associated with increased risk of obesity-related disease in those who have a BMI of 25 to 34.9 kg/m^2.[15]

TREATMENT OPTIONS FOR OBESITY

Treatment for obesity generally begins with lifestyle modifications through improved dietary and behavioral habits and physical exercise. Recent evidence has shown that overweight and obese individuals seeking to implement lifestyle modifications benefit from more intensive interventions with group and individual contact and structured meal plans aimed at helping them achieve their weight loss goals. One-year follow-up data from the Look AHEAD (Action for Health in Diabetes) trial, a multicenter randomized controlled trial involving overweight and obese individuals with type 2 diabetes, showed that intensive lifestyle intervention with group and individual meetings to help achieve and maintain weight loss through decreased caloric intake and increased physical activity was superior to conventional diabetes support and educational efforts in reduction of weight and cardiovascular risk factors and control of diabetes.[16] Unfortunately, in morbidly obese individuals, behavioral approaches to treating obesity result in loss of only 6% to 11% of excess body weight;[17–19] more importantly, they fail to produce sustainable results over the long term due to high rates of recidivism.[13,20]

Pharmacologic therapy is often used as an adjunct to diet and lifestyle changes in obese patients. Two pharmacologic agents have been approved by the US Food and Drug Administration (FDA) for patients with a BMI of at least 30 kg/m^2 and for patients with a BMI of at least 27 kg/m^2 and significant risk factors for use over the long term along with calorie reduction and lifestyle modifications.[21–25] These include sibutramine, which suppresses the appetite through its centrally acting serotonin-reuptake inhibitor mechanism, and orlistat, which causes malabsorption of fat by binding to the intestinal lipase enzyme. The most common side effects associated with sibutramine include a slight increase in blood pressure, dry mouth, dizziness, constipation, and insomnia. Patients are required to have regular blood pressure evaluations while taking the medication. Patients with uncontrolled hypertension should not take sibutramine.[21] The most common side effects associated with orlistat include steatorrhea and increased frequency and urgency of bowel movements.[22] It is worth noting that these agents have not been specifically tested in patients who are severely obese.

In 1991, an NIH consensus development conference was convened to discuss gastrointestinal surgery as a treatment for severe obesity.[26] At that time, the panel recommended that gastric restrictive or bypass procedures could be considered for well-informed and motivated patients with acceptable operative risks.[26] Surgery

is currently indicated in patients with a BMI of 40 kg/m^2 or greater, or in patients with a BMI of 35 kg/m^2 or greater with obesity-related life-threatening or life-altering illnesses such as severe diabetes, obstructive sleep apnea, cardiomyopathy, and joint disease.

SELECTION OF AN APPROPRIATE SURGICAL CANDIDATE

In addition to BMI, several other important factors are considered in selection of an appropriate candidate for weight loss surgery. The preoperative assessment is aimed at identifying behavioral, psychological, social, and medical conditions that may interfere with successful outcomes.

Age

Bariatric surgery is generally offered to patients between age 18 and 60 years. Patients younger than 18 years should be evaluated at centers specializing in adolescent surgery. Although obese adolescents experience significant medical and psychosocial benefits from weight reduction surgery,[27,28] their physical stature may be negatively impacted by nutritional deficiency if surgery is performed before they have attained a majority of their predicted growth. Other issues unique to adolescents include patient compliance with nutritional and lifestyle requirements after surgery as well as the ethical issue pertaining to the decisional capacity of minors. According to consensus recommendations made by a group of surgeons and pediatricians specializing in the treatment of overweight and obese children and adolescents, bariatric surgery should only be offered to patients aged 13 years or older who have normal developmental and decisional capacity, and surgery should only be performed at centers with multidisciplinary weight management teams experienced with meeting the distinct physical and psychological needs of adolescents.[29] Additionally, the 2004 American Society of Bariatric Surgery Consensus Conference Panel recommended consideration of bariatric surgery only if the adolescent has obtained at least 95% of predicted adult stature and has undergone a trial of dietary and behavior modification for at least 6 months.[30] In 2004, less than 1% (349 patients) of all bariatric procedures in the United States were being performed in patients aged 12 to 17 years.[14]

Performing bariatric surgery on elderly (≥ 65 yr) and near elderly (55–64 yr) patients is also somewhat controversial. A retrospective cohort study of more than 16,000 Medicare beneficiaries in the community undergoing bariatric surgery between 1997 and 2002 demonstrated a nearly threefold increase in the risk of early mortality among patients aged 65 years and older: 30-day mortality was 4.8% for those older than 65 years versus 1.7% for those aged 65 years or younger.[31] Other studies similarly have shown higher mortality rates among patients aged 60 years and older.[32–34] It is important to note that the Medicare recipients study highlights the outcomes of bariatric surgery in the community. In contrast, studies from specialized centers suggest that early mortality for elderly patients is not increased when operations are performed at institutions with high operative volume.[35–38] Further analysis of the Medicare data revealed that early mortality for elderly patients was not increased when operations were performed by surgeons with high procedural volume, with a 90-day mortality rate of 1.8% in patients younger than 65 years versus 1.1% in patients aged 65 years and older ($P = 0.40$).[31] Another important point to note is the improved outcomes of bariatric surgery being reported in recent years. Data from the Nationwide Inpatient Sample indicate that between 1998 and 2004, there was a ninefold decrease in overall inpatient mortality related to bariatric surgery, and the inpatient mortality of bariatric surgery among elderly and near elderly patients declined to less than 1% in 2004.[14] With improvements in the structure and process of care and with refinement of surgical technique and expertise, low mortality is now possible among appropriately selected elderly patients. Thus, it is not surprising to note that from 1998 to 2004, the fastest growth in bariatric surgery occurred among adults aged 55 to 64 years, with an increase from 772 operations in 1998 to nearly 16,000 operations in 2004.[14]

Motivation

As noted in the 1991 NIH consensus statement, surgery should be considered only for well-informed and motivated patients.[26] Bariatric surgery is a life-altering event, and patients need to be fully aware of the dietary and behavioral restrictions associated with the procedure: most procedures will significantly limit the quantity of oral intake; some will limit the composition of meals; many will require life-long daily intake of nutritional supplements; and all will require frequent follow-up for the first 2 years postsurgery and regular follow-up thereafter.[30,39] All these conditions will require commitment and motivation by the patient.

Patient motivation has been shown in retrospective analyses to be an independent predictor of greater weight loss after bariatric surgery.[40,41] Frequent patient follow-up also has been associated with greater weight loss after laparoscopic gastric banding.[41] In this study comparing frequent (> 6 times) versus less frequent (≤ 6 times) follow-up visits in the first year after laparoscopic adjustable gastric banding (LAGB), there was a greater weight loss after 1 year in the frequent follow-up group (50% versus 42% excess weight loss).[41]

Motivation may be determined by reviewing the patient's history of prior attempts at weight reduction and adherence to the requirements of previous dietary and behavioral modification programs. The clinician may encounter morbidly obese individuals who have not demonstrated motivation or previous commitment to weight reduction. Such individuals may not be fully cognizant of their obesity problem or its clinical implications. Although weight reduction surgery may be indicated in these individuals, they should first undergo a trial of dietary and behavioral modification while being educated about their surgical options.

Nutritional Behavior

Severe obesity is associated with a high prevalence of nutritional behavioral disorders such as binge eating disorder (up to 40%)[42,43] and the night eating syndrome. A detailed dietary history specifically designed to identify eating disorders will enable the clinician to identify patients in need of supervised behavioral modification after surgery. Abnormal nutritional behavior has been shown to be associated with decreased weight loss after bariatric surgery.[44,45] Patients with abnormal behavioral patterns should undergo counseling prior to surgery and preferably after surgery. A thorough dietary history, in addition to identifying behavioral issues, will also help the bariatric surgeon select the appropriate surgical procedure. For example, a patient with frequent snacking on high calorie liquids will likely not benefit from a purely restrictive operation such as laparoscopic gastric banding since they can continue to consume liquids in spite of gastric restriction.

Psychosocial Issues

Severe obesity is associated with a high prevalence of psychological disorders,[46] such as mood disorders (25%),[43,46] anxiety disorders (48%),[47] and personality disorders (up to 72%).[43,47] Patients being considered for surgery must undergo thorough psychological assessment and screening. Psychologists with experience in dealing with morbidly obese individuals will be able to identify patients with major psychoses, who will not be candidates for bariatric surgery. Patients with less severe conditions such as mood or anxiety disorders require appropriate counseling and therapy in preparation for their surgical procedure. In retrospective analyses, high self-esteem and good mental health have been associated with improved weight loss after bariatric surgery.[44]

Weight and Medical Comorbidities

Some surgical centers may exclude patients heavier than 450 to 500 lb due to weight limitations imposed by their computed tomography scanners and other equipment. In addition, given the myriad of medical conditions associated with severe obesity, it is imperative to diagnose and treat each condition before surgery. The clinician should be able to identify insulin resistance and any associated end-organ injury, hypertension, cardiac disease, pulmonary hypertension, obstructive sleep apnea, thyroid and ovarian abnormalities, gastroesophageal reflux disease, osteoarthritis, psychological disturbances, and other obesity-related conditions. Conditions that will exclude a patient from being considered for bariatric surgery may vary between institutions but include advanced and irreversible congestive heart failure, debilitating pulmonary disease, Child-Pugh class C cirrhosis, and major psychoses.

SURGICAL PROCEDURES FOR WEIGHT LOSS

The first report of a bariatric operation in humans was published in 1954.[48] The operation was jejunoileal bypass, a procedure in which a long segment of small bowel was circumvented, resulting in malabsorption of nutrients and fat. Although the procedure resulted in an adequate amount of weight loss, it had to be abandoned due to a high incidence of associated complications such as liver failure (10%; presumably from bacterial overgrowth in defunctionalized small bowel), renal stones (29%), and renal disease (37%).[49]

Gastric bypass was described in 1967 by Mason and Ito.[50] The procedure was adopted after observing weight loss in patients undergoing gastric resection for peptic ulcer disease.[51] In the following decade, purely restrictive operations were introduced in an attempt to develop less invasive procedures without the risk of nutritional deficiencies. Initially, horizontal gastroplasties were attempted, which involved creation of a proximal gastric pouch through the use of a nondivided horizontal staple line. These operations were associated with a high incidence of technical failure due to failure of the staple lines. As a modification, vertical banded gastroplasty was described in 1982.[52] In this operation, the staple line was placed vertically and a synthetic mesh was used to reinforce the pouch stoma. Although vertical banded gastroplasty successfully resulted in sustainable weight loss, it was further improved upon by the technically less invasive procedure adjustable gastric banding, described in 1986 by Kuzmak.[51] Around this time, the modern era of laparoscopic surgery had begun, which resulted in application of a minimally invasive approach to bariatric surgery.[53]

Currently, the primary weight loss operations performed in the United States are laparoscopic (and less commonly open) Roux-en-Y gastric bypass (RGBP), LAGB, and biliopancreatic diversion (BPD).[51]

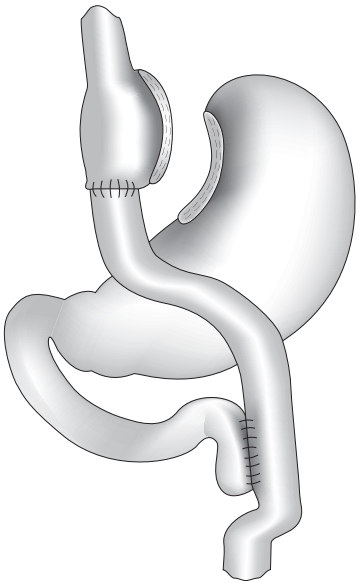

Figure 1. Roux-en-Y gastric bypass.

Laparoscopic sleeve gastrectomy (LSG) is a procedure gaining popularity due to favorable outcomes as a primary restrictive weight loss operation. Vertical banded gastroplasty has been supplanted by the adjustable gastric band and was not commonly performed in 2007. These operations for weight loss can be classified as restrictive, malabsorptive, and combined operations. The restrictive operations induce weight loss by limiting the quantity of nutritional intake. The malabsorptive operations induce weight loss by interfering with absorption of nutrients in the small intestines.

Roux-en-Y Gastric Bypass

RGBP is a combined restrictive and malabsorptive operation. The restrictive component involves creation of a 15- to 30-mL proximal gastric pouch (which is separated from the remainder of the stomach by staples) and a 10- to 12-mm gastrojejunostomy stoma. The malabsorptive component is achieved through creation of a "roux limb" using a variable length (75–150 cm) of jejunum. This is done by dividing the jejunum at a distance of 15 to 20 cm from the ligament of Treitz. The distal portion of the divided bowel is brought up as the roux limb for anastomosis to the gastric pouch. The proximal end of the divided bowel (the biliopancreatic limb) is anastomosed in a side-to-side fashion to the roux limb to create a jejunostomy anastomosis (**Figure 1**).

In addition to its malabsorptive and restrictive components, gastric bypass is associated with hormonal effects that are not fully understood but likely play an important role in appetite suppression, glucose homeostasis, and weight loss after RGBP.[54,55] It has been observed that patients undergoing gastric bypass have suppressed levels of ghrelin,[54] a recently discovered appetite stimulant hormone.[56] These patients also lack the normal meal-related fluctuations and diurnal rhythm in ghrelin levels.[54] The multifactorial mechanism of weight loss with RGBP likely explains the long-term success seen with this operation. At this time, RGBP is the most common bariatric surgery procedure (Table) and is considered the gold standard for surgical treatment of morbid obesity in the United States.

Laparoscopic Adjustable Gastric Banding

LAGB is a restrictive operation in which a circular band is placed immediately distal to the gastroesophageal junction, partitioning a small (15–25 mL) gastric pouch from the remainder of the stomach (**Figure 2**). The band is attached to an access port implanted in the subcutaneous space of the anterior abdominal wall. The inner diameter of the ring, and hence the outflow lumen of the newly created pouch, can be adjusted by injecting the access port with saline. Adjustments are performed sequentially during the outpatient visits until the ideal restrictive diameter is achieved. The degree of weight loss associated with LAGB is less than that associated with gastric bypass,[57] and there is no consensus among the surgical community in the United States regarding the exact indication for this procedure. The procedure, however, remains popular in Australia and parts of Europe. Due to its reversible nature and decreased incidence of serious complications,[58] LAGB may be suitable for placement in carefully selected adolescents under institutional review board–approved protocols (since the device is not FDA-approved for use in adolescents), for older patients with multiple comorbidities, for women of gestational age in whom the ring may be deflated during pregnancy, and for patients choosing to have a less invasive operation. Patients who are superobese (BMI > 50 kg/m^2) are not good candidates for this procedure.

Biliopancreatic Diversion

BPD and BPD with duodenal switch (DS) are malabsorptive operations that are performed in superobese patients. In BPD, the duodenum and jejunum are bypassed. An antrectomy is first performed, then, measuring from the ileocecal junction, 3 portions of bowel are delineated: 50 to 100 cm of distal ileum (the common channel), 250 cm of bowel proximal to the common channel (the alimentary roux limb), and the remaining portion of bowel proximally (the biliopancreatic limb). The roux limb is divided at its junction with the biliopancreatic limb and anastomosed to the stomach. The

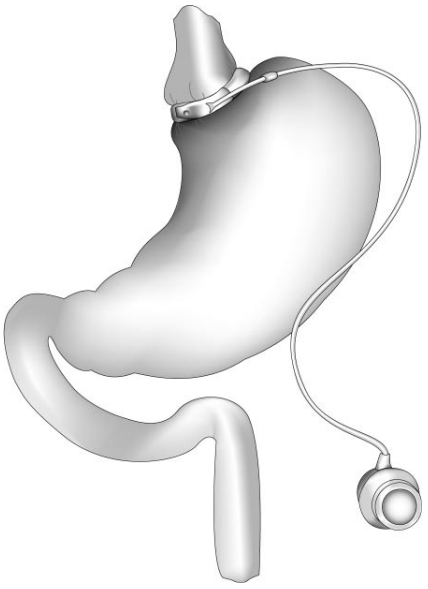

Figure 2. Laparascopic adjustable gastric banding.

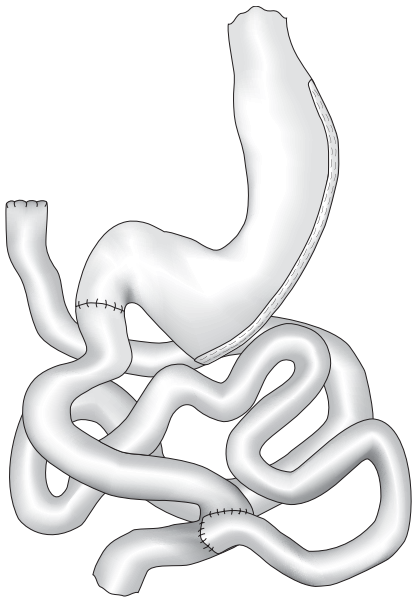

Figure 3. Biliopancreatic diversion with duodenal switch.

biliopancreatic limb is anastomosed to the common channel. The DS operation, which was originally described for treatment of bile reflux,[59] can be combined with BPD by performing a LSG and anastomosing the roux limb to the first portion of the duodenum distal to the pylorus (**Figure 3**). Patients undergoing these operations are at increased risk for nutritional deficiency and need closer follow-up.

Laparoscopic Sleeve Gastrectomy

LSG is gaining popularity as a sole weight loss operation (**Figure 4**). The operation was originally conceived as the first stage of the DS operation and was designed to induce weight loss in a group of patients with very high BMIs in preparation for a completion DS procedure at a later time. The 3-year follow-up data on LSG as a sole weight loss operation indicate an excess weight loss of 68%,[60] which is comparable to the results achieved with gastric bypass. Additionally, complications related to jejunal anastomosis (stomal ulceration, stenosis, and internal hernias) that are seen with gastric bypass may be avoided. Although early results are promising, more studies and longer-term data on success and complications of this operation are required.

POSTOPERATIVE MONITORING

In the immediate postoperative period, patients are monitored for signs of anastomotic leak, pulmonary embolism, and other potential complications. Because physical examination is unreliable in severely obese individuals, particular attention is paid to subtle clinical findings. If anastomotic leak is suspected based on the presence of disproportionate pain, unexplained tachycardia, or fever, an urgent upper gastrointestinal study with gastrograffin is indicated, with a low threshold for surgical reexploration. Similarly, if pulmonary embolism is suspected based on the presence of dyspnea or decreased oxygen saturations, an immediate and aggressive work-up is indicated. Many centers perform upper gastrointestinal studies on postoperative day 1 due to its predictive value in identifying early anastomotic leaks after gastric bypass, although the value of routine use of upper gastrointestinal series has not been demonstrated in randomized controlled trials.[61] If the study does not reveal an abnormality and the postoperative course is otherwise uneventful, the patient is started on a liquid diet and gradually advanced to a solid diet consisting of approximately 6 meals a day. Patients are advised to avoid concentrated carbohydrates (which would induce dumping syndrome after gastric bypass) and carbonated drinks (which may cause excessive gastric pouch distension and vomiting). Liquids are separated from solids and spaced in between meals in order to avoid pouch overdistension. With the laparoscopic approach, the median hospital stay is 3 days.[62]

OUTCOMES AND COMPLICATIONS

The aim of bariatric surgery is reduction in weight and resolution or improvement in obesity-related

Figure 4. Laparoscopic sleeve gastrectomy.

comorbidities. Approximately half of the expected weight loss occurs in the first 6 months after surgery, with the remainder of weight loss occurring between 6 and 18 months after surgery. The mean excess weight loss is 45% to 55% for gastric banding,[58] 68% for sleeve gastrectomy,[60] 55% to 75% for gastric bypass,[58,62–64] and over 70% for BPD.[58,65] Many of the comorbidities associated with obesity are either resolved or improved[58,62,63,66] within a short span of time after surgery. While a detailed discussion of the outcomes of bariatric surgery is beyond the scope of this article, a meta-analysis by Buchwald et al[58] provides a representative summary. This analysis included 136 studies published between 1990 and 2003 involving more than 22,000 patients who underwent gastric banding, gastric bypass, gastroplasty, or BPD/DS. In this study, diabetes was completely resolved or improved in 86% of patients, hyperlipidemia was improved in 70%, hypertension was resolved or improved in 78%, and obstructive sleep apnea was resolved or improved in 84%.[58] It is important to note that although only 10% to 20% excess weight loss is required to improve or resolve the serious obesity-related comorbidities, a higher amount of weight loss contributes to normalization of health-related quality of life.[67] With reduction in weight and improvements in health, patients report higher levels of physical activity and work productivity while experiencing lower levels of health distress and depression.[67]

Overall, the operative mortality for bariatric surgery is less than 1%.[68] In the meta-analysis by Buchwald et al,[58] mortality was 0.1% for purely restrictive procedures, 0.5% for gastric bypass, and 1.1% for BPD. Mortality associated with bariatric surgery is likely to decrease further with implementation of safety standards, systematic improvements, and refinement of surgical techniques. In fact, according to the Agency for Healthcare Research and Quality's 2007 report on bariatric surgery outcomes, the nationwide inpatient death rate associated with bariatric surgery declined by 79% between 1998 and 2004, from 0.89% in 1998 to 0.19% in 2004.[14]

The adverse events rate for bariatric surgery is approximately 10% to 20%,[68] varying widely depending on patient characteristics, surgical approach (open versus laparoscopic), surgical technique, and surgeon's learning curve. In general, early complications include respiratory complications (pneumonia, atelectasis, and respiratory insufficiency; 2%–3%), deep venous thrombosis and pulmonary embolism (1%), anastomotic leak (excluding gastric banding; 2%), and wound infections (10%–14% in open and 0%–2% in laparoscopic surgery).[62,66,68] Long-term complications include incisional hernias (20%–39% in open and 0%–2% in laparoscopic approach),[63,66] nutritional deficiencies, failure to achieve weight loss, and cholelithiasis. Without prophylaxis, cholelithiasis can be a common complication in the first 6 months after surgery in patients with intact gallbladder.[69,70] Use of ursodiol for the first 6 months has been shown to significantly reduce the incidence of new gallstone formation after weight reduction surgery, from 32% without treatment to 2% with treatment.[69] Women of childbearing age, who constitute 80% of patients undergoing weight reduction surgery, are provided with secure birth control methods during the rapid weight loss phase after surgery, since deficient nutrition in pregnancy has been clearly linked to fetal damage or loss.[26]

Complications specific to gastric bypass include anastomotic leaks, strictures (5%–10%), marginal ulcers (5%–10%), internal hernias, acute gastric remnant distension, and nutritional deficiencies.[62,63,68,71] Patients undergoing gastric bypass are at increased risk for developing nutritional deficiencies due to bypass of the stomach, duodenum, and proximal jejunum. These include deficiencies of vitamin B_{12} (the required intrinsic factor is bypassed), iron (requires an acidic medium for conversion of ferric to ferrous form), calcium (also requires an acidic medium for absorption), thiamine, and folate. For this reason, lifelong supplementations with multivitamins, vitamin B_{12}, iron, and calcium are required with this procedure.

Complications specific to adjustable gastric banding include port-related complications (11%),[72] need

for additional surgery (12%),[71] band erosion and slippage, and failure to attain adequate weight loss. The long-term data with 12-year follow-up on laparoscopic gastric banding in a non-intention-to-treat analysis from a single institution indicate a modest reduction in weight from a BMI of 46 kg/m^2 at baseline to a BMI of 37.7 kg/m^2 at 12 years.[72] Some of the band-related complications reported with adjustable gastric banding were attributed to the perigastric technique, which was used in the early experience and in which the posterior limb of the band traveled through the lesser sac. This technique was replaced in 1998 by the pars flaccida technique, in which the lesser sac is not entered.

Complications specific to BPD/DS, in addition to anastomotic complications, include nutritional deficiency of fat, fat-soluble vitamins (A, D and K), calcium, and magnesium. In addition, hyperparathyroidism may develop due to chronic hypocalcemia, and renal insufficiency may develop due to oxalate deposition. Complications specific to sleeve gastrectomy include staple line leakage (1%), pouch dilatation, and inadequate weight loss.

Laparoscopic surgery has significantly reduced the incidence of complications related to bariatric surgery.[62,63,66,73,74] In randomized controlled trials comparing laparoscopic and open gastric bypass with up to 3-year follow-up, the laparoscopic approach was associated with significantly shorter hospital stay (3–5 days versus 4–8 days),[62,66] decreased time to return to activities of daily living and work,[62] and a decreased incidence of late complications, including abdominal wall hernias (0%–2% versus 20%–39%).[63,66] In a separate prospective risk-adjusted analysis comparing open and laparoscopic gastric bypass in more than 1300 patients using the National Surgical Quality Improvement Program database, patients undergoing the open operation were at increased risk of developing a complication within 30 days (odds ratio, 2.08 [95% confidence interval, 1.33–3.25]).[73]

FOLLOW-UP

Lifelong follow-up is required after bariatric surgery. Recommendations by the 2004 American Society for Bariatric Surgery Consensus Conference Panel include lifetime patient follow-up with at least 3 visits with the bariatric surgery team within the first year and more frequent visits for gastric banding patients.[30] The guidelines from the European Society for Endoscopic Surgery include 3 to 8 visits in the first year after surgery, 1 to 4 visits in the second year, and 1 or 2 visits yearly thereafter.[39] During the follow-up visits, the patient's weight loss, eating pattern, and new symptoms are reviewed. Levels of essential vitamins and minerals, including vitamin B_1, vitamin B_{12}, vitamin D, folic acid, iron, and calcium, are monitored twice during the first year and yearly thereafter.

CONCLUSION

More than 120,000 bariatric operations are performed each year in the United States.[30] Morbidly obese patients with previously limited treatment options are now experiencing improvements in health and health-related quality of life due to advancements in the field of laparoscopic bariatric surgery. With the growing prevalence of obesity and the paucity of effective noninvasive treatments for weight reduction, bariatric surgery will continue to be an important treatment for severe obesity in the foreseeable future. Given the multidisciplinary nature of the care that is required in this complex population of patients, clinicians in all specialties should remain familiar with the surgical treatment options to ensure appropriate assessment, expeditious referral, and diligent follow-up. **HP**

Test your knowledge and comprehension of this article with the *Clinical Review Quiz* on page 24.

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(continued on page 29)

(from page 16)

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