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Surgical Management of Obesity

ALEXANDER P. NAGLE, MD and
JAY B. PRYSTOWSKY, MD
Department of Surgery, Northwestern University, Feinberg School of Medicine, Chicago, Illinois

Obesity may be defined as an abnormal state of health in which there is an excess of body fat. Morbid obesity is the most serious form of obesity and generally correlates with a body weight that is more than 170% above ideal body weight, greater than 100 pounds overweight, or a body mass index (BMI) greater than 40 kg/m^2. Based on U.S. 1999 to 2000 population data, 64.5% of U.S. adults are overweight (BMI >25 kg/m^2), 30.5% are obese (BMI >30 kg/m^2), and 4.7% are morbidly obesity (BMI >40 kg/m^2).[1] The prevalence of obesity has increased steadily over the past several decades, and obesity has become an important public health problem. From 1960 to 2000, the prevalence of obesity has more than doubled, from 13.4% to 30.5% of the U.S. population.[1] In the 21st century, obesity is predicted to surpass cigarette smoking as the number one cause of preventable death in the United States. Health care costs associated to obesity are astronomical. Annual direct cost for treating obesity-related illnesses have been estimated at nearly $51.6 billion and indirect cost are estimated at $47.6 billion.[2] Furthermore, the annual U.S. expenditure on weight reduction products and services exceeds $30 billion.[3]

There is general agreement that clinically severe obesity is a complex disease with multiple causes. A simple explanation of obesity is that caloric intake exceeds the expenditure of calories to maintain body function and perform physical activity. Excess calories are stored as fat in the adipose tissue. However, there is significant variability in the energy requirements of individuals. Obesity does not ensue simply because an individual either eats more or exercises less than normal-weight individuals. In short, there is individual variation in susceptibility to develop obesity.[4] There is a strong familial factor in the development of obesity. Children of 2 obese parents have a 50% likelihood of becoming overweight themselves.[5] Twin studies have suggested that genetic factors predominate environmental influences in predicting the development of obesity.[6]

The development of obesity is strongly influenced by social, economic, racial, and ethnic factors.[7] Women are more likely than men to be obese. In developed countries, both children and adults from lower socioeconomic classes are more likely to be overweight.[8] African-American women are at higher risk for obesity than Caucasian women, whereas the reverse is true for

Correspondence: Jay B. Prystowsky, MD, Department of Surgery, Northwestern University, Feinberg School of Medicine, 201 E. Huron Street, Galter 10-105, Chicago, IL 60611. E-mail: jprystowsky@nmff.org

men. Cultural factors may have a role in that different ethnic groups have different ideals regarding body size and appearance. Pregnancy is a precursor to obesity, especially in women with multiple pregnancies.[9]

There is significant evidence that obesity is associated with increased mortality.[10–15] In a 14-year prospective study of more than 1 million adults in the United States, the risk of death increased with an increasing BMI for both men and women in all age groups.[10] A recent study demonstrated that race and gender affect the estimated years of life lost (YLL) associated with obesity.[11] The maximum YLL for young white men with a BMI greater than 45 kg/m^2 was 13 YLL and was 8 YLL for white women.[11] Young blacks with severe levels of obesity had a maximum YLL of 20 for men and 5 for women.[11] In short, it appears that obese individuals die sooner than normal-weight individuals.[10–15]

Obesity is related to a significant number of comorbid illnesses. There is a strong association between obesity and the prevalence of non–insulin-dependent diabetes mellitus.[16,17] A Scandinavian study demonstrated that moderate obesity was associated with a 10-fold increase in the risk of diabetes.[18] There is an increased prevalence of other cardiovascular risk factors in obese patients that include hypertension, hypertriglyceridemia, hyperlipidemia, hyperinsulinemia, and low levels of high-density lipoprotein cholesterol.[19] Other obesity-related illnesses include osteoarthritis of weight-bearing joints, gastroesophageal reflux disease, cholelithiasis, hepatic steatosis, obstructive sleep apnea, obesity hypoventilation syndrome, stress urinary incontinence, migraine headaches, lower extremity venous insufficiency, deep venous thrombosis, pulmonary emboli, and hernias.[20–25] Menstrual irregularities and infertility are common in women with clinically severe obesity.[26] Dermatitides, notably fungal infections, commonly occur in the intertriginous regions of obese patients.[27]

Perhaps the most significant impact of clinically severe obesity is the social effects on these individuals.[28] Obesity carries a stigma in our society that places a high value on thinness. Obesity is often associated with a lack of self-control or other character disorders. Obese children frequently have a reduced self-esteem due to the consistent ridicule by their peers.[29] There are many daily activities that are taken for granted by normal-weight individuals that are challenging for obese individuals (Table 1).[30]

In summary, obesity is a complex disorder with a multi-factorial etiology. Clinically severe obesity is generally defined as a BMI greater than or equal to 40 kg/m^2. These individuals experience reduced life expectancy, significant comorbid illnesses, and impaired social function.

Indications for Surgery

Severe obesity has been notoriously refractory to virtually every method of nonsurgical treatment. The failure rate of diet and behavior modification treatment at 2 years in the morbidly obese approaches 100%.[31] Likewise, the results of drug therapy and jaw-wiring in this group of patients have been

TABLE 1. Specific Problems Associated With Massive Obesity

	% of Patients (N = 1549)
Unable to	
Cut toenails*	73
Cross legs (ie, thighs)	85
Buckle normal belt	27
Fit in fixed booth at McDonald's	33
Fit in theater seat†	36
Wipe self	21
Urinate accurately (men)	52
Walk down stairs, unless backwards	16
Will not	
Undress in front of spouse	73
Wear short sleeves in summer	68
Sleep in room with significant other (snores)	81

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* Usually accompanied by inability to tie own shoelaces, put on socks, fit winter boots.

† Problems in bus, airplanes, turnstiles.

disappointing. Hence, the primary rationale for surgical treatment of obesity is 2-fold: 1) clinically severe obesity is associated with a poor quality of life, serious medical problems, and a shortened lifespan; and 2) nonsurgical therapy has been unsuccessful at stimulating significant and sustained weight loss. The National Institutes of Health (NIH) Consensus Development Conference of 1985 determined that weight reduction should be recommended to obese persons, defined as an increase in body weight of 200% or more above ideal body as defined by the 1983 Metropolitan Life Insurance Company's Height/Weight Table.[32] Weight reduction was also recommended to patients with lesser degrees of obesity if they suffered from comorbid illnesses such as diabetes, hypertension, hyperlipidemia, coronary artery disease, or gout. The 1978 NIH Consensus Development Conference and the 1991 NIH Consensus Development Conference also affirmed the benefits of treating such patients by surgical means, given the ineffectiveness of all nonoperative methods to achieve and sustain significant weight loss for clinically severe obesity.[21,33] These NIH consensus statements, along with guidelines recommended by the American Society for Clinical Nutrition, have helped to form the basis of the indications for the surgical treatment of obesity that includes:

1. The patient should be more than 100 pounds above desirable weight according to the 1983 Metropolitan Life Insurance Company Height/Weight Tables or a BMI greater than 40 kg/m^2.
2. Presence of significant obesity-related illnesses with a BMI of 35 to 40 kg/m^2.
3. Failure of sustained weight loss on supervised dietary and/or medical regimens.
4. Patient shows understanding of the risks and benefits of surgery and understands lifestyle changes subsequent to the operation.
5. Acceptable operative risk.

Some patients may not meet the weight criteria for operation, but may still be candidates for a surgical procedure. If their medical complications are severe and progressive, then surgery may be considered on an individual basis. Bariatric surgery has typically been reserved for patients ages 18 to 60. The results and expected benefits of surgery in the teenagers and in the elderly are less clear. Again, each patient needs to be addressed individually.

Patient Selection

Preoperative evaluation of patients for bariatric surgery is a process that frequently involves several healthcare providers. A thorough history and physical examination should be supplemented by routine blood tests, chest radiographs, and electrocardiogram. Pulmonary function tests and cardiac stress tests are frequently useful for accurate risk stratification. Polysomnography to detect sleep apnea is indicated when the diagnosis is suspected. Patients who suffer from obstructive sleep apnea may benefit from continuous positive airway pressure (CPAP) prior to surgery and during the perioperative period. As for any major operation, other consultations and/or tests may be needed for optimal preoperative preparation and perioperative care.

A thorough discussion of the operations and subsequent lifestyle changes by the surgeon and healthcare team are mandatory for each patient. A complete explanation of the risks of surgery including mortality and major morbidity is indicated. Patients need to be aware that the operation itself is only one aspect of the entire weight-loss process. The behavioral and lifestyle adjustments that will occur subsequent to the operation are difficult and challenging. It is often helpful for prospective patients to speak with those who have already undergone the operation to learn more about the changes they will encounter.

It is also helpful for a patient to meet with a dietitian and psychologist preoperatively. These individuals are often critical in helping a patient manage the lifestyle and dietary changes subsequent to the operation. Their inclusion as part of the multidisciplinary team caring for the bariatric surgical patient cannot be underestimated. Patients who have developed a bond with these healthcare providers prior to surgery benefit greatly in terms of achieving significant and sustained weight lost postoperatively.

Behavioral modification is critical to the long-term success of most bariatric surgical procedures. Accordingly, although there are few medical conditions that absolutely contraindicate performance of surgery, there are behavioral or psychologic considerations that might disqualify patients as candidates for surgery. These may include significant psychiatric disorders such as psychosis or schizophrenia, substance abuse, self-destructive mental behavior, or mental retardation. Even with a technically successful operation, these patients are unlikely to have a satisfactory long-term result. This point emphasizes the value of a comprehensive preoperative psychologic evaluation.

In summary, preoperative evaluation of patients for bariatric surgery is an important step in the surgical care of these patients. It is important both for the purpose of patient selection and patient education. Patients need to understand the risks of surgery and the dramatic lifestyle changes they will encounter. The health care team needs to complete both a medical and psychologic assessment of each patient to be confident they can withstand the operative procedure and successfully adapt to the behavioral changes that the operation intends to stimulate.

Operative Procedures

Bariatric surgical procedures are categorized into 2 main types; restrictive and malabsorptive. Some operations combine both restriction and malabsorption. The operations that are most frequently performed are the Roux-en-Y gastric bypass, vertical banded gastroplasty, biliopancreatic diversion, and various banding procedures. The NIH Conference of 1991 identified the gastric bypass and the vertical banded gastroplasty operations as acceptable surgical treatments for clinically severe obesity based on available clinical data.[33]

Malabsorptive Procedures

The first popular operation for clinically severe obesity was the jejunoileal bypass.[34] A short length of proximal jejunum was connected to the distal ileum and created an obligatory malabsorptive state. Significant weight loss was achieved but the jejunal ileal bypass was associated with serious short-term and long-term complications. Perhaps the most serious postoperative compilation was the development of cirrhosis. Nephrolithiasis, intractable diarrhea with associated hypokalemia and hypomagnesemia, vitamin B_{12} deficiency, and severe malnutrition were common sequelae of this operation. The metabolic complications of this operation have resulted in patient deaths and because of the significant late morbidity and mortality, the jejunoileal bypass should no longer be performed.

Modern malabsorptive procedures have been developed. The biliopancreatic diversion (BPD) as described by Scopinaro et al[35] is a bariatric surgical procedure that aims for selective malabsorption of fat and also provides some restriction of caloric intake (Fig. 1). A BPD involves creating a 200-mL gastric pouch, distal gastrectomy, and gastroileostomy 250 cm proximal to the ileocecal valve. The biliopancreatic limb is anastomosed to the intestinal limb 50 cm proximal to the ileocecal valve. Fat absorption, therefore, is restricted to the short 50-cm common channel, whereas protein and starch are absorbed throughout the 250-cm intestinal limb. The duodenal switch (DS) as described by Marceau et al[36] is a variant of the BPD. The primary differences of the DS include a greater curve "sleeve" gastrectomy and preservation of the pylorus with anastomosis of the intestinal limb to the first portion of the duodenum. Compared to the jejunoileal bypass, these modern malabsorptive operations are associated with less long-term postoperative complications. In particular, there is reduced protein malabsorption and reduced hepatic dysfunction. In addition, there is no blind loop, so that the

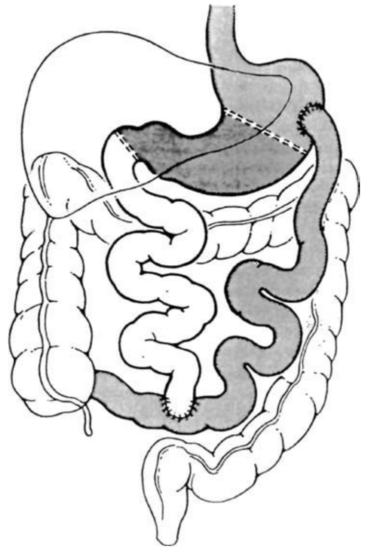

FIGURE 1. Biliopancreatic diversion in which the small bowel is transected beyond the ligament of Treitz. The distal end is anastomosed to the upper stomach (with a subtotal gastrectomy) and the proximal end is anastomosed to the distal ileum 50 cm proximal to the ileocecal valve. Reprinted with permission from Brolin RE. Gastrointestinal surgery for obesity. *Semin Gastrointest Dis*. 1998;9:163–175.[99]

complications related to "blind loop syndrome" are avoided. The short-term morbidity and mortality rates appear to be comparable to those associated with gastric bypass procedures. The BPD and DS have yet to be accepted widely, probably because of the magnitude and length of the operation. There are also concerns about obligatory malabsorption that these operations stimulate. Nonetheless, they are effective weight loss procedures and have gained popularity at several centers around the world.

Gastric Restrictive Procedures

Gastric restriction as a treatment of clinically severe obesity was introduced in the late 1960s. As problems with jejunoileal bypass became more widely recognized, gastric restrictive procedures gained popularity. Mason and Ito[37,38] performed the first restrictive gastric operation for clinically severe obesity with the gastric bypass by using a loop gastrojejunostomy. He defined the anatomic parameters of gastric restriction to include a 12-mm diameter gastrojejunostomy stoma and a small (less than 50 mL) upper gastric pouch.[39] Griffen et al[40] modified Mason loop gastrojejunostomy by performing a retrocolic Roux-en-Y gastrojejunostomy. The construction of a Roux-en-Y or alimentary limb permits diversion of bile and pancreatic juices from the gastrojejunostomy and thereby prevents bile reflux gastritis or esophagitis. It also facilitates technically the mobilization of the jejunum to the upper portion of the abdomen (Fig. 2). Over the past 2 decades, the Roux-en-Y gastric bypass has undergone many technical modifications. Surgeons may choose to partition the stomach or actually divide it. The gastrojejunostomy may be stapled or hand sewn. The Roux limb may be brought up to the left upper quadrant in an antecolic or retrocolic fashion. The length of the Roux limb may vary, although the conventional procedure calls for a length of approximately 75 to 150 cm. Despite these technical choices, most surgeons would agree that Mason's admonition to create a small gastric pouch and a calibrated gastrojejunostomy along with a Roux limb for ingested food to bypass the excluded stomach comprise the critical elements of the operation. The combination of a small gastric pouch and a small outlet stimulates significant caloric restriction and the body's satiety mechanism. The Roux-en-Y gastric bypass does cause malabsorption of certain mineral and vitamins, but there is no significant malabsorption of protein or fat. However, protein malnutrition can develop if protein intake is not adequate.

Mean percent excess weight loss (excess weight = preoperative weight − ideal body weight) at 5 years range from 50% to 75% after gastric bypass.[41–44] In one study of over 600 patients with a 14-year follow-up after gastric bypass, mean percent excess weight loss exceeded 50%.[45]

Several obesity-related illnesses improve substantially after weight-reduction surgery.

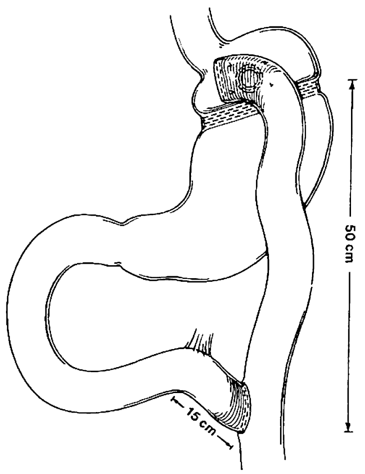

FIGURE 2. Roux-en-Y gastric bypass in which a stapling device has been applied across the gastric cardia, creating a less than 30 mL upper gastric pouch. The jejunum is divided 15 cm distal to the ligament of Trietz. The distal end has been anastomosed to the upper gastric pouch. The proximal end has been anastomosed 50 cm below the gastrojejunostomy. Reprinted with permission from Brolin RE, Kenler HA, Gorman RC, et al. The dilemma of outcome assessment after operations for morbid obesity. *Surgery.* 1989;105:337.[98]

Multiple studies have shown improvement or even resolution of diabetes mellitus, sleep apnea and associated hypoventilation, hypertension, and serum lipid abnormalities.[45–50] Because there is little acid in the gastric pouch of gastric restrictive procedures, gastroesophageal reflux disease is significantly improved or even cured after surgery. Peripheral edema, arthralgia, easy fatigability, and dyspnea are usually improved following weight-reduction surgery. Many patients report improved self-esteem and lessened self-consciousness.[51] In short, obese patients have multiple medical illnesses that are usually improved or cured after weight reduction surgery. In addition, patients experience psychologic and social benefits that lead to an enhanced quality of life.

The Roux-en-Y gastric bypass operation has become a popular choice for weight-reduction surgery. It is technically more challenging than other bariatric operations, but thus far has proven to be the best operation in achieving sustained and significant weight loss. The short-term complication rates are acceptable for a major operation, and the long-term nutritional consequences can be easily treated. Both surgeon and patient satisfaction are high with this operation, and it is currently the most popular bariatric procedure performed in the United States.

The vertical banded gastroplasty (VBG) is a gastric-restrictive operation that was introduced by Mason in 1982.[52] A “window” is cut into the body of the stomach using a specialized stapling device approximately 5 cm from the gastroesophageal junction. A second stapling device is then used to partition the stomach into a small gastric pouch (about 15 mL) and the excluded stomach. A stoma is created between the small gastric pouch and the remainder of the stomach that is 12 mm in diameter and reinforced with a collar of synthetic material such as Marlex (C. R. Bard, Inc, MA), GoreTex (W. L. Gore, Ltd., AZ), or Silastic (Dow Corning, Midland, MI) (Fig. 3). This procedure is attractive in that there is no gastrointestinal anastomosis. Also, the stomach is not excluded from the alimentary stream so that the nutritional consequences of bypassing the stomach or avoided. The procedure was very popular in the late 1980s and early 1990s and the results are acceptable. The VBG is preferred by many surgeons because of its technical simplicity, less operative morbidity, shorter operative time, ease of endoscopic examination when needed, and reduction in nutritional deficiencies. Sugarman et al[53] have shown superior weight loss with gastric bypass compared with VBG in a prospective, randomized trial. Capella and Capella observed similar findings in a consecutive series of patients.[54] Accordingly, gastric bypass has become more popular in North America in recent years. Nonetheless, VBG is a viable option for which acceptable results and a low complication rate can be anticipated.

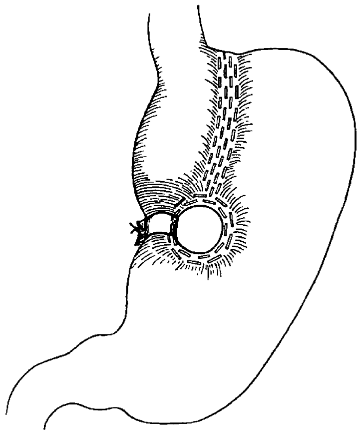

FIGURE 3. Vertical banded gastroplasty with less than 30 mL upper gastric pouch that empties into the remainder of the stomach through a calibrated stoma that is enforced with prosthetic material. Reprinted with permission from Brolin RE. Gastrointestinal surgery for obesity. *Semin Gastrointest Dis*. 1998;9:163–175.[99]

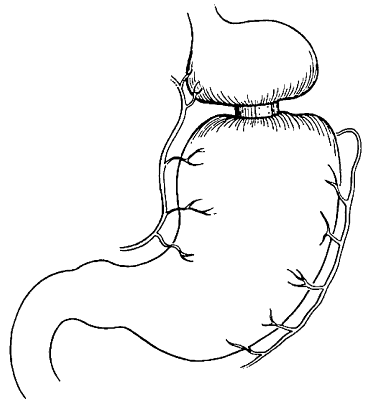

FIGURE 4. Gastric banding in which an upper gastric pouch is fashioned by encircling the stomach with an adjustable prosthetic band. The volume of the upper gastric pouch is usually less than 30 mL. Reprinted with permission from Brolin RE. Gastrointestinal surgery for obesity. *Semin Gastrointest Dis*. 1998;9:163–175.[99]

Gastric banding is the least invasive of the bariatric procedures. Gastric banding is more commonly performed in Europe and Australia than in North America.[55] Most gastric banding procedures use a premeasured prosthetic material that is wrapped around the proximal stomach. This technique produces a small upper gastric pouch with a calibrated stoma through which food can enter the distal stomach. The stomach is not cut or stapled and no anastomosis is made (Fig. 4). Recently, the Food and Drug Administration (FDA) approved a band (LAP-BAND®, Inamed Health, Santa Barbara, CA) in which the diameter of the band can be adjusted by infusion of saline through a subcutaneous reservoir. This is commonly referred to as "the band" or the "lap band." The reported results of weight loss and complication rates with the inflatable bands appear better than those observed with noninflatable bands. Good results with the adjustable band have been reported in Europe and Australia, but the adjustable band has not yet gained widespread acceptance in North America.[56–69] However, as surgeons gain experience and as the surgical technique becomes more refined, the complications are decreasing and the adjustable band is becoming increasingly attractive to more surgeons and patients.[70] Potential complications include band stenosis, band erosion, band slippage, gastric pouch dilation, esophageal dilation, and access port problem.[71] The incidence of band erosion should be less than 1% and the incidence of band slippage should be below 5%.[71] O'Brien et al, from Australia, reported 57% EWL at 6 years.[68] Long-term weight loss results from the U.S. are not currently available. Nonetheless, the adjustable band is attractive in that the procedure is relatively simple and can be performed laparoscopically with low mortality. Furthermore, the diameter of the inflatable band can be adjusted to prevent troublesome symptoms for patients and the band can be removed if necessary.

Laparoscopic Bariatric Surgery

As surgeons have gained more experience with laparoscopic techniques and as technical advances in the instrumentation have been made, minimally invasive techniques have been applied to an increasing number and variety of surgical procedures. Laparoscopic bariatric surgery was first performed in the early 1990s. Since that time, there have been multiple series confirming that laparoscopic Roux-en-Y gastric bypass, laparoscopic VBG, and laparoscopic gastric banding can all be performed with acceptable results. Acceptable results with laparoscopic BPD and DS have been reported in a few small series of patients, but overall, experience is insufficient to draw strong conclusions.[72–75] There is clearly a need for advanced laparoscopic skills with all bariatric procedures, and there is a steep learning curve associated with their performance.[76] Schauer et al showed that operative time decreased significantly and that technical complications decreased by 50% after an experience of 100 laparoscopic Roux-en-Y gastric bypass cases.[76] Hand-assisted laparoscopic techniques have also been applied to bariatric procedures.[77,78]

The benefits of laparoscopic surgery are related to minimizing the length of the incision. Cardiopulmonary complications have been shown to occur less commonly after laparoscopic procedures compared to laparotomy. Preserved pulmonary function is the most well-documented benefit of laparoscopic surgery, with comparatively less impairment in postoperative ventilation, total lung capacity, and oxygen saturation.[79] Nguyen et al showed in prospective randomized studies that laparoscopic Roux-en-Y gastric bypass resulted in less blood loss, reduced pulmonary complications, shorter hospital stay, faster recovery, and reduced need for intensive care compared with open Roux-en-Y gastric bypass.[80,81] Furthermore, wound complications such as hernia formation, seroma, infection, hematoma, and dehiscence are minimized after laparoscopic surgery.[82–86] Overall, operative morbidity and mortality appear to be comparable to an open approach.[82–86] There appears to be no significant difference in weight loss between open and laparoscopic approaches.[82–86] In summary, laparoscopic bariatric surgery is an excellent approach for many patients. Its use in any given patient depends largely on surgeon experience and the patient's BMI.

Complications

Complications of bariatric surgery can be separated into complications associated with the operation and complications associated with alterations in the gastrointestinal anatomy. Operative complications are further divided into major and minor complications. Major operative complications include, death, anastomotic leak, pulmonary embolus, intestinal obstruction, and hemorrhage. The International Bariatric Surgery Registry reported the complications of 14,641 patients who underwent weight-reduction surgery between 1986 and 1996.[87] The Roux-en-Y gastric bypass and VBG operations were the predominant procedures performed on the patients. The 30-day mortality rate was 0.17%, and the most common cause of operative mortality was pulmonary embolism. Overall complication rate was approximately 7%, and a partial listing of these complications and their incidence are listed in Table 2. The incidence of an anastomotic leak following a Roux-en-Y gastric bypass is reported to be about 1% to 2%. Anastomotic strictures at the gastrojejunostomy occur in up to 10% to 15% of patients following a Roux-en-Y gastric bypass.[88] The etiology of these strictures is unclear, but most believe they are secondary to ischemia or tension at the anastomosis. Strictures can be dilated endoscopically, and it is unusual that operative revision is necessary. Multiple dilations may be needed until the patient is symptom free. As with other gastrointestinal operations, intra-abdominal adhesions may form and cause bowel obstruction. An internal hernia through a mesenteric defect is another potential source for bowel obstruction. The most common internal hernia involves herniation of the Roux limb through the transverse mesocolon into the lesser sac or herniation

TABLE 2. Perioperative Deaths and Complications Within 30 Days of Operations (N = 14,641)

Adverse Event	Incidence (%)
Death	0.17
Respiratory	2.35
Wound infection	1.02
Hepatic or cardiac	0.25
Splenic injury	0.21
Pulmonary embolism	0.21
Subphrenic abscess	0.19
Gastrointestinal leak	0.16
Evisceration, dehiscence	0.13
Gastrointestinal bleeding	0.13
Deep venous thrombosis	0.11
Neurologic	0.11
Renal	0.11
Wound seroma	0.04

Reprinted from *Obesity Surgery* with permission.[87]

of small bowel through the mesenteric defect of the jejunojejunostomy. Incisional or trocar hernias may occur after bariatric surgical procedures that can lead to both abdominal pain and obstructive symptoms.

Gastrointestinal hemorrhage may occur in patients with intestinal anastomoses. Marginal ulcers have been recognized at anastomotic sites and the presence of hemorrhage in bariatric surgical patients should prompt endoscopy to assess these potential bleeding sites.

Gallstone formation after weight-reduction surgery is reported to be as high as 30%.[89] However, not all patients who develop gallstones will develop symptoms of biliary colic or cholecystitis. Our current practice is to only perform a cholecystectomy at the same time of the bariatric operation if the patient has preoperative symptoms of biliary disease. However, there are some surgeons who perform routine cholecystectomy at the same time of the bariatric surgery. It is important to include biliary colic and cholecystitis in the differential diagnosis of patients who complain of upper abdominal pain following weight-reduction surgery.

Many patients have difficulty adjusting to their new, small gastric pouch after a gastric restrictive procedure. Protein calorie malnutrition and even dehydration may result in the first few weeks or months after surgery. Hospitalization and parenteral nutrition are sometimes needed for patients who cannot maintain a satisfactory nutritional state. A general recommendation is for a patient to ingest at least 60 g of protein daily, but this is an elusive goal for many patients in the early weeks after surgery. Some patients will develop intolerance to some foods including red meat, certain vegetables, fruit, or dairy products. As mentioned previously, intensive collaboration with a dietitian is critical to ensure that the patient is following a satisfactory dietary program.

When a patient is following a recommended dietary program and continues to have complaints, then an aggressive approach should be taken to find the source of their symptoms. Assessment of the patient's collaboration with a dietitian and adherence to a dietary program will often provide a clue as to the nature of their symptoms. Patients who are not following a prescribed program carefully will often have a variety of gastrointestinal complaints. Strict monitoring of their diet by a dietitian is often helpful in finding the source of their difficulty whether it is eating too fast, too much, or the wrong foods. Dietary modification may provide a solution to the patient's gastrointestinal complaints.

Patients who undergo gastric bypass procedures are at risk for micronutrient deficiencies. The duodenum and proximal jejunum are areas that are responsible for absorption of calcium, vitamin A, iron, and the B vitamins. Because the intrinsic factor-producing area of the stomach is bypassed, B_{12} deficiencies can be predicted.[90] Amaral et al observed significant vitamin and mineral deficiencies up to 6 years after surgery in gastric bypass patients who were not taking supplements.[91] Deficiencies of iron, folic acid, and vitamin B_{12} were most pronounced. Avinoah et al observed a similar finding up to 7 years after gastric bypass surgery and observed that these micronutrients were independent of protein and caloric deficiencies.[92] Most clinicians who treat bariatric surgical patients provide patients with a multivitamin supplement that alleviates their micronutrient deficiencies and suggest that lifetime supplementation is required.[93,94]

Symptoms of "dumping syndrome" are often felt by patients who ingest high-fat or high-carbohydrate foods. They experience symptoms of dizziness, lightheadedness, or diarrhea shortly after ingesting these foods. Patients may experience these symptoms even if they have no other signs of malabsorption. An appropriate dietary history will usually reveal the diagnosis. Patient awareness of the condition and dietary modification usually prevent this group of symptoms.

Pregnancy After Bariatric Surgery

Obesity is associated with a decreased level of sex hormone binding globulin (SHBG), which binds testosterone strongly and estradiol weakly. This results in a relative increase of circulating free androgens. The androgen is converted to estrogen in the stroma of adipose tissue (which is abundant) by a process of aromatization. Thus, obese women have elevated levels of both free androgens and estrogens. Elevated levels of androgens may result in hirsutism, and the elevated estrogens may lead to endometrial hyperplasia and an increased incidence of breast and uterine cancer. Furthermore, sex hormone abnormalities may result in irregular periods, oligomenorrhea or amenorrhea, anovulatory cycles, and infertility. These features are reversed as the sex hormone levels normalize after loss of the excess weight.

As more and more obese women of childbearing age consider bariatric surgery, the issue of safety of pregnancy after bariatric surgery has surfaced—is it safer to become pregnant while morbidly obese or safer to become pregnant once the patient has sustained the majority of her weight loss following bariatric surgery? Obese pregnant women are considered to be high-risk for pregnancy-related complications. Obese pregnant women have an increased incidence of gestational diabetes and hypertension, spontaneous abortion, pre-eclampsia, cesarean section, and deep venous thrombosis. Infants of obese women are more likely to have fetal growth abnormalities, macrosomia, and intrauterine growth retardation. There are no large series in the literature of women who have become pregnant after bariatric surgery. Wittgrove et al, in a retrospective study of 41 women who become pregnant after bariatric surgery, found a decreased incidence of gestational diabetes, gestational hypertension, macrosomia, and cesarean section compared to a control group of obese women.[95] There were no patients with clinically significant anemia, and there was no increased risk of spontaneous abortion, intrauterine growth retardation, congenital anomalies, or maternal nutritional deficiencies. Dixon et al reported the pregnancy outcomes of 20 women who completed 22 pregnancies after laparoscopic placement of an adjustable gastric band.[96] Eight of the 20 women had suffered infertility prior to surgery and subsequent weight loss. The mean maternal weight gain was 18.3 pounds compared to 33.4 pounds for the previous pregnancies of women in this group. There was no difference in birth weights, and there were no premature or low-birth-weight infants. Gestational diabetes occurred in only 1 patient after laparoscopic adjustable gastric band compared to 9.4% of the obese controls. The gestational hypertension rate decreased from 37% to 5%. Based on these series and other reports, pregnancy after bariatric surgery is not only safe, but is associated with fewer complications then pregnancy while being obese.[95–97] However, these women require intense counseling and frequent follow-up. This requires close coordination between the obstetrician and the bariatric surgeon. These pregnancies are at risk for iron deficiency and vitamin B_{12} anemias. Adequate calcium intake or supplementation is important for mineralization of the fetal skeleton, and folic acid must be supplemented to avoid neural tube abnormalities. Pregnancy after bariatric surgery should be delayed until after the phase of rapid weight loss and once the weight loss has stabilized, generally after 12 to 18 months. During this time, the woman is eating very small amounts of food and is generally on a steep weight loss curve. It is important to educate women that their fertility may be increased, and it may be necessary to take birth control pills. During normal pregnancy, weight gain of 25 pounds is optimal. Following weight-reduction surgery, the pregnant women should be under close surveillance to assure proper weight gain to develop a healthy fetus. If adequate weight is not gained during the pregnancy, the fetus risks intrauterine growth retardation, fetal abnormalities, or a small-for-dates neonate.

Conclusion

The field of bariatric surgery has undergone significant evolution over the past 40 years. It is generally accepted that purely malabsorptive procedures are fraught with unacceptable short-term and long-term complications. Over the past 10 to 15 years, it has been increasingly recognized that the VBG and the Roux-en-Y gastric bypass procedures are excellent surgical options in terms of short-term and long-term safety and weight loss that is superior to medical alternatives. Patient selection remains an important and challenging aspect of the surgical care of these patients. For appropriate patients, sustained weight loss of greater than 50% of the patient's excess weight can be anticipated as shown by multiple studies with a 5-year to 14-year follow-up. Resolution or improvement in obesity-related illnesses and improvement in patient's activity and lifestyle are frequent outcomes from these operations. Laparoscopic approaches to weight-reduction surgery are likely to be more available in the future, thereby minimizing the morbidity and recovery time for patients.

In summary, bariatric surgery has undergone a virtual renaissance over the past 10 to 15 years and is now a reliable treatment of selected patients with clinically severe obesity.

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