CHAPTER 26

The Surgical Management of Obesity

Philip R. Schauer and Bruce D. Schirmer

THE DISEASE OF OBESITY

Obesity is a serious disease that carries substantial morbidity and mortality and has mixed genetic and environmental etiologies. Obesity is defined as the accumulation of excess body fat that leads to pathology. Severity is based on the degree of excess body fat, which is commonly assessed using the body mass index [BMI = weight (kg)/height $(m)^2$], which correlates body weight with height. Patients are classified as overweight, obese, or severely obese (sometimes referred to as morbidly obese) (Table 26-1). Obesity may also be defined as body weight that exceeds ideal body weight by 20%, with ideal body weight determined by population studies. Morbidly obese individuals generally exceed ideal body weight by 100 lb or more, or are 100% over ideal body weight. In 1991, the National Institutes of Health defined morbid obesity as a BMI of 35 kg/m^2 or greater with severe obesity-related comorbidity, or BMI of 40 kg/m^2 or greater without comorbidity.[1] *Superobesity* is a term sometimes used to define individuals who have a body weight exceeding ideal body weight by 225% or more, or a BMI of 50 kg/m^2or greater.

Epidemiology and Risk Factors

Morbid obesity is reaching epidemic proportions in the United States. Since 1960, surveys of the prevalence of obesity have been conducted every decade by the National Center for Health Statistics. Twenty-five percent of adult Americans were overweight in 1980 compared to 34% in 1990. Over 58 million adult Americans (one third of the adult population) are overweight.[1] Approximately 4 million Americans have a BMI between 35 and 40 kg/m^2, and an additional 4 million have a BMI exceeding 40 kg/m^2. Despite the expenditure of over $30 billion annually on weight loss products, the prevalence of obesity is increasing. Obesity is most common in minorities, low-income groups, and women. Nearly half of African-American, Mexican-American, and Native American women are overweight.[2]

Genetics plays an important role in the development of obesity. While children of parents of normal weight have a 10% chance of becoming obese, the children of two obese parents have an 80 to 90% chance of developing obesity by adulthood. The weight of adopted children correlates strongly with the weight of their birth parents. Furthermore, concordance rates for obesity in monozygotic twins are doubled compared to those who are overweight to lesser degrees.[3]

Diet and culture are important factors as well; these environmental factors contribute significantly to the epidemic of obesity in the United States. The excess weight often limits physical activity in the morbidly obese, and the sedentary lifestyle and reduction in energy expenditure further hamper weight control.

Table 26-1
Assessing Disease Risk Using Body Mass Index and Waist Size

Category	*BMI*	*Men (<40 in.) Women (<35 in.)*	*Men (>40 in.) Women (>35 in.)*
Underweight	<18.5	–	–
Normal	18.5–24.9	–	–
Overweight	25.0–29.9	+	+
Obesity	³30		
Class I	30.0–34.9	+	++
Class II	35.0–39.9	++	++
Class III (extreme obesity)	³40	+++	

Etiology, Pathogenesis, and Natural History

An excess of caloric intake in relation to caloric expenditure results in deposition of fat or adipose tissue. However, this simplistic model does not adequately explain the etiology of morbid obesity; its causes are multiple and poorly understood. Obesity may be attributed to excessive caloric intake, inefficient utilization of calories, decreased energy expenditure from reduced physical or metabolic activity, a reduction in the thermogenic response to meals, an abnormally high set-point for body weight, or a decrease in the loss of heat energy. The Pima Indians have been described as having greater energy efficiency, and this may explain the tendency toward obesity in this group.[4]

Adipose tissue is deposited in subcutaneous tissues and the intra-abdominal compartment. Males have a greater tendency for abdominal fat distribution, while females typically have more gluteal or peripheral fat deposition. The size of adipose cells tends to parallel this gender pattern; larger fat cells are in the abdomen in males and in the gluteal area in females. Weight gain results from increase in both adipose cell size and number.[5]

Clinical Presentation

The morbidly obese patient often presents with chronic weight-related problems such as migraine headaches; back and lower extremity joint pain from degenerative joint disease; venous stasis ulcers; dyspnea on exertion; biliary colic; stress urinary incontinence; dysmenorrhea; infertility; gastroesophageal reflux; and inguinal, umbilical, and incisional hernias.[6] Those with central or android distribution of fat are more likely to develop complications related to obesity compared to those with peripheral or gynecoid fat distribution. There are a vast number of obesity-related comorbidities (see section on "Related Diagnoses").

The morbidly obese almost uniformly endure discrimination, prejudice, ridicule, and disrespectful treatment from the public. They are commonly viewed as lazy, ugly, and unmotivated, and are often considered to be to blame for their condition, which is unfairly attributed to gluttony and a lack of willpower. Consequently, the stigma of morbid obesity has a major impact on social function and emotional support.

Differential Diagnosis and Related Diagnoses

A few endocrine diseases are associated with obesity, including hypothyroidism, Cushing's disease, and adult-onset diabetes mellitus. However, patients who seek medical or surgical treatment for morbid obesity rarely have an endocrine etiology of their obesity. The combination of central obesity, glucose intolerance, dyslipidemia, and hypertension is known as syndrome X. Those with syndrome X have an elevated risk of developing coronary artery disease and diabetes mellitus.[7] Once diagnosed with syndrome X, an individual should initiate dietary changes, exercise, and weight loss; medical intervention may be necessary as well.

Obesity has a profound effect on overall health and life expectancy. The morbidly obese are predisposed to developing serious weight-related comorbidities, including hypertension, coronary artery disease, adult-onset diabetes mellitus, sleep apnea and/or obesity hypoventilation syndrome (Pickwickian syndrome), deep venous thrombosis, pulmonary embolism, hypercoagulability, hyperlipidemia, and depression, among others. Mortality rates from cancers of the uterus, ovary, breast, colon, rectum, and prostate are increased in the morbidly obese.[8] Obesity is now considered to be the second leading cause of preventable death behind cigarette smoking.

Prognosis

The incidence of morbidity and mortality is directly related to the degree of obesity.[9] In a study with 12-year follow-up, mortality rates for those weighing 50% over average weight were doubled. Mortality and morbidity is largely attributable to the comorbidities of obesity. A study carried out by the Veterans Administration demonstrated a twelvefold increase in mortality among 200 morbidly obese men aged 25 to 34 years, and a sixfold increase among morbidly obese men aged 35 to 44 years. Average weight was 316 lb and mean follow-up was 7 years.[1,10]

MEDICAL AND SURGICAL MANAGEMENT

Goals and Initiation of Medical Treatment

The goal of treatment for morbid obesity is to reduce the excess body weight with maximum safety, minimum side effects or complications, control or prevention of obesity-related comorbidities, and long-term weight control.

Treatment of morbid obesity should begin with simple lifestyle changes, including moderation of diet and initiation of regular exercise such as walking. The treatment of associated comorbidities should be addressed expeditiously. However, because the only effective treatment for morbid obesity is bariatric surgery, these are the initial steps to be taken in preparation for the more definitive, albeit invasive, treatment (Fig. 26-1).

Lifestyle Changes

Lifestyle changes consisting of diet, exercise, and behavior modification constitute the first tier of therapy for obesity. The general objective that underlies the numerous obesity lifestyle change programs is the creation of a caloric deficit that results in loss of body fat over a period of time. Dietary restriction and exercise can each

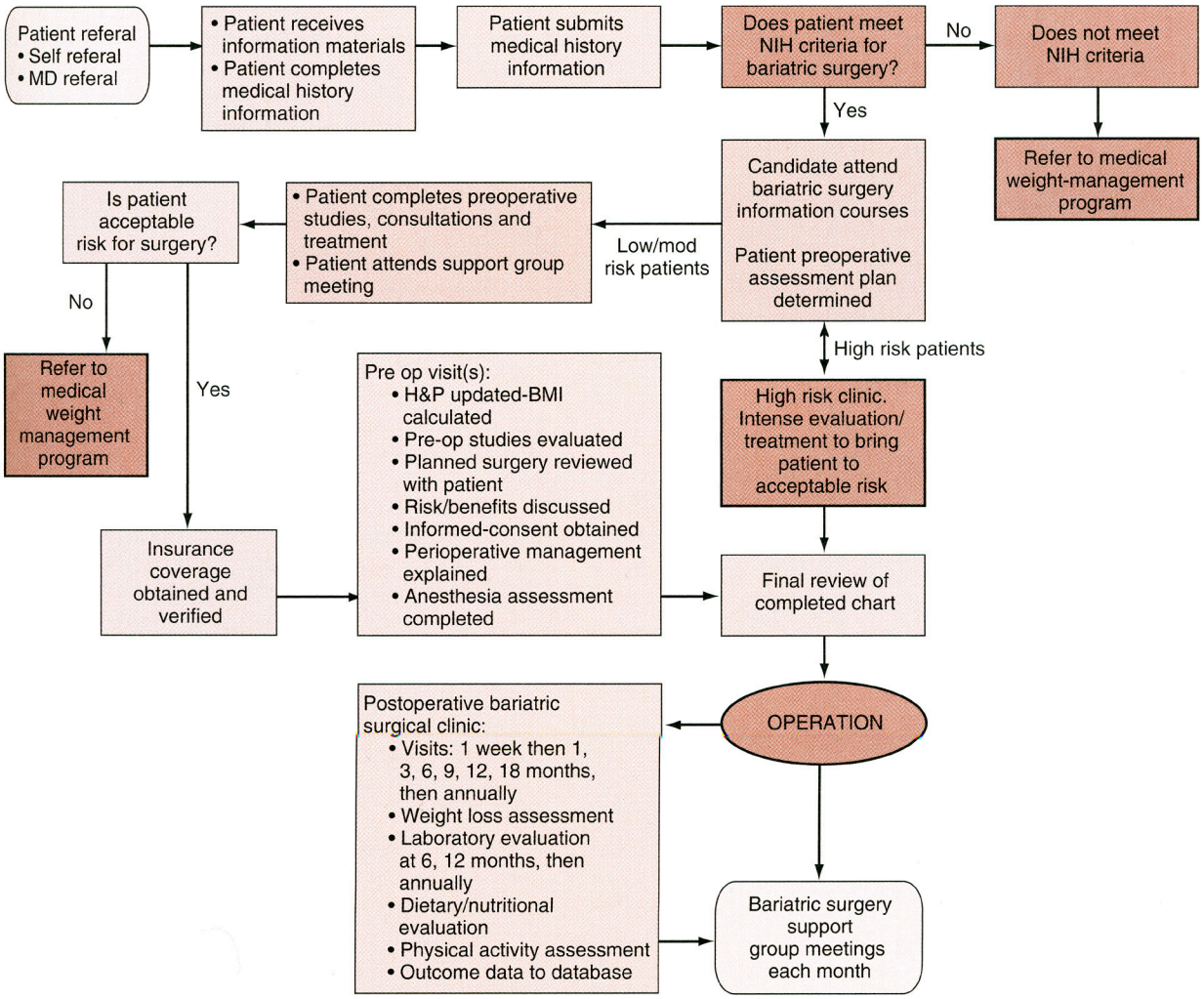

FIG. 26-1. Bariatric flow chart.

independently create an energy deficit. As a rule of thumb, a deficit of 500 kcal per day, resulting in a weekly deficit of 3500 kcal, translates to the loss of one pound of fat a week. Low-calorie diets (800 to 1500 kcal/d) are as effective as very low-calorie diets at 1 year, but carry a lower risk of nutritional deficiency.[11] They are able to achieve on average an 8% weight loss over a 6-month period. Physical activity (3 to 7 sessions a week, lasting 30 to 60 minutes each) can result in a 2 to 3% loss of body weight.[12] Behavior modification is intended to provide positive reinforcement for overcoming barriers to compliance with dietary therapy or increased physical activity. It consists of desirable and tangible nonculinary rewards for meeting short-term dietary or exercise targets. When combined with a dietary or exercise program, behavioral therapy achieved a 10% weight loss at 6 months that is sustained in 60% of patients at 40 weeks.[13] However, a meta-analysis of the long-term effect of this intervention showed that the weight loss maintained at 1 year was only 8.6% (SD 0.8).[14] Nevertheless, it is important to bear in mind that several comorbidities, especially diabetes mellitus, benefit from sustained weight loss as little as 2.3 to 3.7%,[15] and thus such therapies do have a role in the management of the obese patient. Lifestyle changes alone are appropriate for patients with a BMI less than 27, but there are no published studies demonstrating any value of this approach in morbidly obese patients (BMI > 35).

Pharmacotherapy

Pharmacotherapy is a second tier therapy usually used in heavier patients (BMI > 27) or when lifestyle changes alone have failed. It is employed alone or in combination with lifestyle changes. The currently available agents are derived from the amphetamine class of central nervous system stimulants that exhibit a potent anorexigenic effect. Several agents, including phenylpropanolamine, phentermine, and fenfluramine also appeared, with varying efficacy and side-effect profiles. A randomized controlled study demonstrated the efficacy of combining phentermine and fenfluramine in patients with mild obesity in achieving 6% weight loss at 190 weeks, with 23% achieving a 10% or greater weight loss.[16] This combination (called Phen-Fen) allowed fewer side effects compared to using the individual agents, and was used in combination with a program of diet, exercise, and behavior modification. However, significant cardiac and pulmonary artery damage later led to the withdrawal of fenfluramine from the market. Phentermine alone has proved too ineffective to be widely used.

Sibutramine and orlistat are the only current Food and Drug Administration (FDA)–approved drugs for weight loss treatment. Orlistat is a potent and selective inhibitor of gastric and pancreatic lipases that reduces lipid intestinal absorption, while sibutramine is a noradrenaline and 5-hydroxytryptamine reuptake inhibitor that works as an appetite suppressant.[17] Despite their different mechanisms of action, they effectively produce weight loss of 6 to 10% of initial body weight at 1 year, but much of this weight is regained once the drug is stopped.[18]

The National Institutes of Health (NIH) consensus guidelines recommend that drugs should be used only as part of a comprehensive program that includes behavior therapy, diet, and physical activity.[19]

Overview of Bariatric Surgery

Goals and Mechanisms of Action

The goal of bariatric surgery is to improve health in morbidly obese patients by achieving long-term, durable weight loss. It involves reducing caloric intake and/or absorption of calories from food, and may modify eating behavior by promoting slow ingestion of small boluses of food.

Restrictive operations restrict the amount of food intake by reducing the quantity of food that can be consumed at one time, which results in a reduction in caloric intake. Malabsorptive procedures limit the absorption of nutrients and calories from ingested food by bypassing the duodenum and predetermined lengths of small intestine.

The operations currently in use for the management of morbid obesity involve gastric restriction with or without intestinal malabsorption. Gastric restrictive procedures include laparoscopic vertical banded gastroplasty (LVBG) and laparoscopic adjustable gastric banding (LAGB). Malabsorptive procedures include biliopancreatic diversion (BPD), and biliopancreatic diversion with duodenal switch (BPD-DS). Roux-en-Y gastric bypass has features of both restriction and malabsorption. The advent of laparoscopic techniques allowed surgeons to offer minimally-invasive approaches to these bariatric procedures.

Evolution of Bariatric Surgery

Surgery to treat morbid obesity was developed in 1950. Initially, intestinal bypass was performed in order to produce malabsorption, with the intent of producing weight loss through inability to absorb high-calorie foods. The initial jejunocolic bypasses caused electrolyte imbalance, intractable diarrhea, and liver failure unless reversed. This led to development of the jejunoileal bypass (JIB), in which a critical length of intestine was bypassed. However, the shortened intestine was associated with electrolyte imbalance. Liver failure also was not uncommon, especially in protein-deficient patients. Other problems such as oxalate renal stones and blind-loop syndrome also developed in these patients.[20]

In an attempt to restrict food intake, horizontal gastroplasty was developed. Its failure was due to proximal fundal pouch dilatation, outlet dilatation, and staple-line breakdown. In 1980, Mason began performing the vertical banded gastroplasty (VBG). It consists of a stapled vertical gastric channel along the lesser curvature, extending to the angle of His. Sufficient weight loss has been generally achieved; however, breakdown of the partition has produced concern.[21] Other complications of gastroplasty included Wernicke's encephalopathy and vitamin and iron deficiency.

In the late 1960s, a gastric bypass procedure was introduced by Mason and Itoh that achieved weight loss through the production of a small proximal gastric pouch that empties into a loop gastrojejunostomy.[21a] Later, the transverse pouch was changed to a vertical lesser curvature pouch. Gastric pouch problems such as marginal ulcers and staple-line disruption led to the development of a transected gastric pouch. Introducing Roux-loop modification prevented bile gastritis and decreased tension on the bowel loop. Vitamins (particularly vitamins A and B_{12} and folic acid), iron, calcium, and zinc must be replaced and levels monitored after gastric bypass surgery.[22]

In the late 1970s, Scopinaro developed the BPD. In this operation, small bowel is divided 250 cm proximal to the ileocecal valve. The proximal segment of the bowel is anastomosed to the gastric pouch. Protein malnutrition is a sequela of the procedure in some patients. The BPD produces the most effective and sustained loss of excess weight of any of bariatric procedure developed thus far.[23] Further modifications of the BPD included a duodenal switch, in which the pylorus is left intact. This prevents marginal ulceration and improves gastric emptying.

In the late 1970s, gastric banding was also introduced, which used various banding materials to create a small upper gastric pouch. This is the least invasive bariatric procedure, though complications like band migration and slippage occur. Indeed, although all bariatric operations are now being performed laparoscopically, gastric banding lends itself better to a laparoscopic approach than any other procedure. Inflatable bands can be adjusted according to actual outcome and side effects, and the procedure is easily reversible. Results from most European reports have been satisfactory; however, they have not yet been confirmed in American studies.

Indications

Patients that have a BMI of 35 kg/m^2 or more with comorbidity, or those with a BMI of 40 kg/m^2 or greater regardless of comorbidity, are eligible for bariatric surgery. Candidates must have attempted weight loss in the past by medically supervised diet regimens, exercise, or medications. Furthermore, they must be motivated to comply with postoperative dietary and exercise regimens and follow-up. Traditionally, surgeons have offered bariatric surgery to patients aged 18 to 60 years. However, bariatric surgery is now offered to some older adults at some institutions with no reported increase in morbidity or mortality. Adolescent patients with morbid obesity may be considered for bariatric surgery under select circumstances.

Contraindications

Patients who are unable to undergo general anesthesia because of cardiac, pulmonary, or hepatic disease, or those who are unwilling or unable to comply with postoperative lifestyle changes, diet, supplementation, or follow-up may not undergo these procedures. Patients with ongoing substance abuse, unstable psychiatric illness, or inadequate ability to understand the consequences of surgery are also considered to be poor surgical candidates.

Preparation for Surgery

Comorbidities are identified during the medical and surgical history taking and physical examination of the patient. Preoperative testing should be performed and additional studies should be considered, depending on the patient's comorbidities. The morbidly obese are at an increased risk of having hypertension, coronary artery disease, left ventricular hypertrophy, congestive heart failure, and pulmonary hypertension. A preoperative electrocardiogram should be obtained for all patients. Patients with cardiovascular disease should have preoperative evaluation by a cardiologist. Echocardiography,

stress testing, and cardiac catheterization may be indicated for some patients.

Symptoms of loud snoring or daytime hypersomnolence in a morbidly obese patient should prompt a work-up for obstructive sleep apnea. The diagnosis is established by polysomnography at a sleep center. Patients with significant sleep apnea are treated with nasal continuous positive airway pressure. These patients are at risk for acute upper airway obstruction in the postoperative period and should be monitored closely. Obesity hypoventilation syndrome is characterized by hypoxemia (partial pressure of arterial oxygen [$Pao_2 < 55$ mm Hg]) and hypercarbia (partial pressure of carbon dioxide [$Paco_2 > 47$ mm Hg]), with severe pulmonary hypertension and polycythemia. Patients diagnosed with obstructive sleep apnea, obesity hypoventilation syndrome, or severe asthma should have a preoperative evaluation by a pulmonologist. Patients with severe gastroesophageal reflux should undergo upper endoscopy with possible biopsy to rule out esophagitis or Barrett's esophagus. Due to the high incidence of gallstones in the obese population, many surgeons advocate routine preoperative sonography.

Nutritional evaluation and education is invaluable in the preoperative period. The dietitian may help determine whether the patient is able to understand the necessary changes in postoperative eating habits and food choices. The objective of psychologic screening for obesity surgery is to determine whether a patient has realistic expectations about the results of the procedure, as well as a fundamental understanding of the impact that it will have on his or her life. It may also help to identify patients suffering from depression or psychotic disorders that were previously unrecognized and that may require intervention.

Anesthesia for Bariatric Surgery

It is important for anesthesiologists to be familiar with the anatomic and physiologic implications and pharmacologic changes associated with obesity in order to offer optimal preoperative treatment. Hypertension, left ventricular hypertrophy, myocardial ischemia, and atherosclerosis are more common in morbidly obese patients. The greatest concern in these patients is development of myocardial infarction. Preoperative assessment of the cardiovascular system must be meticulous in all obese patients, and should be designed to carefully evaluate the cardiac risk. Laboratory testing should include hemoglobin and platelet count, glucose, blood urea nitrogen, and electrolyte levels. A 5-lead electrocardiogram (ECG) and chest x-ray must be performed, and in patients with a history of myocardial ischemia, an invasive assessment may be included, such as angiography and an estimation of ejection fraction.

One of the main concerns in anesthesia for morbidly obese patients is the difficulty that may be encountered in maintaining an airway. In pulmonary function tests, decreases in expiratory reserve volume, inspiratory capacity, vital capacity, and functional residual capacity are often seen. Drug pharmacokinetics differ in morbidly obese patients as well. Changes in volume of distribution include smaller-than-normal fraction of total body water, greater adipose tissue content, altered protein binding, and increased blood volume. Possible changes in renal and hepatic function have to be taken into consideration when administering drugs.

Pneumoperitoneum

In laparoscopic surgery, exposure is achieved by insufflation of the peritoneal cavity with CO_2 to create a pneumoperitoneum. CO_2 is the preferred gas for laparoscopy because it is inexpensive, readily available, and highly soluble, allowing relatively large quantities to be safely absorbed and excreted by the lungs. It also is noncombustible, permitting the use of lasers and electrocautery. The flow of gas ceases automatically when a preset intra-abdominal pressure is reached. The intra-abdominal pressure is usually set at 15 mm Hg, and can be increased when required for better visualization. Use of two insulators is recommended for laparoscopic bariatric procedures to provide added compensation for gas leakage.[24]

Techniques Used in Bariatric Surgery

By minimizing the size of the access incisions, the laparoscopic surgeon can significantly reduce the recovery time and morbidity compared with laparotomy. Another factor favoring the laparoscopic approach for major abdominal operations is the reduction of the stress response to surgery. The gastrointestinal system also benefits from laparoscopy because postoperative ileus is less common and of shorter duration following some laparoscopic procedures. Laparoscopic access has dramatically reduced the incidence and magnitude of wound-related complications, including hematomas, seromas, infections, hernias, and dehiscence.[25]

The daunting technical hurdles involved in laparoscopic bariatric surgery have led to hand-assisted modifications to facilitate these operations. LVBG and Roux-en-Y gastric bypass (RYGB) have both been performed with hand-assisted techniques, although experience with these procedures is limited. Faster recovery after hand-assisted VBG compared to an open procedure has been confirmed.[26] DeMaria and colleagues recently reported that despite the increased cost, the hand-assisted approach could be valuable in bariatric surgery in the following five areas: (1) repair of an umbilical or ventral hernia, (2) to salvage a total laparoscopic case, (3) when a skilled assistant for a totally laparoscopic approach is not available, (4) in patients with a higher BMI, and (5) to aid in the learning curve of acquiring the skills to do a totally laparoscopic procedure.[27]

Assessment of Results

Weight loss has traditionally been used as the main outcome measure in bariatric surgery. Initially, the main criterion has been based on the concept of "ideal weight," and it was reasonable to attempt to achieve a postoperative weight closest to this desirable weight. It has become clear that weight loss is insufficient as a single outcome goal in bariatric treatment.

The NIH Conference recommended statistical reporting of surgical results, including quality of life, to provide a clearer assessment of outcomes. It underlines the fact weight loss should be considered the main postoperative outcome, but improvement of medical conditions associated with obesity is also desirable.[19] The Bariatric Analysis and Reporting Outcome System (BAROS) has been developed to standardize and compare outcomes of bariatric surgical series. This issue was further complicated by the many definitions of success that are used, and the usually poor long-term follow-up. The BAROS system defines five outcome groups (failure, fair, good, very good, and excellent), based on a scoring system that is used to evaluate three main areas: percentage of excess weight loss, changes in comorbid medical conditions, and quality of life (QOL). To assess changes in QOL after surgical treatment, a questionnaire has been developed that addresses self-esteem and four activities of daily living. Development of complications and the need for reoperation count against the final score. This system analyzes outcomes in a simple, objective, unbiased, and evidence-based fashion.[28]

Documentation

Documentation includes all necessary information about patients' current and past medical, surgical, and abdominal surgery

history, including comorbidities. Meticulous medical, physical, psychologic, pulmonary, and dietary evaluation must be well documented.

The entire preoperative workup checklist should include body measurements and habitus, diagnostic tests (ECG, chest x-ray, sonogram, evaluation of the upper GI tract, endoscopy, motility, and pH studies), laboratory tests (complete blood count, platelets, prothrombin time, International Normalized Ratio, iron, electrolytes, blood urea nitrogen, creatinine, glucose, hemoglobin A_{1c}, liver function tests, albumin, calcium, phosphorus, magnesium, thyroid-stimulating hormone, lipids and cholesterol, urinalysis, and pregnancy test), consultations (nutritional, psychiatric, primary care provider, internal medicine, cardiac, pulmonary, high-risk evaluation, gynecologic/Pap smear, and hematology), cardiac testing (echocardiogram, stress test, and cardiac catheterization), and pulmonary testing (oxiflow screening, polysomnogram, and titration study). Imaging studies essential for bariatric patients include preoperative endoscopies, and in selected patients, postoperative computed tomography (CT) scanning and endoscopy.

A detailed operative report including impressions, step-by-step procedure, unexpected findings, problems, and intraoperative complications is essential. Use of a specific postoperative follow-up clinical evaluation form is strongly advised, and should include surgical procedure type and date, operating room (OR) height and weight, current height and weight, and weight at last clinic visit. Records of recovery must contain information regarding postoperative fever, pain, increased heart rate, bloating, breathing difficulty, and urinary problems. Wound and drain assessment (i.e., color, signs of infection, and healing) is important. Specific information about current patient diet should include any side effects when the diet is advanced, such as nausea or vomiting, and toleration of liquid and solid food. Various other problems such as dumping, diaphoresis, feeling faint, tremors, tachycardia, abdominal cramping, or loose stools should be noted. Bowel function difficulties (i.e., diarrhea, constipation, bloating, and increased flatulence) should be noted. Any postoperative upper GI x-rays, abdominal sonograms, upper endoscopy, and other imaging studies should be documented, if possible. Finally, the postsurgical treatment plan must be outlined, and should include impressions on weight loss, dietary counseling, drain and gastric tube status, exercise counseling, and planned lab work. All new complications occurring since the last visit or discharge must be described in detail.

Additional documentation includes correspondence, insurance issues, and patient requests. Electronically stored documents highly increase availability for follow-up and research. A systematically filled bariatric electronic database is very useful for further analyses.

Follow-Up

The American Society for Bariatric Surgery recommends visits during the immediate postoperative period, and then at variable intervals for life, with additional visits as needed, depending on the patient's condition.[29] The UPMC Center for Obesity Surgery recommends visits at 1 week, 1 month, 3 months, 6 months, 9 months, 1 year, 18 months, and yearly after surgery. During the first visit, a Jackson Pratt drain is usually removed and a more solid diet is introduced. At the 1-month visit, the diet is progressively advanced and exercises are recommended. Diet review usually is scheduled at 3 months after surgery. Laboratory studies are performed 6 months after surgery and then yearly. Malabsorptive procedures often require more frequent and extensive nutritional evaluation, due to the higher frequency of metabolic deficiencies.

Patients are encouraged to comply with lifelong follow-up, exercise, and vitamin supplementation after undergoing bariatric surgery. Follow-up includes assessment of weight loss trends, compliance with diet, and regular monitoring of metabolic and nutritional parameters.

Efficacy

Two randomized controlled trials have established the superiority of surgical weight loss procedures over nonsurgical approaches in achieving durable weight loss. Horizontal gastroplasty and a very low calorie diet produced equivalent weight loss at 12 months, but at 24 months, patients who had undergone the gastroplasty had lost significantly more weight 23 versus 2.8% excess body weight (EBW).[30] The vertical gastroplasty achieves superior weight loss compared to the horizontal gastroplasty,[31] with the difference apparent as early as 3 months postoperatively. The Dutch Obesity Project (DOP) trial showed that at 24 months, patients undergoing jejunoileostomy had lost significantly more weight than those treated medically.[9] Both surgical procedures tested in these randomized controlled trials now have been superseded or replaced by more effective procedures that have even fewer complications. The Swedish Obese Subjects (SOS) matched pair cohort study compared surgery (e.g., vertical banded gastroplasty, gastric banding, and gastric bypass) with nonsurgical treatment.[32] Weight loss at 2 years was 28 $\pm$ 15 kg among the operated patients and 0.5 $\pm$ 8.9 kg among the obese controls. At 8 years the weight loss was 20 $\pm$ 16 kg in the surgical group, with controls gaining weight (0.7 $\pm$ 12 kg). There was also a 32-fold reduction in the 2-year incidence of diabetes, rising to a fivefold reduction after 8 years. While the incidence of hypertension fell in the first 2 years, the incidence became equal in the two groups at 8 years. While 10-year data have yet to be gathered, there is no evidence at 8 years of a reduction in mortality in the surgically treated group. The SOS trial also provides evidence for improvement in quality-of-life measurements[33] of general health perception, mental well-being, mood disorders, social interaction (sickness impact profile), and obesity-related psychosocial problems and eating behavior. Peak values were obtained at 6 or 12 months, with a slight decrease at 24 months, and appear to closely mirror weight loss.

Randomized controlled trials also have compared gastric bypass with gastroplasty. Howard and colleagues showed that patients with a gastric bypass (n = 20) had a 78% excess weight loss (EWL), compared to 52% in patients undergoing vertical banded gastroplasty (n = 22) ($p < 0.05$) at 12 months, with the difference widening at 5 years to 70 and 37%, respectively.[34] This was previously confirmed by Sugerman,[35] with significantly more weight loss at 12 months (68 vs. 43%), 24 months (66 vs. 39%), and 36 months (62 vs. 37%) in the gastric bypass group.

Studies reporting gastric banding results collectively demonstrate a 40 to 60% mean EWL at 3 to 5 years. Mean hospital stay is less than 2 days, with a very low operative mortality (0.01%) rate.

Open RYGB results in a hospital stay ranging from 4 to 8 days with a perioperative complication rate of 3 to 20% and a mortality rate of about 1%. Long-term (5 to 14 years) EWL appears to be 49 to 62%. Pories and associates[36] showed a 65% excess body weight loss at 2 years, but with 15% weight regain over 14 years, after which it stabilizes. Laparoscopic and open approaches to RYGB appear to result in similar weight loss, at least in the medium term. The principal advantage of the laparoscopic approach has been in reducing perioperative morbidity, in particular the marked reduction in wound-related complications, including incisional hernias.[37–39]

Patients with malabsorption procedures had up to 78% EWL at 18 years, but with a major morbidity rate of 20 to 25%.[40]

Complications

Major complications after Roux-en-Y gastric bypass occur early (<30 days), and include pulmonary embolus (1 to 2%), gastrointestinal leak (1 to 5%), and anastomotic stricture (3 to 10%). Common late complications include hernia (5 to 24%), marginal ulcers (3 to 10%), and bowel obstructions (1 to 5%). Vitamin B_{12} deficiency and iron deficiency anemia are the most common nutritional sequelae after gastric bypass arising in approximately 15 and 30%, respectively. Both can be prevented with supplementation in most patients. Unlike malabsorptive procedures, significant protein-calorie malnutrition is rare in the absence of infection, obstruction, or other medical disorders.

The most common complications after malabsorptive procedures include hernia (10%), ulcer (8 to 12%), bowel obstruction (1%), wound infections (1%), wound dehiscence (1%), venous thrombosis (0.5%), and pulmonary embolus (0.5%). Late nutritional complications include anemia (5 to 40%) and protein malnutrition (7 to 12%).[23,40]

Bariatric Surgical Procedures

Vertical Banded Gastroplasty

The VBG is purely restrictive in nature, limiting the amount of solid food that can be consumed at one time, which leads to a calorie deficit. Of note, liquid intake is not limited by this procedure, and as such can be utilized to overcome the intended effect of the operation. A proximal gastric pouch empties through a calibrated stoma, which is reinforced by a strip of mesh or a Silastic ring.

Techniques Used in Vertical Banded Gastroplasty. Mason first described the vertical banded gastroplasty in 1982.[41] A 32F Ewald tube is passed through the mouth and into the stomach to facilitate isolation of the esophagus, and later facilitates pouch volume measurement and calibration of the stoma. The esophagus is encircled with a Penrose drain. The lesser omentum is opened and a 27F thoracostomy tube is passed from this opening behind the stomach and up to the angle of His through the gastrophrenic ligament.

An anvil for a circular stapler is held in the lesser sac against the posterior stomach wall. A trocar is pushed through both walls of the stomach at a point about 8 to 9 cm below the angle of His and into the anvil. A 2.5-cm window is created through the proximal stomach by firing a circular stapler with the Ewald tube pressed against the lesser curvature. A line of four rows of 90-mm staples leads from the circular opening to the angle of His to create a pouch 50 mL in size or smaller. Pouch volume is measured by instilling saline into the Ewald tube. Some surgeons use a linear cutting stapler to create the pouch. A strip of polypropylene mesh measuring 7 by 1.5 cm is placed around the lesser curvature channel and is sewn to itself to create a 5.0 to 5.5 cm collar circumference.

The laparoscopic technique follows the same principles. Using a five-trocar technique, the abdomen is entered and the left hepatic lobe is retracted anteriorly. The peritoneal reflection lateral to the angle of His is incised. The gastrohepatic omentum is incised and the lesser sac is entered. A 25-mm circular stapler is used to create a window through the stomach, 4 cm below the angle of His, near the lesser curvature of the stomach. A 60-mm linear stapler is inserted into this opening and is fired along a 9-mm esophageal bougie to create a divided staple line leading to the angle of His. A 5-cm band of polypropylene mesh is sutured around the gastric pouch.[42]

Another technique involves use of a linear cutting stapler to excise a wedge of fundus, thereby creating a 20-mL pouch without the use of a circular stapler. A polypropylene mesh or polytetrafluoroethylene band is sutured around the distal end of the gastroplasty[43,44] (Fig. 26-2).

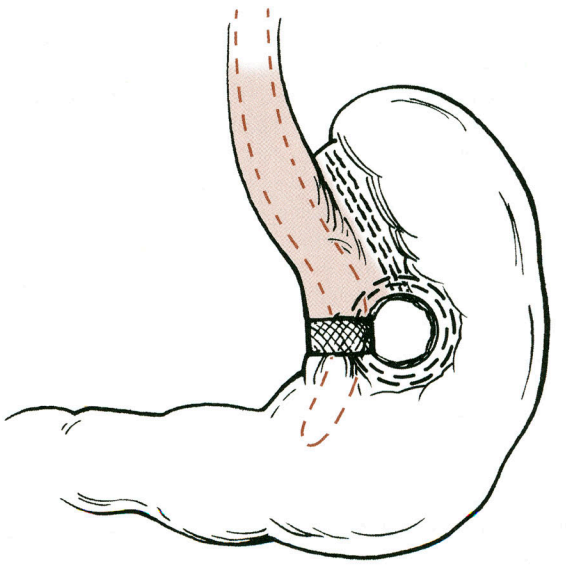

FIG. 26-2. Vertical banded gastroplasty.

Efficacy of Vertical Banded Gastroplasty. Vertical banded gastroplasty achieves acceptable weight loss results. In a series of 305 patients followed for a minimum of 2 years, a mean excess weight loss of 61% was reported.[45] In a study of long-term results following VBG, 250 patients followed for 5 years had a mean excess weight loss of 60% for the morbidly obese and 52 percent for the superobese.[46] A study by van de Weijgert and associates demonstrated a mean excess weight loss of 63% after 7 years in 100 VBG patients.[47] All patients had lost at least 50% of excess weight preoperatively by dieting. Eckhout and colleagues reported on their experience with vertical Silastic ring gastroplasty in 1463 patients; the mean excess weight loss was 63.4%.[48]

A significant number of patients have required reoperation following vertical banded gastroplasty.[49] In a study from Spain, 100 patients followed for a minimum of 5 years after VBG had a mean excess weight loss of 54.3%. However, 25% of patients required reoperation for complications related to technique.[50] A prospective study of 71 patients who underwent VBG with a 99% 10-year follow-up reported that only 26% had maintained a loss of at least 50% of their excess weight, and 17% had a bariatric reoperation.[51] In a study of 60 patients followed for a median of 9.6 years, only 40% maintained the weight loss.[52] Sixty percent regained a significant amount of weight, and 31% returned to or exceeded their preoperative weight. These studies therefore cast doubt on the long-term success rate of vertical banded gastroplasty.

Complications. The overall morbidity rate with vertical banded gastroplasty is under 10%[53] and the mortality rate is 0 to 0.38%.[41] Early complications are infrequent and include splenectomy (0.3%) and peritonitis from leak (0.6%). Late complications include stomal stenosis[54] and staple line dehiscence, which occurs in up to 48%. In a series from MacLean and associates, 30% of all patients required reoperations for this problem.[55] Reflux esophagitis may occur in 16 to 38% of patients, and some patients may require conversion to Roux-en-Y gastric bypass for severe symptoms.[56] Intractable vomiting one or more times a week was seen in as many as 30 to 50% of patients in a series from the Mayo Clinic.[57]

Advantages and Disadvantages. With weight loss following vertical banded gastroplasty, there is significant improvement in comorbidities, including dyspnea, hypertension, diabetes mellitus, orthopedic problems, and quality of life.[58] VBG is associated with minimal long-term metabolic or nutritional deficiencies. Because it is technically easier to perform than Roux-en-Y gastric bypass, it requires less operative time. No anastomoses are required. It has a lower early morbidity rate than gastric bypass and a low mortality rate.

Long-term weight loss is less successful if patients eat sweets or drink high-calorie liquids, which are not restricted by this operation.[59] Patients who have difficulty digesting meat, bread, fruits, and vegetables may alter their eating behavior toward high-calorie soft foods. The vertical banded gastroplasty is less effective in terms of weight loss compared to the gastric bypass. Furthermore, the weight loss in superobese patients undergoing VBG is inferior to that seen with Roux-en-Y gastric bypass. Only 8% of superobese patients had "excellent" results, defined as a reduction of weight to within 25% of ideal body weight.[60]

Laparoscopic Adjustable Gastric Banding

Mechanism of Action. Adjustable gastric banding involves the minimally invasive (laparoscopic) or open-approach placement of a silicone band around the proximal stomach to restrict the amount of solid food that can be ingested at one time. Furthermore, the adjustable nature of the band allows the amount of restriction to be increased or decreased, depending upon the patient's weight loss. The Food and Drug Administration approved the laparoscopic adjustable gastric band for use in the United States in June 2001. Indications for laparoscopic adjustable gastric banding are the same as those for open gastric banding.

Technique. The patient is placed in the steep reverse Trendelenburg position. Six laparoscopic ports are placed. A 5-mm liver retractor is used to elevate the left hepatic lobe. A 15-mL gastric calibration balloon is used to identify the location for the initial dissection. A retrogastric tunnel is created starting at the base of the right diaphragmatic crus, using the parsflaccida technique. The silicone band is passed through the tunnel, toward the angle of His so that it encircles the cardia of the stomach about 1 cm below the gastroesophageal junction. The tail of the silicone band is passed through the buckle of the band and locked into place. A calibration tube is reinserted in order to determine the stoma diameter. Interrupted sutures are placed to secure the anterior stomach to the band. The end of the silicone tube is brought out through the left-sided 15-mm trocar, and is connected to the access port. The port, which will subsequently be used for injection or withdrawal of saline postoperatively for band volume adjustment, is secured to the anterior rectus sheath. It is preferable to place this port superficially so that it can be accessed without radiologic guidance.[61,62] (Fig. 26-3).

Postoperative Care. Patients are given clear liquids a few hours after the procedure. A Gastrografin swallow is obtained on the first postoperative day to confirm band position and patency. Patients can generally be discharged 1 to 2 days after surgery with a liquid diet for 4 weeks. At that time, a gradual transition to a regular diet is started.

Band adjustment may be performed with fluoroscopic guidance initially at 10 to 12 weeks. Patients are assessed monthly for weight loss and tolerance of oral intake. Band adjustments are made accordingly every 4 to 6 weeks during the first year following laparoscopic adjustable gastric banding.

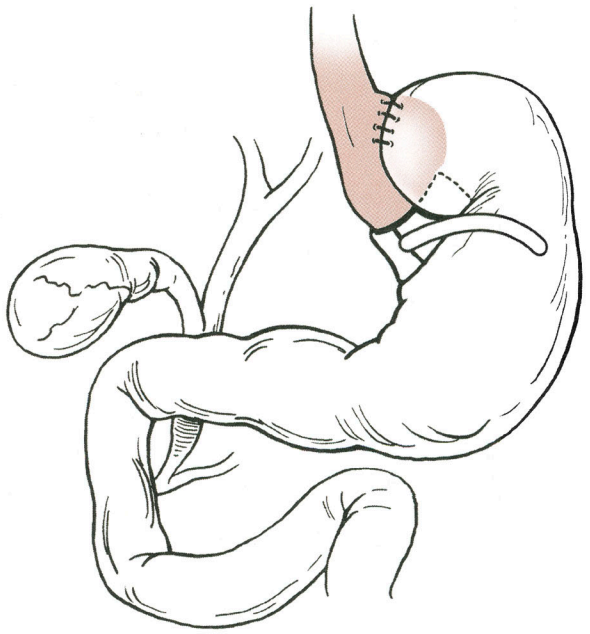

FIG. 26-3. Adjustable gastric band.

Efficacy. Suter and colleagues published their results with laparoscopic banding after 3 years of experience with this technique. One hundred fifty patients underwent laparoscopic adjustable gastric banding, with a mean body mass index of 44.6 kg/m^2 (range 35.1 to 64.1 kg/m^2), and mean initial excess body weight of 102.9% (range 58 to 191%). Mean follow-up was 17 months. Mean excess weight loss at 1 and 2 years was 55 and 56%, respectively.[63]

O'Brien and associates reported on a series of over 700 patients who underwent placement of a laparoscopic adjustable band. There have been no deaths perioperatively or during follow-up. Perioperative complications occurred in 1.2% of patients. Reoperation has been needed for prolapse (slippage) in 12.5%, erosion of the band into the stomach in 2.8%, and for tubing breaks in 3.6%. A steady progression of weight loss has occurred throughout the duration of the study, with 52 ± 19% EWL at 24 months (n = 333), 53 ± 22% EWL at 36 months (n = 264), 52 ± 24% EWL at 48 months (n = 108), 54 ± 24% EWL at 60 months (n = 30), and 57 ± 15% EWL at 72 months (n = 10). Major improvements have occurred in diabetes, asthma, gastroesophageal reflux, dyslipidemia, sleep apnea, and depression. Quality of life as measured by the RAND 36-Item Short Form Health Survey (SF-36) shows highly significant improvement.[64]

Data on 1893 patients who underwent laparoscopic adjustable gastric band placement in Italy (27 surgical centers) were collected and reported by the Italian Collaborative Study Group for the Lap-Band System. Weight loss was evaluated at 6, 12, 24, 36, 48, 60, and 72 months, with a BMI of 37.9, 33.7, 34.8, 34.1, 32.7, 34.8, and 32 kg/m^2, respectively. Postoperative mortality was 0.53%. Conversion to an open procedure occurred in 3.1%. Postoperative complications occurred in 10.2%, including tube port failure (40.9%), gastric pouch dilation (48.9%), and gastric erosion (10.8%). No deaths were recorded as a consequence of surgery.[65]

The impressive weight loss results following laparoscopic adjustable gastric banding reported in Australia and Europe have not been initially reproduced in the United States. In early U.S. experience, the weight loss result was lower compared to that in

Australia and Europe; intermediate results show a maximum weight loss of 34 to 42% in the United States. EWL from one of the original U.S. centers performing laparoscopic adjustable gastric banding was 18% (range 5 to 38%).[66] Recent American results, however, have showed success closer to that seen with this device outside America. In a group of 445 patients with a preoperative BMI of 49.6 kg/m^2, 99 patients have had a 1-year follow-up with an average loss of 44.3% excess body weight. One death was reported. Additional complications included band slippage in 3.1%, gastric obstruction without slippage in 2.7%, port migration in 0.4%, tubing disconnections in 0.7%, and port infection in 1.1%. Two bands (0.4%) were removed due to intra-abdominal abscess 2 months after placement.[67]

A prospective randomized trial from the Netherlands comparing open versus laparoscopic adjustable gastric band placement showed that both were of equal efficacy. Length of stay was significantly shorter for the laparoscopic group (5.9 vs. 7.2 days, $p < 0.05$). There also were fewer readmissions in the first postoperative year following laparoscopic adjustable gastric band placement (6 vs. 15, $p < 0.05$).[68]

Patients with diabetes mellitus, hyperinsulinemia, polycystic ovary syndrome, or a history of gestational diabetes have been shown to have a lower weight loss resulting from laparoscopic adjustable gastric banding.[69]

Complications. Intraoperative complications include splenic injury, esophageal or gastric injury (0 to 1%), conversion to an open procedure (1 to 2%), and bleeding (0 to 1%). Early postoperative complications include bleeding (0.5%), wound infection (0 to 1%), and food intolerance (0 to 11%). Late complications include slippage of the band (7.3 to 21%), band erosion (1.9 to 7.5%), tubing-related problems (4.2%), leakage of the reservoir, persistent vomiting (13%), pouch dilatation (5.2%) and gastroesophageal reflux.[70,71] Fixation of the band to the stomach has reduced the incidence of postoperative gastric prolapse.

In O'Brien's series of 700 patients, seven patients were converted to an open procedure, primarily because of hepatomegaly.[72] There were no mortalities. There were 10 significant adverse events (1.4%): seven port-site infections (1%), one deep venous thrombosis, one occurrence of hepatotoxicity, and one prolonged hospital stay because of failure of gastric emptying. Late complications requiring reoperation included gastric prolapse (15.1%), band erosions into the stomach (3.2%), and complications related to the tubing (4.7%). Among the patients requiring reoperation, 12 (1.7%) had the device removed.

In the FDA trial of laparoscopic adjustable gastric banding, which was initiated in the United States in 1995, the rate of reoperation for band slippage and removal of the band was significantly higher than that reported by investigators in Europe and Australia. DeMaria and colleagues removed 41% of bands from 37 patients, most commonly because of inadequate weight loss.[73] Seventy-two percent had dysphagia, vomiting, or reflux.

Pseudo-achalasia following laparoscopic adjustable gastric band placement has been reported in nine out of 120 patients from Switzerland, despite normal band position and stomal size. Patients with preoperative evidence of insufficiency of the lower esophageal sphincter appear to be at risk for this complication; preoperative manometry may help to identify these patients. Esophageal motility may be adversely affected by the band, and manifests as impairment of lower esophageal sphincter relaxation and abnormal esophageal peristalsis.[74]

Advantages. Laparoscopic adjustable gastric banding is a relatively simple procedure that takes less operative time than the more complex procedures such as laparoscopic RYGB or laparoscopic biliopancreatic diversion. The mortality rate is low (0.06%), as are conversion rates (0 to 4%). No staple lines or anastomoses are required. Recovery is rapid and hospital stay is short. The adjustable nature of the laparoscopic band allows the degree of restriction to be optimized for the patient's weight loss. Increasing band diameter may relieve postoperative vomiting.

Disadvantages. With this procedure, there is a potential for port site complications and the need for frequent postoperative visits for band adjustment. Some patients (5 to 10%) experience band slipping or gastric prolapse, which usually requires reoperation. Other potential problems include band erosion, port-related complications, gastroesophageal reflux, alterations in esophageal motility, and esophageal dilatation. Should inadequate weight loss occur, revision to Roux-en-Y gastric bypass is feasible, but may be technically difficult because of adhesions in the area surrounding the band.

Open Roux-en-Y Gastric Bypass

Mechanism of Action. RYGB is both a gastric restrictive procedure and a mildly malabsorptive procedure.[75] A small gastric pouch restricts food intake, while the Roux-en-Y configuration provides malabsorption of calories and nutrients. Mason described the optimal parameters for restriction necessary for adequate weight loss, including a gastrojejunostomy of 1.2 cm or less in diameter and a gastric pouch of 15 to 30 mL.[76]

Preparation. Patients must be counseled about the possibility of adverse nutritional sequelae following RYGB. For prevention of deep venous thrombosis, bilateral sequential compression devices are applied to the lower extremities, and perioperative subcutaneous unfractionated heparin or low-molecular-weight heparin is administered. Intravenous prophylactic antibiotics are used.

Technique. The abdomen is entered through a midline incision and is thoroughly explored. The gallbladder is inspected and palpated for gallstones. The distal esophagus is mobilized and encircled with a Penrose drain. The gastrohepatic omentum is bluntly entered over the caudate lobe. The phrenoesophageal ligament overlying the anterior and lateral distal esophagus is incised for subsequent esophageal mobilization. The mesentery between the first and second branches of the left gastric artery is divided with cautery. Blunt dissection is carried out between the opening in the gastrohepatic omentum and the angle of His. A 28F red rubber tube is placed from medial to lateral behind the stomach, and the open end of the tube is then brought through the opening in the mesentery.

All tubes and devices are removed from the stomach by the anesthesiologist. The red rubber tube is used to guide a 90-mm linear stapler with 4.8-mm staples across the stomach. Three superimposed staple lines are applied to the stomach so as to create a proximal pouch of 15 to 30 mL. Most surgeons advocate dividing the stomach rather than leaving it in continuity.

The ligament of Treitz is identified and a point 15 to 45 cm distally is identified. The jejunum is divided with a linear stapling device. The mesentery is divided between clamps and a side-to-side jejunojejunostomy is created with a linear stapler to create a 45- to 75-cm Roux limb for a standard gastric bypass, or a 150-cm limb for a long-limb modification in the superobese.[77] With a lengthened Roux limb, there is a greater degree of malabsorption for improvement of weight loss. The enterotomy is closed with a linear stapler and the mesenteric defect at the jejunojejunostomy is sutured closed.

The Roux limb is brought through the transverse mesocolon. A 1-cm gastrojejunal anastomosis is created between the gastric pouch and the jejunum, using a circular stapler or a hand-sewn, two-layer technique. The hand-sewn anastomosis is created over a 30F dilator. An 18F nasogastric tube is passed through the anastomosis into the jejunum with direct guidance by the surgeon after the anastomosis is completed. The integrity of the anastomosis is tested by injecting methylene blue into the nasogastric tube. The mesenteric defects are closed at this time, namely the transverse mesocolon opening and the space beneath the Roux limb, which would cause a Petersen hernia.

Postoperative Care. If a nasogastric tube is left in place at the time of surgery, it is removed within 24 hours. If deemed necessary, Gastrografin swallow is generally obtained on the second or third postoperative day and liquids are started thereafter. Patients are generally discharged 2 to 6 days after surgery.

Efficacy. Gastric bypass results in weight loss that is superior to that of purely restrictive operations. Five-year weight loss results have ranged from 48 to 74% excess weight loss.[1] One series of 608 patients followed over 14 years with less than 3% of patients lost to follow-up has demonstrated a 49% excess weight loss.[36]

RYGB has been demonstrated not only to prevent the progression of non–insulin-dependent diabetes mellitus, but also to reduce the mortality from diabetes mellitus, primarily due to a reduction in the number of deaths from cardiovascular disease.[78] Durable control of diabetes mellitus is achieved following gastric bypass, along with amelioration or resolution of other comorbidities such as hypertension, sleep apnea, and cardiopulmonary failure.

Other obesity-related medical illnesses that have shown improvement or resolution following RYGB include hyperlipidemia, hypertension, asthma, osteoarthritis, angina, venous stasis, and obesity-hypoventilation syndrome.

Complications. Early complications include anastomotic leak with peritonitis (1.2%), acute distal gastric dilatation, Roux limb obstruction, severe wound infection (4.4%), and minor wound infection or seroma (11.4%). Late complications include stomal stenosis (15%), marginal ulcer (13%), intestinal obstruction (2%), internal hernia (1%), staple line disruption (0 to 1%), incisional hernia (16.9%), cholecystitis (10%), and mortality (0.4%). Metabolic complications include deficiencies of calcium, thiamine, vitamin B_{12} (26 to 70%), folate (9 to 18%), iron (20 to 49%), and anemia (18 to 35%).

Advantages. The RYGB is more effective than vertical banded gastroplasty in terms of weight loss. A randomized, prospective trial with 95% follow-up demonstrated that patients addicted to sweets had lost significantly more weight 3 years after gastric bypass than after vertical banded gastroplasty (64 vs. 38% excess weight loss, respectively). The presence of dumping syndrome following gastric bypass may encourage patients to avoid sweets. In a more recent study in which sweet-eaters were assigned to gastric bypass and non–sweet-eaters were assigned to vertical banded gastroplasty, gastric bypass still had superior efficacy in terms of weight loss over vertical banded gastroplasty (69 vs. 50%).[79]

Disadvantages. Dumping syndrome occurs in a variable number of patients following gastric bypass. It is due to rapid emptying of hyperosmolar boluses into the small bowel. Patients may experience bloating, nausea, diarrhea, and abdominal pain after ingesting sweets or milk products. Vasomotor symptoms such as palpitations, diaphoresis, and lightheadedness also may occur. Dumping syndrome may provide a beneficial effect in promoting weight loss by causing patients to avoid sweets.

A few postoperative complications are specific to gastric bypass, including distal gastric distention and internal hernia. Distal gastric distention is often heralded by hiccups and left shoulder pain. If perforation is imminent, it may require percutaneous needle decompression or operative gastrostomy tube placement. Internal hernia may be difficult to diagnose. Patients may present with vague periumbilical pain, nausea, and vomiting. A radiographic upper gastrointestinal study is valuable in diagnosis. Operative repair is indicated, and involves reduction of the herniated bowel and suture closure of the mesenteric defect.[7]

Laparoscopic Roux-en-Y Gastric Bypass

Mechanism of Action. Like the open RYGB, the laparoscopic RYGB is both a gastric restrictive procedure and a mildly malabsorptive procedure. A small gastric pouch restricts food intake, while the Roux-en-Y configuration provides malabsorption of calories and nutrients.

Preparation. Patients must be informed about the possibility of conversion to an open procedure. Preoperative bowel preparation may be useful in reducing bingeing behavior prior to surgery. For prevention of deep venous thrombosis, bilateral sequential compression devices are applied to the lower extremities and perioperative subcutaneous unfractionated heparin or low-molecular-weight heparin is administered.

Technique. Laparoscopic RYGB was first described by Wittgrove, Clark, and Tremblay in 1994.[80] After pneumoperitoneum is established, five or six access ports are inserted. A vertically oriented proximal gastric pouch measuring 15 to 30 mL is created using sequential applications of a linear endoscopic stapler.

The ligament of Treitz is identified, and the jejunum is divided 10 to 12 cm distally with a linear stapler. A 75- to 150-cm Roux limb is constructed and a side-to-side jejunojejunostomy is created with linear endoscopic staplers. Some groups use an elongated Roux limb of 150–250 cm for superobesity.

The gastrojejunal anastomosis may be stapled or hand-sewn. Several stapling techniques have been described. For a circular stapled anastomosis with transoral passage of the anvil, upper endoscopy is then performed. A percutaneous intravenous cannula is placed by the surgeon and is used to introduce a loop of wire into the lumen of the gastric pouch, which is grasped by the endoscopist and attached to the anvil of a 21- or 25-mm circular stapler. The anvil is passed through the oropharynx, esophagus, and into the gastric pouch. Electrocautery is applied over the stem of the anvil to bring it through the gastric wall. A left-sided port site is enlarged for passage of a circular stapler. An incision is made in the Roux limb 8 to 10 cm from the stapled end to admit the circular stapler, which is mated with the anvil to create the stapled anastomosis. The enterotomy is closed with a linear stapler.[37]

To create a circular stapled anastomosis with transgastric anvil insertion, a gastrotomy is created on the anterior stomach and the anvil is introduced into the stomach. The tip is brought through the gastric wall; the pouch is then created using sequential firings of the linear stapler.[81,82]

For a combination hand-sewn and linear-stapled anastomosis, a posterior layer of continuous nonabsorbable sutures is placed to approximate the Roux limb to the pouch. A gastrotomy and an

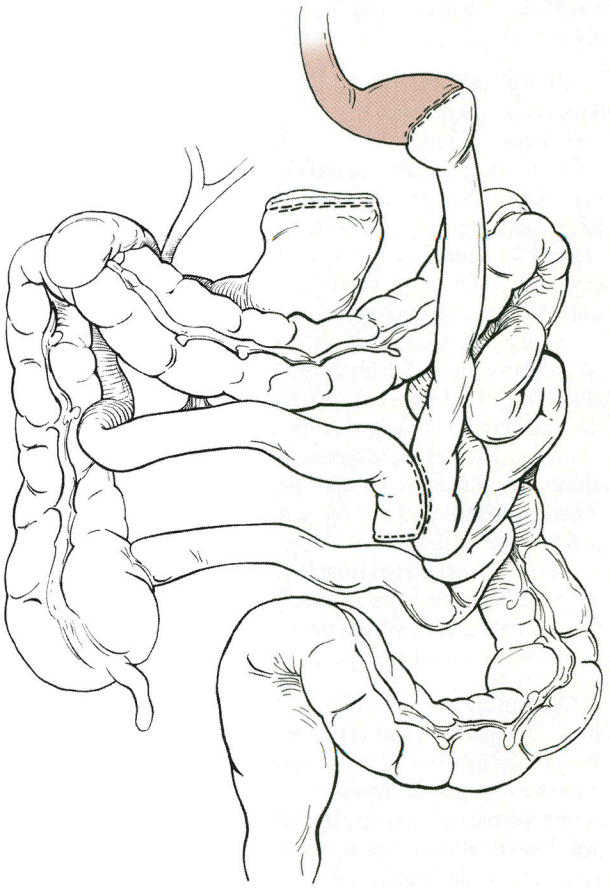

FIG. 26-4. Roux-en-Y gastric bypass.

enterotomy are made with ultrasonic dissection, and a 45-mm linear stapler is used to create the gastrojejunostomy. Upper endoscopy is performed and the flexible endoscope is passed through the anastomosis, which is completed with two layers of running nonabsorbable sutures. The gastrojejunal anastomosis may also be completely hand-sewn in two layers using absorbable suture.

Insufflation of the gastric pouch with air by endoscopy or via nasogastric tube is performed to test the integrity of the anastomosis, which is submerged in irrigation fluid. Alternately, methylene blue may be irrigated into a nasogastric tube. Port sites larger than 5 mm are closed at the fascial level (Fig. 26-4).

Postoperative Care. Some surgeons place a Jackson-Pratt or Blake drain at the anastomosis, which is left in place for a varying length of time, depending on surgeon preference. Nasogastric tubes are not used routinely. Early postoperative mobilization is emphasized.

Efficacy. Mean excess weight loss ranges from 69 to 82% with follow-up of 24 months or less. Wittgrove et al demonstrated a mean excess weight loss of 73% with follow-up of 60 months.[83] In the study by Schauer et al the mean excess weight loss was 83 and 77% at 24 and 30 months, respectively.[37] Most comorbidities were improved or eradicated, including diabetes mellitus, hypertension, sleep apnea, and reflux. Quality of life was improved significantly.

Complications. Postoperative complications include pulmonary embolism (0 to 1.5%), anastomotic leak (1.5 to 5.8%), bleeding (0 to 3.3%), and pulmonary complications (0 to 5.8%). Stenosis of the gastrojejunostomy is observed in 1.6 to 6.3%. Other complications include internal hernia (2.5%), gallstones (1.4%), marginal ulcer (1.4%), and staple-line failure (1%). Conversion to an open procedure occurs in 3 to 9%. The mortality rate is 0 to 1.5%. Nguyen and Wolfe reported a case of hypopharyngeal perforation following transoral insertion of a circular stapler anvil.[81]

Advantages. With the laparoscopic gastric bypass, there is better cosmesis, less postoperative pain, and attenuation of the postoperative stress response. Patients recover rapidly and have a shorter hospital stay.[38] The laparoscopic approach to gastric bypass eliminates the midline laparotomy incision and therefore substantially reduces the morbidity from postoperative wound infections, dehiscence, and incisional hernias. Furthermore, there is a significant improvement in postoperative pulmonary function with the laparoscopic procedure compared to the open gastric bypass.[84]

Disadvantages. The laparoscopic gastric bypass, while safe and feasible, is a technically challenging, advanced laparoscopic procedure with a steep learning curve. This approach may be more difficult in superobese patients who have a preponderance of fat in the abdominal area, which may make exposure difficult. The presence of an enlarged fatty liver may also hinder the surgeon considerably.

Biliopancreatic Diversion

Mechanism of Action. The BPD is a procedure developed by Nicola Scopinaro of Italy. The procedure combines gastric restriction with an intestinal malabsorptive procedure. A 50- to 100-cm common absorptive alimentary channel is created proximal to the ileocecal valve; digestion and absorption are limited to this segment of bowel.

Indications. This procedure is primarily indicated for the superobese or for those who have failed restrictive bariatric procedures. Less commonly, some surgeons perform BPD as a primary operation in the non-superobese.

Contraindications. Patients with anemia, hypocalcemia, and osteoporosis, and those who are not motivated to comply with stringent postoperative supplementation regimens may not be appropriate for this procedure. The laparoscopic approach may be especially challenging in patients who have undergone multiple previous abdominal surgeries, previous weight loss surgery, patients with an enlarged fatty liver, and in those with a large amount of intra-abdominal fat.

Technique. A subtotal gastrectomy is performed, leaving a proximal 200-mL gastric pouch for the superobese patient, or 400-mL pouch for the others. A Roux-en-Y anastomosis is created 50 to 100 cm proximal to the ileocecal valve, and the distal 250 cm of small intestine is anastomosed to the gastric pouch with a 2- to 3-cm stoma. A concomitant cholecystectomy is performed because of the high incidence of postoperative cholelithiasis with this degree of malabsorption.

A modification of this technique with a duodenal switch involves a greater curvature sleeve gastrectomy, with maintenance of the continuity of the antrum, pylorus, and first portion of the duodenum. This allows for a lower marginal ulcer rate (0 to 1%) and a lower incidence of dumping syndrome.[85] For the laparoscopic approach, six to eight laparoscopic ports are inserted. A sleeve gastrectomy is performed to create a gastric reservoir of 150 to 200 mL.

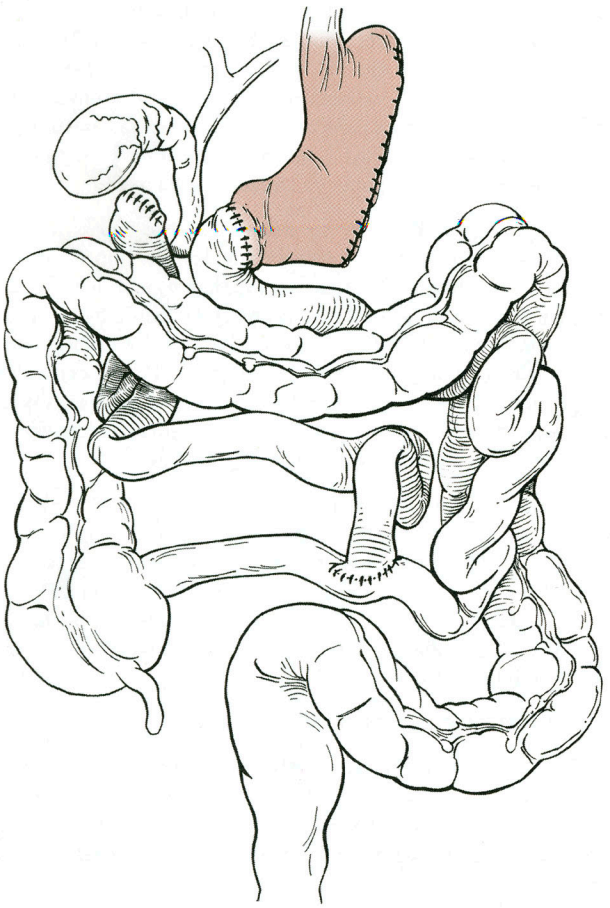

FIG. 26-5. Biliopancreatic diversion with duodenal switch.

To perform the biliopancreatic diversion with a duodenal switch, the continuity of the antrum, pylorus, and first portion of the duodenum is maintained. This allows for a lower marginal ulcer rate (0 to 1%), and a lower incidence of dumping syndrome because the pylorus is preserved.[85] The ileum is divided 250 cm proximal to the ileocecal valve and is anastomosed to the stomach. A Roux-en-Y anastomosis is created, leaving a common channel 100 cm long (Fig. 26-5).

Postoperative Care. The patient must be on lifelong vitamin, calcium, and iron supplementation, and must comply with lifelong follow-up because of the risk of malnutrition.

Efficacy. Weight loss results with BPD are excellent and durable. At 8 years, patients weighing up to 120% of ideal body weight, and those weighing more than 120% of ideal body weight maintained 72 and 77% mean excess weight loss, respectively. A group of 40 patients had a mean excess weight loss of 70% for a 15-year period.[40]

The results of laparoscopic BPD with duodenal switch in 40 patients with a mean follow-up of 12 months were reported.[85] Median BMI was 60 kg/m^2 (range 42 to 85 kg/m^2). There was one conversion to an open procedure (2.5%). Median operative time was 210 ± 9 minutes (range 110 to 360 minutes); this correlated significantly with BMI ($p = 0.04$). Median length of stay was 4 days (range 3 to 210 days). The mean excess weight loss at 6 and 9 months was 46 ± 2% and 58 ± 3%, respectively, with a median follow-up of 6 months.

Complications. The incidence of postoperative complications is quite high following BPD. The most common morbidities include anemia (30%), protein-calorie malnutrition (20%), dumping syndrome, and marginal ulceration (10%). The duodenal switch modification is associated with a lower ulceration rate (1%) and a lower incidence of dumping syndrome. Other complications include vitamin B_{12} deficiency, hypocalcemia, fat-soluble vitamin deficiencies, osteoporosis, night blindness, and prolongation of prothrombin time. The postoperative mortality rate ranges from 0.4 to 0.8%.

From Scopinaro's series, early surgical complications included wound infection and dehiscence (1.2%).[23] Late complications included incisional hernia (8.7%), intestinal obstruction (1.2%), protein malnutrition (7%), iron deficiency anemia (<5%), stomal ulcer (2.8%), and acute biliopancreatic limb obstruction. Bone demineralization was seen in 25% preoperatively; at 1 to 2 years, it was observed in 29%. At 3 to 5 years, it was present in 53%, and in 14% at 6 to 10 years.

In laparoscopic series from Ren and colleagues,[86] there was one death (2.5%). The major morbidity rate was 15%, including anastomotic leak (2.5%), venous thrombosis (2.5%), staple-line hemorrhage (10%), and subphrenic abscess (2.5%).

Advantages. Even if patients consume a great quantity of food, the malabsorptive component of the BPD allows for excellent results in terms of weight loss. This operation may be more effective than gastric bypass or restrictive surgery in patients with severe morbid obesity (e.g., BMI greater than 70 kg/m^2), or in those who have failed to maintain weight loss following gastric bypass or restrictive bariatric surgery.

The laparoscopic BPD with duodenal switch is an effective minimally invasive procedure for weight loss. It offers better weight loss than restrictive procedures because of the malabsorptive component of the operation. This operation may be valuable in patients with severe morbid obesity (e.g., BMI greater than 70 kg/m^2), or in those who have failed to maintain weight loss following gastric bypass surgery or restrictive procedures.

Disadvantages. The BPD is technically a more complex procedure than the restrictive procedures. Protein malnutrition with anemia, hypoalbuminemia, edema, and alopecia are among the serious adverse sequelae of this operation. Severe vitamin deficiencies may occur, leading to osteoporosis and night-blindness. Treatment requires prolonged hyperalimentation and supplementation. Patients have four to six foul-smelling stools per day, reflecting the fat malabsorption from this procedure. Patients may also experience bloating and heartburn following this procedure. Replacement of fat-soluble vitamins is needed for patients following BPD or BPD-DS.

The laparoscopic approach may be especially challenging in patients who have undergone multiple previous abdominal surgeries, previous weight loss surgery, in patients with an enlarged fatty liver, and in those with a large amount of intra-abdominal fat. The laparoscopic BPD is a technically demanding, lengthy laparoscopic procedure, with potential for nutritional sequelae similar to those of the open BPD. Patients may experience abdominal bloating, malodorous stools, heartburn, and abdominal pain. Protein malnutrition with anemia, hypoalbuminemia, edema, and alopecia are potential postoperative sequelae. Severe vitamin deficiencies may be observed. Treatment requires prolonged hyperalimentation and possibly reoperation to lengthen the common channel.

SPECIAL ISSUES RELATING TO THE BARIATRIC PATIENT

Bariatric Procedures in the Adolescent and the Elderly Patient

The prevalence of obesity (defined as a BMI $\geq$ 30 kg/m^2) in the United States has increased rapidly in recent years. A steady increase was observed across all age groups, but the greatest magnitude of increase was found in the 18- to 29-year-old group (7.1 to 14.1%) in a period from 1991 to 2001. In a group of elderly patients aged 60 to 69 years, the increase was 14.7 to 25.3%. Above 70 years of age, prevalence increased from 11.4 to 17.1%. The prevalence of obesity and diabetes among U.S. adults characteristically shows an increasing trend with age. Only 2.1% of obese young people (18 to 29 years old) have diabetes mellitus, whereas 15.5% of obese patients older than 70 years of age have this disease.[87]

Tracking the change in BMI that occurs from childhood to adulthood helps predict the probability of obesity in young adults in relation to the presence or absence of being overweight at various times during childhood. In children 10 to 15 years old, 10% of those with a BMI-for-age less than the eighty-fifth percentile were obese at age 25, whereas 75% of those with a BMI-for-age greater than or equal to the eighty-fifth percentile were obese as adults. Eighty percent of those with a BMI-for-age greater than or equal to the ninety-fifth percentile were obese at age 25. From this study, it is clear that an overweight child is more likely than a child of normal weight to be obese as an adult.[88]

Bariatric Surgery in Morbidly Obese Adolescents

Bariatric surgery in morbidly obese adolescents is controversial. It is generally believed that morbidly obese individuals should be of adult age before undergoing bariatric operations, despite the progressive and debilitating course of this increasingly common disease. An estimated 25% of children in the United States are obese, a number that has doubled over a 30-year period. Very little information has been published on the subject of obesity surgery in adolescents. However, review of the available literature shows that bariatric surgery in adolescents is safe and is associated with significant weight loss, correction of obesity comorbidity, and improved self-image and socialization.

Surgery may be indicated in this population because of the dismal failure of the conservative methods of weight control, the permanence of adult obesity following adolescent obesity, and the many disabling and deadly obesity-related comorbidities of adulthood. Bariatric surgery should be seriously considered after conservative methods have failed. All patients should meet NIH criteria for bariatric surgery.

Stanford and associates reported an average loss of 87% of excess body weight and nearly complete resolution of comorbidities (including hypertriglyceridemia, hypercholesterolemia, asthma, and gastroesophageal reflux disease) in a group of four adolescent patients during 20 months of follow-up. All patients who underwent laparoscopic Roux-en-Y gastric bypass were younger then 20 years of age, and all procedures were completed laparoscopically. There were no complications.[89]

Sugerman and associates described an experience with bariatric surgery in adolescents. Gastroplasty was the procedure of choice in the initial 3 years of the study, followed by gastric bypass. Thirty-three adolescents underwent the following bariatric operations: horizontal gastroplasty in one, vertical banded gastroplasty in two, and gastric bypass in 30. Mean BMI was 52 $\pm$ 11 kg/m^2. Early complications included pulmonary embolism in one patient, wound infection in five, stomal stenoses in three, and marginal ulcers in four. Late complications included small bowel obstruction in one and incisional hernias in six patients. There were two late sudden deaths (2 and 6 years postoperatively), but these were unlikely to have been caused by the bariatric surgical procedure. Significant weight loss was maintained in the majority of patients for up to 14 years after surgery. Most of comorbidities resolved at 1 year. Self-image was greatly enhanced, resulting in successful marriages and educational achievements.[90]

Capella and colleagues reported on 19 adolescent patients (aged 13 to 17) who underwent vertical banded gastroplasty Roux-en-Y gastric bypass. The average percentage of EWL at 3, 4, and 6 years was 80%. The initial average BMI was 49 kg/m^2. The postoperative BMI at the average follow-up time of 5.5 years was 28. One patient was a failure, with a reported EWL of only 35%. There were two revisions and no mortality or morbidity. All comorbidities disappeared and families and patients were satisfied with the surgery.[91]

Abu-Abeid reported on 11 adolescent patients (aged 11 to 17) with severe morbid obesity, who underwent laparoscopic adjustable gastric banding with a 4-year follow-up period. Some specific comorbidities such as amenorrhea and gallstones were noted in younger patients. Mean preoperative BMI was 46.4 kg/m^2. During the follow-up period, the mean BMI dropped from 46.6 to 32.1 kg/m^2, with marked improvement in medical conditions. No late complications developed. Authors noted difficulties involved in psychologically and cognitively preparing this population for surgery.[92]

Bariatric Surgery in Elderly Patients

In most studies, mean body weight increases with age up to about age 60, and then levels off; however, information about the association between body weight and mortality at higher ages is sparse. Some studies actually suggest a protective effect of being overweight in the oldest age groups. Indices of visceral obesity may be better indicators of risk than BMI in these age groups. Not only actual weight, but also weight development over the last decades of life may predict outcome. Most clinical trials exclude older patients, and little is known about the benefits of diets or drugs that induce weight loss in these age groups. More information is available suggesting multiple benefits of physical activity. Mechanical complications of obesity, such as osteoarthritis and static respiratory complications, seem to improve with weight loss, even at higher ages. For health-related and economic reasons it will become important to address treatment strategies in the elderly in the near future, since they will constitute a larger segment of the population. Recent studies suggest that bariatric surgery, previously considered contraindicated in obese patients above age 60, can be safely performed even in patients above age 70, with the same benefits as those seen in younger patients.[93]

Some surgeons have considered age 50 years or older as a relative contraindication to bariatric surgery. Gonzales and associates have reported interesting comparisons between laparoscopic technique and open technique for RYGB in older patients. They demonstrated safety and efficacy of RYGB in a group of patients of aged 50 years or older who underwent RYGB. The percentage of excess body weight lost was 66% at mean follow-up of 12 months. Blood samples drawn after a mean of 8 $\pm$ 2 months revealed no postoperative metabolic alterations. RYGB resulted in significant reduction of comorbidities such as hyperglycemia, hypertension, degenerative

joint disease, gastroesophageal reflux disease, and continuous positive airway pressure–dependent sleep apnea. The laparoscopic approach resulted in fewer intensive care unit admissions and shorter length of stay when compared to open surgery. Authors concluded that RYGB is safe and well tolerated in patients 50 years or older, and resulted in no renal, hepatic, or electrolytic alterations. Weight loss and control of obesity-related comorbidities are satisfactory.[94]

In some previous reports other authors also indicated the effectiveness of bariatric surgery in elderly patients. Macgregor and Rand evaluated the long-term outcome of gastric restrictive surgery in morbidly obese patients aged 55 years and older. Seventy-seven patients had Roux-en-Y gastric bypass, four had vertical banded gastroplasty, and seven had silicone ring vertical gastroplasty. Patients had an average loss of 57% excess body weight and 20 to 48% reduction of comorbidities in a 6-year follow-up period. A BMI of less than 30 kg/m^2 was achieved and maintained by 42% of patients. The authors concluded that surgical treatment of obesity is appropriate for selected patients in the older age groups.[95]

Laparoscopic Gastric Banding in Older Patients

Older patients experience the same benefits from a laparoscopic gastric banding (LGB) operation as do younger patients. Nehoda and colleagues reported a series of 320 patients with an average preoperative BMI of 44.2 who underwent LGB. Patients were divided into two age groups: younger patients (18 to 49 years) and older patients (50 years or older). All patients received LGB with an adjustable gastric band. Clinical outcome, including weight loss, complications, length of hospital stay, and operative times, were reviewed. Sixty-eight older patients (21.5%) were identified. The excess weight loss after 12 months was 68%. Complications requiring reoperation occurred in 10.3% of patients. Ninety-seven percent of the patients reported an improvement in their comorbid conditions. The authors concluded that older patients receive the same benefits from laparoscopic gastric banding as do younger patients, with an acceptable postoperative complication rate. This has led to an increase in the upper age limit to 70 years in the authors' institution.[96]

The Female Patient: Pregnancy and Gynecologic Issues in the Bariatric Surgery Patient

Obesity-induced hormonal disorders could contribute to biologic imbalance, and thus favor the development of dysfunctional ovulation. Pregnancy in obese women should be managed as a high-risk pregnancy. The incidence of gestational diabetes and hypertension is increased. Macrosomia is common. There is a two- to threefold increase in the rate of cesarean sections, with more complications. Fetal morbidity does not appear to be changed when maternal weight gain is limited. With obesity, there is an increased risk for breast and endometrial cancer, due to elevated levels of circulating estrogens resulting from aromatization of male sex steroids in adipose tissue, and decreased levels of sex hormone–binding globulin.[97]

Women who suffer from morbid obesity are often infertile. If these women are able to become pregnant, they are considered high risk because of associated risk factors such as hypertension and diabetes. Following the pregnancy is difficult due to limitations of the physical examinations. More costly, more frequent ultrasound examinations are needed. Bariatric surgery reduces the woman's weight and the incidence of obesity-related comorbidities. Pregnancy in morbidly obese women soon after weight loss surgery may occur unexpectedly during a period of weight loss. Dixon and associates also suggest that morbidly obese women have higher obstetric risks and poorer neonatal outcomes.[98] However, weight loss reduces obstetric risk. They noticed decreased maternal weight gain during pregnancy for women who underwent laparoscopic gastric banding. No difference in birth weights was noted. Obstetric complications were minimal, and there were no premature or low birth weight infants. The ability to adjust gastric restriction allows optimal control of maternal weight change in pregnancy, and should help avoid the risks of excessive weight change.

Wittgrove and coworkers evaluated the rate of complications in patients identified as having been pregnant following gastric bypass for weight loss.[99] They found a lower risk of gestational diabetes, macrosomia, and cesarean section in surgical patients than in those who were obese and had not had the surgery. Because surgical patients have had an operation that restricts food intake, some dietary precautions should be taken in this patient population when they become pregnant. Early experience with pregnancy following gastric bypass in severely obese patients showed development of severe iron deficiency anemia resulting from malabsorption. This can complicate pregnancy following gastric bypass surgery. For women of childbearing age, this potential adverse effect must be considered.[100]

An interesting clinical study showed normalization of many gynecologic and obstetric changes after loss of massive amounts of body weight following bariatric surgery. Menstrual irregularities were present in 40.4% of premenopausal patients preoperatively; after massive weight loss, cycles were abnormal in 4.6%. Infertility problems were present preoperatively in 29.3%. During previous pregnancies, medical complications were frequent (hypertension 26.7%, pre-eclampsia 12.8%, diabetes 7.0%, and deep vein thrombosis 7.0%). After weight-loss stabilization, these obstetric complications did not occur. The incidence of urinary stress incontinence decreased from 61.2 to 11.6%.[101]

The polycystic ovary syndrome results from a systemic hormonal dysfunction. Women with polycystic ovaries are frequently obese and have a higher risk of infertility, anovulation, hyperandrogenism, dyslipidemia, insulin resistance, and abnormal menses.[102]

Obesity has a major impact on stress urinary incontinence. Women suffering from obesity manifest increased intra-abdominal pressures, which adversely stress the pelvic floor and may contribute to the development of urinary incontinence. In addition, obesity may affect the neuromuscular function of the genitourinary tract, thereby also contributing to incontinence. Accordingly, thorough evaluation of obese women must be performed prior to the institution of treatment. Weight loss may relieve urinary incontinence, but definitive therapy via operative procedures is effective, even in obese patients, and should be recommended with confidence.

Involuntary urinary leakage due to a rise in abdominal pressure is usually caused by stress (i.e., coughing, laughing, change in position, walking, running, or carrying heavy weights). The cure of an underlying condition, such as obesity, is sufficient in many cases. Subak and associates evaluated the effect of weight reduction on urinary incontinence in obese women. The study demonstrated an association between weight reduction and improved urinary incontinence.[103]

Dwyer and colleagues reported on results of a series of 368 incontinent women who underwent urodynamic assessment. Sixty-three percent were diagnosed as having genuine stress incontinence, and 27% as having detrusor instability. Obesity was significantly more common in women with genuine stress incontinence and detrusor instability than in the normal population. In those with detrusor instability, the BMI was found to increase with age and parity. In women with genuine stress incontinence, the BMI increased with age and the number of previous incontinence operations, and was

higher in nulliparous than in parous women.[104] Kolbl and Riss confirmed similar findings. A markedly increased BMI was found to be correlated with a positive clinical stress test.[105]

Gallbladder Disease in the Bariatric Surgery Patient

Weight loss following laparoscopic Roux-en-Y gastric bypass (LRYGB) is accompanied by a rise in the incidence of gallstones, with 38 to 52.8% of patients who preoperatively did not have stones going on to develop stones in the first postoperative year.[106,107] Between 15 and 27% of all patients undergoing LRYGB will require urgent cholecystectomy within 3 years.[106,108]

Routine cholecystectomy concomitant with a LRYGB remains controversial.[109,110] The safety of combining laparoscopic cholecystectomy and LRYGB has been established, but performing both in one procedure may increase the length of hospital stay and adds an hour to the operative time.[111,112] An alternative is the prophylactic use of oral ursodiol for 6 months after LRYGB. This significantly reduces the incidence of gallstones,[113] but is hindered by poor patient compliance.[114] The decision to prophylactically remove the gallbladder is made by the surgeon based on the likelihood of the patient to take the postoperative ursodiol, compared to the risk of prolonging the procedure, especially in the superobese.

Choledocholithiasis becomes a difficult clinical problem because of a loss of endoscopic access to the duodenum. Anchoring the remnant stomach to the anterior abdominal wall, preferably with a radiologic marker, may provide a safe point for percutaneous access for endoscopic retrograde cholangiopancreatography.[115]

Gastroesophageal Reflux Disease in the Bariatric Surgery Patient

Symptomatic gastroesophageal reflux disease (GERD) is present in about 58% of morbidly obese individuals, and its presence is proven objectively in 21%.[37] The conventional approach of fundoplication and hiatal reconstruction as definitive treatment is associated with a poorer outcome in obese individuals.[142] Weight loss that results in a BMI less than 30 has been associated with more favorable results. The RYGB has been found to resolve GERD symptoms in the vast majority of patients.[143] In this study, there was a significant decrease in GERD-related symptoms, including heartburn (from 87 to 22%), water brash (from 18 to 7%), wheezing (from 40 to 5%), laryngitis (from 17 to 7%), and aspiration (from 14 to 2%). Furthermore, the postoperative use of medication decreased significantly, both for proton pump inhibitors (from 44 to 9%) and for H_2 blockers (from 60 to 10%).[143] The use of the adjustable gastric band is also associated with resolution of reflux esophagitis in 89%.[64]

After vertical banded gastroplasty, reflux esophagitis may occur in 16 to 38% of patients, who may require conversion to Roux-en-Y gastric bypass for severe symptoms.[56] Late complications after laparoscopic vertical banded gastroplasty that may require reoperation include new-onset gastroesophageal reflux (0.5 to 12%).

Diabetes in the Bariatric Surgery Patient

Paralleling the rise in incidence of morbid obesity is the incidence of type II diabetes, often as a component of the metabolic syndrome comprising central obesity, glucose intolerance, dyslipidemia, and hypertension.[7]

Several comorbidities, especially diabetes mellitus, benefit from sustained weight loss as little as 2.3 to 3.7%,[15] with lifestyle changes alone appropriate for patients with a BMI less than 27, but there are no published studies demonstrating any value of this approach in morbidly obese patients (BMI > 35). However, several recently published outcome studies demonstrate the value of surgical procedures in improving diabetes in the morbidly obese. Laparoscopic adjustable gastric banding, reported in a series of 700 patients, showed complete resolution or definite improvement of diabetes in 97%.[62]

In a study by Schauer et al, 1160 patients undergoing laparoscopic LRYGB over a 5-year period were examined, with 240 (21%) demonstrating impaired fasting glucose or type II diabetes mellitus (T2DM). After surgery, fasting plasma glucose and glycosylated hemoglobin concentrations returned to normal levels (83%) or were markedly improved (17%) in all patients. A significant reduction in the use of oral antidiabetic agents (80%) and insulin (79%) was also observed following surgical treatment. Notably, patients with the shortest duration (<5 years), the mildest form of T2DM (diet-controlled), and the greatest weight loss after surgery, were most likely to achieve complete resolution of diabetes.[141]

Cardiovascular Disease and Hypertension in the Bariatric Surgery Patient

Both the cardiovascular and pulmonary systems appear to be abnormal in obese patients. The presence of pulmonary function abnormalities and correlation between the severity of lung function impairment and the degree of obesity have been well proven. Reduction in functional residual capacity and impairment of diffusion capacity were the most common abnormalities found in obese patients. Obstructive ventilatory impairment was found in some patients. Reduction in static lung volume correlated with the degree of obesity.[116] It also seems that the cardiopulmonary endurance to exercise in morbidly obese patients with upper body fat distribution is lower than in those with lower body fat distribution.[117]

During exercise, cardiopulmonary reserve is exhausted because of augmented requirements, leading to a significant intolerance. Exercise duration increases significantly 6 months following a weight loss surgical procedure. The mean O_2 consumption at peak exercise (peak VO_2) and at the anaerobic threshold (VO_{2AT}) was significantly higher after weight loss. Six months after vertical banded gastroplasty the left ventricle thickness decreased significantly. Diastolic indices, isovolumic relaxation time (IVRT), and early:late (E:A) velocity ratio significantly improved after weight loss. Peak VO_2 and VO_{2AT} were significantly correlated with IVRT and E:A velocity ratio. Weight loss resulting from bariatric surgery improves the cardiac diastolic function, and this is associated with an improvement in cardiopulmonary exercise performance. Left ventricular filling variables could be considered among the most important determinants of exercise intolerance in obese individuals.[118]

Obesity clearly correlates with the development of heart failure (HF). Obese and overweight patients have significantly higher rates of hypertension and diabetes, as well as higher levels of cholesterol, triglycerides, and low-density-lipoprotein cholesterol. However, in a large group of patients with advanced HF of multiple etiologies, obesity was not associated with increased mortality. Further studies are needed to delineate whether weight loss promotion in medically optimized patients with HF is a worthwhile therapeutic goal.[119] Reduced cardiac performance tolerance is linked with a reduced oxygen supply to the active muscles. Study results confirmed a relatively less efficient cardiac performance during progressive work rates in obese patients.[120] Increased left ventricular mass has been shown to be a significant independent predictor of cardiovascular risk. Hypertension and obesity each have significant independent associations with left ventricular mass and wall thickness. Obesity is particularly strongly associated with left ventricular internal diameter.[121]

Elevated arterial pressure in patients with obesity-related hypertension is associated with an increased cardiac output and total peripheral resistance. The elevated output is related to expanded intravascular volume that increases cardiopulmonary volume, venous return, and left ventricular preload; the elevated pressure and total peripheral resistance increase afterload. This dual ventricular overload promotes a dimorphic, concentric, and eccentric hypertrophy in response to the volume and pressure overload. Increased myocardial oxygen demand results from the elevated tension in the left ventricular wall, reflecting its increased diameter and pressure, and provides a physiologic rationale for the greater potential of coronary arterial insufficiency and cardiac failure. There are greater renal blood flow and lower renal vascular resistance in patients with obesity-related hypertension at any level of arterial pressure. This may be offset by an increased renal filtration fraction that may favor protein deposition and glomerulosclerosis, and predisposition of obese patients toward diabetes may aggravate this problem. With weight reduction, these hemodynamic derangements may be reversed: intravascular volume contracts, cardiac output decreases, and arterial pressure falls.[122] Reduction of weight in morbidly obese patients is significantly correlated with the fall in mean arterial pressure. Total circulating and cardiopulmonary blood volumes also are reduced, permitting a decreased venous return and cardiac output. Weight loss is also associated with reduced resting circulating levels of plasma norepinephrine, suggesting that diminished adrenergic function also may be related to weight reduction and its associated fall in arterial pressure.[123]

Sleep Apnea in the Bariatric Surgical Patient

Sleep apnea is defined by a respiratory disturbance index (number of apnea-hypopnea episodes per hour of sleep) of 5 or more in the presence of excessive daytime somnolence.[124] Patients with a BMI over 50, with hypersomnolence, hypertension, or with a history of loud snoring, should be assumed to have sleep apnea.[124] Preoperative administration of the Epworth sleepiness scale questionnaire[125] or a multivariable apnea prediction questionnaire[126] help in predicting a high probability of sleep apnea, and in identifying patients who need inpatient polysomnography.[127] Estimation of the positive airway pressure needed to keep the upper airway patent[128] also can be determined during this investigation.

Apneic arrest can complicate the postoperative course of patients whose sleep apnea has remained undiagnosed or mismanaged. Continuous positive airway pressure (CPAP) in the perioperative period has been shown to be effective in preventing apneic arrest without risk to the anastomosis.[129,130] The risk of apneic arrest is increased by narcotics,[128,131,132] requiring these patients to be in monitored beds and on CPAP when receiving postoperative opioid analgesia. A period of acclimatization to the face mask of at least 2 weeks prior to the surgery is valuable in improving postoperative compliance with CPAP.

A patient at high risk of apneic arrest may be deceptively comfortable with transient episodes of desaturation corrected by oxygen. However, it is the progressive hypercapnia that leads to CO_2 narcosis and respiratory acidosis, leading to cardiac arrest.

Plastic Surgery Following Weight Loss

Most massive weight loss patients are troubled by hanging skin and rolls of skin and fat. Though smaller in size, their clothes fit poorly. Skin macerates under abdominal pannus, hanging inner thighs, and ptotic breasts. Body aroma is unpleasant. Heavy flaps of skin burden the back and inhibit vigorous exercise. Intimate relations may be untenable. Plastic surgery can substantially improve or correct the skin changes resulting from weight loss. Since most insurance carriers maintain limited coverage for plastic surgery, many patients have limited access to its benefits.

Bariatric center staff members must anticipate these issues and encourage comprehensive body contouring surgery by a team of plastic surgeons. When patients are given time to describe their deformities and prioritize treatment, they are more likely to accept the risks, uncertainties, and obligations of body contouring surgery. Candidates with active psychiatric pathology and unrealistic expectations are excluded.

Body contouring surgery advanced considerably during the 1990s,[133–135] and these procedures have been modified for this new post–bariatric surgery population.[136–139]

The massive weight loss patient has a deflated shape that is related to genetically defined fat deposition patterns. The most susceptible regions are the anterior neck, upper arms, breasts, lower back, flanks, abdomen, mons pubis, and thighs. Problematic areas for women include the subcutaneous abdomen and hips and thighs; in men, they are the flanks, abdomen, and breasts. The deformity reflects the initial BMI and its change. Since the etiology of the skin laxity is not understood, there is no medical therapy. The widest possible areas of skin are excised and closed tightly.

Operative planning is based on the deformity and patient priorities. Most have excess tissue of the lower torso and thighs removed through a circumferential abdominoplasty and lower body lift.[136] Starting prone and then turning supine, the operation removes a wide swath of skin and fat along the bikini line. The lift of the buttocks and lateral thighs requires extensive undermining down the thighs followed by a very tight lateral subcutaneous fascial closure. This closure is aided by full abduction of the leg onto a utility table.[138] A panniculectomy that corrects the inflammatory sequelae of an overhanging pannus is included. As an isolated procedure, a panniculectomy is a long transverse excision of skin and fat between the umbilicus and pubis, without flap undermining or reconstruction of the umbilicus.

The circumferential abdominoplasty removes the redundant skin of the lower abdomen, flattens the abdomen, and incorporates the lower body lift. It requires central undermining to the xiphoid and minimal lateral undermining of the superior flap. Large, braided permanent sutures imbricate the central fascia from xiphoid to pubis. The operating table is flexed as the superior flap is approximated to the incision over the pubis and groins, with highest closure tension being lateral. That tension narrows the waist and advances the anterolateral thighs. Liposuction is performed as needed. A medial high transverse thighplasty usually accompanies the lower body lift in massive weight loss patients.

Unwanted skin redundancy distal to the mid-thighs requires long vertical medial excision of skin. Mid-back and epigastric rolls, along with sagging breasts, are corrected with an upper body lift. The upper body lift is a reverse abdominoplasty, removal of mid-torso excess skin, and reshaping of the breasts. For highly selected individuals, and with a well organized team, a single-stage total body lift, which includes a circumferential abdominoplasty, lower body lift, medial thighplasty, an upper body lift, and breast reshaping, can be performed safely in under 8 hours[139] (Figs. 26-6 and 26-7).

The opportunity that these large numbers of massive weight loss patients provide for plastic surgery innovation, treatment, and professional satisfaction is extraordinary, and is similar to the revolution

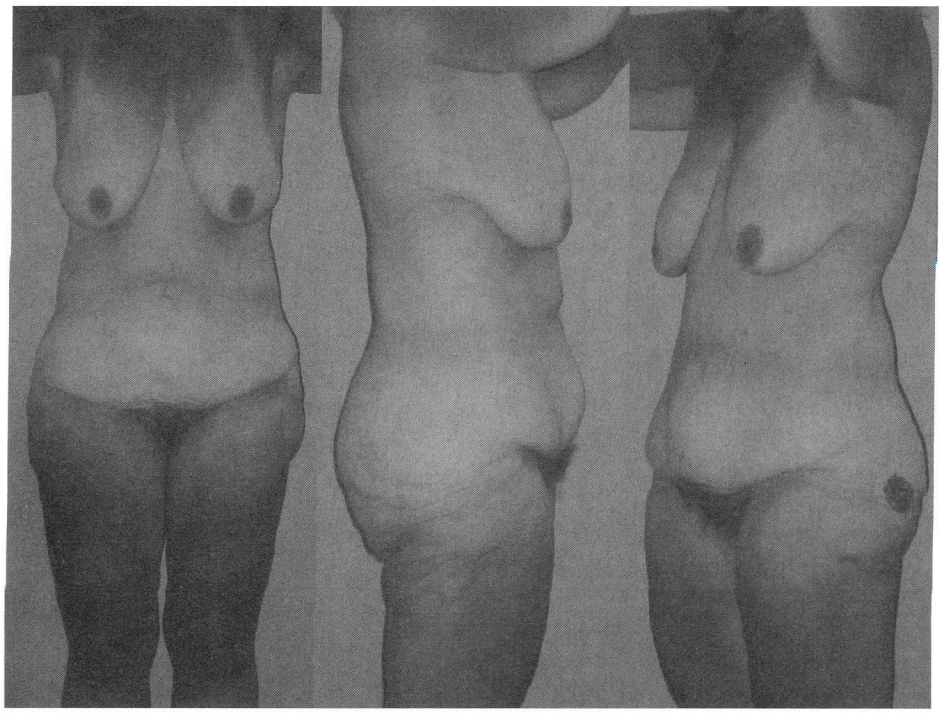

FIG. 26-6. These are the preoperative frontal, right lateral, and left anterior oblique views of a 36-year-old, 150-lb, 5'6" woman who lost 120 lb, 2 years after a laparoscopic Roux-en-Y gastric bypass procedure. She underwent a single-stage total body lift and bilateral brachioplasties. *(Courtesy of Dennis Hurwitz, M.D., Clinical Professor of Plastic Surgery, University of Pittsburgh.)*

of craniofacial surgery in the 1970s and breast reconstruction in the 1980s. Patients are uniformly pleased with their improvements, with the exception of pain and the minor complications noted above. Research in adipocyte physiology, skin biomechanics, and alternative surgical technique should lead to improved care.

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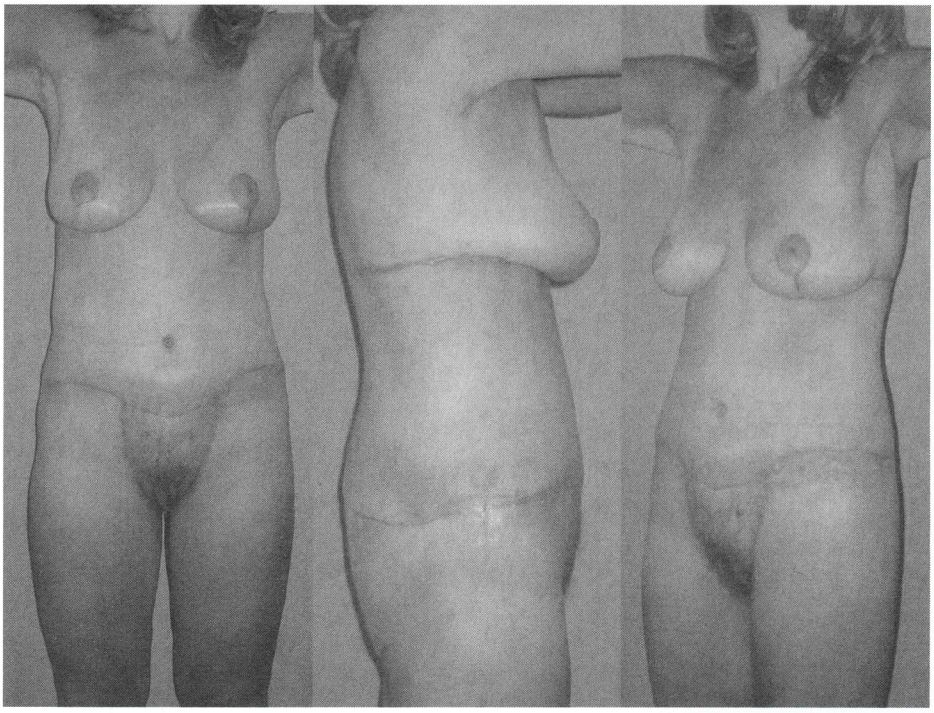

FIG. 26-7. These are the frontal, right lateral, and left anterior oblique views 6 weeks after surgery for the woman in Fig. 26-5. The scars indicate the circumferential abdominoplasty, lower body lift, upper body lift, breast reshaping, and autoaugmentation through a keyhole pattern and bilateral brachioplasties. All redundant skin has been removed, leaving well-positioned scars and feminine features. *(Courtesy of Dennis Hurwitz, M.D., Clinical Professor of Plastic Surgery, University of Pittsburgh.)*

Tomasz Rogula, M. D. Fellow in Laparoscopic and Bariatric Surgery University of Pittsburgh.

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