Bariatric Surgery
A Review

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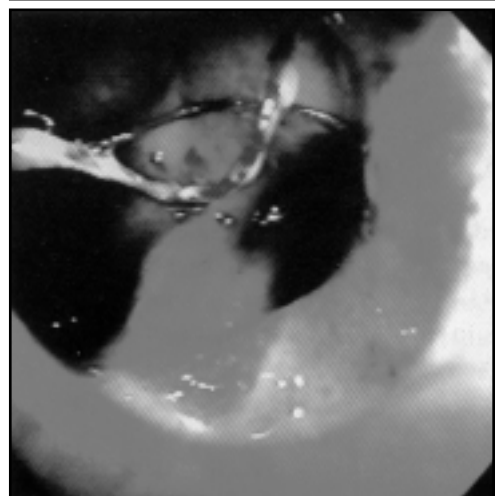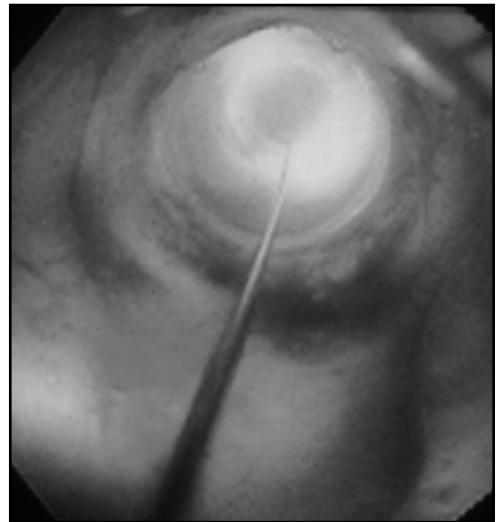
Top—Balloon dilation of stenotic gastrojejunostomy
Bottom—Marginal ulcer

Photos courtesy of Dr. Kenneth G. MacDonald, Jr.

Morbid obesity is recognized as a serious health problem in the United States and in many other areas of the world. While estimates vary, approximately 50 million Americans are obese and at least 12 million are morbidly obese,[1] defined as being more than 100 pounds above ideal body weight (medium frame in the Metropolitan Life Insurance tables) or having a body mass index (BMI) greater than 35 (with serious comorbidity) to 40. The increased morbidity and mortality associated with obesity have been well established. The Framingham Study demonstrated that overweight (>110% of ideal weight) nonsmoking males had 30-year mortality up to 3.9 times that of nonsmoking males of desirable weight (100% to 109% of ideal).[2] Drenick's classic study showed 12-fold excess mortality in a group of obese males (average excess weight of 130%) age 25 to 34 years and a 6-fold excess in the age group of 35 to 44 years.[3]

The costs associated with obesity are substantial. Billions of dollars are spent in the United States yearly on weight management; a much greater amount of the healthcare expenditure in this country is spent on treatment for the many complications associated with obesity, such as type II diabetes.

Comorbidities

Table 1 (page 2) lists the comorbidities associated with obesity. All have a high probability of either lessening or completely resolving with weight loss.

Approximately one third of the morbidly obese have type II diabetes, which is characterized by insulin resistance and hyperinsulinemia. Another one third have impaired glucose tolerance (IGT), of whom one fourth develop type II diabetes 5 years after IGT onset and two thirds 10 years after IGT onset.[4] IGT is associated with an increased risk of development of macrovascular disease.[5] When diabetes is associated with morbid obesity, mortality increases substantially.[6]

Table 1. Comorbidities

- Diabetes
- Asthma
- Sleep apnea
- Obesity hypoventilation
  Pulmonary artery hypertension
  Cor pulmonale
- Hypertension
- Hyperlipidemia
- Atherosclerotic vascular disease
- Gastroesophageal reflux disease
- Cholelithiasis
- Nonalcoholic steatohepatitis
  (NASH)
- Joint and back disease
- Gout
- Amenorrhea/infertility
- Stress incontinence
- Depression
- Pseudotumor cerebri
- Hypercoagulable states
  Venous stasis disease
  Pulmonary embolism
- Focal segmental
  glomerulosclerosis
- Soft tissue infections
  Panniculitis
  Cellulitis
- Accidents
- Malignancies
  Breast
  Uterine
  Colon

A degree of pulmonary insufficiency develops in most morbidly obese patients with reduction in expiratory reserve volume, resulting in exertional dyspnea. Obstructive sleep apnea syndrome is characterized by multiple obstructive apneic episodes during sleep, accompanied by oxygen desaturations. Symptoms include fatigue, morning headaches, and inappropriate daytime somnolence. Obesity hypoventilation syndrome is characterized by chronic reduction of PaO_2 and elevated $PaCO_2$, which may exist alone or in combination as in the Pickwickian syndrome. If untreated, pulmonary insufficiency of obesity may lead to pulmonary artery hypertension and right heart failure (cor pulmonale), associated with high mortality.

Hypertension is one of the most common comorbidities, present in up to 55% to 60% of the morbidly obese, and is a significant factor in the high incidence of cardiovascular disease and related mortality in this population. Hyperlipidemias further add to this risk.

The increased volume of fat cells results in excessive production of estrogen, contributing to dysfunctional uterine bleeding, amenorrhea, and infertility. The excess estrogen may also explain the increased incidence of breast and uterine malignancies in the obese. If obese women are able to become pregnant, there is an increased risk of preeclampsia, gestational hypertension and diabetes, and poor fetal weight gain.

Joint and back problems are almost universal in the obese, often resulting in significant disability. Medical management is often unsuccessful, and surgery has such high complication rates and low success rates that it is often not offered unless the patient loses weight.

Obesity is associated with increased incidence of protein C and S deficiencies, which, combined with mechanical factors such as increased intra-abdominal pressure, result in hypercoagulability and increased risk of deep venous thrombosis, chronic venous stasis disease, and pulmonary embolism.

There are also psychological and socioeconomic consequences of morbid obesity. Obesity is often referred to as "the last socially acceptable form of prejudice" among physicians and the general population. There is discrimination in the workplace, and it is increasingly difficult for the obese to obtain and retain employment. Daily activities are difficult, and quality of life is perceived as poor. Those who are obese are more prone to accidents and mortality from these accidents.[3]

In February 1985, a National Institutes of Health Consensus Development Panel on the Health Implications of Obesity concluded that there is overwhelming evidence that obesity adversely affects health and longevity.[7] The panel also strongly advised treatment for weights greater than 20% above the ideal (BMI >27–28).[7]

Surgical management of obesity

In 1991, a second NIH Consensus Conference on Gastrointestinal Surgery for Severe Obesity reviewed the long-term data on safety and efficacy of medical and surgical weight loss and concluded that surgical therapy should be offered to morbidly ("severely") obese patients unresponsive to nonsurgical therapy for weight loss.[8] The only operations endorsed by the panel were gastric bypass and vertical banded gastroplasty, which at the time were the primary procedures performed in the US with well-documented long-term data. During the decade since this conference there has been a dramatic increase in interest in and acceptance of bariatric surgery, with a corresponding increased understanding of alternative procedures, as well as development of new approaches.

Indications for surgery

Regardless of the operation chosen, the indications should be the same. By accepted standards, weight should be more than 100 pounds above ideal body weight, as defined by "medium build" in the Metropolitan Life Insurance tables. This closely corresponds to the alternative criterion of a BMI of 40 or greater. A BMI of 35 with a major comorbidity is also an acceptable criterion. There should be no contraindication to major abdominal surgery. Demonstration of previous serious dietary attempts at weight loss is helpful to show motivation, but this may be unnecessary considering the uniformly poor results with dieting. Demonstration of any of the many possible comorbidities associated with obesity is generally required, although complete absence of comorbidity is rare in the morbidly obese. The patient must be able to understand the seriousness of the surgery and the possible complications. The patient must also understand and agree to the necessary postoperative diet and exercise recommendations, as well as agree to maintain follow-up after surgery. Ongoing drug or alcohol abuse is an absolute contraindication, as is untreated psychological illness, including depression. Previous demonstration of noncompliance is a relative contraindication. There is disagreement on age limitations at both extremes, although candidates under age 20 or over age 60 should be chosen with particular care.

Preoperative evaluation and preparation

Evaluation begins with a complete and thorough history and physical examination, focusing on the medical problems commonly associated with morbid obesity. Many medical problems are often diagnosed for the first time during this

evaluation. Collaboration with various specialists is often necessary for the perioperative management of these patients.

Obese patients with asthma can pose significant problems during surgery and in the early postoperative period. Medical management should be optimized before surgery and occasionally requires steroids. Patients with severe sleep apnea or obesity hypoventilation, particularly with associated congestive heart failure, should be evaluated by a pulmonologist at the surgical institution to assess risk, enhance preoperative management, and assist with postoperative care. High-risk patients may require Swan-Ganz catheterization and postoperative ventilation. Tracheostomy may be required at the time of surgery, or occasionally far in advance of surgery to improve cardiopulmonary status.

Patients at high risk for or with symptoms suggesting cardiac disease should be evaluated by a cardiologist preoperatively to assess operative risk and to optimize medical management. Heavier patients may not be candidates for catheterization, stenting, or coronary artery bypass graft, but nitrates and other cardiac medications may reduce operative risk.

We obtain routine preoperative anesthesia consultation on any patient of more than 350 pounds or with a short, thick neck to determine possible difficulties with perioperative airway management. It is best for the anesthesiologist to be prepared for a difficult intubation and to prepare the patient for possible tracheostomy. These individuals have very little reserve, and a difficult emergency reintubation after surgery may result in hypoxic brain injury or death.

A careful gastrointestinal system review should assess gastroesophageal reflux disease or peptic ulcer disease, and preoperative upper endoscopy should be performed if indicated. We no longer obtain routine preoperative upper gastrointestinal studies before open surgery after demonstrating lack of benefit.[9] It is helpful to know whether there is a large hiatal hernia, as this may complicate the operation, particularly with laparoscopic procedures. Esophageal strictures or Barrett's esophagus should be identified if present. The distal stomach and duodenum should be considered inaccessible for diagnostic or therapeutic procedures after certain operations, so any concerns should be addressed before surgery. Esophagitis or ulcers should be appropriately managed. If present, *Helicobactor pylori* infection should be treated before surgery. Occasionally, vagotomy may be considered at the time of surgery in individuals at high risk for recurrent ulcer disease.

Although we have found no benefit from routine preoperative psychological evaluation, we screen carefully for any history that might suggest problems and selectively refer as needed. Depression and eating disorders are common, as are other psychosocial problems. Occasionally, family situations that exist should be addressed preoperatively.

Types of procedures

Bariatric surgery is divided into 2 primary groups of operations—restrictive and malabsorptive. (See Table 2, page 4.) The restrictive procedures cause early satiety by creation of a small gastric pouch and prolong satiety by creation of a small outlet to that pouch. These include the many varieties of horizontal gastroplasty, vertical banded gastroplasty, or the similar Silastic ring vertical gastroplasty and gastric banding. The pouch and the outlet must be small enough to adequately restrict intake yet not so small as to cause obstruction. In any of these procedures, the outlet is reinforced by prosthetic material to prevent dilation. Significant dietary compliance is required, as high-calorie liquids or soft or easily masticated foods will result in failure to lose weight. Benefits include technical simplicity with no anastomoses or bypasses of any of the gut. There is also no protein calorie malabsorption and no vitamin or mineral deficiencies. Problems include less weight loss than with alternative procedures and more late failures due to pouch or anastomosis dilation or maladaptive eating behavior. These methods are less effective with sweet-eaters.[10] Late meat or solid food intolerance is not rare, and relative obstruction by the reinforced outlets may cause frequent vomiting and gastroesophageal reflux problems. The prosthetic material at the outlets may erode into the gastric lumen.

Malabsorptive procedures include the old jejunoileal bypass, biliopancreatic diversion (BPD), duodenal switch, and long limb gastric bypass. These surgeries depend upon bypass of various lengths
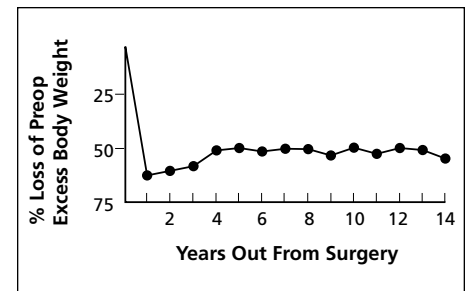

Figure 1. ECU—long-term weight loss after gastric bypass.

of small intestine to cause malabsorption. Benefits include greater sustained weight loss that is less dependent on dietary compliance. Problems include increased risk of malnutrition and vitamin deficiencies, with a need for constant follow-up to reduce these risks. Intermittent diarrhea or steatorrhea is likely. The malabsorptive procedures are generally more technically complex than the restrictive operations, with 2 or more anastomoses and, with the BPD, partial gastric resection.

The standard Roux gastric bypass has historically been considered a restrictive operation, although many argue that there is a degree of malabsorption due to the foregut bypass, with associated vitamin and mineral deficiencies.

ROUX GASTRIC BYPASS

Open Technique

Differences in the technique of open gastric bypass between different groups primarily involve the size of the proximal pouch, the method of partitioning, and creation of the gastrojejunostomy. At East Carolina University, we have performed the operation since 1980 with little modification other than for differences in partitioning the pouch from the distal stomach and in lengths of the alimentary jejunal limb.

After exposure is obtained through an upper midline incision, the cardia of the stomach is encircled with blunt finger dissection beginning at the angle of His, extending slightly caudad during posterior passage of the fingers, and exiting immediately adjacent to the lesser curvature of the stomach approximately 2 cm

Table 2. Bariatric Procedures

- Restrictive
  Horizontal gastroplasties
  Vertical banded gastroplasty (VBG)
  Silastic ring vertical gastroplasty
   (SRVG)
  Gastric banding

- Malabsorptive
  Jejunoileal bypass (JIB)
  Biliopancreatic diversion (BPD)
  Duodenal switch
  Long limb gastric bypass

- Intermediate
  Roux-en-Y gastric bypass (RYGBP)

distal to the gastroesophageal junction.

The correct location is usually immediately proximal or distal to the first prominent vein running onto the anterior gastric wall with a branch of the left gastric artery. A large Malecot catheter (C.R. Bard, Inc.) with the bulbous end removed is then passed through this tract from the lesser curve opening out through the angle of His, leading with the smaller-diameter end. After the anesthesiologist has been instructed to pull the nasogastric (NG) tube from the stomach into the distal esophagus, the catheter is used to guide a PI 90 stapler around the gastric cardia. A pouch of 15 to 20 cc (approximately the size of a thumb) is created by moving a small portion of anterior gastric wall through the opened stapler. The stapler is then locked, and the NG tube is advanced into the pouch to ensure that the esophagus is not obstructed. The stapler is then fired to isolate the pouch.

The instrument is opened and, after replacement of the stapling cartridge, is fired twice more directly over the initial staple line. There is a natural tendency of this stapled partition to partially reopen with time, forming a staple-line dehiscence (SLD) and re-establishing continuity of the pouch with the distal stomach. Some surgeons advocate dividing between staple lines to completely separate the pouch, but this increases the complexity of the procedure and can result in occasional gastrogastric fistulas. These fistulas likely result from contained leaks in the pouch staple line that then drain into the distal stomach.[11]

In a series of 519 patients, using a single application of a four-row stapler, we discovered an SLD rate of 18.7% during long-term follow-up. Using the aforementioned triple-staple technique, we

demonstrated a significant reduction in dehiscence to 2.5% of procedures, all of which were asymptomatic and discovered only by routine barium study at 6 months after the surgery.[12]

The jejunum is next divided at the apex of its mesentery, approximately 40 to 50 cm distal to the ligament of Treitz. The distal end is brought retrocolic through the mesocolon, through the lesser sac, and around the greater curvature of the stomach to lie adjacent to the gastric pouch. The limb should reach without tension, and great care should be taken to avoid any kinking or torsion. Division of any of the jejunal mesentery is rarely required.

Openings are created in the pouch and end of the jejunum, and a side-to-side gastrojejunostomy is performed with 2 layers of running 3-0 polypropylene suture, beginning with the posterior wall, which is placed as close to the staple line as possible to avoid any intervening segment of gastric wall; this may become ischemic. The NG tube is then passed out of the gastric pouch into the jejunal limb, and the anterior wall of the anastomosis is completed with the tube being used as a stent, approximating a diameter of 8 to 10 mm. The NG tube should be moved to ensure that it is not trapped by suture, then taped into place under anesthesia. The jejunum is then occluded just distal to the tube, and the pouch and anastomosis are tested with air insufflation under pressure while immersed in saline to test for leaks.

Next, the jejunojejunostomy is created anywhere from 75 to 150 cm distal to the gastrojejunostomy. Some surgeons use a 100-cm alimentary limb for normal-weight patients and 150 cm for the superobese (BMI >50). It is important to close the mesenteric defect at this anastomosis carefully, to avoid future internal hernia, which often involves the alimentary limb and may occur at any time after surgery. The mesocolic defect should also be closed around the alimentary limb.

Postoperative course

Patients are placed on a cardiac monitor after surgery, as tachycardia may be the first sign of a pouch or anastomotic leak and must be addressed immediately. Patients are ambulated as soon as possible, sometimes as soon as later in the day of surgery. Thromboembolism prophylaxis with subcutaneous heparin and

sequential compression stockings (or foot pumps if the stockings do not fit on large legs) is continued until the patient is discharged from the hospital. A limited Gastrografin swallow is obtained on the second postoperative day, and the tube is removed if there are no leaks or obstructions. Water is then given orally, initially limited to no more than 60 mL per hour, in addition to 60 mL of Ensure 3 times daily. Some groups no longer leave NG tubes or perform routine contrast studies after surgery; we rarely find a problem not anticipated before the study.

In the average uncomplicated case, the patient is ready for discharge on the third postoperative day. Diet is gradually advanced to solids over 1 month. Daily vitamin and mineral supplementation with a chewable multivitamin, 150 µg of vitamin B_{12}, and calcium in the form of Tums antacid tablets is started at 3 weeks after surgery. Iron supplementation is recommended for menstruating women. In patients who still have a gallbladder, prophylaxis with the bile acid ursodiol has been shown to reduce the incidence of gallstone formation from almost 40% to 3% when taken for the first 6 months after surgery.[13]

Exercise is emphasized at every patient encounter, as it is clearly an important determinant of long-term success. Aerobic exercise should be performed for at least 30 minutes 5 times weekly. Weight training after appropriate instruction is recommended at more than 6 weeks after surgery to help preserve muscle mass.

Our follow-up is every 3 months for the first year after surgery, then indefinitely once or twice yearly.

Complications

Early postoperative period

A tachycardia of more than 120 beats per minute in the early postoperative period must be evaluated without delay, as early return to the operating room offers the best chance of survival with a leak from the pouch or anastomosis. Uncontrolled pain, hypovolemia, and hemorrhage must be ruled out as possible causes, and pulmonary embolism must always be considered in the differential diagnosis. Physical examination of the abdomen is not often helpful in the morbidly obese. Contrast studies may yield false negatives and should not

delay exploration if there is clinical suspicion of a leak.

Pulmonary embolus is one of the primary causes of mortality after bariatric surgery, and a high level of suspicion must be maintained. This complication may occur from a few days to several weeks after surgery and may be diagnosed with nucleotide ventilation/perfusion studies or, if the patient's weight allows, a CT scan of the chest.

Pulmonary problems are quite common after surgery, particularly in patients with asthma and sleep apnea. Aggressive pulmonary toilet and early ambulation are the best prophylaxes. The inability to secure a difficult airway emergently is a significant concern in this population, justifying prophylactic tracheostomy in selected high-risk patients.

Stenosis of the gastrojejunostomy occurs infrequently but may require endoscopy with through-the-scope balloon dilation. More severe stenoses may require multiple dilations. Operative revision is rarely required. With the open operation, wound seromas and hematomas are not infrequent; significant infections are fortunately less common with appropriate perioperative antibiotic prophylaxis.

Late complications

Vitamin B_{12} deficiency and iron deficiency anemia are the most common nutritional sequelae after gastric bypass, although both can be prevented in most patients with supplementation. Significant malnutrition or hypoalbuminemia occurs extremely rarely in the absence of infection, obstruction, or other medical problems.

Marginal ulcers at the gastrojejunostomy have occurred in 23 (4.5%) of our patients,[14] although the incidence varies widely in different series of patients. MacLean et al reported an incidence of 16%,[15] observing that no ulcers were seen without a concomitant SLD. Although it does appear that staple-line breakdowns increase the probability of ulcers, we have noted many in patients without demonstrable dehiscences. Marginal ulcers have been diagnosed from a few weeks to many years after surgery in our experience, presenting with GI bleeding, epigastric pain, and nausea and vomiting, either alone or in combination. Late-onset vomiting with or without anastomotic stenosis on barium swallow

is commonly due to marginal ulceration. Endoscopy is undoubtedly the diagnostic study with the highest yield, although the ulcers lie on the jejunal side of the anastomosis and may be missed by this evaluation. These ulcers usually respond well to therapy with proton pump blockers, although patients occasionally have recurrent problems, and chronic suppressive therapy or surgery (in rare instances) may be required.

Although SLD is the primary reason for revisional surgery due to poor weight loss, we have many patients with known small staple-line breakdowns who still have appropriate early satiety and good weight loss. The decision to revise a gastric bypass because of dehiscence should be made only after careful history rules out other reasons for poor weight loss, such as dietary indiscretion.

Our incidence of incisional hernia has remained fairly constant over the years at 20% to 25%; many are asymptomatic and discovered years after surgery by either the patient or physician. Other groups have reported similarly high rates of incisional hernia,[16] undoubtedly due in large part to the very high intra-abdominal pressures in the morbidly obese. A significant wound infection will significantly increase the probability of a future hernia. These tend to be large defects that often require use of prosthetic patch or mesh to try to minimize the high risk of recurrence. When these are discovered during the first 2 years after surgery, we recommend delaying repair until weight loss has reached a plateau and remained stable for several months to minimize nutritional effects on wound healing. Reduction in these hernias may be one of the most important advantages of the laparoscopic technique.

Although adhesive small bowel obstruction may occur after any intra-abdominal surgery, the Roux-en-Y reconstruction with the gastric bypass creates 2 specific potential defects creating the possibility for the formation of a particularly dangerous internal hernia, with herniation of a loop of small bowel either between the alimentary jejunal limb and the transverse mesocolon or through the mesenteric defect at the enteroenterostomy. This predisposes to volvulus or a simple closed-loop obstruction with occlusion of mesenteric blood supply and ischemic necrosis. The obstruction may be difficult to diagnose by plain
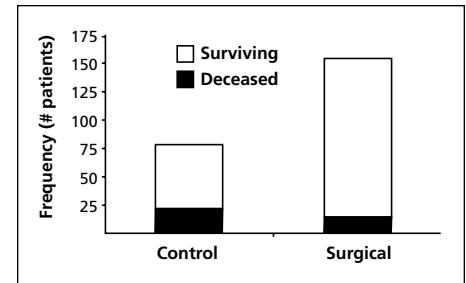

Figure 2. Mortality in control obese diabetics was 28% (22 of 78 patients) compared to 9% (14 of 154 patients) in the gastric bypass group (P<0.0003).

abdominal films, as proximal bowel is often involved and significant bowel distention may not be present. Loss of bowel due to necrosis may lead to short gut syndrome or a difficult reconstruction with potentially high morbidity. Although this complication is relatively uncommon, the potential severe consequences should raise the level of suspicion for any patient who presents with severe periumbilical pain after gastric bypass, prompting additional evaluation or surgical exploration without excessive delay.

Late development of bile reflux is occasionally seen after Roux gastric bypass, manifested by pyrosis, nocturnal bilious reflux with choking or coughing, or nausea and vomiting, either alone or in combination. The diagnosis is primarily supported by the patient history. Diagnostic studies, including barium swallow, endoscopy, and 24-hour pH monitoring, rarely provide specific information of value, although they should be performed to rule out other problems. The incidence seems higher with the shorter alimentary limbs, and the onset is typically many years after the gastric bypass. Treatment with prokinetic agents and bile acid binders often has little effect on the symptoms. Elevation of the head of the bed, and other dietary and lifestyle changes are recommended, though efficacy is variable. If the symptoms are persistent and sufficiently severe, reconstruction of the enteroenterostomy to a distance at least 60 to 70 cm distal to the gastrojejunostomy generally provides relief.
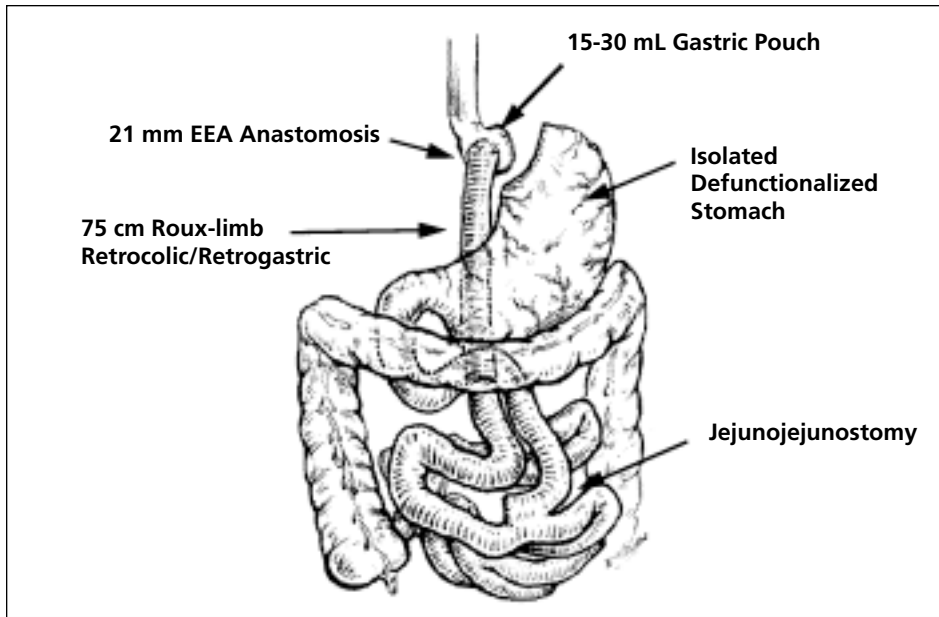
Figure 3.   Laparoscopic Roux gastric bypass.

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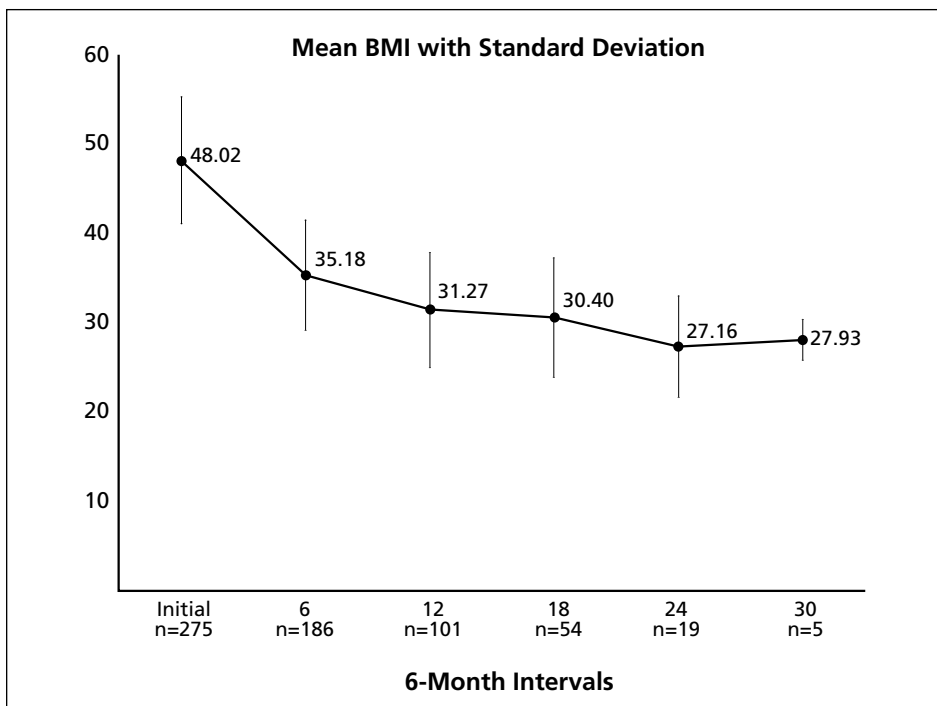

Figure 4.   Reduction in BMI after laparoscopic gastric bypass.

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Results of gastric bypass

Weight loss

Maximum weight loss after gastric bypass generally reaches 70% to 75% of excess body weight lost 2 years after surgery. There is then a tendency to regain some weight, with the mean excess weight loss remaining stable at 50% to 55% from 5 years to as long as 16 years after surgery.[17] (See Figure 1, page 3.) These 16-year data represent a follow-up of 95% (140) of a total of 147 patients who received a gastric bypass between 1980 and 1982 at East Carolina University. Nine percent of this group received a revision operation during the 16-year period. The partitioning staple line in this group was performed with the 4-row stapler, which had an SLD rate of at least 18.7%. It remains to be shown with longer follow-up whether the decreased rate of SLD with the triple-staple technique will lower the amount of late weight regain, as well as the number of revision operations.

Improvement in comorbidities

Sleep apnea resolves completely in essentially all patients after gastric bypass, often with loss of as little as 50 pounds. In our series, the incidence of hypertension was reduced from 59% of the group before surgery to 21% at 5 years and 29% at 16 years after surgery. The incidence of diabetes fell from 26% of the preoperative group to 4% at 5 years and 7% at 16 years. Significant musculoskeletal complaints fell from 29% of preoperative patients to 4% at 5 years. By 16 years after surgery, however, the incidence increased to 15%, likely related to the normal aging process.

Diabetes and mortality

A retrospective comparison between a matched group of obese diabetic controls who did not have surgery (for nonmedical reasons) and a group of obese diabetics who had undergone a gastric bypass at East Carolina University revealed that the incidence of death in the control group was 4.5 times that of the surgical patients.[18] (See Figure 2, page 5.) Twenty-eight percent of the control group died during the 6.2 years of follow-up, while only 9% of the surgical group died during a longer follow-up period of 9 years, including the perioperative deaths. The largest reduction was in cardiovascular mortality, which represented 54.5% of the control deaths versus only 14.3% of the deaths in the surgical group. (See Table 3, page 7.)

We believe this represents the best data yet published to show that surgery reduces long-term mortality in morbidly obese patients. Further studies are required to show similar results with other comorbidities, such as sleep apnea.

LAPAROSCOPIC GASTRIC BYPASS

PHILIP R. SCHAUER, MD

A laparoscopic approach to the Roux-en-Y gastric bypass (RYGBP) was first described by Wittgrove and Clark.[19] Our approach is depicted in

Figure 3, page 6. A 15-cc gastric pouch is created and isolated from the distal stomach by several applications of an endo-GIA stapler using 3.5-mm staples. After division of the jejunum 30 to 40 cm from the ligament of Treitz, the distal limb is passed retrocolic and retrogastric up to the pouch. The gastrojejunostomy is created with a 21-mm stapled circular anastomosis, or alternatively, with a linear stapler for the posterior wall, and is then completed with a running suture anteriorly. Both anastomoses are reinforced with an outer layer of running or interrupted suture and tested with air insufflation and direct visualization with passage of an endoscope.

The jejunojejunostomy is constructed with standard laparoscopic techniques 75 cm distal to the gastrojejunostomy in standard patients and 150 cm in the superobese (BMI >50). The mesocolic and mesenteric defects are closed as completely as possible. Two drains are left in the area of the gastrojejunostomy.

Results

Our initial experience involved 275 patients who underwent laparoscopic RYGBP between July 1997 and March 2000.[20] The conversion rate to open gastric bypass was 1%. Oral intake of fluids began a mean of 1.58 days after surgery. Mean hospital stay was 2 days, with return to work at 21 days. The incidence of early major and minor complications was 3.3% and 27%, respectively. One death occurred secondary to a pulmonary embolus (0.4%). The hernia rate was 0.7%, and wound infections requiring outpatient drainage only were uncommon (5%). Excess weight loss was 83% at 24 months and 77% at 30 months, and the mean BMI changed from 48 kg/m^2 to 27 kg/m^2. (See Figure 4, page 6.)

In patients with more than 1 year of follow-up, most comorbidities were relieved or resolved (Table 4, page 8), and 95% reported significant improvement in quality of life.

Conclusions

The early results of laparoscopic RYGBP compare favorably with most series of open RYGBP procedures. Our experience, which now exceeds 600 patients, suggests the laparoscopic gastric bypass is effective in achieving weight loss and in relieving comorbidities and improving quality of life while reducing recovery

time and perioperative complications. This approach appears to significantly reduce wound-related complications, which may be its greatest advantage over open gastric bypass. As cardiopulmonary complications are less common than wound infections, comparison of results from larger series will be necessary to detect differences from open RYGBP.

The laparoscopic approach, however, is not without developmental challenges. The learning curve is very steep, and long operating times are required. The incidence of intestinal leakage, particularly at the gastrojejunal anastomosis, may be higher after the laparoscopic approach than after open RYGBP. Measures to reduce staple-line leaks, such as minimizing tension at the pouch–jejunum junction, careful endoscopic examination of the anastomosis, and oversewing where necessary, should be routine. The laparoscopic approach is technically more difficult in the superobese, especially those with a preponderance of abdominal adipose tissue. Our current limit is a BMI of 75, primarily because of inadequate instrument length. Finally, the laparoscopic approach may be exceedingly difficult in patients with massively enlarged livers, owing to inadequate exposure of the esophagogastric junction.

For surgeons interested in performing laparoscopic RYGBP, preparation is critical. The surgeon must first be familiar with management of the bariatric patient, including appropriate indications for surgery, preoperative evaluation, perioperative management, and long-term follow-up care. Advanced laparoscopic skills must be mastered, and experience with advanced laparoscopic foregut surgery is essential. Animal laboratory experience and proctoring by an experienced surgeon are highly recommended. Both fundamentals of bariatric surgery and advanced laparoscopic surgery should be mastered before performance of laparoscopic RYGBP.

LONG LIMB GASTRIC BYPASS

Robert E. Brolin, MD

In 1992, our group reported the first prospective comparison of Roux limb length in a series of bariatric surgical patients.[21] In that study, superobese patients (>200 pounds over ideal weight) who had a Roux limb length of

Table 3. Causes of Death in Control and Surgical Groups

Cause of death	Number
Control group	
Cardiovascular	12
Pulmonary embolism	1
Cancer	2
Sepsis	2
Acute respiratory distress	1
End-stage renal disease	1
Trauma	1
Suicide	1
Unknown	1
Total deaths	22
Surgical group	
Perioperative	4
Pumonary embolism (subsequent revision)	1
Nongastric bypass-related sepsis	1
Anemia	1
Asphxia	1
Cardiovascular	2
Malnutrition	1
Auto accident	2
Suicide	1
Total death	14

Cardiovascular mortality was reduced from 54.5% in the controls to 14.3% in the surgical group.

150 cm lost significantly more weight than patients with Roux limbs measuring 75 cm. There was no difference in the incidence of metabolic or other complications between the 2 groups. Other investigators, using longer Roux limbs (150 to 200 cm), have replicated these results in superobese patients.[22] The significant difference in weight loss between the 150-cm patients and patients with Roux limbs under 75 cm has persisted for more than 5 years in our patients. However, these differences in weight loss have not been demonstrated for less obese surgical patients (BMI of <50 kg/m^2 or under 200 pounds above ideal weight) using longer Roux limbs.

Several surgeons, including those in our group, have studied modifications of Roux gastric bypass using considerably longer Roux limb lengths, which pro-

Table 4. Reduction in Comorbidity After Laparoscopic Gastric Bypass

Comorbidity	Total	% Aggravated	% Unchanged	% Improved	% Resolved
OA/DJD	64	2	10	47	41
Hypercholesterolemia	62	0	4	33	63
GERD	58	0	4	24	72
HTN	57	0	12	18	70
Sleep apnea	44	2	5	19	74
Hypertriglyceridemia	43	0	14	29	57
Depression	36	8	37	47	8
Peripheral edema	31	0	4	55	41
Urinary incontinence	18	0	11	39	44
Asthma	18	6	12	69	13
Diabetes	18	0	0	18	82
Migraine headaches	7	0	14	29	57
Anxiety	7	0	50	17	33
Venous insufficiency	7	0	71	29	0
Gout	7	0	14	14	72
CAD	6	0	0	75	26
COPD	3	0	33	67	0
CHF	3	0	33	67	0
OHS	2	0	0	50	50

CAD, coronary heart disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; GERD, gastroesophogeal reflux disorder; HTN, hypertension; OA/DJD, osteoarthritis/degenerative joint disease; OHS, obesity hypoventilation syndrome.

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duced overt manifestations of malabsorption in many patients. Typically, these malabsorptive gastric bypasses incorporate fixed measurements for a "common channel" below the enteroenterostomy (usually in the range of 75 to 150 cm), with varying lengths used for the Roux limb.[23]

These "very, very long" Roux limbs appear to produce better weight loss than the 150-cm limbs in superobese patients, but at a perceptible metabolic price, including fat-soluble vitamin deficiencies and rare cases of protein-calorie malnutrition.

In summary, there are now solid data showing that Roux limb measurements greater than or equal to 150 cm produce significantly better weight loss in superobese patients than Roux limbs measuring 75 cm or less.

BILIOPANCREATIC DIVERSION

Nicola Scopinaro, MD

Biliopancreatic diversion (BPD) consists of a distal gastrectomy (which can be substituted by the bypass of the distal stomach at the price of a high-

er stomal ulcer incidence and the development of precancerous changes) with a long Roux-en-Y reconstruction in which the enteroenterostomy is placed 50 cm (measured fully stretched) proximal to the ileocecal valve, and the gastroenteric anastomosis at 250 cm.[24] (See Figure 5, page 9.)

The essential mechanism for weight loss and maintenance is based on limitation of intestinal absorption due to the virtual annulment of pancreatic digestion. Actually, the fate of pancreatic enzymes is to be digested and absorbed in the small bowel, and this can be easily accomplished in the approximately 5-m biliopancreatic limb. Consequently, fat absorption, conditioned by the presence of bile salts, is confined to the common limb, while protein and starch, digested by the intestinal brush-border enzymes, are absorbed in the entire intestinal segment between the gastroenterostomy and the ileocecal valve. Mono- and disaccharides, short-chain triglycerides, and alcohol, all of which do not require digestion, continue to be entirely absorbed after BPD. Our studies on intestinal absorption showed that, after completion of the intestinal adaptive phenomena, the

digestive-absorptive apparatus of BPD has a constant maximum transport capacity for fat and starch, and thus energy (excluding protein and simple sugar), which corresponds on the average to about 1,250 kcal per day. This results in a lifelong threshold energy absorption that explains the lifelong weight maintenance following the procedure. An additional mechanism that lowers the weight of stabilization is the increased resting energy expenditure due to the adaptive hypertrophy of the entire highly consuming small bowel.

The initial weight loss after BPD is due to a temporary mechanism based on the reduced volume of the stomach, which then rapidly empties into an ileal limb. This causes reduction of appetite and the occurrence of postcibal syndrome, resulting in a food limitation that actually allows the early post-BPD subject to eat less than what he or she can absorb. This phenomenon is that the more intense and lasting, the smaller the gastric remnants—exceptionally, they may be permanent and require restoration—and this is used in the present type of BPD to adapt the operation to the patient's individual characteristics. As a rule, the

patient fully recovers appetite and eating capacity before the stabilization weight is attained. Hence, final weight loss depends on the reduced energy intestinal absorption. The weight of stabilization is also greatly influenced by the gastric volume, most likely because a more rapid gastric emptying accelerates intestinal transit, thereby reducing absorption.

BPD is a flexible procedure. The full understanding of the above-noted mechanisms, together with a good knowledge of the physiology of the gastrointestinal tract, allows any surgeon, by varying the volume of the gastric remnant and the length of the alimentary limbs, to adapt the operation to the characteristics of the patient population, thus ideally duplicating our weight loss results and complication rate.

Of the total series of 2,316 patients undergoing surgery since May 1976, 1,384 (453 men and 931 women) underwent the present "ad hoc stomach" (AHS) type of BPD, performed by the same surgical team. Mean age was 37 years (11-70), mean weight 128 kg (73-236), and mean excess weight 69 kg (20-156), corresponding to 117% (41%-311%) and to a mean BMI of 47 kg/m² (29-87). Maximum follow-up was 15 years. The availability for follow-up evaluation was essentially total.

Weight reduction after AHS BPD in patients not requiring revision, when expressed as percent loss of the initial excess weight (EBWL), was 73 ± 16 at 2 years (1,344 cases), 74 ± 16 at 4 years (1,277 cases), 75 ± 15 at 6 years (1,135 cases), 75 ± 15 at 8 years (836 cases), 76 ± 15 at 10 years (417 cases), 77 ± 16 at 12 years (141 cases), and 78 ± 17 at 14 years (64 cases), with no differences between "morbidly obese" and "super-obese" (EBWL >120%).

The excellent weight maintenance that occurs after BPD is exemplified by a group of 40 subjects who underwent the original "half-half" (HH) type of operation, which differs from the present AHS type only in that the stomach is bigger and the alimentary limb is longer. Therefore, the weight reduction was smaller (EBWL around 70%), but the weight attained was strictly maintained up to the 20th year of follow-up. It is noteworthy that these data are the only 20-year results ever reported in obesity therapy.

The other benefits obtained after BPD are what is to be expected after any great and permanent weight loss, no matter how obtained—the only 2 exceptions being the effects on glucose and cholesterol metabolism.

In fact, out of the 1,890 (total series) AHS BPD patients with a minimum follow-up of 1 year, not only the 271 (14%) with preoperative simple hyperglycemia, nor only the 117 (6.2%) with type II diabetes mellitus manageable with oral hypoglycemics, but also the 33 (1.7%) patients with preoperative type II diabetes requiring insulin therapy, 1 year after BPD and permanently thereafter, had normal serum glucose levels without any medication and on totally free diet. This indicates a specific action of BPD on glucose metabolism, which could be identified with the virtual annulment of the enteroinsular axis. Indeed, serum GIP concentration shows after BPD a substantially flat curve in response to the test meal, along with normalization of basal and meal-stimulated serum insulin levels.

Another specific action of BPD accounts for the permanent serum cholesterol normalization in 100% of the patients operated on, and it is the calibrated interruption of the enterohepatic bile salt circulation that causes an enhanced synthesis of bile acids at the expense of the cholesterol pool. With the NIH criterion of 200 mg/dL as the recommended upper limit for serum cholesterol, out of the total of 2,312 (total series) obese patients submitted to BPD with a minimum follow-up of 1 month, 1,260 had hypercholesterolemia (516 had values higher than 240 mg/dL, and 87 higher than 300 mg/dL). All of these patients had serum cholesterol values below 200 mg/dL 1 month after operation, and the values remained below that level at all subsequent examinations.

BPD may be effectively used for the treatment of severe type II diabetes mellitus and familial hyperlipidemia also in lean subjects.

Side effects

After full resumption of food intake, BPD subjects generally have 2 to 4 daily bowel movements of soft stools. All have foul-smelling stools, and most have flatulence. These phenomena, which can be reduced by modifying eating habits or by neomycin or metronidazole administration, tend to decrease with time along with a reduction of bowel movement frequency and an increase of stool con-
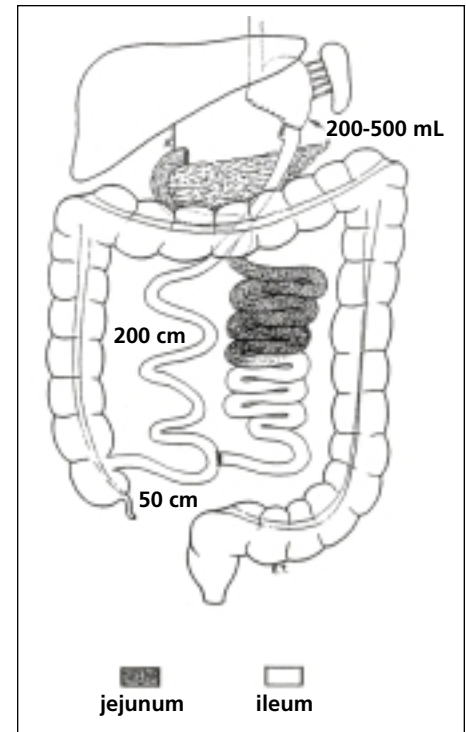

Figure 5. Biliopancreatic diversion.

Image courtesy of Dr. Nicola Scopinaro.

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sistency. Diarrhea usually appears only in the context of postcibal syndrome, and then it rapidly disappears, being practically absent by the 4th month.

Specific late complications

Anemia, essentially due to reduced iron absorption, appears only in BPD patients with chronic bleeding (mainly menstruating females), and its incidence can be reduced to less than 5% with the appropriate supplementations.

The incidence of stomal ulcer, substantially confined to the first postoperative year, is strongly influenced by alcohol and cigarette consumption. Ulcers respond well to medical treatment and have little tendency to recur, provided the patient refrains from smoking. Oral prophylaxis with H_2 blockers during the entire first postoperative year has reduced the incidence of stomal ulcer in our series to around 3%.

Bone demineralization is already present in about one third of the obese patients. Its prevalence increases until the 4th year, when the adverse effect of reduced calcium absorption prevails over the beneficial one of weight loss, and decreases thereafter, being significantly smaller than preoperatively at 6 to
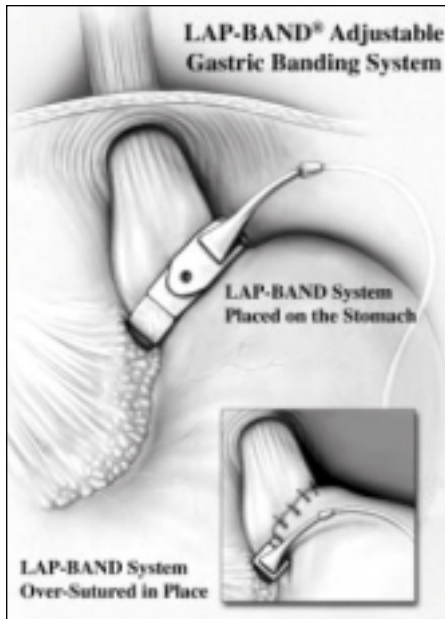
Figure 6. Laparoscopic adjustable gastric banding.

Photo courtesy of Bioenterics Corporation.

10 years in the subjects with the most severe preoperative alterations (ie, the older and the heavier patients). All of our patients are encouraged to maintain an oral calcium intake of 2 g per day (with tablet supplementation, if needed), and the patients from northern Italy to receive a monthly intramuscular vitamin D supplementation of 4 million IU.

Peripheral neuropathy and Wernicke encephalopathy—early complications caused by excessive food limitation—have now completely disappeared because of prompt administration of large doses of thiamine to patients at risk.

Protein malnutrition, characterized by hypoalbuminemia, anemia, edema, asthenia, and alopecia, represents the most serious late specific complication of BPD, and its correction generally requires 2 to 3 weeks of parenteral feeding. The pathogenesis of protein malnutrition after BPD is multifactorial, depending on some operation-related variables (gastric volume, intestinal limb lengths, individual capacity of intestinal absorption and adaptation, amount of endogenous nitrogen loss) and some patient-related variables (customary eating habits, ability to adapt them to the requirements, socioeconomic status). In most cases, protein malnutrition is limited to a single episode that occurs during the first or the second year, the patient-related factors being preeminent. Delayed appearance of sporadic protein malnutrition occurs increasingly less frequently as time

passes. The operation-related factors are of greater importance in the recurrent form of protein malnutrition, usually caused by excessive malabsorption and requiring elongation of the common limb; rarely, it is due to excessive duration of the food limitation mechanism (permanent decrease of appetite and occurrence of the post-cibal syndrome), which may require restoration of intestinal continuity.

Adapting the gastric volume (200 to 500 mL) and the length of the alimentary limb (200 to 300 cm) to the patient's characteristics resulted in a protein malnutrition incidence of 2.7%, with 1% recurrence in the last consecutive 293 operated patients with a minimum follow-up of 2 years, with a still excellent mean EBWL reduction of 71%.

LAPAROSCOPIC ADJUSTABLE GASTRIC BANDING

PROFESSOR PAUL O'BRIEN

The Lap-Band® (Bioenterics) was introduced into Australia in July 1994, and since that time more than 5,000 have been placed. The current rate of placement is in excess of 1,500 per year. National outcomes data for the Lap-Band are not available thus far. Our group has maintained a detailed prospective database so that, as far as possible, all the benefits and adverse outcomes of the Lap-Band placement have been documented and a record of progress for each patient and for all patients as a group is maintained and available.

This report reviews our experience with the first 700 patients.

Technique

A retrogastric tunnel is dissected, beginning a short distance below the gastroesophageal junction on the lesser curvature side of the stomach and ending at the angle of His. (See Figure 6.) The band is then passed through this tunnel until in position around the cardia of the stomach, approximately 1 cm below the esophagogastric junction. The attached silicon tubing is passed through the buckle of the band until it locks. The anterior wall of the stomach below the band is then secured to the anterior wall of the pouch above the band with interrupted sutures.

Unless the path of dissection behind the stomach is above the apex of the lesser sac, it is important to also secure the

posterior wall of the stomach to prevent posterior gastric slippage or prolapse through the band. We achieve this by attaching a bolster of rolled polypropylene mesh to the posterior fundus 2 cm below the band. The silicon tubing is brought out through the left-sided 15-mm trochar, where it is secured to the access port. The port is then secured to the surface of the anterior rectus sheath. A relatively superficial placement of a reservoir permits adjustments of the saline volume of the band to be performed readily in the office without need for radiologic localization.

Outcomes

The Lap-Band was placed laparoscopically in 700 patients. Seven additional patients were converted to open placement, most commonly because of massive hepatomegaly. Preoperative weight was 277±57 pounds, with a maximum of 534 pounds. Mean BMI was 45±7 kg/m², with a maximum of 77. Only 10 patients (1.4%) were considered lost to follow-up.

There were no deaths or serious complications. There were 10 significant perioperative adverse events (1.4%), including 7 infections at the access port site, 1 deep venous thrombosis, 1 episode of hepatotoxicity, and 1 delayed discharge due to failure of emptying.

Late adverse events leading to reoperation occurred with prolapse (slippage) in 15.1%, erosions of the band into the stomach in 3.2%, and tubing problems in 4.7%.

Ninety-two percent of the reoperations consisted of revision and/or replacement of the Lap-Band. Explantation of the device occurred in 12 patients (1.7%). There have been no revisions to other bariatric procedures. The frequency of reoperation for late adverse events has decreased progressively through the period of study, and only 4% of the last 300 patients have thus far required revisional procedures.

Weight loss

Patients lost weight subtly but progressively. There was a loss of 46% of excess weight at 12 months and 51% of excess at 2 years. This percentage of excess weight loss was maintained out to 6 years of follow-up. Median BMI decreased from 45±7 to 31±3 kg/m² at 6 years.

Improvement in comorbidity

Comorbid conditions showed drastic

resolution. Complete resolution or marked improvement occurred in 97% of diabetics, 86% of hypertensives, all asthmatics, 74% of patients with dyslipidemia, 89% of patients with reflux esophagitis, and 94% of patients with sleep apnea. Depression, as measured by the Beck Depression Index, returned to normal range. Quality of life, as measured by the Rand SF-36, showed major improvement in the 8 subscales, each of which returned to or exceeded normal values.

Conclusions

The problem of obesity and its comorbidities can be controlled safely and effectively by the Lap-Band procedure. The rates of revisional surgery are decreasing. The adjustability of the degree of restriction permits gentle, steady weight loss to more than 50% excess weight loss, followed by weight stability over several years. This process is associated with major improvements in health and quality of life. The obese population has sought the procedure as an acceptable surgical approach to the control of their disease.

VERTICAL BANDED GASTROPLASTY

CORNELIUS DOHERTY, MD

In vertical banded gastroplasty (VBG), a transgastric window is made with a circular stapler near the lesser curvature. This facilitates measurement of the pouch volume (<20 cc) and provides easy access for the stapling device used to construct the vertical partition. A collar of polypropylene mesh 7.0 by 1.5 cm is sewn to itself to provide a 5.0-cm circumference collar to prevent dilatation of the outlet channel. Longitudinal analysis of operative experience at the University of Iowa, Iowa City, has revealed operative criteria that yield safe and effective results.[25] There have been reports of unfavorable experience with VBG when strict adherence to these technical criteria was not observed.[26-28] The recent technical change to division of the stapled partition with the 6-row endolinear cutting stapler has solved the problem of dehiscence without increasing the risk of peritonitis.

Late Postoperative Complications: Staple-Line Dehiscence

The reported incidence of staple-line dehiscence after VBG varies from 4% to 48%.[26-28] This wide variance is explained by differences in technique at operation and incomplete investigative follow-up studies of postoperative patients. At the University of Iowa, at least 10% of patients have developed a dehiscence of a magnitude that negates effective restriction by the proximal gastric pouch.[29] There also are patients who develop small dehiscences, about one half of whom achieve 50% excess weight loss.

These small dehiscences rarely enlarge. Development of the 6-row endolinear cutting staplers has eliminated dehiscence of the vertical partition.

Nausea, Vomiting, and Reflux Esophagitis

Nausea, vomiting, and reflux esophagitis occurring after a VBG are infrequent complaints. The most common causes of these symptoms are failing to fully chew foods to a mushy consistency before swallowing and eating beyond proximal pouch capacity. Additional causes that are secondary to partial outlet channel obstruction include stenosis of the outlet, acute viral gastritis, caustic irritation from medications that have not been completely crushed, the presence of a foreign body, the use of aspirin or other anti-inflammatory agents that cause gastric mucosal ulcerations, and pregnancy. There are 1% to 2% of patients who simply are intolerant of VBG who benefit from operative reversal.

There is a subset of patients who tend to eat beyond their pouch capacity and then may induce vomiting for relief. Over time, this relative binge eating results in a large proximal pouch, which is a chronic adaptive response to the unyielding narrow stoma.[30] Food tends to settle in the bottom of the large pouch and distort the outlet channel, causing a partial obstruction. These changes have been described by Mason as the enigmatic large pouch syndrome, characterized by vomiting, reflux esophagitis, and weight gain.[31] Patients with this syndrome frequently adopt maladaptive eating patterns, ingesting soft and liquid high-calorie foods. These changes may develop slowly and not become symptomatic until 10 to 15 years after VBG. Reversal of the VBG or conversion to a divided Roux-en-Y gastric bypass will correct the large pouch syndrome.

Results

VBG results in a sustained loss of 25% excess weight at 5 years after operation in 80% of patients, a loss that is sufficient to relieve comorbidities.[32]

An excess weight loss of 50% is maintained by 50% of patients at 5 years and by 40% of patients at 10 years after surgery.[29]

Discussion

VBG avoids the complications of obstruction of blind segments of the digestive tract, ulceration, dumping syndrome, calcium deficiency bone disease, and protein malnutrition that may be associated with other surgical treatments for morbid obesity. It preserves a normal anatomy for digestion and absorption as well as access for radiographic and endoscopic procedures. It requires a minimum of monitoring for vitamin and mineral supplementation.

VBG, however, is used less and less by bariatric surgeons for the following reasons: 1) poor patient compliance with eating behavior modifications; 2) dehiscence of the vertical stapled partition; 3) accumulating data that VBG is not as effective as the gastric bypass procedure for control of type II diabetes mellitus[33]; 4) requirement for implantation of a foreign body (ie, polypropylene mesh or Silastic ring); and 5) less sustained weight loss over time than with Roux-en-Y gastric bypass.[26,29,34]

The major contributions of VBG have been the confirmation of the importance of a small proximal vertical pouch and stimulation of the changes in the configuration of the gastric bypass procedure to a vertical Roux-en-Y with a divided pouch.

CONCLUSION

KENNETH G. MACDONALD, JR, MD

Because of the well-documented long-term weight loss and reduction in comorbidity with acceptable complications and minimal nutritional problems, gastric bypass has become the most common bariatric procedure performed in the US and may be considered the "gold standard" to which other procedures should be compared. The laparoscopic approach, described by Dr. Schauer in this review, has been shown to be comparable to the standard open technique, with similar weight loss and complications. Advantages include

increased patient acceptance and acceptance by the referring physician, reduced wound complications and incisional hernias, and shorter hospitalization and recovery times. Of significance, the reduced intra-abdominal adhesions will undoubtedly be beneficial if future operations in the upper abdomen are required. Problems associated with the laparoscopic procedure are its technical difficulty and current limitations with the superobese and with reoperations, which will gradually improve with increased experience.

As discussed by Dr. Brolin, increasing the length of the alimentary (Roux) limb to 150 cm has been documented to improve weight loss in the superobese without increasing metabolic or nutritional complications. "Very, very long" alimentary limbs further increase weight loss, but at the expense of increased nutritional sequelae.

Dr. Scopinaro's extensive experience and study of the BPD clearly document excellent and sustained weight loss out to 20 years of follow-up. There are increased nutritional considerations, which mandate meticulous patient compliance and follow-up. Appropriate diet and nutritional supplementation are essential. Reports of hepatic failure[35,36] and other nutrition-related problems after BPD remind us that this is a complex operation.

Dr. O'Brien reported on one of the largest and best-documented experiences with the laparoscopic adjustable gastric band. Advantages with this procedure include ease of laparoscopic placement with minimal perioperative complications. There are no staple lines, anastomoses, or division of bowel or stomach, enabling complete reversal if desired and facilitating revisional surgery if required. The ability to adjust volume of the band gives control over the degree of restriction. Problems include gastric slippage, gastroesophageal reflux, and possible late problems with esophageal motility in predisposed individuals. Results from the ongoing FDA trial of the Lap-Band in the United States have shown significantly higher rates of gastric slippage, reoperation, and band explantation than reported by Dr. O'Brien and other European investigators. Weight loss in the US is also smaller at approximately 36% to 39% maximum excess weight lost. At least one possible explanation for these differences is the fact that few, if any, of the US investigators gained sufficient experience during the trial to pass the learning curve.

There is little doubt, however, that weight loss and degree of reduction in many comorbidities will remain considerably less with the adjustable Lap-Band than with Roux gastric bypass.

Finally, Dr. Doherty explained the gradual decline in popularity of the vertical banded gastroplasty, largely because of poor long-term weight loss in addition to late problems secondary to the unyielding reinforced outlet, which fails to allow any adaptation and predisposes to maladaptive eating behavior. Still, this has been the most durable of the purely restrictive operations and has played an important role in the evolution of modern bariatric surgery. ◆

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