SURGICAL TREATMENT OF OBESITY: A REVIEW

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Obesity is a chronic disease due to excess fat storage, a genetic predisposition, and strong environmental contributions. This problem is worldwide, and the incidence is increasing daily. There are medical, physical, social, economic, and psychological comorbid conditions associated with obesity. There is no cure for obesity except possibly prevention. Nonsurgical treatment has been inadequate in providing sustained weight loss. Currently, surgery offers the only viable treatment option with long-term weight loss and maintenance for the morbidly obese. Surgeries for weight loss are called bariatric surgeries. There is no one operation that is effective for all patients. Gastric bypass operations are the most common operations currently used. Because there are inherent complications from surgeries, bariatric surgeries should be performed in a multidisciplinary setting. The laparoscopic approach is being used by some surgeons in performing the various operations. The success rate—usually defined as >50% excess weight loss that is maintained for at least five years from bariatric surgery—ranges from 40% in the simple to >70% in the complex operations. The weight loss from surgical treatment results in significant improvements and, in some cases, complete resolution of comorbid conditions associated with obesity. Patients undergoing surgery for obesity need lifelong nutritional supplements and medical monitoring. (*J Natl Med Assoc.* 2004;96:61–70.)

Key words: morbid obesity ♦ comorbid conditions ♦ BMI ♦ bariatric surgery ♦ gastric bypass

INTRODUCTION

Obesity is a chronic disease of excess body fat[1]. Body mass index (BMI)[2] currently is the most commonly used measure of obesity. BMI categorizes weight as it relates to the height. The normal BMI ranges from 18–24.9 Kg/m^2. Persons with BMI of 25–29.9 Kg/m^2 are considered overweight. Obesity is characterized by a BMI >30 Kg/m^2. Severe or morbid obesity is characterized by a BMI of ≥40 Kg/m^2 or a BMI ≥35 Kg/m^2 with comorbidities. Super obesity is defined as a BMI ≥50 Kg/m^2. It has also been observed that the fat distribution in any particular individual is an important determinant as to the expression of comorbid conditions[2].

Obesity is a disease affecting an estimated 250 million people worldwide[3-6]. Over 30% of Americans are obese, and the incidence of obesity in American youths is increasing. The incidence of obesity in the African-American community is much higher than in the Caucasian community[6]. Of the obese Americans, about 15 million (5.5%) are morbidly obese. Among African-American women aged 40–60, the rate of those with a BMI over 40 Kg/m^2 is as high as 10%.

Obesity, particularly morbid obesity, is a multifactorial disease. It develops from an integration of genetic, environmental, social, behavioral, psychological, metabolic, neuroendocrine, and psychological factors. The exact etiology is unknown.

Obesity is a chronic condition that is currently considered a disease because of its medical, physical, social, economic, and psychological comorbid

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conditions. Obesity results in over 300,000 deaths per year, ranking it as the second leading cause of preventable deaths, second only to smoking. Comorbid conditions attributable to obesity include type-2 diabetes; coronary heart disease; hypertension; dyslipidemia; lymph edema thrombophlebitis, deep venous thrombosis (DVT); pulmonary emboli (PE); weight-bearing osteoarthritis of the hips, knees, ankles and feet; low back syndrome; herniated disks; lower-extremity edema; gallbladder disease; gastroesophageal reflux disease (GERD); asthma; Pickwickian syndrome; sleep apnea; pseudotumor cerebri; cirrhosis; hepatocellular carcinoma; carcinoma of the breast and uterus; carcinoma of the prostrate; varicosities; and intertriginous dermatitis. Obesity results in physical limitations, such as walking, climbing, crossing one's legs, tying one's shoes, and performing the daily acts of living. Social consequences include clothing limitations, sexual limitations, and limits to various accesses. Economic consequences of obesity include denial of employment, restriction of career advancement and higher educational opportunities, cost of futile weight-loss modalities, cost of special clothes, and uninsurability or high insurance premiums. The obesity problem is the last bastion of overt discrimination that is allowable in our society, thus wreaking emotional havoc to the afflicted with the psychological consequences of depression, withdrawal, guilt, self-hate, neurotic disorders, and suicidal tendencies.

Figure 1.

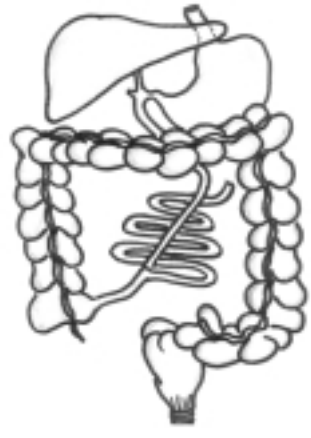


Figure 2.

For patients with obesity—particularly morbid obesity—diets, behavior modification, exercise, pharmacological intervention, or a combination of any or all have not been effective in causing sustained weight loss[7-10].

Currently, bariatric surgery provides the only viable option for sustained weight loss and maintenance in individuals with a BMI >35 Kg/m^2 with comorbidities and certainly for those with BMI >40 Kg/m^2. Bariatric surgery as a surgical discipline is about 50 years old. Surgeons at the department of surgery at the University of Minnesota reported the first bariatric operation, the jejuno-ileal bypass operation[11] (JIB). This operation was conceived from the observation that doctors had made from shortened gut from various causes. Patients with shortened gut lost weight and had problems gaining weight in spite of increased caloric intake. This operation was strictly a malabsorptive procedure. Similarly, in the late 1960s, a new operation, gastric bypass[12] (GBP), was born from observations by doctors that gastric operations on ulcer and cancer patients caused weight loss and maintenance, because of the decreased capacity of the stomach and the anorexic effect of the operations. This became the popular operation in the 1970s, replacing the JIB, which had severe side effects and lethal consequences. The 1980s saw the introduction of a modified malabsorptive operation mostly in Europe, the biliopancreatic bypass[13] (BPB), popularly called the biliopancreatic diversion (BPD) or the Scopinaro operation, that promised to maintain the benefits of the JIB and obviate or minimize its

ill effects. Also in the 1980s, the GBP took a back seat to the strictly restrictive operations—the gastroplasties[14,15] and banding operations[16-18]—which were less complicated and less invasive but promised similar weight loss as the GBP but without the dumping syndrome, and the iron, calcium, and vitamin deficiencies. This promise was short lived, and the 1990s saw the resurgence of GBP operations, though with various modifications, such as increased restriction with the banded gastric bypass[19,20] (BGBP)—popularly called the Fobi-Pouch Operation—or with an increased malabsorptive component with a shortened common limb—the distal Roux-en-Y gastric bypass[21-24] (DRYGBP). Also, the 1990s saw the advent of the modified BPD with the duodenal switch[25,26] and its progressive acceptance in the USA. All bariatric operations are currently done both open and via the laparoscope approach by surgeons.

The weight loss and maintenance from these operations result in complete resolution of some of the comorbid conditions—such as type-2 diabetes, partial resolution of others, and stabilization of some.[4] These results are dramatic and are achieved with minimal operative mortality, morbidity, and long-term complications. The improvement in the quality of life in individuals after these operations has resulted in the proliferation of bariatric operations—a dramatic increase in the number of cases performed yearly from about 30,000 a year in 2000 to possibly 90,000 cases in 2003. This dramatic increase in the number of bariatric operations makes it incumbent on all physicians and health providers to be aware of the various surgical operations for obesity, the outcome and the complications, and what to monitor in case they are faced with any of the patients after bariatric operations.

MALABSORPTIVE OPERATIONS

Jejunoileal Bypass (JIB)

The JIB is the first operation used for control of obesity. This operation has two modifications: one popularized by Payne[27] (Figure 1) with the end-to-side anastomosis, and another popularized by Scott[28] (Figure 2) with the end-to-end anastomosis. Proponents of the Payne modification claim less reflux of colon contents into the small bowel through the ileocolostomy that is used to drain the bypassed small bowel and, thus, less bacteria overgrowth in the bypassed limb. Proponents of the Scott modification claim better weight-loss maintenance due to no reflux of nutrients into the bypassed segment. There were many surgeons and scientists who contributed independently to the establishment of the JIB as an operation for control of obesity. Credit for the first JIB is shared separately and independently by Victor Henricksson of Gothenberg, Sweden, who performed intestinal resection to induce weight loss sometime before or around 1953; and Richard Varco of the University of Minnesota, who performed the first JIB in 1953 but never published it.[29] The first published case report in bariatric surgery was by Kremin, Linner,

Figure 3.

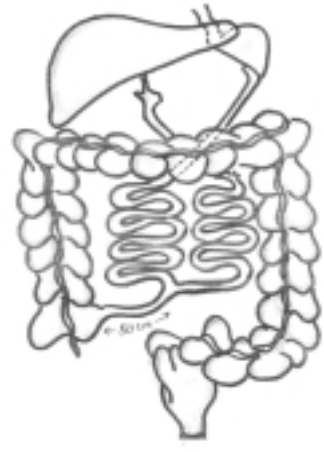
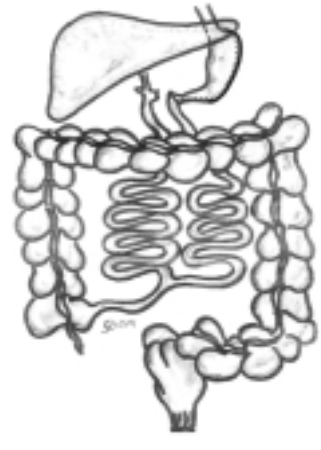


Figure 4.



and Nelson[11] in 1954, hence establishing the JIB operation for obesity. Others, including Sherman[30], Lewis and Turnbull[31], Salmon,[32] and Buchwald and Varco,[33] have contributed significantly to our knowledge on the JIB.

The principle behind the JIB in the control of obesity is decreased caloric absorption due to decreased exposure of ingested foods to the digestive juices in the bowel and the absorptive surface of the small bowel. The average small bowel is about 550-cm long. The JIB leaves only about 40 cm of small bowel exposed to the ingested food. This shortened length results in a rapid transit time of food from the stomach to the colon. This results in frequent liquid stools. The net effect is absorption of about one-third the caloric intake that would normally be absorbed with an intact small bowel. Patients with JIB also have decreased caloric intake either because of a physiological feedback or the deterrent effect of the frequent stools associated with increased food consumption. The combined decreased intake and malabsorption result in weight loss and maintenance.

Figure 5.

Figure 6.

The JIB results in loss of about one-third of the initial weight or 60% excess weight loss in about 80% of the patients[34]. The weight loss has been maintained in some patients for more than thirty years. There is gradual weight regain in about 20% of the patients due to intestinal adjustment, elongation of the bowel length, dilatation of the lumen of the small bowel, and the increased number of and height of the villi, thus, markedly increasing the digestive and absorption surface. The comorbid conditions, type 2 diabetes, sleep apnea, hyperlipidemia, headaches, venous stasis ulcers, GERD, degenerative arthritis in the weight-bearing joints, and many others are ameliorated by the weight loss after JIB. The patients report increased activity levels, increased self esteem, and an overall increase in their quality of life.[35,36]

Complications from the JIB are many and significant and have resulted in this operation being completely abandoned for the treatment of obesity.[37-41] However, there are still a few thousand patients out there who had the JIB and may present with complications. It is thus important to be conversant with the side effects of the JIB. These include frequent loose stools or diarrhea with the associated electrolyte imbalance of potassium, magnesium, and calcium. The frequent stools result in anal excoriation, hemorrhoids, and dehydration. Kidney stones and the associated nephropathy due to oxaluria secondary to disturbance of the enterohepatic circulation of calcium oxalates are also common. Cirrhosis, usually insipient in nature but a common cause of death due to hepatic failure, is the most lethal complication from the JIB. Patients with JIB must be monitored routinely with liver biopsy, because the liver function tests may be normal in the face of significant insipient cirrhosis. The insipient liver problems are due to bacterial overgrowth in the bypassed segment of the small bowel,[34] a syndrome called bypass enteritis. These bacteria produce toxins that are injurious to the liver. These toxins also result in neurological and dermatological problems and generalized myalgia. Bypass enteritis also contributes to the diarrhea seen in patients with the JIB.

The evidence from various reports is that one-third of the patients with JIB have no or mild side

effects and are living happily with their operation. These patients have to be under the care of physicians who are conversant with the operations, making sure the patients take the various supplements and correcting minor side effects before they become significant. Routine liver biopsy every two- to five years is prudent. Another one-third of the patients have moderate complications and are managed medically. Electrolyte imbalances, when they occur, are corrected during hospitalization. Patients are placed on nutrient supplements of calcium, iron, magnesium, and the necessary vitamins. The diarrhea is controlled with bowel rest and intravenous hydration. Medications, such as diphenoxylate atropine, paregoric acid, and loperamide hydrochloride, are used to control the diarrhea. Metronidazole or tetracycline antibiotics are used intermittently to control the overgrowth of bacteria in the bypassed segment, thus helping to control the diarrhea in addition to reducing the toxin production by the bacteria. Kidney stones and the nephropathies are treated accordingly. The other one-third have severe complications and either had the operation reversed, or taken down and replaced with another bariatric operation. It is generally recommended that patients currently with a JIB should have it taken down and replaced with another bariatric operation—preferably a gastric bypass.

Bilippancreatic Diversion (BPD)

The BPD is a modification of the JIB. This operation, first reported by Scopinaro[13] from Italy in 1979 as the biliopancreatic bypass, consists of a 200–250-cc horizontal gastric pouch, a distal gastrectomy and closure of the duodenal stump, a gastroenterostomy with a 250-cm Roux limb, and an anastomosis of the biliopancreatic limb to the Roux limb 50 cm proximal to the ileocecal junction (Figure 3). This operation has both limbs—with flow of food in the Roux limb, and bile and pancreatic juices in the biliopancreatic limb. This minimizes the bypass enteritis of the JIB and prevents the insipient hepatic failure due to the bypass enteritis. The incidence of nephropathy is markedly reduced in this operation, and the increased bowel length significantly reduces the incidence of diarrhea and its sequelae. Protein malnutrition, and calcium, iron, magnesium, and vitamin deficiencies have to be closely monitored in patients with this operation. The need of close monitoring, the frequent voluminous and malodorous stools, and the malodorous flatus and body odor have limited the use of this operation in the USA. Mostly done outside the USA, this operation is very popular in Italy. It does result in about 70% long-term excess weight loss in more than 90% of the patients as reported in the Italian series[42]. As with all other bariatric operations, this operation is being presently performed both open and laparoscopically.[43,44]

Biliopancreatic Diversion With a Duodenal Switch (BPDDS)—In Short, the Duodenal Switch (DS)

This operation was first presented by Hess[25] in 1988 at the Fobi Annual Symposium for Obesity Surgery in Los Angeles. Hess was motivated by the work of DeMeester[45]. The operation was a pylorus-preserving procedure that avoided the dumping syndrome characteristic in other gastroenterostomy

Figure 7.

Figure 8.

operations and decreased the occurrence of marginal ulcers. The BPD-DS has since been popularized by Marceau et al.[46,47] (from Canada), who used to do the BPD but switched to the BPD-DS in 1993. The operation consists of a sleeve gastrectomy, or creation of a gastric tube, preserving the pylorus, dividing the duodenum just beyond the pylorus, a duodenojejunostomy with a 250-cm Roux limb and a long duodenobiliopancreatic limb that is anastomosed to the Roux limb 50 cm from the ileocecal junction just as in the BPD (Figure 4). Open and laparoscopic BPD-DS operations are being performed more frequently both in and out of the USA[46-49]. The outcome from this operation is as in the BPD except there has not been any report of marginal ulcers and dumping syndrome, as reported with the BPD. These patients have to be monitored for calcium, iron, magnesium, vitamins, and protein deficiency. However, this operation is characterized by the same frequent voluminous and malodorous stools, flatus, and body odor; and bloating syndrome. Seventy percent excess weight loss and maintenance in greater than 80% of the patients have been reported with the DS. As with all other bariatric operations, the BPD-DS is also being performed laparoscopically.

Figure 9.

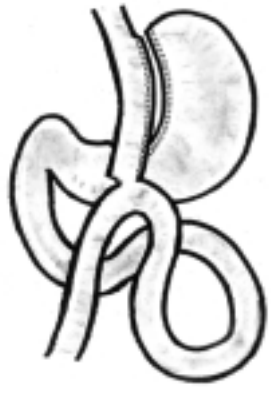


Figure 10.

RESTRICTIVE OPERATIONS

Gastroplasties

There are two gastroplasty operations currently used for treatment of obesity: vertical banded gastroplasty (VBG), introduced and popularized by Edward Mason[14] (Figure 5); and silastic ring vertical gastroplasty (SRVG), popularized by Henry Laws[15] (Figure 6). Both operations were preceded by various gastroplasties: horizontal gastroplasty by Printen[50] and Mason, vertical stapling by Fabito[51], gastrogastrostomy by Buckwalter[52], gastric partitioning by Pace and Carey[53] from Ohio State University, horizontal gastroplasty by Caesar Gomez[54] from St. Louis, and Kroyer's[55] horizontal gastroplasty with a Marlex band. Kroyer was the one who introduced the use of a nonabsorbable, reinforced stoma to prevent dilatation of the stoma in gastric-restrictive operations. All these had shortcomings and are presently not used. They are mentioned here for historical completeness and because there may still be patients out there with the remnant of one of the operations. Also, knowledge of these operations will prevent reinvention of the wheel by surgeons who are just getting introduced to bariatric surgery. Both the VBG and SRVG were performed by stapling the stomach in continuity and vertically, leaving a 10–30-cc pouch. Currently, most surgeons performing gastroplasties are transecting the stomach to decrease the incidence of staple-line breakdown. The concept of transecting the pouch in the gastroplasty operation was first presented by Geoffrey Wynne-Jones[56] (from New Zealand), who did so for economic reasons. (The stapling gun and staples were not available in New Zealand and too expensive to import).

Transecting the pouch in the gastroplasty operation to decrease staple-line breakdown was first presented by Isoa Kawamura[57] when he described the vertical banded K-gastroplasty. Laparoscopically, it is easier to transect the stomach in performing

the various gastroplasties[58]. Gastroplasties produce weight loss by restricting the stomach capacity and limiting the amount of caloric intake. They slow down the eating process by increasing the chewing time. Gastroplasties can be very effective in weight loss and maintenance, but they require patient compliance. Unfortunately, the experience has been that the patients—after a gastroplasty—learn what and how to eat. Consumption of high-caloric fluids and chewables has been the eventuality in most of these patients, with resultant weight gain and recurrence of the associated comorbid conditions.

The advantages of the gastroplasty operations include simplicity, less invasiveness, no rerouting of the gastrointestinal (GI) tract, few complications, no malabsorption, and easy reversibility. Mortality from these operations in experienced hands is in the range of 0–1%. Complications from gastroplasties include vomiting, bezoar obstruction, outlet stenosis and obstruction, staple-line breakdown, band erosion, megaesophagus, and GERD in addition to complications common to all other GI operations, such as wound problems, bleeding, DVT, PE, leaks, fistula formation, incisional hernias, and small-bowel obstruction. Outcome from gastroplasties in prospective clinical evaluations report an average percentage excess weight loss of about 50% in about 50% of the patients[59,60]. Gastroplasties were the operations of the 1980s, accounting for 90% of the bariatric operations performed in the USA. Currently, gastroplasties amount to only 10% of bariatric operations in the USA, and most are being performed laparoscopically.

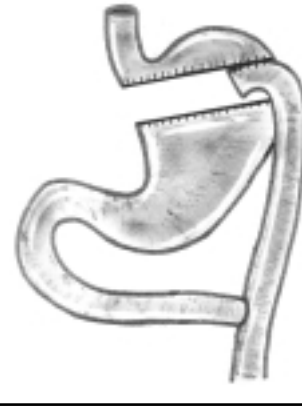
Gastric Banding

Wilkinson from Albuquerque, N.M. placed the first gastric band for weight reduction. However, Knut Kolle[16] (from Norway), and Molina[17] and Kuzmak[18] (in the USA) were the first proponents of the gastric banding (GB) operation in clinical use. These operations consist of placing a tight plastic band around the upper stomach, creating a small proximal pouch. GB operations function very similarly to the gastroplasty operations VBG and SRVG. The advocates of this operation claim less operative risks, shorter hospital stay, and early recovery. Initially, the GB operation was not well received, because of problems with band migration, band erosion, pouch dilatation, and dietary noncompliance leading to weight loss failure. Today, the laparoscopic-adjustable gastric band (LAGB), the lap-band, and the Swedish adjustable gastric band (SAGB) are prototypes of the bands in common use (Figure 7). GB operations are done mostly in countries outside the USA[61-63]. The lap-band is available for use in the USA, but the initial reports have not been as good as in Europe, Australia, and elsewhere. The initial USA experience with the lap-band operation reports a high rate of revision and reversibility[64]. Long-term results will determine the role of this operation in the treatment of obesity. The popularity of the Lap-Band is due in part to the aggressive marketing of the band by the manufacturer, the easy laparoscopic insertion with minimal anatomical distortion, short hospital stay, faster recovery, and easy reversibility.

Complications from this operation include vomiting, pouch dilatation, band slippage, band erosion, esophageal dilatation with reflux, and occasional gastric content aspiration into the lungs. This

Figure 11.

Figure 12.



operation requires significant patient compliance and frequent physician visits.[62]

Weight-loss outcome from GB operations at best equals that of the gastroplasty operations. The advantages of the GB operations include simplicity, high amenability to laparoscopic approach, less invasiveness, no rerouting of the GI tract, few complications, no malabsorption, or deficiencies syndrome, and easy reversibility.

COMBINED RESTRICTIVE AND MALABSORPTIVE OPERATIONS (GASTRIC BYPASS OPERATIONS)

Loop Gastric Bypass

In 1967, Mason and Ito[12] reported the first series on gastric bypass (GBP) operations for obesity. This operation was developed as a consequence of the observation that patients with partial gastrectomy for other reasons lost weight and were observed to be able to eat smaller meals than before the operations. The operation performed by Mason divided the stomach into a proximal pouch attached to the esophagus and a bypassed segment in continuity with the duodenum. GI continuity from the proximal pouch was formed by connecting it to a loop of the jejunum (Figure 8). The bypassed segment included most of the stomach, the duodenum, and about two feet of the proximal jejunum that were excluded from contact with the nutrient stream. This operation has undergone modifications over the years, and, currently, there are many variations of GBP operations in use[65].

The weight loss was about 50% of the excess weight, but there was a high incidence of weight regain. Complications included vomiting; nausea; dumping syndrome; anorexia; weight loss failure; excessive weight loss; marginal ulcers; bile reflux gastritis of the pouch; gastritis of the bypassed stomach; afferent limb obstruction; acute gastric dilatation and blow out; pouch dilatation; stoma dilation; internal hernia; iron, calcium, and vitamins A, D, E, B-1, and B-12 deficiencies; and occasional protein malnutrition in addition to complications (including leaks, bleeding, wound problems, pulmonary complications, DVTs, incisional hernia, gallstones, and small-bowel obstruction) seen in other GI operations (Table 3). The loop gastric bypass is being currently performed at only one center in the USA. The pouch is vertical, and a 70% excess weight loss is reported in more than 80% of the patients[66] (Figure 9).

Figure 13.

Figure 14.

Stapled Gastric Bypass

Alden[67] introduced the use of staples in bariatric surgery. The stomach was stapled horizontally and in continuity, creating a proximal and distal pouch (Figure 10). The proximal pouch is connected to the jejunum using a Roux-en-Y limb about two feet long. This simplified the operation. There was decreased bleeding from not having transected the stomach. The Roux limb eliminated the problem of bile reflux pouchitis. The smaller pouch decreased the incidence of marginal ulcer. A new complication and terminology, "staple-line breakdown," was thus introduced in bariatric surgery. The weight loss was better with this modification than with the initial Mason loop gastric bypass. This operation with a much smaller pouch (less than 30 cc in size)

is still being performed at a few centers across the USA. However, there is a problem with pouch dilatation and gastric outlet dilation and staple-line breakdown. Torres[68] modified this operation by creating a lesser-curvature pouch to take advantage of the thicker muscular wall on the lesser curvature of the stomach and to allow for a more perpendicular drainage of the pouch (Figure 11). This modification decreased the amount of pouch dilatation and staple-line breakdown but not stoma dilation. This is the most common form of stapled gastric bypass performed currently in the USA. It still has the inherent propensity for staple-line breakdown, even with multiple application of the stapling device. Weight loss with this modification over a five-year follow-up is reported to be >60% excess weight loss in more than 70% of the patients. The complications are the same as in the horizontal stapled gastric bypass.

Transected Gastric Bypass

The pouch in the transected gastric bypass is formed by transecting the stomach, just as Mason did in the original gastric bypass (Figure 12). There are still a few surgeons who transect the pouch horizontally,[69] but most surgeons form a vertical transected pouch[70] (Figure 13). The transected vertical gastric bypass is the most common laparoscopic gastric bypass performed. Transecting the pouch eliminates the problems of staple-line breakdown and minimizes the incidence of gastrogastric fistula formation, thus, markedly decreasing the incidence of marginal ulcers and revision operations[71]. Most of the surgeons currently use a pouch less than 30 cc in size. The complications from this modification are the same as in the stapled GBP, except for the absence of staple-line breakdown. Weight loss with this modification over a five-year follow-up is reported to be >70% excess weight loss in more than 70% of the patients. The weight loss maintenance is better, because of the decreased incidence of gastrogastric fistula formation or staple-line breakdown.

Banded Gastric Bypass

The banded gastric bypass (BGBP), popularized by Fobi[72-74] (Figures 14 and 15), has a band around the vertical pouch, thus creating a stoma just as in the gastroplasty operation. This modification addresses the problem of stoma dilation, which results in increased caloric intake and weight

Figure 15.

Figure 16.

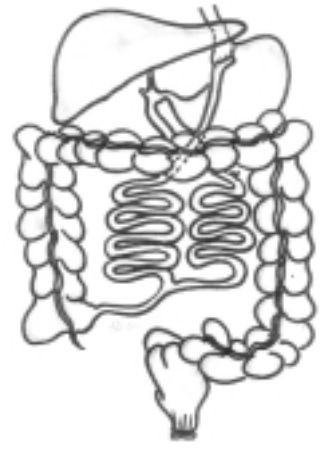
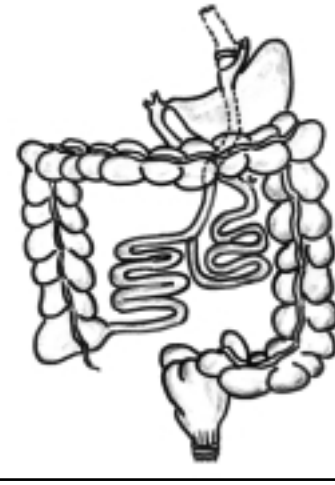


Figure 17.



regain. Up until the description of the BGBP, the problem of stoma dilation with weight gain has long been a concern to bariatric surgeons. Torres[75] attempted to address this problem by interposing an antiperistaltic segment of jejunum as the efferent limb to decrease the rate of the pouch emptying. Linner[76] addressed this problem by placing a silastic ring band around the gastrojejunal anastomosis but experienced a high rate of erosion and changed over to using a fascia lata band. Salmon[19] addressed this problem by creating a gastroplasty pouch within a bigger gastric bypass pouch. In 1989, Fobi[20] reported the use of the band in the gastric bypass with the band around the pouch away from the gastrojejunal anastomosis. The band used in this GBP is usually longer than in the gastroplasty (6–6.5 cm versus 4.3–5 cm). The band materials currently used include silastic tubing, Marlex, Dacron, nonabsorbable sutures, fascia lata, bovine graft, and porcine graft. Talieh[77] reported, in 1996, that 25% of the surgeons were using a band in the gastric bypass. The percentage has definitely increased in the last six years, as more and more bariatric surgeons appreciate the problem of stoma dilation at three years and more of follow-up.

Complications from the BGBP are the same as in the other gastric bypass, plus a 2% incidence of band erosion[78]. The incidence of band erosion is higher in revision and conversion operations than in primary operations. Band erosions are easily managed by endoscopic removal or expectant observation for self-extrusion. Most but not all patients have weight regain after band erosion and removal.

Weight loss after a five-year follow-up with the BGBP is more than 70% excess weight loss in more than 90% of the patients[79,80]. This prompted MacLean[81] to state that this is the best gastric bypass modification operation. Fisher[82] summarized a review of the literature by stating that the BGBP produces more weight loss in more patients maintained over a longer period of time.

Distal Roux-en-Y Gastric Bypass

Distal Roux-en-Y gastric bypass (DRYGP) is a GBP with a 50–75-cm common limb and a 250-cc alimentary limb (Figure 16). This operation, used by Fobi,[22] Wittig,[23] and Torres[24] in the early 1980s, was influenced by the work of Scopinaro with the BPD. The pouch was smaller than that described by Scopinaro, and the stomach was not removed as in the BPD. The weight loss was great—more than 80% excess weight loss—but the operation resulted in a high incidence of protein malnutrition and therefore fell into disfavor. It became obvious that the restrictive small stomach with a caloric intake per day of less than 500 in combination with severe malabsorption was a set-up for disaster. However, the DRYGBP as a revision of an intact GBP or BGBP with inadequate weight loss, has been very effective with less incidence of protein malnutrition[83-85]. This is explained by the finding that the caloric intake in gastric bypass patients after one year is usually increased to more than 900 calories a day, and in patients with inadequate weight loss, there have been documentation of more than 2,000 calories of daily intake. At the Center for Surgical Treatment of Obesity (CSTO), we recommend a modified DRYGBP (Figure 17) with the alimentary limb equal to 50% of the total small-bowel length when revising a failed short-limb GBP or BGBP to a DRYGBP. There are many variations[86-88] of the DRYGBP being currently performed with different limb lengths to increase the weight loss in gastric bypass operations—particularly in the super obese. It has been our experience that African Americans are not very tolerant and usually do not fair well with malabsorptive procedures.

Complications from the DRYGBP include all the complications from the short-limb gastric bypass plus increased incidence of protein malnutrition; frequent watery and malodorous stools and flatus; peculiar body odor; anal excoriation; gas bloating syndrome; and increased incidence of iron, magnesium, calcium, and vitamins A, D, E, B-1, and B-12 deficiencies.

Weight loss with the DRYGBP approaches 80% excess weight loss in more than 90% of the patients. These patients need to be monitored frequently. We have reversed 9% of patients converted to DRYGBP because of intractable diarrhea and or protein malnutrition.

INVESTIGATIONAL PROCEDURES

Gastric Pacing

Gastric pacing is currently an investigational procedure for weight loss. Cigaina[89,90] reported reduced feed intake in young pigs by antral stimulation of the pigs' stomachs. This stimulation alters the pacesetter activity of the gastric pacemaker, resulting in gastric paresis and weight

loss. This has resulted in human experiments both in Europe and in an FDA-approved, randomized trial in the USA—with an implantable gastric stimulator (IGS) analogous to a cardiac pacemaker. The initial reports on weight loss are encouraging. More research in this area is ongoing and may ultimately revolutionize surgical treatment of obesity.

CNS Stimulation

Quaade[91] described stereotaxic stimulation and electrocoagulation of sites in the lateral hypothalamus with resultant, transient reduction in caloric intake and short-term weight loss in a series of patients. This work was done in 1974 and has not been reproduced. This may be an area for future investigation.

Laparoscopic Surgery

Laparoscopy provides a minimally invasive means of performing surgical operations. The operations, risks, and outcome are the same as when done openly. The advantages of laparoscopic access are reduced wound complications, such as infections and hernia; less formation of adhesions; less pain; shorter hospital stay; improved cosmetic results; and faster recovery.

Bariatric operations have turned out to be readily amenable to laparoscopic access. Wittgrove and Clark[92] introduced the laparoscopic access to bariatric operations in 1993. A year later, Belachew[61] published his series of lap-band gastric banding operations done laparoscopically. Currently, all bariatric operations can be performed laparoscopically.[48,58,92-98] The learning curve—particularly with the more complicated operations (GBP, BGBP, DRYGBP, BPD, and BPD-DS)—is very steep. In our experience, the complication rate decreased eight-fold between the first and the second 50 cases done laparoscopically. Currently, we perform one out of four BGBP operations laparoscopically. It is estimated that about 10% of bariatric operations in the USA are done laparoscopically. This percentage will increase as more bariatric surgeons are trained in laparoscopic techniques and as the newer generation of laparoscopically trained surgeons enter the field of bariatric surgery. The two biggest pushes for laparoscopic access are patient requests and push from the pharmaceutical companies that produce laparoscopic instruments.

Bariatric-Related Operations

Morbidly obese patients have fat accumulation at various body locations, resulting in lipodystrophy of the arms, abdomen, flanks, thighs, hips, buttocks, breast, chest wall, and legs. These localized fat collections may have physical, medical, social, and psychological consequences. For example, hypertrophic breasts cause shoulder, neck, back, and breast pain. Lipodystropies of the thighs inhibit mobility, and large abdominal panniculus cause back pain, inhibit the ability to perform the daily acts of living and sexual interactions. Removing or excising these localized fat collections—panniculectomies—can be done before the bariatric operation, concurrently or after weight loss from the bariatric operations.

In our experience[99], concurrent abdominal panniculectomy in the severely obese in cases where the fat collection hinders mobility, results in more weight loss and more patient satisfaction. The complication rate is about the same whether the panniculectomies are done before, concurrently, or after weight loss. Breast and arm reductions should be done after weight loss and not before or concurrent to the weight loss operation. Some of these operations should be done in association with liposuction. The older breed of bariatric surgeons perform panniculectomies. Currently, more comanagement among the bariatric, plastic, and reconstructive surgeons is being reported.

INDICATIONS FOR SURGERY

The indications for weight-loss operations are becoming less stringent; as the operations are more generally understood by the public and made safer and less invasive; as the significance of obesity with its medical, physical, social, economic, and psychological ramifications are more and more appreciated; and, finally, as the long-term abysmal failure of nonsurgical treatment is appreciated.

Currently, the guidelines set by the NIH consensus panel in 1991 are generally used[8] with some modifications. These include weight criteria of BMI ≥40 kg/m^2 and BMI ≥35 Kg/m^2 with obesity associated comorbid, medical, social, physical, economic, or psychological conditions. Potential candidates who have met these weight criteria must have attempted other medical weight loss modalities unsuccessfully. Traditionally, most surgeons have limited surgery to patients between 18 and 50 years of age, but, in the last 10 years, there have

been many reports including patients as young as 8 and as old as 74 years old.[100-103] Patients must be able to make an informed consent for these surgeries, since the patient factor in the success of weight loss operations is very important. Active psychiatric disorders or mental retardations are contraindications for surgery. A strong history of substance abuse or self-destructive behavior is a contraindication to surgery.

PREOPERATIVE EVALUATION

Patients should be evaluated by a multidisciplinary team of the surgeon, nutritionist or dietician, internist, and a psychologist/psychiatrist. The purpose of this team approach is to maximize the care given the patient. Special consultants, such as cardiology, pulmonary, endocrinology, hematology, and gastroenterology consultants, should supplement the team.

A complete history and physical is done to determine comorbid conditions, particularly those that are often overlooked by nonbariatric physicians. Preoperative evaluation to identify significant comorbidities include the regular laboratory and radiological studies, abdominal and pelvic ultrasounds, cardiac evaluation, pulmonary function tests, sleep studies, and body composition measurements.

Patient education is a key component of preoperative evaluation. Patients should be as informed of their planned operation as much as possible. They should understand the changes in their anatomy and the consequence nutritionally. Patients should have a full understanding of the potential complications. The need for long-term nutritional supplements and clinical monitoring should be stressed and understood. The use of patient counselors and people who have had surgery and work for bariatric surgeons to assist other patients through the process greatly facilitates patient education. Attendance at support group meetings where a surgical candidate is able to meet and interact with patients who have had the operation has been found to be beneficial.

HOSPITAL AND POSTDISCHARGE CARE

Patients for weight-loss operations are high-risk patients. Hospital care should focus on minimizing complications. Hospitals where these operations are performed should have specialized beds with trapeze and monkey bars, special wheel chairs, and other devices to facilitate the care and movement of very obese patients. Use of heparin, TED's stockings, and sequential compression devices must be encouraged in these patients. Early ambulation and use of incentive spirometers lowers pulmonary complications. The use of continuous positive airway pressure devices (CPAP) by patients with sleep apnea in the postoperative period is very important. Patient-controlled analgesia has improved early postoperative pain management.

Patients start on ice chips on the day of surgery and are advanced, based on the particular operation and the surgeon, to a defined dietary protocol for the first one- to three months after the operation and then transitioned to a regular diet.

Patients should be monitored closely during this period for signs and evidence of DVT, PE, and leaks. Obese patients do not respond to infection and intra-abdominal catastrophe as do normal-sized patients. The heart rate is a good index of the status of a postoperative bariatric patient. A postoperative bariatric patient with a persistent rapid pulse (>110) should be treated as one with a leak until proven otherwise. Obese patients with peritonitis rapidly progress to severe shock and multiple system failure. Timely intervention in patients with a suspected leak obviates a disaster. Gastrografin swallow or a CT-scan will assist in diagnosing a leak. Surgical intervention as a diagnostic and therapeutic procedure is very indicated in this group of patients. Most surgeons study patients with either a Gastrografin swallow or a barium swallow prior to discharge. The hospital stay ranges from one- to five days depending on the operation and whether done open or laparoscopically. Laparoscopic patients have less pain, early discharge, and faster recovery. Patients should be followed and should take and be monitored for specific nutrients lifelong.

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