Basrah Journal Of Surgery

Review Article
Bas J Surg, September, 13, 2007

BARIATRIC SURGERY; RISK AND BENEFIT

Issam Merdan
FICMS, CABS, Assist. Prof., Department of Surgery, Collage of Medicine, University of Basrah. Iraq.

Abstract

Obese patients loss more weight with bariatric surgery than with medical weight loss treatment. The laparoscopic Roux-en-Y gastric bypass procedure results in more short term weight loss than laparoscopic adjustable gastric banding, but the latter has fewer postoperative complication and lower mortality rate; long term comparative data are currently lacking. The decision regarding which procedure to perform should be based on individual patient and surgeon factors.

Early complications of gastric bypass surgery are bleeding, anastomotic leak, wound infection, thromboembolism, and anastomotic stricture. Longer term complication scan include marginal ulcers, bowel obstruction, gallstones, and nutritional deficiencies.

Complication of adjustable gastric banding includes prolapsed and erosion. Patient typically loses more than 50% of their excess weight after bariatric surgery. Obesity related diseases markedly improve after bariatric surgery, reducing cardiovascular risk and improving life expectancy. Patient undergoing bariatric surgery must commit to a program of lifestyle changes, diet, vitamin supplementation, and follow-up.

Introduction

Outcome of bariatric surgery are getting better all the time, as surgeons gain experience in performing these technically demanding procedures laparoscopically. The risks are not trivial, but they are acceptably low. The benefits: not only do patients lose weight and keep it off, now there are convincing data that many patients are cured of obesity related diseases, notably type 2 diabetes. In fact, the procedure may pay for itself within a few years by reducing medical costs due to obesity related illness. Best of all, the long term mortality rate seems to be lower for morbidly obese patients who undergo this surgery than for those who do not. Managing obesity related co-morbid conditions is challenging, expensive, and often unsuccessful unless the patient can lose a significant amount of weight. Obesity is now epidemic in the United States, affecting more than 60 million people, and the problem will worsen in coming years as the incidence of childhood and adolescent obesity rises[1].

Who is eligible for bariatric surgery?

Candidates for bariatric surgery must have a body mass index (BMI) greater than 40 kg/m^2 or a BMI greater than 35 with significant obesity-related disease, according to the 1991 consensus guidelines from the National Institutes of Health (table I)[2]. Table II lists some of the major obesity-related diseases.

Typical patients are between the ages of 18 and 60. However, carefully selected older patients and adolescents can also benefit from bariatric surgery, and the current indications will likely broaden as long-term data on various subgroups of patients mature.

Other criteria for surgery: prior attempts to lose weight by non surgical means must have failed, and the patient

must complete a thorough, multidisciplinary preoperative evaluation designed to identify co-morbid conditions so that they can be optimally managed prior to surgery and to identify any contraindications to surgery. Patients must be able to comprehend the significant lifestyle changes required after surgery and comply with the postoperative program of diet, vitamin supplementation, and follow-up.

Patients who cannot tolerate general anesthesia because of cardiac, pulmonary, or hepatic insufficiency cannot undergo bariatric surgery. Patients who have ongoing substance abuse or unstable psychiatric illness are poor candidates.

Most importantly, patients must understand that bariatric surgery is not a quick fix. Rather, it is a very powerful tool that, in conjunction with appropriate food choices and physical activity, can produce significant weight loss, resolve co-morbid conditions, and prolong 1ife[3,4].

What procedures are being performed today?

The weight-loss procedures in use today range from placement of an intragastric balloon (the least invasive option) to open biliopancreatic diversion (the most invasive). Bariatric procedures are classified according to their mechanism of action: restrictive, malabsorptive, or a combination of restrictive and malabsorptive (Figure 1).

Restrictive procedures: are so called because the surgeon creates a small gastricpouch with a narrow outlet that restricts the amount of food that the patient can eat at one time. The two restrictive procedures most often performed are vertical banded gastroplasty and laparoscopic adjustable gastric banding.

Vertical banded gastroplasty was developed in 1980 but only 5% of bariatric surgeons still perform it; many patients had long-term complications that necessitated another operation, and long-term weight loss was small[5-9]. Laparoscopic adjustable gastric banding has the advantage of using an adjustable inner collar that allows one to fine-tune the size of the outlet to minimize side effects and maximize weight loss. It was approved for use in the United States in 2001 and now is the second most commonly performed bariatric procedure, after the Roux-en-Y gastric bypass.

Malabsorptive procedures: bypass a segment of the small intestine so that less food is absorbed. Biliopancreatic diversion was developed in 1979 by Scopinaro et al,[10] and is performed at specialized centers using the open and laparoscopic techniques.

The duodenal switch, a modification of the biliopancreatic diversion, was developed to decrease the incidence of dumping symptoms and anastomotic ulceration seen with biliopancreatic diversion. It too can be performed laparoscopically. These procedures are technically demanding to perform, and many patients develop nutritional deficiencies afterward. Therefore, they account for only about 5% of bariatric procedures performed in the United States.

Combination procedures, eg, the Roux en-Y gastric bypass, use both mechanisms to achieve weight loss. In this procedure, which can be performed either laparoscopically or as open surgery, food intake is restricted by creating a small (15–30 mL) gastric pouch, and absorption is limited by bypassing the proximal intestine with a Roux limb (Figure 1). The standard Roux limb is 75 to 150 cm long and bypasses the distal stomach,

duodenum, and a short segment of the jejunum. More than 95% of the small bowel is left intact, so malabsorptive side effects such as diarrhea and protein malabsorption are very uncommon. The Roux-en-Y gastric bypass now accounts for approximately 80% of all bariatric procedures performed in the United States.

Risk of bariatric surgery

Open vs laparoscopic Roux-en-Y gastric bypass

Laparoscopic bariatric surgery was introduced in 1994 when Wittgrove et al[10] published the results of their first five Roux-en-Y gastric bypass cases. Since then, several large series of laparoscopic Roux-en-Y gastric bypass cases[11-16] and three randomized controlled trials[17-19] comparing laparoscopic and open Roux-en-Y gastric bypass have been published. Each approach poses unique risks. Open surgery results in more postoperative pain, slower return to normal activity, and higher rates of iatrogenic splenectomy and abdominal wall complications (up to 20% of patients have incisional hernias). One review of more than 3,000 gastric bypass cases showed that the laparoscopic approach results in less postoperative pain, better postoperative pulmonary function, and significantly fewer wound complications, but it has higher rates of anastomotic stricture (4.7% vs 0.7%, $P<.001$), gastrointestinal bleeding (1.9% vs 0.6%, $P = .008$), and late postoperative bowel obstruction (3.1% vs 2.1%, $P= .02$) than open surgery[20]. The incidence of anastomotic leak was higher with laparoscopic surgery in some series, but not in the randomized trials or in a comprehensive review of the topic[20]. Laparoscopic surgery takes time to learn, and complication rates with laparoscopic Roux-en-Y gastric bypass tend to decline as surgeons gain experience[21]. With experience, operative time and rates of technical complications such as gastrojejunal anastomotic leak decline to those seen with the open approach.

Complication of laparoscopic gastric bypass

Conversion to open surgery

In up to 8% of cases, surgery that is started laparoscopically must be completed as an open procedure. However, in experienced hands, this "conversion" rate is less than 5%. In a review of 3,464 laparoscopic gastric bypass procedures (10 series), Podnos et al[20] found the conversion rate to be 2.2%. The most common reasons for conversion to an open procedure were hepatomegaly, equipment problems, inadequate instrument length, inadequate exposure, injury to the colon or a major blood vessel, and bleeding.

Bleeding

Bleeding complications occur in fewer than 4% of patients. Postoperative bleeding can be from mesenteric or omental vessels within the peritoneal cavity or from an anastomosis or staple line. In the laparoscopic Roux-en-Y gastric bypass, the staple or suture lines of the gastrojejunostomy and the jejunojejunostomy can bleed. Postoperative bleeding from the gastrojejunostomy can be diagnosed and managed endoscopically Bleeding from the excluded gastric remnant can be more difficult to diagnose and treat, since there is no direct endoscopic access to this lumen after gastric bypass. Techniques to decrease the incidence of staple line bleeding include oversewing or buttressing the staple lines.

Anastomotic leak

Anastomotic leak is a dreaded complication of Roux-en-Y gastric bypass and carries a mortality rate of up to 30% when it occurs. The incidence after laparoscopic Roux-en-

Y gastric bypass ranges from 0% to 4.4%. Leakage from the gastrojejunal anastomosis can be contained or can result in diffuse peritonitis. Technical failures of the anastomosis manifest in the early postoperative period with rapid clinical deterioration, but most leaks occur around 5 days after surgery and result from perforation of an ischemic area at the anastomosis. Major complications often present with subtle signs in these patients, and physical findings that confirm peritoneal irritation are the exception rather than the rule when an abdominal catastrophe is developing. Often, tachycardia is the only presenting sign of an anastomotic leak. A heart rate greater than 120 should prompt an investigation, even if the patient looks and feels well. Tachypnea or decreasing oxygen saturation can also signal early sepsis from a leak, and this presentation may be clinically indistinguishable from a pulmonary embolism. Surgeons or internists caring for bariatric patients should aggressively evaluate any postoperative fever, tachycardia, or tachypnea, and the patient should return to the operating room early if diagnostic tests are inconclusive but clinical suspicion for a leak is high. If a patient is diagnosed with a contained leak on computed tomography or an upper gastrointestinal study and is clinically stable, nonoperative management with adequate drainage, bowel rest, and antibiotics may be appropriate.

Wound infection

Wound infection after laparoscopic Roux-en-Y gastric bypass occurred in fewer than 5% of cases in most series. In a pooled analysis, Podnos et al[20] found that wound infections occurred in 97 (2.9%) of 3,258 laparoscopic cases, compared with 34 (6.6%) of 513 open cases ($P < .001$). Laparoscopic port site infections are easy to manage with a short course of antibiotics and wound care and are less serious than open wound infections. The laparoscopic approach eliminates the risk of wound dehiscence or evisceration.

Thromboembolism

Obesity is a risk factor for venous thromboembolism in general surgery patienrs[22]. The higher the BMI, the higher the risk of venous thromboembolism in patients undergoing abdominal operations, even with low-dose heparin prophylaxis[23] and obesity is an independent predictor of recurrent venous thromboembolism[24]. Morbid obesity is associated with elevated levels of fibrinogen, factor VII, factor VIII, von Willebrand factor, and plasminogen activator inhibitor and some evidence suggests a link between inflammatory mediators, central obesity, and a pro coagulant state[25].

The rate of deep vein thrombosis after laparoscopic Roux-en- Y gastric bypass with thromboprophylaxis ranges from 0% to 1.3%, and the rate of pulmonary embolism ranges from 0% to 1.1 %. Pulmonary embolism and anastomotic leak are two major causes of death after Roux-en- Y gastric bypass, and pulmonary embolism accounts for 50% of postoperative deaths. During laparoscopic surgery the peritoneum is inflated, which increases the abdominal pressure and impedes venous return, increasing the risk of deep vein rhrombosis.[26] On the other hand, laparoscopic surgical patients can get up and walk sooner after surgery than patients who undergo open surgery, which should decrease the risk. In pooled data comparing 2,771 open and 3,464 laparoscopic surgical cases, there were no differences in clinically significant thromboembolic events (0.78% vs 0.41 %, P = .09)[20].

Currently, the American College of Chest Physicians (ACCP) recommends routine perioperative thromboprophylaxis for patients at increased risk but provides no specific recommendations for bariatric surgery patients. A survey found that more than 95% of bariatric surgeons used routine deep vein thrombosis prophylaxis and 38% used a combination of two or

more methods of prophvlaxis[27].
These patients should be treated as high risk general surgery patients, and should receive thrornboprophvlaxis according to the ACCP guidelines with low-dose untractionat ed heparin 5,000 U twice a day or low-molecular-weight heparin up to 3,400 U once daily (grade 1A evidence) with the addition of leg compression devices if multiple risk factors are present (grade 1C evidence). Preoperative placement of inferior vena cava filters in high-risk bariatric patients is controversial, but it should be considered in patients with known risk factors for fatal pulmonary embolism including venous stasis disease, obesity hypo ventilation syndrome, BMI 60 or greater, prior thromboembolism, or a known hypercoagulable state[28,29].

Anastomotic strictures

Anastomotic strictures develop at the gastrojejunostomy after laparoscopic Roux-en-Y gastric bypass in 2% to 16% of cases. The rate of this complication largely depends on the surgeon's experience and the technique used to create the anastomosis. The gastrojejunosto my can be hand-sewn (resulting in the lowest stricture rate) or created with a linear stapler or a circular stapler (resulting in the highest stricture rate). Larger studies (with> 100 patients) reported stricture rates of less than 6%; these series included all three techniques[12-16,30,31].

Strictures typically present within the first 3 months after surgery with nausea and vomiting. Most strictures result either from ischemia at the anastomosis due to tension on the Roux limb or are associated with a marginal ulcer. About 85% of anastomotic strictures are managed with a single endoscopic dilation[30]. Seventeen percent require a second dilation, and in a study by Nguyen et a1[32], only 1 of 29 patients with a stricture required a third endoscopic dilation.

Marginal ulcers

Marginal ulcers are postsurgical ulcers that occur at the gastrojejuna1 anastomosis, usually on the jejunal side. Marginal ulcers may be related to tension or ischemia on the anastomosis and have also been associated with foreign material (staples or non-absorbab1e sutures), nonsteroidal anti-inflammatory drug (NSAID) use, excessive acid exposure in the gastric pouch due to gastrogastric fistula, and smoking. Patients present with abdominal pain, vomiting, and bleeding or anemia. The incidence of marginal ulcer after 1aparoscopic Roux-en- Y gastric bypass surgery ranges from 0.7% to 5.1 %. This complication is treated with acid suppression therapy and by stopping the offending agent (NSAID, tobacco). Rarely, anastomotic revision is required for a refractory ulcer.

Bowel obstruction

Bowel obstruction after Roux-en-Y gastric bypass can result from adhesions or internal hernias. Fewer intra-abdominal adhesions form after 1aparoscopic surgery, presumably because there is less tissue trauma and bowel manipulation; this may allow for more internal hernias to develop in a 1aparoscopic approach (due to fewer adhesions, more morbile loops of bowel that can herniate through a mesenteric defect or band) but may decrease the incidence of adhesive obstructions compared with an open procedure.
In 10 large 1aparoscopic Roux-en- Y gastric bypass series,[20] bowel obstruction occurred in 3% of patients. To reduce the incidence of internal hernias, the mesenteric defects are carefully closed during the procedure.

Patients with intermittent, crampy abdominal pain that occurs months to years after gastric bypass should be referred back to their bariatric surgeons for evaluation. We typically perform exploratory 1aparoscopic surgery in these patients to look for mesenteric defects or internal hernias.

Cholelithiasis is common

Weight loss after gastric bypass surgery is accompanied by a rise in

incidence of gallstones: 38% to 52% of patients develop stones within 1 year of surgery,[33,34]. Between 15% and 28% of all patients, irrespective of gallstone status at the time of gastric bypass, require urgent cholecystectomy within 3 years.

Symptomatic cholelithiasis at the time of 1aparoscopic Roux-en- Y gastric bypass is an indication for cholecystectomy during the bypass procedure. In patients with asymptomatic cholelithiasis or no gallstones, however, this practice remains controversia1[35,36].

Some surgeons advocate prophylactic cholecystectomy at the time of 1aparoscopic Roux-en- Y gastric bypass for all patients, due to the high incidence of undiagnosed gallbladder disease (sludge, cholesterolosis, undetected cholelithiasis) in this patient population[35]. The disadvantages of this approach include the potential of performing an unnecessary procedure and the risks (bleeding, bile duct injury, prolonged operative time) of performing a concomitant procedure in a morbidly obese patient. Hamad et a1[37] confirmed the safety of performing combined 1aparoscopic cholecystectomy and gastric bypass in patients with asymptomatic cholelithiasis, but patients undergoing the combined procedure had an operative time that was 50 minutes longer and a hospital stay nearly twice as long compared with patients who underwent 1aparoscopic Roux-en- Y gastric bypass only.

Patients with asymptomatic stones are observed, and those without cholelithiasis are prescribed ursodiol 600 mg daily by mouth for the first 6 months after the procedure, which significantly reduces the incidence of gallstone formation (2% vs 32% with placebo, $P < .01$)[33].

Nutritional deficiencies

Because the stomach and duodenum are bypassed, iron, vitamin B_{I2}, and other micronutrient deficiencies can occur after standard gastric bypass[38].

Taking a single multivitamin tablet alone is insufficient to prevent iron and vitamin B_{12} deficiencies after laparoscopic Roux-en- Y gastric bypass. Iron deficiency occurs in 13% to 52 % of patients within 2 to 5 years after surgery, and supplementation with iron can reduce iron deficiency significantly. Up to 37% of patients who are prescribed a multivitamin after surgery still develop vitamin B_{12} deficiency. Once a specific deficiency is identified during follow-up, additional supplementation is indicated. Calcium absorption in the duodenum and jejunum and vitamin D absorption in the jejunum and ileum are impaired after Rouxen- Y gastric bypass as well. Calcium deficiencies can occur in up to 10% of patients, and vitamin D deficiency in up to 51 %, depending on the length of the bypass[38]. These deficiencies can lead to secondary hyperparathyroidism and can result in increased bone turnover and decreased bone mass as early as 3 to 9 months after surgery[39].

Series that reported nutritional deficiencies after gastric bypass varied greatly in terms of vitamin supplementation regimens. In a survey of 109 bariatric surgeons[40], 96% said they prescribed multivitamins after Roux-en- Y gastric bypass, 63 % prescribed iron, and 49% prescribed vitamin B_{12}. Surveillance for deficiencies and patient compliance vary as well, although most bariatric surgeons recommend annual blood testing. They obtain a complete blood count and iron and B_{12} levels before surgery, 6 months and 1 year after surgery, and yearly thereafter. They recommend routine daily supplementation with a multivitamin, iron, vitamin B_{12}, and calcium.

Peri operative mortality

Buchwald et a1[3] performed a meta-analysis of 136 studies that included 22,094 patients who underwent restrictive, malabsorptive, or gastric bypass procedures (open and laparoscopic). The 30-day mortality rate for gastric bypass was 0.5%. The three randomized trials comparing open

and laparoscopic Roux-en- Y gastric bypass showed no difference in mortality rates. Podnos et a1[20] in their review found a lower mortality rate in laparoscopic patients. In laparoscopic Roux-en- Y gastric bypass series with more than 100 patients, the mortality rate ranged from 0% to 0.9%[12,14-16,41]. The risk of death after gastric bypass surgery increases with age. Livingston et a1[42] found that patients older than 55 years had a threefold higher mortality rate compared with younger patients, despite similar complication rates.[42] Sepsis was the leading cause of death in the older patients.

In a review of 16, 155 Medicare patients who underwent bariatric surgery (81% Rouxen-Y gastric bypass), Flum et a1[49] found that older age, male sex, and lower surgeon volume were associated with a higher risk of early death. Overall, the 30-day all-cause mortality rate was 2.0%, and the 90-day rate was 2.8%. For patients older than 65 years, these rates increased to 4.8% and 6.9%, respectively, and were significantly higher than in younger patients (1.7% and 2.3%). This increase in risk after age 65 is consistent with that after other major gastrointestinal and cardiovascular operations. A review of 60,077 Californians who underwent Roux-en- Y gastric bypass between 1995 and 2004 demonstrated mortality rates more consistent with published case series (0.33% at 30 days and 0.91 % at 1 year)[51].

Complication of laparoscopic adjustable gastric banding

The risk of death with laparoscopic adjustable gastric banding is the lowest for any bariatric surgery performed today, making it an attractive option for many surgeons and patients. In the meta-analysis of Buchwald et al[3], all restrictive procedures had an operative mortality rate (s 30 days) of 0.1 %. In a review of the international literature, Chapman et a1[45] compared the safety and efficacy of laparoscopic adjustable gastric banding, vertical banded gastroplasty, and Roux-en- Y gastric bypass. The operative mortality rate was 0.05% for laparoscopic adjustable gastric banding, compared with 0.5% for Roux-en-Y gastric bypass.

Early postoperative complications occur in 0.8% to 12 % of patients [46-51]. Bleeding after laparoscopic adjustable gastric banding is rare, occurring in only 0.1 % of cases.[46,47]. Given that no anastomoses are formed during this procedure, no anastomotic leaks can form. Iatrogenic bowel perforation during the procedure occurs in 0.5% of cases[46]. Wound infection rates are similar to those with laparoscopic Roux-en- Y gastric bypass and, like other laparoscopic wound infections, are easily managed with minimal morbidity. The risks of deep vein thrombosis (0.01 %-0.15%) or pulmonary embolism (0.1 %) after laparoscopic gastric banding are lower than for other bariatric procedures.[46,50]. This may be related to patient selection or shorter operative times.

However, band-related complications can occur in the early postoperative period or years after the procedure. The placement of a silicone prosthesis in the abdomen carries with it a unique set of mechanical complications not seen with other bariatric procedures. The range of complication rates reported in selected large case series of laparoscopic adjustable gastric banding is shown in Table3[12,14-19,41,45-60].

In a systematic review of the international literature that included 64 studies and 8,504 patients, Chapman et a1[45] reported tube or port malfunction requiring reoperation in 1.7% of cases, band erosion into the gastric lumen in 0.6%, and pouch dilation or band slippage in 5.6%. Overall, complications requiring reoperation can occur in up to 18% of patients, but complications decrease as experience with this procedure increases.

In a series of 1,120 patients, O'Brien and Dixon reported a low incidence of early major complications (1.5 %) but higher rates of late complications. Prolapse occurred in 25% and erosion occurred in 3% of their first 500 patients. In their last 600 patients,

prolapse occurred in 4.7% of patients and there were no erosions[49].
Table 3 compares complication rates in large case series of 1aparoscopic Roux-en- Y gastric bypass and 1aparoscopic adjustable gastric banding.

Benefits of bariatric surgery

Weight loss

Weight loss after bariatric surgery is typically expressed as the percentage of excess weight lost-excess weight defined as the number of pounds above the patient's ideal body weight. In the meta-analysis of Buchwald et a1,[3] excess weight loss for all bariatric procedures combined was 61 %. Analyzed by procedure, excess weight loss was highest after biliopancreatic diversion (70%), followed by gastrop1asty (68%), gastric bypass (62 %), and gastric banding (48%)[3]. Excess weight loss at 1 to 5 years after 1aparoscopic Roux-en- Y gastric bypass is similar to that with the open procedure and ranges from 68% to 80%[12,14-19,41,52]. Durable weight loss after open Roux-en- Y gastric bypass has been demonstrated up to 14 years[61]. Superobese patients (BMI > 50) have less excess weight loss than patients with lower BMIs after standard Roux-en- Y gastric bypass. Excess weight loss after Roux-en- Y gastric bypass and laparoscopic adjustable gastric banding is shown in Table 4[12,14-19,31,41,48-49,51,52,62-64].

Patients typically lose less weight after 1aparoscopic adjustable gastric banding than after 1aparoscopic Roux-en-Y gastric bypass and lose it more gradually (the peak excess weight loss is at 2 to 3 years vs 12 to 18 months with 1aparoscopic Roux-en- Y gastric bypass). However, Chapman et a1[45] reviewed the international literature and found that weight loss at 4 years was similar with both procedures. The success with 1aparoscopic adjustable gastric banding in Europe and Australia was not reproduced in most early US trials. Some recent US studies of 1aparoscopic adjustable gastric banding have approached the success rates seen in international studies, though, including a report of 1,014 laparoscopic adjustable gastric banding procedures with 64% excess weight loss at 4 years[65].

Morbidly obese patients lose less weight with medical therapy than with bariatric surgery. Medical weight-loss therapy consisting of diet modification, exercise, behavioral therapy, and pharmacotherapy can be effective in the short term, particularly when used in combination, but recidivism rates approaching 100% are typical among morbidly obese patients. In a meta-analysis of the US literature, low-calorie or very-low-calorie « 800 calories/day) diets resulted in the loss of 2.1 % and 6.6% of total body initial weight, respectively, after 5 years[66]. At 1 to 2 years, behavioral therapy results in 8% to 10% total body weight loss, but patients return to their baseline weight without continued behavioral intervention.

Currently, two weight-loss agents are approved for long-term use.
Sibutramine suppresses appetite by inhibiting reuptake of serotonin, norepinephrine, and dopamine. At 1 year, average weight loss with sibutramine in combination with a low-fat, low-calorie diet is 5.5% of total weight, and in a meta-analysis of randomized controlled trials, patients receiving sibutramine had a 4.6% greater weight reduction than those taking placebo[67].
Orlistat acts by competitively inhibiting intestina11ipase and blocking the absorption of approximately 30% of dietary fat. Average total body weight loss at 1 year is 7.6%, and a 4-year trial reported an average weight loss of 5.2%[68]. In a meta-analysis of 11 randomized controlled trials, patients receiving orlistat lost 2.9% more weight than patients receiving placebo. This drug typically provides an additional 2-kg weight loss over behavioral therapv alone[69].

Resolution of comorbidities

Obesity-related diseases dramatically resolve or improve after bariatric surgery. No other medical or surgical

intervention simultaneously treats as many disease processes as bariatric surgery does.

Comorbidiry resolution after 1aparoscopic Roux-en- Y gastric bypass has been studied extensively (Figure 2)[4,12,15,16,69-74]. For diabetes, resolution is defined as biochemical evidence of resolution (normal fasting plasma glucose or normal hemoglobin A_1J off medication. For other comorbid conditions, the clinical absence of the condition as determined by history, physical examination, clinical testing, or normal values after stopping of medication determines resolution.

In a study of 70 patients who underwent liver biopsy before and after surgery, there was significant improvement in liver steatosis, inflammation, and fibrosis. In these same patients, 80% had resolution of the metabolic syndrome based on the Adult Treatment Panel III criteria (three or more risk factors including abdominal obesity, elevated fasting glucose, hypertension, hypertriglyceridernia, and elevated high-density lipoprotein cholesterol)[70]. Pro inflammatory and pro thrombotic states are included in the definition of metabolic syndrome, but markers for these risk factors are not routine diagnostic tests.

Comorbidities resolve significantly after 1aparoscopic adjustable gastric banding as well. The resolution rates for hypercholesterolemia (74%), gastroesophageal reflux disease (76%-89%), and sleep apnea (94%) after 1aparoscopic adjustable gastric banding are comparable to rates seen with 1aparoscopic Roux-en-Y gastric bypass. Diabetes resolves in 54% to 64% of patients after 1aparoscopic adjustable gastric banding, and hypertension resolves in 55% of patients[50,51]. In their meta-analysis, Buchwald et a13 calculated that diabetes improved or resolved in 86% of patients, hyperlipidemia improved in 70%, hypertension improved or resolved in 78.5%, and obstructive sleep apnea improved or resolved in 83.6%. Diabetic outcomes varied with operative procedure. Diabetes resolved completely in 99% of biliopancreatic diversion/duodenal switch patients, 84% of gastric bypass patients, 72 % of gastroplasty patients, and 48% of gastric banding patients. Biliopancreatic diversion and gastric bypass patients had the most improvements in hyperlipidemia postoperatively (99% and 97% resolution, respectively).

life expectancy

Morbid obesity is associated with decreased life span. The life expectancy of a man in his 20s is 13 years shorter if his BMI is over 45.[75]. In their observational cohort study, Christou et a1[4] found that the 5-year mortality rate in the bariatric surgical group was 0.68% compared with 16.2% in the medically managed patients- an 89% relative risk reduction. Flum and Dellinger[76] evaluated survival after gastric bypass in a retrospective cohort study and found a 27% lower 15-year mortality rate in morbidly obese patients who underwent gastric bypass compared with those who did not. After the surgical patients reached the first postoperative year, the long-term survival advantage increased to 33%.

Is bariatric surgery cost effective?

The direct and indirect costs of morbid obesity are high. Most of the costs of obesity are related to the chronic comorbidities of diabetes, hypertension, and cardiovascular disease. In 2000, the Centers for Disease Control and Prevention estimated the total cost of obesity at $117 billion per year. Several studies evaluated the cost-effectiveness of bariatric surgery. Sampalis et a1[77] compared long-term direct health care costs in 1,035 patients who underwent bariatric surgery and 5,746 agematched and gender-matched obese controls. Open Roux-en- Y gastric bypass accounted for 79% of procedures. The surgical group had lost 67% of their excess body weight at 5 years. At 3.5

years, the cost of surgery was compensated for by a reduction in total costs. At 5 years, there was a 29% reduction in costs for the surgical group.

Medication cost, specifically for antihypertensive and diabetic medications, are reduced by as much as 77% after bariatric surgery[78]. Snow et a1[79] found that after laparoscopic Roux-en- Y gastric bypass, the savings in drug costs was equal to the cost of surgery at 32 months.

The Swedish Obese Subjects trial compared drug use in 51 0 surgically treated patients, 455 medically treated patients, and 958 normal-weight controls. At 6 years, surgical patients had a significant reduction in costs for diabetic and cardiovascular medication, but this was offset by increased use of gastrointestinal medication and nutritional supplernenrs[80]. Assessments of quality-adjusted lifeyears have also been conducted and favor bariatric surgery over nonsurgical treatment of obesity[78].

The future

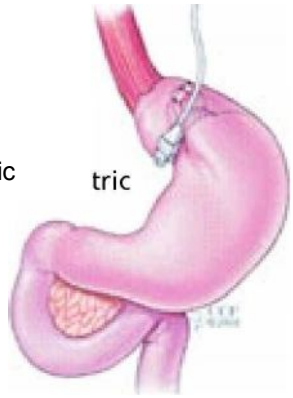
As new technologies emerge, bariatric surgery will undoubtedly change. Endoluminal approaches to bariatric surgery utilizing flexible endoscopy are being investigated. These techniques may further decrease the risk associated with bariatric surgery.

Fig.1& 2: Types and benefits of bariatric surgical procedures

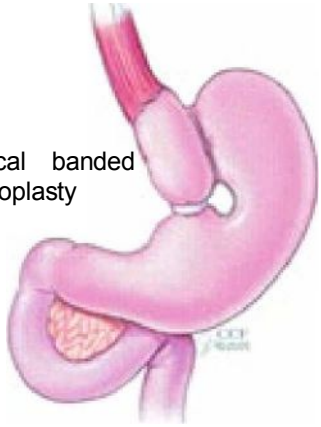
Restrictive procedures

1.

Laparoscopic adjustable gastric banding

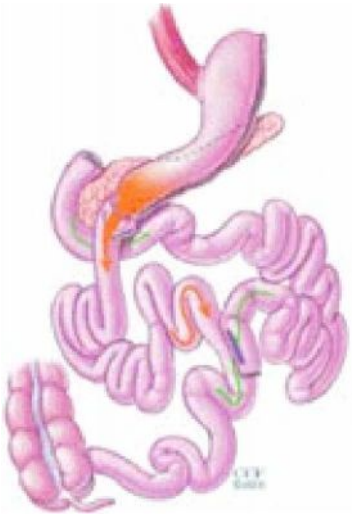


Vertical banded gastroplasty



Malabsorptive procedures

Biliopancreatic diversion



Biliopancreatic diversion with duodenal switch

Combination procedures

Roux-en-Y divided gastric bypass

Migraines
57% resolved

Pseudotumor cerebri
96% resolved[79]

Dyslipidemia hypercholesterolem
63% resolved

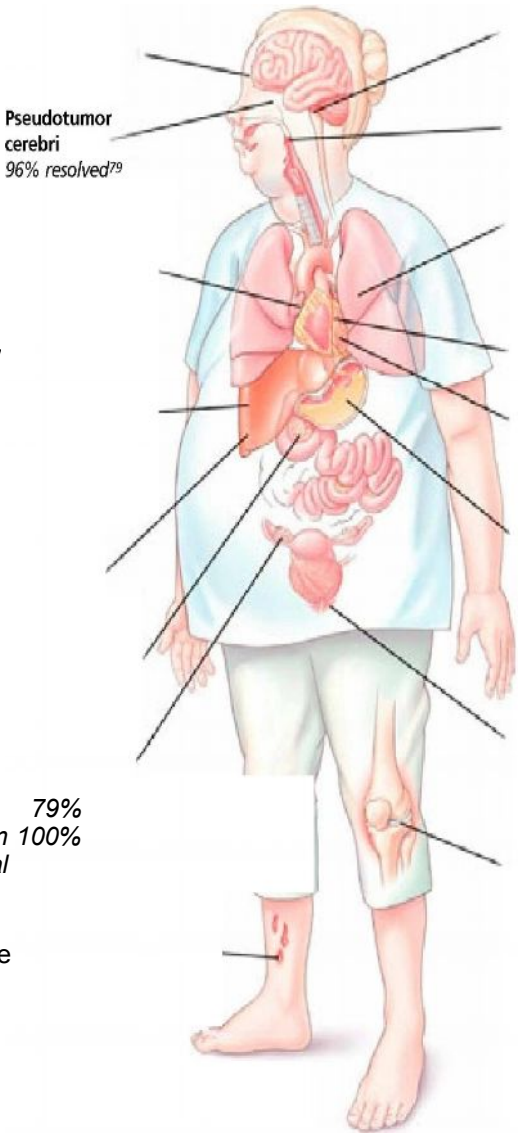
Non-alcoholic fatty liver disease
90% improved steatosis
37% resolution of inflammation 20% resolution of iibrosis?

Metabolic syndrome
80% resolved?

Polycystic ovarian syndrome *79% resolution of hirsuitism 100% resolution of menstrual dysfunction*

Venous statis disease
95% resolved

Quality of life
improved in 95% of patients



Depression
55% resotved

Obstructive sleep apnea
74-98% resolved

Asthma
82% improved or resotved

Cardiovascular disease
82% risk reduction

Hypertension
52-92% resolved

GERD
72-98% resolved

Stress urinary incontinence *44-88% resolved*

Degenerative joint disease *41-76% resolved*

Mortality
89% reduction in 5-year mortality

1.

Table I: Candidates for bariatric surgery

1. Body mass index (BMI) > 40 kg/m^2 or BMI > 35 kg/m^2 with significant Obesity- related co-morbidities.
2. Acceptable operative risk.
3. Documented failure of non surgical weight-loss programs.
4. Psychologically stable with realistic expectations.
5. Well-informed and motivated Patient.
6. Supportive family/social environment.
7. Absence of uncontrolled psychotic or depressive disorder.
8. No active alcohol or substance abuse.

Table II: Obesity-related diseases

Cardiovascular
Congestive heart failure
Coronary artery disease
Hyperlipidemia
Hypertension
Left ventricular hypertrophy
Venous stasis ulcers, thrombophlebitis
Endocrine
Insulin resistance
Polycystic ovary syndrome
Type 2 diabetes
Gastrointestinal and hepatobiliary
Abdominal hernia
Gallstones
Gastroesophageal reflux disease
Nonalcoholic fatty liver disease
Genitourinary
Stress urinary incontinence
Urinary tract infections
Asthma
Obesity hypoventilation syndrome
Obstructive sleep apnea
Hematopoietic
Deep venous thrombosis
Pulmonary embolism
Musculoskeletal
Carpal tunnel syndrome
Degenerative joint disease
Gout
Plantar fasciitis
Neurologic and psychiatric
Anxiety
Depression
Pseudo tumor cerebri
Stroke
Obstetric and gynecologic
Fetal abnormalities and infant mortality
Gestational diabetes
Infertility
Miscarriage
Pulmonary
Pulmonary hypertension

Table III: Risk of laparoscopic bariatric procedures

Complication	Lap. Gastric bypass	Lap. Adjustable gastric banding
Conversion to open procedure	0% - 8%	0% - 3%
Bleeding	0.4% - 4%	0.1%
Bowel leak	0% - 4.4%	0.5% - 0.8%
Wound infection	0% - 8.7%	0.1% - 8.8%
Deep vein thrornbosis	0% - 1.3%	0.01% - 0.15%
Pulmonary embolism	0% - 1.1%	0.1%
Mortality	0% - 2%	0% - 0.7%

References

1. Hedley AA, Ogden Cl, Johnson Cl, Carroll MD, Curtin CR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. JAMA 2004; 291 :2847-2850.
2. NIH conference. Gastrointestinal surgery for severe obesity. Consensus Development Conference Panel. Ann Intern Med 1991; 115:956-961.
3. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004; 292:1724-1737.
4. Christou NV, Sampalis JS, Liberman M, et al. Surgery decreases long term mortality, morbidity, and health care use in morbidly obese patients. Ann Surg 2004; 240:416- 423; discussion 423-424.
5. Kim CH, Sarr MG. Severe reflux esophagitis after vertical banded gastroplasty for treatment of morbid obesity. Mayo Clin Proc 1992; 67:33-35.
6. Nightengale Ml, Sarr MG, Kelly KA, Jensen MD, Zinnsmeister AR, Palumbo PJ. Prospective evaluation of vertical banded gastroplasty as the primary operation for morbid obesity. Mayo Clin Proc 1991; 66:773-782.
7. Maclean ID, Rhode BM, Forse RA. late results of vertical banded gastroplasty for morbid and super obesity. Surgery 1990; 107:20-27.
8. Ramsey-Stewart G. Vertical banded gastroplasty for morbid obesity: weight loss at short and long-term follow up. Aust N Z J Surg 1995; 65:4-7.
9. Balsiger BM, Poggio JL, Mai J, Kelly KA, Sarr MG. Ten and more years after vertical banded gastroplasty as primary operation for morbid obesity. J Gastrointest Surg 2000; 4:598--605.
10. Wittgrove AC, Clark GW, Tremblay LJ. Laparoscopic gastric bypass, Roux-en-Y: preliminary report of five cases. Obes Surg 1994; 4:353-357.
11. Abdel-Galil E, Sabry AA. Laparoscopic Roux-en-Y gastric bypassevaluation of three different techniques. Obes Surg 2002; 12 :639--642.
12. DeMaria EJ, Sugerman HJ, Kellum JM, Meador JG, Wolfe LG. Results of 281 consecutive total laparoscopic Roux-en-Y gastric bypasses to treat morbid obesity. Ann Surg 2002; 235:640--645; discussion 645--647.
13. Higa KD, Ho T, Boone KB. Laparoscopic Roux-en- Y gastric bypass: technique and 3-year follow-up. J Laparoendosc Adv Surg Tech A 2001; 11 :377-382.
14. Papasavas PK, Hayetian FD, Caushaj PF, et al. Outcome analysis of laparoscopic Roux-en- Y gastric bypass for morbid obesity. The first 116 cases. Surg Endosc 2002; 16:1653-1657.
15. Schauer PR, Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes after laparoscopic Roux-en- Y gastric bypass for morbid obesity. Ann Surg 2000; 232:515-529.
16. Wittgrove AC, Clark GW. Laparoscopic gastric bypass, Roux-en- Y- 500 patients: technique and results, with 3-60 month follow-up. Obes Surg 2000; 10:233-239.
17. Lujan JA, Frutos MD, Hernandez Q, et al. Laparoscopic versus open gastric bypass in the treatment of morbid obesity: a randomized prospective study. Ann Surg 2004; 239:433-437.
18. Nguyen NT, Goldman C, Rosenquist CJ, et al. Laparoscopic versus open gastric bypass: a randomized study of outcomes, quality of life, and costs. Ann Surg 2001; 234:279-289; discussion 289-291.
19. Westling A, Gustavsson S. Laparoscopic vs open Roux-en-Y gastric bypass: a prospective, randomized trial. Obes Surg 2001; 11 :284-292.
20. Podnos YD, Jimenez JC, Wilson SE, Stevens CM, Nguyen NT. Complications after laparoscopic gastric bypass: a review of 3464 cases. Arch Surg 2003; 138:957-961.
21. Schauer P, Ikramuddin S, Hamad G, Gourash W. The learning curve for laparoscopic Roux-en- Y gastric bypass is 100 cases. Surg Endosc 2003; 17:212-215.
22. Geerts WH, Pineo GF, Heit JA, et al. Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004; 126(3 Suppl):338S-400S.
23. Wille-Jorgensen P, Ott P. Predicting failure of low-dose prophylactic heparin in general surgical procedures. Surg Gynecol Obstet 1990; 171:126-130.
24. Heit JA. Venous thromboembolism epidemiology: implications for prevention and management. Semin Thromb Hemost 2002; 28(suppl 2):3-13.
25. Mertens I, Van Gaal LF. Obesity, haemostasis and the fibrinolytic system. Obes Rev 2002; 3:85-101.
26. Nguyen NT, Cronan M, Braley S, Rivers R, Wolfe BM. Duplex ultrasound assessment of femoral venous flow during laparoscopic and open gastric bypass. Surg Endosc 2003; 17:285-290.
27. Wu EC, Barba CA. Current practices in the prophylaxis of venous thromboembolism in bariatric surgery. Obes Surg 2000; 10:7-13; discussion 14.
28. Sapala JA, Wood MH, Schuhknecht Mp, Sapala MA. Fatal pulmonary embolism after bariatric operations for morbid obesity: a 24-year retrospective analysis. Obes Surg 2003; 13:819-825.
29. Keeling WB, Haines K, Stone PA, Armstrong PA, Murr MM, Shames ML. Current indications for preoperative inferior vena cava filter insertion in patients undergoing surgery for morbid obesity. Obes Surg 2005; 15:1009-1012.
30. Blachar A, Federle Mp, Pealer KM, Ikramuddin S, Schauer PRo Gastrointestinal complications of laparoscopic Roux-en-Y gastric bypass surgery: clinical and imaging findings. Radiology 2002; 223:625--632.
31. Oliak D, Ballantyne GH, Davies RJ, Wasielewski A, Schmidt HJ. Short-term results of laparoscopic gastric bypass in patients with BMI > or = 60. Obes Surg 2002; 2:643-647.
32. Nguyen NT, Stevens CM, Wolfe BM. Incidence and outcome of anastomotic stricture after laparoscopic gastric bypass. J Gastrointest Surg 2003; 7:997-1003; discussion 1003.
33. Sugerman HJ, Brewer WH, Shiffman ML, et al. A multicenter, placebo-controlled, randomized, double-blind, prospective trial of prophylactic ursodiol for the prevention of gallstone formation following gastric-bypass-induced rapid weight loss. Am J Surg 1995; 169:91-96; discussion 96-97.
34. Iglezias Brandao de Oliveira C, Adami Chaim E, da Silva BB. Impact of rapid weight reduction on risk of cholelithiasis after bariatric surgery. Obes Surg 2003; 13:625-628.

35. Fobi M, Lee H, Igwe D, et al. Prophylactic cholecystectomy with gastric bypass operation: incidence of gallbladder disease. Obes Surg 2002; 12:350-353.
36. Mason EE, Renquist KE. Gallbladder management in obesity surgery. Obes Surg 2002; 12:222-229.
37. Hamad GG, Ikramuddin S, Gourash WF, Schauer PRo Elective cholecystectomy during laparoscopic Roux-en- Y gastric bypass: is it worth the wait? Obes Surg 2003; 13:76-81.
38. Bloomberg RD, Fleishman A, Nalle JE, Herron DM, Kini S. Nutritional deficiencies following bariatric surgery: what have we learned? Obes Surg 2005; 15:145-154.
39. Coates PS, Fernstrom JD, Fernstrom MH, Schauer PR, Greenspan SL. Gastric bypass surgery for morbid obesity leads to an increase in bone turnover and a decrease in bone mass. J Clin Endocrinol Metab 2004; 89:1061-1065.
40. Brolin RE, Leung M. Survey of vitamin and mineral supplementation after gastric bypass and biliopancreatic diversion for morbid obesity. Obes Surg 1999; 9:150-154.
41. Higa KD, Boone KB, Ho T. Complications of the laparoscopic Rouxen-Y gastric bypass: 1,040 patients-what have we learned? Obes Surg 2000; 10:509-513.
42. Livingston EH, Huerta S, Arthur D, Lee S, DeShields S, Heber D. Male gender is a predictor of morbidity and age a predictor of mortality for patients undergoing gastric bypass surgery. Ann Surg 2002; 236:576-582.
43. Flum DR, Salem L, Elrod JA, Dellinger Lp, Cheadle A, Chan L. Early mortality among Medicare beneficiaries undergoing bariatric surgical procedures. JAMA 2005;294:1903-1908.
44. Zingmond DS, McGory ML, Ko CY. Hospitalization before and after gastric bypass surgery. JAMA 2005; 294:1918-1924.
45. Chapman AE, Kiroff G, Game P, et al. Laparoscopic adjustable gastric banding in the treatment of obesity: a systematic literature review Surgery 2004; 135:326-351.
46. Belachew M, Belva PH, Desaive C. Long-term results of laparoscopic adjustable gastric banding for the treatment of morbid obesity. Obes surg 2002; 12:564-568.
47. Biertho L, Steffen R, Ricklin T, et al. Laparoscopic gastric bypass versus laparoscopic adjustable gastric banding: a comparative study of 1,200 cases. J Am Coli surg 2003; 197:536-544; discussion 544-545.
48. Parikh Ms, shen R, Weiner M, Siegel N, Ren CJ. Laparoscopic bariatric surgery in super-obese patients (BMI > 50) is safe and effective: a review of 332 patients. Obes surg 2005; 15:858-863.
49. O'Brien PE, Dixon JB. Weight loss and early and late complicationsthe international experience. Am J surg 2002; 184:425-455.
50. O'Brien PE, Dixon JB. Lap-band: outcomes and results. J Laparoendosc Adv surg Tech A 2003; 13:265-270.
51. O'Brien PE, Dixon JB, Brown W, et al. The laparoscopic adjustable gastric band (Lap-Band): a prospective study of medium-term effects on weight, health and quality of life. Obes surg 2002; 12:652--660.
52. Nguyen NT, Ho Hs, Palmer Ls, Wolfe BM. A comparison study of laparoscopic versus open gastric bypass for morbid obesity. J Am Coli surg 2000; 191:149-155; discussion 155-157.
53. Fernandez AZ Jr, Demaria EJ, Tichansky Ds, et al. Multivariate analysis of risk factors for death following gastric bypass for treatment of morbid obesity. Ann surg 2004; 239:698-702; discussion 702-703.
54. Fernandez AZ Jr, DeMaria EJ, Tichansky Ds, et al. Experience with over 3,000 open and laparoscopic bariatric procedures: multivariate analysis of factors related to leak and resultant mortality. surg Endosc 2004; 18:193-197.
55. Higa KD, Boone KB, Ho T, Davies OG. Laparoscopic Roux-en-Y gastric bypass for morbid obesity: technique and preliminary results of our first 400 patients. Arch surg 2000; 135:1029-1033; discussion 1033-1034.
56. Angrisani L, Alkilani M, Basso N, et al; Italian Collaborative Study Group for the Lap-Band System. Laparoscopic Italian experience with the Lap-Band. Obes surg 2001; 11 :307-310.
57. Cadiere GB, Himpens J, Hainaux B, Gaudissart Q, Favretti 5, segato G. Laparoscopic adjustable gastric banding. semin Laparosc surg 2002; 9: 105-114.
58. Dargent J. Laparoscopic adjustable gastric banding: lessons from the first 500 patients in a single institution. Obes surg 1999; 9:446-452.
59. Ren CJ, Horgan 5, Ponce J. US experience with the LAP-BAND system. Am J surg 2002; 184:465-505. 60. Rubenstein RB. Laparoscopic adjustable gastric banding at a U.S. center with up to 3- year follow-up. Obes surg 2002; 12:380-384.
61. WJ, Swanson Ms, MacDonald KG, et al. Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus. Ann surg 1995; 222:339-350; discussion 350-352.
62. Watkins BM, Montgomery KF, Ahroni JH. Laparoscopic adjustable gastric banding: early experience in 400 consecutive patients in the USA. Obes surg 2005; 15:82-87.
63. Farkas DT, Vemulapalli P, Haider A, Lopes JM, Gibbs KE, Teixeira JA. Laparoscopic Roux-en- Y gastric bypass is safe and effective in patients with a BMI" 60. Obes surg 2005; 15:486-493.
64. Dolan K, Hatzifotis M, Newbury L, Fielding G. A comparison of laparoscopic adjustable gastric banding and biliopancreatic diversion in superobesity. Obes surg 2004; 14: 165-169.
65. Ponce J, Paynter 5, Fromm R. Laparoscopic adjustable gastric banding: 1,014 consecutive cases. J Am Coli surg 2005; 201 :529-535.
66. Anderson JW, Konz EC, Frederich RC, Wood CL. Long-term weightloss maintenance: a meta-analysis of US studies. Am J Clin Nutr 2001; 74:579-584.
67. Padwal R, Li sK, Lau DC. Long-term pharmacotherapy for overweight and obesity: a systematic review and meta-analysis of randomized controlled trials. Int JObes Relat Metab Disord 2003; 27:1437-1446.
68. Torgerson Js, Hauptman J, Boldrin MN, Sjostrom L. XENical in the prevention of diabetes in obese subjects (XENDOs) study: a randomized study of orlistat as an adjunct to lifestyle changes for the prevention of type 2 diabetes in obese patients. Diabetes Care 2004; 27:155-161.
69. Haddock CK, Poston WS, Dill PL, Foreyt Jp, Ericsson M. Pharmacotherapy for obesity: a quantitative analysis of four decades of published randomized clinical trials. Int JObes Relat Metab Disord 2002; 26:262-273.
70. Mattar sG, Velcu LM, Rabinovitz M, et al. Surgically-induced weight loss significantly improves nonalcoholic fatty liver disease and the metabolic syndrome. Ann surg 2005; 242:610-617; discussion 618-620.
71. Schauer PR, Burguera B, Ikramuddin 5, et al. Effect of laparoscopic Roux-en Y Gastric bypass on type 2 diabetes mellitus. Ann surg 2003; 238:467-484; discussion 84-85.
72. Sugerman HJ, Felton WL 3rd, Sisrnanis A, Kellum JM, DeMaria EJ, Sugerman EL. Gastric surgery for pseudotumor cerebri associated with severe obesity. Ann surg 1999; 229:634--640; discussion 640--642.
73. Sugerman HJ, Sugerman EL, Wolfe L, Kellum JM, Schweitzer MA, DeMaria EJ .Risks and benefits of gastric bypass in morbidly obese patients with severe venous stasis disease. Ann surg 2001; 234:41-46.
74. Eid GM, Cottam DR, Velcu LM. Effective treatment of polycystic ovarian syndrome with Roux-en-Y gastric bypass. surg Obes Relat Dis 2005; 1 :77-80.
75. Fontaine KR, Redden DT, Wang C, Westfall AO, Allison DB. Years of life lost due to obesity. JAMA 2003; 289:187-193.
76. Flum DR, Dellinger EP. Impact of gastric bypass operation on survival: a population- based analysis. J Am Coli surg 2004; 199:543-551.
77. Sampalis Js, Liberman M, Auger 5, Christou NV. The impact of weight reduction surgery on health-care costs in morbidly obese patients. Obes surg 2004; 14:939-947.
78. Craig BM, Tseng Ds. Cost-effectiveness of gastric bypass for severe obesity. Am J Med 2002; 113:491-498.
79. Snow LL, Weinstein Ls, Hannon JK, et al. The effect of Roux-en-Y gastric bypass on prescription drug costs. Obes surg 2004; 14:1031-1035.
80. Narbro K, Agren G, Jonsson E, et al. Pharmaceutical costs in obese individuals: comparison with a randomly selected population sample and long-term changes after conventional and surgical treatment: the 50S intervention study. Arch Intern Med 2002; 162:2061-2069.