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Quick fix or long-term cure? Pros and cons of bariatric surgery

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Abstract

The past decade has seen an enormous increase in the number of bariatric, or weight loss, operations performed. This trend is likely to continue, mirroring the epidemic of obesity around the world and its rising prevalence among children. Bariatric surgery is considered by many to be the most effective treatment for obesity in terms of maintenance of long-term weight loss and improvement in obesity-related comorbid conditions. Although overly simplified, the primary mechanisms of the surgical interventions currently utilized to treat obesity are the creation of a restrictive or malabsorptive bowel anatomy. Operations based on these mechanisms include the laparoscopic adjustable gastric band and laparoscopic vertical sleeve gastrectomy (considered primarily restrictive operations), the laparoscopic biliopancreatic diversion with or without a duodenal switch (primarily malabsorptive operation), and the laparoscopic Roux-en-Y gastric bypass (considered a combination restrictive and selective malabsorptive procedure). Each operation has pros and cons. Important considerations, for the patient and surgeon alike, in the decision to proceed with bariatric surgery include the technical aspects of the operation, postoperative complications including long-term nutritional problems, magnitude of initial and sustained weight loss desired, and correction of obesity-related comorbidities. Herein, the pros and cons of the contemporary laparoscopic bariatric operations are reviewed and ongoing controversies relating to bariatric surgery are discussed: appropriate patient selection, appropriate operation selection for an individual patient, surgeon selection, and how to measure success after surgery.

Introduction

Obesity is a problem of epidemic proportions in many developed countries and is becoming an increasing concern in developing countries, which have historically dealt with the burden of undernutrition [1]. Obesity is a major health problem because of its serious health consequences, increased mortality risk, and associated social, psychological and economic costs. Presently, bariatric surgery is the only available treatment for morbid obesity that consistently achieves and maintains substantial weight loss, decreases the incidence and severity of obesity-related comorbidities, and improves overall quality of life and survival [2].

The first bariatric surgery performed in humans was reported in 1954 [3]. The jejunoileal bypass was a purely malabsorptive procedure, bypassing the vast majority of the small intestine, thus limiting the ability of the patient to digest and absorb nutrients regardless of the amount consumed. Unfortunately, this led to several long-term health consequences including severe protein and micronutrient deficiencies, ultimately leading to its abandonment in the late 1970s. Due to the continued demand for weight loss operations, subsequent procedures were developed that focused more on gastric restriction and limited malabsorption. The most commonly performed bariatric operations at present are the Roux-en-Y gastric bypass and the adjustable gastric band. Other bariatric operations include the vertical sleeve gastrectomy, which seems to be gaining in popularity recently, and the biliopancreatic diversion with or without a duodenal switch, an operation generally reserved for the

most severely obese patient. Although the mechanism of weight loss with these operations tends to rely on restriction of food intake, malabsorption of ingested food, or a combination of the two, the exact mechanism(s) appears to be far more complex, implicating hormonal, inflammatory, central nervous system and gut microbial factors [4-6].

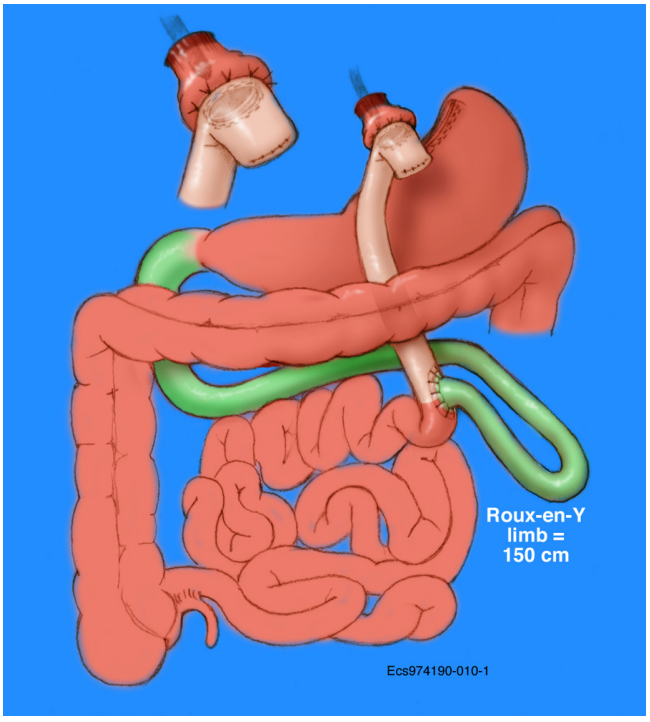
Bariatric operations were performed infrequently until the introduction of laparoscopic technology to bariatric operations in the mid 1990s [7-9]. Laparoscopy allows surgery to be performed through small incisions, minimizing pain and wound complications associated with traditional open interventions. Commensurate with the growing obesity epidemic, the promulgation of guidelines regarding patient selection, and the increasing use of laparoscopy, the stage was set for a profound growth in the rate of performance of bariatric operations as documented by the increase from 13,000 procedures in 1998 to over 220,000 by 2008. Unfortunately, comparing the success and complications of the contemporary bariatric operations has been difficult, in part because there are few direct prospective comparisons, controversies regarding how best to measure outcomes including success, and inconsistent monitoring of nutritional and other complications.

Contemporary bariatric operations

Laparoscopic Roux-en-Y gastric bypass

Laparoscopic Roux-en-Y gastric bypass is considered by many to be the gold standard bariatric operation and is the most commonly performed bariatric operation in the United States (**Figure 1**). Although oversimplified, the mechanism of action is generally considered threefold: a restriction in food intake, selective malabsorption, and the development of dumping syndrome, limiting patients' consumption of triggering foods (e.g. simple sugars). Long-term follow-up data are available, in some cases up to nearly two decades [10]. Weight loss averages 65% for most patients with over 85% of patients losing and maintaining 50% initial excess weight loss. Contemporary series have documented mortality rates of approximately 0.1% and serious early complication rates of 5%. Long-term issues with fat malabsorption, protein-energy malnutrition and micronutrient deficiencies are relatively uncommon and can usually be managed with oral supplementation. Reoperations are infrequently needed for failures or complications. Despite the high likelihood of success both in weight loss and correction of obesity-related medical conditions, the operation requires advanced laparoscopic surgical skills with a learning curve as long as 100 cases, and a 10-15% long-term failure rate.

Figure 1. Laparoscopic Roux-en-Y gastric bypass



In this technique, a small (about 30 ml) gastric pouch is created by stapling across the upper stomach and physically separating the proximal and distal portions of the stomach. A loop of jejunum (Roux limb, indicated in pink) is then connected to the small upper gastric pouch while the pancreaticobiliary limb (indicated in green) is connected to the small bowel a certain length from the gastrojejunal anastomosis (most commonly, 75-150 cm), creating a variable length common channel.

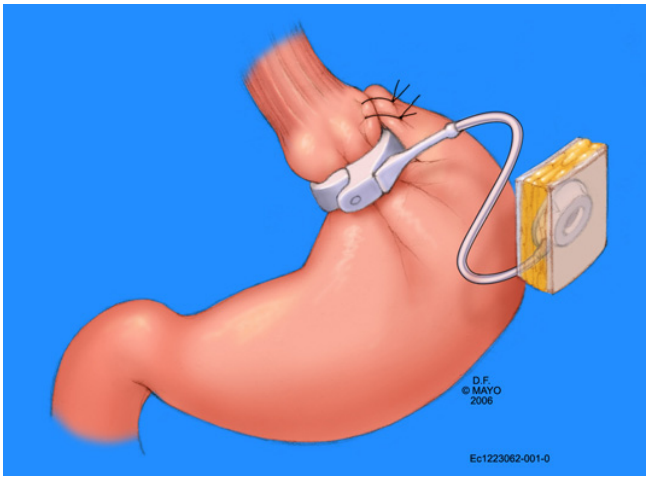
Laparoscopic adjustable gastric band

Laparoscopic adjustable gastric band is the least invasive and most commonly performed bariatric operation worldwide (**Figure 2**). Adjustment of the device is accomplished by inflating a subcutaneous port with saline. This device can be readily reversed laparoscopically if necessary. Furthermore, this bariatric surgery has low risk of mortality and long-term metabolic and nutritional complications are uncommon. Although early reports described a 35% initial excess weight loss on average by most patients, more recent reports describe not only high failure rates but also high reintervention rates for both band-related complications (e.g. band erosion, leakage, slippage, port infection and esophageal dilatation) and failure to lose weight such that as few as 54% of patients may have their band in place after 10 years [11-14].

Laparoscopic biliopancreatic diversion with duodenal switch

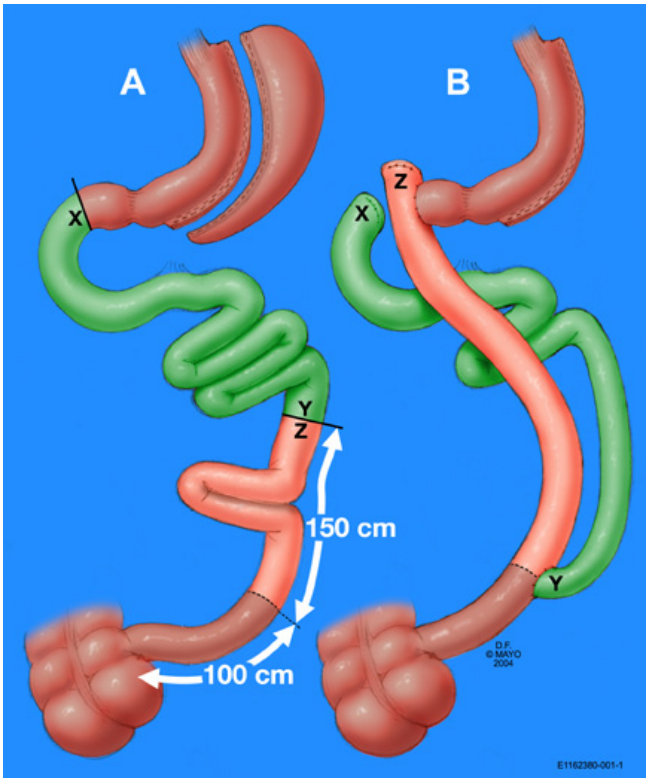
First reported in 1998 as an open operation [15], the laparoscopic biliopancreatic diversion with a duodenal

Figure 2. Laparoscopic adjustable gastric band



This technique consists of the placement of an adjustable silicone ring around the upper part of the stomach, creating a small gastric pouch that restricts food intake.

Figure 3. Laparoscopic biliopancreatic diversion with a duodenal switch



This technique involves a sleeve gastrectomy with preservation of the pylorus as the first stage of the operation (Figure 3a) followed by creation of a long Roux limb with a correspondingly short common channel (Figure 3b). The resulting stomach pouch has a capacity of about 250 ml and malabsorption results from a distal Roux-en-Y reconstruction of the bowel with a pancreaticobiliary limb (indicated in green), an alimentary limb (indicated in pink) and a common channel of usually about 100 cm.

switch (**Figures 3A and 3B**) derives its benefit mostly from promoting malabsorption; however, the concomitant sleeve gastrectomy also creates some degree of restriction of food intake. This is the most technically challenging bariatric operation and, as such, results in consistently higher rates of perioperative complications and death. Unfortunately, this is accompanied by only a marginally higher percentage of successful long-term weight loss and resolution of obesity-related medical problems compared to the laparoscopic Roux-en-Y gastric bypass [16]. In addition, a predictable occurrence of nutritional deficiencies, sometimes severe, including protein-calorie malnutrition, fat malabsorption and a number of micronutrient deficiencies is seen long-term, making this operation unappealing to many surgeons and patients [17].

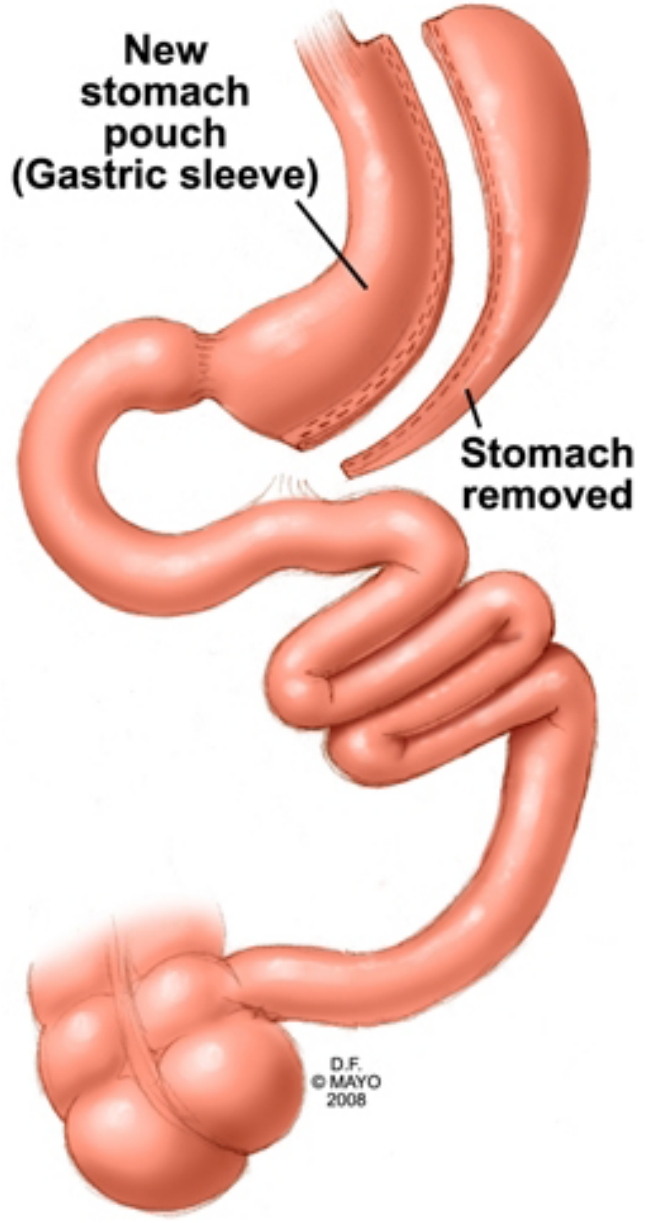
Laparoscopic vertical sleeve gastrectomy

Laparoscopic vertical sleeve gastrectomy was first reported as an initial stage of the laparoscopic biliopancreatic diversion with a duodenal switch in super morbidly obese or high-risk patients (**Figure 4**) [18], it was observed that some patients who had undergone the laparoscopic vertical sleeve gastrectomy lost significant weight and did not require the second malabsorptive stage. As a consequence, and due to many surgeons' dissatisfaction with the long-term results of laparoscopic adjustable gastric band, laparoscopic vertical sleeve gastrectomy has gained popularity in recent years and is now performed as a stand-alone procedure for weight loss. Since it is relatively recently that large numbers of this operation are being performed, long-term data are lacking. Nevertheless, available data suggest that perioperative and long-term complication rates are about the same as laparoscopic Roux-en-Y gastric bypass, and higher than laparoscopic adjustable gastric band. Weight loss and improvement in obesity-related comorbidities are less than laparoscopic Roux-en-Y gastric bypass but better than laparoscopic adjustable gastric band [19,20]. Importantly, because of the lack of long-term (> 5 years) follow-up data and a paucity of data in individuals over 65 years of age, the Centers for Medicare and Medicaid Services (CMS) in a recent National Coverage Determination proposed to limit coverage of laparoscopic vertical sleeve gastrectomy to properly designed randomized trials [21].

Pros and cons

Given the benefits of the bariatric operations described and the disappointing long-term benefits of behavioral

Figure 4. Laparoscopic vertical sleeve gastrectomy



This operation consists of a partial gastrectomy, in which the majority of the greater curvature of the stomach is removed and a tubular stomach is created.

Table 1. Pros and cons of bariatric surgery

Pros	Cons
Initial and sustained weight loss	Initial failure to lose weight
Resolution of obesity-related comorbidities	Potential complication: perioperative, surgical, gastrointestinal, nutritional and psychological
Improved mortality	Initial costs
Reduction in obesity-related health risks	Weight regain
Improved quality of life	Permanency
Psychosocial benefit	

(i.e. diet and exercise) and pharmacological approaches with regards to both the magnitude of the initial and sustained weight loss, and improvement in comorbidities, what is preventing more morbidly obese individuals from undergoing bariatric surgery? In addition to the pros of bariatric surgery, there are also several cons that must be considered (**Table 1**). From a practical standpoint, given the vast number of individuals that are potential candidates for surgery, there are an insufficient number of surgeons with sufficient expertise in these procedures to perform the necessary operations. There are also patient-related factors that may preclude their candidacy for surgery unless modified. For example, patients with binge eating disorder may continue this disordered eating behavior postoperatively, resulting in surgical failure initially or eventual weight regain. Active depression or other significant psychological disorders may result in similarly poor outcomes [22,23]. Clearly, the most successful bariatric surgery patients are those who also demonstrate active lifestyle changes regarding both improved eating patterns and physical activity [2]. Concerns over unknown long-term consequences of some of these operations also persist, particularly because many bariatric surgery patients are young, and consequently have a long life expectancy. Certainly, no one wants to face a situation reminiscent of the abandoned jejunoileal bypass described previously. The development of persistent and well-described unfavorable surgical (symptomatic cholelithiasis, band-related complications, anastomotic strictures and leaks, bowel obstruction) consequences requiring additional surgery, and gastrointestinal (bleeding, small bowel bacterial overgrowth, variety of upper and lower gastrointestinal symptoms) and nutritional (steatorrhea, protein-calorie malnutrition, micronutrient deficiencies) problems [24,25] are additional long-term concerns. These metabolic and nutritional consequences require lifelong monitoring and micronutrient supplementation [26,27].

For those obese patients with multiple medical comorbidities and a resultant poor quality of life and reduced life expectancy, the potential unfavorable consequences of bariatric surgery described above may be surpassed by the potential benefits. No less invasive treatment than bariatric surgery exists that is effective in as many ways and over the long-term for the motivated patient (depending upon the operation performed). Furthermore, despite the initial surgery-related costs, the economics of this form of treatment seem to favor bariatric surgery (depending, of course, upon the surgery's success

and the need for any medical or surgical treatment for complications that develop) [28].

Controversies

Patient Selection

Current guidelines for patient selection for bariatric surgery are based on a National Institutes of Health (NIH) consensus statement from 1991 [29]. These criteria include individuals with a body mass index (BMI) greater than 40 kg/m^2 or 35 kg/m^2 if obesity-related comorbidities exist, who have failed other means of weight loss and are psychologically stable and able to make the diet, exercise and behavioral changes necessary to be maintain long-term success after surgery. Importantly, these guidelines were developed before the application of laparoscopy to bariatric procedures. The reduction in perioperative morbidity and mortality resulting from the laparoscopic approach along with increased surgical experience, together with consistent and sustained improvements in weight loss and obesity-related comorbidities have since increased the acceptance of bariatric surgery as a treatment option [30-33]. To this end, the U.S. Food and Drug Administration (FDA) recently approved the laparoscopic adjustable gastric band for use in diabetics with a BMI as low as 30 kg/m^2 [34]. The lowering of the BMI criterion for eligibility for bariatric surgery appears likely to continue.

An exciting area of active research centers on the role of bariatric surgery (sometimes referred to as "metabolic surgery" in this context) as a treatment of type 2 diabetes mellitus [35]. It has long been observed that hyperglycemia often resolves in the early postoperative period independent of weight loss after bypass operations in type 2 diabetics. This implies an, as yet, incompletely defined role of the enteroinsular axis in this process, with the result of enhanced beta-cell sensitivity to glucose and normalized peripheral insulin sensitivity [36,37]. Long-awaited randomized trials have recently demonstrated the superiority of bariatric operations together with medical therapy compared with medical therapy alone [38,39]. The positive effect of bariatric surgery has led to a number of consensus statements supporting bariatric surgery for the treatment of type 2 diabetes [40,41] and has elicited calls for lowering the BMI criteria for surgical intervention in less obese diabetics.

Weight loss failure is often arbitrarily defined by insurance providers as unsuccessful weight loss after 6-12 months of attempted medically-supervised weight loss. Because few data exist that support the long-term success of any non-surgical weight loss intervention in the morbidly obese population, the need for this criterion is not clear. Similarly, with the exception of severe unstable mental illness, there are few data to suggest that anything more than a psychological evaluation to assure that patients do not suffer from these conditions is warranted before bariatric surgery. Although it has been suggested that addressing other emotional and behavioral conditions may aid patients in understanding, adjusting and complying with postoperative lifestyle changes, once again, supportive data are lacking at this time.

Extreme obesity in the adolescent population is increasingly common with similar causation and health risks as adults. What should be done about the performance of weight loss surgery in adolescents? Currently, the criteria for bariatric surgery in adolescents are restrictive. There are a number of unique issues present in adolescents that may justify these more conservative guidelines including concerns over nutrition requirements, linear growth, future pregnancies, unique psychology and informed consent/assent [42-44]. Nevertheless, several preliminary series have reported promising results in adolescents after bariatric procedures. As the safety and efficacy of these procedures in this patient group become better established, the criteria may eventually be relaxed.

Measuring success

Comparison of the published outcomes of contemporary bariatric operations is difficult, in part, because the reports often use different measures of success. Although success may be judged using a number of outcome measures, weight loss tends to be the most commonly used metric. Measuring success based on change in weight, however, is more complicated than simply comparing the amount of weight lost. Weight-related measures such as percent initial excess weight loss are commonly used as an outcome of weight loss; however, the method for determining initial excess weight is rarely defined. Indeed, the best method for determining initial excess weight remains controversial. For example, options include ideal body weight calculation (e.g. Hamwi method), back-calculation from a healthy BMI (e.g. 25 kg/m^2), or Metropolitan Life tables for initial weight (also a range of acceptable weights). In addition, some studies simply report the absolute body weight loss or % BMI reduction as the measure of weight loss. Direct determination of body composition is infrequently reported. The reporting of improvement or resolution of obesity-related comorbidities has also been hampered by inconsistent definitions of success and reporting. Reporting of quality of life and patient satisfaction suffer from the same problems [45]. Fortunately, pleas for consistent reporting measures have resulted in improvements and ongoing efforts to risk-adjust outcomes will likely improve the ability to differentiate the true value of the operations [46,47]. Hope for future standardization of

measurements and outcome comparisons rests with large, multi-institutional databases such as the Longitudinal Assessment of Bariatric Surgery (LABS) consortium, Iowa Bariatric Surgery Registry (IBSR), Bariatric Outcomes Longitudinal Database (BOLD) and the American College of Surgeons Bariatric Surgery Network (ACSBSN).

Operation selection

The decision to perform one bariatric procedure over another ultimately depends not only on the surgeon's experience but also on a number of patient-related considerations, including the patient's weight, comorbidities, reliability and compliance with lifestyle modifications and follow-up. Furthermore, it is important to recognize that the decision is often based on the biases and abilities of the surgeon along with patient's preference and acceptance of risks. Few prospective studies, let alone randomized trials, have directly compared the currently accepted operations described previously (**Table 2**). Large retrospective comparisons routinely favor laparoscopic biliopancreatic diversion on the basis of the percentage of patients who will achieve success, defined as weight loss and improvement in obesity-related medical conditions postoperatively. Laparoscopic Roux-en-Y gastric bypass generally follows closely in terms of success followed by laparoscopic vertical sleeve gastrectomy and laparoscopic adjustable gastric band.

The type of bariatric procedure performed is important in understanding both the magnitude of the weight loss and the potential postoperative risks. Perioperative morbidity and mortality tend to occur in proportion to effectiveness with the laparoscopic adjustable gastric band being least likely to cause problems followed by the laparoscopic vertical sleeve gastrectomy, laparoscopic Roux-en-Y gastric bypass and laparoscopic biliopancreatic diversion. The laparoscopic Roux-en-Y gastric bypass, particularly its very long Roux limb variant, and the laparoscopic biliopancreatic diversion, both leaving a relatively short common channel, are most likely to cause significant macronutrient and micronutrient deficiencies. On the basis of this information, the laparoscopic Roux-en-Y gastric bypass is often considered, and we believe should be, the preferred bariatric operation for the morbidly obese patient, unless there are compelling reasons to choose the other options described, or in the context of a clinical trial. The laparoscopic Roux-en-Y gastric bypass may be particularly well suited to individuals who consume excessive "sweets" because the dumping syndrome will result after consumption of these high-caloric, simple sugar-containing foods and beverages. Laparoscopic biliopancreatic diversion is often then reserved for the super-obese patient (BMI > 50 kg/m^2). The laparoscopic adjustable gastric band is the least invasive weight loss surgery and can also be reversed if necessary, a potential advantage particularly for obese adolescents.

Table 2. Comparison of bariatric surgery outcomes

	LAGB	LVSG	LRYGB	LBPD-DS
Mortality (%)	0.1	0.4	0.5	1.1
Complications early/late (%)	2 / 60	7 / 24	7 / 15	7 / 55
Excess weight loss (%)	47	47	62	70
Diabetes resolved (%)	47	66	83	99
Hypertension resolved (%)	43		67	83
Cholesterol improved (%)	78		95	87
Obstructive sleep apnea resolved (%)	95		80	92
Long-term failure (< 50% excess weight loss)	> 50	30	15	< 5

Data compiled from references [16,51,52].

Surgeon selection

Bariatric surgery is a complex procedure requiring commitment on the part of both surgeon and facility. The American Society for Metabolic and Bariatric Surgery (ASMBS) and the American College of Surgeons (ACS) have developed parallel processes to certify hospitals and surgeons as Centers of Excellence (ASMBS) or ACS Bariatric Surgery Networks (ACS) [48]. These certifications are designed to ensure that facilities have the capability and commitment to provide quality medical and surgical care to the obese patient, before, during and after a bariatric operation. Since their implementation, the mortality rate for bariatric surgery has dropped from 0.8% to 0.1% [49]. Nevertheless, a potential downside to the certification process is the requirement for an annual surgical volume of 125 cases per institution to achieve and maintain certification, a number that is not evidence-based. Indeed, in a recent report utilizing data from the National Inpatient Sample 2005-2007 for open and laparoscopic bariatric procedures, although a volume-outcome relationship was demonstrated, no inflection point was determined to justify selecting a specific volume threshold [50]. Because insurers have adopted certification by these programs as a requirement for bariatric surgery coverage, this has prevented some otherwise well-qualified smaller programs from performing or increasing their volume of bariatric surgeries.

Conclusion

At present, weight loss surgery is the most effective and sustainable treatment option for severe obesity as long as the individual is motivated to make the lifestyle changes required. Despite the invasive nature of bariatric surgery,

the initial costs involved, the potential need for re-operation and the long-term consequences requiring lifelong monitoring and medical care, given its success and overall safety record and the burden of obesity and its comorbidities, the number of morbidly obese patients seeking and undergoing bariatric surgery will undoubtedly continue to grow. Time will demonstrate the benefits and safety of bariatric surgery to less obese individuals and adolescents while emerging data will help clinicians define the best operation for each individual patient, taking into account the pros and cons of the available operations and patients' personal preferences. Ultimately, bariatric surgery is not a cure for obesity. Nor is it the solution to the epidemic of obesity, given the increasing prevalence of obesity and an insufficient supply of surgeons. Prevention via education and public awareness will be critical over the next several decades to reverse an epidemic that has been decades in the making.

Abbreviations

BMI, Body mass index; ACS, American College of Surgeons; ASMBS, American Society for Metabolic and Bariatric Surgery; CMS, Centers for Medicare and Medicaid Services; NIH, National institutes of health; FDA, Food and Drug Administration; LABS, Longitudinal Assessment of Bariatric Surgery; IBSR, Iowa Bariatric Surgery Registry; BOLD, Bariatric Outcomes Longitudinal Database.

Competing interests

The authors declare that they have no competing interests.

References

1. Ogden CL, Yanovski SZ, Darroll MD, Flegal KM: **The epidemiology of obesity.** *Gastroenterology* 2007, **132:**2087-102.
2. Sjöström L, Lindroos AK, Peltonen M, Torgerson J, Bouchard C, Carlsson B, Dahlgren S, Larsson B, Narbro K, Sjöström CD, Sullivan M, Wedel H; Swedish Obese Subjects Study Scientific Group: **Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery.** *New Engl J Med* 2004, **351:**2683-93.

   F1000 Factor 6
   John Dibaise 14 Sep 2012
3. Kremen AJ, Linner JH, Nelson CH: **An experimental evaluation of the nutritional importance of proximal and distal small intestine.** *Ann Surg* 1954, **140:**439.
4. Korner J, Leibel RI: **To eat or not to eat – how the gut talks to the brain.** *N Engl J Med* 2003, **349:**926-8.
5. Huda MS, Wilding JP, Pinkney JH: **Gut peptides and the regulation of appetite.** *Obes Rev* 2006, **7:**163-82.
6. Zhang H, DiBaise JK, Zuccolo A, Kudrna D, Braidotti M, Yu Y, Parameswaran P, Crowell MD, Wing R, Rittmann BE, Krajmalnik-Brown R: **Human gut microbiota in obesity and after gastric bypass.** *Proc Natl Acad Sci USA* 2009, **106:**2365-70.
7. Wittgrove AC, Clark GW, Tremblay LJ: **Laparoscopic gastric bypass, Roux en-Y: preliminary report of five cases.** *Obes Surg* 1994, **4:**353-7.

   F1000 Factor 6
   John Dibaise 14 Sep 2012
8. 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:**377-82.
9. Nguyen NT, Goldman C, Rosenquist CJ, Arango A, Cole CJ, Lee SJ, Wolfe BM: **Laparoscopic versus open gastric bypass: a randomized study of outcomes, quality of life, and costs.** *Ann Surg* 2001, **234:**279-91.
10. Pories WJ, Swanson MS, MacDonald KG, Long SB, Morris PG, Brown BM, Barakat HA, deRamon RA, Israel G, Dolezal JM: **Who would have thought it? An operation proves to be the most effective therapy for adult onset diabetes mellitus.** *Ann Surg* 1995, **222:**339-52.
11. Lanthaler M, Aigner F, Kinzl J, Sieb M, Cakar-Beck F, Nehoda H: **Long-term results and complications following adjustable gastric banding.** *Obes Surg* 2010, **20:**1078-85.

    F1000 Factor 6
    John Dibaise 14 Sep 2012
12. Tice JA, Karliner L, Walsh J, Petersen AJ, Feldman MDL: **Gastric banding or bypass? A systematic review comparing the two most popular bariatric procedures.** *Am J Med* 2008, **121:**885-93.

    F1000 Factor 6
    John Dibaise 14 Sep 2012
13. Guller U, Klein LV, Hagen JA: **Safety and effectiveness of bariatric surgery: Roux-en-Y gastric bypass is superior to gastric banding in the management of morbidly obese patients.** *Patient Saf Surg* 2009, **3:**10.
14. Christou N, Efthimiou E: **Five-year outcomes of laparoscopic adjustable gastric banding and laparoscopic Roux-en-Y gastric bypass in a comprehensive bariatric surgery program in Canada.** *Can J Surg* 2009, **52:**E249-58.
15. Hess DS, Hess DW: **Biliopancreatic diversion with duodenal switch.** *Obes Surg* 1998, **8:**267-82.

    F1000 Factor 6
    John Dibaise 14 Sep 2012
16. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, Schoelles K: **Bariatric surgery: a systematic review and meta-analysis.** *JAMA* 2004, **292:**1724-7.

    F1000 Factor 6
    John Dibaise 14 Sep 2012
17. Gracia JA, Martínez M, Elia M, Aguilella V, Royo P, Jiménez A, Bielsa MA, Arribas D: **Obesity surgery results depending on technique performed: long-term outcome.** *Obes Surg* 2009, **19:**432-8.

    F1000 Factor 6
    John Dibaise 14 Sep 2012
18. Regan JP, Inabnet WB, Gagner M: **Early experience with two-stage laparoscopic roux-en-Y gastric bypass as an alternative in the super-super obese patient.** *Obes Surg* 2003, **13:**861-4.
19. Shi X, Karmali S, Sharma AM, Birch DW: **A review of laparoscopic sleeve gastrectomy for morbid obesity.** *Obes Surg* 2010, **20:**1171-7.

    F1000 Factor 6
    John Dibaise 14 Sep 2012
20. Mehran A, Koleilat A: **Sleeve Gastrectomy Failure: just when we thought we had the perfect operation.** *Bariatric Times* 2010, **7:**16-7.
21. Center for Medicare and Medicaid Services [http://www.cms.gov/medicare-coverage-database/details/nca-proposed-decision-memo.aspx?NCAId=258&ver=3&NcaName=Bariatric+Surgery+for+the+Treatment+of+Morbid+Obesity&CoverageSelection=National&KeyWord=bariatric&KeyWordLookUp=Title&KeyWordSearchType=And&where=index&nca_id=219&basket=nca*3a%2400397N*3a%24219*3a%24Surgery+for+Diabetes*3a%24Open*3a%24New*3a%245&bc=gAAAABAAIAAA&]. Accessed June 9, 2012.

22. Kinzl JF, Schrattenecker M, Traweger C, Mattesich M, Fiala M, Biebl W: **Psychosocial predictors of weight loss after bariatric surgery.** *Obes Surg* 2006, **16:**1609-14.

F1000 Factor 6
John Dibaise 14 Sep 2012

23. van Hout GC, Verschure SK, van Heck GL: **Psychosocial predictors of success following bariatric surgery.** *Obes Surg* 2005, **15:**552-60.

F1000 Factor 6
John Dibaise 14 Sep 2012

24. Koch T, Finelli F: **Postoperative metabolic and nutritional complications of bariatric surgery.** *Gastroenterol Clin N Am* 2010, **39:**109-24.

F1000 Factor 6
John Dibaise 14 Sep 2012

25. Dalcanale L, Oliveira CP, Faintuch J, Nogueira MA, Rondó P, Lima VM, Mendonça S, Pajecki D, Mancini M, Carrilho FJ: **Long-term nutritional outcome after gastric bypass.** *Obes Surg* 2010, **20:**181-7.

F1000 Factor 6
John Dibaise 14 Sep 2012

26. McMahon MM, Sarr MG, Clark MM, Gall MM, Knoetgen J 3rd, Service FJ, Laskowski ER, Hurley DL: **Clinical management after bariatric surgery: value of a multidisciplinary approach.** *Mayo Clin Proc* 2006, **81**(Suppl):S34-S45.

27. Heber D, Greenway FL, Kaplan LM, Livingston E, Salvador J, Still C; Endocrine Society: **Endocrine and nutritional management of the post-bariatric surgery patient: an Endocrine Society Clinical Practice Guideline.** *J Clin Endocrinol Metab* 2010, **95:**4823-43.

F1000 Factor 6
John Dibaise 14 Sep 2012

28. Clegg AJ, Colquitt J, Sidhu MK, Royle P, Loveman E, Walker A: **The clinical effectiveness and cost-effectiveness of surgery for people with morbid obesity: a systematic review and economic analysis.** *Health Tech Assess* 2002, **6:**1-153.

F1000 Factor 6
John Dibaise 14 Sep 2012

29. **Gastrointestinal surgery for severe obesity. National Institutes of Health Consensus Development Conference Statement 1991 March 25-27.** *Am J Clin Nutr* 1992, **55:**615S-9S.

F1000 Factor 6
John Dibaise 14 Sep 2012

30. Sjöström L, Narbro K, Sjöström CD, Karason K, Larsson B, Wedel H, Lystig T, Sullivan M, Bouchard C, Carlsson B, Bengtsson C, Dahlgren S, Gummesson A, Jacobson P, Karlsson J, Lindroos AK, Lönroth H, Näslund I, Olbers T, Stenlöf K, Torgerson J, Agren G, Carlsson LM; Swedish Obese Subjects Study: **Effects of bariatric surgery on mortality in Swedish obese subjects.** *N Engl J Med* 2007, **357:** 741-52.

F1000 Factor 12
Bruce Bistrian 11 Sep 2007, Lauren Gerson 29 Nov 2007

31. Pontiroli AE, Morabito A: **Long-term Prevention of Mortality in Morbid Obesity through bariatric surgery. A systematic review and meta-analysis of trials performed with gastric banding and gastric bypass.** *Ann Surg* 2011, **253:**484-7.

F1000 Factor 6
John Dibaise 14 Sep 2012

32. Buchwald H, Estok R, Fahrbach K, Banel D, Jensen MD, Pories WJ, Bantle JP, Sledge I: **Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis.** *Am J Med* 2009, **122:**248-56.

F1000 Factor 6
John Dibaise 14 Sep 2012

33. Adams TD, Gress RE, Smith SC, Halverson RC, Simper SC, Rosamond WD, Lamonte MJ, Stroup AM, Hunt SC: **Long-term mortality after gastric bypass surgery.** *N Engl J Med* 2007, **357:** 753-61.

34. Department of Health and Human Services [http://www.accessdata.fda.gov/cdrh_docs/pdf/p000008s017a.pdf]. Accessed 2/1/12.

35. Rubino F, Ganger M: **Potential of surgery for curing type 2 diabetes mellitus.** *Ann Surg* 2002, **236:**554-9.

36. Guidone C, Manco M, Valera-Mora E, Iaconelli A, Gniuli D, Mari A, Nanni G, Castagneto M, Calvani M, Mingrone G: **Mechanisms of recovery from type 2 diabetes after malabsorptive bariatric surgery.** *Diabetes* 2006, **55:**2025-31.

37. Rubino F, Forgione A, Cummings DE, Vix M, Gnuli D, Mingrone G, Castagneto M, Marescaux J: **The mechanism of diabetes control after gastrointestinal bypass surgery reveals a role of the proximal small intestine in the pathophysiology of type 2 diabetes.** *Ann Surg* 2006, **244:**741-9.

38. Schauer PR, Kashyap SR, Wolski K, Brethauer SA, Kirwan JP, Pothier CE, Thomas S, Abood B, Nissen SE, Bhatt DL: **Bariatric surgery versus intensive medical therapy in obese patients with diabetes.** *N Engl J Med* 2012, **366:**1567-76.

F1000 Factor 6
John Dibaise 14 Sep 2012

39. Mingrone G, Panunzi S, De Gaetano A, Guidone C, Iaconelli A, Leccesi L, Nanni G, Pomp A, Castagneto M, Ghirlanda G, Rubino F: **Bariatric surgery versus conventional medical therapy for type 2 diabetes.** *N Engl J Med* 2012, **366:**1577-85.

F1000 Factor 6
John Dibaise 14 Sep 2012

40. Dixon JB, Zimmet P, Alberti KG, Rubino F: **Bariatric surgery: an IDF statement for obese type 2 diabetes.** *Diabet Med* 2011, **28:**628-42.

41. Rubino F, Kaplan LM, Schauer PR, Cummings DE: **The Diabetes Surgery Summit consensus conference: recommendations for the evaluation and use of gastrointestinal surgery to treat type 2 diabetes mellitus.** *Ann Surg* 2010, **251:**399-405.

42. Fullmer MA, Abrams SH, Hrovat K, Mooney L, Scheimann AO, Hillman JB, Suskind DL; National Association of Children's Hospitals and Related Institutions; North American Society of Pediatric Gastroenterology, Hepatology, and Nutrition: **Nutritional strategy for adolescents undergoing bariatric surgery: report of a working group of the Nutrition Committee of NASPGHAN/NACHRI.** *J Pediatr Gastroenterol Nutr* 2012, **54:**125-35.

43. Murray PJ: **Bariatric surgery in adolescents: mechanics, metabolism, and medical care.** *Adolesc Med State Art Rev* 2008, **19:**450-74.

44. Inge TH, Krebs NF, Garcia VF, Skelton JA, Guice KS, Strauss RS, Albanese CT, Brandt ML, Hammer LD, Harmon CM, Kane TD, Klish WJ, Oldham KT, Rudolph CD, Helmrath MA, Donovan E, Daniels SR: **Bariatric surgery for severely overweight adolescents: concerns and recommendations.** *Pediatrics* 2004, **114:** 217-24.

45. Ballantyne GH: **Measuring outcomes following bariatric surgery: weight loss parameters, improvement in co-morbid conditions, change in quality of life and patient satisfaction.** *Obes Surg* 2003, **13:**954-64.

46. Dixon JB, McPhail T, O'Brien PE: **Minimal reporting requirements for weight loss: current methods not ideal.** *Obes Surg* 2005, **15:**1034-9.

47. Baltasar A, Perez N, Serra C, Bou R, Bengochea M, Borrás F: **Weight loss reporting: predicted body mass index after bariatric surgery.** *Obes Surg* 2010, **21:**367-72.

F1000 Factor 6
John Dibaise 14 Sep 2012

48. Pratt GM, McLees B, Pories WJ: **The ASBS Bariatric Surgery Centers of Excellence program: a blueprint for quality improvement.** *Surg Obes Relat Dis* 2006, **2:**497-503.

49. Nguyen NT, Masoomi H, Magno CP, Nguyen XM, Laugenour K, Lane J: **Trends in use of bariatric surgery, 2003–2008.** *J Am Coll Surg* 2011, **213:**261-6.

F1000 Factor 6
John Dibaise 14 Sep 2012

50. Gould JC, Kent KC, Wan Y, Rajamanickam V, Leverson G, Campos GM: **Perioperative safety and volume: outcomes relationships in bariatric surgery: a study of 32,000 patients.** *J Am Coll Surg* 2011, **213:**771-7.

F1000 Factor 6
John Dibaise 14 Sep 2012

51. Gill RS, Birch DW, Shi X, Sharma AM, Karmali S: **Sleeve gastrectomy and type 2 diabetes mellitus: a systematic review.** *Surg Obes Relat Dis* 2010, **6:**707-13.

52. Aasheim ET, Björkman S, Søvik TT, Engström M, Hanvold SE, Mala T, Olbers T, Bøhmer T: **Vitamin status after bariatric surgery: a randomized study of gastric bypass and duodenal switch.** *Am J Clin Nutr* 2009, **90:**15-22.