

Surgery for obesity

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Purpose of review

Bariatric surgery today is the only effective therapy for morbid obesity. Commonly performed procedures include adjustable gastric banding and vertical banded gastroplasty, variations of the Roux-en-Y gastric bypass, biliopancreatic diversion or duodenal switch, and mixed procedures. This review discusses key issues in the surgical management of morbid obesity.

Recent findings

The two most common bariatric procedures performed worldwide are laparoscopic adjustable gastric banding and laparoscopic Roux-en-Y gastric bypass. Controversy exists regarding the best surgical procedure. Weight loss decreases according to the procedures performed in following decreasing order: biliopancreatic diversion, Roux-en-Y gastric bypass, vertical banded gastroplasty, adjustable gastric banding. Concerning the complications and quality of life, there is no single operation for morbid obesity without drawbacks. Cost-effectiveness analyses have demonstrated that bariatric surgery is cost effective at less than \$50 000/quality-adjusted life years.

Summary

According to current opinion, gastric restrictive procedures (adjustable gastric banding, vertical banded gastroplasty) are generally considered safe and quick to perform, but the long-term outcome and quality of life have been questioned. By contrast, the long-term efficacy of adjustable gastric banding can be improved by the development of new band devices. More complex bariatric procedures, such as the Roux-en-Y gastric bypass or biliopancreatic diversion, have a greater potential for serious perioperative complications but are associated with good long-term outcome in terms of weight loss combined with less dietary restriction.

Keywords

bariatric surgery, choice of operation, complications, cost-effectiveness, morbid obesity, obesity surgery, weight loss

Abbreviations

AGB	adjustable gastric banding
BMI	body mass index
BPD	biliopancreatic diversion
RYGB	Roux-en-Y gastric bypass
VBG	vertical banded gastroplasty

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Introduction

This review focuses on clinically relevant developments in obesity surgery, with emphasis on the effective weight loss and comorbidity outcomes of bariatric surgery as well as on the choice of operation and cost effectiveness.

General considerations

Obesity is associated with multiple complications and related comorbidities that lead to both physical and psychologic problems. There are 400 000 deaths attributable to obesity in the United States each year, and obesity has been identified as the second most common cause of death after smoking from modifiable behavioral risk factors [1]. Unfortunately, the conservative approach to weight loss consisting of diet, exercise, and medication generally achieves no more than a 5 to 10% reduction in body weight, and recidivism after such weight loss exceeds 90% within 5 years [2]. The disappointing results of these approaches have led to a burgeoning interest in bariatric surgery [3]. Bariatric surgical procedures can be divided fundamentally into restrictive procedures that limit caloric intake by downsizing the stomach's reservoir capacity and malabsorptive procedures that decrease the length of the small intestine. Examples of restrictive procedures include adjustable gastric banding (AGB) (Fig. 1a) and vertical banded gastroplasty (VBG) (Fig. 1b) [4]. Both involve the creation of a small gastric pouch, which then empties through a narrow outlet to the remainder of the stomach. Examples of malabsorptive procedures include biliopancreatic diversion (BPD) with or without duodenal switch (Fig. 1d). Some procedures have both a restrictive and a malabsorptive component, such as the Roux-en-Y gastric bypass (RYGB), whereby a small pouch that is isolated from the rest of the stomach empties into a loop of small intestine (Fig. 1c). Additional types of mixed procedures include a gastric bypass component with banding (e.g. gastroplasty with gastric bypass and banding with gastric bypass) or a gastric bypass component with BPD.

Traditionally, obesity surgery is considered appropriate for adult patients with body mass index (BMI) greater than

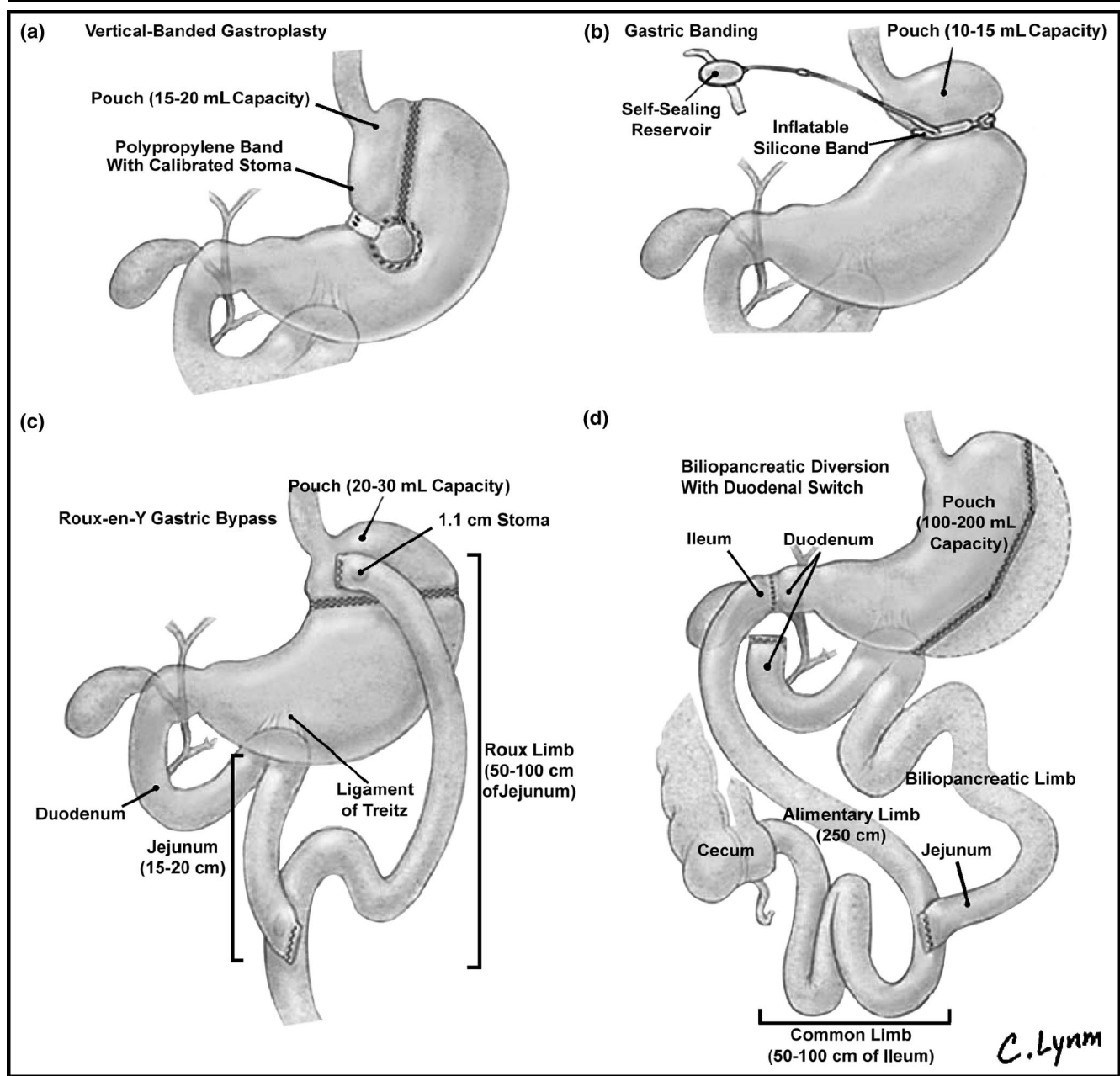
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Figure 1. Bariatric surgery techniques.



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40 or a BMI between 35 and 40 with an obesity-related comorbidity. These selection criteria were developed in March 1991 by the National Institutes of Health Consensus Development Panel and have subsequently been adopted by all major surgical and nonsurgical societies [5**]. Bariatric surgery can be performed safely in older patients with low morbidity and mortality [6,7]. Despite an extensive bariatric surgery literature, several questions remain. What is the long-term impact of bariatric surgery on effective weight loss? What is the long-term impact of bariatric surgery on obesity-related comorbidities such as

diabetes, hyperlipidemia, hypertension, and obstructive sleep apnea? Can surgical therapy be individually tailored?

Long-term outcomes of effective weight loss and comorbidity

The most commonly used criterion for effective weight reduction after bariatric surgery is loss of excess weight (the difference between actual weight and the ideal body weight for a given height). The estimation of ideal body weight can be obtained from the Metropolitan Life tables for middle-frame individuals [8].

A Canadian two-cohort study by Christou *et al.* [9] analyzed the results in 1035 patients who underwent different bariatric procedures (bypass surgery 81.4%, VBG 18.7%). The control group (n = 5746) consisted of severely obese patients who had not undergone weight reduction surgery, matched for age, gender, and duration of follow-up. With a follow-up time of 5.3 years, bariatric surgery resulted in a 67% mean reduction in excess weight ($P < 0.001$).

Buchwald *et al.* [10•] performed a systematic review and metaanalysis of 136 studies that included a total of 22 094 patients. The metaanalysis concentrated on weight loss outcomes and the impact of bariatric surgery on four selected obesity comorbidities: diabetes, hyperlipidemia, hypertension, and obstructive sleep apnea. The mean (95% confidence interval) percentage of excess weight loss was 61.2% (58.1–64.4%) for all patients, 47.5% (40.7–54.2%) for patients who underwent gastric banding, 61.6% (56.7–66.5%) for gastric bypass, 68.2% (61.5–74.8%) for gastropasty, and 70.1% (66.3–73.9%) for BPD or duodenal switch. Diabetes completely resolved in 76.8% of patients and resolved or improved in 86.6%. Hyperlipidemia improved in 70% or more of patients. Hypertension resolved in 61.7% of patients and resolved or improved in 78.5%. Obstructive sleep apnea resolved in 85.7% of patients and was resolved or improved in 83.6% of patients.

In a prospectively controlled clinical study, Lee *et al.* [11] analyzed the impact of laparoscopic VBG and laparoscopic RYGB on the metabolic syndrome. The syndrome was present in 52.2% of the 645 enrolled patients. Significant weight reduction 1 year after surgery was associated with resolution of the metabolic syndrome in 95.6% of patients. There was no difference between operations, with 95% and 98.4% resolution with VBG and RYGB, respectively.

Choice of procedure: gastric banding or gastric bypass?

Ideally, bariatric surgery should (1) provide low risk (mortality <1% and morbidity <10%), (2) provide long-term excess weight reduction greater than 50% in at least 75% of patients, (3) provide good quality of life with few side effects, (4) provide a low rate of reoperation (<2% per year), and (5) be reversible and reproducible [12•].

All four of the procedures mentioned above (AGB, VBG, RYGB, BPD) can be effective in the treatment of morbid obesity. They are performed by open surgery and more recently by laparoscopy. The two most common bariatric procedures performed worldwide are laparoscopic AGB and laparoscopic RYGB [13]. Controversy exists regarding the best surgical procedure. For example, gastric bypass is the procedure of choice in the United States, whereas most surgeons in Europe and Australia favor gastric banding [13,14]. This discrepancy indicates that the choice of the procedure is driven by geographic factors and the

surgeon's skills rather than by medical evidence. Current opinion is that the restrictive procedures (AGB, VBG) are safe and quick to perform, but the long-term outcome and quality of life, especially with regard to eating patterns, is less well documented. More complex bariatric procedures, such as RYGB and BPD, have a greater potential for serious perioperative complications but are associated with better long-term outcome in terms of weight loss and less dietary restriction [15–17].

It is commonly believed that eating sweets, binge eating, and superobesity (BMI >50) can negatively affect the results of AGB or VBG. Thus, it is of particular interest that Korenkov *et al.* [18] demonstrated no influence of eating sweets and superobesity on postoperative weight reduction after laparoscopic AGB. Similar results were reported by Mittermair *et al.* [19]. By contrast, Larsen *et al.* [20•] reported a negative relation between binge eating and outcome after laparoscopic AGB. In a retrospective single-center study, Mognol *et al.* [21] compared 179 patients after laparoscopic AGB with 111 patients after laparoscopic RYGB. The patients after laparoscopic RYGB had significantly better excess weight loss than did those after laparoscopic AGB (63% compared with 41% at 1 year, and 73% compared with 46% at 2 years). The early complication rate was higher in the laparoscopic RYGB group (10% compared with 2.8%, $P < 0.01$). The late complication rate was higher in the laparoscopic AGB group (26% compared with 15.3, $P < 0.05$).

The *pars flaccida* technique is generally used to create the retrogastric tunnel with blunt dissection in preparation for band placement. With respect to band position, gastric banding is preferred over esophagogastric banding [5••]. Owing to frequent modifications in the operative technique and the gastric band used, the results of surgery are rarely based on prospective long-term trials. Since the introduction of AGB, two bands mainly have been available: the Lapband (Bioenterics, Carpinteria, CA, SUA) and the Swedish Adjustable Gastric Band (SAGB; Obtech Medical, Zug, Switzerland). In a prospective randomized trial, Suter *et al.* [22] reported no significant difference in postoperative weight loss and complications between the Lapband and the Swedish Adjustable Gastric Band.

The VBG is a gastric restrictive procedure similar to AGB, but its use is not as widespread. Olbers *et al.* [23] compared the results of laparoscopic RYGB with those of laparoscopic VBG in a randomized clinical trial, which had a 2-year follow-up and a 97.6% follow-up rate. RYGB and VBG were comparable in terms of operative safety and postoperative recovery, but weight reduction was greater after RYGB (84.4% compared with 59.8% at 2 years).

Band-related complications include band slippage, leak, intolerance, infection, and migration as well as insufficient

weight loss. The management of these complications includes (1) band replacement for slippage, leak, and migration, (2) band removal for infection, (3) band removal plus RYGB for intolerance, (3) and the addition of BPD or band removal plus RYGB for insufficient weight loss [24–27]. Evidence-based data for the choice of option selection are lacking.

The RYGB is currently the gold standard for most American bariatric surgeons. The standard gastric bypass includes a pouch volume of approximately 20 to 30 ml, an alimentary limb of at least 75 cm, and a biliary limb of at least 50 cm. Long limb distal gastric bypass may be preferable in superobese patients [5^{*}]. RYGB can be performed laparoscopically without mortality [7,28]. Complications include stoma stenosis, gastric distension, anastomotic leakage, gastrointestinal hemorrhage, gastrojejunal ulcers, and nutritional deficiencies as well as inadequate weight loss [29–32]. Revision surgery after RYGB is feasible by both conventional and laparoscopic approaches [33,34].

The BPD causes more malabsorption than RYGB. In its classic form, BPD consists of partial gastrectomy with a Roux-en-Y gastroenterostomy. In its duodenal switch form, a vertical sleeve gastrectomy is combined with a duodenoenterostomy. Few data have been published on limb length, but it is generally recommended that the common limb should measure more than 50 cm but less than 100 cm [35]. Of note, no randomized trial to date has compared BPD with other procedures. BPD, however, can lead to massive weight loss: as much as 70% of the patient's initial excess weight [35]. The malabsorption created by this operation frequently leads to deficiencies in iron, calcium, and vitamins.

There is little consensus regarding the choice of bariatric surgical procedure. Although RYGB with standard or long limb or BPD may be the gold standard, AGB or VBG is frequently regarded as the procedure of first choice. In patients with failed AGB or VBG, RYGB or BPD may be offered. Some surgeons recommend AGB for patients with BMI below 50 and RYGB for patients with BMI greater than 50.

Cost effectiveness of bariatric surgery

Cost-effectiveness analyses of bariatric operations are of paramount importance, given the high cost of the procedure, its potential for saving future costs related to comorbidities, and the growing population of operative candidates. Cost is often cited as a major barrier to payers and other interested parties. It should be noted that most payer groups insist on and pay for a variable course of non-surgical approaches to weight loss even though these are often ineffective in the long term.

Cost effectiveness, as measured in dollars per quality-adjusted life years, takes into account both the quantity and the quality of life generated by an intervention, providing a common currency to assess the benefits gained. Salem *et al.* [14] report a paucity of data to determine the cost effectiveness of bariatric surgery. Despite this, three qualifying cost analyses identified in the review suggest that bariatric surgery is cost effective, at less than \$50 000/quality-adjusted life years, although significant limitations in the design, selection of data points, and analysis demonstrate the need for more complete and appropriately designed studies.

Conclusion

Obesity is a serious medical problem that is increasing at an alarming rate. Significant obesity is associated with numerous comorbid conditions that improve with weight loss. At present, bariatric surgery is the most effective treatment to produce sustained weight loss in morbidly obese patients. The most effective surgery is BPD, followed by RYGB, VBG, and AGB. Given that all bariatric surgical procedures have benefits, risks, and little evidence-based literature upon which to tailor a specific operation for a specific individual, there is no single gold standard. Nonetheless, the literature suggests that bariatric surgery is a cost-effective therapy for the morbidly obese patient.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 721).

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