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Surgical Treatment of Obesity

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Those who cannot remember the past
are condemned to repeat it.
(G. Santayana)

Surgical treatment of obesity ('bariatric surgery'; anti-obesity surgery) passes the pragmatic test: it works, most of the time. It is also cost-effective and on a cost per-kg-lost basis is superior to any other method of weight loss for class II and III obesity. Most important: the results are durable, defined as providing maintenance of medical significant weight loss for more than 5 years.

Why, then, is surgical treatment not more widely appreciated or performed? A recent survey of attendees of a weight-loss clinic showed that most of the obese patients were willing to take a 6% risk of immediate death if they were guaranteed to reach their desired weight and 25% of the patients were willing to take a 21% risk of dying (1). Yet only a small fraction of eligible patients undergo anti-obesity surgery, this most effective treatment with a mortality rate below 1%. Men in particular do not have such surgery though their relative risk of dying from obesity is substantially higher than the risk of women of equal body mass index (BMI) (2) and also higher than their risk of dying from anti-obesity surgery. There are many causes for a relative underutilization of anti-obesity surgery, some of which are frankly irrational.

Developments during the past decade effectively address earlier concerns over safety and reliability. This text will describe the fundamental principles of the three most common surgical techniques, will discuss safety and will attempt to define crucial problems influencing the outcome of anti-obesity surgery. Recent trends in this field threaten to repeat mistakes from the 1960s and 1970s.

METHODS

Operations systematically performed to achieve weight loss first appeared in the early 1950s, initially as removal of long segments of small bowel, subsequently as bypass of even longer intestinal segments excluded from the nutrient stream but available for reattachment should the need arise (*intestinal bypass*; jejuno-ileal bypass). Stomach operations, pioneered by Edward E. Mason of Iowa in the 1960s, similarly evolved from gastric resection into *gastric bypass*, excluding a large portion of the stomach, attaching the remnant to a loop of small bowel (Figure 34.1). Mason was convinced that the mechanism of weight loss was mechanical restriction of intake through the small gastric remnant ('pouch'). Thus, he went on to develop a purely restrictive operation, *gastroplasty*, consisting of a stapled pouch with an externally banded conduit into the stomach proper. The small size of the pouch (< 15 ml) and the small diameter of the outlet (9 mm) physically limit the amount of food that can be consumed during a single meal.

Gastric bypass provides greater weight loss, sustained for longer periods of time in a larger proportion of patients than does gastroplasty. This implies that gastric bypass functions through other mechanisms than restriction alone. Undigested nutrients

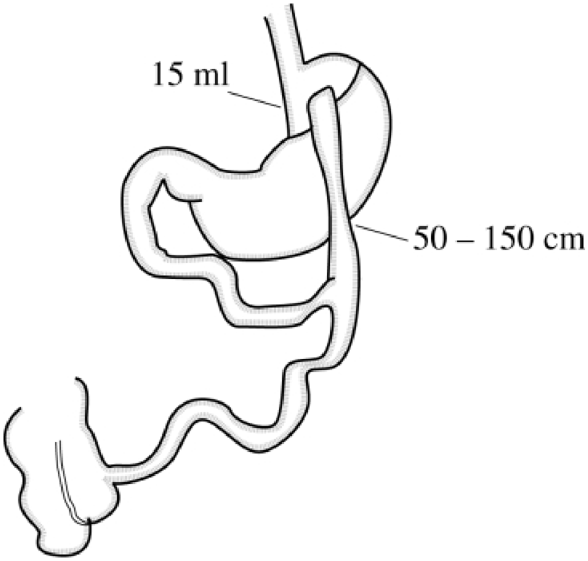

Figure 34.1 Gastric bypass. Roux-en-Y gastric bypass with a Roux limb measuring 50–150 cm in length

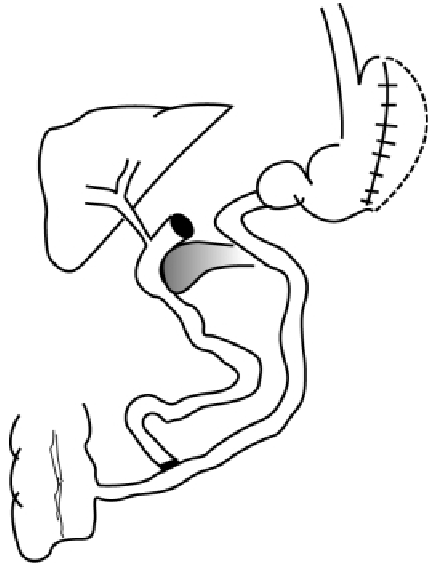

Figure 34.2 Biliopancreatic bypass with duodenal switch. Sleeve gastrectomy (hatched) and duodeno-ileostomy with 150 cm common limb

emptying from the small stomach pouch into the segment of small bowel (jejunum) evoke satiety signals via mechanoreceptors. Calorically dense liquid or soft food rapidly emptying into the small bowel causes weight loss through 'dumping', an aversive physiological response associated with release of vasoactive gastrointestinal peptides elicited by chemoreceptors, portal chemoreceptors and possibly potentiated by peptide receptors in the brain. Regardless of mechanism, gastric bypass achieves greater weight loss than purely restrictive gastric operations.

Variants of gastric bypass use longer limbs of bypassed small bowel (Figure 34.1) causing more maldigestion and adding malabsorption leading to greater weight loss, appropriate in heavier patients (those with BMI ≥ 50). Predictably, these operations have greater potential for causing deficiencies. The first of these more aggressive gastrointestinal bypass operations, *biliopancreatic diversion* (BPD), was introduced in 1976 by Nicola Scopinaro of Genoa. In its original form it included resection of the stomach with diversion of digestive bile and pancreatic secretions to the terminal 50 cm of ileum. These more malabsorptive operations have been performed in a few centers worldwide, though the series have been fairly large. A recent modification of biliopancreatic bypass, maintaining the pylorus and a portion of the duodenum, called 'duodenal switch' (Figure 34.2) seems to improve protein absorption and cause fewer side effects than the biliopancreatic bypass of Scopinaro (3,4). This improved side-effect profile, replicated in several centers, is leading to wider adoption of these types of operations, such that they can be considered to be a legitimate alternative in selected patients.

Laparoscopic Surgery

All types of surgery have been dramatically transformed during the last decade owing to the technical advances making possible the development of laparoscopic techniques. Insertion of tiny fiberoptic light sources and cameras into inflated body cavities for transmission of images to video screens allows insertion and operation of instruments through smaller incisions with less surgical trauma—aptly called 'minimally invasive' surgery.

These techniques are especially appropriate in obese patients who generally require large incisions for exposure. Because of their reduced hemodynamic and respiratory reserves, obese patients withstand trauma less well than their lean counterparts, which is why they are considered to be higher operative risks. This is one of many

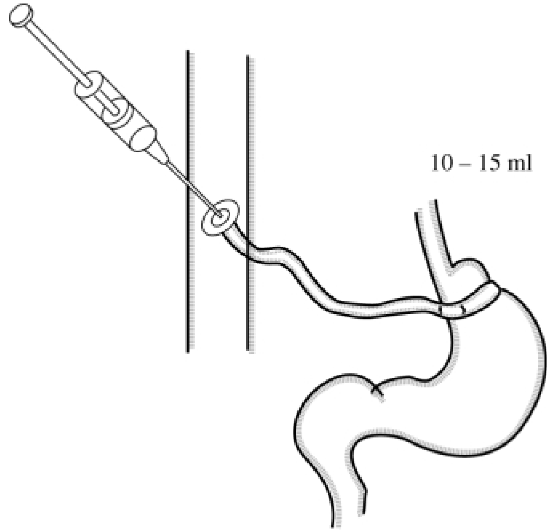

Figure 34.3 Laparoscopic adjustable gastric band. The inflatable band is attached to an intramuscularly placed injectable port

factors that traditionally has led to underutilization of surgical services among the obese. Minimally invasive techniques, with their shorter recovery times and shorter periods of postoperative rehabilitation, have made operations safer for obese patients, thus expanding their access to surgery.

The first bariatric surgical procedure to capitalize on the minimally invasive approach was circumgastric adjustable banding. This is a truly restrictive procedure, originally developed for open surgery by Lubomyr Kuzmak of New Jersey around 1985. An inflatable Silastic ring is placed just below the esophagogastric junction and is attached via tubing to a subcutaneous injectable port (Figure 34.3). As the patient's eating behaviour changes and the gastric wall adapts, the functional inner diameter of the conduit may change. The adjustable band allows titration of the desirable degree of restriction.

Vertical banded gastroplasty and gastric bypass became feasible laparoscopically with the development of laparoscopic stapling instruments. As with all surgery, laparoscopic or open, there is a learning curve until technical mastery can be achieved, with its attendant reduced complication rate. As of the end of 2000, there are reports of series of patients who have undergone these laparoscopic stapling operations. None have the appropriate 5-or-more year period of observation in sufficient numbers of patients necessary to evaluate the efficacy of these approaches. However, it does appear as if the safety of performance of these operations via laparoscopy is at least equivalent to that of the open procedures.

Staged Surgery

Because of the high degree of safety of performance of laparoscopic adjustable gastric banding, with very quick postoperative return to full function, and the relative ease of completely reversing the operation because of the non-reactive nature of the Silastic implant (band + tubing), it is reasonable to expand the availability of this very effective method for achieving weight loss. Patients developing complications and *unmanageable* side effects of the gastric restriction would be candidates for reversal of the operation as would be patients with inadequate weight loss. Given the $>95\%$ recidivism of obesity and its comorbities after reversal of any bariatric operation, such patients should be offered a malabsorptive type of operation such as gastric bypass at the time of the reversal. Staged surgery appears to be a logical strategy in the overall management of severely obese patients (5).

RESULTS

The simplest outcome measure, *weight reduction*, can be expressed in absolute or relative terms, with the latter based on percentage of preoperative body weight or reduction of 'excess' body weight determined from life insurance tables of desirable weight for height. As a 'rule of thumb' weight loss is approximately one-third of initial (maximum) weight after gastric bypass compared to 20–25% after gastric restriction and 40% after biliopancreatic diversion or duodenal switch. In terms of reduction of excess weight (% excess weight loss, % EWL), gastric restriction achieves 50–55%, gastric bypass 60–65% and BPD around 75%. Variations in these weight losses are related to initial body weight and to differences in setting, location and patient selection between different series.

The majority of severely obese patients undergoing anti-obesity operations (women, aged 35–40 years with BMI around 42 kg/m^2) want sufficient weight loss to become 'lean' or at least not visibly obese regardless of health implications. Most sur-

Table 34.1 Response of comorbidity to surgically induced weight loss

	% cured[a]	% improved[b]
Asthma	95	100
Diabetes	90–95	100
Dyslipidemia	70	85
Heart failure	60	90
Hypertension	60–65	90
Sleep apnea	100	100

[a]No need for further treatment.
[b]Reduced medication dosage.

Table 34.2 Complications of open gastric bypass

Complication	%	Complication	%
Mortality	1	Wound infection	
		severe	3.5
		minor	10
Thromboembolism	2	Marginal ulcers	6
Leaks	1.5	Bowel obstruction	2
Pneumonia	1.9	Abscess	2.5
Splenectomy	2.7	Arrhythmia	1.5
Hemorrhage	1		

geons, wishing to please their patients, comply with defining 'success' in terms of weight loss. Indeed, the whole concept of % EWL is predicated on reducing excess weight to bring the patient to an 'ideal' or 'desirable' non-obese weight. However, the weight-for-height standards are derived from large populations of individuals who have not lost weight, particularly not large amounts of weight. There are no actuarial standards for people who have lost significant amounts of weight after being severely obese (BMI ≥ 35) because people at these weight levels are undersampled in population studies.

Since severely obese patients generally have increased body cell mass, reflected in large organ sizes, elevated cell numbers and increased bone mass, it is neither realistic, nor necessarily 'healthy' to reduce 100% of excess weight. It is obvious from the post-surgical weight loss figures cited above that loss of 100% of excess is rarely attained and thus should be of little concern. However, both surgeons and patients need to understand the physiological limitations on weight loss in order to avoid unrealistic, potentially unhealthy expectations.

Reduction of comorbidity with attendant increases in longevity and improved quality of life should be the appropriate goal of anti-obesity surgery. Solely for the purpose of amelioration of comorbidity, it seems that sustained reductions of 10% of body weight are sufficient and a large population study of women showed a 25% reduction in mortality with intentional loss of ≥ 9 kg (6). There is very little evidence that non-surgical methods are able to maintain this degree of weight loss for periods of 5 years or more, especially in patients with BMI greater than 33 kg/m^2.

Table 34.1 lists obesity comorbidities in surgical patients and their response to surgically induced weight loss. These impressive results, particularly with respect to type 2 diabetes, beg the question whether it is ethical to withhold surgical treatment from obese patients with insulin-resistant diabetes. Before answering the question, it is necessary to scrutinize the side effects, complications and costs of anti-obesity surgery.

Complications

Since reviewing this topic in 1994 including a presentation of definitions and analysis of the quality of the data (7), more information has become available, particularly regarding laparoscopic approaches. Table 34.2 lists early complications of open gastric bypass operations in three centers performing large numbers of gastric bypasses yearly. The early mortality rate of 1% is based on the total experience from the mid-1980s. Subsequently mortality seems to have dropped well below 1%. In general, complication rates are similar in gastric restrictive procedures though gastroplasty operations are less complex. This is because gastroplasty is performed more widely in hospitals less familiar with bariatric surgery than the highly specialized centers performing gastric bypass.

As mentioned earlier, the laparoscopic approaches have not been available sufficiently long to provide adequate assessment of safety or efficacy. The surgeons who have pioneered the laparoscopic bariatric operations are naturally especially dedicated during the development phase. Early results from laparoscopic bypass in centres reporting between 35 and 700 patients over the last 4 years have not demonstrated any mortality, though reoperations have been required for various technical reasons. One series has been plagued by anastomotic strictures, requiring endoscopic dilatation and in

Table 34.3 Rules of eating after gastric restriction

Eat slowly in a quiet setting—no stress
Advance your diet from liquids to purees to solids
Chew properly before swallowing
Stop eating immediately when your pouch is full
Never drink with your food
Wait at least 1 hour before drinking after food
If you vomit or regurgitate:
Identify the reason(s)
Wait 4 hours before drinking
Advance your diet, only if tolerated
If not tolerated: contact your surgeon

some cases reoperation.

The best documented series of laparoscopic adjustable banding revealed only one early complication in 273 patients, an infected reservoir site (8). Among late postoperative complications the authors encountered obstructing prolapse of the stomach through the band in 22% of their first 100 patients. After small technical changes, they have not had any such complication in their last 100 cases (8).

Side Effects

It seems intuitively obvious that vomiting might be an effect or side effect of gastric restriction, while diarrhea would follow malabsorptive operations bypassing large segments of small bowel. Although it is true that vomiting and diarrhea might be mechanisms of weight loss in these procedures, it is a common misconception that they are obligate (and thus acceptable) sequelae.

Vomiting, with the rare exception of organic or band-related stricture or stenosis, is a behavioral failure preventable by proper education in the majority of patients. If patients have learned and adhere to the 'rules of eating' (Table 34.3; Kral (9)), vomiting is a rare ($< 10\%$) event (7).

Diarrhea, similarly, can be controlled by cognitive means—at least after an initial (approximately 3 months) postoperative phase of intestinal adaptation. The amount and the timing of liquid intake determines the number and consistency of stools, especially when combined with reduced intake of fat. Otherwise there is a medical problem which needs to be addressed (10). The most important cause of adverse outcomes after intestinal bypass operations, which led to their virtual abandonment, was the failure of the medical profession to respond to diarhea as an unacceptable symptom caused by bacterial overgrowth and/or some other hazardous inflammatory condition when it did not respond to dietary manipulation.

The same type of mistake is now being repeated by the profession by accepting vomiting as an obligate effect of gastric anti-obesity operations. Over the long term vomiting gives rise to deficiencies and acid–base disturbances as well as esophagitis (potentially carcinogenic) and the risk of aspiration leading to acute or chronic lung disease. If vomiting does not respond to behavior modification, an organic cause must be sought. Furthermore, it is necessary to be vigilant for development of bulimic behavior (11), though this does not appear to be a risk after gastric bypass (12).

Deficiencies

The purpose of all bariatric surgery is to reduce the intake and/or absorption of nutrients. Ideally this 'programmed undernutrition' should preferentially shunt non-essential lipid calories, while maintaining essential macro- and micronutrients. Clearly this is not feasible without routine supplementation of nutrients predictably at risk for depletion. Most bariatric procedures have the potential to create deficiencies of hemic precursors (iron and vitamin B_{12}), while gastric bypass also affects calcium and biliopancreatic diversion in addition causes malabsorption of protein (reviewed in Cannizzo and Kral (13)). By routinely prescribing at-risk supplements and regularly monitoring blood levels it is possible to prevent all types of deficiencies. There is, however, no method for guaranteeing that patients, in spite of being fully informed of the adverse consequences, cooperate with treatment plans. This, of course, is perceived as a weakness of the surgery.

CRITIQUE

Cost–benefit analyses of treatments for obesity are lacking (14). For non-surgical treatments this is expected since such treatments are unable to provide durable, truly long-term weight loss allowing such analyses. A few studies have attempted to perform econometric analyses of anti-obesity surgery focusing on employment status, consumption of medical services and sick-leave, while others have attempted to assess global changes in quality of life (15). In general, the outcomes are extremely favorable for surgical treatment of severe obesity, but there are some serious limitations in the representativity of the populations and the scope of the studies.

The short-term success brought about by the relative safety and ease of performing anti-obesity operations laparoscopically and the lure of the burgeoning market of candidates for such surgery pose serious threats to this field. Just as was the case with intestinal bypass operations in the 1960s and 1970s, when any reasonably technically competent, enterprising surgeon performed them without any knowledge of or desire for managing the sequelae of the operation, there is now a recruitment of 'handymen' willing to demonstrate their technical proficiency in the belief that others will step in to take care of the specific needs of such patients. Unfortunately, there are no such 'others'. Internists, whether endocrinologists, nutritionists, gastroenterologists or generalists, have no interest in taking care of these 'surgical' cases. Indeed, many view the surgeons as (well-paid) competitors in this market, and would rather see them fail than recognize this as an opportunity to improve the quality of care for these patients.

It is tragic that the internists' focus on the development of new drugs (16), and the surgeons' lack of understanding of the importance of behavioral modification, patient selection, and psychodynamics for the outcome of gastric restrictive operations stand in the way of progress in this field. Entrenched, often adversarial positions encumber the necessary interdisciplinary collaborations that might otherwise improve the treatment of severely obese patients.

Most surgeons performing bariatric surgery, whether newcomers to the field or seasoned veterans, are committed to one type of procedure: gastric restriction for the newcomers and gastrointestinal bypass for the veterans. The arguments over 'gold standard', procedure-of-choice or even standard of care embody an anti-intellectual and hazardous failure to recognize the complexity of the disease of obesity and the need to individualize. The complexity goes beyond the advances in molecular genetics and cell biology, which as yet have not translated into clinical practice or improved patient satisfaction. Unfortunately many surgeons engaged in treating obesity do not seem to have realized that this surgery is not simply a technical exercise but rather a behavioral intervention requiring *patient education* (9), not just 'informed consent'. Furthermore, patient selection requires more refinement than has been brought to bear by practitioners of the behavioral sciences (17).

SUMMARY

Anti-obesity surgery has increasingly become safer and its efficacy is indisputably superior to any other existing treatment. However, there are numerous problems impeding wider use of surgery, some political and some conceptual. Surgeons fail to recognize the contribution of behavioral factors to side effects and complications, possibly because they are usually less severe than obesity and its comorbidities. Internists, behaviorists and nutritionists seem unwilling, if not unable to be involved in the care of these 'surgical' patients. There is a lack of outcome predictors to aid in the selective assignment of patients to appropriate treatment modalities and much remains to be done to improve pre- and postoperative patient education.

In the final analysis, before the prevalence of obesity is drastically reduced by prevention, surgical treatment should be further refined, not as a technical exercise, but as an integrated component of broad-based treatment requiring education of patients as well as the interdisciplinary team of professionals necessary to treat this complex disease on an individualized basis.

REFERENCES

1. Weiss B, Klein S, Nease R. What risks will obese patients take to lose weight? 2000; submitted for publication.
2. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath Jr CW. Body-mass index and mortality in a prospective cohort of US adults. *N Engl J Med* 1999; **341**: 1097–1105.
3. Scopinaro N, Adami GF, Marinari GM, *et al.* Biliopancreatic diversion. *World J Surg* 1998; **22**: 936–946.
4. Marceau P, Hould FS, Simard S, *et al.* Biliopancreatic diversion with duodenal switch. *World J Surg* 1998; **22**: 947–954.
5. Kral JG. Overview of surgical techniques for treating obesity. *Am J Clin Nutr* 1992; **55**: 552S–555S.
6. Williamson DF, Pamuk E, Thun M, Flanders D, Byers T, Clark H. Prospective study of intentional weight loss and mortality in never-smoking overweight US white women aged 40–64 years. *Am J Epidemiol* 1995; **141**: 1128–1141.
7. Kral JG. Side effects, complications and problems in anti-

obesity surgery: Introduction of the obesity severity index. In: Angel A, Anderson H, Bouchard C, Lau D, Leiter L, Mendelson R (eds) *Progress in Obesity Research: 7*. London: John Libbey, 1996: 655–661.

8. O'Brien PE, Brown WA, Smith A, McMurrick PJ, Stephens M. Prospective study of a laparoscopically placed, adjustable gastric band in the treatment of morbid obesity. *Br J Surg* 1999; **85**: 113–118.
9. Kral JG. The role of surgery in obesity management. *Int J Risk Safety Med* 1995; **7**: 111–120.
10. Kral JG. Current procedures in bariatric surgery. In: Haubrich W, Schaffner F, Berk JE (eds) *Bockus Gastroenterology*, 5th edn. Philadelphia: WB Saunders. 1994: 3231–3239.
11. Hsu LKG, Betancourt S, Sullivan SP. Eating disturbance before and after vertical banded gastroplasty: A pilot study. *Int J Eat Disord* 1996; **19**: 23–34.
12. Rand CSW, Macgregor AMC, Hankins GC. Eating behavior after gastric bypass surgery for obesity. *South Med J* 1987; **80**: 961–964.
13. Cannizzo Jr F, Kral JG. Obesity surgery: A model of programmed undernutrition. *Curr Opin Clin Nutr Metab Care* 1998; **1**: 363–368.
14. Martin LF, White S, Lindstrom Jr W. Cost-benefit analysis for the treatment of severe obesity. *World J Surg* 1998; **22**: 1009–1017.
15. Kral JG, Sjöström LV, Sullivan MBE. Assessment of quality of life before and after surgery for surgical obesity. *Am J Clin Nutr* 1992; **55**: 611S–614S.
16. Heymsfield SB, Greenberg AS, Fujioka K, *et al*. Recombinant leptin for weight loss in obese and lean adults. *JAMA* 1999; **282**: 1568–1575.
17. Kral JG. Surgical treatment of obesity. In: Kopelman PG, Stock MJ (eds) *Clinical Obesity* London: Blackwell Science, 1998: 545–563.