Surgical treatment for morbid obesity

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Since severe obesity is frequently associated with serious metabolic, cardiovascular and psychological co-morbid conditions, and given the usually unsuccessful results of conservative therapeutic approaches, surgical treatment based on gastric restriction procedures is increasingly recognized as a treatment of choice for morbidly obese persons. Among several surgical approaches designed to promote a substantial loss of weight, two gastric restriction procedures, i.e. the vertical banded gastroplasty and the gastric bypass, have been increasingly used during the past years. Both techniques induce an impressive loss of weight, and are surprisingly well tolerated, even by severely obese persons. The usual 50–75% reduction of initial weight excess, is followed by a clear-cut reduction, or even disappearance of, obesity-related co-morbidity, such as hypertension, diabetes mellitus or sleep apnea syndrome. While serious peri- and postoperative risks are very limited, the intractable vomiting occurring after gastroplasty, and potential sequelae related to iron and calcium malabsorption after the gastric bypass, represent much more frequent complications of the surgical treatment of obesity. There is also a tendency towards a late regain of weight, but the benefit in terms of improvement in the obesity-associated co-morbidity is in general maintained despite this partial increase in weight. Gastric procedures are, therefore, an effective treatment of severe obesity and of its co-morbid conditions. However, careful medical and nutritional supervision is necessary during the follow-up after surgery, to prevent potential nutritional or digestive complications.

There is growing evidence that severe obesity should be considered as a serious morbid condition responsible for increased morbidity and mortality. Indeed, life expectancy is reduced proportionally to the severity of the overweight, and obesity-linked morbidity can be considered as the second most preventable cause of death, after cigarette smoking. Obesity-induced health risks result from several co-morbid conditions, such as hypertension, dyslipidaemia, insulin resistance with increased prevalence of non insulin-dependent diabetes mellitus, respiratory dysfunction and some types of cancer. In addition to these somatic diseases, obesity has a deleterious impact on the quality of life; a less positive mood and anxiety lead frequently to overt depression. It has even been reported that the poor well-being of obese
Obesity persons is worse than the psychological consequences of several serious morbid states, such as cancer or spinal cord injury. It is, therefore, evident that severe obesity should be treated in an effective way, and that obese patients should expect their doctors' help to achieve at least a partial reduction of their overweight. Yet classical conservative treatments, such as dietary and behaviour therapies or the use of anti-obesity drugs, are in general unsuccessful in the long-term. The failure of these treatments is probably partly related to the frequent negative judgement of the obese by physicians. Severely obese persons suffer from prejudice and discrimination; they are frequently considered to be lacking in will-power, lazy, and emotionally unstable, and many physicians share this attitude towards them. It is significant in this respect that nearly 80% of severely obese patients asking for bariatric surgery consider having been previously treated disrespectfully by their doctors because of their weight.

This rather dramatic general context of conservative treatment of obesity, as well as an increasing prevalence of obesity over the past decades, prompted the search for a more radical and effective treatment of obesity such as offered by bariatric surgery. While impressive in terms of weight reduction, early procedures such as jejuno-ileal bypass induced unacceptable sequelae including chronic diarrhoea with malabsorption, electrolytic disturbances, hepatic failure and deficiencies of fat-soluble vitamins leading ultimately to bone demineralization. The severity of these complications contributed to the downfall of intestinal bypass surgery, and may explain some of the negative attitudes of physicians towards surgical treatment of the overweight. Even today, many physicians are of the opinion that the overall risks and side effects of bariatric surgery do not justify the benefits. However, the interest in developing surgical procedures for the treatment of severe obesity came from the growing recognition of its health consequences, and from the poor long-term results usually seen with medical therapy.

This initially negative opinion concerning the surgical treatment of obesity has been modified by the introduction of gastroplasty and, later on, of gastric bypass. Indeed, gastric partitioning, which considerably limits the amount of ingested food while maintaining the anatomical continuity of the digestive tract, is surprisingly well tolerated, even by extremely obese persons. Moreover, the benefits of gastric surgery are impressive, not only in terms of reduction in weight excess, but also in terms of reduction in co-morbidity and of prevention of further complications of obesity.

The official recognition of gastroplasty, as well as of other forms of gastric bypass, by the National Institutes of Health consensus conference, as an appropriate treatment for severe obesity associated
with serious co-morbid conditions, was followed by an increased use of bariatric surgery, and by further refinement of the originally developed surgical techniques.

**Current surgical options**

The most popular surgical procedures used for treatment of severe obesity involve gastric partitioning, referred to as gastroplasty, and the gastric bypass (Fig. 1)\(^\text{13,5}\). Both techniques induce a rapid and sustained loss of weight, and are relatively well tolerated\(^1,5,12\). Only some general features of these techniques will be described here, while emphasis will be laid essentially on the beneficial effects and potential sequelae.

**Gastroplasties**

These procedures create a small gastric pouch, which is drained through a narrow calibrated stoma\(^5,13\). The intake of solids is, therefore, considerably limited. Patients appear not to experience hunger, and rapidly feel full, even after a small meal. These procedures do not involve gastric resection and maintain the anatomical and functional continuity.

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**Fig. 1** (I) Vertical banded gastroplasty. A staple line (A) to produce a 20 to 30 ml pouch is applied to the stomach and a Gortex band produces an outlet diameter of about 1 cm. (II) Gastric bypass. A loop of small bowel is brought up to drain an isolated section of stomach (B) produced by stapling (A). (III) Scopinaro biliopancreatic diversion. The stomach is divided and resected and anastomosed to a Y loop of intestine (D). The gall bladder is removed (A), and the duodenum closed (C); the jejunum is anastomosed to the ileum (B).
Obesity of the gastro-intestinal tract. Digestion and intestinal absorption are, therefore, normally maintained, and the loss of weight is due solely to a very restricted energy intake.3,5

Vertical banded gastroplasty Vertical banded gastroplasty, introduced by Mason in 1982,14 rapidly became the most popular technique of gastric restriction, and is still widely used. This technique involves the stapled partition of the stomach creating a small upper pouch of 30 ml, which empties to the remaining part of the stomach through a narrow outlet with diameter calibrated from 8 to 10 mm, and reinforced by a Gortex band, or by a similar prosthetic material3,5,13. Because of the limited capacity of the gastric pouch, the amount of ingested food before rapid onset of satiety is considerably limited3. This induces, obviously, a rapid loss of weight, which occurs mainly during the first 6 months after the operation5,8,15. The peri-and early postoperative mortality is lower than 1%, while the immediate postoperative complications are in general limited to wound infection encountered, however, only in 2% of patients according to the recent report of Mason and Doherty8. In other series, wound problems have been seen in 23% of patients9. Intractable vomiting represents a more frequent postoperative complication, caused by too rapid intake of solids, rather than by stenosis of the stoma3,5. Frequent vomiting associated with gastro-oesophageal reflux may, however, occur in some patients, as a result of stomal stenosis; this may prove refractory even to multiple attempts at endoscopic balloon catheter dilation16. Late failure in terms of insufficient loss of weight, or even of weight regain, may result either from an excessive ingestion of high-calorie liquids and sweet foods, or from staple disruption. The later is usually followed by a suddenly increased capacity of solid food ingestion, and may be easily evidenced by radiography.

Horizontal gastroplasty Horizontal gastroplasty may involve a stapled horizontal partition of the stomach, but is more frequently realized by encircling the upper stomach with a plastic collar3,5. Some surgeons are using an inflatable prosthetic device, allowing a variable calibration of the outlet to the lower part of the stomach3. This procedure may be relatively easily performed by laparoscopy, but it is, in general, considered as mechanically unreliable and gives rather disappointing results3,5. Insufficient loss of weight is frequently related to the distension of the thin-walled gastric fundus8. In addition, reflux oesophagitis is relatively common after this kind of surgery. Since gastric restriction surgery performed by laparoscopy is followed by a shorter and less cumbersome postoperative recovery, some surgeons are using this technique to perform not only gastric banding but also vertical banded gastroplasty17. These are, however, technically difficult operations,
the limited experience in this field does not allow a conclusion as to whether this approach represents a real advantage with respect to open surgery.

If vertical banded gastroplasty is followed by complications, such as intractable vomiting with gastro-oesophageal reflux, staple line disruption or inadequate loss of weight, some authors advocate conversion of complicated or failed gastroplasty to gastric bypass. This opinion is not shared by Mason who considers that, in the case of staple disruption, the simplest revision is to restaple the pouch, and that vertical banded gastroplasty not followed by a stenosis of the outlet, is amongst the best of antireflux operations.

**Gastric bypass**

This surgical procedure creates a larger pouch, emptied by an anastomosis directly into the jejunum, thus bypassing the duodenum. It is considered now as the most effective and safe surgery for morbid obesity. This technique induces weight loss by combining restricted intake and a moderate degree of malabsorption. There is no doubt that the initial loss of weight is greater after this procedure than following gastroplasty. The gastric pouch is separated from the excluded part of the stomach by stapling, and drained through a relatively large stoma directly into a jejunal loop in a Roux-en-Y arrangement. Thus, one limb of a Y-shaped reconstruction of jejunum allows the drainage of the gastric pouch, while the bile and pancreatic juice are evacuated by the second limb of the Y structure. Since hypertonic contents of the stomach rapidly enter the small bowel, patients frequently experience a dumping syndrome consisting of weakness and sweating after a carbohydrate-rich meal. This may obviously discourage them to consume sweet foods; hence the opinion that this type of gastrojejunal surgery is particularly indicated for obese patients considered as 'sweet eaters'. It should be stressed, however, that by bypassing the duodenum, this kind of surgery may cause malabsorption of iron and calcium, increasing the risk of anaemia, osteoporosis and hip fracture.

**Biliopancreatic diversion** A particular form of gastric bypass, referred to as biliopancreatic diversion, introduced in 1968 by Scopinaro, was designed to bypass a large part of the intestine with a concomitant resection of the excluded part of the stomach to decrease the risk of gastric ulcer. While the volume of the remaining gastric pouch is much larger than in other procedures, and may vary from 200–500 ml, the loss
of weight is essentially due to intestinal malabsorption. This procedure seems very effective in terms of loss of weight, but frequently induces protein malnutrition and other metabolic complications. It is, therefore, not surprising that the extent of weight loss after this kind of surgery is proportional to the length of the intestinal bypass and, thus, to the severity of malabsorption and risks of late complications.

**Long-term benefits of gastric surgery**

The loss of weight induced by gastric restriction procedures is due solely to decreased energy intake. Given the considerably reduced capacity of gastric pouch, the ingestion of energy is limited usually during the first three postoperative months to 400–600 kcal/day. Dietary records indicate that, during this initial period after gastroplasty, protein and fat intake is less than 30 g/day, the remaining energy consisting of carbohydrates ingested mainly as sweet liquids and semi-solid foods. Protein intake is limited by the aversion towards meats, which may persist for several months. The intake of protein is provided by dairy products and eggs and, later on, by poultry and fish. Patients are instructed to take frequent and small meals and, to prevent vomiting, to eat slowly and to avoid drinking during meals.

As a result of these radical changes in eating habits, a rapid loss of weight usually averaging 20–25 kg develops during the first 3 months after operation. At least 70% of the weight lost during this period is accounted for by a reduction of fat mass, the remaining loss corresponding to fat-free mass (lean tissue, intracellular and extracellular water). While the loss of lean tissue, resulting from a negative nitrogen balance, which averages 2–4 g of nitrogen per day, occurs mainly during the first weeks after surgery, the water lost during this period is usually recovered after 2–3 months. Later on, weight loss corresponds solely to the reduction of body fat, thus to the essential goal of the treatment. Loss of weight continues, albeit at a slower rate, during the following 3 months, and corresponds, at 6 months after surgery, to 40–50% of the pre-operative weight excess. At this time, the adaptation of eating habits and improved gastric tolerance allows a progressive increase and variety in consumption of solid foods, with a concomitant increase in protein, fat as well as mineral and vitamin intake. Energy intake thereafter progressively increases, and at 1 year after surgery averages 800–1000 kcal/day. This obviously reduces the loss of weight, which frequently ceases 12–18 months after gastroplasty, by when the loss of weight may account for to 60%, or even to 75%, of the initial excess of weight.
The loss of weight during the first year after surgery is proportional to the degree of the pre-operative obesity, and depends largely on the frequency of the follow-up visits. It may be considerably slower in obese subjects who consume large amounts of sweets and high-energy liquid foods rich in sugars and fat. According to some authors, vertical banded gastroplasty is not a suitable intervention in these subjects, and gastric bypass offers them much better postoperative results. Indeed, the gastric bypass procedure is followed by rapid emptying of the gastric pouch into the small bowel with ensuing aversion to sweets, due to the dumping syndrome.

Long-term loss of weight 2 years after surgery is variable and depends largely on eating habits. Despite some tendency toward a weight regain, some reports indicate that at least a 50% reduction of the pre-operative weight excess may be maintained for periods as long as 10–15 years after surgery. Weight loss is greater and maintained for longer periods after gastric bypass or biliopancreatic diversion than after gastroplasty. This is not surprising since the former procedures induce a variable degree of intestinal malabsorption, as will be discussed later on.

According to recent results published by Mason and Doherty, at 5 years after vertical banded gastroplasty, 48% of patients achieve a reduction of 51% or more of the initial weight excess. Modest success, defined as a loss of excess weight ranging between 25% and 50%, is obtained in 30% of patients. 22% can be considered to fail, due either to the insufficient loss of weight (16%) or to complications requiring revisional surgery (6%).

The impressive loss of weight, which usually follows gastric restriction procedure, is associated in most patients with a considerable improvement in the quality of life. The most important benefit, however, relates to a rapid improvement in several co-morbid conditions, such as hypertension, hyperlipidaemia, hyperuricaemia and glucose intolerance. The latter results from a significant increase in the sensitivity to insulin, with the clearcut improvement in glucose tolerance normalising hyperglycaemia in most previous non insulin-dependent diabetic subjects. Respiratory function is also improved, with significant regression or even disappearance of the sleep apnea syndrome. There is also a rapid amelioration of abnormal cardiac function. According to Stunkard, the most striking indication of improvement in health is the increased life expectancy, but results from long-term follow-up studies are needed to confirm this. The Swedish Obese Subjects (SOS) study was designed to address this important question. The preliminary data arising from this study are impressive: a considerable reduction in the incidence of diabetes mellitus and in cardiovascular complications.
While weight is seldom normalised, the partial reduction of the overweight is, in general, sufficient to correct many co-morbid conditions\textsuperscript{3,15}. These improvements are frequently associated with increased work capacity, hence a better rehabilitation into professional and social life.

**Gastric surgery — related risks and complications**

As already mentioned, the peri-operative mortality and early complications are extremely low, and the expected improvement in health considerably reduces the risk-to-benefit ratio. However, late gastric and nutritional complications may be relatively serious in some patients, largely depending on the type of operation as well as on the frequency and quality of the medical, psychological and nutritional follow-up.

Although vertical banded gastroplasty is well tolerated by most patients, some reports indicated a relatively high frequency of intractable vomiting related to gastro-oesophageal reflux \textsuperscript{27}. This complication rarely results from stenosis of the gastric pouch outlet, and is usually secondary to too rapid eating\textsuperscript{3}. Another, relatively frequent, complication is disruption of the staple line\textsuperscript{3,8,9}. This complication, usually followed by a sudden increase in eating capacity, with ensuing regain of weight, may need revisional surgery: either restapling of the gastric pouch, or the conversion of gastroplasty into gastric bypass. An intragastric migration of the polypropylene band restricting the gastric outlet, or ulceration of the stoma, have also been reported, but remain rare. Nutritional deficiencies are seldom encountered after vertical banded gastroplasty, despite the considerable restriction of nutrient intake, described by some authors\textsuperscript{28} as a state of ‘starvation in the midst of plenty’.

The most frequent nutritional deficiency is insufficient intake of iron and proteins, and thus anaemia\textsuperscript{29}. While low serum iron and ferritin levels are frequently observed after gastroplasty\textsuperscript{15}, there is usually no fall in hemoglobin level or in the number of blood red cells. Thiamine deficiency, with neurological sequelae, may also occur\textsuperscript{28,29}, especially in subjects suffering from intractable vomiting. If intravenous glucose is administered, it may exacerbate the problem by increasing demand for thiamine\textsuperscript{28}. The most threatening early complication of gastric bypass is an anastomotic leak, which, according to some reports\textsuperscript{9}, occurs in up to 4\% of patients. More frequent complications include anaemia, vitamin and mineral deficiencies and dehydration\textsuperscript{9,29}.

Nutritional deficiencies are much more frequent after gastric bypass than after gastroplasty\textsuperscript{8,9}, since the duodenum, the site of iron and
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calcium absorption, is bypassed. As well as iron and calcium depletion, low serum vitamin B12 and vitamin B1 concentrations are more frequently seen after gastric bypass than following simple gastric partitioning procedures\textsuperscript{16,29,30}. These nutritional deficiencies are even more frequent and serious after the biliopancreatic diversion, which bypasses not only the duodenum but also a large proportion of the small bowel\textsuperscript{20}. The excluded limbs are much longer following this type of surgery and, in addition, a large part of the stomach is removed (to decrease the risk of gastric ulcer)\textsuperscript{20}. Obviously this procedure considerably increases the risk of protein, mineral and vitamin deficiencies, a risk further aggravated by a tendency for patients to develop chronic diarrhoea\textsuperscript{9,20}. To prevent the serious risk of malnutrition, especially anaemia and bone demineralization, patients should be supplemented early after the surgery with iron, calcium as well as with vitamins B1 and B12. According to the recent report by Scopinaro\textsuperscript{20}, the impressive loss of weight, averaging a 78\% reduction of weight excess at 2 years and still 70\% reduction 15 years after surgery, may be associated with severe nutritional deficiencies. Indeed, protein malnutrition is observed in 12\% of patients, most by developing at the same time as iron, calcium and vitamin deficiencies which occur in 35\% of patients\textsuperscript{20}.

Nutritional supplementation after gastric bypass procedures, and especially after biliopancreatic diversion, is therefore mandatory. The risk of peripheral neuropathy and Wernicke's encephalopathy\textsuperscript{28,29}, necessitates supplementation with vitamin B1. To avoid calcium depletion and osteoporosis, Scopinaro advises a daily supplement of 2 g calcium (often not taken by patients), as well as a monthly intramuscular injection of 400,000 IU vitamin D\textsuperscript{20}. Despite these preventive measures, 7\% of patients undergoing this surgical treatment develop bone demineralization, usually between the second and fifth postoperative years\textsuperscript{19}. Since vitamin B12, in its protein-bound form, is poorly absorbed in these patients, Rhode\textsuperscript{30} has recently suggested daily administration of the crystalline form of vitamin B12 at very high dosage. Indeed, at least 350 \(\mu\)g of crystalline vitamin B12 are necessary to normalize the serum levels of this vitamin, and a dosage as high as 500 \(\mu\)g/day has been recommended\textsuperscript{16}. Monthly vitamin B12 injections may be substituted for oral administration. Gastric outlet obstruction and severe nutritional deficiency may necessitate revisional surgery, consisting usually of conversion into the vertical banded gastroplasty\textsuperscript{12}.

In addition to nutritional deficiencies, the restrictive eating behaviour and marked loss of weight which occurs after gastric surgery may lead exceptionally to anorexia nervosa\textsuperscript{31}. This complication may occur despite a careful psychiatric assessment prior to bariatric surgery\textsuperscript{31}. It is, in general, considered that the pre-operative evaluation of psychiatric status is of little value in predicting the magnitude of weight loss after
Albeit the gastric procedures are successful in producing weight loss, gastroplasty does not change abnormalities of eating behaviour that existed before surgery\textsuperscript{3,32}. Indeed, recent evaluation of a large number of patients who had undergone gastroplasty\textsuperscript{32}, indicated that surgery did not attenuate disturbances of eating behaviour, such as bulimia nervosa or ‘night eating syndrome’. This is of importance, since individuals who crave sweets and consume large quantities of soft foods and sweet liquids, may not lose weight satisfactorily after either gastroplasty or gastric bypass procedures. The available data indicate that co-morbid psychiatric disorders are not improved by weight-reduction surgery, despite the usual substantial improvement in psychosocial functioning\textsuperscript{5,32}. This clearly indicates that patients undergoing bariatric surgery should be followed closely from a psychological, or even psychiatric, standpoint for several years after operation. It appears, nevertheless, that the psychiatric status and personality disturbance do not seem to affect the weight loss outcome of bariatric surgery\textsuperscript{8,32}. Furthermore, psychologists or psychiatrists cannot predict reliably whether dietary compliance will be satisfactory or not after surgery, nor whether the patient will improve or deteriorate from a psychological point of view.

**General conclusions and indications for gastric surgery**

There is an increasing body of evidence suggesting that gastric restriction procedures, such as vertical banded gastroplasty and the gastric bypass, represent an appropriate, and sometimes the only effective therapy for morbidly obese subjects. While the surgeon should inform the morbidly obese patient that surgery is unlikely to normalise body weight, the patient can be advised that even a moderate loss of weight will be sufficient to greatly reduce the obesity associated co-morbidity. When properly conducted conservative approaches fail to produce significant weight reduction in the overweight, the treatment of choice is surgery. Less severely obese patients may also be considered for surgical treatment, if they suffer from significant co-morbidity.

The choice of procedure is important. According to current opinion, patients who consume large amounts of sugars or carbohydrates are more suited to gastric bypass, because symptoms of dumping may be important in contributing to a drastic reduction of energy intake. In contrast, in so called ‘big eaters’, the vertical banded gastroplasty, which induces early satiety even after a small meal, seems to be a preferred surgical option.

The impressive loss of weight which follows gastric restriction surgery is in general well tolerated and followed by a considerable improvement
or even disappearance of many co-morbid conditions, such as hypertension, respiratory and cardiac dysfunction, abnormal serum lipid profile and non insulin-dependent diabetes mellitus. Gastric restriction surgery may be, therefore, proposed as a treatment for obesity if the following criteria are fulfilled:

1. The patient should be morbidly obese with a body mass index (BMI) above 40 kg/m²
2. The patient with a BMI between 36 and 40 kg/m² may also be considered for gastric surgery if there are serious obesity-associated co-morbidities
3. Obesity should have been present for at least 5 years, and be refractory to several attempts at reducing weight by non-surgical methods
4. There should be no history of alcoholism or major psychiatric disorders. In this respect, it appears that the current mental state of the patient is more relevant than a past history of depression or minor psychiatric disorders.

Providing patients are appropriately selected both on the above criteria and also on the nature of the co-existing abnormalities of eating behaviour, gastric restriction surgery represents a significant progress in the treatment of severe obesity and of its health-threatening complications.

References

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