

# Surgical management of morbid obesity

**Obesity affects 1.7 million people worldwide, and is a leading cause of morbidity and mortality. Outcomes of conservative management are generally poor. Surgery for morbid obesity has reported excellent results, leading to an exponential increase in numbers of procedures performed.**

Obesity is a chronic condition characterized by an excess of body fat. A more exact definition is obtained through calculation of one's body mass index (BMI): weight in kilograms divided by height in metres squared ( $\text{kg}/\text{m}^2$ ). A BMI of 20–25  $\text{kg}/\text{m}^2$  is suggested to be ideal, people with a BMI between 25 and 30  $\text{kg}/\text{m}^2$  are characterized as overweight, those with a BMI between 30 and 40  $\text{kg}/\text{m}^2$  are obese, and over 40  $\text{kg}/\text{m}^2$  denotes morbid obesity (Wilding, 1997; Arterburn and Noel, 2001).

Obesity increases the risk of premature mortality and a number of comorbidities: type 2 diabetes, hypertension, hyperlipidaemia, heart disease, stroke, obstructive sleep apnoea, back and lower extremity weight-bearing degenerative disorders, many forms of cancer (e.g. large bowel and endometrial) and depression. It causes more than 2.5 million deaths per year (Arterburn and Noel, 2001).

Compared to an individual with normal weight, a 20-year-old man with a BMI  $>45 \text{ kg}/\text{m}^2$  is predicted to have a 22% reduction in lifespan (Fontaine et al, 2003). People with obesity have more than 10 times the risk of developing type 2 diabetes than their lean counterparts, and three times the risk of coronary heart disease. In addition, these risks rise with increasing obesity.

The incidence of obesity has been steadily increasing over the past 20 years leading to a worldwide epidemic. There are estimated to be 1.7 billion people in the world who are overweight (BMI  $>25 \text{ kg}/\text{m}^2$ ). The USA has the highest prevalence of overweight individuals (60%), followed closely by Germany, Russia and the UK (all 50%), 20% in Austria, Brazil, Colombia, Italy and Switzerland, and 10% in China. More specifically, more than 30% of the US population is obese and 4.9% is morbidly obese (Solomon and Dluhy, 2004). In 2000, the annual health-care cost arising directly from obesity was calculated as £2 billion in the UK and £45 billion in the USA (Wolf and Colditz, 1994; Bower, 1996). Perhaps more importantly, the prevalence of overweight in children and adolescents (BMI in the 95th percentile or higher for age and sex) has more than doubled since 1976 (Centers for Disease Control and Prevention, 1997).

The epidemic of obesity is most likely a result of sedentary lifestyles combined with easy availability of palatable, high fat foods. Doctors treat the consequences of obesity, but obesity itself is often ignored because available treatments are considered ineffective or unsafe. Furthermore, obesity is deemed to be a lifestyle choice, inflicted upon oneself and perhaps less important to treat than other diseases. This article reviews the current lit-

erature pertaining to the management of morbidly obese individuals, primarily from a surgical point of view.

## Lifestyle and medical therapies for obesity

Although 29% of men and 44% of women in the USA describe themselves as trying to lose weight, only about 20% report restricting caloric intake while increasing energy expenditure – an effective combination (Serdula et al, 1999). Dieting usually results in weight loss; more severe caloric restriction increases the rapidity of weight loss, although not the rate of long-term success in maintaining a reduced weight. For most obese individuals, improvements are not sustained and weight is regained to the pre-intervention body weight, or even higher. Losing weight is difficult for most obese people, although the greater challenge is to maintain the reduced body weight.

Although adding exercise to caloric restriction minimally increases weight loss during the acute phase of weight loss, it appears to be the component of treatment that is most likely to promote long-term maintenance of a reduced weight (McGuire et al, 1999). Behavioural treatments can also help obese persons to develop adaptive thinking, eating and exercise habits that enable them to decrease their weight and avoid weight regain (Wadden and Foster, 2000).

In response to the increase in obesity, pharmaceutical treatments for obesity have become both more numerous and more commonly used (Yanovski and Yanovski, 2002). Drugs prescribed for weight loss can be categorised as those that decrease food intake by reducing appetite or increasing satiety (appetite suppressants) and those that decrease nutrient absorption (lipase inhibitors) (Li et al, 2005). Most appetite suppressants work by increasing the availability of anorexigenic neurotransmitters – namely noradrenaline (such as phentermine or benzphetamine), serotonin (fenfluramine and dexfenfluramine) or both (sibutramine) – in the CNS. The only

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Food and Drug Administration approved medication for obesity that reduces nutrient absorption is orlistat (Roche Laboratories Inc., Nutley, NJ, USA), which binds to gastrointestinal lipases in the lumen of the gut, preventing hydrolysis of dietary fat into absorbable free fatty acids.

These medications, although moderately effective, can help carefully selected obese patients to lose weight and reduce the rate of regain. However, the safety and efficacy of weight loss medications has not been established beyond 2 years of use, so they should only be considered as an adjunct for patients who are at substantial medical risk from their obesity and in whom non-pharmacological treatments have not resulted in sufficient weight loss to improve their health or prevent regain. This background, and the increasing prevalence of obesity, has led to the development of obesity (or bariatric) surgery. Steinbrook (2004) stated that the 'epidemic of obesity in the US has spawned a second epidemic – of bariatric surgery'.

### Surgical management of obesity

The number of gastrointestinal surgeries performed in the USA annually for morbid obesity has increased exponentially from about 16 000 in the early 1990s to about 103 000 in 2003 (Steinbrook, 2004). This increase has in part been fuelled by the increased prevalence of morbid obesity, the failure of diets and pharmacotherapy, and the advent of laparoscopic techniques. The growth also reflects public perceptions of 'a quick fix', with a number of primarily American celebrities (and surgeons) undergoing bariatric procedures (Solomon and Dluhy, 2004).

A Cochrane review in 1997 noted that good results had been obtained from surgery in morbidly obese patients (Glenny et al, 1997). Over the past decade, the National Institutes of Health (NIH) in the USA and the Scottish Intercollegiate Guidelines Network have suggested that surgery is the most effective treatment for selected patients who are morbidly obese; both organizations recommend that surgery be carried out more frequently (NIH Consensus Development Conference, 1996). In 2002, the National Institute for Clinical Excellence (NICE) published guidance on the use of surgery to aid weight reduction for people with morbid obesity.

The selection criteria for surgery have been established by the NIH. The criteria are having a BMI of  $>40$  kg/m<sup>2</sup>, or a BMI of 35–40 kg/m<sup>2</sup> in patients with two co-morbidities which are treatable by weight loss, being obese for a minimum of 5 years, having had conservative treatment that failed, having no history of alcohol misuse or major psychiatric illness, and being aged between 18 and 55 years with acceptable operative risk as determined by preoperative assessment. Women must avoid becoming pregnant within 2 years of the operation (Baxter, 2000).

Surgery should be delivered within a multidisciplinary environment, including a dietician or specialist nurse to counsel the patient before and after surgery, a physician to assess fitness for surgery and exclude patients who have endocrine causes of obesity, a psychologist to help

patients adjust to new eating habits following surgery, an experienced bariatric anaesthetist, and a radiologist who can interpret special radiological investigations and carry out gastric band adjustments if fitted (Baxter, 2000).

### Surgical techniques

Bariatric surgical procedures can be broadly divided into two types, restrictive or malabsorptive. With restrictive surgery, the size of the stomach is restricted so the patient experiences the feeling of fullness with less food. This may be achieved with gastric banding, or vertical banded gastroplasty. Malabsorptive surgery involves bypass of parts of the gastrointestinal tract to decrease the absorption of food, i.e. jejunioileal bypass, biliopancreatic diversion and duodenal switch. Roux-en-Y gastric bypass is strictly speaking a combined approach with both a restrictive and malabsorptive component to the mechanism of weight loss (*Figure 1*).

Two procedures have dominated the surgical treatment of morbid obesity over the past 15 years. Gastric banding involves placing a band around the stomach at its upper end, creating a small pouch and a restricted passage to the larger remaining part of the stomach. Roux-en-Y gastric bypass involves the construction of a proximal gastric pouch whose outlet is a Y-shaped limb of small bowel of varying lengths. The proximal stomach is separated from the remaining part of the stomach with surgical staples.

Choosing between these procedures involves the surgeon's preference, patient eating habits and patient choice (Buchwald, 2002). Although generally gastric bypass is deemed to be more effective, its benefits should be weighed against its greater invasiveness as a surgical procedure, and the higher risk of nutritional deficiencies (*Figure 2*).

Within the past decade, the options have been further widened with the advent of laparoscopic surgery. Wittgrove and Clark performed the first laparoscopic Roux-en-Y gastric bypass in 1993 (Wittgrove et al, 1994). Patients did not have to tolerate a large midline laparotomy, and subsequently had smaller scars, reduced pain, a shorter hospital stay and an earlier return to daily activities (Soper et al, 1992). In 2003, about 56% of all bariatric operations were performed laparoscopically, the most common being laparoscopic Roux-en-Y gastric bypass (Buchwald and Williams, 2004).

### Measuring outcomes of bariatric surgery

While definitive therapy for obesity is not available at the present time, the aforementioned surgical procedures are capable of inducing significant weight loss in morbidly obese patients and this, in turn, has been associated with improvement or resolution of a number of co-morbid conditions. The efficacy of surgical treatments may be measured by a number of indices:

- **Weight loss:** the current aim of bariatric surgery is for patients to lose weight. This can be defined in a number of ways – absolute weight lost, amount of decrease in BMI, or percentage excess weight loss

- **Co-morbidities:** weight reduction surgery has had a positive effect on a number of comorbid conditions – type 2 diabetes, hyperlipidaemia, hypertension and obstructive sleep apnoea. Studies primarily report improvement as a binary function (yes or no) of defined variables such as glycosylated haemoglobin concentration, cholesterol concentration or blood pressure, rather than absolute figures
- **Metabolic effects:** interestingly, the improvement of insulin resistance after bariatric surgery occurs in advance of weight loss, and has led to the concept that these procedures also have a ‘metabolic’ effect (Rubino et al, 2004). A number of novel mechanisms to explain this have been proposed, whereby changes in postoperative gut hormones such as glucagon-like peptide 1, gastric inhibitory polypeptide and ghrelin may play a putative role (Patrioti et al, 2004)
- **Psychosocial effects:** although a number of patients have reported improvements in mood and depression, these factors have been difficult to quantify
- **Mortality:** long-term mortality data following bariatric surgery are few, but gradually increasing in number. Christou et al (2004) revealed that after a 5-year follow up, the mortality rate in obese patients undergoing bariatric surgery was 0.68% compared to 6.17% for controls, which corresponded to a relative risk reduction of mortality of 89%
- **Quality of life:** this measure has been assessed by a handful of authors in terms of quality-adjusted life years, or the more specific bariatric analysis and reporting outcome system (BAROS) questionnaire which incorporates percentage excess weight loss, changes in co-morbidities and the Moorehead–Ardelt quality of life questionnaire (Oria and Moorehead, 1998).

## Outcomes from bariatric surgical procedures

In 2004, Buchwald et al published a meta-analytical review of bariatric surgery. Their aim was to determine the impact of bariatric surgery on weight loss, operative mortality outcome, and four co-morbid conditions (diabetes, hyperlipidaemia, hypertension and obstructive sleep apnoea). A total of 136 fully extracted studies were included, with a total of 22 094 patients. Nineteen per cent of patients were male, with a mean age of 32.6 years (range 16–64 years). The baseline BMI for 16 944 patients was 46.9 kg/m<sup>2</sup> (range 32.2–68.8 kg/m<sup>2</sup>). Percentage excess weight loss across all patients was 61.2%, increasing from 47.5% (gastric banding), 61.6% (gastric bypass), and 68.2% (vertical banded gastroplasty) to 70.1% (biliopancreatic diversion or duodenal switch).

With regard to resolution of co-morbidities, diabetes was said to be completely resolved in 76.8% of patients, and resolved or improved in 86.0%. Hyperlipidaemia improved in 70.0% of patients. Hypertension was resolved in 61.7% of patients, and resolved or improved in 78.5%. Obstructive sleep apnoea was resolved in 85.7% of

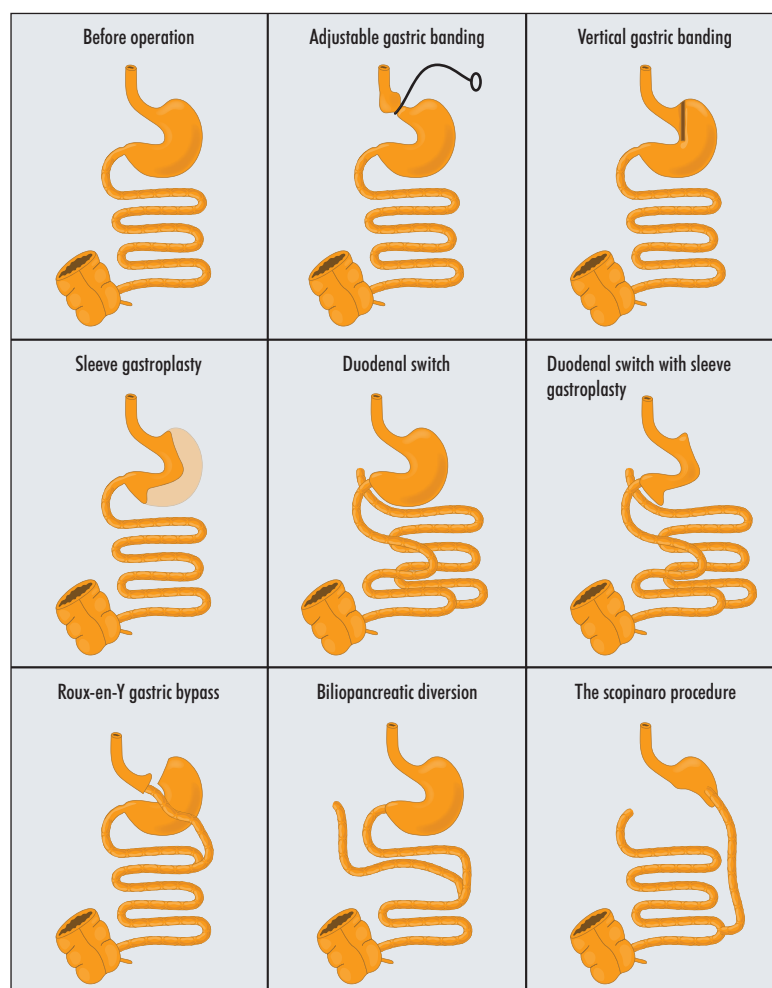
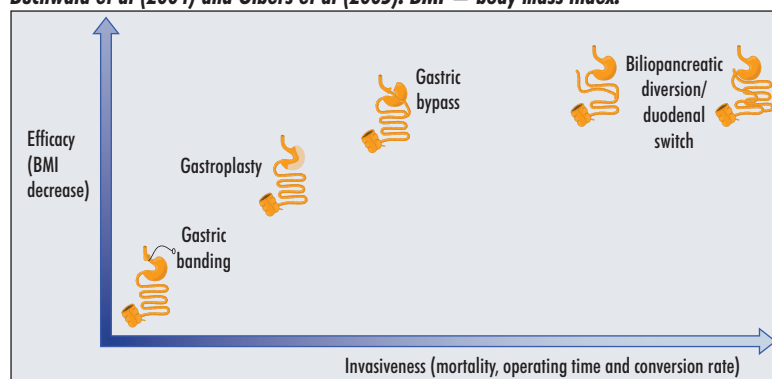


Figure 1. Bariatric surgical procedures.

patients and was resolved or improved in 83.6% of patients. The 30-day postoperative mortality was 0.1% for purely restrictive procedures, 0.5% for gastric bypass and 1.1% for biliopancreatic diversion or duodenal switch (10 times greater than for restrictive procedures).

These are excellent results compared with lifestyle and pharmacological treatments of obese patients (Wadden and Foster, 2000; Li et al, 2005). A further meta-analysis published in 2005 assessed 147 studies, and supported the

Figure 2. The relationship between procedural complexity and efficacy. Based on data from Buchwald et al (2004) and Olbers et al (2005). BMI = body mass index.



finding that surgery led to greater weight loss than medical treatment alone, patients with a BMI of 40 kg/m<sup>2</sup> or more achieving 20–30 kg of weight loss which was maintained for up to 10 years and accompanied by improvements in some co-morbid conditions (Maggard et al, 2005). Gastric bypass procedures resulted in greater weight loss than gastroplasty, with an overall mortality of less than 1%.

Maggard et al (2005) also commented on the fact that a laparoscopic approach results in fewer wound complications than an open approach. This is now generally upheld, proven by the extensive work of Nguyen et al (2005) comparing laparoscopic *vs* open gastric bypass in terms of clinical outcomes (pulmonary function, postoperative pain, recovery and weight loss), adverse events (anastomotic leak, wound-related complications, retained foreign body, iatrogenic splenectomy, bowel obstruction, gastrointestinal haemorrhage, anastomotic stricture and mortality), cost and quality of life measures. The fundamental differences between laparoscopic and open procedures are method of access to the abdominal cavity and operative exposure. Reducing the size of the surgical incision and the trauma associated with operative exposure lessens the physiological insult to the patient. This leads to a reduction in impairment of postoperative pulmonary function and less pulmonary atelectasis. Clinical advantages include lower operative blood loss, shorter hospital stay, reduction in postoperative pain, and a faster recovery. Laparoscopic Roux-en-Y gastric bypass does not differ in terms of long-term weight loss, improvement of co-morbidities or quality of life measures.

It may be suggested that laparoscopic procedures are more expensive because of the specialized equipment required. A randomized clinical study of 155 patients undergoing laparoscopic (*n*=79) or open (*n*=76) Roux-en-Y gastric bypass was undertaken (Nguyen et al, 2001). Mean operative time was longer for the laparoscopic group, although operative blood loss was less. Median length of hospital stay was shorter for the laparoscopic group (3 *vs* 4 days), with wound-related complications such as infection (1.3 *vs* 10.5%) and incisional hernia (0 *vs* 7.9%) greater in the open group. Weight loss at 1 year was similar between the two groups. At 6 months, the BAROS outcome was good or better in 97% of laparoscopic *vs* 82% of open Roux-en-Y gastric bypass patients. With such superior outcomes of the laparoscopic approach, although the operative costs for laparoscopic Roux-en-Y gastric bypass were higher, hospital costs were lower. The authors concluded that laparoscopic Roux-en-Y gastric bypass is a safe and cost-effective alternative to open Roux-en-Y gastric bypass.

Although Nguyen et al's study was conclusive, how does laparoscopic Roux-en-Y gastric bypass fare in comparison to less invasive laparoscopic procedures such as gastric banding or gastroplasty? Two European studies have sought to answer this question. In a prospective database of 678 bariatric procedures, 103 laparoscopic Roux-en-Y gastric bypass were case-matched to 103 laparoscopic gastric band procedures (Weber et al, 2004). The procedures

were all feasible and safe, although pouch dilatations after gastric banding led to greater numbers of complications in this group, and thus decreased efficacy of the procedure. The authors concluded that laparoscopic Roux-en-Y gastric bypass appears to be the bariatric procedure of choice. A further study by Olbers et al (2005) sought to perform a randomized clinical trial of laparoscopic Roux-en-Y gastric bypass *vs* laparoscopic vertical gastric banding in 83 morbidly obese patients. All procedures were completed laparoscopically, although mean operating time for laparoscopic Roux-en-Y gastric bypass was longer (138 *vs* 105 minutes). Weight reduction was significantly greater after laparoscopic Roux-en-Y gastric bypass at 1 and 2 years after surgery. The authors agree with their counterparts that laparoscopic Roux-en-Y gastric bypass seems to be the procedure of choice for morbidly obese patients. But is this solely a function of the operative procedure type?

Nguyen et al (2003) sought to analyse preoperative factors that may be associated with operative outcomes for laparoscopic Roux-en-Y gastric bypass. They evaluated 150 consecutive procedures performed by a single surgeon in terms of patient factors (age, sex, abdominal surgery history, smoking), obesity-specific factors (BMI, hypertension, diabetes, sleep apnoea), and surgeon-specific factors (75 cases or less, *vs* more than 75 cases). Outcomes were based on procedure time, postoperative complications, major complications, reoperation and length of hospital stay. Although age and male gender were associated with higher complication rates, surgeon experience was also associated with longer operative times, major complications and lengthier hospital stays. The authors suggested that an operative experience of greater than 75 cases is the threshold beyond which operative outcomes improved, and surgeons learning the procedure should strive to reduce the length of this learning curve.

### The learning curve for bariatric surgery

Laparoscopic Roux-en-Y gastric bypass is a complex procedure, and the learning curve has been quoted to be between 75 and 100 cases, during which time complication and conversion rates may be twice as high as those of experienced surgeons (Oliak et al, 2003; Ballantyne et al, 2005; Shikora et al, 2005). This is a result of the complexity of both the operative procedure and the skills necessary to carry out the procedure. The surgeon must work in more than one abdominal quadrant and perform tasks such as gastric pouch creation and Roux limb formation. Advanced skills for bowel manipulation, laparoscopic suturing and the use of new tools (laparoscopic staplers, high energy devices) must also be mastered (Higa et al, 2000). Shikora et al (2005) reviewed the perioperative deaths and complications of 750 consecutive morbidly obese patients undergoing laparoscopic Roux-en-Y gastric bypass over a 6-year period at a single centre. The overall complication rate was 15% with 0.3% mortality rates. For the first 100 cases the overall complication rate was 26% (with mortality of 1%), decreasing to approximately 13%

for the remaining 650 patients. Major complications such as anastomotic leak decreased from 3% to 1.1%, as did small bowel obstruction from 5% to 1.1%. Overall operating time was also decreased from 212 minutes for the first 100 cases to 105 minutes for the last 100 cases.

The inference from these results is that morbidity and mortality can be reduced by 50% with experience, i.e. beyond the initial learning curve of 100 cases. Similarly, Schauer et al (2003) reviewed their first 150 laparoscopic Roux-en-Y gastric bypass cases and reported that operative complications halved after their 100th case. Oliak et al (2003) found dramatic reductions in operative time (from 189 to 125 minutes) and perioperative complications from 32% to 15% after the 75th case. It is pertinent to question the current state of training programmes to enable surgeons to ascend this long and steep learning curve.

Buchwald and Williams (2006) published a questionnaire study of 251 accredited surgery residency training programmes in the USA, of which 185 (74%) performed bariatric surgery, primarily open Roux-en-Y gastric bypass. Forty three of 48 minimally invasive fellowship programmes performed bariatric surgery, primarily laparoscopic Roux-en-Y gastric bypass. All centres replied that they taught bariatric surgery to their residents, with a mean of 150 (range 10–750) cases performed annually. It thus seems that bariatric surgery has been mainstreamed into accredited training programmes in the United States. However, the study must be criticized as there is no mention of degree of involvement of residents during cases, use of simulation-based material to teach technical skill, and mode of credentialing to ensure competence.

It is now 10 years since the International Federation for the Surgery of Obesity (Cancun IFSO) Statement on Bariatric Surgeon Qualifications was published (Cowan Jr, 1998). Eight recommendations were made regarding minimal standards for a surgeon to achieve before independent practice. It was not until 2003 that the American Society for Bariatric Surgery published similar guidelines for granting privileges in bariatric surgery, with an update in 2006 (American Society for Bariatric Surgery, 2006). The aim was to define the degree of experience, exposure and support considered to be minimally acceptable credentials for general surgery applicants to be eligible for hospital privileges to perform bariatric surgery.

### Centres of bariatric surgical practice

The American College of Surgeons (ACS) has developed a Bariatric Surgery Center Network Accreditation Programme. The aim is to deliver high-quality surgical care for patients who undergo bariatric surgery. A manual for this defines four levels of inpatient facilities (1a, 1b, 2a and 2b) and standards for outpatient facilities. The analogy is with the classification of trauma centres, recognizing 1a and 1b designated centres to provide complete tertiary care. These hospitals will have high volumes of practice, enabling them to manage the most complex and challenging of patients. Level 2a and 2b centres shall have

lower volumes, and offer services to patients with lesser levels of obesity and co-morbidities. The designation into different levels is based on organization of services, measurable standards in terms of staff and equipment, and reliable measurement of outcomes. The process to obtain approval from the ACS Bariatric Surgery Center Network Accreditation Programme is fairly lengthy, although is a definite move in the right direction towards regulation of practice. The aim is to enter outcomes data into a national database, leading to accurate measurement of procedures performed, complications and mortality, and to enable the collection of long-term follow-up data.

In a similar but less stringent manner, societies such as the European Association for Endoscopic Surgeons and the Society for American Gastrointestinal Endoscopic Surgeons have published consensus statements regarding the optimal management of obese surgical patients (Jones et al, 2004; Sauerland et al, 2005). The guidelines are particularly useful for centres contemplating starting a bariatric surgical practice. Safadi et al (2004) described their experience in setting up a bariatric surgical programme, stating that a key factor was the multidisciplinary team approach. This is essential to the development of a new practice with significant risks, not only for enrolment of patients, but also in terms of close follow-up post-procedure.

This role of team-based practice can also be extended to a group of surgeons learning the procedure together, enabling one to build from the other's performance, and vice versa. This may also lead to a shortening of the learning curve, and subsequent improvements in morbidity and mortality in the first 75 to 100 cases.

### The future of bariatric surgery

It has been stated that 'any debate over the value of bariatric surgery for the treatment of morbid obesity appears over; it works better than lifestyle modification or drug therapy' (Mitka, 2006). Beyond weight loss, bariatric surgery also helps resolve co-morbid conditions such as type 2 diabetes mellitus, hypertension, hyperlipidaemia and sleep apnoea. However, questions remain regarding the long-term safety and efficacy of bariatric surgery, with common late complications such as dumping syndrome, vomiting, reflux and diarrhoea. Initiatives such as the centres of excellence should continue to improve outcomes.

So, is surgery the answer for all obese patients? Will patients with significant co-morbidities who have a BMI of less than 35 kg/m<sup>2</sup> also benefit from this form of surgery? There is some preliminary work investigating the effect of gastric bypass on non-obese type 2 diabetic patients – the early outcomes seem to support resolution of disease (Cohen et al, 2007), but this has yet to be confirmed in large-scale randomized controlled trials.

A further question is whether surgical management is a short-lived phenomenon, and the development of a 'magic bullet' for treatment of obesity is in the pipeline. Cummings et al (2002) have published extensively on the role of ghrelin, a 28 amino-acid peptide that is

predominantly synthesized in the endocrine cells of the stomach. Ghrelin has been suggested to be obesogenic, and the search for a ghrelin antagonist seems fruitful. Nonetheless, obesity is likely to be caused by more than a single hormone, and we are some way from an anti-obesity pill. Until then, surgical management seems to be the mainstay of treatment for morbid obesity. **BJHM**

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## KEY POINTS

- Obesity is a worldwide epidemic, leading to increased rates of morbidity and mortality.
- Lifestyle and medical therapies are moderately effective and can help carefully selected patients to lose weight.
- Surgical management of morbid obesity is successful in attaining weight loss, involving either restrictive or malabsorptive procedures.
- The laparoscopic approach leads to further reductions in the morbidity of the operative procedure.
- Obesity surgery can also improve co-morbid conditions such as diabetes, hyperlipidaemia, hypertension and obstructive sleep apnoea.