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Bariatric Surgery

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Risks of Obesity

"Globesity" – as termed by WHO, describes the worldwide epidemic of obesity. It has an effect on the individual and society.

USA expenditure on obesity related problems
1990: $ 46 billion (6.8% of their health care costs)
Current estimates: > $100 billion

Morbid obesity affects every organ system:
Obese persons have more than 10 times the risk of type 2 diabetes and 3 times the risk of coronary heart disease of those who are lean, and the risks of these and other coexisting conditions rise with increasing obesity.

This escalation in obesity is a time bomb for the future risk of diabetes and other illnesses and for the attendant costs. A recent systematic review [1]of over 890 000 participants found that each 5 point increase in body mass index (kg/m^2) over 25 was associated with a 30% increase in overall mortality.

40% for vascular mortality
60–120% for diabetic, renal, and hepatic mortality
10% for neoplastic mortality
20% for respiratory and for all other mortality

Definition of Obesity

There is no precise definition. A person is considered obese when the amount of body fat increases beyond the point where health and life expectancy deteriorate.
Total body weight = fat body weight + lean body weight
Lean body weight includes: bones, muscle, viscera, ligaments, tendons, water, etc.

Measurements

Bioelectrical impedance assessment devices
Imaging studies
CT *
MRI*
Dual-energy x-ray absorptiometry
(*Generally limited to research centres)

With direct measurement of fat topography came the sub classification of the truncal fat compartments:
truncal/central obesity
upper body obesity
with the findings of body fat distribution as a more relevant predictor of adverse health consequences. Hence android and gynaecoid (apple vs pear) obesity replaced the body habitus concept (construct of ectomorph, mesomorph and endomorph).

Body composition provided evidence for waist and waist-to-hip ratio (WHR) measurements.

National Heart, Lung and Blood Institute has standardised these definitions:
Waist: narrowest circumference between ribs and umbilicus
Hips: circumference at the level of the umbilicus
Currently waist circumference appears to be a more valid and reliable indicator of fat deposition than WHR, and studies have confirmed it as better predictor of cardiovascular disease than WHR; and when combined with BMI, is better in predicting metabolic risk than either variable alone.

Current guidelines:

Waist > 102 cm in men; > 88cm women: associated with increased cardiovascular risk. (Opinion that even >94cm in men and >80 cm in women may be more appropriate at identifying people at risk of cardiovascular disease.)
WHR >1.0 in men & >0.85 in women ***not*** currently recommended for initiation of treatment. However many clinicians still recognise and use these landmarks and values.
BMI is considered an indirect measure of body fat.

Treatment options

Diet

Energy expenditure must exceed energy intake, with an integrated programme of caloric and fat restriction, exercise and behaviour modification. Dietary interventions focus on total caloric intake and diet composition.

NHLBI guidelines suggest:

An initial weight loss goal of 10% reduction from baseline weight;
Use of a low-calorie diet (800–1500 kcal/d) and avoidance of very-low-calorie diets;
Composition of diet: 30% calories from fat, 15% calories from protein, 55% calories from carbohydrates;
Net daily caloric deficit of 500 to 1000 kcal/d to produce a weight loss of 1 to 2 lbs per week;
Initial weight loss period of 6 months for the majority of patients with frequent, regular contact between the health professional and the patient;
Long-term weight maintenance program after 6 months; and
Physical activity for 30 to 45 minutes 3 to 5 days per week

Pharmacotherapy

Canadian Task Force on Obesity did not present guidelines for therapeutic intervention after an analysis of 813 obesity treatment trials. 39 of these trails met their inclusion criteria and it was felt that there was insufficient data to evaluate the long-term effectiveness of obesity treatment methods.

NHLBI after reviewing 44 trails issued federal issued guidelines based on:
- BMI
- Waist circumference,
- Presence of comorbidities:
    e.g. established coronary heart disease / other atherosclerotic disease, type 2 diabetes, sleep apnoea.

They recommend pharmacotherapy for:
- BMI >30 kg/m2
- Waist circumference > 88cm in women; >102cm in men
- BMI >27kg/m^2 and comorbid condition or more than one risk factor for "weight-related" disease, e.g., hypercholesterolemia, diabetes, hypertension.

Drugs must be used in conjunction with lifestyle modification, dietary intervention, behavioural therapy and increased physical activity. The patient's motivation and willingness to adopt an integrated lifestyle modification program should also be assessed as part of the evaluation.

3 categories of drugs for the treatment of obesity [2]:
1) anorexiants, which target neurotransmitters, e.g. sertraline
2) lipid-partitioning medications, which diminish energy intake, e.g. orlistat
3) thermogenic drugs, which increase energy expenditure – not FDA approved

Off lable usage of medication is also practised. Eg metformin, topiramate, zonisamide, bupropion.[3]

Surgery

Unfortunately, dieting, exercise, and cognitive behavioural therapy achieve long term weight loss in only a small minority of highly motivated individuals.
Bariatric surgery is the only treatment that randomised controlled trials have shown to produce effective long term weight loss. Bariatric surgery also relies on a committed patient, dedicated to long term surveillance and therapy, and should not be viewed as a quick fix for someone prepared to undertake the risk of surgery.

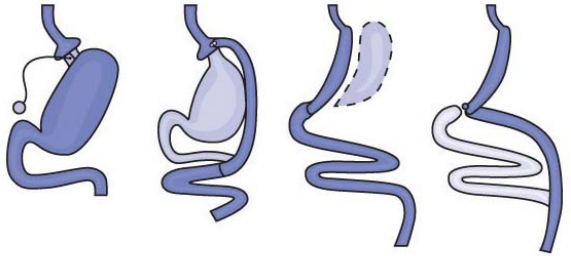
There is no single or standard procedure for management of morbid obesity. There is continuous evolution in operative approaches. Some surgeons offer only one procedure, where as others are able to perform a variety of them. Procedures can be divided into gastric restrictive operations (in order to reduce food intake) and malabsorptive operations (these reduce food uptake from the GIT):

Gastric restrictive operations
- Laparoscopic adjustable gastric banding
- Sleeve gastrectomy
- Vertical banded gastroplasty (now obsolete)

Malabsorptive operations
- Biliopancreatic diversion (BPD)
- BPD with duodenal switch

Malabsorptive/restrictive operations
- Roux-en-Y bypass
- Mini-gastric bypass

For all bariatric procedures, pure reversal without conversion to another bariatric procedure is almost certainly followed by a return to morbid obesity.



Roux-en-Y gastric bypass (open and laparoscopic) and laparoscopic adjustable gastric banding account for 90% of bariatric procedures performed worldwide. The number of procedures performed in the United States in 1994 approximately 16,200 and in 2005 over 171,000 and numbers are still increasing. The choice of bariatric procedure is usually dictated by the medical factors of individual patients and by the deep-seated preferences of both surgeons and patients, essentially the short term survival (post operative mortality) vs long term survival (pathology resolution).

Laparoscopic vs open procedures

By 2003 nearly two-thirds of bariatric procedures worldwide were performed laparoscopically. Open and laparoscopic bariatric operations are not competitive but are complementary. Open bariatric operation has certain advantages over laparoscopic procedures. These include tactile control of dissection and the ability to palpate tissues, greater ease and speed for lysis of adhesions, freedom to use fine suture technique and materials, greater facility to perform ancillary procedures, possibly a lower incidence of certain perioperative complications (e.g., leaks, haemorrhage), and decreased risk of specific long-term complications (e.g., anastomotic strictures, internal hernias, bowel obstructions).

Laparoscopic bariatric surgery has certain advantages over open procedures, such as minimal incisional scars, less postoperative pain, increased mobility, shortened hospital stay, shorter convalescent time, and fewer late ventral hernias.

Operative times vary between open and laparoscopic procedures from surgeon to surgeon. Costs are similar; the cost of additional operative equipment disposables needed for laparoscopic surgery equals the cost of longer hospital stay for open

procedures. Long-term weight loss and amelioration of comorbid conditions are essentially the same for open and laparoscopic bariatric operations.

A difficult laparoscopic approach can convert to an open operation. Other advantages of the laparoscopic procedure include reduced hospital stay, more rapid return to normal activity, improved cosmesis, and a marked reduction in the incidence of incisional hernia and wound infection.

For certain conditions the open approach may be indicated, e.g., super (BMI >50 kg/m^2) and central obesity, hepatomegaly, inability to tolerate pneumoperitoneum, presence of congenital anomalies, anticipated severe adhesions, certain abdominal wall hernias, management of complications, and some planned revision procedures.

Short-term survival

The Obesity Surgery Mortality Risk Score (OS-MRS), developed by DeMaria from a single institution's experience of 2075 patients, uses five patient characteristics to predict peri-operative mortality [4].

- Age≥ 45 years
- Hypertension
- BMI >50 kg/m^2 or greater
- Male gender,
- Risk of pulmonary embolism (history of VTE, pulmonary hypertension, and obesity hypoventilation)

The scoring system was then validated in 4431 patients from 4 validation centres that were nonparticipants in the original defining cohort study [5].
Currently in print, in a retrospective review of 25 years of RYGB surgery at a single centre, the OS-MRS score was found to predict the 90 day peri-operative 90 day mortality [6].

Results are compared.

OS-MRS class	Class A (0-1 risks)	Class B (2-3 risks)	Class C (4-5 risks)
Defining cohort [4]	0.31%	1.90%	7.56%
Validation cohort [5]	0.37%	1.21%	2.4%
Retrospective 25yr review [6]	0.3%	1.5%	3%

The utility of this scoring system has so far been suggested to help in surgical decision making and in obtaining informed consent and may allow standardization of outcome comparisons between different centres. The recently published LABS–1[7] trail is a prospective, multicenter observational study assessing the 30-day complication rates in 4776 patients having a first-time bariatric procedure. The composite end points looked at were death; venous thromboembolism; percutaneous, endoscopic, or operative reintervention; and failure to be discharged from the hospital.

- 30-day mortality rate = 0.3%
  Laparoscopic adjustable gastric banding 0%
  laparoscopic Roux-en-Y gastric bypass 0.2%
  open Roux-en-Y gastric bypass 2.1%
- Composite end point = 4.1%
  laparoscopic adjustable gastric banding 1.0%
  laparoscopic Roux-en-Y gastric bypass 4.8%
  open Roux-en-Y gastric bypass 7.8%

Data may represent a best-case scenario as operations were performed in high-volume bariatric centers all the skilled bariatric surgeons, though evidence exists that bariatric outcomes are similar, even in centres that are not certified as "centers of excellence" or high volume. The risks seem greatest when a surgeon performs < 25 cases a year and when the institution hosts < 50 cases a year. The risks are lower when the surgeon performs >50 cases a year and the institution hosts > 150 cases a year [8].

Long-term effects

Surgery for severe obesity goes beyond weight loss, and can result in complete remission or significant improvement of type 2 diabetes and other life-threatening diseases in most patients.

The first meta-analysis on co morbidity outcomes of bariatric surgery was published in 2004 in JAMA [9].

In over 22,000 patients it found that the average loss of excess weight was 61 %;
• Type 2 diabetes remission in 76.8% and significantly improved in 86% of patients
• Hypertension eliminated in 61.7% and significantly improved in 78.5% of patients
• High cholesterol reduced in more than 70% of patients
• Sleep apnoea was eliminated 85.7% of patients

The majority of the studies included were uncontrolled case series, and a minority involved more than two years of follow-up.

A large prospective study in 2004 was published in the NEJM [10]. It included men and women with BMI > 34 and 38, respectively, who underwent bariatric surgery (gastric banding, vertical banded gastroplasty, or gastric bypass) or no surgery. The study was not randomized as review boards considered the post operative mortality rates of 1-5% at the time high enough to preclude this.

Comparison group of subjects who did not undergo surgery was assembled by computerized matching of such subjects to subjects in the surgery group on the basis of sex, age, and anthropomorphic, metabolic, and psychosocial measures.
3505 subjects (87% follow up rate) were evaluated at 2 years and 1268 (74% follow up rate) evaluated at 10 years.

Mean weight loss from baseline (% loss of total body weight)

	2 years	10 years
Surgical group	23%	16%
Control group	1%	2%

Weight losses were greatest among the patients who underwent gastric bypass.

At the 10-year follow-up, "recovery" from diabetes, hypertension, hypertriglyceridaemia, and hyperuricaemia (but not hypercholesterolemia) was significantly more likely in the surgery group than in the control group; in addition, the new development of diabetes, hypertriglyceridaemia, and hyperuricaemia was significantly less common in the surgery group. The rates at which these obesity-associated complications were eliminated or avoided were less impressive at 10 years than at 2 years; so loss of the initial benefits of bariatric surgery after 10 years, but potential benefit none the less.
The accompanying editorial pointed out that what was still not known was whether these benefits translated into reduced rates of myocardial infarction, stroke, and ultimately, death; and also that the authors indicated that the current data was insufficient to reveal a clear increase or decrease in overall mortality, and they provided no data on the rates of cardiovascular disease.

Two landmark articles were published in 23 August NEJM 2007:

1. Sjöström et al. conducted a prospective, controlled study of bariatric surgery, called the Swedish Obese Subjects (SOS) study [11], in which obese patients wishing surgery were matched with equally obese patients not desiring surgery. These 4047 patients were the same set as that which formed the 2 year follow up group in their 2004 trail mentioned above.

Weight loss

Surgical patients: (% decrease in total body weight)

	2 years	10 years
Gastric banding	20%	14%
Vertical banded gastroplasty	25%	16%
Gastric bypass	32%	25%

The average weight change in control subjects was less than ±2% during the period

Mortality (results for all but 3 patients)

	Surgery	Control
1st 90 days from study initiation	5	2
Remainder of study	96	127
Total	101	129

In the surgery group, there was a significant reduction in the adjusted hazard ratio for death (29%)

2. Adams et al, in a retrospective cohort study, took 9949 patients who had undergone gastric bypass surgery and 9628 severely obese control persons who applied for driver's licenses [12]. From these 2 groups, 7925 surgical patients were matched to 7925 severely obese control subjects; for age, sex, and body-mass index. Death rate from any cause and from specific causes (with the use of the National Death Index) was determined, with a mean follow-up of 7.1 years.

Deaths from all causes were reduced by 40%, from diabetes by 92%, from coronary artery disease by 56%, and from cancer by 60%. Incidentally, rates of death not caused by disease, such as accidents and suicide, were 58% higher in the surgery group than in the control group.

Deaths in the first year were essentially the same in the surgery group and the control group.

In that NEJM issue the editorial on these 2 trials ends:

"Thus, the question as to whether intentional weight loss improves life span has been answered, and the answer appears to be a resounding yes." [13]

Diabetes

American Diabetes Association

From : Standards of Medical Care in Diabetes—2009

Bariatric surgery should be considered for adults with BMI >35 kg/m^2 and type 2 diabetes, especially if the diabetes is difficult to control with lifestyle and pharmacologic therapy. Although small trials have shown glycaemic benefit of bariatric surgery in patients with type 2 diabetes and BMI of 30–35 kg/m^2, there is currently insufficient evidence to generally recommend surgery in patients with BMI <35 kg/m^2 outside of a research protocol.
How then should it be considered? The most recent evidence comes from Buchwald et al in a meta-analysis [14]. The objective was to determine the impact of bariatric surgery on type 2 and the weight reduction achieved.

Overall weight loss was 38.5 kg or 55.9% EBW.
greatest for patients undergoing biliopancreatic diversion/duodenal switch
followed by gastric bypass, least for banding procedures
complete resolution* of diabetes in 78.1%
improved* or resolved diabetes in 86.6%
* "resolved" = being off medications, having a fasting glucose at follow-up of <5.6 mmol/L and/or having an HgA1c <6%;
"improved" = use of fewer medications and/or fasting glucose levels between 5.6-6.9 mmol/L.

Insulin levels declined significantly postoperatively, as did HbA1c and fasting glucose values. Weight and diabetes parameters showed little difference at less than 2 years and at 2 years or more.

The accompanying editorial questioned the applicability of the findings of this meta-analysis to broader populations with type 2. Apart from only 10 of the included studies (1.6%) qualifying as Class I evidence, its population consisted primarily of markedly obese women (80%) and subjects who were relatively young (mean age = 40 years); the average BMI was 47.9 kg/m^2.

Previous studies have noted that with bariatric surgery, older patients or those with diabetes of longer duration are less likely to improve their glucose tolerance; and conversely, patients with the shortest duration of diabetes, and those whose diabetes was controlled by diet preoperatively, are the most likely to improve their glucose tolerance.

Another point raised was that when assessing benefits of any therapy on type 2 diabetes; as a minimum, an acceptable impact on HgA1c and fasting glucose levels needs to be shown. The meta-analysis reported a change in HgA1c of 2.1% - obtainable with many currently available pharmacologic regimens. The editorial concludes by saying that we are not yet able to ascertain whether we have found a surgical cure for type 2 diabetes or another effective treatment option to be used in a more narrowly defined clinical and/or demographic profile.

One of the greater insights has come from the Roux-en-Y gastric bypass (RYGB). The rearrangement of the GIT engages antidiabetes mechanisms beyond those related to weight loss. The diabetes typically resolves within a few days to weeks, long before substantial weight loss has occurred, even controlling glucose levels without medication within 3 days post operatively. When evaluated at an equivalent percentage weight loss, patients who have undergone RYGB surgery display greater improvements in glucose tolerance than those who have undergone LAGB surgery.

RYGB procedure increases insulin sensitivity and may directly improve beta-cell function; reports of patients post RYGB developing late onset severe hyperinsulinaemic hypoglycaemia - sometimes even requiring pancreatectomy, implying a beta-cell stimulatory effect. This has opened the window for researchers to elucidate these pathophysiological mechanisms, and manipulate them pharmacologically as future therapy for type 2 diabetes. In 2007 bariatric surgery societies in the United States, South America, and Europe changed their names to highlight this concept of “metabolic surgery.”

Patient selection and referral

The 1991 NIH convened a Consensus Development Conference on gastrointestinal surgery for severe obesity, and issued the first criteria for bariatric surgery. It is still considered reasonable today.

They are:

- BMI >40 kg/m^2
- BMI of 35.0 kg/m^2 to 39.9 kg/m^2 in the presence of severe comorbidities*.

* = type 2 diabetes, life-threatening cardiopulmonary problems (e.g., severe sleep apnoea, Pickwickian syndrome, obesity-related cardiomyopathy), obesity-induced physical problems interfering with a normal lifestyle (e.g., joint disease treatable but for the obesity), and body size problems precluding or severely interfering with employment, family function, and ambulation.

This is the selection criteria recommended by American Society of Metabolic and Bariatric Surgery (ASMBS), as well as other organisations.
The American College of Physicians are more conservative, recommending surgery be considered in patients with a BMI > 40 and coexisting conditions.
On the issue of BMI 30 – 35 with comorbidities amenable to cure or marked improvement with surgery, ASMBS feels there is insufficient evidence to draw a conclusion as to the increased benefit to the risk exposed. This is an area of controversy, with American and Australian reports showing benefit in this group.
The role of surgery outside the age of 18 – 60 is not well established, but is not a specific contraindication.

NICE guidelines:

Surgical treatment is beneficial as a
First line treatment

- BMI >50

Second line (non surgical methods failed to achieve maximal benefit for at least 6 months)

- BMI >40
- BMI >35, and coexisting disease that could be improved by weight loss, e.g. OSA,Type II diabetes, hypertension.

Surgery only appropriate when

- Specialist management is provided
- Patient “fit for anaesthesia”
- Patient committed to long term follow up.

There are very few specific contraindications to bariatric surgery. Those mentioned are cognitive impairment (precluding informed consent), active malignancy, advanced liver disease with portal hypertension, unstable coronary artery disease, and uncontrolled severe obstructive sleep apnoea with pulmonary hypertension (pulmonary systolic pressure >50 mm Hg) and severe coexisting diseases.

Assessment for Bariatric surgery

Ideally, bariatric surgery is a tertiary referral practice involving a multidisciplinary team approach. The team should include bariatric surgeons, anaesthetists, cardiologists, respiratory physicians, endocrinologists, psychiatrists, and specialist nurses and dieticians.

After investigations the case is discussed at a multidisciplinary team meeting, to analyse the risk-benefit ratio, and identify patients in need of further investigation—such as echocardiography, cardiopulmonary exercise testing, and an endocrine or cardiology review—and to consider the most appropriate procedure, based on a patient's body mass index, target weight, dietary history, likely weight loss, severity of comorbidities.

Anaesthetic Considerations

Most of the issues relate generally to anaesthesia for obesity – and have been covered in the FMM 2008 by Dr Keshav.

Pre operative considerations

Bariatric surgery is not mentioned in the AHA/ACC 2007: Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery. Bariatric patients are at increased risk of obstructive sleep apnoea, obesity hypoventilation syndrome, systemic hypertension, pulmonary hypertension, coronary heart disease, congestive heart failure, cerebrovascular disease, dyslipidaemia, and Type II diabetes. Each needs its individual assessment.
Pulmonary hypertension evaluation:

Common symptoms include exertional dyspnoea, fatigue, and syncope,

- echocardiography: tricuspid regurgitation useful confirmation
- chest x-ray: prominent pulmonary arteries.
- electrocardiogram: right ventricular hypertrophy (tall precordial R waves, right axis deviation, and right ventricular strain).

Mild to moderate pulmonary hypertension

Avoid worsening pulmonary vasoconstriction

- physiologically (hypoxia, acidosis, hypercarbia, hypothermia)
- pharmacologically (nitrous oxide)

Severe pulmonary hypertension

PA catheterization and monitoring may be necessary.\

Cardiorespiratory fitness levels in the morbidly obese are similar to patients with advanced heart failure (class III and IV), with a graded inverse relationship between BMI > 25 kg/m^2 and peakVO_2 [15].

Cardiopulmonary exercise testing has been suggested as a stratification method for identifying patients preoperatively [16].

Evaluated cannulation sites: peripheral, central venous and arterial should discussed invasive monitoring. Baseline arterial blood gas: evaluate carbon dioxide retention and guide perioperative oxygen administration.

Premedication
Oral benzodiazepines can be used for anxiolysis.

Intraoperative considerations

Induction, Intubation, and Maintenance of Anaesthesia

Airway
Routine airway assessment is made.
Mask ventilation is known to be difficult in the obese [17].
Neck circumference has been shown to be the best single predictor of problematic intubation [18] – a 35 % incidence at 60cm vs a 5% incidence at 40cm. Studies have shown no correlation between increasing BMI and grade of direct laryngoscopy [19], with the same incidence of difficult intubation as in the in the general.

No single variable should be solely relied on. Better correlation has been shown with advancing age, male gender, TMJ pathology, Mallampati 3 or 4, a history of OSA and abnormal upper incisors. Ultimately one should prepare for a potentially difficult airway and to base each case on its own merits, with prudent use of awake techniques.

H2-receptor antagonists or PPI and pre induction non particulate antacids can reduce gastric volume and acidity and reduce the risk of aspiration complications. Obesity in its self is not an indication for a rapid sequence induction for protection against aspiration. There is little evidence to support a higher incidence of reflux or aspiration pneumonitis in this patient group.

Head-up position provides the longest safe apnoea position during induction of anaesthesia and PEEP during pre-oxygenation improves oxygenation. "Stacking" (lifting the chin higher than the chest), or head-elevated-laryngoscope position (this elevates the head, shoulders and upper body, so that external auditory meatus and suprasternal notch are horizontal to each other). Suxamethonium is highly recommended for intubation. An additional anaesthetist as well as a surgeon capable of performing tracheosotomy at induction is recommended.

Ventilation
Tidal volumes >13 mL/kg IBW offer no added advantage during ventilation of morbidly obese patients during anaesthesia, and it seems prudent to use moderate levels of PEEP to improve oxygenation; 10cmH_2O PEEP with recruitment manoeuvres. Some bariatric centres routinely use tidal volumes of 10–12 mL/kg with respiratory rates of up to 12–14 breaths/minute to maintain normocapnia during laparoscopic bariatric surgery.

Monitoring
Cuff *bladders* should encircle at least 75% of the upper arm circumference, preferably the entire arm.
Comparable and accurate blood pressure readings can be obtained from the wrist or ankle with appropriately sized blood pressure cuffs if needed.

Invasive arterial monitoring is indicated in the “super morbidly obese” with severe cardiopulmonary disease and inability to obtain non-invasive measurements due to mechanical factors.

Central venous catheters can be used when peripheral access cannot be obtained or considered for postoperative IV access (especially with difficult IV access).

PA catheters are reserved for serious cardiopulmonary disease.

Positioning

Specially designed tables or two normal tables joined together may be required for bariatric surgery. Normal operating room tables have a maximum weight limit of approximately 205 kg.

Operating tables capable of holding up to 455 kg are available. Electrically operated or motorized tables are preferable. Patients need to be secured onto the table, as they are prone to slipping off during changes in table position. Using a bean bag may be helpful.

Pressure sores and neural injuries are more common in this group, especially in the super obese and the diabetic. Attention needs to be given to this but despite careful positioning and appropriate padding, nerve injury may still occur.

Laparoscopy and Anaesthesia

There is a biphasic cardiovascular response to increases in intraabdominal pressure (IAP).

An IAP <10 mm Hg, results in an increase venous return, increase in cardiac output and arterial pressure (blunted with hypovolaemia).

With IAP >20 mm Hg caval compression occurs, decreasing venous return and cardiac output decreased renal blood flow and GFR due to increased renal vascular resistance.

Respiratory mechanics are affected by both obesity and pneumoperitoneum, but little with the changing body position during the procedure. Catastrophic complications that should be kept in mind include massive gas embolism, pneumothorax, and mediastinal emphysema.

Pharmacology/Weight-Based Dosing

	Dosing
Propofol	IBW. Maintenance: TBW
Systemic clearance and Vd at steady-state correlates well with TBW. High affinity for excess fat and other well perfused organs. High hepatic extraction and conjugation relates to TBW.	
Thiopentone	TBW
Increased Vd. Increased blood volume, cardiac output, and muscle mass. Increased absolute dose. Prolonged duration of action.	
Midazolam	TBW
Central Vd increases in line with body weight. Increased absolute dose. Prolonged sedation because larger initial doses are needed to achieve adequate serum concentrations.	
Succinylcholine	TBW
Plasma cholinesterase activity increases in proportion to body weight. Increased absolute dose.	
Vecuronium	IBW
Recovery may be delayed if given according to TBW because of increased Vd and impaired hepatic clearance.	
Rocuronium	IBW
Faster onset and longer duration of action. Pharmacokinetics and pharmacodynamics are not altered in obese subjects.	
Atracurium & Cisatracurium	TBW
Absolute clearance, Vd, and elimination half-life do not change. Unchanged dose per unit body weight without prolongation of recovery because of organ- independent elimination	
Fentanyl & Sufentanil	TBW
Increased Vd and elimination half-time, which correlates positively with the degree of obesity. Distributes as extensively in excess body mass as in lean tissues. Dose should account for total body mass.	
Remifentanil	IBW
Systemic clearance and Vd corrected per kilogram of TBW—significantly smaller in the obese. Pharmacokinetics are similar in obese and nonobese patients. Age and lean body mass should be considered for dosing.	

Desflurane has been suggested as the inhaled anaesthetic of choice in this patient population because of its more rapid and consistent recovery profile. Also, when compared with isoflurane, sevoflurane demonstrated favourability in terms of rapid of recovery, better hemodynamic control, lower incidence of nausea and vomiting, prompt regaining of psychological and physical functioning, early discharge from the hospital, and small cost.

The high oxygen demand and potential for pulmonary hypertension limits the use of nitrous oxide.
Complete muscular relaxation is crucial during laparoscopic bariatric.

Nasogastric tubes
Intraoperative placement of intragastric balloon and nasogastric tubes help the surgeon size the gastric pouch, as well as performing leak tests with saline and methylene blue to detect anastomotic defects.
Aspiration of methylene blue can cause a chemical pneumonitis, so ensuring a tight endotracheal tube cuff seal is important. Before gastric division all tubes need to be removed, not just withdrawn into the oesophagus, in order to avoid unplanned stapling and transection of them. Once the RYGB pouch has been created, the NGT needs to be advanced carefully whilst watching the laparoscopic monitor to avoid disrupting the anastomosis.

Extubation
Least adverse effects on respiration occur in the semirecumbent position, and postoperative application of CPAP or bi-level positive airway pressure is advocated. They do not increase the incidence of major anastomotic leaks after gastric bypass.

Current widespread use of laparoscopic techniques for bariatric procedures results in less postoperative pulmonary dysfunction, possibly reducing the need for incentive spirometry. Patients with a history of severe sleep apnoea may require overnight observation in the intensive care unit because prolonged obstructive apnoea is a real possibility, especially when parenteral narcotics are used.

Postoperative analgesia

Open bariatric procedures are painful. Analgesic techniques used include thoracic epidural analgesia and indwelling spinal catheters (delivering opioids). Proposed advantages of thoracic epidurals over parenteral opioids are better analgesia, prevention of DVT, earlier recovery of intestinal motility as well as less oxygen consumption and decreased left ventricular stroke work. The use of a multimodal intraoperative analgesic technique reduces postoperative opioid consumption as well as drowsiness – such drugs include paracetamol, NSAIDs, clonidine, magnesium sulphate, ketamine and methylprednisolone. Though epidural would seem ideal in the open surgical technique – technically it may prove difficult to site, and evidence shows acceptable analgesia achieved by using a PCA as compared to an epidural [20].

Laparoscopic bariatric surgery is less painful, and less likely to interfere with pulmonary mechanics. Local anaesthetic wound infiltration and parenteral narcotics are usually sufficient. Post RYGB, PCA has been shown to provide satisfactory analgesia without deleterious effects on oxygen saturation, blood pressure, heart rate, or respiratory function [26], and after contrast confirmation of gastrointestinal integrity, oral narcotics can usually be initiated day 1 post operatively. Short term use of NSAIDs is used, but long term use is discouraged due to concern about gastric ulcers after bariatric procedures. The obvious concern would be the use of opioids in patients with OSA – necessitating nursing and observation in a higher dependency environment.

DVT prophylaxis
There is a lack of evidence on a reasonable regimen for sufficient DVT prophylaxis in bariatric surgery; instead, there are only recommendations from the guidelines and statements of medical societies. From ASMBS, their recommendations are as follows[21]:

- Early post-operative ambulation
- Use of lower extremity sequential compression devices
- Chemoprophylaxis (unless contra indicated).

They state that the choice of anticoagulant, dosage regimen, duration of prophylaxis (including prolonged post-discharge administration), as well as the possible role of inferior vena cava filters, remain controversial and recommendations regarding these issues have not been established.

The available evidence supports the conclusion that adherence to the current guideline for VTE prevention will reduce but not eliminate VTE as a complication of bariatric surgery.

The current usage of post operative DVT prophylaxis is probably best demonstrated by the following[22]:

A survey to all ASMBS was conducted in 1998 to determine the current practices for VTE prophylaxis and published in 2000; the survey was repeated in 2007 and published in 2009, comparing the results.
35% completed the survey (332 responses).
The number of cases annually per surgeon almost doubled in the study period (145 versus 85). Laparoscopic gastric bypass was the most common procedure performed, followed by laparoscopic gastric banding. Previously open gastric bypass was the most common.
95% surgeons use chemical prophylaxis to prevent VTE, 60% preferred LMWH (13% in 1998)
>60% of bariatric surgeons discharged their patients with chemical prophylaxis (12% in 1998).

Inferior vena cava filters for prophylaxis are considered by 55% (7% in 1998).
The incidence of reported deep vein thrombosis was significantly lower in 2007 (2.635% versus 0.93%), as was the incidence of pulmonary embolism (0.95% versus 0.75%).
Almost 50% of surgeons still reported one or more fatality due to VTE complications.

The choice of prophylaxis can be tailored to the specific patient and procedure. A prospective observational trial supported the selective avoidance of pharmacological prevention post laparoscopic Roux-en-Y gastric bypass in patients meeting their inclusion criteria of ≥18 years, no history of VTE, early ambulation and relatively short operative times. The VTE prophylactic regimen consisted of calf-length pneumatic compression devices placed before anaesthesia induction and mandatory ambulation beginning on the day of operation [23].

Conclusion

Bariatric surgery is known to be the most effective and long lasting treatment for morbid obesity and many related conditions, and mounting evidence suggests it may be among the most effective treatments for metabolic diseases and conditions including type 2 diabetes, hypertension, high cholesterol, non-alcoholic fatty liver disease and obstructive sleep apnoea.

Very few specific contraindications exist. Patients need to be highly motivated and agree to long term treatment plan. The best type of procedure to undergo has not been fully elucidated as relies on both surgeon and patient factors, but patients need to be managed in a referral centre used to dealing with high volumes of bariatric surgery to try to ensure improved results.

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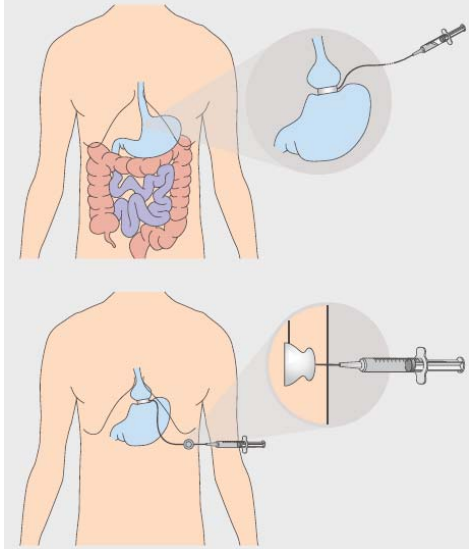
Additional reading

Description of types of procedures [25]

Category	Sleeve gastrectomy	Laparoscopic adjustable gastric band	Roux-en-Y gastric bypass	Biliary pancreatic diversion with duodenal switch
Technical difficulty	Straightforward	Straightforward	Complex	Complex
Hospital stay	2-3 days	1 day or day case	2-3 days	2-3 days
30 day mortality (%)	0.36 to 1.46	0.05	0.50	0.8
Reversibility	Irreversible	Straightforward	Complex	Complex
Start of weight loss	Immediate	Six weeks	Immediate	Immediate
Excess weight loss at 10 years (%)	Not available	59 (at 8 years)	52	>77
Remission of type 2 diabetes (% of patients)	Immediate in some cases, a few weeks or months in others (81)	Associated with weight loss (60)	Immediate (80)	Immediate (85)
Complications	Weight regain, heart burn	Erosion, slippage, symmetrical dilatation, port related problems; rate of repeat operation >10%	Anastomotic leak, dumping syndrome, vitamin deficiencies	Anastomotic leak, dumping syndrome, vitamin deficiencies, malnutrition

Laparoscopic adjustable gastric banding



Laparoscopic adjustable gastric banding is simple and well standardised, and is the least invasive of the purely restrictive bariatric surgery procedures. A band is placed around the upper part of the stomach. There are six adjustable bands available worldwide. Mainly two bands are used: the Lapband (Bioenterics) and the SAGB (Swedish Adjustable Gastric Band; Obtech Medical).

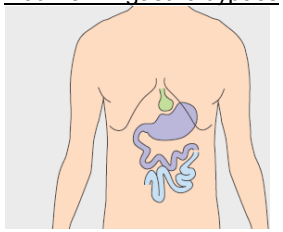
There is no statistically significant difference in postoperative weight loss and complications between the two bands. The band is adjusted on the hydraulic by isotonic liquid into the port. This allows the band to be inflated and deflated. Appropriate adjustments, performed up to six times annually, are critical for successful outcomes. The aim of increasing restriction is to reduce hunger and provide a feeling of satiety after eating a small meal.

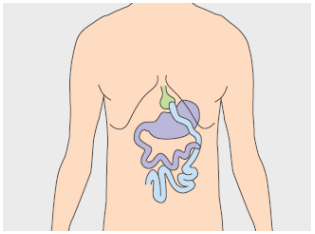
Weight loss:
50% of the EBW and about 25% of the BMI at 2 years. Weight loss with this procedure may be progressive over time.
Operative mortality and morbidity: (when performed by skilled surgeons)
30-day mortality 0.1%.
morbidity is about 5%.

Long-term complications:
Unique long-term complications include gastric prolapse, stomal obstruction, oesophageal and gastric pouch dilation, gastric erosion and necrosis, and access port problems. Experience markedly reduced the incidence of these complications.
Use of a prosthetic device introduces additional potential problems of malfunction and infection.

Reversal and revision:
Laparoscopic adjustable gastric banding can be completely reversed with removal of the band, tubing, and port.
For failed weight loss, revision procedures include removal of the device and performance of a restrictive-malabsorptive procedure or a primarily malabsorptive.
In sleeve gastrectomy most of the body and all of the fundus of the stomach are resected to leave a long narrow tube of stomach.

Roux-en-Y gastric bypass





In a Roux-en-Y gastric bypass a small gastric pouch is formed by division of the upper stomach, on to which the jejunum is joined, so that food bypasses the stomach and upper small bowel. This can be performed by both open or laparoscopic techniques.

Weight loss:
After a standard 75 cm Roux gastric bypass usually exceeds 65% - 70% of the excess body weight (EBW) and about 35% of the BMI.

The longer-limb bypasses are used to obtain comparable weight reductions in super obese (BMI >50 kg/m^2) patients.

Weight loss generally levels off in 1 to 2 years, and a regain of up to 9kgs from the weight loss nadir to a long-term plateau is common.

Operative mortality and morbidity:
30-day mortality for gastric bypass when performed by skilled surgeons is about 0.5%.
Operative morbidity (pulmonary emboli, anastomotic leak, bleeding, and wound infection) is about 5%.
Compared with open procedures, laparoscopic gastric bypass has a higher rate of intraabdominal complications; whereas duration of hospitalization is shorter, wound complications are lower, and postoperative patient comfort is higher.

Long-term complications:
Gastric bypass can be associated with the dumping syndrome, stomal stenosis, marginal ulcers, staple line disruption, and internal hernias.

Life-long oral or IM vitamin B12 supplementation, and iron, vitamin B, folate, and calcium supplementation is recommended to avoid specific nutrient deficiency conditions.
Ventral hernia formation is more prevalent after open gastric bypass than after the laparoscopic approach.

A unique complication of gastric bypass is dilation of the bypassed distal stomach in the event of a small bowel obstruction, which can lead to rupture and death if not rapidly managed by distal gastric decompression.
Reversal and revision: Gastric bypass can be functionally totally reversed, though this is rarely required. A standard Roux gastric bypass with failed weight loss can be revised to a very long-limb Roux-en-Y procedure.

Biliopancreatic diversion with duodenal switch

A sleeve gastrectomy has already been performed. The small bowel has been divided just beyond the pylorus (at A) and 250 cm from the ileocaecal valve (between B and C). Right: The configuration once the bowel is rejoined.

Biliopancreatic diversion and biliopancreatic diversion with duodenal switch function by bypassing most of the small bowel, leaving a small segment through which nutrients can be absorbed. Common themes are that food passes through a segment of small bowel about 250 cm long and that a shorter segment of this (50-150 cm) receives both food and digestive juices.
Open biliopancreatic diversion and duodenal switch are long and difficult procedures requiring skilled surgeons and adequate experience. Both procedures have been performed by total or by hand assisted laparoscopic techniques.

Weight loss:
70% of the EBW and about 35% of the BMI. Weight loss with these procedures is at the upper end of the efficacy range. Weight loss may be sustained without a rise from the weight nadir.
Operative mortality and morbidity:
Mortality 1% & morbidity 5%.
Long-term complications:
On occasion, these procedures are associated with diarrhoea. Some patients report malodorous stools and flatus.
Long-range complications can consist of vitamin, mineral, and nutrient deficiencies, in particular, protein deficiency.

These contingencies need to be anticipated and properly managed by dietary supplements with
about 75 to 80 g of dietary protein and B vitamins, calcium, and iron.
Biliopancreatic diversion may be associated with postoperative dumping; the duodenal switch is not.
Reversal and revision: Normal intestinal continuity can be restored, but the partial gastrectomy cannot be reversed.
For failed weight loss after these procedures, shortening of the common channel has produced a desired result in some, but not all, patients.

Bariatric Surgery in Children

By Dr Jenna Taylor

The aim of bariatric surgery is not only to prevent further deterioration of organ function, but actually to reverse some of the damage that has already taken place. This applies, in particular, to diabetes. There are two atypical groups of patients in whom bariatric surgery is an option but is not widely performed:

1) The obese patient who is not yet in the morbidly obese BMI range (particularly BMI 30 -35)
2) The paediatric patient

Surely, we should actually be targeting these groups more aggressively, in order to *prevent* the situation of morbid obesity, diabetes and the host of other lifespan reducing complications. This is particularly relevant to the paediatric population.

The USA, the 'fat capital' of the world, has an 18% incidence of obesity in children[1]. Therefore, it seems that although the importance of obesity prevention is not to be underestimated, the need for obesity *treatment* in children is becoming a reality.

Table below taken from

US Prevalence [8]

Age, y	At Risk (%) BMI > 85th centile	Obese (%) BMI > 95th centile
6 - 19	31	16
2 - 5	22.6	10.3
6 - 11	31.2	15.8
12-19	30.9	16.1

The first challenge lies with the definition of obesity in paediatrics. The most widely accepted definition is[1]:

Age 2 – 18 years:

BMI between 85th – 95th percentile (for age & gender) = at risk for obesity

BMI above 95th percentile = obesity

Obese children have the same complications as obese adults. Longitudinal studies demonstrate that obesity in childhood is associated with an increased prevalence of hypertension; very high rates of dyslipidaemia and insulin resistance; impaired glucose tolerance; and an alarmingly increased incidence and prevalence of type 2 diabetes[2] (although these rates are not specified).

However, obese children also have their own set of problems:

Obesity Related Co-morbidities in Children:[3]

1) Developmental
   a. Early maturation & puberty
   b. Orthopaedic
      i. Blount's disease
      ii. Slipped capital femoral epiphysis
2) Metabolic
   a. Type II Diabetes & Insulin Resistance
   b. Hepatic steatosis
   c. Polycystic Ovarian Syndrome
   d. Lipid abnormalities
3) Other
   a. Obstructive sleep apnoea
   b. Hypertension
   c. Cardiovascular disease (constellation of risk factors for vasculopathy from a very young age)
   d. Focal nodular sclerosis of the kidneys
   e. Asthma

Obesity in childhood has specific psychological problems: Depression, bullying, and ADHD (Attention Deficit Hyperactivity Disorder).

IPEG (The International Paediatric Endosurgery Group) Guidelines for Surgery[3]:

• BMI >35 kg/m^2 with the following severe co morbidities:
  Type 2 diabetes mellitus
  Moderate or severe obstructive sleep apnoea (AHI >15 events/hour)
  Pseudotumour cerebri

• BMI > 40 kg/m^2 with the following obesity-related co morbidities
  Hypertension
  Dyslipidaemia
  Obstructive sleep apnoea (AHI > 5 events/hour)
  Venous stasis disease
  Panniculitis
  Urinary incontinence
  Significant impairment in activity of daily living
  Moderate to severe non-alcoholic fatty liver disease
  Gastroesophageal reflux
  Severe psychosocial distress
  Significantly impaired quality of life
  Weight-related arthropathies

According to Browne and Ing[1], obesity should be viewed as 'a chronic incurable disease that has life-threatening present and future co morbidities, (and) there should be no question of providing treatment'[1].

An obese child can be viewed as a patient with an energy intake / expenditure imbalance. Children, however, are still growing and have high metabolic demands. Sometimes, in a rapidly growing child, all that is necessary is to stop weight *gain* (i.e. weight loss is not the aim).

In order to justify surgical treatment for obesity, the following must be satisfied[5]:

1) The child should be 'extremely' obese (the text does not define this)
2) The child should be suffering from significant adverse effects from the obesity (medical or psychosocial)
3) They must understand:
   a. the procedure
   b. the role they will play in a successful outcome
   c. the importance of adherence to regimes

Obviously, informed consent is particularly important – patients and their families often see bariatric surgery as an easier and more reliable method of weight reduction[5] and it is important that they are adequately counselled on the complications of the procedure.

IPEG recommends the following[4]:

Adolescents Being Considered For Bariatric Surgery Should :

• Have attained or nearly attained (e.g. > 95 % of) adult stature
• Have failed to attain a healthy weight with prior organized attempts at conventional weight management
• Demonstrate commitment to comprehensive paediatric psychological evaluation both before and after surgery and agree to avoid pregnancy for *at least* 1 year postoperatively
• Be capable of, and willing to adhere to, nutritional guidelines postoperatively
• Have decisional capacity and provide informed assent for surgical management

All surgical procedures that have been mentioned in adults are options in obese children, but there is little experience with these procedures in the paediatric population. Gastric banding devices are not licensed to be used in children <18 yrs, although they are used. Mal-absorptive procedures are particularly controversial due to the multiple vitamin and mineral deficiencies that they may cause, with subsequent implications for growth & development of the child.

The roux-en-Y gastric bypass (RYGB) is the most commonly performed procedure for adolescents in the USA[1].

It has been proven to improve:

Type 2 diabetes and insulin resistance
Dyslipidaemia
Sleep efficiency and obstructive sleep apnoea
Hypertension and cardiac hypertrophy
Proteinuria
Depressive symptoms
Quality of life
Body composition[1]

The adverse effects of bariatric surgery can be particularly deleterious in the paediatric population[6]:

1) Protein Energy Malnutrition
2) Vitamin & mineral deficiencies (peripheral neuropathy rate 5 – 16%)
3) Reduced bone density (osteoporosis & osteopaenia)

Although significant, the above complications are easily treatable if detected early enough. This highlights the importance of regular follow up and careful patient selection.

Evidence regarding the reversal of the metabolic syndrome and left ventricular hypertrophy in obese adolescents has supported "the hypothesis that surgical weight loss in extremely obese adolescents may improve cardiac health to a greater extent than surgical weight loss used in adulthood"[7].

The key to bariatric surgery in this age group is that although bariatric surgery has significant morbidity and mortality, so too does untreated obesity. The most persuasive argument revolves around diabetes. In Type II diabetes there is a progressive loss of pancreatic beta cells, through apoptosis. Therefore it is inevitable that eventually all Type II diabetics will become insulin requiring. The degree of beta cell destruction is a product of time and disease severity. Therefore, the earlier the disease process is halted, the less beta cell destruction. The aim for bariatric surgery could therefore be seen as preserving and enhancing beta cell function[6].

In the paediatric patient in particular, the possibility of disease reversal by bariatric surgery is possible, diabetes and cardiac disease in particular. So why wait?

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