Anaesthesia for bariatric surgery

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Key points

Bariatric surgery is the only current treatment proven to achieve significant and sustained weight loss in the morbidly obese.

Major weight loss can lead to partial/complete resolution of a range of conditions including, diabetes mellitus, ischaemic heart disease, and hypertension.

The preoperative assessment is crucial in identifying potential risk factors that might lead to perioperative adverse events.

One of the most important criteria for ensuring successful direct laryngoscopy and tracheal intubation is proper patient positioning.

The risk of perioperative pulmonary aspiration during subsequent procedures is increased after bariatric surgery and dramatic weight loss.

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The word 'bariatric' is derived from the Greek words *baros* meaning 'weight' and *iatrics* meaning 'medical treatment'.

Obesity is one of the greatest health challenges facing Western countries. Obesity is defined as a body mass index (BMI) >30 kg m^{-2}, whereas those with a BMI >35 and >55 kg m^{-2} are considered 'morbidly' obese and 'super morbidly' obese, respectively. Recent figures suggest that up to 23% of men and 25% of women in the UK are obese.[1] Associated obesity-related medical conditions include hypertension, coronary artery disease, sudden (cardiac) death, restrictive lung disease, obstructive sleep apnoea (OSA), diabetes mellitus, gallstones, a range of cancers (breast, gynaecological, and gastrointestinal), degenerative joint disease, and socioeconomic and psychosocial impairment. Quality of life and life expectancy are reduced. Obesity also leads to an increased demand for health-care services.

Studies have shown that weight loss of 5–10% of initial body weight can improve glucose intolerance, type II diabetes mellitus, hypertension, and hyperlipidaemias.[2]

Treatment for overweight patients should encompass a multidisciplinary team offering a complete weight loss programme, which includes diet and lifestyle modification alongside increased physical activity. Approved drug therapy may also have a role in weight loss. Unfortunately, weight loss obtained by these non-invasive measures is rarely sustained, which has led to bariatric surgery increasingly being offered as a solution. Bariatric surgery has been recommended by the National Institute of Clinical Excellence as a treatment for obesity.[3]

Bariatric procedures may achieve weight loss of more than 50% of excess weight.

Bariatric surgery is relatively safe, has low morbidity and mortality, and can provide long-term sustained weight loss with significant improvement of co-morbidity and quality of life in the morbidly obese patient. It is one of the fastest growing areas of surgery in terms of patient numbers treated. This reflects both the ability of bariatric surgical procedures to provide a solution to an otherwise insoluble problem and the evolution of safer, less invasive surgical methods.

This article will focus on anaesthesia and how it relates directly to the speciality of bariatric surgery. For a more detailed and generalized review of obesity and how it relates to anaesthesia, the reader is directed to alternative text for further reading.[4]

Medical therapy

Orlistat and sibutramine are the only two drugs that can be recommended for long-term use to achieve and maintain weight loss.

Sibutramine is a centrally acting sympathomimetic that inhibits the reuptake of norepinephrine, serotonin, and dopamine, which causes early satiety. Peak weight loss occurs within 6 months. Side-effects include dry mouth, insomnia, anorexia, constipation, and a transient increase in arterial pressure.

Orlistat is a synthetic derivative of lipstatin that is a potent inhibitor of pancreatic lipase, thereby reducing the absorption of dietary fats in the upper gastrointestinal tract. This causes weight loss and a decrease in serum low-density lipoprotein. Gastric side-effects are caused by decreased fat absorption. Reduced absorption of fats can lead to a decreased serum concentration of fat-soluble vitamins, A, D, E, and K. The decreased absorption of vitamin K in patients on warfarin may potentiate its anticoagulant effect.

Neither of the above drugs has been shown to induce sufficient weight loss for treating obesity, and their long-term efficacy and safety are unknown.

Rimonabant was the first selective cannabinoid CB1 receptor blocker approved for use as an appetite suppressant but has recently been withdrawn from the UK market due to high risks of psychiatric disorders.

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Studies and literature on the direct interactions between sibutramine or orlistat and anaesthetic drugs are few.[2]

Surgical treatment of obesity

Surgery may be considered if:

- Patients have a BMI >40 kg m^{-2}, or between 35 and 40 kg m^{-2} with co-existing disease that could be improved with weight loss.
- All appropriate non-surgical measures have failed to achieve or maintain adequate and clinically beneficial weight loss for at least 6 months.
- Patients are receiving or will receive intensive specialist management.
- Patients are generally fit for anaesthesia and surgery.
- Patients are committed to the need for long-term follow-up.

The aim of bariatric surgery is to reduce the volume of the gastric cavity, thereby resulting in the development of satiety after the ingestion of a small volume of food. The strategy to this early satiety involves creating a small gastric pouch together with a limited gastric outlet, which prolongs these effects. This is the goal of the *restrictive* type of bariatric surgery.

The alternative is to perform *malabsorptive* procedures, which not only limits the size of the stomach by creating a small gastric pouch, but also involves shortening the length of the gut, thereby reducing the amount of food absorbed.

Contraindications to surgery may include:

- inflammatory diseases of the gastrointestinal tract (ulcers, oesophagitis, or Crohn's disease);
- upper gastrointestinal bleeding (varices);
- portal hypertension;
- liver cirrhosis;
- chronic pancreatitis;
- laparoscopic surgery may be technically difficult in patients weighing >180 kg and this may be considered a relative contraindication.

Restrictive surgery

The adjustable gastric band (AGB) was first placed by laparotomy in 1986.[5] In 1992, Cadiere and colleagues[6] placed the AGB by the minimally invasive laparoscopic approach, which is the most common approach used today. The AGB is placed around the proximal stomach, which creates a small pouch with a capacity of about 25 ml (Fig. 1). This pouch fills after a small amount of food is ingested which leads to a sensation of fullness. The size of this restriction into the stomach can be adjusted, by inflating or deflating the band with saline, via a port placed s.c. in the abdominal wall at initial surgery.

Advantages of the AGB placed laparoscopically, when compared with malabsorptive procedures, include:

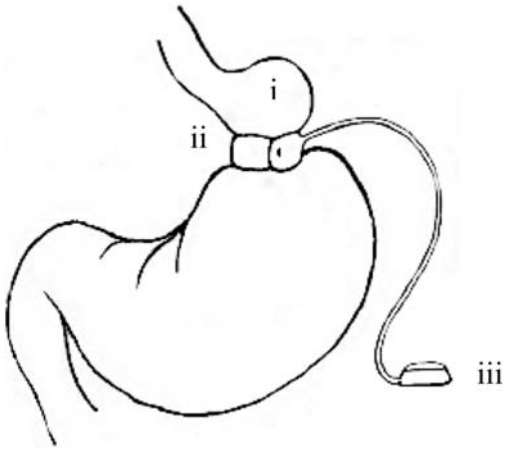

Fig 1 Adjustable gastric band: (i) proximal pouch, (ii) adjustable band, and (iii) needle access port which adjusts the band by injection or removal of saline.

- its safety;
- minimal invasiveness;
- adjustability;
- reversibility;
- overall effectiveness in producing acceptable levels of long-term weight loss.

Complications of AGB include:

- band slippage;
- pouch dilation;
- stomach prolapse;
- obstruction;
- dysphagia;
- reflux;
- band erosion;
- erosive oesophagitis;
- port leakage;
- tubing disconnection and malfunction.

Other restrictive procedures include vertical banded gastroplasty, sleeve gastrectomy, and the insertion of gastric balloon done at endoscopy. They have generally been superseded by laparoscopic ABG.

Malabsorptive surgery

The Roux-en-Y gastric bypass (RYGB) is the most common malabsorptive procedure performed. It is viewed as the 'gold standard' of bariatric operations combining gastric restriction with a degree of malabsorption. It involves anastomosing a surgically formed proximal gastric pouch to a segment of the proximal jejunum, 'bypassing' most of the stomach and the entire duodenum (Fig. 2). It is usually performed laparoscopically and is considered the most effective bariatric procedure to produce weight loss. Patients can lose 50–60% of excess body weight and show

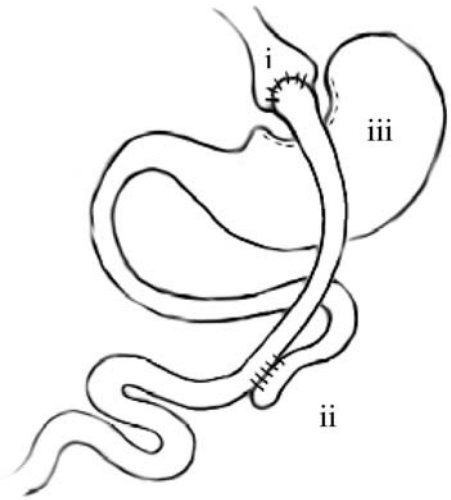

Fig 2 Roux-en-Y gastric bypass: (i) 20–30 ml gastric pouch to the jejunum, (ii) jejunojejunostomy, and (iii) stomach remnant.

a decrease in BMI of ~10 kg m^{-2} in the first 1–2 yr. It is, however, a longer and technically more demanding procedure that is irreversible when compared with AGB. It also carries the possibility of additional adverse consequences due to long-term malabsorption. Nutritional abnormalities can include vitamin B12, iron, calcium, and folate deficiency.

A 'dumping syndrome' may develop in up to 10% of patients. It follows the ingestion of high sugar liquid meals which transit rapidly into the small bowel. It causes post-prandial abdominal and vasomotor symptoms which include palpitations, sweating, abdominal cramps, diarrhoea, and anxiety. Dumping syndrome is caused by the release of vasoactive neurotransmitters, splanchnic vasodilatation, and fluid shifts coupled with relative hypovolaemia. The late dumping symptoms are caused by reactive hypoglycaemia resulting from an exaggerated insulin release.

Other complications include strictures, obstruction, ulceration, and anastomotic leak.

A systematic review by the Australian Safety and Efficacy Register of New Interventional Procedures-Surgical (ASERNIP-S) found that the mean short-term mortality rate associated with laparoscopic AGB was 0.05%. In contrast, mortality from RYGB is reported at between 0 and 5%, with the ASERNIP-S systematic review, showing a mean short-term mortality rate of 0.5%—10 times the risk of laparoscopic AGB.[7]

Anaesthetic considerations for patients presenting for bariatric surgery

Preoperative evaluation

Patients should be assessed by a multidisciplinary team, which may include endocrinologists, dieticians, psychologists, specialist nurses, and experienced surgeons and anaesthetists.

The preoperative assessment of the patient is crucial in identifying and stratifying risk to ascertain the level of perioperative care required, and also each individual's suitability for surgery.

Patients should be evaluated for indicators of systemic or pulmonary hypertension, ischaemic heart disease, and heart failure. In addition to a detailed history and examination, the ECG may demonstrate signs of right ventricular hypertrophy. Further cardiac evaluation may include stress echocardiography and cardiopulmonary exercise testing.

Patients should be assessed for the possibility of a difficult intubation. Brodsky and colleagues demonstrated that only obesity *with* clinical signs such as large neck circumference and a Mallampati score $\geq$3 are predictors of a potentially difficult intubation, whereas BMI or weight *per se* did not predict difficult intubation. They found that the probability of a problematic intubation was ~5% with a 40 cm neck circumference and 35% with a 60 cm neck circumference. They were, however, unable to define the degree of obesity or neck size that justifies interventions such as an awake fibreoptic intubation.[8] Despite several studies on predictors for difficult intubation in this group of patients, there is a lack of evidence of predictors and incidence of difficulty of bag–mask ventilation post-induction.

Approximately 5% of morbidly obese patients will have OSA.[4] In patients who give a history of such snoring, apnoeic periods during sleep and day-time somnolence should be considered for overnight polysomnography. This can define the type and severity of OSA and also whether continuous positive airway pressure (CPAP) or bi-level positive airway pressure is required before operation. This can help reverse associated co-morbidity, which may include day and night hypoxaemia, decreased sensitivity to high Pa_{CO_2}, pulmonary hypertension, and decreased exercise tolerance.

It has been recommended that prophylaxis against aspiration be considered in all patients even if they do not declare any symptoms of heartburn or reflux. Drugs include H_2 blocker (e.g. ranitidine 150 mg orally) and a prokinetic (e.g. metoclopramide 10 mg) given 12 and 2 h before surgery.[4]

Those presenting for repeat bariatric or non-bariatric surgery should be screened for long-term metabolic and nutritional abnormalities secondary to drug therapy and liver shrinkage diet before operation. These include vitamin B12, iron and folate, and vitamin K deficiency and also hypoproteinaemia. These will not only affect changes in fluid compartments, protein binding of drugs, drug metabolism and clearance, and coagulation but can also increase the risk of postoperative neuropathies. Preoperative blood indices should be checked; these should include vitamin B12, folate, and coagulation.

Intraoperative considerations

Appropriate operating tables that are electrically powered should be used. The patient may be positioned on the operating table before induction. This avoids unnecessary manual handling of

large patients by staff and also allows patients to position themselves comfortably, which may reduce the risk of nerve injury. If anaesthetic rooms are used, an air hover mattress may be considered for safe patient (and staff) transfer. Laparoscopic bariatric surgery is generally carried out in a modified Lloyd Davis position (steep reverse Trendelenburg position with legs spread apart and both arms out on arm boards), although positioning may vary according to surgical preference. Patients are susceptible to slipping down the table during steep Trendelenburg positioning. To prevent this, a foot-rest is placed at the foot of the table and the patient is strapped and secured on the table. Arm gutters and beanbags may also be used if available. Close attention should be paid to protecting pressure areas because pressure sores and nerve injuries are more common in this group of patients. This is particularly the case for patients placed in the Lloyd Davis position, which places the large nerves of the distal limb at risk of a stretch or pressure injury and could also result in compartment syndrome.

Invasive arterial monitoring should be directed by the patient's co-morbidities and the accuracy and reliability of the non-invasive arterial pressure cuff. Central venous access may be limited to patients with poor peripheral access, significant co-morbidity, or repeat surgery. Pulmonary artery catheterization and monitoring may be necessary in those with serious cardiopulmonary disease.

Drugs with weak or moderate lipophilicity can be administered according to ideal body weight (IBW), as their volume of distribution (V_D) remains relatively consistent between obese and normal-weight individuals. A more accurate calculation of the drug dosage uses the lean body mass, which requires addition of 20% to IBW.[2] Drugs in this group include the non-depolarizing neuromuscular blocking agents.

An exception to the above rule is remifentanil, whose V_D is not affected in this manner, despite its highly lipophilic properties. Succinylcholine should be administered based on actual body weight because of the increase activity of plasma cholinesterase in proportion to body weight. I.V. induction agents are highly lipophilic with large V_D and this needs to be considered when dosing, as different formulas have been used to establish an appropriate dose, although no one method supersedes the other in terms of effectiveness of dose prediction.

Induction of anaesthesia is likely to be particularly hazardous in patients with increased risk of difficult or failed intubation. Bag and mask ventilation may be difficult because of upper airway obstruction and reduced pulmonary compliance. Gastric insufflation during ineffective mask ventilation will further increase the risk of regurgitation and aspiration of stomach contents. If the patient is considered to be at risk of regurgitation or aspiration at induction, a rapid sequence induction using succinylcholine following a period of adequate preoxygenation should be considered.[4] Awake fibreoptic intubation may be required in those at risk of difficult intubation.

Patient positioning is vital to improve laryngeal visualization and facilitate tracheal intubation during laryngoscopy. The aim of 'stacking' the patient up with pillows and blankets is to elevate the head, upper body, and shoulders significantly above the chest. In one study using this position, 99 out of 100 morbidly obese patients were successfully intubated using direct laryngoscopy. One patient had a failed intubation with direct laryngoscopy but was easily intubated using a fibreoptic bronchoscope. His lungs were easy to ventilate using a face mask.[8]

Maintenance of anaesthesia using desflurane has been suggested because of its low blood:gas partition coefficient which results in a more rapid and consistent recovery profile.[2] Easily titratable drugs such as remifentanil and propofol have also been successfully used.

Obese patients generally tolerate pneumoperitoneum surprisingly well without experiencing a decrease in cardiac output.[9] It has been shown that the reverse Trendelenburg position is a simple and safe intraoperative posture for obese patients and may even offer some cardiorespiratory advantages which include improved respiratory compliance, alveolar unit recruitment, and increasing the functional residual volume.[10]

Morbid obesity is a major independent risk factor for sudden death from acute postoperative pulmonary embolus. Deep vein thrombosis is the most common complication of bariatric surgery with an incidence between 2.4% and 4.5%.[4] Appropriate evidence-based thromboprophylaxis protocols should be in place and adhered to. Antibiotic prophylaxis is important because of the increased risks of postoperative wound infection.[2]

An orogastric tube is usually inserted to decompress the stomach. This will need to be manipulated during surgery to assist the surgeon to optimize the surgical conditions. This will also need to be withdrawn proximally before formation of the anastomosis. During RYGB, once the anastomosis is complete, a leak test is performed using air or methylene blue to assess anastomotic integrity.

Postoperative management

Areas where these patients can be safely managed after operation include general surgical wards, the post-anaesthetic care unit (PACU)/recovery or high dependency unit (HDU)/ITU. The Montefiore Obesity Surgery Score (MOSS) can be used to help decide on the most appropriate location; this states that patients aged more than 40–50 yr or with a history of asthma or snoring should be observed in an HDU. MOSS recommends that ICU be reserved for those where complications occur.[11]

In our institution, we use a modified version of MOSS. If patients have four or more of the following seven criteria, they are classified as moderate to high risk and are managed on the HDU or ITU.

(i) Gastric bypass surgery.
(ii) Male gender.
(iii) BMI $\geq$50 kg m^{-2}.
(iv) Age $\geq$50 yr old.
(v) A confirmed diagnosis of OSA.

(vi) Significant medical or surgical co-morbidity.
(vii) Previous abdominal surgery.

It should be noted that as experience with anaesthesia and surgical technique increases in specialist centres performing these procedures, the number of patients requiring HDU/ITU reduces over time.

In recovery, patients should be nursed 45° head up with continuous pulse oximetry and invasive AP (if *in situ*). Continuous ECG monitoring is only required in patients at risk of arrhythmias which is more likely to occur in patients with cardiorespiratory disease.

Supplemental humidified oxygen should be administered at an appropriate fraction of inspired oxygen ($F_{I_{O_2}}$). There is evidence that postoperative incentive spirometry or CPAP started in recovery may accelerate the return to preoperative pulmonary function.[2]

Optimal analgesia ensures adequate ventilation and pulmonary mechanics and reduces the risk of postoperative chest infections. It has been shown that most laparoscopic bariatric patients have little pain with adequate local anaesthetic wound infiltration and a patient-controlled analgesia.[2] For open procedures, the anaesthetist can consider siting a thoracic epidural or the surgeon may perform a rectus sheath block under direct vision at the end of surgery.

For all bariatric procedures, multi-modal analgesics regimes can be adopted and may include:

- regular i.v. acetaminophen;
- short-term use of non-steroidal anti-inflammatory drugs, if not contraindicated;
- tramadol.

Other postoperative considerations should include appropriate thromboprophylaxis, proton-pump inhibitors, and postoperative antibiotics according to local protocols.

Fluid management should be considered according to individual requirement and careful recording of fluid input and output recorded.

All these factors need to be considered in addition to high-quality nursing care, which will ensure a reduction in complications associated with surgery and hospitalization.

A final and important point

Patients may present for excess skin removal surgery after significant weight loss produced by bariatric surgery. Patients may, of course, also present for non-bariatric-related surgery. A recent study found that bariatric surgery and dramatic weight loss, appears to be a significant and independent risk factor for pulmonary aspiration on induction of anaesthesia. This may be as a result of decreased oesophageal–gastric peristalsis and also reduced lower oesophageal sphincter tone.[12]

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Conflict of interest

None declared.

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Please see multiple choice questions 1–4.