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Anaesthesia for bariatric surgery

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Obesity is a global epidemic posing a major public health and economic problem.[1] According to the World Health Organization (WHO), worldwide obesity has nearly tripled between 1975 and 2016.[2]

Obesity is commonly classified according to body mass index (BMI) (Table I). The major disadvantage of BMI is that individuals with increased body weight because of high muscle mass may be classified as obese by BMI but may not have the pathophysiological changes related to excess adiposity and will not have an increased perioperative risk.[1,3]

The WHO's latest classification of obesity according to BMI, and the ASA grade corresponding to each class is shown in Table II.[1]

Given the shortcomings of BMI, other measures, including waist circumference and waist-to-hip ratio, can be added to BMI as it accounts for the distribution of visceral fat and correlates with the risk of obesity-related diseases. Patients with central obesity (Table III) or 'visceral' fat are at greater perioperative risk than those with peripherally distributed fat and are far more likely to have metabolic syndrome.[4]

Increases in the incidence of obesity are greater in developing countries compared to developed countries, and despite various actions, there has been little success in reducing this. The USA ranks first, and importantly for us, South Africa ranks 30th worldwide for the prevalence of obesity.[1]

Bariatric surgery continues to be the most effective and durable treatment for morbid obesity and with the high prevalence of obesity, it's important to know how to provide anaesthesia for patients undergoing bariatric surgery.[5]

Management of obesity

Lifestyle modification

Obesity results from complex interactions among genetic, behavioural, and environmental factors. As a result, it is difficult to treat, with the initial management being lifestyle modification. This includes three primary components: diet, exercise, and behaviour therapy.[6]

Medical management

This is considered if lifestyle modification fails or if weight loss cannot be sustained. Medications are only considered as part of a specialist-led weight management programme and never as the sole management.[5]

Table I: Body mass index[1,3]

	Calculation	Advantages	Disadvantages
BMI	BMI $= \frac{\text{Weight (kg)}}{\text{Height}^2\text{ (m)}}$	• Easy to calculate • Useful for risk stratification • Allows teams to plan and prepare for procedures	• Does not describe the composition and distribution of body tissue • Not useful for drug dosing

Table II: WHO classification of obesity and ASA grades[1]

Category	BMI (kg/m^2)	ASA grade
Underweight	< 18.5	1
Normal weight	18.5–24.9	1
Overweight	≥ 25	1
Pre-obese	25–29.9	1
Obese	≥ 30	1
Class 1	≥ 30–34.9	1
Class 2	≥ 35–39.9	2
Class 3	≥ 40	3

Table III: Definition of central obesity[4]

	Definition
Central obesity	Waist circumference > 88 cm in females > 102 cm in males **OR** Waist-to-hip-ratio ≥ 0.85 in females ≥ 0.90 in males **OR** Waist-to-height ratio > 0.55

Surgical management

Patients should only be considered for bariatric surgery after being fully assessed by a specialist-led weight management team. The performance of bariatric surgery has significantly increased in the last 10 years, especially since bariatric surgery has proven to be the most effective sustained weight loss option for patients with class II or III obesity.[5,7]

Bariatric surgery is indicated when all the following criteria are met:

1. A BMI > 40 kg/m^2 or a BMI > 35 kg/m^2 with significant comorbidities.
2. All appropriate non-surgical measures have been tried but the person has not had or maintained adequate, clinically beneficial weight loss.
3. The person has been receiving, or will receive, intensive management by a multidisciplinary specialist-led team.
4. The person is generally fit for anaesthesia and surgery.
5. The person commits to the need for long-term follow-up.[8]

A joint statement by international diabetes organisations in 2016 recommends that metabolic surgery be considered as an option to treat type two diabetes mellitus (DM) in patients with class-I obesity and inadequately controlled hyperglycaemia despite optimal medical treatment, showing just how effective bariatric surgery can be at treating DM.[9]

The benefits of bariatric surgery include:

- Sustainable weight loss.
- Improvement or complete resolution of several metabolic comorbidities (including DM and hypertension).
- Improvement in severity of obstructive sleep apnoea (OSA) and obesity hypoventilation syndrome (OHS).
- Improved functional status (independency) and quality of life.
- Improvement/resolution of asthma.
- Improved life expectancy.[10]

The contraindications for having bariatric surgery include:

- The patient not meeting the criteria to have bariatric surgery.
- Untreated major depression or psychosis.
- Untreated eating disorders.
- Ongoing substance abuse problem.

Table IV: Bariatric procedures[5,12]

PROCEDURE AND DESCRIPTION	AIM AND REVERSIBILITY	DURATION AND ANALGESIC REQUIREMENTS	ADVANTAGES	COMPLICATIONS
ADJUSTABLE GASTRIC BANDING An adjustable gastric band is inserted around the proximal stomach. The band can be inflated or deflated with saline, via a subcutaneous injection port often over the xiphisternum, to alter the size of the restriction. Done less commonly nowadays because the impact on obesity-related diseases and long-term weight loss is less than with other procedures.	• To decrease the gastric capacity and lead to early satiety • Can be reversed by removing the band	• Short procedure • Minimal analgesic requirements	• Low rate of complications post-surgery • Lowest risk for vitamin and mineral deficiencies	• Band slippage • Can result in swallowing problems and enlargement of the oesophagus
SLEEVE GASTRECTOMY The stomach is freed from structures around it, and then stapled into a banana shape around a bougie placed orally along the lesser curvature of the stomach. Technically easier to perform vs gastric bypass.	• To decrease the size of the stomach and cause early satiety • It is irreversible	• Should take 1–2 hours if uncomplicated • Moderate analgesic requirements	• Lower morbidity and mortality vs gastric bypass surgery with equivalent effectiveness for weight loss	• Gastric leak • May worsen or cause new onset reflux and heartburn
ROUX-EN-Y GASTRIC BYPASS (GASTRIC BYPASS) The stomach is divided into two, with an upper small pouch to receive food from the oesophagus. The distal small bowel is then mobilised, and a 'Roux loop' is brought up to be anastomosed to the upper small stomach pouch, to allow food to pass directly into the distal small bowel bypassing the distal stomach, duodenum and jejunum. A distal end-to-small bowel anastomosis to deliver digestive enzymes is done. A commonly performed procedure.	• Decreases size of stomach and decreases absorption in the small bowel • Can be reversed but it is a complex procedure with numerous potential complications	• Should take 1–3 hours if uncomplicated • Most painful procedure requiring multimodal analgesia	• Reliable and long-lasting weight loss • Most effective against reversing comorbidities, e.g. Type 2 DM	• Anastomotic leaks • Malabsorption causing vitamin and mineral deficiencies, and necessitating lifelong replacement supplementation • Dumping syndrome • Risk of developing ulcers

- Medical, psychiatric or cognitive conditions that prevent adherence to postoperative diet or medication regimen.[11]

Some commonly performed laparoscopic bariatric procedures are summarised in Table IV. The decision about which procedure to be performed is multifactorial.[5,12]

Perioperative management of patients presenting for bariatric surgery

The management of bariatric surgery patients should incorporate enhanced recovery after surgery (ERAS) principles.[13]

Preadmission

Multidisciplinary team (MDT) approach

Patients presenting for bariatric surgery should ideally be managed by an MDT, including a dietician, a psychologist, a bariatric surgeon, an anaesthetist and a physician or endocrinologist.[5]

Counselling and education

This is vital for ensuring successful bariatric surgery. Preoperative information needs to be given to patients, ideally in both verbal and written format. The counselling needs to address both their realistic and unrealistic expectations.[10,13]

Patients need to be informed about the benefits, risks, and consequences of having bariatric surgery as well as the benefits and risks of not having surgery. They need to be informed about the actual procedure to be performed, the anaesthesia they will receive and the fact that they will be required to adhere to lifelong diet, behaviour changes and medications.[13] Adequate preoperative counselling and education ensures more realistic expectations about hospitalisation, pain experienced, analgesia given, mobilisation, and discharge. This, in turn, leads to reduced anxiety, wound complications, postoperative pain and length of hospital stay.[5,10,13]

Anaesthetic assessment and optimisation

Obese patients have an increased incidence of obesity-related diseases affecting several organ systems and, as such, present challenges that require specific perioperative care. Bariatric surgery is elective, and this means that we have adequate time for both assessment and optimisation of these patients prior to admission for surgery.[5]

Determining if patients have central obesity and metabolic syndrome is important for identifying those at high risk for perioperative complications.[1,5]

Airway assessment needs to be done thoroughly, using the usual measures for predicting difficult ventilation and tracheal intubation. It is extremely important to measure neck circumference to help predict a difficult laryngoscopy.[1,4,5] Bag mask ventilation is also a bit more difficult in the obese population especially if the patient has a beard, so it should be shaved or at least trimmed preoperatively.[4]

For cardiac assessment, ECG evaluation is essential as obese patients have an increased incidence of arrhythmias due to sino-atrial node dysfunction and fatty infiltration of the conducting system.[4] Any further cardiac testing depends on findings during patient assessment.[5]

OSA and the related OHS has a prevalence of 35–94% in bariatric surgery patients.[13] Screening for OSA using one of the screening tools (e.g. STOP-Bang) is important as many patients are undiagnosed, and untreated moderate to severe OSA is a risk factor for postoperative pulmonary complications.[5,13] OSA diagnosed preoperatively and treated with continuous positive airway pressure (CPAP) decreases the risk of postoperative complications regardless of the OSA severity.[4,13] Unfortunately as many as 50% of patients are not compliant on nocturnal CPAP and compliance should always be questioned preoperatively.[4] Patients with OSA on CPAP for a minimum of six weeks should ideally bring their own CPAP machines for use postoperatively and those patients with OSA that can't tolerate CPAP may require admission to a high dependency unit for monitoring and supplemental oxygen.[5]

Since diabetes in the bariatric population ranges from 15–30%, depending on the definition used, it is important to adequately manage it to prevent perioperative complications. There is adequate clinical evidence available with recommendations to manage diabetes perioperatively including perioperative intravenous insulin to achieve glycaemic targets (8–10 mmol/l) in hospitalised patients.[13]

Preoperative weight loss

Patients should be strongly encouraged to lose 5–10% of their weight preoperatively, with either a low (1 000–1 200 Kcal/day) or very low (500–800 Kcal/day) calorie diet. This has been shown to reduce liver volume resulting in better operating conditions and therefore shorter surgery time. It has also been shown to decrease perioperative complications and lead to improved short-term postoperative weight loss.[10,13]

Smoking and alcohol cessation

Although there is a lack of evidence in bariatric patients, we know that both smoking and high alcohol consumption lead to an increased risk of postoperative complications. It would therefore be advisable to stop smoking at least four weeks before surgery. If the patient has a history of alcohol abuse, surgery should be postponed until the patient has abstained from alcohol for 1–2 years. Also, in the case of a history of alcohol abuse the risk of relapse post-surgery should be noted and addressed.[10]

Preoperative

Postoperative destination

To assist in deciding where the patient needs to go postoperatively, it is advisable to use the Obesity Surgery Mortality Risk Score (OS-MRS) (Table V), which is a validated preoperative screening

tool for bariatric surgery. Patients scoring 4–5 points should be considered high risk, requiring a monitored bed.[5,14]

Risk assessment for all other comorbidities is the same as for all patients.

Table V: Obesity Surgery Mortality Risk Score[14]

Risk factor	Points
Arterial hypertension	1
Age > 45	1
Male gender	1
Body mass index ≥ 50 kg/m^2	1
Risk factors for pulmonary thromboembolism*	1

Risk group	Score	Postoperative mortality
A (low risk)	0–1	0.3%
B (moderate risk)	2–3	1.7%
C (high risk)	4–5	3.2%

*Pulmonary hypertension, previous pulmonary thromboembolism, vena cava filter, hypoventilation ($PaCO^2$ ≥ 45 mmHg)

Preoperative fasting

Starvation guidelines for the obese are the same as for non-obese patients, because it has been shown that when compared to non-obese patients, there is no difference in residual gastric fluid volume, pH or gastric emptying rates in obese patients.[10]

Carbohydrate loading

Despite the benefits of preoperative carbohydrate loading in many ERAS protocols, there is insufficient evidence to make a recommendation for bariatric patients.[10]

Pharmacological agents

Chronic medication needs to be reviewed and taken if deemed appropriate. Administering dexamethasone 90 minutes before induction can help to reduce postoperative nausea and vomiting (PONV) as well as decreasing the inflammatory response.[10]

Intraoperative

Patient dignity

Obese patients are sensitive about their body image and dignity is very important. We play an important role by being mindful of what we say and by ensuring that things like theatre gowns are available in appropriate sizes.[1]

Safety briefing

It is important before each case to do a safety briefing with the entire theatre team, where the patient's BMI is confirmed, and anticipated anaesthetic and surgical complications are discussed. The availability of the correct sized operating table able to take extremes of body weight with appropriate arm and leg board attachments, adequate staffing and appropriate equipment and monitoring also need to be confirmed.[5]

Positioning

It is best if the patient self-positions as this avoids pressure injuries as well as avoiding excessive manual handling.[1,5] The patient should be in a ramped position to assist airway management; this position would be suited for laparoscopic surgery as well.[1,5,13] A steep reverse Trendelenburg position is usually required for surgery, so arms should be placed on arm boards and strapped, while legs should be placed in gutters with a foot support to stop slippage.[5]

Monitoring

Standard monitoring including electrocardiography, saturation, non-invasive blood pressure (NIBP) and capnography are essential. Invasive arterial pressure monitoring is only required if dictated by the patient's comorbidities or if the NIBP is not reading properly. Neuromuscular monitoring is strongly recommended.[1,3,5] Depth of anaesthesia monitoring is also strongly recommended especially when propofol is used for maintenance.[3,10]

Airway

Placing the patient in a ramped position to elevate the head, neck and shoulders such that the patient's chin is higher than the chest and the patient's ear is level with the sternum is extremely important.[1,5,13] Obesity is associated with difficulty in maintaining an airway and oxygenation before intubation and also with rapid oxygen desaturation.[1,5] The patient requires good-quality preoxygenation, which can be achieved with a tight-fitting face mask, CPAP or high-flow oxygen techniques, to achieve an end-tidal oxygen concentration of 90%.[5] Tracheal intubation should be used for all patients undergoing laparoscopic bariatric

Table VI: Different weight calculations[3,5]

Weight	Description	Calculation
IBW	Predicted weight of a person from the person's height and a predicted normal BMI of 22 utilising the BMI formula.	IBW = 22 x Height^2
LBW	This is the mass of non-adipose tissues and often used in obese patients for drug dosing, especially for polar drugs with a small volume of distribution. Use a maximum of 100 kg in males and 70 kg in females.	**Males** LBW = 1.1 x TBW - 0.0128 x BMI x TBW **Females** LBW = 1.07 x TBW - 0.0148 x BMI x TBW
ABW	This uses a correction factor for the distribution of the drug.	ABW = IBW + 40% excess weight Excess weight = actual body weight - IBW

IBW – ideal body weight, BMI – body mass index, LBW – lean body weight, TBW – total body weight, ABW – adjusted body weight

Table VII: Drug dosing according to weight[3-5]

LBW	ABW	TBW
Induction dose of propofol	Propofol infusion	Suxamethonium
Alfentanil	Antibiotics	Low-molecular-weight heparin
Fentanyl	Sugammadex	
Remifentanil bolus + infusion	Neostigmine (max dose of 5 mg)	
Morphine		
Non-depolarising muscle relaxants		
Paracetamol		
Local anaesthetics		
Adrenaline		
Noradrenaline		

LBW – lean body weight, ABW – adjusted body weight, TBW – total body weight

surgery and the device used to achieve this depends on the anaesthetist's personal preference.[1,4,5] It is, however, advisable that a video laryngoscope be available if needed.[5]

Drugs

For drug dosing, one needs to understand the differences between lean (LBW), ideal (IBW) and adjusted (ABW) body weights (Table VI).[3,5] Table VII advises which drugs to use according to the different weights.[1,3–5]

Induction

Rapid sequence induction is rarely required. Propofol is the most used induction agent and should be dosed on LBW. According to the United Kingdom's (UK's) 5th National Audit Project (NAP 5) on accidental awareness under anaesthesia, which included a disproportionate number of obese patients who suffered awareness, half of the incidents of awareness in obese patients occurred during induction of anaesthesia. This may be because the dose of induction agent based on LBW was not quickly followed by introduction of maintenance anaesthesia. Anaesthesia will occur before redistribution from the central compartment, but more rapid redistribution of induction agents into the larger fat mass means that obese patients wake up more quickly than non-obese patients after a single bolus dose.[1,5,15]

Maintenance

Any maintenance agent can be used, ideally using short-acting drugs. With volatile anaesthetic agents, desflurane offers faster wake-up times but can induce increased airway resistance as well as hypertension and tachycardia. Which inhalational agent to use should therefore be based on existing comorbidities and availability.[4]

If using propofol for maintenance, then ABW should be used, but all target-controlled infusion (TCI) models become inaccurate at high BMIs, and therefore, propofol should be used with a depth of anaesthesia neuromonitor.[1]

Deep neuromuscular blockade may improve surgical conditions with lower insufflation pressures, and this may be advisable as higher pneumoperitoneum pressures have unfavourable cardiovascular and ventilation effects, especially in obese patients.[5,13] Rocuronium dosed on LBW is considered a good choice because of its speed of onset and reversibility.[5]

For gastric bypass and sleeve gastrectomy procedures, a large-bore (34Fr) bougie may need to be placed orally. It will assist the surgeon in clearly delineating the anatomy and allow testing for anastomotic leaks. The surgeon may request 60–180 ml of water containing methylene blue to be injected into the stomach remnant. This needs to be done carefully as spillage of methylene blue will cause skin and hair discolouration and there is a potential risk of stomach and mediastinal perforation if done with too much force.[5]

Ventilation

Lung protective ventilation with volumes based on IBW and sufficient PEEP to ensure adequate oxygenation, should be used.[1,5] The optimal PEEP to use is still a matter of debate. A higher PEEP may decrease atelectrauma but may increase inflammation and impair haemodynamics.[13] A higher peak airway pressure may need to be accepted because of both an increased BMI and a pneumoperitoneum, but the reverse Trendelenburg position can mitigate this to some extent.[5]

Analgesia

Adequate analgesia is a key component of ERAS because pain has been shown to delay mobilisation and result in prolonged admission.[13] There is a high level of evidence to support the use of multimodal opioid-sparing analgesia.[10] The use of lignocaine, dexmedetomidine, ketamine, magnesium and nonsteroidal anti-inflammatory drugs may have better anti-inflammatory effects than classical opioid-based anaesthesia whilst also reducing opioid consumption.[10,13] The use of local anaesthetic infiltration before incision and intraperitoneal instillation of bupivacaine also decreases opioid consumption and postoperative pain.[5,10]

Postoperative nausea and vomiting

PONV prophylaxis is another key component in the ERAS pathway. PONV delays recovery and leads to decreased patient

satisfaction. Bariatric patients usually have multiple risk factors for PONV. A multimodal approach to PONV should be adopted including using three antiemetic agents from different classes (strong evidence), avoiding volatiles (limited evidence), avoiding fluid overload (to prevent postoperative ileus) and minimising the use of opiates.[10,13]

Fluid management

Hypovolaemia can cause organ injury especially acute kidney injury, while hypervolaemia is a risk factor for PONV and increased length of stay.[13] The aim is therefore to maintain normovolaemia using goal-directed fluid therapy guided by stroke volume variation or pleth variability index.[10,13]

Drains

Nasogastric tubes, for the purpose of decreasing anastomotic leaks, and abdominal drains, for the purpose of detecting anastomotic leaks early, should not be left in at the end of surgery. They have not been shown to make a difference for anastomotic leaks but have been shown to cause more pain.[10]

Emergence

According to the UK's NAP 4, patients with obesity were at high risk of airway obstruction, hypoventilation, and regurgitation at extubation.[16] Emergence should therefore be recognised as a period of increased risk. Prior to extubating, always ensure that the patient is warm, well analgesed, in the head-up (semi-sitting) position and fully reversed. Neuromuscular block must be reversed fully because there is a strong association between residual blockade and pulmonary complications in the postanaesthetic care unit.[5,13] Sugammadex, dosed on ABW, may be useful because it has been associated with fewer adverse events and it reverses rocuronium more rapidly when compared to traditional reversal agents.[5,10]

Postoperative

Postoperative oxygenation

Obesity is associated with a higher risk of perioperative atelectasis and hypoxaemia. Despite this, supplemental oxygen needs to be used with caution because, while improving oxygen saturation, it also increases the duration and time to detection of apnoea as well as carbon dioxide retention.[10]

Patients with uncomplicated OSA should receive supplemental oxygen in the head-up position.[4] Patients with OSA on home CPAP therapy should use their own equipment in the immediate postoperative period.[4,5] In patients with OHS, the use of non-invasive ventilation (NIV) should be considered liberally, particular in the presence of hypoxaemia.[4]

Thromboprophylaxis

The incidence of postoperative thromboembolism may be as much as 10 times higher in obese female patients, and that may be why thromboembolic complications are one of the main causes of morbidity and mortality after bariatric surgery.[4] Thromboprophylaxis should involve both mechanical and pharmacological measures, with doses and duration of treatment being individualised.[5]

Early postoperative nutritional care

A clear liquid diet is usually initiated a few hours after surgery, before moving on to nourishing fluids.[10] Nutritional care should involve a dietician with a protocol-driven staged meal plan.[5]

Chronic medication

All anti-diabetic medication, except metformin and incretin-based therapies, should be withheld unless there is proof of hyperglycaemia.[13] This is because bariatric surgery improves glucose homeostasis, by a variety of mechanisms, in the immediate postoperative period. Continuing these medications may lead to hypoglycaemia.[10,13] All other chronic medication can usually be started. Antihypertensive agents may also need to be adjusted later, not in the immediate postoperative period.[11]

Supplementation of vitamins and minerals

All patients should have access to a comprehensive nutrition and dietetic assessment preoperatively. After bariatric surgery, there is an increased risk of developing deficiencies of various vitamins and minerals, necessitating the use of lifelong supplemental vitamins and minerals as well as nutritional biochemical monitoring.[5,10]

Proton pump inhibitor prophylaxis

Proton pump inhibitor (PPI) prophylaxis should be considered for at least 30 days after Roux-en-Y bypass to prevent marginal ulcers and can be considered after a sleeve gastrectomy due to the high incidence of postoperative gastroesophageal reflux in these patients.[10]

Postoperative complications

Complications that can occur early in the postoperative period and delay discharge include:

- PONV
- Thromboembolism
- Postoperative pulmonary complications
- Anastomotic leaks: A leak would typically present from 24 hours to a few days after surgery, with persistent tachycardia, pyrexia and abdominal pain. It increases overall morbidity and mortality.
- Bleeding: A relatively common complication (0.5–4%), with supportive management usually being adequate.[5]

Complications that can occur later include:

- Nutritional deficiencies

- Psychological issues: Bariatric surgery tends to generally have a positive impact on patients after bariatric surgery through weight loss, but the incidence of suicide in these patients is higher than the general population.
- Dumping syndrome: This occurs as a result of malabsorption after surgery, with the patient presenting with nausea, vomiting, diarrhoea and abdominal pain.[5]

Conclusion

The use of laparoscopic surgery and the implementation of perioperative care of the obese patient have resulted in lower rates of morbidity and mortality and decreased lengths of hospital stay in patients undergoing bariatric surgery. We should continue making an effort to further decrease postoperative complications from these elective procedures to decrease morbidity to the individual and cost to the healthcare system.[10,13]

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