FOCUS ON: BARIATRIC

Anaesthetic considerations and management of the obese patient presenting for bariatric surgery

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1. Introduction

Historically, obesity has been associated with affluence and fertility. With rates of both adult and childhood obesity rapidly rising, obesity no longer signifies affluence but is instead becoming one of the leading public health issues facing the developed world. Between 1993 and 2004, the prevalence of adults in England with a Body Mass Index (BMI) of 30 kg/m² or greater increased from 13.6% to 24.0% in men and from 16.9% to 24.4% in women. If recent trends in adult obesity continue, it has been projected that approximately a third of all adults (almost 13 million individuals) will be obese by 2012. Obesity has long been recognized as a precursor of morbidity and premature mortality. Epidemiological studies show morbidity and mortality to be positively correlated with a BMI > 30 kg/m², and individuals with a BMI > 35 kg/m² at aged 50 years have double the risk of premature death.

The field of bariatric surgery in the UK has undergone exponential growth within the last decade. Bariatric surgery is associated with improved rates of sustained weight loss, long-term reduction in obesity-related disease and a decline in long-term mortality.

The obese patient presents particular challenges for the anaesthetist. We can expect to be increasingly confronted with this patient population, as the demand for bariatric intervention escalates. This article reviews the anaesthetic assessment and management of the morbidly obese patient presenting for bariatric surgery. The surgical management of obesity is discussed elsewhere in this supplement by Bonanomi et al.

2. Background

The World Health Organization (WHO) classifies obesity based on BMI, and describes:

- Class I obesity – BMI of 30–34.99,
- Class II as 35–39.99,
- Class III as a BMI equal to or greater than 40.

Individuals with a BMI of 35 or greater who have concomitant, obesity-associated disease or those with a BMI of 40 or greater, regardless of co-morbidities, are described as morbidly obese. Although BMI is the most commonly used tool for assessing the severity of obesity, it is not necessarily the best clinical predictor of disease. The distribution of adipose tissue rather than the absolute weight or BMI per se, appears to be more clinically relevant. Centrally distributed adipose tissue (android obesity), is more metabolically active than peripheral tissue, and there is an increased incidence of metabolic complications in individuals with a waist circumference greater than 102 cm in men, and 89 cm in women. Those with extensive visceral fat are also at greater risk of ischaemic heart disease (IHD), hypertension, premature coronary death and stroke.

In the UK, the National Institute for Health and Clinical Excellence (NICE) recommends bariatric surgery as an intervention when non-surgical measures for weight loss have failed to achieve or maintain clinically beneficial weight loss for at least 6 months. This guidance refers to adults with a BMI of ≥40 kg/m², or ≥35 kg/m² plus significant obesity-related disease likely to improve with weight loss. Surgical intervention is recommended as a first-line option in super-obese adults (BMI ≥ 50 kg/m²). Rates of post-operative morbidity and mortality following bariatric surgery vary...
between institutions. Santry reviewed bariatric surgical admissions across the United States between 1998 and 2003, of which gastric bypass surgery accounted for 80% of procedures. The observed in-hospital mortality rate was between 0.1% and 0.2%, unexpected re-operation rate for surgical complications of 6–9%, and respiratory and cardiac complications varied from 4–7% to 1–1.4% respectively. Known predictors of post-operative complications include male gender, surgical inexperience, age ≥45 years, BMI ≥50 kg/m², Obstructive Sleep Apnoea (OSA), asthma, diabetes mellitus, hypertension and those at increased risk of venous thromboembolism.

Contra-indications to bariatric surgery include mental and cognitive impairment, ongoing substance abuse, advanced liver disease with portal hypertension, malignancy with poor 5-year prognosis, unstable coronary artery disease (CAD) and uncontrolled severe OSA with pulmonary hypertension. Age is not a contra-indication per se, but careful assessment of functional capacity and co-morbidity is warranted in these patients to ensure suitability.

3. Pre-operative assessment

The objective of pre-operative assessment is to optimize patient outcomes. It facilitates the appropriate selection of patients suitable for bariatric surgery, enables timely identification and treatment of pre-existing medical conditions, and determines how and where each patient should be managed post-operatively. The bariatric multi-disciplinary team (MDT) approach to pre-operative assessment ensures that patients are appropriately selected, informed and motivated, and optimized medically. At this institution, all new bariatric referrals are initially assessed by a bariatric clinical nurse specialist, prior to discussion at MDT meetings. These are attended by dieticians, psychologists, endocrinologists, respiratory physicians, anaesthetists and bariatric surgeons. High risk patients are identified and referred for further assessment by a bariatric anaesthetist in a consultant-run, bariatric pre-assessment clinic. The pre-operative interview takes place 6–12 weeks in advance of the proposed date for surgery. It allows for comprehensive history-taking and thorough physical examination with particular attention to the airway, respiratory and cardiovascular systems. Where further investigation or management is indicated, there are easily accessible and efficient referral pathways for specialist consultation in sleep and respiratory medicine, endocrinology, cardiology and psychiatry.

3.1. Airway

Obese patients have traditionally been considered to be at increased risk of difficult tracheal intubation. However, studies have shown that absolute weight and BMI per se are poor predictors of difficult tracheal intubation, whereas large neck circumference (≥40 cm), Mallampati score ≥3 and thyromental distance <6 cm are more specific indicators of potential difficulty. Assessment and management of the obese airway is thoroughly addressed elsewhere in this issue by Wyatt and Haire.

3.2. Respiratory system

Obese patients have increased basal oxygen consumption and carbon dioxide production. Obesity is also associated with decreased lung and chest wall compliance, increased airways resistance and reduced functional residual capacity (FRC). The latter often falls below the closing capacity, resulting in atelectasis, ventilation/perfusion mismatch and impaired oxygenation. The supine position, induction of anaesthesia and pneumoperitoneum during laparoscopic procedures further compound these effects. Baseline respiratory function should be established from the patient history and physical examination. Smoking contributes to both respiratory and cardiovascular disease and has been identified as an independent risk factor for post-operative complications after bariatric surgery. Cessation of smoking for >8 weeks preoperatively is associated with improved cardiovascular parameters and a reduction in post-operative pulmonary complications. Chest X-ray, arterial blood gas analysis and pulmonary function tests (PFTs) should be selectively performed where clinically indicated. Patients with reversible, obstructive respiratory deficit should be optimized by respiratory specialists prior to surgery.

OSA is strongly associated with obesity. The prevalence of OSA in morbidly obese patients is approximately 70%, and the condition is often undiagnosed. Individuals with a large neck circumference (collar size >43 cm in men or >40 cm in women) are at increased risk. This population of patients may be at increased risk for peri-operative morbidity and mortality. Our practice is to screen patients based on their history (witnessed apnoeas, snoring, disturbed sleep) and the Epworth Sleepiness Scale. Patients scoring ≥12 or with a history strongly suggestive of OSA, are then referred for polysomnography. If the study is positive for OSA (Apnoea-Hypopnoea Index ≥5 per h), patients are commenced on nocturnal continuous positive airways pressure (CPAP) or bilevel positive pressure (BiPAP) ventilation for 6–12 weeks prior to surgery. The optimal duration of treatment prior to surgery is unclear, and some benefit may be gained from shorter treatment periods. If OSA is moderate or severe, baseline PaO₂, PaCO₂ and bicarbonate are determined. Further information on OSA can be found elsewhere in this supplement by Margarson.

3.3. Cardiovascular

Cardiovascular complications following high risk, non-cardiac surgery are an important cause of morbidity and mortality. Obesity, particularly the android variety, is recognized as an independent risk factor for coronary artery disease (CAD). Additionally, other obesity related sequelae can compound CAD, culminating in cardiac failure (Figs. 1 and 2), and a poor post-operative outcome. Timely pre-operative assessment facilitates thorough evaluation of cardiac risk and implementation of medical measures wherever possible, to minimise risk.

Cardiac function can be difficult to ascertain in morbidly obese patients from the clinical history, as mobility is frequently limited. Clinical examination can be unreliable as heart sounds are muffled, necks of a larger circumference conceal jugular venous pressure (JVP) and peripheral oedema may be attributed to a sedentary lifestyle. Functional capacity can be better assessed according to the patient’s ability to undertake activities of daily living. Those able to perform activities requiring at least 4 metabolic equivalents (METS), e.g. climbing a flight of stairs, walking up-hill or walking on level ground at 4 miles per hour, are classified as having moderate functional capacity. The Revised Cardiac Risk Index is commonly used to assess cardiac risk in patients undergoing non-cardiac surgery, and identifies 6 independent predictors of cardiac complications (high-risk surgery, IHD, congestive cardiac failure, cerebrovascular disease, IDDM, and renal insufficiency). Based on this model and the patient’s functional capacity, the AHA/ACC have produced a framework for the selection of patients who should proceed to provocative cardiac testing (Fig. 3). Patients with functional capacity greater than 4 METS and no risk factors undergoing bariatric surgery are generally considered to be at low risk of cardiovascular complications, and can usually proceed to surgery without further investigation. In contrast, the sedentary patient without a history of cardiovascular disease, but with risk factors predictive of increased cardiac risk, should be considered for...
further cardiac function assessment. The choice of test should take into account the effect of obesity on the quality of images obtained and the weight limitations of the imaging equipment. For example, the diagnostic accuracy of Single Photon Emission Computed Tomography (SPECT) is reduced by obesity-mediated amplification of photon scatter and attenuation artifact. Cardiac Positron Emission Tomography (PET) has significantly better specificity than SPECT, but its use is limited by its availability and the weight and
Fig. 3. Algorithm for the cardiac evaluation of patients undergoing intermediate risk, bariatric surgical procedures (adapted, with permission, from ACC/AHA guidelines 2007).

Endocrinological and genetic aetiologies should be elucidated and controlled prior to referral for bariatric surgery. Diabetes is more prevalent in this particular cohort of patients, and strict glycaemic control is desirable to reduce adverse events. Obese patients are also at increased risk of developing peri-operative neuropathies. Pre-existing symptomatic neuropathies such as carpal tunnel syndrome, should be clearly documented. Thromboembolic complications account for the majority of post-operative deaths following bariatric surgery. Patients at increased risk (BMI > 60, a history of OSA/OHS or previous thromboembolism) should be considered for inferior vena cava (IVC) filter insertion as prophylaxis preoperatively.

3.5. Baseline investigations

Routine baseline blood tests should include full blood count, electrolyte profile, renal, liver and thyroid function tests. Additional laboratory investigations should be requested where indicated. Some authors have questioned the need for routine electrocardiograms (ECGs) in all patients undergoing bariatric surgery. Our sentiment is that an ECG is an inexpensive test that is easy to perform, and our practice is to obtain a baseline ECG in all patients presenting for bariatric surgery.

3.6. Scoring systems

Scoring systems that stratify peri-operative mortality risk facilitate the standardization and comparison of outcomes, prognostication, and development of post-operative management strategies. The Obesity Surgery Mortality Risk Score (OS-MRS) is a recently validated scoring system specific to obese patients undergoing bariatric surgery. It allocates 1 point to each of 5 pre-operative variables including:

- BMI > 50 kg/m²
- male gender
- systemic hypertension
- risk factors for pulmonary embolism
- age > 45 years

Patients with total score of 0–1 are classified as low risk (class A, mortality of 0.31%), those scoring 2–3 as intermediate risk (class B, mortality 1.9%), and patients scoring 4–5 as high risk (class C, mortality 7.1%).

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mortality 7.56%). High risk patients have been characterized by a 12-fold greater mortality than the lowest risk group and a disproportionate 9% of all mortalities.

4. Intra-operative management

Bariatric patients should be managed at a facility that is appropriately equipped and staffed. This includes specialist interventional, diagnostic, transport and operating room equipment, and access to critical care facilities. In 2007, the AAGBI recommended that each hospital should have a designated consultant anaesthetist and theatre staff member who are responsible for ensuring that the operating suite is adequately resourced to safely manage the morbidly obese patient.17 Routine monitoring can be difficult to institute. Even when appropriately sized BP cuffs are used for example, they may produce inaccurate readings as a good upper arm fit may be difficult to achieve with conical shaped arms. Invasive BP monitoring should be used if non-invasive BP measurements are unreliable, in high risk patients and those undergoing prolonged procedures. Arterial line placement also facilitates repeat blood sampling in both the intra- and post-operative period. Procurings intravenous access can be challenging and patients should be warned of the potential need for central venous access if good peripheral access cannot be achieved. Ultrasonography has been shown to reliably assist in the cannulation of neck veins in morbidly obese patients and should be routinely used.

4.1. Induction

Absolute weight and BMI per se, are poor predictors of difficult intubation and the majority of obese patients presenting for surgery do not have a difficult airway.7 Nonetheless, there is an increased incidence of difficult intubation in this patient population and timely recognition of the patient in whom airway management may be problematic is important. The presence of OA, a previous history of difficult intubation, Mallampati score ≥3, neck circumference >40 cm, thymorental distance <6 cm and limited cervical or temporomandibular joint mobility have been cited as predictors of difficult intubation. The range of airway devices immediately available should be in accordance with the DAS practice guidelines for management of the difficult airway.25 If difficult tracheal intubation is anticipated, then consideration should be given to proceeding with an awake fibreoptic technique. Airway assessment and management in obese subjects is discussed in further detail by Myatt and Haire.8

Pre-oxygenation in the 25 degree head-up position and the application of pre-induction Positive End Expiratory Pressure (PEEP, 10 cm H2O for 5 min), followed by 10 cm H2O PEEP prior to intubation has been shown to prolong the duration of non-hypoxic apnoea in patients with a BMI >35 kg/m2.19,20 In elective, fasted patients without signs indicative of a difficult intubation or risk factors for pulmonary aspiration, we induce anaesthesia with propofol and use a non-depolarising muscle relaxant, usually rocuronium 0.6 mg/kg, based on ideal body weight (IBW).21 Mask ventilation should be undertaken after placement of a guedel airway, to minimise stomach insufflation and any impediment to surgery. Rapid-sequence induction with suxamethonium and cricoid pressure is common practice in some bariatric surgical centres. Whilst it has been shown that residual gastric volume >25 mL and pH <2.5 is more prevalent in fasting morbidly obese than lean surgical patients, recent studies have failed to demonstrate a relationship between obesity and the incidence of pulmonary aspiration, and our experience to date reflects these findings.22–24

In contrast, patients requiring general anaesthesia following previous bariatric surgery are at increased risk of pulmonary aspiration, and should undergo RSI with cricoid pressure.25 It is postulated that anatomical and physiological gastric changes occur after bariatric intervention and predispose to an increased aspiration risk.

A large bore naso- or oro-gastric tube should be inserted to decompress the stomach prior to surgical manipulation. It is imperative to ensure that this is either withdrawn or removed entirely to avoid inadvertent surgical fixation in some forms of bariatric surgery. Frequently, a methylene-blue dye test is performed intra-operatively to test the integrity of a gastric anastomosis, and this is usually performed with the tip of the tube in the distal oesophagus.

4.2. Anaesthetic agents

Rapid recovery from general anaesthesia is desirable in morbidly obese patients to minimize the risk of post-operative airway or respiratory complications. The increase in adipose tissue and physiological effects of obesity alter the pharmacokinetic and pharmacodynamic profiles of drugs. The volume of distribution (Vd) of highly lipophilic drugs such as barbiturates and benzodiazepines is increased, in keeping with the increased proportion of body fat. This should in theory, be reflected by slower elimination of such drugs. However, obesity related modifications in protein binding and clearance can alter the pharmacodynamics of drugs in a complex manner. Albumin binding for example appears unchanged in obesity, but an increase in other plasma proteins means that while the free fraction of acidic drugs is unchanged, that of basic drugs is increased. Drug effects are therefore often unpredictable, with large inter-patient variation between obese subjects.

A study investigating the effects of obesity on the pharmacokinetics of thiopentone has shown that the induction dose is reduced in obese patients compared to non-obese patients when based on total body weight (TBW) (3.9 mg/kg vs 5.1 mg/kg), the VD is increased, and the elimination half-life significantly increased in obese (27.8 h) compared to non-obese patients (6.33 h).26 In contrast, Servin et al. found that the elimination half-life of propofol was similar in obese and non-obese subjects, with no signs of propofol accumulation in obese subjects.27 These findings were in spite of an increased volume of distribution of propofol. Given that propofol does not appear to accumulate in obese patients, one could assume that the induction dose should be based on TBW. However, such large doses of propofol could result in significant haemodynamic sequelae, and it has been recommended that the induction dose be based on Lean Body Mass (LBM).28 The pharmacokinetic modelling of propofol target controlled infusion (TCI) for the maintenance of anaesthesia in the morbidly obese patient is extremely complex. Numerous weight correction formulae have been proposed, but as of yet there is no consensus as to what formula best correlates predicted to actual measured concentrations. Depth of anaesthesia monitoring should therefore be used in morbidly obese patients when using TCI, to guide infusion rates and minimize the risk of awareness.

The optimal inhalational agent for the maintenance of anaesthesia in obese subjects remains debatable. Isoflurane has by and large been superseded by sevoflurane and desflurane which are associated with faster emergence and recovery times in bariatric surgery. Desflurane has both a lower blood–gas and oil–gas partition coefficient than sevoflurane and should theoretically result in faster emergence. There is some evidence to suggest that the recovery profile of desflurane is superior to sevoflurane in obese patients in terms of earlier response to command and quicker
extubation.29 Other studies have found no clinical advantage of desflurane over sevoflurane.30 Nitrous oxide exhibits analgesic properties and has a fast wash-in/wash-out profile but its use is limited in gastric bypass surgery because of concerns over associated bowel distension resulting in poorer operating conditions.

Opioids are highly lipophilic drugs and should therefore, in theory, accumulate in the obese patient. However, this is not necessarily reflected in practice. Clinical effects of fentanyl appear to be similar to the non-obese population and no dose changes are generally required, whereas alfentanil should be dosed based on TBW.

Although remifentanil is highly lipophilic, pharmacokinetic properties in the obese and non-obese populations are similar. This may perhaps be predominantly due to plasma cholinesterase metabolism and infusion regimes should generally be based on IBW.31 The combination of remifentanil TCI and BIS guided desflurane anaesthesia has been suggested. Bergland et al. have reported impressive recovery profiles in 500 patients following the use of this combination when titrated to BIS values of 45–55.24 Hydrophilic substances such as non-depolarising muscle relaxants demonstrate little differences in VD and should be dosed according to IBW or lean body mass (LBM). Use of LBM is thought to be more accurate than IBW in obesity, as 20–40% of the increase in total body weight may be attributable to an increase in mass of non-adipose tissue.

4.3. Ventilation

General anaesthesia in the obese patient is associated with a 50% reduction in FRC, a 10–25% intrapulmonary shunt and an increasing alveolar–arterial oxygen tension gradient which rises linearly with increasing BMI. Creation of a pneumoperitoneum further compounds these effects, predisposing to the cascade of hypoxaemia, hypercapnia, pulmonary hypertension and right heart failure.32 High inspired oxygen concentrations and the use of PEEP can attenuate some of these effects and improve oxygenation but may also compromise cardiac output. End-tidal CO2 may not be reflective of arterial PaCO2, and during prolonged procedures, should not be exclusively relied upon as an indicator of sufficient ventilation. There is no evidence to recommend a particular mode of ventilation for bariatric surgery.33,34 Excessive tidal volumes of ≥20 ml/kg (based on IBW) result in excessive hypocapnia and an increase in peak and plateau pressures without a significant oxygenation benefit. Shaping forces created by large tidal volumes repeatedly opening and closing small airways also predispose to inflammatory change and increased lung water. More conservative tidal volumes of 10 ml/kg (IBW) should therefore be used to minimise risk of volutrauma, along with moderate amounts of PEEP. A minor degree of permissive hypercapnia is usually well tolerated. However, any serious respiratory acidosis may activate the sympathetic system, causing tachycardia, dysrhythmias, and increased systemic vascular resistance (SVR) and pulmonary artery pressure (PAP). Most bariatric procedures are performed in the steep head up or reverse Trendelenburg position (RTP) and this significantly improves respiratory dynamics.35

4.4. Circulation

The pneumoperitoneum created in laparoscopic procedures (>20 mm Hg) causes inferior vena caval compression, an increase in systemic vascular resistance and a reduction in cardiac output and glomerular filtration rate. These cardiovascular effects are further exacerbated by the reverse trendelenburg position, intermittent positive pressure ventilation and PEEP.

Intra-operative ventricular dysfunction may be precipitated by rapid fluid administration, pulmonary hypertension, pulmonary embolism, myocardial ischemia or the negatively inotropic effect of anaesthetic agents. Early detection of ischaemia and aggressive management of hypotension with intravenous fluids and vasopressors is important as these patients frequently have minimal reserve. The ideal fluid regime for patients undergoing bariatric surgery is not known, and neither a restrictive (4 ml/kg/h) nor liberal approach (12 ml/kg/hr) has proved superior. Intra-operative urine output is frequently reduced in laparoscopic bariatric procedures, and may not provide an accurate indication of intravascular volume status. Central venous pressure monitoring is more reliable and should be used to guide fluid management in patients with ischaemic heart disease or cardiac failure.

4.5. Other considerations

The neuroendocrine surgical stress response can result in a relative hyperglycemia that should be controlled in all diabetic patients and those at risk of myocardial ischaemia during the peri-operative period. Obese patients, particularly the obese diabetic patient, are also at increased risk of post-operative wound infection, and as part of our intra-operative management protocol, all patients receive prophylactic antibiotics.

Peri-operative hypothermia is associated with adverse outcomes including surgical wound infection, coagulopathies, prolonged recovery from anaesthesia and cardiac morbidity, and should be avoided.

Rhabdomyolysis following bariatric surgery has a reported incidence ranging from 12.9 to 37.8%. Risk is increased where surgery is prolonged (>240 min), the patient has a BMI >50 and open techniques are employed. Preventative measures include padding of pressure points and changing patient position during prolonged procedures and recovery. Similarly, the risk of peri-operative neuropathies and pressure sores is reduced by proper patient positioning and cushioning of vulnerable areas.

5. Post-operative management

Bariatric patients are at increased risk of both early and late post-operative complications. Initial post-operative considerations include airway and respiratory support, pain control and prevention of thromboembolism.

Exubation in morbid obesity carries serious risk of loss of airway control, rapid onset of hypoxaemia, haemodynamic instability and pulmonary aspiration. At the end of the procedure, patients should be extubated by experienced anaesthetists in the semi-upright or sitting position, when fully awake, after complete resolution of neuromuscular blockade. The latter is evidenced by neuro-muscular stimulation, return of airway reflexes, sustained head lift for >5 s and generation of adequate peak inspiratory pressure and vital capacity. Qualified personnel and emergency airway equipment should be immediately available in case re-intubation is required. Patients in whom respiratory function is compromised or surgery has been prolonged and complicated may require delayed extubation in the Intensive Care Unit (ICU).

Patients should be cared for postoperatively in a facility that is appropriate to their individual requirements. The Post Anaesthetic Care Unit (PACU) should have immediate access to qualified personnel trained in airway management and respiratory support devices, clinical laboratories and radiological facilities. Discharge from the PACU to a level 0.1 or 2 amenity depends on the individual patients physiological reserve, airway control and complexity of surgery. Patients with minor pre-operative co-morbidity, undergoing uncomplicated, more minor procedures may usually be
discharged to a level 0 facility. Patients with moderate co-morbidity or those undergoing prolonged, complex procedures may require more intensive observation and Level 1 care may be more appropriate. Pre-existing CO₂ retention, significant cardiopulmonary disease, prolonged duration of surgery and peri-operative hypotension are risk factors for post-operative respiratory dysfunction, and these patients may best be directed to a level 2 area.

Respiratory complications following bariatric surgery occur in 4–7% of patients. Post-operative atelectasis, abdominal splinting and OSA stress the limited respiratory reserve of morbidly obese patients and supplemental oxygen should be administered until baseline oxygen saturations can be achieved on room air alone. Patients with OSA are particularly sensitive to the depressant effects of opioids, sedatives and anaesthetic agents. Extubation followed by immediate CPAP therapy, has been shown to maintain spirometric lung function better than delayed application at 24 h following laparoscopic bariatric surgery. Additional requirements including treatment with CPAP or NIPPV pre-operatively should be re-established on the appropriate appliance during periods of sleep as soon as is practicable. Exacerbation of OSA and respiratory depression may occur on the third to fifth postoperative nights as “REM rebound” occurs and normal sleep architecture is restored. Intermittently applied bedside oximetry has not been shown to improve patient outcome. The ASA task force on peri-operative management of patients with OSA recommend that pulse oximetry should be continuously employed until room air oxygen saturations remain greater than 90% during periods of sleep and that significant airway obstruction or hypoxaemia necessitates escalation of ventilatory support, with either CPAP or NIPPV. Additional post-operative respiratory support tools include chest physical therapy and incentive spirometry.

The evolution of minimally invasive surgical techniques has improved pulmonary function and reduced post-operative analgesic requirements. Multimodal, opioid-sparing analgesic regimens including local anaesthetic infiltration of trocar sites, NSAIDS, paracetamol, TENS and other modalities help reduce the incidence of opioid-related adverse effects including respiratory complications, nausea and vomiting.

Neuraxial analgesic techniques can be technically challenging in obesity due to difficulty in identifying anatomical landmarks and positioning patients. Since the introduction of laparoscopic techniques in bariatric surgery, the use of epidural anaesthesia has declined. Neuraxial local anaesthetic in combination with opioids has been used in bariatric patients, but there are reports of delayed respiratory arrest in patients with OSA secondary to accumulation of neuraxial opioids. It may therefore be prudent to limit the duration of epidural infusions or use local anaesthetic alone in this group of patients. Morbidly obese patients with ongoing epidural infusions should be turned at regular intervals to circumvent the development of decubitus pressure sores.

Alternative local anaesthetic techniques that may also reduce opioid requirements, include rectus abdominis sheath blocks, which may be performed by the operating surgeons following open procedures. Although a fairly newly described technique and as of yet not trialled in bariatric surgery, a high or subcostal approach to the transversus abdominis plane (TAP) block using ultrasound guidance, may potentially prove a useful technique in providing supra-umbilical analgesia.

Patient controlled analgesia (PCA), with intravenous morphine, does not achieve ideal body weight, is safe and effective in morbidly obese patients and has been associated in one retrospective study, with a reduced incidence of post-operative wound infection when compared to patients receiving epidural analgesia.8,29 To date, there are no randomized controlled trials comparing post-operative morphine PCA to epidural analgesia in bariatric patients. Intravenous paracetamol in obesity is subject to increased clearance, and increased frequency of dosing has been suggested accordingly. NSAIDS can further reduce opioid requirements, but care should be taken in patients at risk of rhabdomyolysis or renal failure, and they should not be administered without concomitant gastrointestinal mucosal protection.

Deep venous thrombosis (DVT) and thromboembolism are amongst the most common complications of bariatric surgery. Enhanced venous stasis during laparoscopy contributes to the development of deep venous thrombosis and aggressive multimodal thromboprophylactic measures including treatment with low molecular weight heparin, pneumatic calf compression devices and graduated compression stockings is mandatory. Scholten et al. demonstrated that 40 mg enoxaparin twice daily was more effective than 30 mg twice daily, in the prevention of DVT, and importantly did not increase the rate of bleeding complications.40 Patients should be educated regarding the importance of early ambulation, and contribution from physiotherapists is essential to ensure continued patient motivation in this regard.

6. Conclusion

The number of patients resorting to bariatric surgery for sustained weight loss is increasing exponentially. These patients are at increased risk of peri-operative complications by the presence of obesity related co-morbidities, and not their BMI per se. Preoperative identification and optimization of associated disease in conjunction with perioperative management by a multidisciplinary team is essential to optimize patient outcome and reduce healthcare costs.

Conflict of interest

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