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Anesthetic Considerations in Patients Undergoing Bariatric Surgery: A Review Article

Hassan Soleimanpour,[1] Saeid Safari,[2,*] Sarvin Sanaie,[3] Mehdi Nazari,[4] and Seyed Moayed Alavian[5,6]

[1]Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Pain Research Center, Iran University of Medical Sciences, Tehran, Iran
[3]Tuberculosis and Lung Research Center, Tabriz University of Medical Sciences, Tabriz, Iran
[4]Anesthesiology Research Team, Tabriz University of Medical Sciences, Tabriz, Iran
[5]Baqiyatallah Research Center for Gastroenterology and Liver Diseases, Baqiyatallah University of Medical Sciences, Tehran, Iran
[6]Tehran Hepatitis Center, Tehran, Iran

[*]*Corresponding author*: Saeid Safari, Pain Research Center, Rasoul Akram Medical Center, Iran University of Medical Sciences, Tehran, IR Iran. Tel: +98-9392117300, E-mail: drsafari.s@gmail.com

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Abstract

Context: This article discusses the anesthetic considerations in patients undergoing bariatric surgery in the preoperative, intraoperative, and postoperative phases of surgery.

Evidence Acquisition: This review includes studies involving obese patients undergoing bariatric surgery. Searches have been conducted in PubMed, MEDLINE, EMBASE, Google Scholar, Scopus, and Cochrane Database of Systematic Review using the terms obese, obesity, bariatric, anesthesia, perioperative, preoperative, perioperative, postoperative, and their combinations.

Results: Obesity is a major worldwide health problem associated with many comorbidities. Bariatric surgery has been proposed as the best alternative treatment for extreme obese patients when all other therapeutic options have failed.

Conclusions: Anesthetists must completely assess the patients before the surgery to identify anesthesia- related potential risk factors and prepare for management during the surgery.

Keywords: Obesity: Definitions, Prevalence, Complications

1. Context

Obesity is a major health problem affecting every organ system and is associated with many health consequences including an increased risk for coronary artery disease, dyslipidemia, hypertension, diabetes mellitus, degenerative joint disease, gallbladder disease, obstructive sleep apnea, and socioeconomic and psychosocial impairment (1). Obese patients have more annual admissions to the hospital, more outpatient visits, and higher prescription drug costs than nonobese adults. Obesity is generally classified based on body mass index (BMI). BMI is calculated by dividing the weight in kilograms (kg) by the square of height in meters (m^2). A person with a BMI of 20 - 25 kg/m^2 has normal weight, whereas an individual with a BMI of 26 - 29.9 kg/m^2 is defined as overweight. A patient with a BMI of 30 - 39.9 kg/m^2 is called obese, and is called extreme/morbid obese with a BMI > 40 kg/m^2. A patient with a BMI > 50 kg/m^2 is superobese, and with a BMI > 60 kg/m^2 is supersuperobese (2). The risk of developing one or more of the obesity- related conditions is based on BMI, as being low risk for overweight patients and being very high risk for morbid or super obese patients (3). Obesity has become a global epidemic problem, with more than 1 billion adults being overweight and at least 300 million of them being obese (4). It is estimated that more than 40% of the adult population in the United States will be obese by the year 2025 (5).

2. Pharmacological Management of Obesity

BMI $\geq$ 30 kg/m^2 or $\geq$ 27 kg/m^2 in combination with obesity-related disease or risk factors is the indication for pharmacotherapy. These drugs decrease appetite, reduce fat absorption, or increase metabolic rate energy expenditure. Although the prescribed weight loss drugs will not do magic, they may be effective, especially when combined with proper diet programs and physical activity (6). The drugs used for obesity management are classified into 2 groups of CNS-acting and non-CNS-acting agents. CNS-acting drugs include catecholaminergics, serotninergics, and a combination of catecholaminergic and serotninergic agents. Catecholaminergic drugs exert their effect by increasing the availability of norepinephrine amphetamine, a catecholaminergic and anorexic agent, which has a high potential for abuse and is not recommended anymore for obesity treatment. Serotoninergic drugs act by increasing serotonin levels in the brain. Fenfluramine and dexfenfluramine are 2 of the serotoninergic drugs. Fenfluramine was commonly used in combination with phentermine (fen-phen) and used to be one of the most popular treatments for obesity. However, they were removed from the market and were no longer approved by the food and drug administration (FDA) in 1997 after observing their cardiopulmonary side effects. Sibutramine (Meridia) is a combination of catecholaminergic and serotoninergic drugs that was approved in 1997 for weight loss. It acts by inhibiting the reuptake of serotonin and norepinephrine in the brain, decreasing hunger and increasing satiety and metabolic rate. However, some clinical trials indicated an increased risk of cardiovascular adverse events including heart attack and stroke in patients using sibutramine. Thus, it was withdrawn from the market in 2010 by FDA (7). Orlistat is another weight loss drug with a unique and unusual mode of action. It prevents the absorption of one third of fat from the diet by inhibiting gastrointestinal lipase. This reduced fat absorption can represent 150 - 200 kcal/day, depending on the fat content of the diet (8). Side effects are gastrointestinal complaints induced by fat malabsorption. Absorption of fat-soluble vitamins (A, D, E, and K) decreases, which necessitates supplementation with these vitamins (9, 10). Since April, 2015, 5 weight loss drugs have been approved by the FDA for long-term use. They are Orlistat (Xenical), lorcaserin (Belviq), phentermine-topiramate (Qsymia), naltrexone-bupropion (Contrave), and liraglutide (Saxenda) (11).

3. Surgical Management of Obesity

The national institutes of health consensus development conference panel has recommended weight reduction surgery as the best alternative treatment for extreme obese patients who cannot lose weight by diet, exercise, and weight loss medications. Bariatric surgery is considered as the only effective long-term treatment for patients with BMI $\geq$ 40 or $\geq$ 35 with comorbidities (1). In addition to significant and consistent weight loss, bariatric surgery has additional advantages for the patients. Recent studies have shown that it can help improve cardiovascular disease, hypertension, glucose intolerance, and Type 2 diabetes, dyslipidemia, and mortality (12-15). Bariatric surgery rate is increasing day by day, especially because of failure of nonsurgical methods of weight loss (life style modification, diet, exercise, and drug therapy). Weight reduction surgery can be categorized as malabsorptive, restrictive, or a combination of both (16). Jejuno-ileal bypass and biliopancreatic bypass are malabsorptive methods and are rarely used now (17). Restrictive procedures include the vertical banded gastroplasty (VBG), adjustable gastric banding (AGB), and sleeve gastrectomy (GS) (18, 19). Roux-en-Y gastric bypass (RYGB) is a combination of gastric restriction and a small degree of malabsorption (20, 21). AGB and RYGB are currently the most common performed operations among bariatric surgeries. VBG, AGB, GS, and RYGB can be performed by laparoscopy. Laparoscopic procedures are now more preferred. They have more advantages compared with open bariatric operations including earlier recovery, lesser risk of postoperative pulmonary complications, and reduced postoperative pain. RYGB is one of the most common, most effective, and the gold standard of weight reduction surgeries. It is performed by anastomosingthe proximal gastric pouch to a segment of theproximal jejunum, bypassing most of the stomach, duodenum, and proximal jejunum (22). AGB is a restrictive procedure and usually performed by a minimally invasive laparoscopic method. It consists of an adjustable silicone elastomer band with an inflatable inner shell. The band is placed laparoscopically around the proximal stomach to limit oral intake (23). Each of these methods has its own advantages and disadvantages. Effort is made to minimize the side effects and achieve better results.

As the risk of anesthesia and surgery is higher in obese patients than the normal population, anesthesiologists should be familiar with the clinical management of obese patients for all types of surgery, especially for weight reduction procedures. They must completely assess the patients before the surgery to identify anesthesia- related potential risk factors and prepare for management during the surgery. Induction and maintenance of anesthesia and oxygenation, intubation, and pain management can be challenging in these patients. Moreover, obese patients are at a higher risk for postoperative complications.

4. Evidence Acquisition

This review includes studies involving obese patients undergoing bariatric surgery. Searches have been conducted in PubMed, MEDLINE, EMBASE, Google Scholar, Scopus, and Cochrane Database of Systematic Review using the terms obese, obesity, bariatric, anesthesia, perioperative, preoperative, perioperative, postoperative, and their combinations. Literature, in English language, published up to 2016 including randomized controlled trials, cohort studies, case-control studies, cross-sectional studies, case reports, meta-analyses, systematic reviews, and expert opinions have been assessed. We identified more than 70 papers; the 48 most relevant were reviewed in detail. This article discusses the anesthetic considerations in patients undergoing bariatric surgery in the preoperative, intraoperative, and postoperative phases of surgery.

5. Results

5.1. Preoperative Considerations

As obesity is associated with many chronic medical conditions, preoperative history and physical examination are very important. Comorbidities include disorders in respiratory, cardiovascular, endocrine, gastrointestinal, musculoskeletal systems and various types of malignancy as well as metabolic changes such as protein, vitamin, iron, and calcium deficiencies. Drug history including diet drugs and appetite suppressors should be assessed and be listed preoperatively because they may have important implications for anesthetic management such as cardiopulmonary and gastrointestinal problems. Other usual medications, except insulin and oral hypoglycemics, are better to be continued until the time of operation. As postoperative wound infection is high due to the longer incisions and operative times, inability of adipose tissue to resist infection and tissue trauma from excessive traction, antibiotic prophylaxis should be considered in such patients (24).

Although the incidence of wound infection is higher in open bariatric surgery than thelaparoscopic approach, antibiotic prophylaxis is recommended for both operation methods.

Special attention and care is needed in obese patients regarding airway and cardiorespiratory status. Patients should be evaluated for ischemic heart disease, systemic and pulmonary hypertension, right or left ventricular failure signs, and sleep-disordered breathing. Nitrous oxide and other drugs, which may worsen pulmonary vasoconstriction, should be avoided in patients with pulmonary hypertension. As inhaled anesthetics cause bronchodilation and decrease hypoxic pulmonary, vasoconstriction may be beneficial (25). Airway management in bariatric surgery is a challenge for anesthesiologists. Difficult or failed intubation is more common in obese patients than the nonobese (26). Obesity is associated with a 30% greater chance of difficult or failed intubation (27); however, it is not a risk factor for difficult laryngoscopy (28). Preoperative identification of patients at a high risk for airway management problems is highly important. Anesthesiologists should evaluate the risk for intubation to avoid life-threatening complications by preoperative assessment of some airway parameters. The Mallampati score and the neck circumference are some of the most important parameters of the preoperative assessment. The Mallamati score uses the visibility of the base of uvula, faucial pillars, and soft palate to assess how difficult an intubation will be. Based on Mallamati score, patients are classified into 4 classes. In class 1, these structures are best visible, and in class 4 the structures are least visible. Mallampati classes 1 and 2 are associated with relatively easy intubation, and classes 3 and 4 are associated with higher probability of a difficult intubation (29, 30). A neck circumference $\geq$ 43 cm and Mallampati class $\geq$ 3 are related to increased risk of difficult intubation in patients with morbid obesity (31-33).

The anesthesiologist must also assess the thyromental distance and the range of movements of the neck and larynx.

6. Intraoperative Considerations

6.1. Patient Positioning

Two conventional operating room tables placed together or specially designed tables may be required to accommodate a particularly large patient. Conventional operating room tables are capable of holding maximum 205 kg of weight, but there are specially designed tables with a little extra width and strong enough to support a patient weighing up to 455 kg.

Attention should be paid to protect pressure areas because pressure sores and neural injuries are common in these patients, especially in the super obese and patients with diabetes. It is essential to carefully pad all the pressure points to avoid pressure sores and neurologic injury. Brachial plexus and sciatic nerve palsies have also been reported in these patients, which can be due to the excessive stretch or prolonged ischemic pressure (34, 35). Proper patient positioning is crucial for a safe and efficient surgery. Respiration is difficult in the supine position; functional residual capacity (FRC) is markedly reduced causing further ventilation/perfusion mismatch. So, significant increases in O_2 consumption and cardiac output can occur in this position. Abdominal weight can compress the inferior vena cava and the aorta, impeding normal blood flow. The Trendelenburg position exacerbates this condition and decreases lung volume; thus, it may cause fatality due to the cardiorespiratory decompensation. Overweight patients do not tolerate the prone position well. The diaphragm is compressed and consequently the ventilation will be difficult and restricted. Moreover, compression on the abdomen constricts the inferior vena cava and the aorta (as in the supine and Trendelenburg position). The reverse Trendelenburg position is better tolerated and is a simple and safe intraoperative posture for obese patients. In this position, the diaphragm is unloaded and has some cardiorespiratory advantages including improved respiratory compliance, alveolar unit recruitment, and increasing FRC (36). The lateral decubitus position is usually well- tolerated if the panniculus is displaced off the abdomen. Proper size and placement of the axillary support is essential in this position (37, 38).

7. Monitoring

Standard monitors including blood pressure and temperature measurements pulse oximetry, ECG, and end-tidal capnography should be applied. Blood pressure measurements may be inaccurate if the used cuff has a wrong size. It can be falsely increased, if the cuff is too small for the arm. If there is difficulty with the upper arm blood pressure cuff, blood pressure can be obtained from the wrist or ankle with cuffs having an appropriate size (39, 40). For more accurate pressure monitoring, a radial artery is often cannulated. Central venous catheters can be used for major abdominal and thoracic procedures when peripheral IV access cannot be obtained. A central line can also be helpful for postoperative needs because postoperative IV access can be problematic in obese patients and is more easily performed in anesthetized patients (38).

8. Pharmacologic Considerations

Distribution, binding, and elimination of the anesthetic drugs are affected by the physiological changes of obesity. Anesthetic drugs are administered based on the body weight in routine surgeries, but this may not be valid in the bariatric surgery of obese patients.

Most of the anesthetic medications are highly lipophilic. Volume of distribution (Vd) is significantly increased for highly lipophilic drugs such as barbiturates, benzodiazepines in obese patients compared to the nonobese. To achieve adequateserum concentrations, larger initial doses are needed and their doses are calculated based on total body weight (TBW). However, their maintenance dosing should be decreased and calculated based on the ideal body weight (IBW) because their elimination half-lives are longer (41, 42). Digoxin (43), procainamide (44), and remifentanil (45) are some exceptions to this rule, as they are highly lipophilic medications but there is no change in their Vd in obese patients. Therefore, their doses should be calculated based on IBW. Vd of non- or weakly- lipophilic medications does not change in obese patients. Their doses are calculated based on LBW. Because 20% to 40% of increase in TBW can be attributed to an increase in LBM in an obese patient, LBW is calculated by adding 20% to 40% to IBW (38). Proper doses of nondepolarizing musclerelaxants can be calculated this way. There is no evidence to show the preferably of any nondepolarizing muscle relaxants in bariatric surgery. Neuromuscular recovery time is not different between obese and nonobese patients with atracurium, rocuronium, or vecuronium (46). Succinylcholine dosages are increased and calculated based on TBW, because plasma cholinesterase levels and activity increases in obesity. Halogenated inhalational anesthetic agents are more metabolized in obese patients than the nonobese. Desflurane and sevoflurane have more rapid and consistent recovery, prompt regaining of psychological and physical functioning, infrequent incidence of nausea and vomiting, good hemodynamic control, and early discharge from hospital. So, inhaled anesthetic medications are preferred in bariatric surgery (47-49). As fat content, cardiac output, and blood volume increase in obese individuals, larger doses of induction agents such as propofol may be needed in these patients. On the other hand, obese patients are more sensitive to these medications. Consequently, induction agents should be given based on LBW. Opioids are highly lipophilic medications and their loading doses should be calculated based on TBW. However, using high doses of long-acting opioids such as morphine needs caution because it can lead to respiratory depression (38). Obesity does not significantly affect systemic absorption of oral medications.

9. General Anesthesia

9.1. Tracheal Intubation

Possibility of a difficult intubation and potential airway management problems must be considered and preparation should be made for it. Large neck circumference and high Mallampati score are some of the most important parameters of the preoperative assessment and reliable predictors of problematic intubation in morbidly obese patients (33).

The supine position is not well-tolerated by a morbidly obese patient. Posterior cervical fat can exaggerate the flexed position of the head and neck, and head elevation with a conventional 8-cm cushion is not sufficient to optimize conditions for direct laryngoscopy. Proper positioning can be obtained by the elevation of the head, neck, and shoulders with a towel or folded blankets under the shoulders and head. In this position, known as “stacked” or “ramped” position, the tip of the chin is placed at a higher level than the chest and the patient’s ear is placed at the same level with his sternum to facilitate laryngoscopy and intubation (50). It is necessary to preoxygenate the patients in the reverse Trendelenburg position until their SPO_2 reaches to100% and remains for several minutes (51). As FRC is reduced and O_2 reserves are limited in the obese patients with apnea, hemoglobin will quickly desaturate. A rapid IV induction with propofol and succinylcholine in addition to cricoid pressure is the best way to establish airway for most of the patients.

10. Ventilation

Several ventilatory strategies have been proposed to improve gas exchange patients with morbid obesity. Visick et al. suggested using large tidal volumes (Vt) to increase PaO_2 (52); however, other studiers did not confirm the efficacy of this strategy. It has been found that large Vt not only does not improve oxygenation in patients with morbid obesity, but also produces severe hypocapnia and increases the risk of lung injury (53, 54). Atelectasis is common after induction of anesthesia of morbidly obese patients and use of high positive end-expiratory pressure (PEEP) may theoretically be beneficial for its improvement. However, PEEP combined with a large Vt can decrease cardiac output and O_2 delivery to the tissues, and therefore worsen hypoxemia (55). Alveolar recruitment maneuver is a strategy to reopen atelectatic lung areas, which is present during anesthesia. It is performed by the use of high, sustained, positive airway pressure to increase end-expiratory lung volume and reexpand atelectatic lung areas (56). It is the most effective method to improve intraoperative PaO_2 in patients with obesity. Sustained inspiratory pressure of at least 40 cm H_2O is needed to open collapsed alveoli in nonobese patients (57-60). To maintain open alveoli, recruitment needs to be followed by adequate levels of PEEP (61, 62). Whalen et al. assessed the effect of recruitment maneuver on arterial oxygenation in patients undergoing laparoscopic bariatric surgery. They demonstrated that this strategy may be effective in improving intraoperative PaO_2 in patients with morbid obesity (63).

11. Postoperative Considerations

Patients can be safely managed after the surgery in general surgical wards, the postanaesthetic care unit (PACU)/recovery, or high dependency unit (HDU)/ITU. It should be noted that as experience with anesthesia and surgical techniques increases in specialist centers performing these procedures, the number of patients requiring HDU/ITU reduces over time (64). The most important anesthetic considerations during this phase are as follow: pain control, wound care, deep vein thrombosis prophylaxis, and fluid management. The reverse Trendelenburg or semirecumbent position maximizes oxygenation because it increases FRC. When the patients are hemodynamically stable, their airway can be extubated with an elevation of 30° to 45° in the upper body. They can be then transferred in the same position from the operating room. Thereafter, all patients should be placed in that semirecumbent position with continuous pulse oximetry and should receive supplemental oxygen therapy (38). Supplemental humidified oxygen should be administered at an appropriate fraction of inspired oxygen (FIO_2). There are some evidences that postoperative incentive spirometry or continuous positive airway pressure (CPAP) started in early postoperative phase may accelerate the return to preoperative pulmonary function, especially in patients with obstructive sleep apnea (65). Concerns that CPAP may cause gastric insufflations and distention resulting in anastomotic failure have largely been discredited (66). Optimal analgesia ensures adequate ventilation and pulmonary mechanics and reduces the risk of postoperative chest infections. Pain severity during laparoscopic procedures is less than open surgeries, so pain control is much easier if the patient undergoes laparascopic bariatric surgery (67). As pain severity is less and toleration is easy, the patients don't usually need epidural analgesia. Pain control is better with patient-controlled analgesia (PCA) technique. Intravenous opioids may induce respiratory depression, especially with continous infusion method, but the risk is decreased if opioids are used judiciously with PCA (68-70). Thromboembolism is an important cause of postoperative mortality in these patients. Phlebothrombosis can develop as a result of prolonged immobilization. Other risk factors of thrombosis include diabetes, hypercholesterolemia, greater blood volume and polycythemia, and accelerated fibrin formation of obese patients. One of the most important interventions for deep vein thrombosis prevention is early postoperation ambulation. Other interventions such as anticoagulant therapy or inferior vena cava filter should also be considered (71, 72). Multimodal pain control regimen could be ideal for pain control and may include acetaminophen, NSAIDs, intravenous opioids, local anesthetics injected to wound or port site, and tramadol. There are some studies with good results with dexmedetomidine use for decreasing opioid requirements (73-75). Fluid management should be considered according to personalized requirements and careful recording of fluid input and output. To ensure reduction in complications, all these factors should be considered in addition to high quality nursing care.

12. Conclusions

As the risk of anesthesia and surgery is higher in obese patients than the normal population, anesthesiologists should be familiar with the clinical management of obese patients for all types of surgeries, especially for weight reduction procedures. In this field, there is variety of recommendations, but there is a lack of a general consensus about the perioperative care of these patients. Induction and maintenance of anesthesia and oxygenation, intubation, and pain management can be challenging in these patients. Moreover, obese patients are at higher risk for postoperative complications.

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Footnotes

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