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Day-surgery adult patients with obesity and obstructive sleep apnea: Current controversies and concerns

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Obesity and obstructive sleep apnea are considered independent risk factors that can adversely affect perioperative outcomes. A combination of these two conditions in the ambulatory surgery patient can pose significant challenges for the anesthesiologist. Nevertheless, these patients should not routinely be denied access to ambulatory surgery. Instead, patients should be appropriately optimized. Anesthesiologists and surgeons must work together to implement fast-track anesthetic and surgical techniques that will ensure successful ambulatory outcomes.

Introduction

Advances in anesthetic and surgical techniques as well as broad implementation of enhanced recovery after surgery (ERAS) pathways have increased the number of surgical procedures performed in the ambulatory setting [1,2]. This, combined with economic benefits for the patient, surgical center, and the payor, has changed the landscape of outpatient surgery over the past decade [3]. Patients with comorbidities such as obesity and obstructive sleep apnea (OSA) are increasingly being scheduled for invasive surgical procedures in free-standing ambulatory surgery centers (ASCs) [4]. Several studies demonstrate that obese patients are at greater risk for poor postsurgical outcomes than nonobese patients because of the postoperative cardiopulmonary complications, wound infection, presence of

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thrombosis, and requirement for repeat surgery [5–7]. While common in the obese population, OSA is considered an independent risk factor for postoperative complications secondary to airway compromise, respiratory complications, and cardiovascular instability [5,8–10]. This review discusses the combined risk of obesity and OSA on patient outcomes after ambulatory surgery and proposes optimal anesthetic management to improve safety and postoperative outcomes.

Obesity

Obesity is a global epidemiological concern in which body fat distribution is associated with an inflammatory state, resulting in metabolic changes affecting all organ systems [11]. According to the World Health Organization (WHO), more than 1.9 billion adults aged >18 years are overweight with >650 million being obese [12]. In clinical practice, the body mass index (BMI), which is body mass divided by the square of the body height, is used to define the severity of obesity. A BMI of 25.0–29.9 kg/m^2 is defined as overweight, a BMI >40 kg/m^2 is morbid obesity, and a BMI >50 kg/m^2 is considered super morbid obesity. Although widely adopted in clinical practice, BMI does not distinguish between lean muscle mass and body fat, and thus may not reflect body composition and fat distribution [13,14]. Therefore, waist circumference and waist-hip ratio or the combination of BMI and waist circumference may be a superior indicator of obesity-related comorbidities [15,16].

Perioperative care for an obese patient can be challenging for an anesthesiologist because of numerous associated comorbidities (Fig. 1). Hypertension is commonly seen in this population because of sodium retention, activation of the sympathetic nervous system, as well as the renin–angiotensin–aldosterone axis. These individuals have an increased intravascular blood and stroke volume, causing an increase in cardiac output. This, in turn, leads to left ventricular hypertrophy (LVH). These patients also have a higher risk of coronary artery disease because of dyslipidemia, hypertension, LVH, presence of type 2 diabetes mellitus, and a prothrombotic state [17]. Long-standing obesity can cause structural and functional changes that lead to obesity cardiomyopathy.

Obesity is responsible for several respiratory complications that can challenge anesthetic care. Increased visceral fat, as well as fat deposits on the chest wall, leads to a decrease in airway compliance, reduction in the functional residual capacity, and expiratory reserve volume. This, combined with the presence of a ventilation-perfusion mismatch brought about by increased atelectasis, predisposes obese patients to rapid oxygen desaturation with brief apneic episodes. These changes are amplified when a patient moves from the upright to supine position [11].

A pro-inflammatory state associated with obesity predisposes individuals to insulin resistance, type 2 diabetes mellitus, nonalcoholic fatty liver disease, or nonalcoholic steatohepatitis, venous thromboembolism, and gastroesophageal reflux disease [11].

There is a high prevalence of sleep-disordered breathing (OSA and/or obesity hypoventilation syndrome [OHS]) in the obese people. The resulting hypoxia and hypercarbia lead to pulmonary hypertension, right ventricular dysfunction, or failure [5]. OHS can be diagnosed in individuals with a BMI >30 kg/m^2, daytime hypercapnia (awake resting arterial partial pressure of carbon dioxide [$PaCO_2$] of >45 mmHg), and after other causes of chronic alveolar hypoventilation have been excluded. These

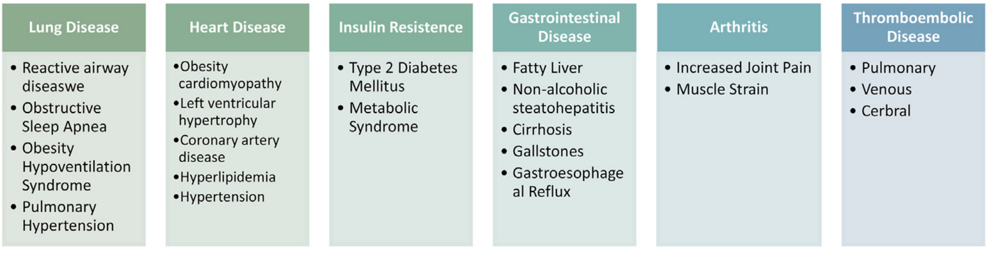

Fig. 1. Comorbidities associated with obesity.

patients are at an increased risk of adverse postoperative events, including respiratory or heart failure, prolonged intubation, intensive care unit admission, and a longer hospital stay [18].

Obstructive sleep apnea

OSA is characterized by cyclic, partial, or complete collapse of the upper airway, leading to apnea and hypopnea, intermittent hypoxia, and hypercapnia. This often results from unfavorable changes in upper airway anatomy, the ventilatory control center, and arousal thresholds [19]. OSA causes sleep fragmentation and activation of the sympathetic nervous system, leading to a systemic inflammatory response. While OSA and obesity have similar physiological changes, OSA is considered to be an independent risk factor for multiple medical comorbidities [20]. OSA has a higher prevalence in the older obese male population and is associated with multiple symptoms and physical findings (Fig. 2) [21].

Identifying the presence of OSA in the preoperative period is imperative for reducing perioperative morbidity and mortality [10,22]. The gold standard for identifying OSA is polysomnography [19]. This requires an overnight stay at a sleep laboratory in a room that is equipped with numerous monitors measuring airflow, body positioning, end-tidal carbon dioxide (CO_2), and sleep quality and duration. The resulting studies yield the apnea index, the apnea–hypopnea index (AHI), and the respiratory disturbance index [5,22]. A diagnosis of OSA is made with an AHI of 5 with symptoms. The severity of OSA is determined by the AHI. An AHI of 5–15 is mild OSA, a score of >15 but <30 is moderate OSA, and a score of >30 is severe OSA [21].

While polysomnography is the gold standard, it is cumbersome, costly, time-consuming, and since the onset of the COVID-19 pandemic, sleep services have been significantly disturbed [23]. Therefore, home sleep apnea testing has become a popular option for detecting OSA because of the added convenience for the patient, its cost-effectiveness, as well as collecting data over several nights. This form of testing calculates the respiratory event index, a measure of respiratory events over the total number of hours getting monitored. An index between 5 and 14.9 with the presence of OSA symptoms or a score of >15 events per hour is indicative of OSA [5]. Overnight oximetry is the least invasive way to predict sleep apnea in the surgical population. This provides continuous heart rate and oxygen saturation and calculates the severity and frequency of hypoxic events [5,24].

Several clinical tools have been developed and validated for preoperative diagnosis of OSA, the most frequently used of which is the snoring, tiredness, observed apnea, high blood pressure, body mass index, age, neck circumference, and male sex (STOP-Bang) questionnaire [22]. This questionnaire has a series of 8 yes or no questions, and one point is assigned to each positive answer. Individuals with a score of 0–2 have a low risk of having moderate-to-severe OSA, a score of 5–8 implies a high risk of moderate-to-severe OSA, and a score of 3–4 requires further investigation. Patients who fall into this

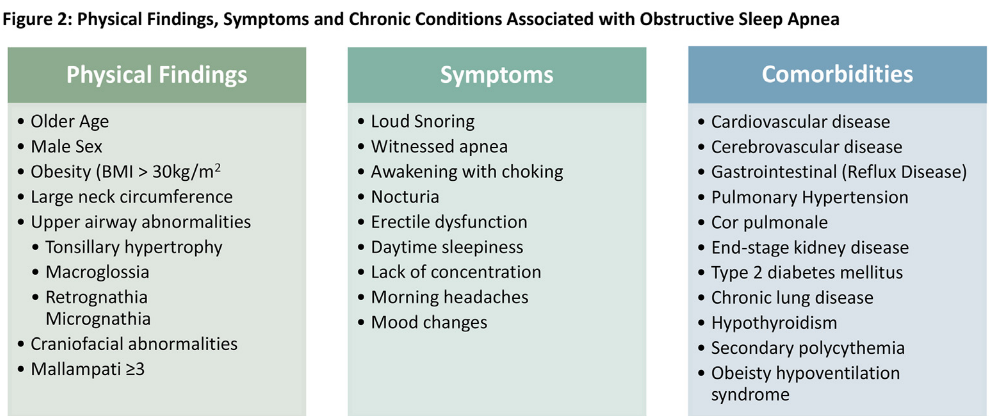

Fig. 2. Physical findings, symptoms, and chronic conditions associated with obstructive sleep apnea.

intermediate category should be considered as having a high risk of OSA if they have any points for the "bang" questions [22]. Note that the Society for Ambulatory Anesthesia guidelines recommend that a preoperative STOP-Bang score of ≥5 or be used for presumptive diagnosis of OSA [10].

While obesity is a major factor in the development of OSA, four additional phenotypes for OSA have been identified, and understanding the differences between them allows for a personalized approach to treating patients in the perioperative period (Fig. 3) [8,25]. The phenotypes are further classified into anatomical and nonanatomic components. The anatomical component describes patients with a predisposition to having a collapsible airway. Large deposits of adipose tissue are found in the soft tissues of the neck and posterior portion of the tongue in the obese population, resulting in a decreased airway diameter. Additionally, patients with a smaller mandible (length and depth), smaller bony dimensions and increased upper airway length, and a more inferior position of the hyoid bone are predisposed to pharyngeal collapse. The supine position also increases collapsibility of the airway. The two nonanatomic phenotypes include altered respiratory feedback pathways or "high-loop gain" caused by a discordance between $PaCO_2$ levels and upper airway muscle responsiveness, and a decreased respiratory arousal threshold [8,25].

Preoperative considerations

Selection for ambulatory surgery

It is well recognized that in the ambulatory setting patient selection is crucial for patient safety. Given that obesity and OSA are independent risk factors of adverse perioperative outcome, appropriate selection of these patients for ambulatory surgery is necessary. Suitability for ambulatory surgery should consider the invasiveness of the procedure, presence and severity of comorbidities, anesthetic technique, postoperative opioid requirements, and the surgical venue (e.g., free-standing ASC or hospital-based outpatient department) should the need for advanced treatment arise [4].

It is recommended that patients with optimized comorbid conditions and BMI <40 kg/m^2 could safely undergo surgery in an outpatient setting [4,7]. A study investigating the suitability of ambulatory surgery in obese patients undergoing hernia surgery concluded that there is no clear BMI cutoff for ambulatory surgery based on postoperative complication rates [26]. Gabriel et al. [27] suggest

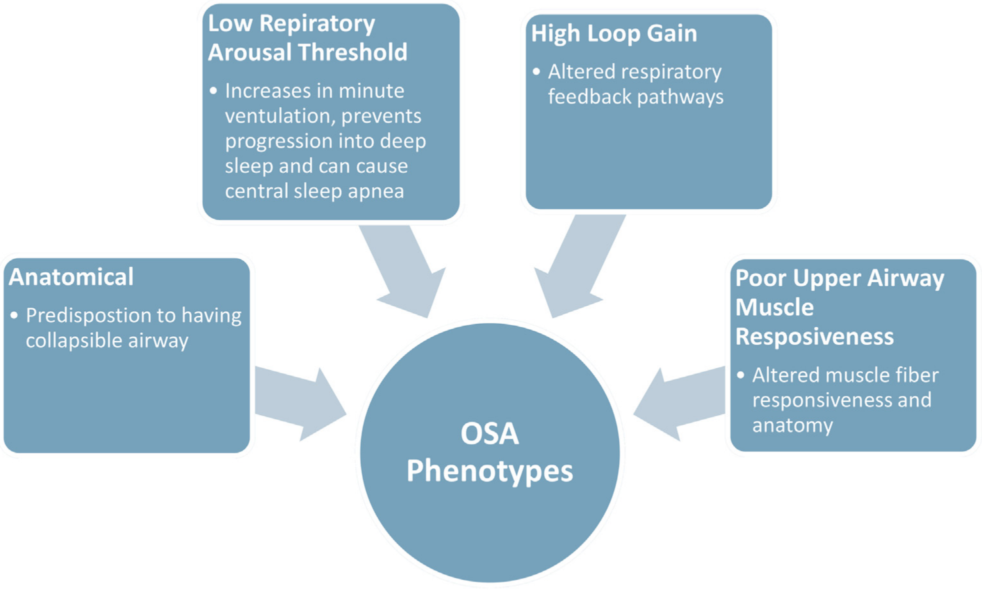

Fig. 3. Phenotypes for obstructive sleep apnea.

“surgery-specific” thresholds for assessing the appropriateness of ambulatory surgery. For example, patients undergoing tonsillectomy with a BMI of >40 kg/m^2 are at an increased risk of hospital readmission and thus should be avoided in an outpatient setting [27]. Patients with a BMI between

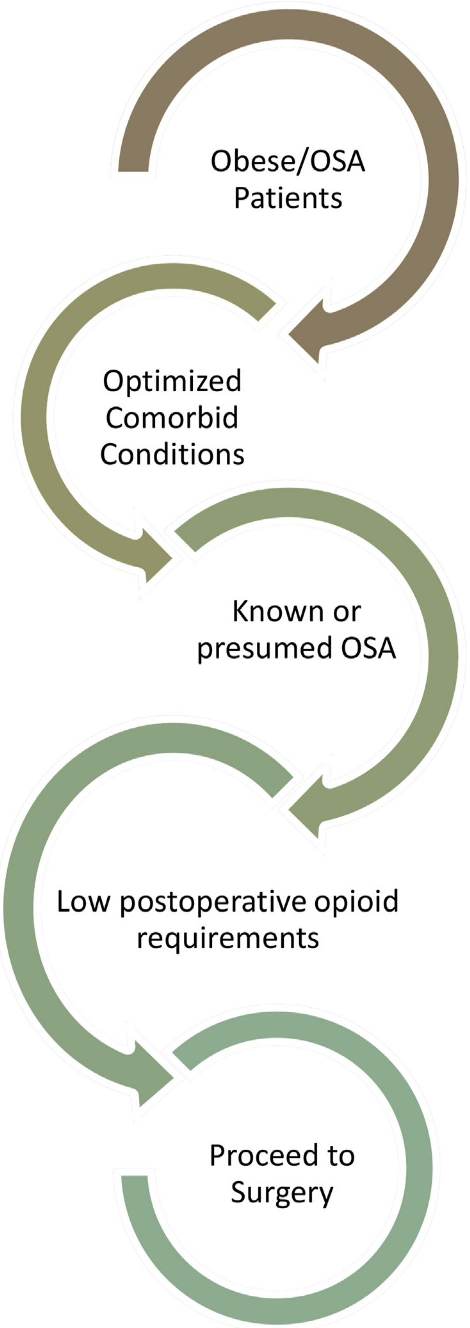

Fig. 4. Algorithm for successful ambulatory surgery in patients with obesity and obstructive sleep apnea.

40 kg/m^2 and 50 kg/m^2 should follow the approach for the selection of OSA patients, given its high prevalence in this population (Fig. 4) [4,7]. Patients with super morbid obesity (i.e., BMI >50 kg/m^2) can be challenging and may have a higher risk of postoperative complications because of longer operative times and increased incidence of cardiopulmonary complications [7]. However, Hajmohamed et al. [28] found that super morbid obesity was not associated with higher rates of early postoperative complications compared with morbidly obese patients regardless of surgical procedure. They concluded that BMI alone should not exclude a patient from outpatient procedures [28]. Tumminello et al. [29] reported that while super morbid obesity may cause an increase in surgical-site infections following inguinal hernia repair and laparoscopic cholecystectomy, severe complications resulting in hospital readmission were rare and these patients should be considered for routine ambulatory procedures.

Overall, BMI or weight should not be the sole determinant of suitability for ambulatory surgery. Nevertheless, patients with a BMI >50 kg/m^2 require greater attention with respect to preoperative evaluation and optimization, as well as a consensus between all-care team providers on postoperative care [30]. In addition, before scheduling these patients in an ambulatory setting, factors that might influence efficiency in the ASC should be considered. These include potential difficulty with venous access, patient positioning challenges, need for specialized equipment, and the possibility of prolonged postoperative monitoring [4].

Selection of OSA patients for ambulatory surgery is a complex process [4,9,10]. While concrete evidence is lacking, most experts believe that for patients with presumed OSA (based on preoperative screening), it is not recommended to delay surgery to confirm the diagnosis of OSA, but rather, if OSA is suspected, the anesthesia team should take the same precautions for those patients with diagnosed OSA.[9,10]If their comorbidities are also optimized, they may safely undergo ambulatory surgery, assuming that postoperative opioid requirements can be kept to a minimum (Fig. 4) [9,10]. In contrast, patients with a confirmed diagnosis of OSA on positive airway pressure (PAP) therapy may be suitable for ambulatory surgery if they are able to continue PAP therapy postoperatively. Those patients who are unable to continue PAP therapy may still undergo ambulatory procedures if postoperative opioid use is kept to a minimum [10].

There are conflicting views on whether or not patients with OSA should undergo airway surgery in the ambulatory setting because these procedures may result in upper airway swelling and bleeding that may exacerbate OSA complications [10]. Guidelines published by Ravsloot et al. [31] suggest that upper airway surgery in the ambulatory setting for OSA patients should be limited to nasal surgery or minimally invasive palate or base of tongue surgery. However, recent studies indicate that otolaryngology-head and neck surgery may be safely performed in patients with OSA in the ambulatory setting and that complications are due to a higher ASA score and older age *versus* the presence or absence of OSA [32–34]. This is an area requiring further research, and at this time, both the surgeon and the anesthesiologist must carefully determine the need for prolonged recovery and airway monitoring and ensure that an outpatient facility is capable of providing advanced treatment for airway complications.

Preoperative assessment and testing

Obesity and OSA are both associated with several comorbidities, and both can cause postoperative cardiorespiratory complications. OSA is also an independent risk factor for difficult intubation and/or mask ventilation [35]. A focused preoperative evaluation includes the assessment of the airway, cardiovascular, respiratory, and endocrine systems [9]. Patients' functional status should be evaluated, and they should be questioned regarding the symptoms of dyspnea, orthopnea, peripheral edema, chest pain, and arrhythmias (Fig. 1). Screening for OSA using the STOP-Bang questionnaire should be a routine part of all preoperative exams [9,10]. Physical examination findings predicting a difficult airway include increased fat deposit in the head, neck and pharynx, an enlarged tongue, enlarged tonsils, a smaller upper airway diameter, presence of a "buffalo hump," or increased adipose tissue in the upper back or chest area [11,35,36]. These findings can result in difficult mask ventilation and/or poor visualization of the vocal cords during direct or video laryngoscopy, predisposing patients to airway trauma and laryngeal injury.

Clinical practice guidelines discourage routine preoperative screening tests for low-risk patients undergoing low- and intermediate-risk surgical procedures [37]. Functional capacity, rather than BMI, should be used to determine the need for further testing. However, some obese patients may have difficulty achieving the standard 4 metabolic equivalents (METS) despite the absence of cardiopulmonary dysfunction. The American College of Cardiology and the American Heart Association recommend an electrocardiogram be obtained in patients with at least one risk factor for heart disease and/or poor exercise tolerance [38]. Signs of right ventricular hypertrophy, right axis deviation, and right bundle branch block suggest pulmonary hypertension, while a left bundle branch block may suggest occult heart disease. The presence of cardiac chamber enlargement or abnormal pulmonary vascularity on chest X-ray may suggest undiagnosed heart failure or pulmonary hypertension. Note that spirometry should not be routinely obtained for patients with obesity and/or OSA despite the documented changes in lung volumes in this population [5].

Preoperative medications

Patients with OSA and obesity should continue cardiovascular medications in the immediate preoperative period. Antidiabetic therapy should be tailored based on the patient's medication regimen and history of glucose control [39]. Patients with a diagnosis of gastroesophageal reflux disease should continue H_2 antagonists and proton pump inhibitors; however, the routine use of preoperative prophylaxis with these agents is not recommended. Because of the increased risk of thromboembolism, patients should have sequential compression or pneumatic compression devices placed and pharmacological prophylaxis should be given to those patients with additional risk factors. Premedication for anxiolysis, sedation, or amnesia with intravenous midazolam should be avoided in the immediate preoperative period [40,41]. Obesity and OSA can exacerbate the respiratory depressant and airway obstructive effects of even small doses of midazolam.

Intraoperative considerations

Vascular access, monitoring, and patient positioning

Venous access may be challenging in the obese people; however, ultrasound-guided vascular access should facilitate the placement of intravenous catheters [11]. The anesthesiologist should also ensure that the patient has an appropriately sized adult noninvasive blood pressure cuff. Because of the distribution of adipose tissue as well as positioning difficulties, unconventional sites such as the forearm might be beneficial [42]. Obese surgical patients carry an increased risk of nerve injury. Prone positioning, as well as steep Trendelenburg positions, is particularly challenging for patients with a larger BMI because of decreased lung volumes and potential for airway and face edema in the dependent areas. Adequate padding and frequently checking the eyes, ears, nose, and other pressure points minimize the risk of positioning related complications.

Local/regional anesthesia

Local/regional anesthesia techniques are preferred as they avoid the adverse cardiorespiratory effects of drugs used to provide general anesthesia such as sedative-hypnotics, neuromuscular blocking agents, and opioids [1,40]. Local/regional anesthesia also avoids the need for airway instrumentation and associated trauma. This is particularly important because obesity and OSA are independent risk factors for having a difficult airway. Regional anesthesia can decrease postoperative opioid requirements, nausea and vomiting, and can promote early ambulation. Note that in ambulatory setting, the benefits of spinal anesthesia over a “fast-track” general anesthetic technique remain controversial [43]. Importantly, intrathecal opioids should be avoided because of the concerns of adverse effects such as pruritus and nausea and vomiting, as well as delayed respiratory depression after discharge home. Sedative-hypnotic drugs should be used prudently when administering local/regional anesthesia so that deep sedation and the resulting respiratory effects are avoided.

General anesthesia

When general anesthesia is unavoidable, care must be taken to use short-acting drugs at the lowest possible doses [41]. Care should be taken not to overdose medications. It is appropriate to use lean body weight or ideal body weight for dosing sedative-hypnotics and neuromuscular blocking agents, although pharmacokinetics and pharmacodynamics of drugs used to provide general anesthesia are altered in the obese population because of altered distribution and elimination of drug volumes [11].

Residual neuromuscular blockade (train-of-4 ratio of <0.9) can increase postoperative airway obstruction and respiratory depression, which can cause hypoxia and hypercarbia, as well as negative pressure pulmonary edema [19,41]. In addition to limiting the use of neuromuscular blocking drugs, appropriate reversal of residual paralysis using sugammadex is beneficial.

Opioid use should be limited by using nonopioid multimodal analgesic techniques [44]. Patients with obesity and OSA will have an increased likelihood of opioid-induced respiratory complications because of opioid interference with the ventilatory control centers [25,45]. Opioids diminish the respiratory response to hypoxia and hypercarbia, which is more pronounced in patients with OSA and may cause airway obstruction and central apnea. Chronic hypoxia in OSA patients can also exacerbate opioid-related adverse events. Treating pain in this setting can be challenging, and it is best to use short-acting opioids such as fentanyl or remifentanil. Longer-acting opioids (hydromorphone or morphine) should be avoided, if possible [19,41]. However, the use of opioid-free anesthesia by using analgesic adjuncts such as ketamine, dexmedetomidine, lidocaine, and magnesium is not recommended because of the concerns that these drugs may have adverse effects with little clinical benefits [46].

Studies have not found any significant differences between total intravenous anesthesia (TIVA) and inhalational anesthetics. However, shorter-acting volatile anesthetics (i.e., sevoflurane and desflurane) allow earlier eye opening, response to verbal commands, and earlier tracheal extubation compared with TIVA with propofol. In contrast, Stewart et al. recently reported that using TIVA for upper airway surgery in patients with OSA in the ambulatory setting spent significantly less time in phase 1 and the recovery room overall; however, further studies regarding the obese and OSA population for airway surgery are required [47]. Importantly, nitrous oxide, the shortest-acting inhaled anesthetic, need not be avoided because of the perceived side effects (e.g., bowel distension, nausea, vomiting or cardiopulmonary complications) [48].

Airway management

Before the induction of general anesthesia, obese patients should be appropriately positioned such that the chin is higher than the chest ("stacking"). In addition, patients should be placed in head-up position, and if that is not possible, in reverse Trendelenburg position as this will decrease airway collapse and increase lung volume by decreasing pressure from the abdomen and upward shift of the diaphragm. This should increase safe apnea time by improving preoxygenation [35,49]. Because of the possibility of difficult mask ventilation and/or tracheal intubation, ambulatory centers must be equipped with difficult airway equipment and additional staff in the event airway emergencies arise. Supraglottic airway devices (SADs) are included in the American Society of Anesthesiology's difficult airway algorithm and should always be available in the ambulatory setting. However, there is controversy about using these devices instead of tracheal intubation because of the increased risk of aspiration as well as potential for high peak airway pressures, which may increase leaks. Nevertheless, newer-generation SADs are considered safer in this patient population when undergoing short peripheral procedures in a supine position [50,51]. The newer SADs also have a separate port for passing an orogastric tube, which may decrease the risk of aspiration.

Mechanical ventilation

Lung-protective ventilation using tidal volumes of 6–8 mL/kg ideal body weight with the addition of positive end-expiratory pressure of 5–10 cm H_2O has become standard of care. No specific mode of ventilation has been found to be superior in this patient population [5]. Hyperventilation and hypocapnia must be avoided because of the result of metabolic alkalosis and postoperative hypoventilation [5]. Recent studies suggest that maintaining end-tidal CO_2 levels around 40 mmHg reduces the minimum alveolar concentrations of volatile anesthetics as well as postoperative pulmonary complications [52, 53].

Hemodynamic management

Obese and OSA patients with cardiovascular comorbidities require prudent perioperative hemodynamic management, which includes maintaining an adequate intravascular volume and perfusion pressures (e.g., mean arterial pressures >65 mmHg). Perioperative fluid imbalance for ambulatory surgical procedures is low because patients are encouraged to hydrate well during the fasting period and will resume oral intake immediately after surgery, as well as the likelihood of significant blood loss and intraoperative fluid shifts is low. A baseline intraoperative crystalloid administration of 3–5 mL/kg/h is recommended. In healthy ambulatory patients, liberal intraoperative fluid administration (~20 mL/kg bolus) has been reported to reduce postoperative postural hypotension, dizziness, drowsiness, nausea, and fatigue [54]. However, for patients who have an anatomical predisposition to the development of OSA, one must be cognizant of rostral fluid shifts into the tissues surrounding the upper airway that can exacerbate OSA symptoms, as well as airway edema and postoperative respiratory complications [55]. Because of the increased incidence of cardiovascular disease in obese/OSA patients, it is imperative to avoid fluid overload, particularly in patients with preoperative heart failure. Acute hypervolemia can cause an exaggerated increase in left atrial pressures, leading to pulmonary edema and worsening cardiorespiratory function in an already at-risk group [56].

Pain management

Obese patients often suffer from chronic pain related to musculoskeletal/joint strain, and patients with OSA may have increased pain perception because of frequent arousal from sleep, which increase the risk of postoperative pain [57,58]. In addition, these patients are at high risk of postoperative opioid-related adverse events. Therefore, multimodal nonopioid analgesic techniques are recommended. All patients should receive a combination of acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), or cyclooxygenase (COX-2)-specific inhibitors, unless contraindicated [58]. These medications may be administered preoperatively or during the intraoperative period. Whenever possible, procedure-specific regional analgesia techniques should be administered, and surgeons should be encouraged to use surgical-site infiltration of local anesthetics [59,60]. Gabapentinoids should be avoided because of concerns regarding sedation, visual disturbance, and dizziness, as well as exacerbation of opioid-related adverse events [58,61]. Postoperatively, acetaminophen and NSAIDs or COX-2-specific inhibitors should be used on a scheduled basis and opioids only used as “rescue” analgesics [58].

Postoperative nausea and vomiting prophylaxis

Postoperative nausea and vomiting (PONV) can interfere with timely discharge. Postdischarge nausea and vomiting may also prevent adequate nutritional intake, interfere with sleep hygiene, and prevent ambulation, leading to an increased risk of venous thromboembolism, which is particularly harmful to the obese and OSA patients [58,62]. Therefore, aggressive PONV prophylaxis is imperative. All patients, irrespective of their PONV risk, should receive antiemetic prophylaxis with a combination of 2–3 antiemetics from different classes [62]. It is common practice to use a combination of dexamethasone (8–10 mg) given intravenously after induction of anesthesia and a 5-hydroxytryptamine [HT]-3 receptor antagonist such as ondansetron (4 mg, IV) at the end of the surgical procedure [62]. Dexamethasone is preferred because of its long duration of action, as well as analgesic efficacy. A single, low-dose dexamethasone does not increase adverse events such as wound infection and healing. For patients with a high risk of PONV (i.e., those with a history of motion sickness or previous PONV), additional antiemetic therapy through a transdermal scopolamine patch or low-dose promethazine (6.25 mg, IV) should be given. Patients experiencing PONV in the postoperative recovery unit should receive an antiemetic from a different class of drugs than those used in the intraoperative period. Postdischarge nausea and vomiting can be treated with oral ondansetron or other over-the-counter antiemetics [62].

Emergence from general anesthesia

Obesity and OSA predispose patients to airway obstruction and rapid oxygen desaturation after tracheal extubation [25,63]. Altered lung volumes secondary to obesity increase the likelihood of airway collapse. Use of pressure support ventilation during the emergence of anesthesia has been shown to avoid atelectasis and improve oxygenation [64]. Residual anesthetics may also decrease the response to apnea/hypopnea episodes exacerbating hypoxemia and hypercarbia. To avoid these complications, patients should be extubated only when they are fully awake. Early head-up positioning and application of PAP therapy can significantly reduce airway edema and be extremely beneficial for these patients [65]. Patients with a history of a difficult airway may benefit from the placement of a nasal airway prior to extubation to facilitate management in the event of an airway emergency, and difficult airway equipment should be readily available [5,8,66].

Postoperative considerations

The diversity of comorbid conditions present in patients with obesity and OSA can lead to numerous postoperative complications. Patients are at an increased risk of postoperative upper airway obstruction, cardiovascular instability, and poor glycemic control [8,11,67]. Furthermore, respiratory arousal resulting from hypoxemia may be abolished by residual effects of anesthetic drugs causing prolonged apnea. Patient monitoring is essential for early identification and mitigation of any of these adverse events. Patients undergoing upper airway procedures in the ambulatory setting must be monitored for respiratory distress, bleeding, or formation of head or neck hematomas [31]. Patients with respiratory difficulty should have continuous capnography in the immediate postoperative period.

Patients with OSA and obesity should be recovered in a head-up position when possible. These patients should receive supplemental oxygen during the recovery period from anesthesia. However, it is important to realize that while supplemental oxygen diminishes hypoxemia, it may result in CO_2 retention [19,68]. Use of high-flow nasal canula or noninvasive ventilation improves oxygenation while reducing adverse respiratory events because of improved airway patency that arises from positive pressure oxygen delivery [69]. A recent study found that the combination of head-up position and high-flow nasal oxygen improved postoperative oxygenation [70].

Continuation of PAP therapy in the postoperative period prevents airway collapse and is highly effective in reversing the anatomic component of OSA [25]. Use of CPAP improves oxygenation and reduces the need for reintubation and mechanical ventilation. One of the limiting factors of PAP use in the immediate postoperative period is the lack of compliance. PAP therapy should not be used if patients have undergone certain head or neck surgery (functional rhinoplasty, skull base surgery, or maxillofacial surgery) because of the risk of developing subcutaneous emphysema [31]. The use of incentive spirometry of chest physiotherapy postoperatively improves pulmonary function, particularly in obese patients [11].

Discharge after ambulatory surgery

For patients with OSA and obesity undergoing ambulatory surgery, in addition to routine discharge criteria, patients must demonstrate an ability to maintain their preoperative oxygen saturation on room air. Patients and their caregivers need clear instructions regarding the need for increased vigilance for episodes of airway obstruction at home. They should be advised about the potential for aggravation of OSA and the need to limit opioid use. Patients should be encouraged to maintain a semi-upright position and continue with incentive spirometry. Emphasizing compliance with PAP therapy after discharge home is essential in reducing perioperative respiratory complications. Strict adherence to antidiabetic treatment will help decrease the risk of wound dehiscence or surgical-site infection.

Continuation of VTE prophylaxis should be considered and discussed with surgeons because these patients are at an increased risk of postoperative adverse thromboembolic events. Patients who have the presumptive diagnosis of OSA based on preoperative screening should follow up with their primary physician.

Summary

There is a high prevalence of obese and OSA patients in the surgical population. Obesity and OSA are two independent risk factors for perioperative complications. The unique physiological and pharmacological changes that accompany these disease processes pose several challenges to the anesthesiologist. Implementation of ERAS pathways should facilitate meticulous planning between the surgical and anesthetic teams, which can increase successful patient outcomes. A focused history and physical and appropriate laboratory workup can help identify the patients at the highest risk of adverse perioperative outcomes. Preoperative screening for OSA provides an opportunity for heightened awareness and potential risk reduction by implementing perioperative precautions and interventions. The presence of comorbid conditions, particularly uncontrolled comorbidities, rather than BMI or OSA, appears to influence postoperative complications. Patients should not be denied access to ambulatory surgery by weight classification or the presence of obesity and/or OSA alone. Preoperative and postoperative education of the patients and their caregivers is crucial in improving postdischarge outcomes. Use of "fast-track" anesthesia techniques and using the shortest-acting drugs at the lowest possible doses is beneficial. The use of opioids should be minimized. Aggressive pain and PONV prophylaxis are necessary for improved outcomes. Postoperatively, patients with OSA should be maintained in the head-up position, when possible. In addition, there should be close vigilance and

Practice points:

- Although obesity and OSA are considered independent risk factors for perioperative complications, the presence of obesity-related and OSA-related comorbid conditions, particularly uncontrolled comorbidities, is associated with a higher risk of postoperative complications.
- BMI or weight should not be the sole determinant of suitability for ambulatory surgery. However, patients with a BMI >50 kg/m^2 require greater attention with respect to preoperative evaluation and optimization of comorbid conditions. All patients should be screened for OSA preoperatively.
- Patients with known OSA who are prescribed PAP therapy are suitable for ambulatory surgery if their comorbid conditions are optimized and they are able to use PAP therapy postoperatively. Patients with presumptive diagnosis of OSA through STOP-Bang questionnaire are suitable for ambulatory surgery if their comorbid conditions are optimized and postoperative opioid requirements are minimal.
- Optimal general anesthesia technique includes avoidance of routine use preoperative midazolam, avoidance of deep anesthesia, use of opioid-sparing analgesic approach, and minimization of neuromuscular blocking agents and appropriate reversal of residual paralysis.
- The use of opioid-free anesthesia remains controversial given the lack of good evidence and concerns about the potential adverse effects of analgesic adjuncts (ketamine, dexmedetomidine, lidocaine, and magnesium).
- Multimodal opioid-sparing pain management and nausea and vomiting prophylaxis are crucial in improving postoperative outcomes.
- Patient and their caregivers should receive clear instructions regarding the need for increased vigilance for episodes of airway obstruction. The need to limit opioid dose and compliance with PAP therapy if prescribed must also be emphasized.

Research agenda:

- Clinical research efforts should continue to assess the combined role of both obesity and OSA and whether or not the presence of both factors precludes surgery at an ambulatory center.
- Properly designed studies are necessary to determine the appropriate cutoffs for OSA patients undergoing otolaryngology, head, or neck surgeries at a freestanding ASC.
- Future studies should assess the association between combination of BMI and waist circumference and postoperative outcomes.
- The usefulness of quantitative neuromuscular monitoring and nociceptive monitors in reducing intraoperative neuromuscular blocking agents and opioid dosing, respectively, needs further study.
- There is an urgent need for properly designed studies with adequate sample size assessing the effects of perioperative interventions in influencing complications in the obese and OSA patients.
- Further studies are necessary to elucidate the optimal postdischarge opioid doses associated with increased postoperative complications.

appropriate monitoring (e.g., pulse oximetry and CO_2 monitoring) to capture and treat any apneic and/or hypoxic episodes. Furthermore, the threshold to use PAP should be low. Finally, there is an urgent need for properly designed studies with adequate sample size assessing the effects of perioperative interventions in influencing complications in OSA patients.

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None.

Declaration of competing interest

Girish Joshi has received honoraria from Baxter International Inc.
Omaira Azizad – None.

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