Review Article

Patients with sleep-disordered breathing for bariatric surgery

ABSTRACT

The prevalence of patients with obesity continues to rise worldwide and has reached epidemic proportions. There is a strong correlation between obesity and sleep-disordered breathing (SDB), and, in particular, obstructive sleep apnea (OSA). OSA is often undiagnosed in the surgical population. Bariatric surgery has been recognized as an effective treatment option for both obesity and OSA. Laparoscopic bariatric procedures, particularly laparoscopic sleeve gastrectomy (LSG), have become the most frequently performed procedures. OSA has been identified as an independent risk factor for perioperative complications and failure to recognize and prepare for patients with OSA is a major cause of postoperative adverse events, suggesting that all patients undergoing bariatric surgery should be screened preoperatively for OSA. These patients should be treated with an opioid-sparing analgesic plan and continuous positive airway pressure (CPAP) perioperatively to minimize respiratory complications. With the number of bariatric surgical patients with SDB likely to continue rising, it is critical to understand the best practices to manage this patient population.

Key words: Anesthesia, bariatric surgery, obesity, OSA, sleep-disordered breathing

Introduction

According to data from the American Society for Metabolic and Bariatric Surgery (ASMBS), the number of bariatric surgeries performed each year continues to increase.[1] Worldwide, the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) Worldwide Survey reported that almost 700,000 bariatric surgeries were performed in 2018.[2] With the worldwide prevalence of obesity reaching epidemic proportions and continuing to rise, the number of patients seeking bariatric procedures will likely continue to rise as well.

The prevalence of sleep-disordered breathing (SDB) has been estimated to be around 34% and 17% in 30–70-year-old men and women, respectively.[3] The prevalence of obstructive sleep apnea (OSA), the most common form of SDB, among patients with obesity ranges from 35–94%, with several studies reporting a prevalence greater than 60%.[4-8] Furthermore, the high prevalence of SDB may be underestimated when considering the number of undiagnosed patients.[9]

SDB is characterized by upper airway dysfunction during sleep and encompasses a wide spectrum of conditions including increased resistance to and reduction in airflow, snoring, and apnea. In the perioperative period, especially postoperatively, patients with SDB have been found to have a higher rate of pulmonary and cardiovascular complications compared to patients without SDB.[10-16] Given the likely increase of bariatric surgical patients in the future, there is special interest in understanding the best practices to

Access this article online	
	Quick Response Code
Website: www.saudija.org	
DOI: 10.4103/sja.sja_300_22	

How to cite this article: Oh MW, Chen JL, Moon TS. Patients with sleep-disordered breathing for bariatric surgery. Saudi J Anaesth 2022;16:299-305.

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Submitted: 09-Apr-2022, **Accepted:** 10-Apr-2022, **Published:** 20-Jun-2022

care for these patients including preoperative screening, intraoperative management, and postoperative monitoring.

Methods

A literature review was conducted using the PubMed search engine and the search terms "bariatric surgery," "obstructive sleep apnea," and "obesity." Publications were filtered by publication date within 10 years. Any articles that were not published in English were excluded. More articles were found beyond this initial search from key studies referenced within other articles. A total yield of 89 articles was included based on their relevancy to the subject matter and publication date.

Bariatric Surgery as a Treatment for Obesity and OSA

Bariatric surgery is indicated as an effective treatment option for both obesity and OSA.[4,17-20] The 1991 National Institutes of Health guidelines, which remain widely used to this day, recommend that patients with a body mass index (BMI) ≥40 kg/m^2 or with a BMI ≥35 kg/m^2 with serious obesity-related comorbidity be considered for bariatric surgery.[20] For patients with obesity, bariatric surgery has been found to be associated with long-term weight loss and improvements in obesity-related comorbidities, including type 2 diabetes mellitus, sleep apnea, and hypertension.[19,20] With regard to OSA specifically, bariatric surgery has been shown to be associated with favorable anatomic airway remodeling and reductions in the apnea–hypopnea index (AHI).[18,21] Further research with long-term follow-ups is necessary to determine if the improvements in OSA from bariatric surgery extend beyond the first one to two years postoperatively, as a systematic review found that there was a higher probability of OSA relapse beyond the short/medium-term time period.[22] The variability in the effectiveness of the different procedures for improving SDB can be attributed to differences in weight-dependent effects, weight-independent effects, anti-inflammatory effects, and central nervous system cytokine changes.

Bariatric Surgery Techniques

Since its introduction in 1993, laparoscopic bariatric procedures have rapidly surpassed open bariatric procedures in popularity due to the decreased risk of wound infection and incisional hernias, reduced healing time, and lower incidence of pneumonia, pulmonary complications, and mortality.[19,23,24] The ASMBS officially recommends laparoscopic sleeve gastrectomy (LSG) as an approved primary bariatric procedure due to the low rate of complications and mortality, improved quality of life, improvements in medical comorbidities, and significant and long-lasting weight loss.[2] Other benefits associated with LSG include the absence of foreign material, avoidance of gastrointestinal (GI) anastomosis and malabsorption, short operative time, simpler surgical technique, and high patient acceptance.[25] Thus, the LSG has become the most frequently performed bariatric procedure worldwide, making up 61.4% of all cases.[1] Following LSG, the next most commonly performed procedures worldwide are Roux-en-Y gastric bypass (RYGB) (17.0%), revision procedures (15.4%), balloon placement (2.0%), gastric band (GB) (1.1%), and biliopancreatic diversion-duodenal switch (BPD-DS) (0.8%).[1]

Preoperative Evaluation

OSA screening

OSA is undiagnosed in up to 80% of patients at the time of surgery. Failure to recognize OSA preoperatively can lead to perioperative complications including oxygen desaturation and adverse cardiac events. Thus, all bariatric surgical patients should be preoperatively screened for OSA.[16,26,27] Currently, the gold standard in the diagnosis of OSA is polysomnography (PSG), a resource-intensive sleep test that monitors the electroencephalogram (EEG), and electrooculogram (EOG), and submental electromyogram (EMG) during sleep. A study performed by Hallowell *et al*.[28] found a significant reduction in intensive care unit (ICU) admissions related to respiratory complications when mandatory PSG screening and preoperative treatment were implemented in patients undergoing gastric bypass procedures. Ideally, all bariatric patients would undergo PSG evaluation. However, routine use of preoperative PSG for every bariatric surgical patient may not be feasible or cost-effective and may delay the surgical treatment of obesity and SDB. If PSG is not feasible, it is still recommended that all patients be screened for OSA to risk-stratify patients and determine the need for and ideal level of continuous positive airway pressure (CPAP), as well as to plan for postoperative monitoring.[29-31] Patients at high risk for SDB may be identified by utilizing the classic triad of observed apnea or snoring with hypopnea during sleep, arousal from sleep, and daytime sleepiness or fatigue. The most widely used screening tool for detecting OSA is the STOP-Bang (snoring, tiredness, observed apnea, blood pressure, body mass index, age, neck size, gender) questionnaire, which provides an 8-point OSA prediction score and has been found to be both easy to use and a good predictor of severe OSA (AHI >30).[32] For a STOP-Bang score ≥3, this screening tool has a sensitivity of 93% and specificity of 43% at an AHI >15 and a sensitivity of 100% and specificity of 37% for an AHI >30.[33,34] Other OSA screening tools include the Berlin questionnaire, the American Society of Anesthesiologists (ASA) checklist, abbreviated versions of the STOP-Bang questionnaire, Epworth sleepiness scale, and type III portable sleep monitors.[35-37]

If patients are suspected of having OSA based on clinical criteria, a definitive diagnosis with PSG and preoperative CPAP should be considered.[27] Although further research needs to be performed regarding preoperative CPAP administration in the bariatric surgical population specifically, preoperative CPAP for patients with OSA undergoing a variety of other surgeries has shown to reduce the risk of postoperative adverse events and complications,[29,30] improve underlying conditions including hypertension,[38] and reduce ICU and hospital length of stay.[39]

Obesity hypoventilation syndrome (OHS) screening

OHS is another common SDB and is characterized by alveolar hypoventilation leading to oxygen desaturation and high arterial carbon dioxide levels.[4] It consists of a triad of components: BMI $\geq$30 kg/m^2, daytime hypoxemia, and hypercapnia. OHS has been found to coexist in up to 20% of patients with OSA, and it is an independent risk factor for severe desaturation.[40] The combination of both OHS and OSA is associated with higher morbidity and mortality in patients undergoing bariatric surgery.[30,41] Furthermore, patients with OSA undergoing elective, non-cardiac procedures who were hypercapnic experienced higher incidences of ICU admission, longer hospital and ICU lengths of stay, and acute heart failure and respiratory failure compared to patients with OSA who were not hypercapnic.[41] Therefore, all bariatric patients should be screened for both OSA and OHS to identify those at increased risk for perioperative complications.[40] To screen patients for the coexistence of OHS, it is recommended to perform venous bicarbonate measurements, with a bicarbonate value $>$27 mEq/L suggestive of OHS.[40]

Intraoperative Management

Airway management

Patients with OSA and obesity can have more collapsible upper airways and reduced functional residual capacity (FRC) that predispose them to rapid desaturation, even after short periods of apnea or hypoventilation.[42,43] OSA has been found to be a risk factor for difficult tracheal intubation (DI)[43] and difficult mask ventilation (DMV).[12,44-47] Furthermore, the Fourth National Audit Project (NAP4), found that patients with obesity (BMI 30–35 kg/m^2) and morbid obesity (BMI $>$35 kg/m^2) had twice and four times as many serious airway complications as patients without obesity, respectively.[48] Thus, it is imperative that special precautions be taken when securing the airway of this patient population. Patients with diagnosed or suspected OSA undergoing bariatric surgery should be positioned in the ramped or head-elevated laryngoscopy position (HELP), which improves the laryngoscopic view during intubation, increases FRC, and elevates arterial oxygen tension.[49,50] Patients with obesity have a much shorter safe apnea time, so it is imperative that these patients are maximally preoxygenated, and the use of apneic oxygenation should be considered.[42,44,49-52]

Perioperative opioid use

When managing patients with OSA and obesity, it is advantageous to utilize an opioid-sparing technique to reduce the risk of postoperative respiratory complications. Opioids impair the neural input to the upper airway dilator muscles and decrease the ventilatory response to hypoxemia and hypercarbia. Furthermore, patients with obesity may have increased sensitivity to both the central and peripheral effects of opioids. These suggest that patients with obesity and OSA may require reduced opioid dosing for comparable levels of analgesia compared to patients without these comorbidities.[53,54] Thus, it is recommended that anesthesiologists utilize a multimodal and opioid-sparing approach that includes the use of non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, N-methyl-D-aspartate (NMDA) antagonists, α-2 agonists, dexamethasone, lidocaine, and regional anesthesia whenever possible.

Opioid-sparing agents

The use of NSAIDs for patients undergoing bariatric surgery has been shown to provide analgesia without the risk of respiratory depression and decrease post-anesthesia care unit (PACU) length of stay.[55-57] Ketorolac has been found to significantly reduce hospital length of stay and decrease total in-hospital opioid consumption for bariatric surgical patients compared to patients receiving opioids alone.[58] Although many hospitals and institutions seek to limit the use of NSAIDs due to potential GI complications, a study analyzing 400 sleeve gastrectomy patients reported no GI complications attributed to postoperative NSAID use.[59] Acetaminophen is an alternative that can be considered as it does not increase the risk of GI ulcers and has been shown to have a more favorable side effect profile compared to NSAIDs while reducing opioid consumption and pain scores in patients undergoing bariatric surgery.[60-62]

NMDA antagonists, including ketamine and magnesium, have been shown to reduce morphine consumption without increasing pain scores in patients undergoing bariatric surgery.[63,64] However, further research is necessary to determine whether postoperative pulmonary complications can be reduced with their use. Intraoperative dexmedetomidine can also be considered for patients with OSA undergoing bariatric surgery as it provides analgesia through α-2 receptor agonism and has minimal respiratory depressant effects. Studies evaluating patients undergoing laparoscopic bariatric surgery have shown that dexmedetomidine infusions significantly reduced PACU length of stay, reduced opioid requirements, and were associated with a reduced time to meet discharge criteria.[65,66] Lidocaine infusions are controversial as studies have yielded conflicting results. Some studies have found decreased pain scores as well as decreased need for postoperative opioids with the use of lidocaine infusions. However, other studies have found no effect on postoperative pain, nausea and vomiting, and PACU and hospital lengths of stay.[13,67,68] If lidocaine infusions are utilized, providers should ensure there are adequate protocols and infrastructure in place for the identification and treatment of local anesthetic systemic toxicity.

Regional anesthetic techniques can be incorporated as a component of the anesthetic and analgesic regimen for bariatric surgical patients. Intraperitoneal administration of local anesthetics or transverse abdominis plane (TAP) blocks can be used. A study conducted by Safari *et al*.[69] found that the use of intraperitoneal lavage with 0.2% bupivacaine significantly decreased pain levels and reduced opioid consumption for up to 24 h postoperatively. However, a systematic review and meta-analysis of TAP blocks in laparoscopic bariatric surgery found that there was no association with decreased opioid consumption or pain scores.[70] Although further research must be conducted to determine the utility of regional anesthetics in laparoscopic bariatric procedures, regional anesthetic techniques should be considered when these patients are expected to have higher postoperative pain scores or increased opioid consumption. For minimally invasive procedures, local anesthetic infiltration has been shown to reduce pain scores, postoperative morphine consumption, and the need for rescue analgesia.[71] Local anesthetic infiltration is a simple and efficient method of reducing incisional pain and should be considered for all patients.

Postoperative Considerations

Enhanced recovery after bariatric surgery (ERABS)

The ERABS pathways integrate a multimodal approach designed to facilitate early return of bodily function, reduce physiological stress, and decrease hospital length of stay. These pathways have been implemented in many centers performing bariatric procedures and have been shown to reduce hospital length of stay, morbidity, 30-day readmission rates, and complications.[72-74] Although further research is needed to assess the efficacy of ERABS protocols in reducing healthcare resource utilization and improving outcomes in the bariatric surgical population with OSA specifically, it is recommended that these protocols are followed for most patients undergoing bariatric surgery.[4,75]

Postoperative complications in bariatric surgery patients with OSA

Although the incidence of serious complications following bariatric surgery is low (1–2.5%) and continues to decrease, special precautions must be taken when managing patients with OSA.[76] In the general surgical population, OSA significantly increases the risk of ICU admission, cardiac events, and postoperative respiratory complications.[14] In bariatric surgery, OSA is recognized as an independent risk factor for postoperative bleeding, hospital readmission, and emergency department visits,[77] but there is no clear association between OSA and mortality, ICU admission, hospital length of stay, and cardiorespiratory morbidity.[78] Serious complications in bariatric surgical patients with OSA are generally low because of an increasing trend toward minimally invasive procedures, improvements in the perioperative care of patients with OSA, and advancements in anesthetic and surgical techniques. Providers and healthcare entities need to balance the risk of complications with the optimization of healthcare resource utilization when creating care pathways for bariatric surgery patients with OSA.

Postoperative monitoring and disposition

Postoperative non-invasive positive-pressure ventilation (PPV) should be applied to patients with OSA after bariatric surgery to prevent airway collapse and improve lung function and gas exchange.[79,80] A retrospective study analyzing patients with OSA undergoing bariatric procedures found that patients with OSA who used CPAP preoperatively and postoperatively had a shorter length of stay compared to patients with OSA who did not use CPAP.[39] Furthermore, a study evaluating patients with mild to severe OSA undergoing bariatric surgery found that postoperative CPAP use in the PACU and up to 24 h after discharge from the PACU during sleep were associated with decreased postoperative complications.[81] As several studies have demonstrated the decrease in postoperative complications and adverse events when utilizing CPAP for patients with OSA, it is recommended that patients with OSA or presumptive OSA are treated with postoperative CPAP and pulse oximetry monitoring as soon as possible after surgery.[29,39,82-85]

Requirements for postoperative monitoring and disposition of patients undergoing bariatric procedures depend on patient-specific factors (e.g., associated comorbidities, severe OSA, high BMI), anesthetic technique, type and duration of the procedure, intraoperative course, and institutional and national practices and standards.[86] Patients with OSA undergoing bariatric procedures have been shown to have similar rates of respiratory complications, 30-day major complication rates, and lengths of PACU and hospital stay compared to patients without OSA when they are properly managed with continuous pulse oximetry monitoring, postoperative CPAP, and adequate nursing experience.[87,88] The majority of adverse events have been found to occur within the first 24 h after surgery and higher levels of postoperative monitoring are associated with better outcomes.[10,89] With adequate postoperative monitoring, patients with OSA can have similar dispositions to those without OSA. For patients with severe OSA undergoing extensive surgical procedures that require significant opioid analgesia, closer monitoring may be necessary. A study reviewing OSA patients with death or near-death complications found that 81% of adverse events occurred within the first 24 h and factors associated with these complications were related to suboptimal use of postoperative CPAP, morbid obesity, undiagnosed OSA, administration of opioids and sedatives, and lack of monitoring.[89] These studies suggest that patients with OSA undergoing bariatric surgery may have improved outcomes with preoperative OSA screening, an opioid-sparing pain regimen, and adequate monitoring in the postoperative period with continuous pulse oximetry and CPAP.

Conclusion

As the incidence of obesity and SDB continues to rise, more bariatric surgical procedures are being performed worldwide. Bariatric surgery is not only an obesity treatment, but it is also effective as a treatment for SDB and OSA. Anesthesiologists must be cognizant of the best practices to manage this patient population. For patients undergoing bariatric surgery, a thorough perioperative screening should be conducted to identify and risk-stratify patients with SDB. Even though preoperative PSG may not be feasible for all patients, all patients can be screened using tools such as the STOP-Bang questionnaire. Patients with moderate to severe OSA should be treated with CPAP preoperatively to minimize postoperative complications and optimize their preoperative pulmonary status. It is also necessary to develop and utilize a multimodal, opioid-sparing intraoperative and postoperative analgesic plan. In the postoperative period, patients with OSA are predisposed to airway obstruction and desaturation. Thus, adequate postoperative monitoring, use of CPAP, and continuous pulse oximetry monitoring are recommended.

Authors' contributions

Matthew W. Oh, B.S.: Drafting and revision of the manuscript; Joy. L Chen, M.D.: Drafting and revision of the manuscript; Tiffany S. Moon, M.D.: Drafting and revision of the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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