Review Article

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Preoperative risk evaluation and perioperative management of patients with obstructive sleep apnea: a narrative review

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Obstructive sleep apnea (OSA) is a common sleep-breathing disorder associated with significant comorbidities and perioperative complications. This narrative review is aimed at comprehensively overviewing preoperative risk evaluation and perioperative management strategies for patients with OSA. OSA is characterized by recurrent episodes of upper airway obstruction during sleep leading to hypoxemia and arousal. Anatomical features, such as upper airway narrowing and obesity, contribute to the development of OSA. OSA can be diagnosed based on polysomnography findings, and positive airway pressure therapy is the mainstay of treatment. However, alternative therapies, such as oral appliances or upper airway surgery, can be considered for patients with intolerance. Patients with OSA face perioperative challenges due to difficult airway management, comorbidities, and effects of sedatives and analgesics. Anatomical changes, reduced upper airway muscle tone, and obesity increase the risks of airway obstruction, and difficulties in intubation and mask ventilation. OSA-related comorbidities, such as cardiovascular and respiratory disorders, further increase perioperative risks. Sedatives and opioids can exacerbate respiratory depression and compromise airway patency. Therefore, careful consideration of alternative pain management options is necessary. Although the association between OSA and postoperative mortality remains controversial, concerns exist regarding adverse outcomes in patients with OSA. Understanding the pathophysiology of OSA, implementing appropriate preoperative evaluations, and tailoring perioperative management strategies are vital to ensure patient safety and optimize surgical outcomes.

Keywords: Obstructive Sleep Apnea; Preoperative Evaluation; Perioperative Management.

INTRODUCTION

Obstructive sleep apnea (OSA) is the most common sleep-breathing disorder, affecting 2%–4% of the general population [1,2]. It is prevalent in obese individuals, with over 40% of individuals diagnosed with OSA [3]. Men are more susceptible to developing OSA compared to women, and the risk increases with age [4,5]. The prevalence of OSA has increased, which might be related to the increasing rates of obesity, metabolic syndrome, and aging population [1,6-8].

OSA is not only a stand-alone condition but also associated with other comorbidities, such as hypertension, diabetes, arrhythmias, cognitive disorders, and all-cause mortality [9-12]. Furthermore, OSA is associated with an increased perioperative complications [13,14]. Therefore, evaluating and managing OSA are crucial, both

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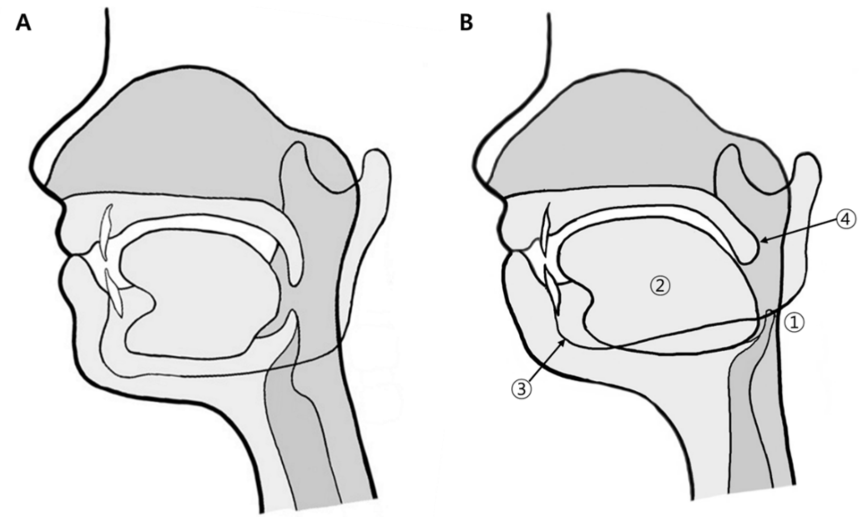

Fig. 1. Maxillofacial and soft tissue changes in OSA. A. normal anatomy, B. anatomical changes in OSA: ① tonsillar hypertrophy, ② enlarged tongue, ③ retro-position of the mandible, ④ enlarged uvula

preoperatively and perioperatively. However, a significant number of OSA patients are undiagnosed before elective surgery, and approximately 10%–20% of patients undergoing surgery are identified as having a high risk of OSA through preoperative screening [15,16]. Furthermore, 80% of patients with OSA remain undiagnosed and untreated [17]. Unrecognized OSA can increase postoperative complications [18]. Therefore, preoperative evaluation of the risk of OSA and implementation of appropriate perioperative management strategies are crucial.

Patients with OSA may present with many challenges, including hypoxemia, difficulties in maintaining airways, and complications associated with using sedatives and opioids during surgery [18,19]. OSA is associated with higher risks of cardiovascular events, atrial fibrillation, stroke, severe hypoxemia, and sudden death after general anesthesia [18,20,21]. Oral and maxillofacial surgeries are associated with comorbidities in the postoperative period. [22]. This narrative review is aimed at comprehensively overviewing the key aspects and considerations crucial in the perioperative management of patients with OSA.

1. Pathophysiology of OSA

OSA is a sleep-related breathing disorder characterized by intermittent episodes of complete upper airway obstruction (apneas) or partial upper airway obstruction (hypopneas) during sleep, resulting in desaturation and recurrent arousal. The complex pathophysiology of OSA involves several pathophysiological mechanisms. Alterations in the anatomical structure of the upper airway, neuromuscular function, and sleep-related changes play significant roles in OSA development.

Anatomical features, such as tonsillar hypertrophy, enlarged tongue or soft palate, enlarged uvula, or retro-positioning of the mandible can cause narrowing of the upper airway and promote obstructive apnea and hypopnea events during sleep (Fig. 1) [23-25]. Short and thick necks and obesity contribute to the development of OSA by causing anatomical narrowing of the airway [26].

In addition, when a patient falls asleep in the supine position, the muscle tone in the nasopharynx decreases, leading to airway narrowing. Muscle relaxation causes the base of the tongue to approach the posterior pharyngeal wall. Increase in the thickness of the lateral pharyngeal wall also predisposes the development of OSA [26,27].

These obstructive apnea and hypopnea events elevate carbon dioxide levels and reduce blood oxygen levels, respectively. Obstructive events cause partial arousal from sleep, resulting in sleep fragmentation, and are associated with increased sympathetic nerve activity, high blood pressure, and elevated heart rate. These effects

Table 1. Diagnostic criteria and classification of the OSA severity

The diagnostic criteria of OSA		
RDI* ≥ 5 AND either symptoms or medical disorders of followings; - Symptoms: daytime sleepiness, insomnia, fatigue, snoring, choking or gasping during sleep, observed apnea, or nocturnal respiratory disturbance - Medical disorders: atrial fibrillation, hypertension, coronary artery disease, congestive heart failure, stroke, type 2 diabetes mellitus, mood disorder, or cognitive dysfunction OR RDI ≥ 15 even in the absence of associated symptoms or disorders		
Classification of the severity of OSA		
Mild	Moderate	Severe
5≤ AHI†<15	15≤ AHI <30	AHI ≤ 30

*RDI = (number of Apneas + Hypopneas + Respiratory effort-related arousal)/total sleep time.
†AHI = (number of Apneas + Hypopneas)/total sleep time.
AHI, apnea-hypopnea index; OSA, obstructive sleep apnea; RDI, respiratory disturbance index.
Adapted from references [70,84,85].

negatively impact daytime quality of life and can lead to cognitive decline, cardiovascular complications, and metabolic disorders [24,26].

2. Diagnosis and treatment of OSA

Polysomnography (PSG) is the gold standard for OSA diagnosis. According to the International Classification of Sleep Disorders-3 guidelines, the diagnosis of OSA is confirmed if the respiratory disturbance index (RDI) of PSG is greater than 5 events/h with either typical symptoms or medical disorders. In addition, OSA is also defined if the RDI is 15 or more even if the patient does not have related symptoms (Table 1) [1,2]. The apnea–hypopnea index (AHI), defined as the average number of apnea and hypopnea events per hour of sleep, was used to assess OSA severity. The severity of OSA is classified as follows: mild (5≤ AHI <15), moderate (15≤ AHI <30), and severe (AHI ≤ 30; Table 1) [2-4].

Management of OSA varies with the patient's symptoms, comorbidities, and severity. Positive airway pressure (PAP) therapy is the treatment of choice in adults with OSA [28,29]. In addition, lifestyle modifications, such as weight loss, and postural modifications may help alleviate OSA [30,31].

However, not all patients tolerate PAP treatment because of mask discomfort, frequent awakening, mouth dryness, or nasal obstruction [32]. The American Academy of Sleep Medicine and American Academy of Dental Sleep Medicine recommend that oral appliances can be considered for the treatment of adult patients with OSA intolerant to continuous PAP (CPAP) therapy rather than no treatment [33]. Various oral appliances, such as mandibular advancement devices and tongue repositioning or retaining devices, can be used to treat OSA when appropriate [30,34].

In some patients, upper airway surgeries, such as maxillary–mandibular advancement (MMA), uvulopalatopharyngoplasty, or both can be considered [29]. Surgical treatment with MMA reduced the AHI from 49 to 10.9 events/h ($P < 0.0001$) in 79% of patients who had undergone surgery when observed over a long-term period [35]. Drug-induced sleep endoscopy can also assess the site and pattern of airway obstruction and be performed simultaneously with MMA [36].

In adults with OSA, surgical consultation can be considered in the following cases [37]:

(1) PAP intolerance
(2) Persistently inadequate PAP adherence owing to pressure-related side effects
(3) Obvious upper airway anatomical abnormalities potentially amenable to surgery

Considering the severity of OSA, associated comorbidities, and unique anatomical and physiological characteristics, a multidisciplinary team can formulate a customized approach to optimize treatment outcomes.

PERIOPERATIVE RISK FACTORS ASSOCIATED WITH OSA

1. Difficult airway

Surgery in patients with OSA presents with additional challenges in airway management owing to anatomical changes associated with OSA. Airway difficulty can occur in the form of difficult intubation or mask ventilation during surgery [38].

OSA is often characterized by anatomical abnormalities of the upper airway, including a narrowed or collapsible pharyngeal airway, enlarged tonsils, elongated uvula, or excessive soft tissue in the throat and neck region (Fig. 1) [23,26]. According to the Mallampati classification, as the level increases, the tongue position relative to the uvula rises [39]. Structural variations increase the risk of airway obstruction and can make it more challenging to insert and position airway devices, such as endotracheal tubes or laryngeal masks, during surgery or anesthesia. In addition, some patients with OSA may experience dental or jaw alignment problems. Patients with OSA may also develop mandibular retrognathia [40]. These structural issues can contribute to airway obstruction and make appropriate airway management challenging during surgery.

In addition, patients with OSA may have reduced muscle tone in the upper airway. During sleep or unconsciousness, the muscles that support the airway naturally relax; however, this relaxation is often exaggerated [41]. Decreased muscle tone can further contribute to airway collapse and obstruction, making it more difficult to maintain an open airway during procedures that require general anesthesia [42]. A prospective cohort study involving surgical patients aged 45 years or older confirmed that moderate (odds ratio [OR] = 3.26, 95% confidence interval [CI]: 1.37–8.38; adjusted P = 0.010) and severe (OR = 4.05, 95% CI: 1.51–11.36; adjusted P = 0.006) OSA was associated with difficult intubation [43]. According to the meta-analysis, difficult intubation was 3.46 times higher in patients with sleep apnea than in patients with non-sleep apnea (OR = 3.46, 95% CI: 2.32–5.16; P < 0.00001). Difficult mask ventilation was also 3.39-fold higher in patients with sleep apnea (OR = 3.39, 95% CI: 2.74–4.18; P < 0.00001) [38].

OSA is also commonly associated with obesity [3]. Several studies have examined the association between obesity and airway difficulty. Excessive weight and fat deposition around the neck and throat can compress the airway and limit its diameter, increasing the likelihood of airway blockage. A meta-analysis revealed a significant association between obesity and the risk of difficult intubation (pooled risk ratio [RR] = 2.04, 95% CI: 1.16–3.59; P = 0.01) [44]. Moreover, morbid obesity is associated with a higher risk of tracheal reintubation [45].

Therefore, anatomical features observed in patients with OSA pose significant challenges during surgery or anesthesia. Particularly in dental or orofacial surgery, airway maintenance may be difficult because of soft tissue swelling or bleeding. Therefore, when planning dental surgery for patients with OSA, recognizing these anatomical changes and associated problems is crucial for evaluating the patient's airway status and selecting appropriate airway management techniques to ensure safety and prevent complications.

2. Comorbidity-associated OSA

OSA-related comorbidities may also increase perioperative risks. Since OSA is closely linked to cardiovascular disorders, such as hypertension, coronary artery disease, and arrhythmia [18,46-48], these comorbidities increase the risk of perioperative cardiovascular complications. OSA-related intermittent hypoxemia, increased sympathetic activity, and systemic inflammation further contribute to the cardiovascular risk [49,50]. The incidence of adverse cardiac events is higher in patients with OSA undergoing surgery than in those without OSA. In a study involving 1,364 patients who had undergone major noncardiac surgery, unrecognized OSA was significantly associated with an increased risk of 30-day postoperative cardiovascular complications (adjusted hazard ratio [HR] = 2.23, 95% CI: 1.49–3.34;

P = 0.001) [18].

Respiratory diseases associated with OSA increase the perioperative risk in patients. Compared to patients with OSA alone, those with obesity hypoventilation syndrome (defined by the combination of sleep-disordered breathing, obesity, and daytime hypercapnia [$PaCO_2 \geq 45$] [51]) are more likely to experience postoperative complications, such as respiratory failure (OR = 10.9, 95% CI: 3.7–32.3; P < 0.0001), prolonged intubation (OR = 3.1, 95% CI: 0.6–15.3; P = 0.2), and heart failure (OR = 5.4, 95% CI: 1.9–15.7; P = 0.002) [52].

OSA is characterized by recurrent episodes of complete or partial upper airway obstruction leading to repetitive hypoxemia and hypercapnia. These respiratory disturbances can impair respiratory function and increase the risk of perioperative respiratory complications, such as postoperative hypoxemia, atelectasis, pneumonia, and respiratory failure.

3. Impacts of sedatives and analgesics

When performing surgery in patients with OSA, it is important to consider the effects of sedatives and analgesics on perioperative complications. Sedatives are commonly used during surgery and interventions, particularly dental procedures, to induce relaxation and alleviate anxiety. However, sedatives can cause respiratory depression and compromise the airways in patients with OSA. The upper airway collapses more frequently during anesthesia than during sleep [53]. Depressant effects of sedatives on the central nervous system can exacerbate airway obstruction and increase the risk of breathing difficulties during and after a procedure. Patients with OSA are susceptible to sedative-induced respiratory depression that can lead to oxygen desaturation [54]. Therefore, sedatives should be used carefully during procedural sedation in patients with OSA without airway protection. In particular, caution should be exercised when administering sedatives in situations, such as dental surgery, in which oral bleeding or soft tissue edema may occur.

Analgesics, such as opioids, are often administered for pain management during and after dental procedures or other surgeries. Respiratory depression is the main adverse effect of opioids, and comorbidities, such as OSA and obesity, increase the risk of opioid-induced respiratory depression (OIRD) [55,56]. A meta-analysis reported that OIRD occurs 1.4 times more frequently in patients with OSA undergoing surgery than in patients without OSA (OR = 1.4, 95% CI: 1.2–1.7; P = 0.0003) [57]. Opioids can suppress the respiratory drive, leading to apnea and hypopnea episodes in patients with OSA. Additionally, they can suppress ventilatory responses to hypercapnia/hypoxia and cause sedation and drowsiness, which may exacerbate the compromised respiratory function in patients with OSA [58,59]. Therefore, alternative pain management options, such as nonopioid analgesics or regional anesthesia techniques, should be considered to minimize the risk of postoperative complications and optimize postoperative pain control.

4. Perioperative morbidity in patients with OSA

However, the association between postoperative mortality and OSA in patients undergoing surgery remains controversial. OSA was associated with increased in-hospital mortality after joint arthroplasty (OR = 1.9; P = 0.002) after joint arthroplasty surgery [60]. Additionally, severe OSA was associated with cardiac death (adjusted HR = 13.66, 95% CI = 1.63–114.19) [18]. However, a large cohort study revealed that prior diagnosis of OSA or positive screening for the OSA risk was not associated with increased 30-day or 1-year postoperative mortality [61].

Despite these controversies, concerns remain about its association with postoperative mortality in patients with OSA. In 66 patients receiving general anesthesia alone or combined with local anesthesia, death and severe complications associated with the “OSA Death and Near Miss Registry” were analyzed [62]. Most patients were diagnosed with OSA before surgery (83%) or classified as high-risk based on screening tests. Of these patients, 65% died and 35% had brain damage, most of which occurred within 24 h after surgery. In addition, various

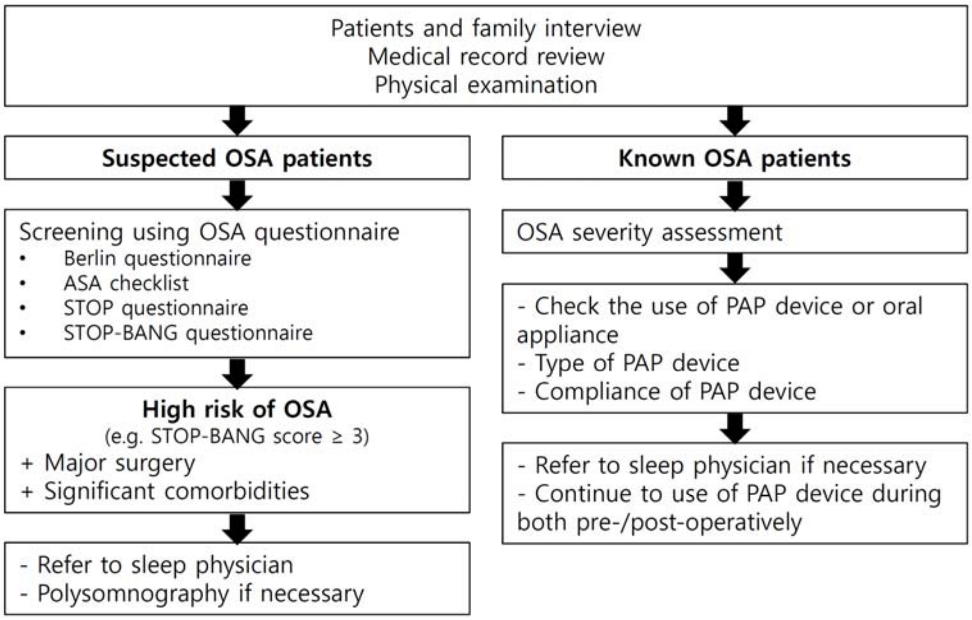

Fig. 2. Preoperative evaluation of patients with suspected and known obstructive sleep apnea. Adapted from references [63-65].

doses of opioids were prescribed within 24 h after surgery in 97% of the patients, often in combination with sedatives (62%). Unwitnessed events, coadministration of opioids and sedatives, lack of respiratory monitoring, and lack of supplemental oxygen were identified as significant risk factors associated with death and brain damage. However, age, sex, degree of OSA, or degree of obesity was not significantly associated with the number of accidents. Notably, 21% of patients experienced an event at home not monitored after discharge. Ambulatory surgery is often performed in cases involving multiple dental or uncomplicated procedures. In such cases, close monitoring or adequate oxygen supply may be difficult to provide, and it may be difficult to respond appropriately when postoperative complications occur. Therefore, monitoring patients with OSA who are undergoing surgery is important.

PREOPERATIVE EVALUATION FOR OSA

1. Methods of prescreening for OSA

The preoperative patient evaluation included a medical record review, patient and family interviews, prescreening protocols, and physical examination [63]. Preoperative evaluation is required to identify patients with known OSA or those at a high risk of OSA to implement preventive measures that can help reduce perioperative complications and allow perioperative interventions [63, 64]. Preoperative evaluation is required depending on whether the patient has already been diagnosed with or is suspected of having OSA [65]. Figure 2 shows the preoperative evaluation of patients with suspected and known OSA.

1-1. Preoperative evaluation of suspected OSA patients

Approximately 20% of patients are diagnosed with OSA preoperatively without OSA being diagnosed at the time of surgery [15]. It is not recommended to postpone surgery because various tests for OSA diagnosis, such as PSG, have not yet been performed. [63]. Instead, several questionnaires have been developed to screen for OSA, including the Berlin questionnaire, ASA checklist, STOP, and STOP-Bang questionnaire [63,66,67]. A previous study that validated four questionnaires in surgical patients before surgery revealed no significant differences in the predictive parameters for OSA among various screening

Table 2. STOP-Bang questionnaire

STOP		
Do you SNORE loudly (louder than talking or loud enough to be heard through closed doors)?	☐Yes	☐No
Do you often feel TIRED, fatigued, or sleepy during daytime?	☐Yes	☐No
Has anyone OBSERVED you stop breathing during your sleep?	☐Yes	☐No
Do you have or are you being treated for high blood PRESSURE?	☐Yes	☐No
BANG		
BMI more than 35 kg/m^2?	☐Yes	☐No
AGE over 50 years old?	☐Yes	☐No
NECK circumference > 16 inches (40 cm)?	☐Yes	☐No
GENDER: Male?	☐Yes	☐No
Score 1 point for each positive response. Scoring interpretation: 0 to 2 = low risk 3 or 4 = intermediate risk ≥ 5 = high risk		

The STOP Questionnaire: A tool for screening patients for obstructive sleep apnea [67]. BMI, body mass index.

tools [68]. A recent meta-analysis has shown that pooled sensitivities of the STOP-Bang questionnaire for all, moderate-to- severe, and severe OSA were 85%, 88%, and 90%, respectively. Furthermore, the negative predictive value was 93.2%, demonstrating high discriminative power to reasonably exclude severe OSA [69]. The patient was at a high risk of OSA if ≥ three items scored positively on the STOP-Bang questionnaire (Table 2). If a patient at high risk for OSA is about to undergo major surgery and has significant comorbidities, such as heart failure, uncontrolled hypertension, arrhythmias, or cerebrovascular disease, physicians should consider recommendations for preoperative sleep physician referral and PSG if resources permit. Early and timely consultation provides sufficient time for sleep physicians to prepare perioperative care plans, including those for PAP treatment.

However, a STOP-bang score ≥ 3 has a high sensitivity (83.6%) for OSA diagnosis but a low specificity (56.4%) [67]. In addition, a neck circumference of 40 cm and BMI of 35 kg/m^2, which are obesity standards for Caucasians, may not be appropriate for Asian populations. Therefore, the risk assessment of OSA and decisions regarding preoperative sleep studies should be considered holistically on an individual basis based on the physician's clinical judgment.

1-2. Preoperative evaluation of patients with known OSA

OSA severity assessment is required for patients with OSA. This can be accomplished by taking the patient's medical history and reviewing the PSG results. OSA severity is classified as follows: normal (AHI < 5), mild (5≤ AHI < 15), moderate (15≤ AHI < 30), and severe (AHI ≤ 30) [70]. Long-lasting OSA can result in systemic complications, including hypoxemia, hypercapnia, and polycythemia. Comorbidities, such as heart failure, uncontrolled hypertension, arrhythmias, cerebrovascular disease, and obesity, should also be evaluated.

Among patients with OSA using PAP devices, the type of device (CPAP, auto-titrated PAP, or bilevel PAP) and compliance with PAP should be evaluated. Furthermore, the use of PAP is strongly recommended during the entire pre- and post-operative hospital stay in previously compliant patients, unless specifically contraindicated [64].

OSA is diagnosed or suspected in preoperative evaluation, and the surgeon and anesthesia team are informed in advance regarding the potential for difficult airways in these patients. They should be made aware of the potential need for short-acting anesthetics, and minimize the use of opioids. Full reversal of neuromuscular blockade before extubation should be ensured, and extubation in a non-supine position should be considered.

2. Preoperative determination of ambulatory and inpatient surgery

Several dental surgeries are performed on an outpatient basis. However, the literature is insufficient for providing guidelines by which patients with OSA can be safely managed on an inpatient and outpatient basis. To evaluate whether patients should be treated on an ambulatory or inpatient basis, age, presence of sleep apnea, anatomical and physiological abnormalities, presence and severity of comorbidities, type of anesthesia, type of surgery, requirement of opioids postoperatively, adequacy of observation after discharge, and capacity of the outpatient facility should be considered together [63]. Even if a surgeon decides to perform ambulatory surgery, the same-day discharge plans for patients with OSA should be carefully evaluated based on their postoperative status. During recovery from anesthesia, patients with recurrent or severe respiratory disorder should be monitored.

Ambulatory surgery can be performed in patients with a diagnosis or suspicion of OSA who can use PAP after discharge, have well-controlled comorbidities, and undergo procedures not requiring opioid analgesics [16,71]. Patients with poorly controlled comorbidities, such as heart failure, uncontrolled hypertension, arrhythmias, cerebrovascular disease, and metabolic syndrome, may not be suitable candidates for ambulatory surgery.

No guidelines for patients with OSA to undergo upper airway or dental surgery exist because of limited evidence. Upper airway and dental surgeries can exacerbate OSA owing to upper airway edema or oral bleeding, and using a PAP device postoperatively may be challenging. Therefore, caution must be exercised when determining the suitability of postoperative discharge, considering the type of surgery and assessing the patient's condition.

PERIOPERATIVE MANAGEMENT

1. Preoperative management of OSA

OSA treatment should be optimized before surgery to improve the perioperative physical status. Preoperative preparation includes PAP therapy, using oral appliances, and weight loss, when feasible.

The Society of Anesthesia and Sleep Medicine guidelines recommend that patients with OSA on CPAP should continue with the treatment both preoperatively and postoperatively [63]. A recent meta-analysis has revealed that CPAP significantly reduces the postoperative AHI (preoperative vs. postoperative AHI: 37 ± 19 vs. 12 ± 16 events/h) and tends to reduce the length of hospital stay (CPAP vs. no CPAP: 4.0 ± 4 vs. 4.4 ± 8 days, P = 0.05) [72]. A large-scale retrospective study revealed that the risk for cardiovascular adverse events was lower in patients with OSA prescribed with CPAP therapy preoperatively than in those with undiagnosed OSA (OR = 0.34, 95% CI: 0.15–0.77; P = 0.009) [73]. In addition, untreated patients had significantly higher cardiopulmonary complication rates than those prescribed with PAP therapy (adjusted OR = 1.8, P = 0.001) [14].

The American Society of Anesthesiologists guidelines recommend that patients who have been using oral appliances continue to use them during the perioperative period, if feasible; however, their impact on reducing the risk of postoperative complications is not well established [63]. Patients undergoing surgery should be educated about weight loss, alcohol abstinence, and smoking cessation. Reducing the degree of obesity can directly contribute to reducing the degree of OSA [31]; however, evidence is insufficient to evaluate its efficacy in postoperative complications.

2. Intraoperative management

A final airway evaluation was performed, and the degree of preparation for a difficult airway was assessed. Even if OSA is not diagnosed or is not determined as a difficult airway in airway evaluation, obese patients with OSA are considered as having a difficult airway and should be prepared.

Patients with OSA whose airways are often blocked during sleep are sensitive to respiratory depression caused by anesthetics, sedatives, and opioids. Therefore, the postoperative effect on respiration should be considered when selecting an intraoperative anesthetic [63,74]. Sedatives and opioids should not be routinely administered as premedications for patients with OSA. For simple dental surgery or procedures, local or regional anesthesia is preferred over general anesthesia. Postoperative outcomes may improve when regional anesthesia is used instead of general anesthesia [74,75]. For procedures requiring moderate sedation, pulse oximetry and/or capnography should be monitored for the early detection of airway obstruction or respiratory depression. A nasopharyngeal airway device is used to maintain the airway during surgery if it cannot be maintained in the supine position or if the head cannot be turned lateral [76]. Since an airway may be difficult to secure when a procedure requiring deep sedation is performed, safe administration of general anesthesia is recommended to secure the airway. If there are no contraindications, it is safe to extubate after the patient regains consciousness and confirms the complete reversal of the muscle relaxant. Patients should be extubated in a head-up position, maintaining a sniffing position with the upper body is elevated, or in a lateral position, as these are more advantageous compared to the supine position in the early recovery period, if feasible [77,78].

3. Postoperative management

3-1. Supplemental oxygen

Among patients with OSA, postoperative supplemental oxygen is recommended to decrease the AHI and improve oxygenation [79]. The American Society of Anesthesiologists Task Force recommends that supplemental oxygen therapy be continued until preoperative oxygen saturation is achieved while breathing room air [63]. However, when supplemental oxygen is supplied, hypoventilation and apnea may be obscured, leading to hypercapnia [79]. This risk is particularly elevated in patients with OSA and obesity hypoventilation syndrome [51,80]. Therefore, hyperoxia should be avoided when supplemental oxygen is supplied, and supplementary oxygen should be discontinued when adequate SpO_2 is maintained under room air to prevent hypoventilation and hypercapnia from worsening [63].

3-2. PAP therapy and oral appliances

Continuous administration of PAP and oral appliances is recommended for patients with OSA who use these modalities before surgery [64]. However, clinical judgment should be exercised, as the application of PAP can be difficult owing to preoperative and postoperative changes, such as facial or oral edema, upper airway edema, and postoperative oral bleeding. Patients with OSA diagnosed preoperatively and receiving PAP can be managed similarly in the perioperative setting.

In patients suspected with previously untreated OSA, PAP treatment may be considered if severe airway obstruction or hypoxemia is observed during postoperative monitoring [63]. In patients with suspected OSA receiving PAP after surgery, empirical titration may be performed starting at a level of 6–8 cmH_2O in the CPAP mode until apnea, snoring, and hypoxemia improve. However, the effectiveness of postoperative PAP in patients with undiagnosed OSA who have not previously received PAP therapy remains uncertain. Bilevel PAP can be used in patients with obesity or in those combined with hypoventilation and hypercapnia [81,82].

Evidence is insufficient regarding the effects of using oral appliances in the postoperative period on postoperative complications. However, in patients with OSA who are intolerable to PAP or use oral appliances preoperatively, their use of oral appliances can be maintained after surgery [63].

3-3. Postoperative analgesia

Whenever feasible, opioid-sparing analgesic techniques should be considered to reduce the requirement of postoperative opioids in patients with OSA. When systemic opioids are used for pain control, continuous infusion should be avoided or used with caution while closely monitoring the patient's respiration and ventilation. To reduce opioid requirements, non-opioid analgesics, such as nonsteroidal anti-inflammatory drugs, acetaminophen, cyclooxygenase-2 inhibitors, or other modalities (e.g., ice and transcutaneous electrical nerve stimulation), should be considered, if appropriate. Compared to opioid analgesia alone, multimodal analgesia is associated with a decreased risk of critical care admission (OR = 0.60, 95% CI: 0.48–0.75) and mechanical ventilation (OR = 0.23, 95% CI: 0.16–0.32) [83].

CONCLUSIONS

The increasing prevalence of obesity, an aging population, and metabolic disorders contribute to a higher prevalence of OSA. Patients with OSA may have an increased risk of complications after surgery owing to the influence of a difficult airway, comorbidities associated with OSA, and analgesics or sedatives used in the perioperative period. Therefore, it is necessary to understand the pathophysiology, diagnosis, and treatment of OSA and to screen patients with OSA in advance through preoperative evaluation. In addition, perioperative management involving securing a safe airway and minimizing the use of opioids, oxygen treatment, and PAP treatment before and after surgery are necessary to ensure patient safety and optimize surgical outcomes.

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AUTHOR CONTRIBUTIONS

Eunhye Bae: Data curation, Visualization, Writing - original draft

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ABBREVIATIONS: OSA: obstructive sleep apnea
PSG: polysomnography
RDI: respiratory disturbance index
AHI: apnea–hypopnea index
PAP: positive airway pressure
CPAP: continuous positive airway pressure
MMA: maxillary–mandibular advancement
OR: odds ratio
CI: confidence interval
RR: risk ratio
HR: hazard ratio
OIRD: opioid-induced respiratory depression

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