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Obstructive Sleep Apnea: Respiratory Complications – A Review Article

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ABSTRACT

Background: It's not uncommon for people to suffer obstructive sleep apnea syndrome (OSAS); 2%-25% of the general population are affected. However, OSAS is common in those who have undergone elective surgery. Patients with collapsing upper airway have an increased risk of surgical complications when under sedation and/or anesthesia. To effectively treat individuals with OSAS, it's critical to rapidly identify them.

Objective: In this review, the epidemiology of OSAS in postoperative patients was examined. We emphasized the significance of anaesthesia, sedation, opioids, while describing why these patients have a higher postoperative complications' risk. Further, we addressed the preoperative identification and perioperative management of these individuals.

Methods: Research was carried out through PubMed, Google scholar and Science direct using the terms OSAS, Perioperative complications, Respiratory problems, and continuous positive airway pressure (CPAP). References from relevant literature, including all identified research and reviews, were evaluated (only studies published between July 2003 and January 2022 were included). There were no reliable sources of interpretation for documents written in any language other than English. All but the most important scientific papers had been omitted: not available as a complete written text such as a transcript of a conversation or a formal paper such as a conference abstract or thesis.

Conclusion: Opioids, sedation, and anesthesia have been proven to aggravate sleep apnea during the perioperative phase, which may raise the risk of perioperative problems. It is essential to identify these individuals before surgery in order to take the necessary precautions during their perioperative care.

Keywords: OSAS, Perioperative complications, Respiratory complications, CPAP.

INTRODUCTION

In obstructive sleep apnea (OSA), upper airway blockage occurs often and intermittently during sleep. Disruptions to the sleep cycle, such as these, lead to tiredness during the day. Obstructive sleep apnea syndrome (OSAS) has been linked to an increased risk of car accidents, diabetes, hypertension, heart disease, stroke, and overall mortality[(1)].

Perioperative complications such as pneumonia, hypoxia, myocardial infarction, as well as atelectasis and pulmonary emboli are all more likely to occur in surgical patients who have sleep apnea. These patients may also experience difficulty intubating, cardiac arrhythmias, and unexpected intensive care unit (ICU) hospitalization[(2)].

It's common for patients with OSA to be undiagnosed when they arrive, which increases the risk of complications throughout their stay in the hospital. As a result, it is critical to identify these individuals before to surgery in order to apply the appropriate postoperative procedures[(3,4)].

Epidemiology

Obesity and the ageing of the population have led to a rise in the incidence of OSAS[(5)]. According to various definitions, a staggering 2% to 25% of people suffer from sleep apnea, which is a serious sleep disorder. Apnea-hypopnea index (AHI) equals or more than 5/h was defined as a prevalence of 24% in males and 9% in women in an epidemiological examination of sleep apnea. OSAS was identified in 2% of women and 4% of men who met the AHI 5/h and daytime drowsiness criteria. Based on results from the Berlin Questionnaire, the National Sleep Foundation (NSF) projected in 2005 that one in four Americans is at risk of developing sleep apnea[(6)].

Patients who have undergone surgery are more likely to suffer from sleep apnea thereafter[(5)]. Patients who underwent bariatric surgery had a sleep apnea prevalence of more than 70%[(6,7)].

Before undergoing bariatric surgery, it is routine practise for these patients to have a thorough sleep evaluation. In a cross-sectional investigation, nocturnal polysomnography (NPSG) was performed on 39 epilepsy surgery patients. According to another study, a small group of patients who underwent brain tumour surgery had a 64% prevalence of sleep apnea[(8)].

Pathophysiology

During the perioperative phase, sedation, anaesthesia, and painkillers are administered to surgical patients. It has been demonstrated that these medications aggravate perioperative sleep apnea by increasing pharyngeal collapse, decreasing ventilatory responsiveness, and increasing alertness[(9)].

Impact of Sedation, Anesthesia, and Opioids

It has been demonstrated that general anaesthetics reduce, in a dose-dependent manner, the activity of the upper airway dilator muscles, hence

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enhancing the upper airway's collapsibility[10]. In a research of 12 healthy persons undergoing minor surgery, increased propofol anesthetic depth was found to increase critical airway pressure and lower the upper airway's ability to expand[11].

Over time, as the upper airway became more condensed, genioglossus muscle activity reduced significantly. Hypoxia, cardiac arrhythmias, and surgical consequences are all elevated in individuals with OSA when the upper airway becomes obstructed[11,12].

As a prophylactic therapy for OSA, anaesthetics suppress the arousal response, so preventing airway constriction. Benzodiazepines, opioids, and hypnotics, in addition to anaesthetics, may produce respiratory depression and reduce minute ventilation [13]. A new study shows that halothane reduces the human respiratory system's reaction to hypoxemia and hypercapnia. Due to halothane's effect on the peripheral chemoreflex loop, this depression is expected. Hypoxic ventilatory response can be reduced by administering a low dosage of isoflurane via peripheral chemoreceptors[14].

Opioids are commonly given to surgical patients in order to alleviate their pain. By altering both the peripheral and central carbon dioxide chemoreflex loops, opioids diminish respiratory performance [15]. Even in healthy individuals, epidurally administered micro-doses of opioids impair respiratory function. Respiratory depression produced by opiates appears to be influenced by both gender and race. It has been demonstrated that morphine attenuates the hypercapnic and hypoxic ventilatory response in females but not in males[16].

Alternately, morphine increases the apnea threshold in males, while having no impact on women. It has been demonstrated that the combination of opiates and benzodiazepines exacerbates the severity of hypoxemia and apnea. Probably because both opiates and benzodiazepines diminish the hypoxic ventilatory response considerably[4].

Evidence on Sleep Apnea as a Risk Factor for Perioperative Complications

Table (**1**) shows relevant studies on the association between OSA and perioperative outcomes.

Table (1): Studies reporting association between obstructive sleep apnea and perioperative complications

Author	Type of Study	Number of Patients	Diagnosis of OSAS	Type of Surgeries	Complications	Results
Vasu *et al.* [4]	Historical cohort study	135 patients with completed STOP BANG Questionnaire	STOP BANG Questionnaire	Orthopedic, Head and Neck, Abdominal, ENT, Vascular, Gyn, Cardiothoracic	Pneumonia, hypoxemia, pulmonary embolism, hypotension, atelectasis, atrial fibrillation	Patients with a high risk of sleep apnea, as measured by the STOP BANG Questionnaire, were more likely to have postoperative complications.
Auckley *et al.* [17]	Historical cohort study	81 patients with completed Berlin Questionnaire	Berlin Questionnaire	Elective surgery (surgery type was not included in the abstract)	Hypoxemia, reintubation, hypercapnia, atelectasis, pneumonia, thromboembolism, arrhythmia	Patients with high-risk of sleep apnea based on the Berlin Questionnaire had a higher rate of postoperative complications (20% vs 4.5%).
Sabers *et al.* [18]	Case control study	234 patients with OSA and 234 matched controls	Poly-somnography	Non-otorhino-laryngologic outpatient surgical procedures	Unplanned hospital admission, upper airway obstruction, bronchospasm, atrial fibrillation, hypotension, pulmonary edema	No significant difference in the rate of unplanned hospital admissions (23.9% vs 18.8%) or other adverse events (2.1% vs 1.3%)
Hwang *et al.* [19]	Historical cohort study	172 patients underwent home nocturnal oximetry	Home nocturnal oximetry	Abdominal, ENT, Vascular, Thoracic, Gyn, Urologic, Neurosurgical, Orthopedic and Cardiothoracic	Hypoxemia, arrhythmia, GI bleed, atelectasis, pulmonary embolism, pneumonia	Patients with ODI4% ≥ 5/h had a higher rate of postoperative complications than those with ODI4% < 5/h (15.3% vs 2.7%).
Gali *et al.* [20]	Prospective cohort study	693 patients with completed Flemons Criteria and SACS score	Flemons Criteria and SACS score	Orthopedic, Plastics, ENT, Neurosurgery, Gyn, Urologic, Thoracic, General abdominal	Arrhythmia, ICU admission, MI, pneumonia, need for mechanical ventilation	Postoperative respiratory events were associated with high SACS and PACU events
Liao *et al.* [21]	Retrospective matched cohort study	240 patients with OSA and 240 matched controls	International Classification of Disease (ICD-9) codes	Cardiac, ENT, Spine, Orthopedic, Urologic, Gyn, General, and Plastic	Hypoxemia, bronchospasm, pulmonary edema, arrhythmia, confusion	Patients with OSA had a higher incidence of postoperative complications (48% vs 36%)
Memtsoudis *et al.* [22]	Case control study	45547 general surgery patients with OSA and 58358 orthopedic patients with OSA were matched for controls in 1:3 manner	International Classification of Disease (ICD-9) codes	General and Orthopedic surgery	Aspiration pulmonary embolism, pneumonia, need for intubation, ARDS and mechanical ventilation,	Orthopedic and general surgery patients with sleep apnea had an increased risk of aspiration pneumonia, ARDS, and the requirement for intubation and mechanical ventilation.
Kaw *et al.* [23]	Cohort study	471 patients who underwent non-cardiac surgery within 3 years of PSG	Patients with an apnea-hypopnea index (AHI) ≥ 5/h were defined as OSA, and those with AHI < 5 as controls	Non-cardiac surgery	Atrial fibrillation, hypoxemia, respiratory failure, transfer to ICU, delirium, congestive myocardial infarction, heart failure, hospital length of stay	Patients with OSA had a higher rate of postoperative hypoxemia

ICU, Intensive Care Unit; **PSG**, Polysomnography; **PACU**, Postanesthesia Care Unit; **SACS**, Sleep Apnea Clinical Score; **ARDS**, Acute respiratory distress syndrome ; **OSA**, Obstructive sleep apnea.

A number of factors, including age, American Society of Anesthesiologists (ASA) class, and medical history, raise a patient's risk of problems after surgery, as well as other factors; type of paralytics, low albumin, current smoking, duration of surgery, type of anaesthesia, and other comorbidities, particularly coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), and renal failure[27]. Moreover, the probability of postoperative complications varies with surgical treatment. Patients undergoing abdominal surgery[24], aortic aneurysm repair[25], thoracic[26], vascular[27], and neck surgery[28] are more prone to complications[29].

Obstructive sleep apnea patients had a higher rate of surgical complications (39% vs. 18%), ICU admissions (24% vs. 9%), and a longer hospital stay as compared to age, gender, and BMI-matched control patients (all other factors being equal). A study found that OSA patients who received continuous positive airway pressure (CPAP) therapy before to surgery had a lower incidence of severe complications and a shorter hospital stay by one day. Patients with OSA were shown to have a greater rate of surgical complications (44% vs. 28%) in another study by **Liao *et al.*[30]**. CPAP users with OSA noncompliant patients had a higher-risk of surgical problems. It was also found that OSA patients had higher rates of encephalopathy, postoperative infections (mediastinitis), and longer hospitalizations in the intensive care unit than other patients[21]. Researchers found that patients with sleep apnea who underwent general or orthopedic surgery were more likely to have postoperative pulmonary complications[22].

It was found by **Hwang *et al.*[19]** that overnight desaturation during home nocturnal oximetry increased the probability of surgical complications. Prior to elective surgery, 172 patients were assessed in this research utilizing home nocturnal oximetry. Using nocturnal home oximetry, the quantity of occurrences per hour of oxygen desaturation 4% (also known as the oxygen desaturation index or ODI 4%) for each patient was determined. Significantly more individuals with an ODI 4% 5/h than those with an ODI 4% 5/h reported postoperative problems [31].

Following noncardiac surgery within three years of a polysomnogram, a new cohort study examined the postoperative complications and hospital stay length in 471 patients in this cohort. It has been proven that individuals with sleep apnea are more prone to postoperative complications, such as hypoxemia [31]. The Flemons criteria and sleep apnea clinical score (SACS) were used by **Gali *et al.*[20]** to determine whether a patient had a high or low probability of developing obstructive sleep apnea. There was an increased risk of postoperative respiratory problems in patients who had a high number of SACS and postanesthesia care unit (PACU) sessions. For the same reason, The Berlin Questionnaire was used by **Auckley *et al.*[17]** to identify people at high-risk.

Regarding the impact of OSA on ambulatory surgical patients, two investigations have been conducted. A procedure that does not necessitate an overnight stay according to these studies, people with a history of OSA were not at a higher-risk of unexpected hospitalization. Ambulatory surgical patients with sleep apnea were examined using a prediction model developed by **Stierer *et al.*[24]**. According to their findings, 107 patients with an OSA propensity of less than 70% were more likely to experience intubation difficulties, an increase in oxygen demand, and intraoperative tachycardia.

Identifying Patients with Sleep Apnea

Nocturnal polysomnography (NPSG) is very beneficial to detect OSA among patients. However, it is difficult to implement in the perioperative context for a variety of reasons, including the fact that it prolongs the surgical operation and raises the total cost. It may also be difficult to get in some healthcare settings. In addition to questionnaires, home sleep testing, and nocturnal pulse oximetry, additional methods for identifying persons at risk for OSA have been proven [32].

Questionnaires

Using a variety of surveys, it is feasible to identify patients at high-risk for obstructive sleep apnea. There has been a lot of validation of the Berlin Questionnaire, the ASA checklist, and the STOP-BANG questionnaire in the surgical population. People at high-risk for OSA can be identified using the Berlin questionnaire. Primary care patients have confirmed the validity of this questionnaire, which consists of 11 questions divided into three symptom categories. For patients with a respiratory disturbance index (RDI) greater than 5/h, it is 86% sensitive and 89% accurate in primary care settings. There is evidence that the Berlin questionnaire can identify patients with moderate to severe OSA, with a sensitivity of 74.3–79.5 percent and a negative predictive value (NPV) of 76% to 89%[33]. The scoring system for this questionnaire, on the other hand, is cumbersome and time-consuming[34].

The American Society of Anesthesiologists (ASA) Task Force has endorsed the use of the ASA checklist to identify patients with OSA. Among the choices are 12 for adults and 14 for kids. In postoperative patients, the ASA checklist diagnoses OSA with a sensitivity of between 78.6 and 87.2 percent and a negative predictive value that ranges from 72.7 to 90.9 percent, respectively[23].

The STOP-BANG questionnaire has recently been validated as a preoperative screening tool for OSAS. There are eight yes/no questions on this short, self-administered survey. A patient is considered at high-risk for OSAS if at least three of the following questions are answered "yes" or "No". To identify individuals with moderate (AHI > 15) to severe sleep apnea (AHI > 30), this questionnaire has an acceptable degree of sensitivity, specificity, and NPV. The STOP-

BANG scoring algorithm accurately excludes a patient with moderate-to-severe sleep apnea from having a low risk for OSA[33].

Nocturnal Pulse Oximetry

Obstructive sleep apnea can easily be detected utilizing Nocturnal Pulse Oximetry. Using nocturnal oximetry and ambulatory monitoring, researchers from **Malbois *et al.*[29]** investigated the sensitivity of these methods for detecting bariatric surgery candidates who had sleep apnea. According to their findings, persons with moderate OSA (AHI > 10) can be distinguished from those with severe OSA (a desaturation index of 3 percent) using nocturnal oximetry. This affordable and readily available method might speed the preoperative examinations of these individuals.

Home Sleep Testing

High-risk individuals for sleep apnea may benefit from ambulatory monitoring. However, this is only recommended for people with a high likelihood of sleep apnea prior to testing and no associated cardiac concerns. In addition, patient usage is restricted. Obstructive sleep apnea (OSA) was verified in 82% of high-risk surgical patients who had been diagnosed with OSA prior to ambulatory monitoring in a study. For a subset of surgical patients, OSAS may be diagnosed using this method[30].

The prevalence of sleep-disordered breathing in individuals after cardiovascular surgery has been found to be high; nevertheless, data indicating an influence on perioperative complications has been unexpectedly inconclusive. **Abdelsattar *et al.*[31]** conducted a large cohort research that included 2,646 general and vascular surgery patients with a suspected or confirmed diagnosis of obstructive sleep apnea, of whom 1,465 were untreated. According to **Kaw *et al.*[23],** there were 13 studies (3,942 patients) that contained data that could be quantitatively synthesised. Postoperative desaturation, respiratory failure, cardiac events, and ICU transfers were all linked to OSA.

Memtsoudis *et al.*[32] analysed national hospital discharge data and discovered a rise in complications but no effect of OSA on in-hospital mortality. Another large national research revealed a link between obstructive sleep apnea and cardiac issues. However, there is no link to an increased risk of death in the hospital. Hospital length of stay is affected by sleep-disordered breathing, which is varied.

Uncertainty surrounds the efficacy of perioperative positive airway pressure (PAP) therapy. **Zarbock *et al.*[33]** presented the findings of a prospective, randomised, controlled trial of preventative CPAP in 2009. A CPAP with a pressure of 10 cm H_2O was utilised for at least six hours, as compared to 10 minutes every four hours. Significant reductions were observed in the frequency of hypoxemia, pneumonia, reintubation rate, and ICU readmission. In 2013, **Liao *et al.*[30]** presented the findings of a randomised, controlled, open-label clinical study of perioperative auto-titration PAP in postoperative patients with obstructive sleep apnea. But there was no difference in the number of problems. Obstructive Sleep Apnea has been found to lessen cardiovascular difficulties, improve arterial oxygenation, reduce the risk of pulmonary complications (reintubation or pneumonia), and reduce the need for intensive care unit re-admission. [48]. According to a study and meta-analysis by **Nagappa *et al*. [16]**, there was no significant difference in post-operative outcomes between patients who utilized CPAP and those who didn't.

Perioperative Management

The American Society of Anesthesiologists (ASA) issued treatment guidelines for those receiving surgery for obstructive sleep apnea in 2006. In addition, an OSA grading system for perioperative risk assessment was introduced. Based on these concepts, perioperative care may be separated into three components: preoperative evaluation, intraoperative therapy, and postoperative care (Table **2**) [35].

Table (2): Obstructive Sleep Apnea Syndrome (OSAS) Preoperative and Post Operation for Patients at High-Risk [35].

Prior to the Surgery 1. History. 2. Full checkup. 3. Screening by the STOP-BANG, ASA, and Berlin questionnaires for spotting patients at high-risk. 4. If you're in a high-risk group, you should think about getting a sleep evaluation.
Managing intraoperatively 1. The goal of surgery is to reduce the amount of stress on the patient. 2. Reduced recovery time after surgery. 3. Instead of general anesthesia, use of regional or local anesthetic. 4. Preparations for intubation might be difficult. 5. Extubation in a semi-upright position with the patient aware is an option to be considered.
Managing post-operation 1. Use less sedatives and painkillers following surgery. 2. Use acetaminophen, NSAIDs, or localized analgesia to alleviate pain. 3. Check the oxygen saturation values in the post-operative period. 4. A CPAP machine should be used even after surgery for patients with a confirmed diagnosis of sleep apnea. 5. The use of an automatic CPAP machine following surgery is recommended for patients with sleep apnea who have a high surgical risk.

6. After being discharged from the hospital, patients can continue their treatment for sleep apnea at the sleep center.

Indications for CPAP use before surgery

In order to open the upper airway during sleep, CPAP acts as an inflatable splint. In addition to enhancing functional residual capacity and oxygenation, CPAP reduces breathing effort. It has been observed that CPAP improves the significant daytime fatigue of OSAS patients. The use of CPAP during surgery may reduce the probability of postoperative problems[(21)].

CONCLUSIONS

Surgery patients have a higher than average risk of OSAS. People with OSAS are often unaware of their condition at the time of surgery because they haven't been diagnosed. These persons have a higher-risk of problems following surgery. Opioids, sedation, and anaesthesia have been proven to aggravate sleep apnea during the perioperative phase, which may raise the risk of perioperative problems. It is essential to identify these individuals before to surgery in order to take the necessary precautions during their perioperative care. High-risk patients can be identified using simple preoperative screening tools like the STOP-BANG, Berlin, or ASA checklist. To reduce the likelihood of problems, patients at high-risk for surgery should have their postoperative care organised in a methodical manner. After being discharged from the hospital, patients with severe sleep apnea should be assessed for long-term treatment.

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