Perioperative treatment of patients with obstructive sleep apnea

Sanjay S. Jain and Rajiv Dhand

Purpose of review

Obstructive sleep apnea is a common disorder. Despite reports of its role as a risk factor for postoperative morbidity and mortality, only a few investigators have examined the optimal treatment of patients during this vulnerable period. Recognition of obstructive sleep apnea during conscious sedation or in the perioperative period is important to prevent the occurrence of adverse outcomes. This review discusses the influence of sedative, anesthetic, and analgesic agents and other factors during the perioperative period on patients with obstructive sleep apnea. The aim of this article is to emphasize the importance of recognizing and appropriately treating surgical patients with obstructive sleep apnea.

Recent findings

Sedative, analgesic, and anesthetic agents used perioperatively play a major role in the development of sleep-disordered breathing during the postoperative period. Postoperative apneic episodes frequently occur even after surgery remote from the upper airway. Sleep apnea predisposes patients to a greater than normal risk for postsurgical complications. Adequate screening of patients preoperatively and initiation of continuous positive airway pressure therapy perioperatively could prevent serious complications, including hypoxemia, arrhythmias, myocardial infarction, and respiratory arrest.

Summary

Obstructive sleep apnea places a significant proportion of surgical patients at increased risk of perioperative complications. Obstructive sleep apnea can be induced, unmasked, or exacerbated by the effects of sedative, analgesic, and anesthetic agents regardless of the site of surgery. The role of sleep apnea as a risk factor for development of postoperative complications needs greater emphasis. Increased awareness of the risk posed by an obstructed upper airway and appropriate management are important to optimize the perioperative care of patients with obstructive sleep apnea.

Keywords

obstructive sleep apnea, conscious sedation, perioperative management

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Division of Pulmonary, Critical Care and Environmental Medicine, University of Missouri-Columbia and Harry S. Truman VA Hospital, Missouri, USA

Correspondence to Sanjay Jain, Division of Pulmonary, Critical Care and Environmental Medicine, University of Missouri-Columbia and Harry S. Truman VA Hospital MA-417, One Hospital Drive, Columbia, MO 65212, USA
Tel: 573 884 9072; fax: 573 884 4892; e-mail: jains@health.missouri.edu

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Abbreviations

CPAP	continuous positive air pressure
OSA	obstructive sleep apnea
REM	rapid eye movement

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Introduction

Obstructive sleep apnea (OSA) is a common disorder that affects all age groups. Among the general population of adults in the United States, 4% of men and 2% of women are estimated to have OSA [1]. Patients with OSA are predisposed to the development of upper airway obstruction during sleep. The development of apnea leads to vigorous breathing efforts to open the collapsed airway, and arousal from sleep is followed by restoration of airflow. Such events are repeated with varying frequency throughout the sleep duration; the patient is unable to have uninterrupted sleep and is frequently sleep deprived. Similar events are likely to occur when sedative or anesthetic agents depress consciousness. Thus, patients with OSA could experience upper airway obstruction during and after various surgical procedures. This propensity to obstruct the upper airway makes patients with OSA susceptible to a variety of serious complications during and after surgery. Several investigators have reported that patients with OSA are predisposed to cardiac arrhythmias, myocardial ischemia, cerebrovascular insufficiency, and intracranial hypertension [2–6]. Hypoxemia associated with OSA predisposes patients to mental dysfunction and possibly poor wound healing after surgery [7,8]. Moreover, nearly fatal respiratory complications and even unexpected deaths have been reported after surgery in patients with serious OSA that has been unrecognized or inadequately treated in the perioperative and postoperative periods [9]. With more than 41 million surgical procedures performed annually in the United States, a huge population is at risk of serious complications because of OSA [10]. Considering its magnitude, this problem has, somewhat surprisingly, not been adequately emphasized in the medical literature. The purpose of this article is to review the pertinent information in an attempt to improve aware-

ness among clinicians regarding the importance of recognizing and treating patients with OSA undergoing various surgical procedures.

Effects of sedatives, analgesics, and anesthetic agents on the upper airways

The patient with OSA is likely to have disturbances of breathing when sedated. Table 1 shows various effects of sedation and anesthesia that could influence OSA in patients undergoing surgery. Anesthetic and sedative drugs are central nervous system depressants, and they inhibit respiration. Similarly to the changes occurring during sleep, sedation and anesthesia reduce functional residual capacity and predispose to atelectasis [11,12]. They also depress skeletal muscle tone and relax the upper airway with an increase in the tendency for the upper airway to collapse. In comparison with normal individuals, patients with OSA seem to be much more sensitive to the effects of sedation [13]. In normal, awake individuals, phasic activity of the pharyngeal muscles produces their contraction immediately before inspiration. This contraction of the pharyngeal muscles resists the negative pressure generated by the diaphragm and prevents collapse of the upper airway [14,15]. The phasic pharyngeal muscle contraction is markedly reduced by rapid eye movement (REM) sleep and by the administration of narcotic analgesics [16]. During general anesthesia, neural input to upper airway muscles is impaired to a greater extent compared with the reduction in phrenic nerve activity [17]. Thus, the administration of sedation or anesthesia may worsen, or even induce, significant sleep apnea during surgery. Among 23 patients with previously unrecognized sleep apnea undergoing outpatient diagnostic procedures under conscious sedation, Sharma *et al.* [18] noted that OSA developed in 17 patients (74%). Furthermore, sedative and anesthetic drugs depress responses to hypoxia and hypercapnia and compensatory reflexes to applied resistive or elastic respiratory loads [19–21]. In addition, arousal from sleep is an important defense mechanism to overcome the upper airway obstruction in patients with OSA. Unlike persons in natural sleep, patients may not arouse during apnea when their consciousness is depressed by sedative or anesthetic agents. The sum of these effects is that apnea could have life-threatening consequences for the sedated or anesthetized patient with OSA.

Abnormalities of breathing may persist into the postoperative period in patients with OSA. The type of anesthesia used is probably not of much significance with regard to the development of apnea in the postoperative period [22]. However, this could be a critical period for patients with OSA because monitoring may not be as vigorous during this period, the effects of sedatives and anesthetics may persist, and the artificial airway may no longer be present to protect the upper airway. The type and extent of surgery also have a significant impact on disturbances of sleep architecture in the postoperative period. After surgery, total sleep time is reduced, and there is a significant reduction in REM and slow wave sleep [23,24]. Several factors, including pain, analgesics, and other hormonal and metabolic changes after surgery, may contribute to the sleep disturbances [25,26]. Recovery from these disturbances in sleep architecture may take as long as 1 week [27]. Patients who are predisposed to apneas during REM sleep may experience significant complications as the period spent in REM sleep increases back to normal levels in the days after surgery. Moreover, nocturnal hypoxemia due to apneas during REM sleep may contribute to the development of myocardial ischemia and infarction, cardiac arrhythmias, mental confusion, cerebrovascular accidents, and wound breakdown [8]. Thus, the patient with OSA remains vulnerable to several postoperative complications if apneas are not recognized and appropriately treated.

Other factors influencing surgical risk

Factors not related to anesthesia, analgesia, or sedation also contribute to complications after surgery. Most patients are nursed in the supine position, and this may worsen airway obstruction in some patients with position-dependent apnea. The effects of anxiety, the underlying disease process for which surgery was performed, pain, alterations in circadian rhythm, and nursing activity all contribute to loss of sleep in the perioperative period. Because sleep deprivation exacerbates sleep-disordered breathing, these patients may have more severe apnea as they begin to pay back the sleep debt accumulated perioperatively.

Table 1. Effects of analgesic and sedative drugs that influence perioperative care in patients with obstructive sleep apnea

Effect	Influence	Study
CNS depression	Depressed consciousness	
	Decrease in skeletal muscle tone	Nishino *et al.* [17]
	Reduced upper airway tone	Meoli *et al.* [39•]
	Reduced neural input to upper airway muscles	Nishino *et al.* [17]
	Diminished arousal responses	
Respiratory depression	Decrease in FRC, atelectasis	Pelosi *et al.* [11], Sargent *et al.* [12]
Ventilatory responses	Reduced ventilatory response to hypoxemia and hypercapnia	Sollevi and Lindahl [19], Catley *et al.* [49]
Response to respiratory workloads	Reduced response to elastic and resistive workload	Wiegland *et al.* [20], Wilson *et al.* [21]

CNS, central nervous system; FRC, functional residual capacity.

Clinical considerations in patients with obstructive sleep apnea before surgery

The clinician should remain alert to several possible presentations of OSA in a patient being evaluated for surgery:

1. Patients with already diagnosed OSA who are receiving treatment.
2. Patients with already diagnosed OSA who are not receiving treatment, who are noncompliant with treatment, or in whom treatment has been unsuccessful.
3. Patients without a diagnosis of OSA. This category represents the large majority of patients [28]. Such patients may have the typical symptoms of OSA, such as heavy snoring, witnessed apneas, lack of refreshing sleep, fatigue, and excessive daytime sleepiness. Patients may also have the characteristic stigmata of OSA on examination, including obesity, short thick neck, nasal obstruction, tonsillar hypertrophy, narrow oropharynx, and retrognathia. Although these clinical features are suggestive of OSA, they are not reliable predictors of the presence or severity of the disease [29]. There is yet another group of patients who may lack these typical clinical features. In such individuals the suspicion of OSA may arise because of difficulty in intubation or in maintaining the airway during anesthesia. Witnessed apneas and unexplained hypoxemia postoperatively could also be the first indicators of airway obstruction during sleep.
4. Patients with unexplained hypoxemia, polycythemia, hypercapnia, pulmonary hypertension, or right-side heart failure. Such patients could have undiagnosed, and often severe, OSA.

The severity of OSA also merits consideration because it influences the risk of complications [29]. Riley *et al.* [30] reported a higher rate of complications in patients with a preoperative apnea index greater than 70 events/hour, a minimum arterial oxygen saturation below 80%, and intraoperative use of narcotics. Likewise, in patients undergoing upper airway surgery, Esclamado *et al.* [29] found that frequency of apnea and reductions in arterial oxygen saturation were predictors of complications. By contrast, Gupta *et al.* [31] reported that even mild OSA was associated with a higher perioperative risk in orthopedic patients. Although patients with severe OSA seem to be at higher risk of perioperative complications, careful observation and early intervention should be recommended for patients with all grades of severity of sleep-disordered breathing.

The type and extent of the surgery also contribute to the variation in responses among patients with OSA. The following factors should be considered in relation to surgery in patients with OSA:

1. Patients undergoing surgery for heavy snoring (uvulopalatopharyngoplasty) or for relieving upper airway obstruction (adenoidectomy, tonsillectomy, tracheostomy).
2. Patients undergoing upper airway surgery. In such patients, postoperative swelling in the upper airway may further compromise the narrowed upper airway lumen [32,33]. Moreover, nasal continuous airway pressure (CPAP) may not be applicable if the nose is packed. The presence of a nasogastric tube may also complicate the use of CPAP.
3. Patients undergoing surgery of the thorax and upper abdomen. In such patients ventilatory function may be depressed, and the ability to overcome upper airway obstruction could be compromised [34,35].
4. Patients undergoing surgery on the lower abdomen, pelvis, and extremities are also at higher risk of complications due to OSA [31,36].

Whether the operation is a routine, planned procedure or an emergent one also factors into the evaluation of the condition of a surgical patient with OSA.

Complications in patients with obstructive sleep apnea after upper airway surgery

Several investigators have reported on postoperative complications and treatment of patients with OSA undergoing upper airway surgery for treatment of sleep-disordered breathing. Riley *et al.* [30] analyzed the data from patients undergoing upper airway surgery for OSA and identified potential factors that could affect risk-management outcome. Upper airway surgery included a combination of uvulopalatopharyngoplasty (162 patients; 77%) and maxillofacial procedures (173 patients; 82%). Intubation was difficult in 39 (18.6%) patients. Neck circumferences greater than 45.6 cm and skeletal deficiency (Sella-Nasion-Point B $<75^{\circ}$) were noted to have a positive correlation ($P > 0.001$) with difficult intubations. All endotracheal tubes were removed with the patient awake in the operating room with two transient episodes of airway obstruction. Intraoperative and postoperative intravenous antihypertensive medications were required in more than two-thirds of the patients, particularly in those with a preoperative history of hypertension [30].

Terris *et al.* [37] retrospectively analyzed the operative records of 109 adult patients who underwent 125 surgical procedures on the upper airway over a 5-year period. Airway complications occurred in 1 patient (0.8%), who experienced obstruction immediately after surgery and responded to naloxone and suctioning. Five other patients (4%) experienced oxygen desaturation to levels below 90%. Cardiac complications, primarily significant hypertension, were the most common adverse events. Four (3.2%) bleeding complications were encountered; all occurred after the patients were discharged from the hospital [37].

In summary, perioperative complications after upper airway surgery are common in patients with OSA, and awareness of them is increasing. Close attention to the risk factors for these complications helps in reducing the associated morbidity.

Complications in patients with non–upper airway surgery

The patient with untreated OSA may present difficult and potentially life-threatening challenges to the surgical team even when the anticipated surgery is remote from the upper airway. Rennotte *et al.* [38] reported on 16 adult patients with documented OSA syndrome undergoing various types of surgical procedures, including coronary artery bypass surgery. Anesthesia was administered with the usual type of drugs for each type of surgery. Postoperative opioid analgesia and sedation were not restricted. One patient with previously diagnosed but untreated OSA syndrome died after various complications, including a respiratory arrest in the hospital bed. Another patient experienced serious postoperative complications, including failed extubation, until treatment for OSA with nasal CPAP was instituted, and thereafter he made an uneventful recovery. Gupta *et al.* [31] performed a retrospective analysis to identify and assess the impact of postoperative complications in patients with unrecognized or known OSA undergoing hip or knee replacement. These complications included respiratory events such as hypoxemia, hypercapnia, episodes of delirium, unplanned days in the intensive care unit, reintubation, cardiac events, and longer hospital stay. In comparison with control patients undergoing similar operations, adverse postoperative outcomes occurred at a higher rate (39% *vs* 18%; $P = 0.001$) in patients with a diagnosis of OSA undergoing hip or knee replacement. Interestingly, the complication rates were similar in the group with previously diagnosed sleep apnea in comparison with the group with undiagnosed sleep apnea. Contrary to their expectation, the authors did not find any association between the severity of OSA, as determined by absolute and mean values of respiratory disturbance index, and the incidence of postoperative complications.

Management

To our knowledge, at the time of writing this article, there is no standardized protocol for the postoperative treatment of patients with sleep apnea. Recently, the Clinical Practice Review Committee of the American Academy of Sleep Medicine published its recommendations on managing the upper airway of the adult patient with OSA in the perioperative period [39•]. Recommendations for safe perioperative care are summarized in Table 2.

Preoperative management

Preoperative recognition of OSA is an essential first step in preventing potential complications. A thorough history and physical examination are important in raising a suspicion of OSA, but the absence of typical clinical features does not exclude the diagnosis of OSA syndrome. Hence, in some instances, the diagnosis of OSA may be presumptive, yet the same precautions should be exercised as in treating a patient with an established diagnosis. When OSA is recognized, several intraoperative and postoperative initiatives could ensure a satisfactory outcome [40].

In a patient suspected of having sleep apnea, if the situation permits, surgery should be postponed until the patient has been evaluated by means of an overnight polysomnogram. If possible, the patient should be treated with at least 4 to 6 weeks of CPAP before surgery, because an increase in pharyngeal size and a decrease in tongue volume have been noted on MRI after 4 to 6 weeks of nasal CPAP therapy [41,42]. In one investigation, patients with OSA who received nasal CPAP before surgery and on a near-continuous basis for 24 to 48 hours after extubation and thereafter for all sleep periods did not experience major complications [38]. The OSA did not influence intensive care unit and hospital lengths of stay. Thus, nasal CPAP started before surgery and resumed immediately after extubation allowed these investigators to safely perform a variety of surgical procedures in patients with OSA syndrome, and to freely use sedative, analgesic, and anesthetic drugs without major

Table 2. Recommendations for safe perioperative care in patients with suspected obstructive sleep apnea (OSA)

Preoperative	Operative	Postoperative
1. Screening for OSA by questionnaires [39], physical examination 2. Evaluate for possible difficult intubation [43] 3. Defer elective surgery and consider overnight polysomnography in patients with high degree of suspicion for severe OSA 4. Assess and encourage adherence to nasal CPAP	1. Consider intubation over fiberoptic bronchoscope 2. Avoid even brief periods of loss of control of airway 3. Ensure that alternative methods of securing airway are immediately available in the event of unsuccessful intubation	1. Close monitoring until level of consciousness improves and analgesic requirements are minimized 2. Use of nasal CPAP in patients with known OSA [30] 3. Postoperative pain relief using regional anesthesia rather than continuous administration of opiates [49]

CPAP, continuous positive airway pressure.

complications [38]. The authors recommended that every effort should be made to identify patients with OSA and to institute nasal CPAP before and after surgery [38].

Intraoperative management

The first indication for the presence of OSA may be difficulty with intubation. The Mallampati score is a relatively simple grading system, which involves preoperative ability to visualize the faucial pillars, soft palate, and base of the uvula. The degree of difficulty in visualizing these three structures is an accurate predictor of difficulty with direct laryngoscopy [43]. A high Mallampati score predicts difficulty with intubation and should increase the suspicion of OSA [43].

During intubation, even brief periods of loss of control of airway must be avoided. Intraoperative airway risks may be reduced by direct visualization with a fiberoptic bronchoscope for intubation in patients with increased neck circumference and skeletal deficiency. Additionally, Eastwood *et al.* [44•] suggest that sleep-disordered breathing should be considered in all patients with a pronounced tendency for upper airway obstruction during anesthesia or during recovery from it. These workers studied 25 patients who were having minor surgery on their limbs, and they found that patients who needed positive pressure to maintain airway patency had more severe sleep-disordered breathing than those whose airway remained patent at or below atmospheric pressure [44•]. This association was strongest during REM sleep.

Extubation of the patient after surgery should be performed only after the patient is sufficiently awake, has adequate muscle tone in the upper airway, and has low analgesic requirements. The patient should be carefully monitored after extubation to ensure that the upper airway remains unobstructed. Monitoring may need to be continued in an intermediate care setting for a longer period than that required in patients who do not have OSA. Nursing the patient in the lateral position may be helpful for patients whose airway obstruction is worse in the supine posture. In patients with known OSA, nasal CPAP at the preoperative settings should be instituted after extubation. The CPAP pressure may need to be adjusted in the postoperative setting to obtain optimal efficacy. Patients who are unable to sustain spontaneous breathing through an obstructed airway may need reintubation.

Patients with OSA undergoing various outpatient procedures are also at risk for airway obstruction. Analgesic and sedative doses in such patients should be carefully titrated so that upper airway tone and respiratory stability are not compromised. Obstruction of the upper airway may be out of proportion to the level of sedation achieved [29]. After outpatient procedures, patients with OSA should be carefully observed until they are fully awake.

Postoperative management

Careful monitoring and vigilance for unexpected complication is required during the first 24 hours postoperatively in patients with OSA. Even though high-risk patients with OSA cannot always be identified preoperatively, and complications including death have occurred beyond the 24-hour period, significant complications after upper airway surgery for OSA usually emerge within 2 hours after surgery [27,37,45]. Thus, a decision regarding the level of postoperative monitoring needed may be made with confidence while the patient is in the recovery room. Routine postoperative intensive care monitoring may not be necessary for all adult patients undergoing upper airway surgery for OSA [37].

Patients with OSA syndrome are at a significantly increased risk for hypertension. Large fluctuations in systolic and diastolic blood pressure may occur during periods of apnea in the postoperative period [46,47]. Supplemental oxygen, in the absence of CPAP, should be used with caution. Hypoxia seems to be a key factor producing arousal during an apneic episode. By removing the hypoxic drive, supplemental oxygen may increase the incidence and duration of apneic episodes [15,48]. Nasal CPAP can eliminate the postoperative risk of hypoxemia, which would then allow the use of adequate parenteral or oral analgesics. Riley *et al.* [30] achieved analgesia with intravenous morphine sulfate or meperidine hydrochloride (intensive care unit) and oral oxycodone (non–intensive care unit), while the patients were receiving CPAP during all periods of sleep after surgery. There were no significant reductions in SpO_2, regardless of the severity of OSA syndrome or obesity.

For patients who are not previously accustomed to its use, CPAP in the postoperative period may be complicated by the presence of pain, agitation, and hypoxemia. Moreover, the optimal settings of CPAP may be difficult to determine. The use of CPAP in such patients may require placement in an intensive care unit, or other closely monitored setting, for a few days postoperatively until the level of consciousness improves and analgesic requirements are minimized. Postoperative pain relief using regional anesthesia rather than continuous administration of opiates may be an option in patients who are not able to tolerate CPAP. The work of Catley *et al.* [49] suggests that postoperative pain relief using regional anesthesia has a greater margin of safety in terms of respiratory side effects than does the continuous administration of opiates. Close observation may also be needed postoperatively for children undergoing upper airway surgery because serious complications could occur after swelling in the upper airway [32,33].

Conclusion

Obstructive sleep apnea places a significant proportion of surgical patients at increased risk of perioperative complications. OSA can be induced, unmasked, or exacerbated by the effect of sedative, analgesic, and anesthetic agents regardless of the site of surgery. Once OSA develops, these patients are at higher risk of several life-threatening complications. The role of OSA as a risk factor for the development of postoperative complications needs to be emphasized. Preoperative recognition of OSA, constant control of the airway, titration of analgesic and sedative drugs, and careful monitoring could avoid many unexpected complications after surgery. In patients with OSA, nasal CPAP should be used for 48 to 72 hours after surgery and during sleep thereafter. Preferably, the optimal settings of CPAP should be determined before surgery is undertaken in patients with OSA. Increased awareness of the risk posed by an obstructed upper airway and appropriate management are important to optimize the perioperative care of patients with OSA.

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