REVIEW ARTICLE

Unrecognized Sleep Apnea in the Surgical Patient: Implications for the Peri-operative Setting

Roop Kaw

Department of Internal Medicine, Cleveland Clinic Lerner College of Medicine, Cleveland Clinic Foundation. 9500 Euclid Avenue

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Obstructive sleep apnea syndrome(OSAS), is defined as at least five apneas and/or hypopneas per hour in association with symptoms attributable to sleep disordered breathing.[1] Recent epidemiologic data have placed the prevalence of OSAS at about 5% among the Western countries.[2] The prevalence in patients presenting to surgery has been estimated to be 1-9%, though it may be even more common in certain populations.[3] It is notable that the majority of these individuals have not been diagnosed.[4] As such, patients with sleep apnea may present for surgery without a prior diagnosis. Adverse surgical outcomes appear to be more frequent in patients with known OSAS. Therefore, early identification of this disorder in the surgical patient is important as it may allow for specific interventions that could improve postoperative outcomes.

Effects of the Peri-operative state on Sleep

Both anesthesia and surgery affect the architecture of sleep. Numerous studies have documented that sleep is reduced in amount and highly fragmented on the first night postoperatively.[5,6,7.] Rapid Eye Movement (REM) sleep is usually absent on the first and sometimes the second and third postoperative nights.[6] In most patients, REM sleep subsequently reappears with increased density and duration and REM associated hypoxemic episodes increase about three fold on the second and third nights compared with the night before surgery.[6,8.] Sleep studies performed in patients undergoing major abdominal surgery and open heart surgery have shown suppression of REM and SWS after surgery with a subsequent rebound in the late postoperative period.[5,6,7,9.] The return of REM sleep in the late postoperative period (at a time when oxygen therapy would have been discontinued) has been linked to significant respiratory abnormalities in a group of elderly patients who underwent abdominal vascular surgery.[10.] No studies with EEG monitoring have been performed later than the sixth night after abdominal surgery.

Sleep disturbances also appear to be impacted by other factors such as anesthesia, the location and type of surgery as well as the use of medications. The magnitude of surgery is important in REM sleep, as the reduction in REM sleep, SWS and the lack of inherent rhythmicity are more pronounced after major surgery (i.e, gastrectomy or vagotomy) rather than after minor surgery (i.e, hernia repair).[9.] Sleep disturbances are less after laparoscopic surgery. Postoperative administration of morphine has been claimed to be a contributing factor in sleep disturbance. Healthy volunteers without pain demonstrated both REM and SWS suppression at doses of morphine greater than or equal to 0.2mg/kg.[11]. There are no data on the effect of systemic or extradural morphine on sleep in postoperative patients. In the patient with severe OSAS, post-operative REM rebound could conceivably act in conjunction with opioid administration and supine posture to aggravate sleep disordered breathing. Sedatives or analgesics, as well as the residual effects of anesthetic agents may worsen OSAS by decreasing pharyngeal tone and therefore increase upper airway resistance.[12]. These agents may also attenuate the ventilatory and arousal responses to hypoxia, hypercarbia and obstruction, worsening the underlying sleep apnea.

Address for correspondence:

Dr. Roop Kaw
Assistant Professor
Section of Hospital and Perioperative Medicine, Department of Internal Medicine, Cleveland Clinic Lerner College of Medicine, Cleveland Clinic Foundation, 9 500 Euclid Avenue

OSAS and Peri-operative outcomes

REM rebound has been suggested to contribute to hemodynamic instability, myocardial ischemia and infarction, stroke, mental confusion and wound breakdown.[13,14,15, 16, 26]. In REM sleep, the neural drive to the pharyngeal muscles is at a minimum and the atonia of antigravity muscles predisposes to airway instability causing episodic hypoxemias.[17]. In a small study of 25 patients undergoing minor limb surgery the need for using positive pressures to maintain upper airway patency in sleep disordered patients was highest during the REM sleep.[18]. Episodic hypoxemias during REM sleep lead to brief arousals associated with profound sympathetic activation which may cause hemodynamic instability and increased mean arterial pressure.[19,20]. Postoperative respiratory obstructions are associated with large fluctuations in systolic and diastolic blood pressures in patients with OSAS.[21]. (**Figure1**). Surgical stress including post-operative pain and endocrine changes increase the sympathetic activation further. As a result of chronic adrenergic arousal, patients with sleep apnea may have down regulated alpha and beta receptors and thus have an attenuated response to vasopressors.[22]. REM rebound and the link to sympathetic tone may be particularly dangerous, leading to myocardial ischemia, infarction and even unexplained postoperative death. This hypothesis is supported by the finding that the majority of unexpected and unexplained postoperative deaths occur at night within seven days of surgery.[23]

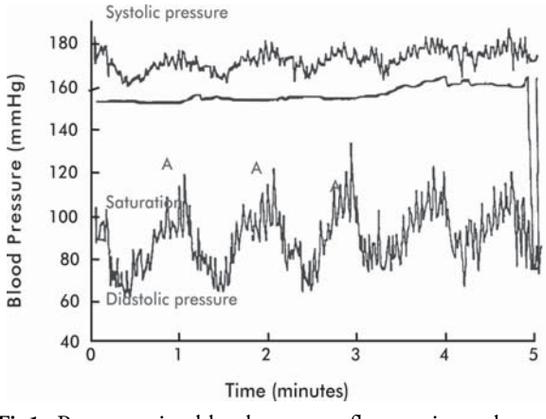

Fig1: Postoperative blood pressure fluctutations observed during obstructed breathing. Tracings show systolic and diastolic blood pressure during obstructed breathing. Large pulsus paradoxus in troughs marked A are the result of negative intrapleural pressure swings consequent upon obstruction. Peaks of blood pressure with smaller pulsus paradoxus coincide with arousal, release of obstruction & hyperpnoea.

It is interesting to note that nocturnal ST-segment changes consistent with myocardial ischemia are evident in patients with OSAS who are free of clinically significant Coronary artery Disease (CAD).[24]. The Sleep Heart Health Study Research Group found Apnea-Hypopnea indices (AHI) as modest as 1-10 to be associated with CVD manifestations.[25]. Hung and colleagues studied 101 male survivors of acute Myocardial Infarction (MI) and 63 age matched controls. An apnea index greater than 5 was found in 36% of MI patients compared with only 3.8% of the control patients.[26]. After adjustment for age, Body Mass Index (BMI), hypertension, smoking and serum cholesterol they found that an apnea index > 5.3 was independently predictive of MI with an odds ratio of 23.3($p<0.001$). Cardiac arrhythmias such as ventricular tachycardia and severe bradycardia are common with sleep apnea and can exacerbate underlying heart disease especially if massive blood loss or large fluid electrolyte shifts have occurred during surgery. The most frequent dysrhythmia observed in OSAS is a sinus brady-tachyarrhthmia. The extent of slowing correlates with apnea duration and the severity of desaturation. The sudden increase in heart rate that occurs after apnea termination is considered the combined effect of decreased vagal parasympathetic tone and increased sympathetic neural activity related to hypoxemia and arousal. Sinus pauses of 2 to13 second's duration have been reported in 9-11% of patients with OSAS and second degree AV block in 4-8%.[27-29]. Finally data from the Sleep Heart Health Study reveals that patients with OSAS have an odds ratio of 4.5 for the development of atrial fibrillation as compared to matched controls.[30.]

OSAS as an independent risk factor for perioperative complications

In a retrospective study in orthopedic patients, up to one-third of those with OSAS developed substantial respiratory or cardiac complications including arrhythmias, myocardial ischemia, unplanned ICU transfers, and /or reintubation. The length of hospital stay was significantly higher for patients with OSAS compared with control. The majority of the cardio-respiratory or neuro-psychiatric postoperative complications occurred within the first 72 hours after the joint replacement.[31] (**Figure 2**).

In a small prospective study evaluating the incidence of arrhythmia in patients with OSAS who had coronary artery bypass surgery, those with an oxygen desaturation index (ODI - defined as the number of desaturations $\geq$ 4% per

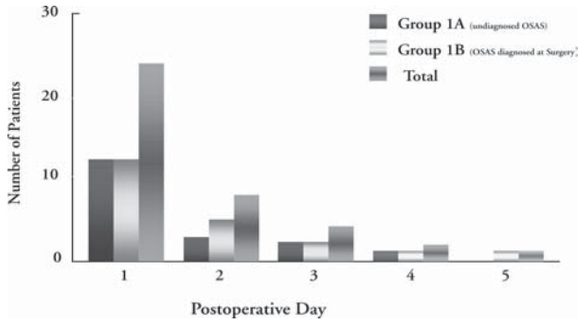

Fig 2: Time course of postoperative complications in patients undergoing Hip or Knee Replacement. (*Gupta R, Parvizi J, Hanssen A, Gay P. Mayo Clinic Proceedings Vol 76(9) September 2001, 897-905.)*

hour) ≥ 5 had a relative risk of 2.8 for the development of atrial fibrillation postoperatively. However, while there was a trend towards an increased incidence of atrial fibrillation in those with an AHI ≥ 5 (32% vs. 18%), this finding did not achieve statistical significance.[32].

Diagnosis of OSAS in the perioperative setting

A majority of patients without a previous diagnosis of sleep apnea were found to have obstructive sleep apnea when an outpatient diagnostic procedure involving conscious sedation was used. About 74% met the minimum criteria for the diagnosis of OSAS and 48% had RDIs of 15 or greater suggesting significant sleep apnea.[33]. The problem in addressing the relative impact of OSAS on perioperative outcomes is further hindered by the difficulty in diagnosing OSAS. The diagnosis can be elusive as the symptomatology of sleep apnea may be difficult to distinguish from normal variations in sleep behavior. Inquiry about heavy snoring, sudden awakenings with a choking sensation, and witnessed apneas by a bed partner should be a routine component of the preoperative visit. The severity of these historical items correlates with the severity of sleep study-proven OSAS.[34,35.] It should be recognized that patients with a known diagnosis of OSAS who have undergone uvulopalatopharyngoplasty surgery and no longer snore may still have residual OSAS and warrant further evaluation. Use of a simple screening questionnaire for OSAS would seem reasonable, though none have so far been validated for use in the preoperative setting.

Physical examination may reveal characteristic stigmata of OSAS including short thick neck, nasal obstruction, tonsillar hypertrophy, narrow orophaynx, retrognathia and obesity. Although typical these clinical features are not reliable predictors of the presence of severity of the disease [36]. Clinical examination carries a diagnostic sensitivity and specificity of only 50-60% for sleep apnea, even when performed by experienced sleep physicians [37]. Physical examination and laboratory studies may also reveal the presence of unexplained right heart dysfunction or erythrocythemia, suggesting severe OSAS. Clinical suspicion for sleep apnea may also first be recognized intra-operatively if the patient has problems with maintenance of the airway, proves difficult to intubate, or is observed postoperatively to be snoring and/ or having obstructions. Airway obstruction out of proportion to the apparent degree of sedation can suggest undiagnosed sleep apnea as well.[36]. Eastwood et al suggest that sleep–disordered breathing be considered in all patients wih a pronounced tendency for upper airway obstruction during anesthesia or recovery from it.[18]. The degree of difficulty in visualizing the faucial pillars, soft palate and the base of the uvula predicts difficulty with intubation and should increase the suspicion of OSAS.[38].

The main issue with intervention centers around the most efficient, inexpensive and reliable tool available for assessing the severity of OSAS. Polysomnography remains the gold standard for diagnosing and treating OSAS. However, restricted access and practical application may limit its utility in the preoperative setting. In Gupta's series of orthopedic patients, while the presence or absence of OSAS correlated with postoperative outcomes, the severity of sleep apnea (as determined by polysomnographic measure Respiratory Disturbance Index (RDI)), did not correlate with the incidence of postoperative complications.[31].Of interest, the supine RDI was found to be high in patients with OSAS undergoing joint replacement even though they had a low pre-operative RDI. At present, the optimal preoperative screening tool to assess for the presence and severity of OSAS is not known. Until further data is available to answer this question, a formal polysomnogram should be performed in high risk patients, assuming it is feasible in the given clinical situation.

Peri-operative management of patients with OSAS

Current treatment of OSAS in the non-surgical setting consists of continuous positive airway pressure (CPAP) administered during sleep at night. In patients with known OSAS, nasal CPAP has been recommended by some authors prior to surgery and to be resumed soon after extubation to

allow safe use of analgesic and anesthetic medications in patients with OSAS.[39]. Also in individuals with a known diagnosis of OSAS on CPAP therapy, it is believed that the perioperative use of CPAP will reduce the risk of postoperative complications.[40]. This is also suggested by the case-control study of Gupta et al, in which patients with known OSAS on CPAP at home experienced significantly fewer postoperative complications regardless of whether they used CPAP postoperatively or not. This finding also implies that there may be a beneficial "carryover" effect of CPAP on the airway, though the small number of subjects in this subanalysis limits the strength of these conclusions. Thus, while there is no definitive evidence that the timing of surgery should be delayed for initiation of CPAP therapy, this issue has not been adequately studied to guide management decisions.

One possible approach in surgical patients suspected of having OSAS, but unable to undergo polysomnographic evaluation, would be to empirically place the patient on CPAP in the perioperative setting utilizing self-adjusting or auto-adjusting CPAP devices. This approach has not been studied and may have significant limitations to implementation. If the patient is not familiar with CPAP, technical difficulties upon initiating CPAP postoperatively may limit its effectiveness. In addition, titrating CPAP for the first time in the postoperative period is less likely to be successful.[41] In general, surgery need not be delayed to allow for improvements in cognition and hemodynamics that accompanies the long term use of CPAP. This latter effect may however, be beneficial in certain settings, such as before major elective intra-abdominal, intra-thoracic or vascular surgery is planned.

Making the case for use of Peri-operative CPAP

There are numerous effects of CPAP therapy that may be beneficial in the perioperative setting. Nasal CPAP is highly effective at preserving airway patency during sleep and over several weeks can improve the diminished reflex responses to hypoxia and hypercapnia.[42]. This may in part be related to upper airway stabilization, a residual effect of CPAP following as little as four hours of use.[43] Hemodynamic fluctuations accompanying early episodes of respiratory obstruction in a patient with undiagnosed sleep apnea after aortic reconstructive surgery were abolished with nasal CPAP. (**Figure 3**). Reductions in mean systolic, diastolic and mean blood pressure after CPAP were 27.7%, 16% & 25% respectively.[10] Treatment with CPAP significantly reduces the total duration of ST segment depression in persons with sleep apnea.[44] In patients cardioverted for atrial fibrillation, the presence of untreated sleep apnea doubles the likelihood of recurrence of the atrial fibrillation within 12 months when compared with patients with OSA receiving CPAP therapy.[45]

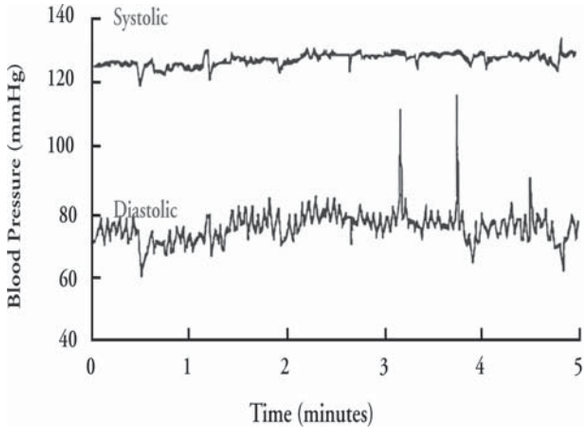

Fig 3: Postoperative blood pressure fluctuations following nasal CPAP. Large peaksin blood pressure were abolished following relief of respiratory obstructions using nasal CPAP.

Post-operative monitoring of the OSAS patient

Factors to consider when evaluating how patients with suspected OSAS should be monitored postoperatively include the preclinical suspicion of the severity of OSAS, the type of surgery being performed, the need for narcotics postoperatively and the clinical course in the recovery room. Patients with OSAS having abdominal or invasive surgery, significant expected pain or opioid requirement, severe OSAS at baseline needing CPAP at home, or with observed obstruction or episodic desaturations evident in recovery room should be considered for continued inpatient monitoring 46. Routine postoperative ICU admission may not be necessary except in patients with co-existing cardiopulmonary disease, a difficult airway or significant postoperative pain. It should be recognized that an unsupervised holding area is inappropriate for a pre-medicated sleep apnea patient. In practice, some anesthesiologists will not pre-medicate patients with OSAS due to concerns of airway compromise. It is probably prudent to minimize or avoid sedatives in this patient population and to minimize narcotics as best able.

Benzodiazepines should be avoided altogether in the postoperative setting for these patients due to their effects on the central nervous system and upper airway musculature. Likewise, narcotics should be limited and alternative forms of analgesia, such as nonsteroidal anti-inflammatory medications, nerve blocks or local analgesics should be considered. If narcotics are required for pain control, then patient controlled analgesia with no basal rate and restricted dosing may help to limit dosing. Whether the use of epidurals in this setting is helpful has not been studied and users should be aware that respiratory depression can still occur with this type of analgesia. Respiratory arrest has been reported in those with OSAS receiving epidural opioids at 2 to 3 days postoperatively.[39]. Suspected OSAS patients requiring intravenous narcotics should be kept in a monitored setting with frequent assessments and naloxone should be kept at the bedside. With this approach, if compromise is detected, naloxone can be given if needed, CPAP can be applied, with supplemental oxygen added as needed.[40].

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