REVIEW/UPDATE

Perioperative considerations and anesthesia management in patients with obstructive sleep apnea undergoing ophthalmic surgery

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Obstructive sleep apnea (OSA) is a disorder characterized by breathing cessation caused by obstruction of the upper airway during sleep. It is associated with multiorgan comorbidities such as obesity, hypertension, heart failure, arrhythmias, diabetes mellitus, and stroke. Patients with OSA have an increased prevalence of ophthalmic disorders such as cataract, glaucoma, central serous retinopathy (detachment of retina, macular hole), eyelid laxity, keratoconus, and nonarteritic anterior ischemic optic neuropathy; and some might require surgery. Given that OSA is associated with a high incidence of perioperative complications and more than 80% of surgical patients with OSA are unrecognized, all surgical patients should be screened for OSA (eg, STOP-Bang questionnaire) with comorbidities identified. Patients suspected or diagnosed with OSA scheduled for ophthalmic surgery should have their comorbid conditions optimized. This article includes a review of the literature and highlights best perioperative anesthesia practices in the management of ophthalmic surgical patients with OSA.

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Obstructive sleep apnea (OSA) is characterized by breathing cessation caused by obstruction of the upper airway during sleep. The estimated prevalence of OSA is approximately 5% in the adult population, and it is increasing in tandem with obesity and older age.[1] It is associated with multiorgan comorbidities such as obesity, hypertension, heart failure, arrhythmias, diabetes mellitus, and stroke.[2] Most patients with OSA are unrecognized before surgery, thus putting them at increased risk for perioperative complications.[3] Therefore, all surgical patients with suspected OSA, including those presenting for ophthalmic surgery, require screening and preoperative evaluation.[3] Patients with known or suspected OSA require a tailored intraoperative and postoperative anesthetic management to avoid perioperative adverse events. This article reviews the interaction of ophthalmic disorders with OSA and explores best perioperative anesthesia care in the management of ophthalmic surgery in patients with OSA.

OPHTHALMIC DISORDERS IN PATIENTS WITH OSA

Patients with OSA might present with accompanying ophthalmic disorders requiring surgery such as cataract, glaucoma, and detachment of retina and macular hole.[4,5] The patients with OSA might also have concurrent pathological conditions involving reduced ocular blood flow, nonarteritic anterior ischemic optic neuropathy, and retinal vein occlusion,[6–8] which might have relevance to anesthesia.

Severe OSA causes an increase in intraocular pressure (IOP) and a decrease in flow velocity in the retrobulbar circulation.[9] Several morphological and functional changes occur at the microvascular level in OSA patients. Kato et al.[10] suggest that there is decreased nitric oxide excretion or decreased capillary response to nitric oxide that might cause marked endothelial damage and dysfunction in the advanced stages of OSA. Ocular hemodynamic autoregulatory mechanisms are impaired because of increased IOP in severe OSA. High IOP and low ocular blood flow can be hazardous to eyes, especially those with compromised ocular and optic nerve head circulation such as in glaucoma or ischemic optic neuropathy.[11] Of note, a prolonged supine position can increase IOP,[12] and this might increase surgical complications. A meta-analysis involving 2 288 701 participants[13] suggested an association of OSA with glaucoma. Another meta-analysis of 12 studies[14] demonstrated that patients with

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OSA, relative to those without, have an increased odds ratio (1.24) of a comorbid glaucoma diagnosis. From these large sample size meta-analyses, one could conclude that there seems to be an association of OSA with glaucoma.[15] Intermittent hypoxia, changes in sleep architecture, increased sympathetic tone, inflammation, oxidative stress, and hypercapnia might have a role.[15] In patients with unrecognized OSA, a rise in IOP during anesthesia can have deleterious effects, potentially resulting in a glaucoma crisis and surgical failure. Thus, it has been suggested that OSA patients with concomitant glaucoma and progressing neuropathy be treated regardless of the IOP reading.[9]

Central serous retinopathy, such as detachment of retina and macular hole, are idiopathic detachments of the retina secondary to serous fluid collection beneath the retina. The apneic and hypopneic episodes for OSA patients are associated with increased levels of circulating catecholamines (adrenaline and noradrenaline). These cause endothelial dysfunction on the blood–retinal barrier, which could lead to the accumulation of subretinal serous fluid.[4,16] Urgent and prolonged surgery will usually be required in this situation. The modality of anesthesia (general versus regional anesthesia) used might vary; the surgeon's preference and the complexity and duration of the surgery play important roles in the decision.

Nearly 37% of OSA patients have retinal vein occlusion (RVO),[17] and RVO is a common cause of blindness from vascular disease in the retina.[18,19] Patients who suffer RVO typically describe visual loss after awakening, either centrally or peripherally, depending on the vascular area of involvement.[18] The pathogenesis of RVO remains unclear. It possibly results from multifactorial variables, which include the slowdown of retinal circulation, that aggravate the vicious circle of local hyperviscosity, leading to the occlusion of the capillary bed.[19] In addition to other well-known risk factors of RVO, including ageing, arterial hypertension, and glaucoma, OSA has also been blamed.[20] Although RVOs are rare, visually devastating complications of periorbital anesthesia have been reported.[21,22]

Patients with OSA also suffer from eyelid laxity, and thus might have chronic papillary conjunctivitis, chronic ocular irritation, or floppy eyelid syndrome, requiring surgical correction.[23] Eyelid surgery is usually performed under local anesthetic infiltration.

Keratoconus is characterized by conical steepening and thinning of the cornea and its prevalence is high in patients with OSA.[24] The patients with keratoconus are usually young and require general anesthesia for corneal transplantation.

Anesthetic management significantly influences the changes in IOP throughout the perioperative period, and strategies to safeguard retinal perfusion, reduce the ischemic risk, and minimize the potential for expulsive bleeding must be central to the anesthetic techniques selected.[25] Several well-known factors during general anesthesia (laryngoscopy, coughing bucking, postoperative nausea and vomiting, etc.) can increase IOP.[25] Those with preexisting compromised ocular blood flow are especially vulnerable to intraoperative ischemia, including those with hypertension, diabetes, atherosclerosis, or glaucoma.[25] Considering the comorbid conditions of OSA and the hazards of general anesthesia, regional anesthesia is preferred.[26]

The needle-based (peribulbar) block is known to increase IOP immediately after injection.[27] The canula-based (sub-Tenon) block appears to have less of an effect or no effect on IOP.[28,29] Both needle-based as well as cannula-based blocks have been associated with ischemic complications, such as central retinal vascular occlusion, optic atrophy, and ischemic optic neuropathy.[30,31] Any impairment of pulsatile ocular blood flow after orbital regional anesthesia can have deleterious effects on retinal circulation and compromise vision, especially in elderly patients who might have associated vascular occlusive disorder.[31] During regional anesthesia, any accumulation of carbon dioxide under the surgical drape should be avoided[32] because patients with OSA usually have higher carbon dioxide in the blood and any further increase in carbon dioxide could be deleterious.

PREOPERATIVE CONSIDERATIONS

Given that OSA is associated with a high incidence of perioperative complications and more than 80% of surgical patients with OSA are undiagnosed, the Society for Ambulatory Anesthesia[33] and the Society of Anesthesia and Sleep Medicine (SASM)[3] preoperative guidelines recommend that all surgical patients are screened for OSA. Multiple OSA screening tools are available to help identify individuals with OSA, including the Berlin questionnaire, P-SAP (perioperative sleep apnea prediction) score, the American Society of Anesthesiologist checklist, and others.[3] The STOP-Bang (**s**noring, **t**iredness, **o**bserved apnea, high blood **p**ressure, **b**ody mass index, **a**ge, **n**eck circumference, and male **g**ender) questionnaire is recommended because it is easy to use and has been studied the most in surgical populations.[3] STOP-Bang is a concise 8-point mnemonic that evaluates parameters on patients' symptoms and physical characteristics (Table 1).[34] Initially, a STOP-Bang score of 3 or more was suggested to assign a risk for OSA.[34] However, it was later recommended that scores of 5 or more should be used to determine the risk for OSA because they are associated with the greater probability of moderate-to-severe OSA[35] and reported to predict intraoperative and early postoperative adverse events during urgent and elective surgeries.[36] Of note, these did not include lower risk ophthalmic operations.[36]

A meta-analysis[35] found that patients with a high risk for OSA on the STOP-Bang scoring have greater odds of postoperative adverse events and longer hospital stays compared with patients who have a low risk for OSA on STOP-Bang scoring. There is, however, a dearth of literature regarding the validity of the OSA screening tool in ophthalmic surgery.

Patients with known or suspected OSA should be assessed for potential difficult mask ventilation and tracheal

Table 1. STOP-Bang Questionnaire and scoring algorithm for OSA in the general population.*

Issue	Question	Answer†	
		Yes	No
Snoring	Do you snore loudly (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)?		
Tired	Do you often feel tired, fatigued, or sleepy during the daytime (such as falling asleep during driving)?		
Observed	Has anyone observed you stop breathing or choking/gasping during your sleep?		
Pressure	Do you have or are being treated for high blood pressure?		
BMI	BMI more than 35 kg/m2?		
Age	Age older than 50 years?		
Neck size	Neck size large? (Measured around Adam's apple) Circumference greater than 40 cm or 16 inches?		
Gender	Gender = Male?		

BMI = body mass index; OSA = obstructive sleep apnea; STOP-Bang = **s**noring, **t**iredness, **o**bserved apnea, high blood **p**ressure, **b**ody mass index, **a**ge, **n**eck circumference, and male **g**ender
*Proprietary to University Health Network (Toronto, ON, Canada). Reprinted with permission
†Risk for OSA: Low = yes 0 to 2 questions; moderate = yes to 3 to 4 questions; high = yes to 5 to 8 questions, or yes to 2 or more of 4 STOP questions + male gender, or yes to 2 or more of 4 STOP questions + BMI >35 kg/m^2, or yes to 2 or more of 4 STOP questions + neck circumference >40 cm or 16 inches

intubation.[37] The morphological characteristics are similar for OSA and the difficult airway—with a reduction in the skeletal structure size and/or an increase in oropharyngeal soft tissue, leading to pharyngeal anatomical imbalance.

OSA patients should be evaluated for comorbid conditions, which should be optimized before elective surgery.[33] There is a strong association between OSA and obesity, with 70% of patients with a body mass index above 40 kg/m^2 having OSA.[38] Ophthalmic surgeries are mostly performed in an ambulatory environment and the patients are expected to be discharged from the hospital at the end of the operation. Patients with a body mass index greater than 50 kg/m^2 appear to be at higher risk for post-discharge readmission; therefore, caution is advised when including these patients for ambulatory surgery, in particular, for those who require general anesthesia.[39]

There is no clear evidence to suggest that delaying a procedure to obtain a sleep study and initiate positive airway pressure (PAP) therapy (eg, continuous positive airway pressure [CPAP] mask) would improve perioperative outcomes.[33] However, any comorbidities must be optimized, and patients on CPAP should be able to use it after discharge.[33]

INTRAOPERATIVE CONSIDERATIONS

Same-day discharge ophthalmic surgery under local anesthesia is now preferred by most patients, surgeons, and anesthesiologists because it is associated with the least disruption to the patient's normal activity.[40,41] Overall, the requirement for anesthesia in ophthalmic surgery is usually low, with many cases being amenable to topical and regional techniques on an ambulatory basis. Occasionally, general anesthesia might be necessary because of surgical-related or patient-related (eg, dementia) considerations.[42]

General Anesthesia

General anesthesia might be the technique of choice because of surgical-related and patient-related considerations. OSA patients presenting for surgery who receive general anesthesia might be at risk for perioperative complications because anesthetic and analgesic agents reduce central respiratory drive, blunt airway protective reflexes, and arousal responses. A recent systematic review of 61 studies, in excess of 410 000 OSA patients and more than 8.5 million controls demonstrated that OSA was associated with increased postoperative pulmonary complications, desaturation and intubation, atrial fibrillation, and postoperative delirium[3]; albeit these have not been demonstrated in the context of lower risk ophthalmic surgery.

Anesthetic management significantly influences the changes in IOP throughout the perioperative period and strategies to safeguard retinal perfusion, reduce the ischemic risk, and minimize the potential for expulsive bleeding must be central to the anesthetic techniques selected.[25] Several well-known factors during general anesthesia (laryngoscopy, coughing bucking, postoperative nausea and vomiting, etc.) can increase IOP.[25] Those with preexisting compromised ocular blood flow are especially vulnerable to intraoperative ischemia, including those with hypertension, diabetes, atherosclerosis, or glaucoma.[25] Considering the comorbid conditions of OSA and the hazards of general anesthesia, regional anesthesia is preferred.[26]

Identifying OSA patients and instituting risk mitigation measures would help to ameliorate adverse outcomes. The SASM, the American Society of Anesthesiologists, the Canadian Anesthesiologists' Society, and others provide guidance for optimal intraoperative management of adult patients with OSA.[2,37,43,44]

General measures include anticipating possible difficult airway and making adequate preparations such as preoxygenation (head-up position, application of CPAP), using video laryngoscopes or other airway adjuncts, and adopting the ramp (head elevated laryngoscopy) position if the patient is obese.[44] Short-acting anesthetic agents (eg, remifentanil and desflurane) are preferred. Opioids are avoided or minimized both intraoperatively and postoperatively.[37,45] In addition, opioids are not the favored drugs for ophthalmic anesthesia practice because of its emetogenic effects, which can also jeopardize postoperative globe integrity. Multimodal analgesia with alternatives such as paracetamol, nonsteroidal antiinflammatory drugs, cyclooxygenase-2 specific inhibitors, tramadol, and dexamethasone have the desired analgesic effects.[44] Notably, most ophthalmic surgical procedures are associated with anticipated mild-to-moderate postoperative pain. Residual muscle paralysis should be monitored intraoperatively and reversed with appropriate doses of reversal agents.[37] Current evidence does not favor a particular reversal agent (ie, sugammadex versus neostigmine). Extubation and recovery should be performed preferably in a 20-degree to 30-degree upright position after determining patient cooperation and consciousness if the ophthalmic surgical condition allows.

Regional Anesthesia, Monitored Anesthesia Care, and Sedation

Most routine ophthalmic surgical procedures can be safely performed under regional anesthesia (ophthalmic needle and cannula blocks) or topical anesthesia without sedation; although preferences and practices vary around the world.[40] Prerequisites include cooperation from the patient and the ability to lie supine, absence of claustrophobia, and uncomplicated short duration ophthalmic procedure. Several advantages of regional anesthesia exist, including obviating the requirement for the management of potential difficult airway with its accompanying postintubation edema and effective postoperative surgical analgesia. A systematic review of 6 observational studies suggested improved postoperative outcomes when regional anesthesia was compared with general anesthesia; albeit in the context of the non-ophthalmology cohort.[37]

Both needle-based as well as cannula-based blocks have been associated with complications,[46,47] including central retinal vascular occlusion, optic atrophy, and ischemic optic neuropathy.[30,31] The needle-based (peribulbar) block is known to increase IOP immediately after injection.[27] The canula-based (sub-Tenon) block appears to have less of an effect or no effect on IOP.[28,29] These blocks could cause impairment of pulsatile ocular blood flow and have deleterious effects on retinal circulation, compromising vision, especially in elderly patients who might have associated vascular occlusive disorder.[31] During regional anesthesia any accumulation of carbon dioxide under the surgical drape[32] should be avoided because patients with OSA usually have higher carbon dioxide in the blood and any further increase in carbon dioxide could be deleterious.

Sedative-hypnotics and opioids are sometimes administered with ophthalmic blocks and topical anesthesia; however, they should be used with caution and in lower doses because OSA patients are susceptible to their respiratory depression and upper airway obstruction effects. Airway obstruction can trigger unintentional movements through snoring, choking, gasping, and deep obstructed breathing. Also, even low doses of sedative-hypnotics and opioids could blunt hypoxia and hypercarbia, which further exacerbate the IOP rise. Intravenous benzodiazepine sedation is known to result in upper airway collapse and airway compromise in susceptible patients with coexisting OSA. Continuous propofol and remifentanil infusion have also been used during cataract surgery while the patients breathe spontaneously through their own CPAP equipment.[26] Drugs that do not decrease upper airway muscle activity and that have a favorable respiratory profile might be preferred, including low-dose ketamine and α_2-adrenergic agents such as dexmedetomidine. These agents have also been promoted for some ophthalmic cases because of their positive effect on postoperative cognitive functions and intraoperative optimum sedation.[40,46–50] The SASM guidelines on intraoperative management of patients with OSA, however, state that the evidence on the impact of these agents specifically in OSA is lacking.[37]

Appropriate intraoperative monitoring should include continuous oximetry and capnography.[41,43] Patients with severe OSA might consider using their own PAP devices or oral appliances during the procedure. Of note, the former will potentially hinder the conduct of ophthalmic surgery. Timely conversion to general anesthesia to ensure safe airway management and avoidance of hypoxia and hypercapnia should avoid related ophthalmic complications.

POSTOPERATIVE CONSIDERATIONS

The postoperative care and readiness for discharge in OSA patients can be challenging in an ambulatory setting. OSA patients should be carefully monitored in the recovery unit and observed for desaturation and apneic and bradypneic episodes.[43,44] If required, oxygen supplementation can be administered until the patients' baseline saturations on room air are maintained. Oxygen therapy can prolong apneic episodes in OSA patients by raising arterial oxygen pressure; thus, detection of hypopnea or apnea might be delayed. A recent prospective randomized controlled trial in postoperative surgical patients with newly diagnosed untreated OSA compared supplemental oxygen via nasal prongs versus no oxygen as a control.[51] Interestingly, oxygen therapy was found to decrease the postoperative apnea–hypopnea index and improve oxygenation, without increasing the incidence of hypercarbia.[51]

In patients using PAP therapy before the surgery, these devices should be used when the patient is transferred to the recovery area as soon as the patient is able to cooperate.[33] However, use of PAP therapy sometimes can be ineffective or challenging because of altered ocular anatomy after surgery such as bilateral placement of Jones tubes for dacryostenosis.[52,53] The patients might complain of air leakage to the eye from nose with high pressure from PAP equipment or they might subsequently present with orbital emphysema.[54–56] PAP devices have also been associated with dryness, excessive tearing, corneal ulceration.[57,58]

Discharge from the hospital should occur after the patient is no longer at significant risk for postoperative respiratory depression. An indication of this is when patients can maintain adequate oxygen saturation in an unstimulated environment while breathing room air.[43] In general, OSA patients with optimized medical comorbidities, who have minimal opioid use and are compliant with PAP therapy, should be able to return home after surgery.[33] OSA patients are more prone to apneic episodes after the second postoperative night, possibly because of rebound increase in the rapid eye movement sleep. Attentive care should be continued until the patient returns to a daily sleep routine.[59]

CONCLUSIONS

Increasing number of patients with OSA are expected to undergo ophthalmic surgery. The majority of OSA patients will be undiagnosed before surgery. Both ophthalmologists and anesthesiologists should be aware of its impacts and recognize perioperative problems to ensure safe care of the patients with OSA during eye surgery. There is a paucity of high-level evidence relating to anesthesia management in patients with OSA undergoing ophthalmic surgery. Further research in this field should be encouraged.

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