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Sedation for Ophthalmic Surgeries: Balancing Patient Comfort and Surgical Efficiency

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Anesthesia for ophthalmic surgery follows many of the rules of other surgical specialties, but also adheres to specific guidelines pertaining to procedures involving the eye and periorbital area. Optimal anesthetic and analgesic measures reduce patient discomfort and anxiety, which permits quick and safe performance of the surgery, while at the same time avoiding excess anesthesia and its associated adverse effects. This issue of *Ophthalmology Rounds* aims to describe the critical steps needed to optimize the ophthalmic surgical experience for the surgeon, patient and anesthesia care team. This paper will reflect the typical flow of the patient undergoing an ophthalmic surgery.

As with other specialties, anesthesia for ophthalmic surgeries involves a great deal of preoperative assessment, preparation, understanding of potential adverse reactions and their respective interventions, and good communication with the surgical team. The anesthetic goal for many ophthalmic surgeries can often be met with local anesthetics plus procedural sedation. Subsequently, sedation is achieved with the use of sedatives and analgesics to induce drowsiness and alleviate fear, anxiety and pain without the loss of verbal communication.[1]

The shortage of anesthesiologists across Canada has become a growing concern.[2] The largest shortage is in Ontario.[2] In response, the Ontario Medical Association (OMA) and the Ontario Ministry of Health and Long-term Care (MOHLTC) established the Anesthetic Care Team (ACT) model in 2006 to address the staffing crisis. The key members of the ACT comprise an anesthesiologist and anesthesia assistant. Anesthesia assistants are healthcare professionals (nurses or respiratory therapists) who have undergone specialized training to manage a stable surgical patient during general, regional, or neuroleptic anesthesia through medical directives under the supervision of an available anesthesiologist.[3]

General Principles of Anesthesia

Preoperative assessment

The primary goal of pre-anesthetic assessment is to obtain the pertinent information required to plan the anesthetic management.[4] Guidelines by the Canadian Anesthesiologists' Society (CAS)[4] and American Society of Anesthesiologists (ASA)[5] require that all patients receive a preoperative anesthetic evaluation. This serves as a screening tool to anticipate and avoid airway difficulties or problems with anesthetic medications.[4-6] The airway is a primary concern of the anesthesia team, particularly as the airway is often inaccessible during most ophthalmic procedures. Additional considerations include the ability of the patient to lie flat for the duration of the surgery, and having mental ability to understand and cooperate during the procedure.

Optimization of the patient's health status prior to surgery includes clear instructions regarding fasting guidelines (Table 1), the presence of a responsible adult to escort the patient home after discharge, and which medications to take on the day of the surgery.[4] The presence of one or more comorbidities may have a significant influence on ophthalmic surgical procedures and on safe administration of anesthesia. Preoperative laboratory and diagnostic tests should be ordered prior to the day of surgery on the basis of positive findings from the history and physical examination.[6]

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Table 1: Fasting guidelines[7]	
Type of Food	**Time required**
Clear fluids	2 hours
Breast milk	4 hours
Light meal (toast), formula, non-human milk	6 hours
Meal with meat, fried or fatty food	8 hours

The above fasting guidelines apply to all forms of anesthetic care, including procedural sedation. Fasting guidelines are important to adhere to as sedation and analgesics impair protective airway reflexes. Some examples of clear fluids are water, ice chips, plain Jell-O®, black coffee, plain tea, and apple juice.

The entire preoperative process should allow time for patient education regarding the sedation and perioperative period, to answer all questions, and to obtain informed consent. At the end of this assessment, an ASA physical status (PS) score is assigned to indicate the patient's physical status and fitness for surgery (Table 2).[7]

Ophthalmic surgeries are increasingly being performed in out-of-hospital settings. Basic principles, training requirements, equipment and medication still follow the same guidelines. The 2014 CAS Practice Guidelines suggest that ASA PS I and II patients may be considered for anesthesia in an out-of-hospital facility, and that PS III patients may be accepted in special circumstances. ASA PS IV patients should undergo anesthesia only in a hospital facility.[4]

Emergency drugs

Emergency drugs are prepared as standard routine of the anesthetic component in the operating room. These drugs should be readily available in case indicated. The 4 medications that are routinely drawn up are phenylephrine, ephedrine, atropine, and succinylcholine. Their indications, mechanisms of action and potential ocular effects are listed in Table 3.[6,8-10]

Table 2: American Society of Anesthesiologists (ASA) Physical Status (PS) Classification System[7]	
ASA I	A normal healthy patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease
ASA IV	A patient with severe systemic disease that is a constant threat to life
ASA V	A moribund patient who is not expected to survive without the operation
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes

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Intraoperative period

Once the patient is brought into the operating room, monitoring equipment is applied and must be in continuous use throughout administration of all anesthetics. Required monitors include pulse oximetry, blood pressure (BP), electrocardiography, and capnography.[4] The medical literature supports the use of supplemental oxygen during sedation to reduce the incidence of hypoxemia.[5] An anesthetic record should be completed, itemizing monitors, equipment, medications, fluids, and vital signs. Heart rate and BP should be documented at least every 5 minutes. Oxygen saturation is to be continuously monitored. Respiratory monitors should be considered in remote sedation, and for patients at risk for respiratory depression. For deep sedation,[4,5] the addition

Table 3: Emergency drugs[6,8-10]			
Name	**Indication**	**Mechanism**	**Ocular and other effects**
Phenylephrine	Hypotension	• Sympathomimetic and is considered a pure agonist increases both venous and arterial constriction • Induces reflex bradycardia secondary to a vagal reflex	• Pupillary dilation and capillary decongestion • CAD patients may experience severe myocardial ischemia, cardiac dysrhythmias, and even MI after topical 10% eye drops
Ephedrine	Hypotension with bradycardia	• Indirect acting synthetic noncatecholamine sympathomimetic that stimulates both α and β adrenergic receptors • Increases BP, HR, and CO	• Causes mydriasis
Atropine	Bradycardia	• Anticholinergic that increases HR and decreases oral secretion.	• No change to IOP • Causes mydriasis and cycloplegia • Avoid use in narrow-angle glaucoma
Succinylcholine	Paralytic to facilitate endotracheal intubation	• Depolarizing neuromuscular blocking agent that causes skeletal muscle relaxation • Contraindicated for patients with malignant hyperthermia	May cause transient increase in IOP by 5-15 mmHg

CAD = coronary artery disease; MI = myocardial infarction; BP = blood pressure; HR = heart rate; CO = cardiac output; IOP = intraocular pressure of capnography should be used as impedance plethysmography may fail to detect airway obstruction.[4,5] Deep sedation is defined by a Ramsay sedation scale (RSS) of 4–6 (Table 4).[4,11] The anesthesiologist or anesthesia assistant must remain with the patient at all times until the transfer to an appropriate care unit.[4,5]

Postoperative period

Recovery and discharge

In any facility providing anesthetic services, a postanesthetic care unit (PACU) must be available. The PACU must be equipped with supplemental oxygen and suction, and emergency equipment for resuscitation and life support.[4] The patient's heart rate, BP, oxygen saturation and respiration should also be monitored.

Postoperative nausea and vomiting (PONV)

PONV is one of the main causes of delay in discharge from the PACU.[6,8,12] The adult populations at the highest risk for PONV include women, nonsmokers, and those with a history of PONV or motion sickness. Undergoing a general anesthetic and being exposed to volatile agents also increases the risk of PONV.[6,12] Vomiting increases intraocular pressure (IOP) and could lead to damage to blood vessels in the retina or increased nasal bleeding post dacryocystorhinostomy (DCR) surgery or orbital hemorrhage.

Postoperative pain

Inadequate pain control is another main cause of delay in discharge from the PACU.[6,8,12] Effective analgesia is an essential part of postoperative management. Each patient's care should be prudently individualized to ensure patient safety and satisfaction. Discussion of common postoperative analgesia options is beyond the scope of this article.

Local Anesthetics in the Ophthalmic Surgical Setting

Local anesthetics can provide anesthesia and analgesia, and they are frequently used in the ophthalmic anesthesia setting (Table 5).[6,8-10] Local anesthetics block the transmission of pain sensation along nerve fibres by targeting the voltage-gated sodium channel.[6] They are categorized as either amino-esters or amino-amides, based on their chemical linkage. The degree of nerve blockade depends on both drug concentration and volume, while potency is related to hydrophobicity and physiochemical properties of the agent. In general, more potent agents are more lipid soluble.[6] Efficacy and duration of action of local anesthetics may be increased by the addition of opioids, epinephrine, and other α2-adrenergic agonists. Local anesthetics containing epinephrine may cause an increase in heart rate and BP if there is a significant uptake into the vascular system, therefore caution should be exercised with their use if the patient has a significant cardiac history.[8]

Local anesthetics readily cross the blood-brain barrier and generalized central nervous system (CNS) toxicity may occur from systemic absorption or direct vascular injection.[6] Signs of CNS toxicity are dose dependent, and may include analgesia, lightheadedness, tinnitus, numbness of tongue, seizures, unconsciousness, respiratory arrest, coma, and CV depression. In general, much greater doses of local anesthetics are required to produce CV toxicity than CNS toxicity. CV collapse from local anesthetic systemic toxicity (LAST) is often difficult to resuscitate. Management of LAST includes airway management, suppression of seizure activity, management of cardiac arrhythmia and hemodynamic, and intravenous lipid emulsion therapy.[13]

Table 4: Ramsay Sedation Scale (RSS)[11]

Clinical score	Level of sedation achieved
6	Asleep, no response
5	Asleep, sluggish response to light glabellar tap, or loud auditory stimulus
4	Asleep, but with brisk response to light glabellar tap or loud auditory stimulus
3	Patient responds to commands
2	Patient is cooperative, oriented, and tranquil
1	Patient is anxious, agitated, or restless

Sedation Techniques

A number of local anesthetic or nerve block options exist in combination with IV sedation. These options include retrobulbar block, peribulbar block, subtenon (episcleral) block, topical anesthesia, and intracameral injection.

Finding the balance of sedation and analgesia is beneficial to the patient and surgeon alike. The proper level of sedation-analgesia can decrease anxiety and discomfort and will allow the patient to tolerate unpleasant procedures, which allows the surgeon to perform the procedure quicker and safer. Under very light sedation, the patient may move and cause injury

Table 5: Commonly used local anesthetics[6,8-10]

Name	Concentration (%)	Route	Onset	Duration (hours)	Maximum recommended single dose (mg)
Lidocaine	0.5-1 1-1.5 1.5-2 4	Infiltration Peripheral nerve block Epidural Topical	Fast Fast Fast Fast	1-4 1-3 1-2 0.5-1	300/500 (epi) 300/500 (epi) 300/500 (epi) 300
Bupivacaine	0.25	Infiltration	Fast	2-8	175/225 (epi)
Tetracaine	2	Topical	Fast	0.5-1	20

epi = with epinephrine

and make it more difficult for the surgical procedure to be performed. A closed claims study of monitored anesthesia care cases during ophthalmic surgery that resulted in blindness or poor visual outcome found that in >80% of these cases the patient received inadequate anesthesia and/or the patient moved during the block or intraoperatively.[14] Optimal sedation is achieved with the goals of CV and respiratory stability, and rapid return of the patient's preoperative mental and physical state.[1]

The following section describes some current anesthetic practices currently employed by the Anesthetic Care Team at Kensington Eye Institute and Mount Sinai Hospital as examples of ophthalmic surgical anesthetic options. These practices are not exhaustive and are not intended to be used as "anesthetic recipes." Some of the commonly used sedatives are illustrated in Table 6.

Topical anesthetic with IV sedation

Cataract surgery

In our practice, cataracts are predominately performed with the combination of topical anesthetic (tetracaine eye drops) and IV sedation. Analgesia is achieved by the topical anesthetic administered preoperatively. Some surgeons may choose to further enhance analgesia with intracameral lidocaine injection at the beginning of the surgery. Occasionally, peribulbar injection may be given to increase perisurgical anesthesia. Opioids are often used in combination with sedatives to achieve the desired neuroleptic effects. The combination of midazolam and fentanyl administered in small increments (0.5–1 mg and 25–50 µg, respectively) are used commonly because of their rapid onset and relatively short duration. They are synergistic in effect and provide the patient with analgesia and anxiolysis. Midazolam should be used with caution in elderly patients as it may induce an unwanted state of dissociation or disinhibition. Surgical time is relatively short (usually <30 minutes). The sedation requirements are typically minimal based on short surgical time, compounded by the fast turnover of most cataract surgeries. Oversedation may cause sudden patient movements upon awakening, and may lead to catastrophic events. Furthermore, the

Table 6: Commonly used sedation medication[6,11,12]

Medication	Sedation dosages	Onset and duration of action	Mechanism	Adverse effects
Fentanyl	Bolus 12.5-50 µg	Peak effect: 3-5 minutes Duration: 30-60 minutes	• µ receptor agonist • 50-100 times more potent than morphine • Produces analgesia • Decreases IOP	• Nausea and vomiting • Respiratory depressant • Potential chest wall rigidity with larger dosages
Remifentanil	Bolus 12.5-25 µg Infusion 0.01-0.2 µg/kg/min	Peak effect: ~90 seconds Duration: ~5-10 minutes	• µ receptor agonist • Produces analgesia • Rapid biotransformation • Decreases IOP	• Nausea and vomiting • Respiratory depressant
Propofol	Bolus 0.2- 0.5 mg/kg Infusion 25-75 µg/kg/min	Peak effect 40-60 seconds Duration 3-5 minutes (single bolus)	• CNS depressant • Produces hypnosis, amnesia and has antiemetic properties • Decreases IOP • ACHOO reflex	• Depresses myocardium and lowers BP • Pain on injection • Formulation supports bacterial growth
Midazolam	Bolus 0.5-1 mg	Peak effect: 3-5 minutes Duration: 15-80 minutes	• Enhances affinity of GABA receptors • Produces anxiolysis, sedation, and amnesia • Synergistic effect when combined with opioids	• Decreases respiratory drive and airway protective reflexes • Potential paradoxical reactions in children and elderly patients
Ketamine	Bolus 0.25-1 mg/kg IV	Onset: 1-2 minutes Duration: 20-60 minutes	• Profound analgesia and amnesia • Dose-dependent CNS depression and dissociative state • Minimal respiratory and CV depression • Increases IOP (relative contraindicated for glaucoma or open globe surgery)	• Increases oral secretions thereby increases risk of laryngospasm • Produces hallucination

ACHOO = autosomal dominant compelling helio-ophthalmic outburst; GABA = γ aminobutyric acid; CV = cardiovascular airway is not easily accessible due to the plastic drape that is applied over the eye area to maintain the surgical field. Therefore, it is imperative that the sedation is carefully titrated to an RSS of 2–3 to achieve surgeon and patient satisfaction.

Trabeculectomy

Trabeculectomy is a surgical procedure used for the treatment of glaucoma by relieving IOP. The sedation technique for trabeculectomy is usually similar to that of the cataract surgery; however, this operation is longer than a cataract surgery (usually 45–90 minutes), so overall sedation requirements for the patient are generally higher.

Local anesthetic infiltration with IV sedation

Lacrimal surgery

DCR is a surgical creation of a passage for drainage between the lacrimal sac and the nasal cavity. This surgery can be done under general anesthesia or local anesthesia plus sedation depending on the patient and the surgical approach. A retrospective study comparing the outcomes of general versus local anesthesia in DCR surgeries found that local anesthesia and sedation may be advantageous.[15] The length of surgery is reduced, intraoperative bleeding is decreased, postoperative adverse events are diminished, and excluding ecchymosis the incidence of minor complications is not increased. These benefits are predominantly desirable in the elderly population where the risks of general anesthetics can be avoided. The endonasal approach for DCR at Mount Sinai Hospital is currently performed under general anesthesia and will not be discussed in this article. This section will focus on the external procedure that is performed under local anesthesia and sedation.

Prior to the patient entering the operating room, a nasal spray is administered to help with decongestion of the nasal mucosa. Once the patient is on the operating table, an intravenous line is started and supplemental oxygen is applied. The head of the patient is wrapped and the face is left exposed for the procedure. This exposed face allows for ease to access the airway for suctioning, administering supplemental oxygen as well as positive pressure ventilation if required. Once the surgical team is ready, sedative medications are administered. The initial sedation will help relax the patient and provide some pain relief from the local anesthetic injection by the ophthalmologist at the surgical site. Typical sedation administered to an uncomplicated patient includes midazolam 0.5–2 mg, remifentanil 25–50 µg bolus and possibly propofol 10–30 mg depending on the patient's comfort level. A background infusion of remifentanil 0.05–0.1 µg/kg/min is also started and continued for the duration of this procedure. Additional administration of midazolam, remifentanil, and propofol may be given throughout for patient comfort. Caution should be taken when combining remifentanil with propofol or midazolam due to the increased possibility of severe respiratory depression. The effects of remifentanil cease shortly after the infusion is stopped. In this context, fentanyl 50 µg is administered about 5 minutes before the procedure is finished to prevent or minimize postoperative pain.

Special consideration should be taken to avoid oversedation. Sedation weakens the patient's protective airway reflexes.[6] During DCR surgery, blood and debris can accumulate in the oropharynx because the patient's ability to swallow is impaired. These patients could be at a higher risk for aspiration. In addition, ingesting blood may cause nausea and vomiting; therefore, antiemetic prophylaxis should be considered.

Eyelid surgery

Eyelid surgeries such as entropion, ectropion, eyelid cancer surgery, and ptosis are usually performed with local anesthetic infiltration with sedation. Sedation is administered to the patient prior to the surgeon injecting the local anesthetic into the surgical site. The sedation regimen for these surgeries is typically midazolam 0.5–2.0 mg and fentanyl 25–50 µg. Once the local infiltration is completed, the patient usually does not require further sedation. Surgeons may require the patient to open or close the eyelid during surgery; therefore, sedation should be titrated to achieve an RSS of 2–3.

Regional anesthetic with IV sedation

Retina

Anesthesia for adult patients undergoing retina surgery is accomplished primarily with subtenon, peribulbar, or retrobulbar block. In our practice, the type of regional anesthesia is decided and performed by the ophthalmologists. Sedation for patients undergoing regional blocks is usually achieved with increments of midazolam (0.5–2 mg) and fentanyl (25–50 µg) prior to local anesthetic injection. Further anxiolysis can be achieved with the use of small propofol boluses (10–30 mg). Typical surgical duration of retinal surgeries ranges from 45–60 minutes; thus, supplementation of midazolam and fentanyl may be required.

The patient should be comfortable enough to tolerate the initial block but remain alert enough to allow for the assessment of the block's effectiveness, such as the presence or absence of eyelid akinesia. Eyelid akinesia is often a direct consequence of the larger volume of local anesthetic used for peribulbar blocks. In contrast, retrobulbar blocks often leave the orbicularis oculi fully functional.[6] The anesthesia assistant must also be vigilant in the detection and management of potential oculocardiac reflex. This reflex is triggered by manipulation or pressure on the globe, and by traction on the extraocular muscles, conjunctiva, and orbital structures. It may also be induced by the retrobulbar block itself. It is most commonly manifested as sinus bradycardia, but other arrhythmias may also be present.[6] Management of such complication would include releasing pressure or traction of the extraocular muscles. In addition, administration of atropine, glycopyrrolate, or ephedrine may be appropriate if these symptoms persist.

Avoid the use of nitrous oxide in most retinal surgery because it can dangerously increase IOP when given concomitantly with the gases (hexafluoride or perfluorocarbons) used in retinal surgeries.[6]

Cornea

Corneal surgeries often require regional blocks, and sedation for receiving the block is similar to that of retinal surgeries described above. However, in certain corneal procedures such as penetrating keratoplasty, special care must be taken to avoid elevation or sudden changes of IOP. Sedation goals of corneal surgeries should be to maintain akinesia and proper control of IOP. Surgical duration is relatively longer, ranging from 1-2 hours, and sedation supplementation is usually required. This can be accomplished with small boluses of midazolam or fentanyl as needed. Alternatively, a low-dose propofol infusion (25–50 µg/kg/min) may be used.

Reversal Agents

The ASA recommends that specific antagonists should be available whenever opioid analgesics or benzodiazepines are administered for sedation/analgesia.[5] Naloxone or flumazenil may be given to improve spontaneous ventilation in patients who may have received opioids or benzodiazepines, respectively.

Summary

Since the introduction of the ACT model, patient care has improved by increasing patient access and decreasing surgical wait times. In particular, the ACT has played a major role in ophthalmology services by enabling safe and efficient anesthesia care in various hospital and out-of-hospital settings.

There are many benefits to administering procedural sedation for ophthalmic procedures, including decreased PONV, decreased costs, and faster recovery time when compared to general anesthesia. For successful outcomes and improved patient satisfaction, a multidisciplinary approach is imperative. Detailed communication of sedation or special requirements for each surgical procedure will optimize the patient and team experience. A thorough preoperative assessment and preparation is also vital, including identification of any existing comorbidities. Furthermore, it is essential to have a good working knowledge of the medications administered and their ocular implications. Ultimately, the sedation technique and medications should be customized and tailored to suit the individual needs and goal for each patient.

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