Special Issue
UPDATES IN PEDIATRIC ANESTHESIA, PAIN & INTENSIVE CARE

SPECIAL ARTICLE

Updates in pediatric ophthalmic anesthesia

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SUMMARY

This review offers a comprehensive review of the updates and the current practices in ophthalmic anesthesia for the pediatric population. The principles specific to this group of patients, starting from preanesthesia assessment and preparation to the anesthesia management in the operating room and even postoperative considerations are discussed. The physiologic and pharmacologic specifics are described. A special part has been dedicated to the special needs and considerations in regard to some of the specific ophthalmic disease conditions.

Key words: Ophthalmic disorders; Pediatric patients; Mucopolysaccharidoses; Craniosynostosis disorders; Craniofacial syndromes; Oculocardiac reflex; Oculorespiratory reflex; Difficult airway

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INTRODUCTION

Ophthalmic disorders, in pediatric patients undergoing ophthalmic procedures , vary from conventional to nonconventional disorders, which may have important anesthetic implications.[1] however traumatic injuries cataracts and nasolacrimal duct stenosis, usually occur in healthy pediatric patients. In contrast to adults, infant and children are not candidates for local anesthetic techniques and therefore almost always require general anesthesia, so it is important to understand the unique anesthetic considerations aiming to provide optimal perioperative care for pediatric patients. This essay will present a general review of the conscience of anesthesia for infant and children undergoing eye surgery and a delineation of anesthesia for some specific procedures

PRINCIPAL FINDINGS

Even though most pediatric patients undergoing ophthalmic procedures are ASA I, day-case patients ,those who are unable to see or be aware of what is going around them, special care should be taken in approaching and handling them . Premedication and induction are a matter of anesthetist preference. although it is often more appropriate to use a laryngeal mask airway , spontaneous ventilation via a facemask is usually sufficient for simple eye examination , For intraocular procedures, In order to maintain a still, 'quiet' eye for optimum surgical conditions, certain depth of anesthesia should be provided .Airway security is a must because it will be difficult to reach the airway when the face is covered with sterile drapes.

In most ophthalmic procedures postoperative pain and discomfort can be managed with topical anesthetic agents and simple analgesics such as paracetamol and the non-steroidal analgesics. Which can be give preoperatively either orally or rectally at induction. If postoperative pain is more sever such as in squint surgery, evisceration of the eye and vitreoretinal surgery stronger analgesia may be necessary such as codeine or, in older children, tramadol. However, as in squint surgery patients are at risk of postoperative nausea vomiting (PONV),it will be better to avoid intraoperative opioid analgesia if possible.

PREOPERATIVE CONSIDERATIONS

The majority of pediatric patients undergoing eye surgery are healthy and managed as day-cases. Only small percentage may have some underlying disorders, often of chromosomal or metabolic nature, which may provoke more challenges in anesthetic technique.[2,3] cases range from those, associated with mental , developmental delay and behavioral problems who should be treated kindly. and others, in whom associated disorders may be of more direct anesthetic impact. A number of syndromes in which there can be major difficulties with intubation are associated with cataracts, glaucoma or squints. These include the mucopolysaccharidoses, the craniosynostosis disorders (e.g. Crouzon's, Apert's and Pfeiffer's syndromes) and the craniofacial syndromes (e.g. Goldenhar, Treacher–Collin and Smith–Lemli–Opitz). The Hallerman–Strieff syndrome, although rare, may present for cataract surgery in the neonatal period and invariably is associated with a

particularly difficult airway. Stickler's syndrome, which is associated with early retinal detachment and glaucoma, is a progressive connective tissue disorder that has some of the features of the Pierre Robin syndrome; it can also present intubation problems. Suitable precautions and techniques for patients with potential intubation difficulties should be induced in these patients.

Some patients need a thorough clinical examination specially those suffering from neurofibromatosis, von Hippel–Lindau disease, tuberous sclerosis and the Sturge–Weber syndrome. The congenital phakomatoses may show cardiac or intracranial lesions, seizures and frequently pheochromocytoma

Ectopia lentis is a common presentation of Marfan syndrome and homocystinuria. These patients need surgical extraction of their dislocated lenses, patients with homocystinuria should receive aspirin before and after surgery as a prophylaxis against thromboembolic episodes. Preoperative intravenous glucose infusion is needed to counteract the hypoglycemia that may result in cases with homocystinuria due to the metabolic disorder. Aortic and valvular anomalies are common with Marfan syndrome, careful positioning and hypertension should be avoided in these patients.

Congenital and juvenile glaucoma patients are usually on beta blocker eye drops e.g. timolol, betaxolol etc. That may be sometimes absorbed systemically causing hemodynamic adverse effects.[4,5]

Surgery during the first few days of life is indicated in an infant suffering from congenital cataract. The possibilities that this cataract maybe due to metabolic disorder or occurring following intrauterine infection should be taken into consideration and one should be ready for prompt management and monitoring if respiratory problems such as postoperative apneic episodes had occurred after surgery.

Antibiotic prophylaxis is unnecessary in majority of ophthalmic surgeries in patients with cardiac anomalies as bacteremia is not expected. On the other hand a prophylactic antibiotic is given to patients with structural cardiac lesion and undergoing a nasolacrimal duct procedure in which the incidence of bacteremia is high, but it has become a debatable issue now.

Fasting prior to surgery is required to reduce the risk of aspiration of food or liquids while under anesthesia. While rare, this is very serious complication and parents need to strictly follow recommendations and very specific policies regarding children's ages and time periods for fasting, which are based on safety standards.

The following guidelines for fasting times prior to surgery apply to healthy patients who are having elective surgery. A history of diabetes or reflux may require longer fasting times

- Clear liquids – two hours
- Breast milk – four hours
- Infant formula – six hours
- Nonhuman milk – six hours
- Light meal – six hours

PRE-MEDICATION, INDUCTION OF ANESTHESIA

A plan should be made to pre-medicate the child and choose the induction technique either inhalational or intravenous that suits the child and preferred by the anesthesiologist. Child with poor vision should be handled in a careful manner.

Paracetamol, NSAIDs may be given as oral preparations or rectally preoperatively. If midazolam is used as a premedication there may be some anti-emetic benefit,[6] other benzodiazepines, such as lorazepam and diazepam have shown to decrease PONV in strabismus patients;[7] the use of oral clonidine 2-4 μg/kg as a premedication has shown mixed results.[1,7]

AIRWAY MANAGEMENT

If intraocular tension (IOP) has to be measured, intubation should be avoided as it raises the intraocular pressure, instead a face mask may be used.

Laryngeal mask airway (LMA) is used for simple procedures such as examination under anesthesia (EUA), specially in older children. Some anesthesiologists find it more appropriate to maintain spontaneous respiration especially where a sterile field is required. It also has the benefit of reduced cough at the end of surgery and controlled ventilation with muscle relaxant can be used. Very young children are best managed with intubation and controlled ventilation as well as in cases of intraocular surgery requiring a still eye with low intraocular pressure. Reinforced flexible tracheal tubes (ETT) are preferred to ensure airway security; also the tube should be firmly fixed in place as the access to the airway will be restricted during surgery.

MAINTENANCE OF ANESTHESIA

Anesthesia maintenance technique widely depends upon the choice of the anesthesiologist and the availability of different agents, the depth of anesthesia should be considered. Sevoflurane anesthesia with bispectral index (BIS) 60[8] was associated with a higher incidence of oculocardiac reflex (OCR) compared with BIS of 40.

Incidence of bradycardia, dysrhythmias and ventilatory BIS disturbances, is higher with halothane specially when hypercarbia is present or preparations containing

atropine or adrenaline are used during surgery. Isoflurane or sevoflurane may be preferable; whereas there is no difference between sevoflurane and desflurane and their effects on OCR.[9]

Total intravenous anesthesia (TIVA) with propofol is effective in reducing the risk of PONV as propofol has anti-emetic effects. Remifentanil can reduce volatile requirements.[10,11]

Hahnenkamp et al[12] Compared four anesthetic techniques and their effect on OCR. The groups included: propofol and alfentanil infusions, ketamine and midazolam infusions, sevoflurane and halothane. The ketamine and midazolam group experienced the least amount of hemodynamic changes due to OCR. Also a further study evaluating ketamine demonstrated that a single bolus of ketamine 1 or 2 mg/kg for induction lowered the incidence of OCR when compared with propofol and sevoflurane combination.[13] A proposed mechanism may be the increased sympathetic tone associated with ketamine that counteracts parasympathetic stimulation of OCR.

Nitrous oxide should be avoided in ocular surgery Firstly; nitrous oxide is known to increase the risk of PONV. Secondly, in vitreoretinal surgery, where intraocular gas bubbles of sulphur hexachloride or perfluropropane are introduced into the eye to tamponade detached surfaces, nitrous oxide diffuses from the blood into gas filled spaces cause a significant rise in intraocular pressure with subsequent ischemic damage . As well if nitrous oxide was used at the beginning of surgery, it will diffuse out of the bubble at the end of procedure, and the bubble will shrink which increase the incidence of recurrent detachment.

FLUIDS

Oral intake of clear fluids until two to three hours preoperatively is recommended to maintain hydration; liberal hydration with intravenous crystalloids intraoperatively is effective in reducing the risk of PONV. Recently a study demonstrated that an intraoperative lactated ringer's solution at 50 ml/kg/hr is more effective in reducing PONV in strabismus surgery patients than a solution at 10 ml/kg/hr.[14]

ANESTHESIA AND IOP

Most anesthetic agents reduce IOP.[15,16] Normally it ranges from 10–20 mmHg.

ANESTHETIC AGENTS EFFECT

Propofol, thiopentone: IOP reduced by 20-30% (3-7 mmHg)

Halothane, sevoflurane, isoflurane, desflurane: IOP reduced by 20-30% (3-7 mmHg)

Opioids: Minimal to no effect on IOP

Ketamine: Minor, dose dependent increase in IOP; marked effect when dose exceeds 5 mg/kg

Atropine: No effect on IOP

Non-depolarising muscle relaxants: Minimal to no effect on IOP

Suxamethonium: Significant increase in IOP within 30 sec of administration (approx 8 mmHg), effect lasts for 5-7 minutes, less if given with agents that reduce IOP

Acetazolamide, mannitol, dextrans: Used for acute reduction of IOP preoperatively

ANESTHETIC TECHNIQUES AND IOP

IOP affected by many physical and physiological events during anesthesia; coughing, straining, crying, bucking on the tube and the process of tracheal extubation may all cause a rise in IOP. A dose of lidocaine 1 mg/kg 3 min before intubation or extubation is beneficial in preventing acute increase in IOP. The LMA has little effect on IOP, and allows smoother induction and emergence from anesthesia.[17] IOP is increased by hypoxia and hypercapnia, and decreased by hypocapnia and hypothermia.

THE OCULOCARDIAC REFLEX (OCR)

OCR is frequently encountered during ocular surgery in pediatrics particularly in strabismus surgery. It is defined by some authors as a 20% decrease in heart rate (HR),[18] and by others as a10-30% decrease in HR from baseline.[19] Continuous ECG monitoring is mandatory during surgery. A sinus bradycardia and occasionally junctional rhythms, atrioventricular block, atrial ectopics or ventricular ectopics may occur. Traction on extraocular muscles triggers OCR. Medial rectus muscle traction is more common to trigger OCR than traction on other extraocular muscles. However, Blanc et al[20] were unable to show that the medial rectus triggers OCR more often than the other extraocular muscles if the same type of stimulus is used. It is important to note that ocular trauma, increased intraorbital pressure from injection or hematoma or pressure on orbital apex after enucleation are also triggers of OCR.[1,12] The reflex takes its afferent innervations from the ophthalmic division of the trigeminal nerve, relays via the sensory nucleus in the 4th ventricle, with the efferent impulse in the vagus nerve. Vagal escape or OCR fatigue means disappearance of the response when the stimulus is discontinued. It is a physiologic defense mechanism where the HR response weakens with repeated or sustained stimulation of extraocular muscles. Intravenous atropine 20 μg/kg or glycopyrrolate 10 μg/kg at induction of anesthesia will block the OCR. Atropine can be given anytime during surgery if the OCR occurs, so it is important to have the drugs available and ready to use if bradycardia had

occurred. The reflex can be counteracted by applications of topical local anesthetic eye drops such as tetracaine, or by blocking the afferent limb of the reflex with a peribulbar block, which is not commonly used in pediatric patients due to the risk of globe perforation.[21]

OCR is less common to occur with sevoflurane than with halothane, on the other hand more likely to occur with rocuronium rather than atracurium.[1,2,19] Hypercarbia doubles the incidence of significant bradycardia, so controlled ventilation should be considered. PONV is more likely to occur in pediatric patients who experience OCR during surgery,[22] therefore antiemetic drugs should be given during anesthesia.

OCULORESPIRATORY REFLEX

Extraocular muscles manipulation can also provoke oculorespiratory reflex which results in reduction in tidal volume and respiratory rate; [23] consequent hypercapnia and hypoxemia may occur, which in turn increase the risk of OCR. Oculorespiratory reflex has the same afferent pathways as in OCR which relays in brainstem respiratory control area, and the efferent impulses travel along phrenic nerve and other nerves involved in respiration.

EXTUBATION AND EMERGENCE FROM ANESTHESIA

Laryngeal mask airway is used in suitable pediatric patients in order to avoid straining and coughing on the tracheal tube at the end of surgery. Intubated patients need deep extubation and smooth recovery but this is contraindicated with possibility of full stomach (e.g. in emergency surgery) or in cases with difficult airway management in whom awake extubation is indicated, 1mg/kg IV of lidocaine is given to minimize the effect of extubation on IOP. Oral intake is resumed as early as possible as most pediatric patients undergoing ocular surgery are considered day cases but the high incidence of PONV sometimes favors hospital overnight admission.

PRINCIPLES OF PAIN RELIEF AND POSTOPERATIVE CARE

To mange mild to moderate postoperative pain which occur in most ocular procedures, topical local anesthetic agents, NSAIDs or simple analgesics such as paracetamol may be given preoperatively either orally, rectally or IV at induction of anesthesia.

More severe pain as in vitreoretinal, enucleation and squint surgeries need strong analgesics given intraoperatively beside previously mentioned drugs such as intravenous fentanyl. Postoperative codeine phosphate or in older children tramadol or even morphine may be given if needed. Opioid use increase the risk of PONV and antiemetics are indicated

Good analgesia can be produced by peribulbar block although most anesthesiologist avoids using this technique in children for fear of globe perforation and retrobulbar hemorrhage. Tenon's capsule is the fascial layer that extends from the limbus posteriorly to the optic nerve, separating the globe from orbital fat. Sensation of the eye is provided by ciliary nerves that cross the episcleral space after emerging from the globe. Sub-Tenon block is very effective in pain relief if administrated at the end of surgery, strabismus surgery confined to this space and instilling local anesthetic can induce postoperative analgesia.

Otimal postoperative analgesia is crucial as pain may partly be responsible for PONV, emotional distress, and discharge delay if not properly treated. In 2008, the Association of Pediatric Anaesthetists of Great Britain and Ireland published guidelines for certain procedures, including, recommendations for strabismus surgery.[24] There were three grade B recommendations:

1- Intraoperative local anesthetic blocks (sub-tenon or peribulbar) are effective in reducing PONV as well as improving preoperative analgesia when compared with intravenous opioids.
2- Topical nonsteroidal anti-inflammatory drugs (NSAIDs) have no extra beneficial effect on pain scores or postoperative analgesic requirements when compared with topical local anesthetics or placebo.
3- Intraoperative opioids and NSAIDs have same postoperative analgesic effect, but opioid use increases the risk of PONV.

The highest incidence of PONV was found in the meperidine group of patients when comparing the effect of fentanyl, meperidine, and peribulbar block, in combination with propofol infusion on PONV; the lowest was found in the peribulbar block, and fentanyl was in between.[25] Practically, the use of opioids should be minimized by administering acetaminophen and NSAIDs, in order to reduce the incidence. Other studies have shown that fentanyl increases PONV after strabismus surgery; but, a propofol and sufentanil technique showed less PONV compared with a propofol and isoflurane technique.

In comparison with sevoflurane and desflurane, bradycardia in response to OCR is more prominent with remifentanil.[26] But it had the same incidence of PONV, when compared with fentanyl and as expected, higher pain scores were found in patients who received remifentanil.[1]

Topical tetracaine proved to be effective in two separate studies;[27, 28] however this cannot be demonstrated by another study.[29] Topical diclofenac has excellent analgesic effect with low incidence of PONV, however ketorolac did not show this benefit.[29]

POSTOPERATIVE NAUSEA AND VOMITING

Nausea alone is difficult to be determined in children who usually had a higher incidence of PONV when compared to adults. Postoperative vomiting is very common in children after strabismus surgeries, especially in children over the age of 2 years. About two-thirds of children vomit after strabismus surgery, if no preventive measures were taken. Most of the studies focus on prophylaxis rather than treatment. A systematic review of publications between 1981 and 1994 on vomiting in children after squint surgery demonstrated a mean incidence of vomiting within 6 hr of 54% in children receiving no prophylactic anti-emetic and 59% within 48 hr.[30]

The exact mechanism of vomiting is not understood however it was suggested that it is a part of an ocular-emetic reflex, involving the ophthalmic division of the trigeminal nerve and the vomiting centre in the medulla, retrobulbar or peribulbar block reduces the incidence of postoperative vomiting probably due to local anatomical reasons for the reflex, as the incidence of vomiting varies according to the surgical techniques, e.g. squint repair using the Faden myopexy technique has a significantly higher incidence of POV than the simpler muscle recession/ resection technique. Other prophylactic strategies to avoid postoperative vomiting included the use of anticholinergic agents, dexamethasone dimenhydrinate, clonidine, anti-emetics (e.g. metoclopramide, droperidol, ondansetron) or using the anti-emetic properties of propofol either as an induction agent or as part of TIVA technique.[31] However, 5-HT_3 (serotonin) antagonists has led to marked reduction in the incidence of POV,[32] if given intraoperatively. Ondansetron 0.1 mg/kg is very effective and smaller doses have been proved to be equally effective. Combination therapy (e.g. ondansetron and dexamethasone) is better than ondansetron alone. Cheaper 5-HT_3 antagonists (e.g. dolasetron 0.35 mg/kg) have been proved to be as effective as ondansetron,[33] although dolasetron is not commonly available. Finally, acupressure to the P6 acupuncture point, a less common form of anti-emetic treatment, was found to be effective.[34]

ANESTHESIA FOR SPECIFIC OPHTHALMIC PROCEDURES

1. Eye examination and measurement of IOP

For eye examination under general anesthesia (EUA), either inhalational or intravenous induction technique with facemask to maintain the airway will be satisfactory. For longer time EUA it is better to use LMA. Repeated examinations under GA are required in most of these children so it is recommended to manage them gently. Most anesthetic agents reduce IOP, so it can mask a high IOP and lead to mismanagement. The use of ketamine in such cases is preferred by many anesthesiologists because it does not reduce IOP. A dose of 5–10 mg/kg ketamine intramuscularly is sufficient to make a child calm and still enough within a few minutes to allow eye examination. It is reported that ketamine causes a slight increase in IOP; however, it is safer to have a falsely high rather than a falsely low IOP reading. Atropine 20μg/kg or glycopyrrolate 10μg/kg is usually given as ketamine increases respiratory secretions. Maintenance of patent airway is mandatory, but instrumentation of the airway is rarely required.[2,6] Inhalational induction with sevoflurane via face mask with the presence of surgeon, is appropriate alternative technique to ketamine, and to measure the IOP as soon as the child is asleep. The sevoflurane should be kept at <5%, the child's eyes should be central and pressure on the eyes by the facemask should be avoided. It is recommended to measure IOP before airway instrumentation, however there is little evidence to prove that the latter significantly increases IOP. A proper technique should be maintained when serial measurements of IOP are to be made.

2. Syringing and probing of nasolacrimal ducts

Blocked nasolacrimal ducts in young children present early in life with increased tearing. For syringing and probing of nasolacrimal ducts the LMA will suffice if the surgeon does just probing. But if the aim is to inject saline in the nasolacrimal duct then intubation is important to secure airway and avoid aspiration. In case of failure of simple probing, inferior turbinate bone may be fractured to or silicon catheter may be placed for few weeks to relieve the obstruction. Dacrocystorhinostomy is more complicated procedure which involves exposure of the duct and creation of new opening through the nasal cavity.[1] In order to reduce bleeding topical vasoconstrictor is applied on the nasal mucosa of the child and hypotensive anesthesia is induced, it is essential to secure the airway by intubation and packing the throat; adequate suction of the nasopharynx before extubation is required. Postoperative analgesia with opioids is needed. Antibiotic prophylaxis in patient at risk of infective endocarditis is no longer given routinely in this procedure.

3. Strabismus surgery

Strabismus is usually idiopathic but secondary strabismus may occur in cases of trauma, infections, and space-occupying lesions, immunological, endocrine or inflammatory conditions that may result in muscle palsy. Most children with strabismus are healthy, however some may present with disorders of central nervous system such as cerebral palsy, hydrocephalus and myelomeningocoele. Other diseases or syndromes may be associated with strabismus such as cardiomyopathy and congenital heart diseases; each disease or syndrome has its specific anesthetic implication and should be considered during evaluation and management. Possible incidence of malignant hyperthermia

in patient with positive family history[3] is common with strabismus surgery and the possibility is confirmed with a cuff muscle biopsy and caffeine test. Strabismus surgery is the most commonly performed pediatric eye surgery. It affects both males and females similarly.

During strabismus surgery the surgeon may use forced duction testing to differentiate a paretic from restrictive squint. Sometimes botulinum toxin maybe injected into extraocular muscle requiring electromyelogram (EMG). Muscle relaxants are avoided in those cases. Topical local anesthetic can be used in fine adjustments after adjustable suture techniques in older children for minimum 24 to 48 hours after surgery.

Anesthetic technique, airway security and choice of ventilation vary according to the anesthesiologist choice. Both, TIVA or volatile anesthetics can be used for maintenance of anesthesia, however TIVA reduces the incidence of PONV.

PONV is very common up to 50–75% postoperatively. Combination of ondansetron 0.1 mg/kg IV and dexamethasone 0.1-0.2 mg/kg IV is effective in reducing this percentage by 10%.[35] Atropine 20 μg/kg IV or glycopyrolate 10 μg/kg IV should also be considered to overcome this problem.

Deep extubation is preferred, it is better to avoid intraoperative opioids due to high risk of PONV, but fentanyl is considered. If necessary, postoperative pain can be managed using NSAIDs, paracetamol and topical local anesthetics. A peribulbar block decreases the incidence of PONV by blocking the ophthalmic division of trigeminal nerve that passes to the vomiting centre in the medulla as well as providing analgesia after surgery, however it is not recommended by most anesthesiologist due to high risk of globe perforation.[21] Intraoperative sub-tenon block is very effective for analgesic requirements.

4. Intraocular surgery

Intraocular procedures are performed in pediatric patients mainly for management of glaucoma or for cataract aspiration with or without lens implantation. Pediatric glaucoma surgeries include goniotomy, trabeculotomy and trabeculectomy, to maintain balance between production and drainage of aqueous humour and keep the normal IOP 10-22 mmHg. For cases not corrected surgically a cryoprobe at −60 to −80°C behind the corneoscleral limbus is applied, the procedure is painful and opioid analgesia may be essential.

Any increase in venous pressure of the eye due to coughing or straining will cause an immediate rise in IOP by interfering with aqueous drainage via the canal of Schlemm and altering the volume of the choroid; on the other hand arterial pressure has little effect on IOP.

Neuromuscular blockade and controlled ventilation should be applied as it is important to keep the child's eye central and motionless. Sudden rise in IOP should be avoided to prevent extrusion of the eye content through surgical incision especially in keratoplasty when cornea is penetrated and large defect should be covered with graft.

In order to prevent IOP rising, acetazolamide which decreases aqueous production, or IV mannitol can be given during these procedures. However, in penetrating keratoplasty IOP shouldn't be lowered too much as it causes the eye to collapse. The surgeon may suture a ring around the cornea to support the eye during surgery.

Anesthesia is best maintained until neuromuscular blockade has been reversed, and patient is breathing spontaneously and extubation has been performed. Deep extubation is recommended , a small dose of propofol (0.5 mg/kg) immediately before extubation can be given in order to obtain smooth extubation and preventing increased IOP which be caused by coughing, straining on the endotracheal tube at the end of surgery. In older children, topical anesthesia to the airway is effective although this should be avoided in infants. Early resumption of oral intake is the simplest way to avoid the elevated IOP associated with crying in the immediate postoperative period. LMA and pressure controlled ventilation is safe and effective,[36] even though there is possibility of gastric insufflation and reflux, it can be used even in small children undergoing intraocular surgery. This has the benefit of smooth extubation with less coughing and decreased incidence of acute IOP elevation compared with the usual tracheal tube.[37] LMA should be properly positioned and well secured otherwise tracheal tube should be used. Combination of paracetamol and diclofenac is usually effective to control postoperative pain as intraocular procedure is not particularly painful.

Combined general and local anesthesia can be done for older children undergoing intraocular surgeries using low volume single injection peribulbar block with short fine needle 25-27G to decrease anesthetic requirements and to allow rapid smooth recovery.

5. Enucleation and evisceration

Intraocular tumors such as retinoblastoma or endophthalmitis or cosmetic purposes, where there is an unsightly blind eye, removal of the whole eye is indicated. So long the procedure involves dissection of the extraocular muscles off the globe, OCR can be easily initiated, same anesthetic management as in squint surgery should be chosen. However, the risks of PONV are much lowered. In evisceration, the content of the globe are removed leaving the sclera behind with the extraocular muscles intact. Because the procedure is painful intaoperative fentanyl may be needed.

6. Vitreoretinal surgery

Retinal detachment in pediatrics may be primary due to retinal defect or secondary due to underlying disease. Repair of the detached retina is performed via vitreoretinal surgery, however this is unusual in children. The procedure involves creating a choreoretinal scar and placing a scleral buckle towards the back of the eye, which helps to oppose the neuroretina and retinal pigment epithelium. To tamponade the detached surfaces together,[2,3] the surgeon injects an intraocular bubble of either sulphur hexafluoride or perfluropropane. Nitrous oxide is avoided if intraocular gas is injected or in patients having intraocular bubble placed for several weeks after surgery. Mechanical ventilation and neuromuscular blockade are indicated to keep the eye motionless and avoid increased IOP during the surgery. Deep extubation is indicated for the same reason. Postoperative analgesics including opioids, and antiemetic should be considered for proper management of severe pain and PONV.

7. Emergency surgery

Emergency surgeries cannot be delayed for prompt repair of rapture globe with or without an intraocular foreign body; the faster the repair the less is the incidence of infection. In many cases the stomach is full and prompt intubation for airway protection is achieved by rapid sequence crush induction using succinylcholine and cricoid pressure. However, succinylcholine may cause transient increased IOP and subsequent extrusion of intraocular contents through even small wounds leading to the hazard of total loss of vision, although no well- documented reports have proven this.[38] Intubation can be performed using a large dose of a non-depolarizing relaxant while maintaining cricoid pressure to avoid the effect of succinylcholine on IOP. To summarize, it is recommended to consider succinylcholine in cases of difficult airway management or there is high risk of regurgitation. If succinylcholine is contraindicated, or the risk of regurgitation is less concerned, a non-depolarizing relaxant with nerve stimulator monitoring can be used

8. Retinopathy of prematurity

Retinopathy of prematurity (ROP) is common in babies of birth weight <1500 g and/or <31 weeks gestational age. ROP is classified in five stages ranging from mild (stage 1) to severe (stage 5). Infants with stage 3 or above are at high risk of retinal detachment and blindness. The abnormal peripheral retinal neovascularization should be abolished by the use of cryotherapy or laser therapy. Good results obtained when early interference is done, so early diagnosis and repeated examination of at risk infants should be considered between 6 and 7 weeks postnatal age 2-weekly until the risk has passed. Cryotherapy is a painful procedure and requires strong analgesic such as an opioid e.g. fentanyl. Postoperative ventilation with appropriate support is needed for the babies to avoid apneic episodes following anesthesia. In many infants other systemic disorders because of their extreme prematurity (e.g. bronchopulmonary dysplasia) need careful assessment.

CONCLUSION

This assay has reviewed the current general principles of anesthesia for pediatric eye surgery, as well as detailed an anesthetic plan for some common procedures including anesthetic techniques. The important points include; general anesthesia is the preferable choice by most anesthesiologists, most of the cases are healthy and managed as day cases. Understanding the mechanism of oculocardiac reflex and oculorespiratory reflex and their associated risk factors and treatment, in addition to analgesia options and antiemetic prophylaxis should be considered.

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