# Anaesthesia for eye surgery in paediatrics

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## Abstract

Children are rarely able to tolerate being awake for any type of surgery under local anaesthesia, therefore the majority of paediatric eye surgery is performed under general anaesthesia. Most patients presenting on a paediatric ophthalmology operating list will be otherwise healthy children who are suitable for day surgery. However, some children may have eye abnormalities as part of a congenital disorder. The perioperative plan should be formulated after assessment of the child's behaviour, co-existing medical issues and the surgical conditions required for the specific procedure. Factors influencing Intraocular pressure may require to be controlled, and anaesthetists should be vigilant for the oculocardiac reflex. Postoperative nausea and vomiting (PONV) is increased in ocular surgery, particularly with strabismus correction. Pain and opioid analgesics can both increase the risk of PONV. In most cases, simple analgesia and the intraoperative use of topical local anaesthesia will provide effective postoperative pain relief.

**Keywords** Anaesthesia; intraocular pressure; oculocardiac reflex; ophthalmic; paediatric

**Royal College of Anaesthetists CPD Matrix:** 1A02, 2D02, 3A12

## Learning objectives

After reading this article, you should be able to:

- describe the preoperative considerations for paediatric eye surgery, including potential associated congenital conditions
- list the anaesthetic factors influencing intraocular pressure and how to optimize them
- describe the oculocardiac reflex and how to attenuate it
- understand the importance of reducing the risk of post-operative nausea and vomiting
- discuss a suitable anaesthetic plan specific to the urgency and type of ophthalmic procedure

Children are rarely able to tolerate being awake for any type of surgery under local anaesthesia. The majority of paediatric eye operations will therefore be performed under general anaesthesia. The perioperative plan will be informed by considering the child's behaviour, comorbidities and the surgical intra-operative requirements.

## Preoperative assessment

Most patients presenting on a paediatric ophthalmology list will be otherwise healthy children who are suitable for day surgery. However, some children may have eye abnormalities as part of a congenital disorder. An appreciation of the potential associated anaesthetic challenges of these disorders (Table 1) is essential to prepare a safe perioperative plan.

### Premedication

During the preoperative assessment of any paediatric patient, it is important to assess their behaviour and anxiety. Developmental delay, previous hospital admissions and visual impairment may increase the possibility of anxiety or distress. The approach to preoperative anxiety is multi-modal but sedative premedication remains a key part of anaesthetic management. If it is thought that the child may be unco-operative in the anaesthetic room, then the option of premedication can be discussed with the parent and child. Commonly used oral premedication agents include midazolam (0.5 mg $kg^{-1}$) or clonidine (2–4 μg $kg^{-1}$).

## Intraoperative anaesthetic plan

There is no set recipe for anaesthesia for eye surgery and it should be tailored to both the needs of the patient and optimal conditions for the surgeon.

### Induction

There is no evidence to suggest superiority between inhalational or intravenous induction of anaesthesia, therefore the choice will depend on patient factors and individual anaesthetist preference. Nitrous oxide should probably be avoided if planning an inhalational technique. Not only may it increase the already high rates of postoperative nausea and vomiting (PONV), nitrous oxide may also have deleterious effects on intraocular pressure or diffuse into an intraocular air bubble during retinal detachment surgery.

### Airway

The airway management plan will be influenced by both the predicted level of difficulty and the required operative conditions. It may be sufficient to manage a short examination or extra-ocular procedure with the patient spontaneously breathing on a laryngeal mask airway (LMA). Intra-ocular surgery often requires a completely immobile eye with muscle relaxation. An LMA technique may offer smooth emergence where regurgitation risk is minimal, however an endotracheal tube (ETT) and controlled ventilation is often favoured for these procedures due to limited access to the airway under sterile drapes. A south-facing RAE or reinforced ETT are both suitable choices for securing the airway. In patients under 6 months old it may be preferable to use a reinforced ETT, as the fixed distal length of a RAE tracheal tube increases the risk of endobronchial intubation in the short infant trachea.

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## Congenital disorders and associated anaesthetic challenges

| Congenital disorder | Eye presentation | Potential anaesthetic challenges |
|---|---|---|
| Craniosynostosis Disorders<br>• Crouzon's<br>• Apert's<br>• Pfeiffer's | Cataract, glaucoma, squint | Midface hypoplasia → **upper airway obstruction**<br>Choanal atresia → **nasal obstruction**<br>Tracheal anomalies → **ventilation issues** |
| Craniofacial syndromes<br>• Goldenhaar<br>• Treacher-Collin<br>• Smith-Lemil-Opitz | Cataract, glaucoma, squint | Retrognathia, ↓mouth opening, ↓neck extension, macroglossia<br>→ **difficult laryngoscopy** |
| Mucopolysaccharidoses | Cataract, glaucoma, squint | **Post extubation stridor and respiratory collapse**<br>**Difficult mask ventilation and difficult intubation** |
| Hallerman-Streiff | Neonatal cataract | Mandibular hypoplasia and microstomia → **difficult intubation** |
| Congenital phakomatoses<br>• Sturge-Weber<br>• Neurofibromatosis<br>• von Hippel Lindau | Haemangiomas, ocular melanocystosis, retinal haemangioblastoma | Associated seizures, intracranial pathology, phaeochromocytoma |
| Homocystinuria | Dislocated lenses | **Hypoglycaemia, thromboembolism → hydration ± glucose** |
| Marfan's syndrome | Dislocated lenses | Aortic root or aortic valve disorders → **avoid hypertension** |
| Stickler's | Glaucoma, retinal detachment | Mandibular hypoplasia → **difficult facemask and intubation**<br>Retromicrognathia, cleft palate |

**Table 1**

### Intraocular pressure

Maintaining a normal intraocular pressure (IOP) of 10–20 mmHg is important for some forms of eye surgery. Anaesthetic factors influencing IOP and management options are summarized in Table 2.

### Oculocardiac reflex

When the afferent ophthalmic branches of the trigeminal nerve are stimulated by muscle traction, this can produce a vagal response. The efferent vagal activity can result in worsening bradycardia. The oculocardiac reflex (OCR) has been reported to occur in more than half of strabismus surgery cases during traction of the extra-ocular muscles. Heart rate often returns to normal when traction is released, but prophylaxis or treatment with atropine or glycopyrrolate may be necessary. Rocuronium has been demonstrated to attenuate the OCR. Previously the OCR was thought to be a predictor of PONV, but this association has not been reliably demonstrated.

### Postoperative nausea and vomiting

The incidence of PONV is quoted between 50 and 75% with paediatric ocular surgery if no antiemetic is given. Strabismus correction is particularly emetogenic; the incidence may be up to 90% without intraoperative prophylaxis. Minimizing the risk of PONV is particularly important in this patient group, as vomiting and retching increase IOP and may potentially compromise surgical recovery. The anaesthetist may wish to incorporate some antiemetic strategies to their anaesthetic plan – consider total intravenous anaesthesia (TIVA); avoid emetogenic drugs, such as nitrous oxide and neostigmine; minimize opioid analgesia; optimize hydration and minimize fasting times; and incorporate multimodal antiemesis. Dexamethasone 0.15 mg $kg^{-1}$ and ondansetron 0.1 mg $kg^{-1}$ are commonly used. PONV induced by increased IOP will not settle with pharmacological interventions, therefore an ophthalmology review should be considered in refractory PONV.

### Analgesia

In the majority of cases, post-operative pain is mild to moderate and can be managed with a combination of simple analgesia and local anaesthesia. If local anaesthesia drops or a sub-Tenon block (by the surgeon) are used, paracetamol and ibuprofen should provide adequate pain control. Pain and opioid analgesics can both increase the risk of PONV, therefore it is important to provide effective analgesia while avoiding opioids wherever possible. Higher pain scores are often associated with strabismus correction, vitreoretinal surgery and evisceration of the eye, and opioid analgesia (e.g. oral morphine) may be required for these procedures.

## Specific procedures

### Examination of the eyes (including IOP measurement)

Younger children will often require general anaesthesia for full ocular examination. Unless only a very brief examination is

**Anaesthetic factors affecting intraocular pressure (IOP)**

| Factors increasing IOP | Anaesthetic techniques to control IOP |
|---|---|
| $\downarrow O_2$ $\uparrow CO_2$ | Control of ventilation; intermittent positive pressure ventilation; maintain normal oxygen saturations; normal end tidal $CO_2$ |
| ↑ Ocular venous pressure | Facilitate venous drainage<br>Tape endotracheal tube, slight head up position on table, neutral head position |
| Drugs | Avoid use of nitrous oxide |
| • Suxamethonium (transient) | Only use ketamine or suxamethonium if clinical necessary |
| • Nitrous oxide | Propofol, opioids, volatile agents and non-depolarizing muscle relaxants safe to use |
| • Ketamine (transient) | |
| Direct external pressure | Care taken during facemask ventilation.<br>Protect the eyes prior to commencement of surgery |
| Coughing, straining, seizures | Smooth induction and emergence, avoid light anaesthesia |
| Pain | Adequate analgesia |
| Increased muscle tone | Consider using muscle relaxants |
| Vomiting | Prophylactic antiemetics. Avoid nitrous oxide. Consider TIVA |
| Hypertension | Adequate depth of anaesthesia throughout<br>Consider opioid for laryngoscopy. |

**Table 2**

required, this is often best achieved with a LMA. This allows the surgeon better access and allows the anaesthetist to be hands free. Additionally, some full ophthalmic examinations may take a significant amount of time.

Historically, ketamine was used for induction if IOP measurement was planned. Modern practice involves the use of standard anaesthetic intravenous or gas induction techniques with rapid assessment of the IOP by the ophthalmologist (often in the anaesthetic room). The evidence relating to changes in IOP with various anaesthetic agents and techniques is conflicting. The most important principle is likely to be communicating the agents and technique to the ophthalmologist, especially if serial measurements are to be made.

### Syringe and probe

Probing of the nasolacrimal ducts is a brief but common procedure in younger children. Although a short procedure, it is often easier to place a LMA to allow the surgeon access. It also offers some protection of the larynx against fluid used by the surgeon to flush through the duct that occasionally causes laryngospasm or coughing.

### Ocular procedures for glaucoma

Goniotomy, trabeculotomy and trabeculectomy are related drainage procedures used to treat congenital glaucoma. A motionless eye with control of IOP is required by the surgical team and this will necessitate controlled ventilation. This can be achieved with a LMA but will often necessitate intubation and paralysis in smaller patients. Intraocular procedures are not particularly painful and simple analgesia with paracetamol and a NSAID should be sufficient.

### Strabismus surgery

Surgery for squint is a very common procedure in children. It can usually be performed as a day case, but there is always the risk of significant PONV and adequate prophylaxis should be provided (see above). It is important to be vigilant for the oculocardic reflex (see above). Most procedures are usually performed with spontaneous ventilation, but it is important to note that the OCR may be more marked with significant hypercapnia. Pain is fairly minimal and can be treated with simple analgesia. The previously quoted association between malignant hyperthermia and strabismus surgery does not hold up to scrutiny.

### Vitreoretinal surgery

Retinal detachment may occasionally occur in children. Surgical treatments often involve scleral buckling, vitrectomy or a combination of techniques. Sometimes an intraocular gas bubble is placed to tamponade the detached surface. It is imperative to avoid nitrous oxide in these cases as this will diffuse into and expand the gas bubble potentially causing irreversible ischaemic damage. Patients with a gas bubble may have to adopt a particular position post operatively. Silicone oil is increasingly used to avoid some of these potential issues. Vitreoretinal surgery can be uncomfortable and analgesia is usually augmented with a sub-Tenon block.

### Enucleation and evisceration

Removal of the whole eye may be considered because of retinoblastoma or for cosmetic reasons in an otherwise blind eye. Due to the extensive muscular dissection the OCR may easily be evoked. Both these procedures are painful and opioid analgesia is likely to be required.

### Penetrating eye injury

Some eye injuries may require expedited exploration and wound closure without the time for adequate fasting. With the widespread introduction of sugammadex and the routine use of rocuronium for rapid sequence induction (0.9–1.2 mg $kg^{-1}$) traditional concerns regarding suxamethonium and increases in IOP are no longer relevant. The goals are a smooth induction and intubation, without coughing and any additional rises in IOP. If suxamethonium is the only available muscle relaxant then an adequate dose of induction agent should counteract any significant rise in IOP.

### Retinopathy of prematurity

Retinopathy of prematurity can result in permanent visual loss and blindness. The primary risk factors are low birthweight (<1500 g) and gestation (<32 weeks). At risk babies are screened on a regular basis in the neonatal unit. Those requiring intervention (laser, cryotherapy or modern biologics) are managed in some centres in the neonatal unit. In any neonate requiring intervention in theatre, the standard considerations for

anaesthesia in a preterm neonate apply (see Special considerations in the premature and ex-premature infant. *Anaesthesia & Intensive Care Medicine* 2017; **18** (2): 79–83). These include meticulous attention to temperature regulation and fluid management along with an appreciation of the other potential complications of prematurity (e.g. cardiac disease, bronchopulmonary dysplasia, necrotizing enterocolitis and neurological injury). For this reason most babies will return to the neonatal unit ventilated. ◆

## FURTHER READING

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