Disclosures

No relevant financial relationships.
Learning Objectives:

• Review ophthalmologic physiology relevant to anesthetic management.
• Identify commonly used ophthalmologic medications and their side effects.
• Recognize the effect of surgical urgency on anesthetic management.
• Recognize the perioperative issues specific to common pediatric ophthalmologic procedures.
Ophthalmologic Physiology
Anatomy of the Eye

https://commons.wikimedia.org/w/index.php?curid=1597930
Intraocular Pressure (IOP)

- **Normal**: 12-15 mmHg; **Elevated**: >20 mmHg
- Elevated IOP may lead to extrusion of contents if the globe is ruptured
- Factors increasing IOP
  - Increased central venous pressure
  - Systemic hypertension
  - Hypercarbia
  - Drugs (succinylcholine, ketamine)
Succinylcholine and IOP

• Increases IOP 6 to 10 mmHg
  - Effect begins 1 min after administration
  - Duration of effect: 10 min

• Mechanisms
  - Cycloplegia
  - Tonic contraction of extraocular muscles
  - Increased choroidal blood volume
  - Relaxation of orbital muscles

Consider rocuronium 1.2 mg/kg as an alternative to succinylcholine
Oculocardiac Reflex

• Triggered by pressure on globe or traction on extraocular muscles.
  - *Afferent Pathway*: cranial nerve V (ophthalmic branch)
  - *Efferent Pathway*: cranial nerve X

• May result in dysrhythmias
  - Sinus or junctional bradycardia
  - Atrioventricular block
  - Ventricular ectopy
  - Asystole
Treatment of Dysrhythmias

• Stop surgical stimulation
• Verify adequate oxygenation/ventilation
• Vagolytic agents
  - Atropine 20 mcg/kg IV
  - Glycopyrrolate 10-20 mcg/kg IV
  - Epinephrine 1-10 mcg/kg IV
• Refractory cases may require local anesthetic infiltration of ocular muscles
Ophthalmologic Medications and Syndromes
# Commonly Used Ophthalmologic Medications

<table>
<thead>
<tr>
<th>Drug</th>
<th>Indication</th>
<th>Side Effect Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cholinergic Agonists</strong></td>
<td></td>
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</tr>
<tr>
<td>Carbachol</td>
<td>Induce miosis</td>
<td>Corneal edema, retinal detachment</td>
</tr>
<tr>
<td>Pilocarpine</td>
<td>Glaucoma</td>
<td></td>
</tr>
<tr>
<td><strong>Cholinesterase Inhibitors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physostigmine</td>
<td>Glaucoma</td>
<td>Retinal detachment, miosis</td>
</tr>
<tr>
<td>Echothiophate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Muscarinic Antagonists</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atropine</td>
<td>Cycloplegic retinoscopy</td>
<td>Photosensitivity, blurred vision, increased heart rate, dry mouth</td>
</tr>
<tr>
<td>Scopolamine</td>
<td></td>
<td></td>
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<tr>
<td>Homatropine</td>
<td></td>
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<tr>
<td>Cyclopentolate</td>
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<tr>
<td>Tropicamide</td>
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</tbody>
</table>
# Commonly Used Medications (continued)

<table>
<thead>
<tr>
<th>Drug</th>
<th>Indication</th>
<th>Side Effect Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sympathomimetic Agents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dipivefrin</td>
<td>Glaucoma</td>
<td>Photosensitivity, hypersensitivity</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>Glaucoma</td>
<td></td>
</tr>
<tr>
<td>Phenylephrine</td>
<td>Mydriasis</td>
<td></td>
</tr>
<tr>
<td>Apraclonidine</td>
<td>Glaucoma</td>
<td></td>
</tr>
<tr>
<td>Brimonidine</td>
<td>Glaucoma</td>
<td></td>
</tr>
</tbody>
</table>

| **Alpha and Beta-Adrenergic Antagonists** | |                                               |
| Dapiprazole (alpha)             | Reverse mydriasis   | Conjunctival hyperemia                        |
| Betaxolol (beta 1)              | Glaucoma            | Decreased heart rate and blood pressure, bronchospasm |
| Carteolol (beta)                | Glaucoma            |                                               |
| Levobunolol (beta)              | Glaucoma            |                                               |
| Metipranolol (beta)             | Glaucoma            |                                               |
| Timolol (beta)                  | Glaucoma            |                                               |
## Associated Systemic Disorders

<table>
<thead>
<tr>
<th>Systemic Disorder</th>
<th>Ophthalmologic Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prematurity</td>
<td>Retinopathy of prematurity, congenital cataracts, glaucoma, strabismus</td>
</tr>
<tr>
<td>Trisomy 21 (Down syndrome)</td>
<td>Neonatal cataracts, strabismus, glaucoma, nasolacrimal duct obstruction, nystagmus</td>
</tr>
<tr>
<td>Alport syndrome</td>
<td>Cataracts, retinal detachment, keratoconus</td>
</tr>
<tr>
<td>Connective tissue disorders</td>
<td>Retinal detachment, lens dislocation, glaucoma, cataracts, optic atrophy, intraocular hemorrhages</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td></td>
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<tr>
<td>Homocysteinuria</td>
<td></td>
</tr>
<tr>
<td>Ehlers-Danlos syndrome</td>
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</tr>
<tr>
<td>Craniofacial syndromes</td>
<td>Severe proptosis, multiple other ocular disorders</td>
</tr>
<tr>
<td>Apert syndrome</td>
<td></td>
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<tr>
<td>Crouzon syndrome</td>
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</tbody>
</table>
Ophthalmologic Procedures
Common Ophthalmologic Procedures in Children

• Emergent and penetrating globe injury
• Examination under anesthesia
• Cataract excision
• Strabismus repair
• Glaucoma surgery
• Treatment for retinopathy of prematurity
Emergent Procedures

Example - Ruptured Globe

May need to proceed with surgery despite not being NPO

• Modified rapid sequence IV induction with Propofol* and rocuronium; intubation with cuffed ETT to secure airway

• If no IV, gentle inhalational induction; proceed with second practitioner available to place IV as quickly as possible to facilitate securing airway

*Consider thiopental 5 mg/kg or methohexital 1-2.5 mg/kg if Propofol unavailable.
Exam Under Anesthesia (EUA)

• Common Indications:
  - General eye exam
  - Fundoscopy
  - IOP measurement

• General anesthesia needed when child uncooperative or too young to follow commands

• Preoperative evaluation for associated conditions or syndromes
Exam Under Anesthesia

Anesthetic technique

• Simple/short duration exam: consider mask general anesthetic
  - Inhalational induction
  - +/- IV access
  - Intermittent deepening of anesthetic as needed

• Longer/more involved exams: consider LMA
  - Inhalational induction
  - IV access established
  - LMA placement
Exam Under Anesthesia

IOP measurements – special considerations

• Important to have accurate measurement for assessing glaucoma/treatment
• “Safer” to have falsely elevated measure as falsely low measure could delay treatment
IOP Measurement

• Consider effects of induction agents on IOP to limit effects on the measurement
• Allow measurement of IOP as soon as child stops moving
• Ensure face mask does not compress eyes
• If airway device planned, measure IOP prior to airway manipulation
Cataract Surgery

Types of cataracts

• Congenital: Early repair may allow photo-stimulation of retina
• Post traumatic
• Metabolic

*Surgery involves corneal incision, removal of opacified patient lens, +/- intraocular lens implant*

https://search.creativecommons.org/search?q=cataract&provider=&li=&lt=commerci&searchBy; accessed 7/22/19
Cataract Surgery

*Preoperative evaluation*

- Identify associated conditions/syndromes and anesthetic implications
- Evaluation of child to determine anesthetic technique
  - General anesthesia in the majority of pediatric patients
  - Can consider local anesthetic with sedation in older and more mature teenagers
<table>
<thead>
<tr>
<th>Condition/Syndrome</th>
<th>Potential Anesthetic Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucopolysaccharidoses</td>
<td>Difficult airway</td>
</tr>
<tr>
<td>Hallerman-Strieff syndrome</td>
<td>Difficult airway</td>
</tr>
<tr>
<td>Trisomy 21</td>
<td>Congenital heart disease, atlantoaxial instability, subglottic stenosis, bradycardia with induction</td>
</tr>
<tr>
<td>Alport syndrome</td>
<td>Hearing loss, renal disease, myopathy</td>
</tr>
<tr>
<td>Homocystinuria</td>
<td>Coronary artery disease, hypercoagulability, renal disease</td>
</tr>
<tr>
<td>Marfan Syndrome</td>
<td>Aortic dilation/dissection concern</td>
</tr>
<tr>
<td>Fabry disease</td>
<td>Cardiac/renal/pulmonary involvement</td>
</tr>
<tr>
<td>Prematurity/congenital cataract</td>
<td>Postoperative apnea, pulmonary disease, patent foramen ovale, patent ductus arteriosus</td>
</tr>
</tbody>
</table>
Cataract Surgery

• Communication with ophthalmologist important
  - Limited access to airway
  - Microscopic surgery requires still operating field
  - LMA or ETT can be used for airway

• Induction/maintenance
  - Elevated IOP usually not a concern
  - Inhalational or IV induction at anesthesiologist’s discretion
  - IV access important to treat possible OCR
Cataract Surgery

**Emergence/postoperative management**

- Prevent acute rises in IOP
  - Consider deep extubation
  - Topical local anesthetic +/- sub-tenon blocks for post-op pain control
  - Pharmacologic PONV prophylaxis
  - Limit opioids to prevent post-op nausea or vomiting (multimodal anesthesia)

- Typically outpatient procedure unless coexisting conditions or prematurity mandate post-operative monitoring
Strabismus

https://search.creativecommons.org/search?q=strabismus&provider&li&lt=modification&searchBy: accessed 7/22/19
Strabismus

• Divergent visual axes of eyes
• Common names: squint or cross eyed
• Often isolated finding but may be related to systemic disease/syndromes
  - Craniofacial syndromes: Crouzon, Apert, Pfeiffer
  - Prematurity
  - Myopathies/cardio-myopathies
  - Central nervous system disorder
  - Fetal alcohol syndrome
Strabismus Repair

• Realigns divergent visual axes of eyes by detaching and reattaching extraocular muscles of the globe

• Forced duction test
  - Performed prior to repair
  - Mechanical restriction to movement of eye assessed by ophthalmologist
  - Differentiates a paretic EOM from muscle restriction impeding movement of eye

• High risk for postoperative nausea and vomiting
• One of most painful ophthalmologic procedures
Strabismus Repair

Induction/Maintenance

• Inhalational or IV induction at discretion of anesthesiologist
• IV access essential for treating PONV, pain and possible OCR
• LMA for airway management
• Pharmacologic PONV prophylaxis
• Limit opioids to prevent PONV
• Multimodal analgesia: acetaminophen, NSAIDS
• Consider propofol-based anesthetic to minimize PONV
Strabismus Repair

Emergence/Postoperative Management

• Pharmacologic PONV prophylaxis prior to emergence
• May consider deep extubation
• May need additional PONV treatment such as scopolamine patch or benzodiazepine (Ativan)
• Typically outpatient procedure
• Discharge from PACU if no significant PONV and able to take POs
PONV Prevention Review

- Limit preoperative dehydration: Give clears until 2 hours prior to surgery
- Avoid nitrous oxide
- Consider intraoperative fluid bolus of 30 ml/kg
- Serotonin 5-HT₃ antagonist (e.g. ondansetron)
- Dexamethasone (0.1 mg/kg up to 10 mg)
- Benzodiazepines
- Scopolamine patch
- Propofol-based anesthetic with minimal volatile agents
- Minimize narcotics: utilize multimodal analgesia
Glaucoma

Medical Management

• Agents may be used as first-line management or as adjunct to surgery

• Therapeutic window for topical medications can vary widely with age

• Most common: beta-blocker +/- carbonic anhydrase inhibitor (CAI)
  - Beta blocker: systemic effects include bronchospasm, bradycardia
  - CAI: topical usually systemically safe; oral therapy may result in metabolic acidosis
Glaucoma Surgery

Goniotomy and Trabeculectomy are most common surgical procedures.

• Eye must remain motionless to avoid extrusion of intraocular contents
  - Avoid coughing on extubation
  - Consider endotracheal intubation and neuromuscular paralysis

• Acetazolamide may be administered IV during procedure to reduce IOP
Retinopathy of Prematurity

• Abnormal blood vessel growth in the retina

• Associated with prematurity, low birth weight, exposure to supplemental oxygen

• Severe disease (Stage 3 or above) may lead to retinal detachment and blindness
ROP Treatments

*Cryotherapy or laser therapy*

• Neonatal unit versus operating room
• Avoid high FiO₂
• May require opioid administration
• Consequences of extreme prematurity
  - High incidence of bronchopulmonary dysplasia
  - Apneas → may require postoperative ventilation
Conclusions:

• Communication with the ophthalmologist is essential.
• Thorough preoperative assessment for associated conditions and syndromes is vital.
• Oculocardiac reflex: Be vigilant and have anticholinergic medications immediately available.
• During emergent ocular surgery, the risk of aspiration must be weighed against the risk of IOP increases.
• PONV prevention is important.
References:


References:
