Anesthesia For
Ophthalmic Surgery

DR. FATMA ALDAMMAS
Ophthalmic Surgery

Eye surgery provides several unique challenges for the anesthesiologist including:

- regulation of intraocular pressure
- prevention of the oculocardiac reflex
- management of oculocardiac reflex
- control of intraocular gas expansion
Why was this patient a particular challenge to the anesthesiologist?

- The combination of a full stomach and an open-globe injury, both of which conditions is problematic for the anesthesiologist.
- Besides the increased risk of aspiration of gastric contents, any drug or maneuver that raises intraocular pressure (IOP) can cause extrusion of the vitreous humor and loss of vision.
APPLIED ANATOMY OF THE ORBIT

Diagram showing various structures of the eye, such as the sclera, choroid, retina, ciliary body, conjunctiva, Schlemm's canal, zonule, cornea, corneal endothelium, iris, lens, anterior chamber, posterior chamber, vitreous, optic nerve, central retinal vein and artery, pia, c.s.f. space, dura, and lamina cribrosa.
The orbit

Four-sided bony pyramid
Base pointing anteriorly
Apex posteromedially.
The medial wall of the right and left orbits are parallel to each other
The mean distance from the inferior orbital margin to the apex is 55 mm.

*This has important implications when injections are made into the orbit.*
Squeezing and closing of the eyelids are controlled by the zygomatic branch of the facial nerve (VII), which supplies the motor innervation to the orbicularis oculi muscle.

The facial nerve supplies secretomotor parasympathetic fibres to the lacrimal glands, and glands of the nasal and palatine mucosa.
Movement of the globe is controlled by the six extraocular muscles.

The eye is a hollow sphere with a rigid wall.

Intraocular pressure: 12—20 mmHg

Ophthalmic surgery can be classified into subspecialities and intraocular or extraocular procedures, each has different anaesthetic requiems.
# Table 47.1 Categorization of ophthalmic surgery

<table>
<thead>
<tr>
<th>Ophthalmology subspecialities</th>
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<tbody>
<tr>
<td>Paediatric</td>
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<tr>
<td>Oculoplastic</td>
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<tr>
<td>Retinovitreous</td>
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<tr>
<td>Anterior segment</td>
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<tr>
<td>Glaucoma</td>
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<tr>
<td>Neuro-ophthalmology</td>
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</tbody>
</table>

**Extraocular operations**
- Globe and orbit
- Eyebrow and eyelid
- Lacrimal system
- Muscles
- Conjunctiva
- Cornea, surface

**Intraocular operations**
- Iris and anterior chamber
- Lens and cataracts
- Vitreous
- Retina
- Cornea, full thickness
How is aqueous humor formed and eliminated?

- Aqueous humor is a clear fluid that occupies the anterior and posterior chambers of the eye.
- Its total volume is 0.3 ml.
- Aqueous humor is produced primarily in the posterior chamber.
- Circulates through the pupil to the anterior chamber, passes through the Schlemm’s canal.
- Drains into the episcleral veins and finally into the cavernous sinus or jugular venous.
Physiology of Intraocular Pressure

DR. FATMA ALDAMMAS
Physiology of Intraocular Pressure

- The eye is a hollow sphere with a rigid wall.
- Intraocular pressure 12—20 mm Hg
- If the contents of the sphere increase, the intraocular pressure rise.
## Physiology of Intraocular Pressure

<table>
<thead>
<tr>
<th>Variable</th>
<th>Effect on IOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central venous pressure</td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>↑↑↑↑↑↑↑↑↑</td>
</tr>
<tr>
<td>Decrease</td>
<td>↓↓↓↓↓↓↓↓↓</td>
</tr>
<tr>
<td>Arterial blood pressure</td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td>↑</td>
</tr>
<tr>
<td>Decrease</td>
<td>↓</td>
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<tr>
<td>( \text{PaCO}_2 )</td>
<td></td>
</tr>
<tr>
<td>Increase (hypoventilation)</td>
<td>↑↑</td>
</tr>
</tbody>
</table>
| Decrease (hyperventilation)| ↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓→
Physiology of Intraocular Pressure

Any anesthetic event that alters these parameters can affect intraocular pressure

- laryngoscopy
- Intubation
- airway obstruction
- Coughing
- Trendelenburg position
Effect of Anesthetic Drugs on intraocular Pressure

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Most anesthetic drugs either lower or have no effect intraocular pressure
Inhaled anesthetics

- Inhalational anesthetics decrease intraocular pressure in proportion the depth of anesthesia.
- The decrease has multiple causes:
  1. A drop in blood pressure reduces choroidal volume
  2. Relaxation of the extraocular muscles lowers wall tension
  3. Pupillary constriction facilitates aqueous outflow.
Intravenous anesthetics

Intravenous anesthetics drugs decrease intraocular pressure

Exception is ketamine, which usually raises arterial blood pressure and does not relax extraocular muscles.
Muscle relaxants

• Succinylcholine increases intraocular pressure by 5—10 mm Hg for 5—10 minutes principally through prolonged contracture of the extraocular muscles.

• Nondepolarizing muscle relaxants do not increase intraocular pressure.
The effect of anesthetic agents on intraocular pressure (IOP).

<table>
<thead>
<tr>
<th>Drug</th>
<th>Effect on IOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhaled anesthetics</td>
<td></td>
</tr>
<tr>
<td>Volatile agents</td>
<td>↓↓</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>↓</td>
</tr>
<tr>
<td>Intravenous anesthetics</td>
<td></td>
</tr>
<tr>
<td>Barbiturates</td>
<td>↓↓</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>↓↓</td>
</tr>
<tr>
<td>Ketamine</td>
<td>?</td>
</tr>
<tr>
<td>Narcotics</td>
<td>↓</td>
</tr>
<tr>
<td>Muscle relaxants</td>
<td></td>
</tr>
<tr>
<td>Depolarizers (succinylcholine)</td>
<td>↑↑↑</td>
</tr>
<tr>
<td>Nondepolarizers</td>
<td>0/↓</td>
</tr>
</tbody>
</table>

↓ = decrease (mild, moderate).
↑ = increase (mild, moderate).
0/↓ = no change or mild decrease.
? = conflicting reports.
SYSTEMIC EFFECTS OF OPHTHALMIC DRUGS

DR. FATMA ALDAMMAS
Topical ophthalmic drugs can be absorbed through the conjunctiva, or they drain through the nasolacrimal duct and be absorbed through the nasal mucosa.

Usage of topical medications can have implications for the anesthesiologist.
**Atropine**

- Used to produce mydriasis and cycloplegia. The 1% solution contains 0.2 to 0.5 mg of atropine per drop.

Systemic reactions include tachycardia, flushing, thirst, dry skin, and agitation. Atropine is contraindicated in closed-angle glaucoma.
**Scopolamine**

- One drop of the 0.5% solution has 0.2 mg of scopolamine.

CNS excitement can be treated with physostigmine, 0.015 mg/kg IV, repeated one or two times in a 15-minute period.

It is contraindicated in closed-angle glaucoma.
Phenylephrine Hydrochloride

- Phenylephrine hydrochloride is used to produce capillary decongestion and pupillary dilatation. Applied to the cornea, it can cause palpitations, nervousness, tachycardia, headache, nausea and vomiting, severe hypertension, reflex bradycardia, and subarachnoid hemorrhage.

Solutions of 2.5%, 5%, and 10% (6.25 mg phenylephrine per drop) are available.
Epinephrine

- Topical 2% epinephrine will decrease aqueous secretion, improve outflow, and lower intraocular pressure in open-angle glaucoma.

- Side-effects include hypertension, palpitations, fainting, pallor, and tachycardia.
- The effects last about 15 minutes.
- One drop of 2% solution contains 0.5 to 1 mg of epinephrine.
**Timolol Maleate (Tinwptic)**

- Timolol maleate is a beta-blocker used in the treatment of chronic glaucoma.

Side-effects include light-headedness, fatigue, disorientation, depressed CNS function, and exacerbation of asthma. Bradycardia, bronchospasm, and potentiation of systemic beta-blockers can occur.
**Acetyicholine**

- Acetyicholine can be injected intraoperatively into the anterior chamber to produce miosis. Side-effects are due to its parasympathetic action they include hypotension, bradycardia, and bronchospasm.
Echothiophate Iodide (Phosphazolinne Iodide)

- A cholinesterase inhibitor, echothiophate iodide is used as a miotic agent.
- Prolong the effect of both succinylicholine and ester-type local anesthetics.
- Levels of pseudocholinesterase decrease by 80% after 2 weeks on the drug.
- Succinylicholine and ester-type local anesthetics should be avoided.
THE OCULOCARDIAC REFLEX

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The Oculocardiac Reflex (OCR) is manifested by:
- Bradycardia
- Bigeminy
- Ectopic
- Nodal rhythms
- Atroventricular block
- Cardiac arrest
THE OCULOCARDIAC REFLEX

Caused By

- Traction on the extraocular muscles (medial rectus)
- Ocular manipulation
- Manual pressure on the globe.
THE OCULOCARDIAC REFLEX

The OCR is seen during

- Eye muscle surgery
- Detached retina repair
- Enucleation
What are the afferent and efferent pathways of the oculocardiac reflex?

- The oculocardiac reflex is trigeminovagal.
- The afferent pathway is by way of the ciliary ganglion to the ophthalmic division of the trigeminal nerve, and through the gasserian ganglion to the main sensory nucleus in the fourth ventricle.
- The efferent pathway is through the vagus nerve.
What factors contribute to the incidence of the oculocardiac reflex?

- Preoperative anxiety
- Light general anesthesia
- Hypoxia
- Hypercarbia
- Increased vagal tone owing to age
The reported incidence of cardiac rhythm is higher in children during eye muscle surgery.
How do you diagnose and treat the oculocardiac reflex?

- Monitor the electrocardiogram intraoperatively and during any eye manipulation.
  - Stop the surgical stimulus immediately.
  - Ensure that ventilation is adequate.
  - Ensure sufficient anesthetic depth.
**THE OCULOCARDIAC REFLEX**

*Is atropine useful?*

- Atropine use is controversial.
- Atropine (0.4 mg IM) as a premedicant has no vagolytic effect after 60 minutes and is of no value in preventing or treating the OCR.
- Atropine (0.4 mg IV) is effective for 30 minutes in preventing bradycardia associated with the oculocardiac reflex.
- Doses >0.5 Mg intravenously can cause tachycardia, which can be detrimental in certain patients with heart disease.
INTRAOCULAR GAS EXPANSION

DR. FATMA ALDAMMNAS
INTRAOCULAR GAS EXPANSION

• A gas bubble injected by the ophthalmologist into the posterior chamber during vitreous surgery.

• Intravitreal air injection will tend to flatten a detached retina and allow anatomically correct healing.

• The air bubble is absorbed within 5 days by gradual diffusion through adjacent tissue and into the bloodstream.
INTRAOCULAR GAS EXPANSION

• If the patient is breathing nitrous oxide, the bubble will increase in size.
• because nitrous oxide is 35 times more soluble than nitrogen in blood
• nitrous oxide tends to diffuse into an air bubble more rapidly than nitrogen is absorbed by the bloodstream.
• If the bubble expands after the eye is closed, intraocular pressure will rise.
**Sulfur hexafluoride (SF6)**

- It is less soluble in blood than is nitrogen and much less soluble than nitrous oxide.
- Its longer duration of action (up to 10 days) compared with an air bubble can provide an advantage to the ophthalmologist.

- Bubble size doubles within 24 hours after injection because nitrogen from inhaled air enters the bubble more rapidly than the sulfur hexafluoride diffuses into the bloodstream.

- Even so, unless high volumes of pure sulfur hexafluoride are injected, the slow bubble expansion does not usually raise intraocular pressure.
GENERAL ANESTHESIA
FOR OPHTHALMIC SURGERY

DR. FATMA ALDAMMAS
GENERAL ANESTHESIA

PREMEDICATION

- Pediatric patients often have associated congenital disorders (eg, rubella syndrome, Goldenhar’s syndrome, Down syndrome).

- Adult patients are usually elderly (HTN, DM, CAD).

All of these factors must be considered when selecting premedication.
GENERAL ANESTHESIA

INDUCTION

The choice of induction technique for eye surgery usually depends more on

- the patient’s medical problems
- the patient’s eye disease
- the type of surgery contemplated.
GENERAL ANESTHESIA

INDUCTION

One exception is the patient with a ruptured globe. controlling intraocular pressure with a smooth induction.
coughing during intubations must be avoided by achieving a deep level of anesthesia and profound paralysis.
The IOP response to laryngoscopy and endotracheal intubation can be blunted by prior administration of intraenous lidocaine (1.5 mg/kg) or an opioid (eg, alfentanil 20 pg/kg).
GENERAL ANESTHESIA

INDUCTION

An nondepolarizing muscle relaxant is used instead of succinylcholine because of the latter’s influence on intraocular pressure.

Most patients with open globe injuries have full stomachs and require a rapid-sequence induction technique.
GENERAL ANESTHESIA

MONITORING & MAINTENANCE

• Eye surgery necessitates positioning the anesthesiologist away from the patient’s airway, making pulse oximetry mandatory for all ophthalmologic procedures.
• Continuous monitoring for breathing-circuit disconnections or unintentional extubation is also crucial.
• The possibility of kinking and obstruction of the endotracheal tube can be minimised by using a reinforced or preformed right-angle endotracheal tube.
• The possibility of dysrhythmias caused by the oculocardiac reflex increases the importance of constantly scrutinizing the electrocardiograph.
most pediatric surgery, infant body temperature often rises during ophthalmic surgery because of head-to-toe draping and insignificant body-surface exposure.

End-tidal CO2 analysis helps differentiate this from malignant hyperthermia.
GENERAL ANESTHESIA

EXTUBATION & EMERGENCE

• a smooth emergence from general anesthesia
• deep level of anesthesia.
• intravenous lidocaine (1.5 mg/kg)
REGIONAL ANESTHESIA
FOR OPHTHALMIC SURGERY

DR. FATMA ALDAMMAS
Regional anesthesia for eye surgery has traditionally consisted of:

- a retrobulbar block.
- a facial nerve block.
- intravenous sedation.
REGIONAL ANESTHESIA

RETROBULBAR BLOCKADE

Local anesthetic is injected behind the eye into the cone formed by the extraocular muscles.

A blunt-tipped 25-gauge needle penetrates the lower lid at the junction of the middle and lateral one-third of the orbit (usually 0.5 cm medial to the lateral canthus).

The patient is instructed to stare supranasally as the needle is advanced 3.5 cm toward the apex of the muscle cone.
REGIONAL ANESTHESIA

RETROBULBAR BLOCKADE

After aspiration to preclude intravascular injection, 2—5 mL of local anesthetic are injected and the needle is removed.
REGIONAL ANESTHESIA
Complications

- retrobulbar hemorrhage
- globe perforation
- optic nerve atrophy
- frank convulsions
- oculocardiac reflex
- acute neurogenic pulmonary edema
- trigeminal nerve block
- respiratory arrest.
FACIAL NERVE BLOCK

• A facial nerve block prevents squinting of the eyelids during surgery and allows placement of a lid speculum.

• There are several techniques of facial nerve block:
  
  van Lint, Atkinson, and O’Brien
Complication
subcutaneous hemorrhage.
vocal cord paralysis
laryngospasm
dysphagia
respiratory distress.
Figure 38–2. There are many techniques of facial nerve block, including (1) van Lint, (2) Atkinson, and (3) O’Brien.
### Table 38-5. Strategies to prevent increases in intraocular pressure (IOP).

- Avoid direct pressure on the globe
  - Patch eye with Fox shield
  - No retrobulbar or peribulbar injections
  - Careful face mask technique
- Avoid increases in central venous pressure
  - Prevent coughing during induction and intubation
  - Ensure a deep level of anesthesia and relaxation prior to laryngoscopy*
  - Avoid head-down positions
  - Extubate deeply asleep*
- Avoid pharmacologic agents that increases IOP
  - Succinylcholine
  - Ketamine(?)

*These strategies are not recommended for patients with full stomachs.