Case:

A 28 y/o man presented to the emergency room with a fishhook embedded in his eye. He had eaten a full meal just before the fishing accident.

Questions:

How is IOP affected by arterial Pao2, systemic blood pressure, coughing and vomiting, deep inspiration, and hypoxemia?

The choroidal arterioles vasodilate in response to hypercapnia and constrict during hypocapnia, thereby changing intraocular volume and pressure. However, the effect is minimal within the normal physiologic range of Pao2.

Minor fluctuations in arterial blood pressure also have minimal effects on IOP, although IOP may be seen to increase when hypertension is sustained and can fall significantly with induced hypotension. Changes in venous pressure, on the other hand, have a major impact on IOP. Vomiting, coughing, and bucking on the endotracheal tube cause a dramatic increase in IOP by 30 to 40 torr. These actions, and also Valsalva's maneuver, cause congestion in the venous system, which impedes outflow of aqueous humor and increases the volume of choroidal blood.

A deep inspiration may reduce IOP by 5 torr. Hypoxemia may increase IOP through choroidal vasodilatation.


Are topically applied ophthalmic medications absorbed systemically? How can this absorption be reduced? Which eyedrops may have effects that are of concern to the anesthesiologist?

Topical ophthalmic drugs may be absorbed through the conjunctiva or may drain through the nasolacrimal duct and be absorbed through the nasal mucosa. Absorption is increased when the eye is instrumented, diseased, or traumatized. Finger pressure on the inner canthus for a few minutes after instillation of eyedrops will impede absorption by occluding the nasolacrimal duct.

Usage of the following topical medications may have implications for the anesthesiologist.

Atropine
Atropine is used to produce mydriasis and cycloplegia. The 1 % solution contains 0.2 mg to 0.5 mg of atropine per drop. Systemic reactions, seen primarily in children and older adults, 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. Central nervous system (CNS) excitement can be treated with physostigmine, 0.015 mg per kg intravenously (IV), repeated one or two times in a 15-minute period. Scopolamine is contraindicated in closed-angle glaucoma.

Cyclopentolate (cyclogel)
Cyclopentolate, a short-acting mydriatic and cycloplegic, may cause transient neurotoxic effects, such as incoherence, visual hallucinations, slurred speech, ataxia, and seizures. It is contraindicated in closed-angle glaucoma.

Tropicamide (mydriacyl)
Tropicamide is used to produce mydriasis for refraction or funduscopic examination. It may have CNS effects and can elevate intraocular pressure (IOP) in closed-angle glaucoma.

Phenylephrine hydrochloride (neosynephrine)
Phenylephrine hydrochloride is used to produce capillary decongestion and pupillary dilatation. Applied to the cornea, phenylephrine hydrochloride 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. The dose is 1 drop per eye per hour of the 2.5% solution (children) or the 5% solution (adults).

Epinephrine
Topical 2% epinephrine will decrease aqueous secretion, improve outflow, and lower IOP in open-angle glaucoma. Side effects include hypertension, palpitations, fainting, pallor, and tachycardia. The effects last approximately 15 minutes. One drop of 2% solution contains 0.5 to 1 mg of epinephrine. Epinephrine 1:200,000 in a balanced salt solution is sometimes continuously infused into the anterior chamber during cataract surgery. Systemic effects may occur.

Timolol maleate (timoptic)
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 and bronchospasm may occur as well as potentiation of systemic p-blockers.

Betaxolol HCI (betoptic)
Betaxolol HCI is a cardioselective (beta-1) blocking agent used to treat glaucoma. It may be hazardous in patients with sinus bradycardia, heart block, or heart failure.

Acetylcholine
Acetylcholine may be injected intraoperatively into the anterior chamber to produce miosis. Side effects are due to its parasympathetic action and include hypotension, bradycardia, and bronchospasm. Intravenous atropine is an effective treatment.
Echothiophate iodide (phospholine iodide)
Echothiophate iodide, a cholinesterase inhibitor, is used as a miotic agent. It may prolong the effect of both succinylcholine and ester-type local anesthetics. Levels of pseudocholinesterase decrease by 80% after 2 weeks on the drug. It takes 3 to 6 weeks for return to normal pseudocholinesterase activity after stopping the drug (4 weeks for return to 75% activity). Succinylcholine and ester-type local anesthetics should be avoided. Demecarium is another such cholinesterase inhibitor.

Cocaine
Cocaine is used to produce vasoconstriction and to shrink mucous membranes during dacryocystorhinostomy. One drop of 4% solution contains approximately 1.5 mg of cocaine, and the maximum dose is approximately 3 mg per kg. Systemic effects may be seen with a dose as low as 20 mg and involve the CNS, respiratory, and cardiovascular systems.


How would you premedicate this patient?

Premedications should be given parenterally because gastrointestinal absorption is unreliable. Sedatives and anxiolytics may be given as necessary. Metoclopramide (0.15 mg/kg intramuscularly [IM] or intravenously [IV]) may be used to facilitate gastric emptying and to increase the tone of the cardiac sphincter. Narcotics should be used cautiously because they may cause nausea and vomiting. Nonparticulate antacids and H2-receptor antagonists (cimetidine 2 mg/kg IM) should be considered to reduce the risk of aspiration pneumonitis. Intravenous droperidol (0.01 mg/kg) or ondansetron (0.1 mg/kg) can be given for antiemesis.

Atropine or glycopyrrolate will be useful to reduce secretions and gastric acidity, and they may also inhibit the oculocardiac reflex (OCR).


What are some factors that may increase the risk of vitreous herniation during induction and maintenance of anesthesia?

- Face mask pressing on the eyeball
- Increased pressure from coughing, straining, bucking, and head-down position
- Extraocular muscle spasm induced by depolarizing muscle relaxants or surgical stimulation during light anesthesia
- Poorly applied cricoid pressure, which blocks venous drainage from the eye
- Choroidal congestion from hypercarbia, hypoxia, osmotic diuretics, intubation, or increases in blood pressure
How will you perform a rapid-sequence induction and intubation without using succinylcholine?

The safety of the patient must always be the primary concern; the preservation of the injured eye is secondary. Measures must be taken to guarantee adequate anesthetic depth and to blunt the hemodynamic responses to laryngoscopy and endotracheal intubation. Pretreatment measures such as narcotics, β-blockers, calcium channel blockers, lidocaine, or midazolam should be considered. Before induction, the patient should breathe 100% oxygen for several minutes, administered by a gently applied face mask. Anesthesia can then be induced using carefully applied cricoid pressure with intravenous sodium thiopental (5 mg/kg) or propofol (2 to 3 mg/kg) and a nondepolarizing muscle relaxant. Several options exist:

. Pancuronium (0.15 to 0.2 mg/kg) will provide intubation condition in 90 seconds. Tachycardia and prolonged muscle relaxation may be a problem.

. Atracurium (0.5 mg/kg) will allow safe intubation in 3 minutes. A larger bolus (1.5 mg/kg) will allow intubation in 60 to 90 seconds, but may cause hypotension, tachycardia, and histamine release.

. Cisatracurium—because of its intermediate onset of action, cisatracurium (0.10 to 0.15 mg/kg) is not recommended for rapid-sequence endotracheal intubations. Cisatracurium (OA mg/kg) 8 x
ED95 will allow intubation in 90 seconds without histamine release, but duration of action may exceed 60 minutes.

- Vecuronium (0.2 mg/kg) should provide adequate intubating conditions after 90 seconds.

- Rocuronium (0.8 to 1.0 mg/kg) gives excellent intubating conditions at 60 to 70 seconds. Time to recovery is variable and may take 45 to 60 minutes.

- An alternative is to pretreat the patient with a small dose of the nondepolarizing relaxant several minutes before induction, which may shorten the onset of action and lessen the dose required of subsequently administered relaxant. This has been referred to as a priming dose. Its use is controversial in that it may lead to diplopia, muscle weakness, respiratory distress, and aspiration while offering no definite advantage over the use of larger initial doses of nondepolarizing muscle relaxants. The doses for rapid tracheal intubation with succinylcholine or various nondepolarizing relaxants.

Whatever technique is selected, it is essential to monitor the degree of muscle relaxation with a neuromuscular blockade monitor. It is also possible to intubate the patient without any muscle relaxant at all after a deep level of anesthesia has been reached, but this is not a recommended technique. Not only is the airway unprotected for a long period of time but also prevention of bucking cannot be guaranteed and positive pressure ventilation by face mask may exert pressure on the eye.


Lennon RL, Olson RA, Gronert GA. Atracurium or vecuronium for rapid sequence endotracheal intubation. Anesthesiology 1986;64:510.


**How do inhalation agents affect intraocular pressure (IOP) and by what mechanism?**

Inhalation agents cause dose-related decreases in IOP as a consequence of the following:

- Reduced aqueous humor production
- Depression of the central nervous system (CNS) control center
- Facilitation of aqueous humor outflow
- Decreased extraocular muscle tension
- Lowered arterial blood pressure

The degree of IOP reduction is proportional to the depth of anesthesia.

What are the afferent and efferent pathways of the OCR?

The OCR 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 the vagus nerve.


What would you do before extubating this patient?

- Empty the stomach with an orogastric tube while the patient is still paralyzed.
- Suction the pharynx with the patient still paralyzed or deeply anesthetized.
- Give an antiemetic, such as droperidol 0.01 mg per kg intravenously (IV) or ondansetron 0.1 mg per kg IV, 20 to 30 minutes before the end of surgery.
- Give lidocaine 1.5 mg per kg IV or remifentanil 0.5 to 0.8 /.lg per kg IV to prevent coughing during emergence.

Will taping the eyes shut or applying ointment prevent corneal abrasions? Are there any contributing factors? What should you do when you suspect that your patient might have a corneal abrasion?

There is no guarantee that an eye that has been taped shut or lubricated will not sustain a corneal abrasion. Most anesthesiologists protect the eyes in some way; however, abrasions still occur. Corneal abrasions represent the most common ophthalmic complication associated with general anesthesia. The incidence may be as high as 44% when no preventative measures have been taken and the cornea is exposed. The mechanism is thought to be drying of or direct trauma to exposed cornea. Possible contributing factors may be mask anesthesia, prone position, or having the patient's face in the surgical field.

Prompt consultation with an ophthalmologist should be solicited for precise diagnosis and treatment. The patient should be reassured that corneal abrasions usually heal and that relief of pain occurs within 24 to 48 hours. Possible treatments include eye patching and topical administration of antibiotics, short-acting cycloplegics, or antiinflammatory agents. The use of eye patches is controversial.

A topical anesthetic for the cornea should never be given to a patient for self-administration. Misuse may cause delayed wound healing and keratopathy.


