

General anaesthesia for ophthalmic surgery

Stuart Young

Aravind Basavaraju

Abstract

The majority of ophthalmic surgeries are performed as day cases under topical or regional anaesthesia with or without intravenous sedation. However, general anaesthesia is necessary in certain circumstances e.g. local anaesthetic allergy or patients who are unable to cooperate or to lie flat or still. Patients for ophthalmic surgery are frequently elderly with multiple comorbidities, such as diabetes and hypertension. Patients with rare genetic syndromes may present for eye surgery. Therefore adequate preoperative evaluation and preparation will minimize perioperative complications. The goals of general anaesthesia are smooth induction and emergence, with stable intra-ocular pressure (IOP) and akinesia of the globe. These can be achieved with a combination of intravenous and inhalational agents with or without muscle relaxants and opiates. Use of the laryngeal mask airway has the advantage of causing a smaller rise in IOP on insertion and less coughing on emergence. Total intravenous anaesthesia with propofol and remifentanyl has the advantages of causing less postoperative nausea and vomiting (PONV), reduced stress response to airway intervention, rapid recovery and smooth emergence. Some eye procedures require special consideration, for example, strabismus and vitreoretinal surgery involves traction of the rectus muscles producing a higher incidence of oculocardiac reflex and PONV. Most ophthalmic surgery produces mild to moderate pain amenable to non-opioid analgesics. Intraoperative topical and regional anaesthesia reduce postoperative pain and opiate requirement. Open globe injury and a full stomach present unique challenges to prevent increase in IOP as well as protecting the airway.

Keywords General anaesthesia; oculocardiac reflex; ophthalmic drugs; ophthalmic surgery

Royal College of Anaesthetists CPD Matrix: 1A02, 2A03, 2A07, 3A12

Although ophthalmic surgery under regional anaesthesia (RA) is widespread, certain patients or procedures require general anaesthesia (GA) (Table 1). The goals of GA for ophthalmic surgery include a smooth induction, stable intraocular pressure (IOP), motionless field, neutral gaze, good analgesia, minimizing the risks of surgery and anaesthesia and a rapid smooth recovery. The choice of anaesthetic technique is ultimately made on the basis of the duration of surgery, risks and benefits of each technique and patient preference.

Stuart Young MBChB FRCA is a Specialist Registrar in Anaesthesia and Critical Care at the Queen Elizabeth University Hospital, Glasgow, UK. Conflicts of interest: none declared.

Aravind Basavaraju MBBS MD FRCA is a Consultant Anaesthetist at the Queen Elizabeth University Hospital, Glasgow, UK. Conflicts of interest: none declared.

Learning objectives

After reading this article, you should be able to:

- describe the indications and goals of general anaesthesia for ophthalmic surgery
- discuss assessment and safe management of general anaesthesia for ophthalmic surgery
- formulate a safe approach to deal with the unique issues encountered during specific ophthalmic surgeries

Preoperative management

Patients requiring eye surgery are usually a high-risk group; they tend to be elderly and have less physiologic reserve with a higher incidence of comorbidities and polypharmacy.¹ Most have risk factors, such as hypertension, diabetes and atherosclerosis. Surgery may be required for ocular manifestation of systemic disease and uncommon medical or genetic conditions, especially in paediatrics. Optimizing and preparing these patients for surgery is essential to minimize perioperative complications.

A focused review of the medical history helps with perioperative planning and establishing rapport with the patient. Physical examination is focused on detecting major cardiac and pulmonary decompensation. Laboratory tests are guided by the history, physical examination and the surgical procedure.

Diabetes mellitus

Diabetic patients can suffer from cataracts, vitreous haemorrhage, glaucoma and retinal disease; and surgery may be required in any of these conditions. Schedule the patient early in the morning to minimize starvation time and disruption of their daily routine. A perioperative blood glucose range of 4–12 mmol/l should be the aim.

Hypertension

Patients may present with retinal detachment or vitreous haemorrhage requiring surgical intervention. Presence of hypertensive retinopathy increases the risk of cardiovascular morbidity related to hypertension. Any underlying ischaemic heart disease should be optimized. Blood pressure should be optimally controlled to a systolic <160 mmHg and/or diastolic <100 mmHg, prior to surgery.²

Cardiac considerations

Most ophthalmic procedures can be classed as low-risk procedures for cardiac complications. However unstable coronary syndromes, haemodynamically significant arrhythmias, decompensated cardiac failure or symptomatic severe aortic stenosis need to be rectified before proceeding with surgery. Increasingly we are encountering patients with pacemakers and implantable cardioverter defibrillators (ICD) for ophthalmic surgery. In general, ophthalmic surgery involves low voltage bipolar

Indications for general anaesthesia for ophthalmic surgery

Patient factors	Unable to communicate	Deaf, language barrier
	Unable to cooperate	Anxiety, claustrophobia, dementia, Parkinson's disease
	Unable to lie supine comfortably	Chronic obstructive disease, congestive cardiac failure, back pain
	Young children	
Surgical factors	Axial length >25mm (risk of globe perforation with retro bulbar block)	
	Local sepsis (preventing regional technique)	
	Patient preference	
	Complex and long duration procedure	
Anaesthetic factor	Allergy to local anaesthesia	
	Abnormal coagulation precluding regional technique	

Table 1

electrocautery in short bursts, therefore the risk of interfering with pacemaker function is negligible. Intraoperative discharge of an ICD can occur during eye surgery either appropriately or inappropriately due to electromagnetic interference causing sudden patient movement. This can threaten vision during an operation, albeit there are no reported cases. With increasing prevalence of patients with ICD it is recommended that the antitachycardia function of the ICD be inactivated before surgery by involving the cardiac physiology department.³

Genetic syndromes

Eye disorders, such as strabismus, cataracts or myopia, are prevalent in many genetic syndromes, e.g. fragile X syndrome, Marfan's and Prader–Willi syndrome. There is a high prevalence of congenital cardiac disease associated with genetic syndromes and this needs to be considered in the pre-operative assessment. Other considerations are managing perioperative anxiety and communicating effectively with such patients.⁴

Medication

Patients should continue their regular medications unless advised otherwise (e.g. anticoagulants). Topical ophthalmic drugs used to treat ophthalmic pathology can have potential systemic effects that anaesthetists must be aware of (Table 2).

Many patients undergoing ophthalmic surgery are on either antiplatelet agents or anticoagulants. Perioperative management involves weighing the risks of thrombotic complications versus the possibility of haemorrhagic complications. Ophthalmic surgeries can be risk stratified for bleeding risk and antiplatelets/anticoagulants are managed according to the risk of perioperative thromboembolism.⁵

Bleeding complications which compromise vision are rare. Overall, these agents can be continued perioperatively for most ophthalmic procedures, including regional blocks. With glaucoma, orbital and oculoplastic surgery, there is a higher risk of bleeding and antiplatelet/anticoagulant agents are likely required

to be stopped unless the benefit does not outweigh the risk, e.g. drug eluting stent, metallic heart valve.

As there are no randomized controlled trials comparing thrombotic events and haemorrhagic surgical complications, anticoagulant management should be tailored to the individual patient. This may involve discussion between the physician who prescribed the drug, the ophthalmologist, the anaesthetist and the patient.

For patients having general anaesthesia their risk of VTE should be assessed on admission and prophylaxis should be provided with anti-embolism stockings or an intermittent pneumatic compression device and early mobilization. This is important in prolonged procedures or vitreoretinal surgery with intraocular gas necessitating a special postoperative posture which prevents early mobilization. Pharmacological prophylaxis with low molecular weight heparin is limited to high risk patients.

Patients are fasted for 6 hours for solid foods and clear fluids are allowed until 2 hours before induction.

The eye to be operated on should be marked by the surgeon and confirmed during surgical brief. The contralateral eye is taped after induction of anaesthesia and the surgical side is reconfirmed just before surgery during the surgical pause.

Premedication

Anxiolytics, such as midazolam, may be indicated in anxious paediatric and adult patients. Caution should be exercised in elderly patients with dementia and in day cases as this may increase the incidence of postoperative confusion and delayed discharge. Antiemetic and vagolytic premedication are considered in patients at high risk of postoperative nausea vomiting (PONV) and oculocardiac reflex (OCR), respectively. Proton pump inhibitors or antihistamines (H2 blockers) should be considered in patients with heartburn and oesophageal reflux.

Intraoperative management

Positioning

Patient position should be a joint decision by the anaesthetist and surgeon to accommodate patient safety and surgical convenience. The patient is usually supine with the head positioned at the top edge of the operating table on a headrest. Gentle handling, with attention to proper head and neck alignment, pressure points and arm position are necessary to avoid pressure-related complications.

Monitoring

Monitoring is started as per the guidelines of the Association of Anaesthetists of Great Britain and Ireland. If muscle relaxants are used, then a neuromuscular block monitor is necessary to ensure adequate paralysis to prevent sudden coughing. A forced air warming blanket is used during prolonged procedures and in frail patients to prevent hypothermia. An arterial line is indicated if significant hypotension is required for the surgery.

Induction and maintenance

Intravenous (IV) induction of anaesthesia is routine except in some paediatric patients. The pharmacodynamic profile of propofol (e.g. rapid recovery, less PONV) makes it an excellent agent for ophthalmic anaesthesia. In the vast majority of cases the use of a laryngeal mask airway (LMA) suffices for managing the

Topical ophthalmic medications and some of their associated systemic adverse effects

Effect on eye	Class of drug	Example	Systemic adverse effect
Anti glaucoma	Beta-blockers	Timolol, betaxolol	Bradycardia, arrhythmias, hypotension, bronchoconstriction
	Muscarinic agonist	Pilocarpine	Tachycardia, hypertension, confusion
	Carbonic Anhydrase Inhibitors	Acetazolamide, dorzolamide	Hypokalemia
	Prostaglandin agonists	Lanatoprost	Hypertension
Mydriasis	Sympathomimetic agents	Phenylephrine	Hypertension, arrhythmia, pulmonary oedema, myocardial infarction
	Parasympatholytic agents	Atropine, cyclopentolate	Tachycardia, hypertension, ataxia
Anti-inflammatory agents	Non-steroidal anti-inflammatory drugs	Diclofenac	Bronchospasm

Table 2

airway. It avoids laryngoscopy and the need for muscle relaxants and reduces the incidence of coughing and straining on an endotracheal tube (ETT) which can increase intra-ocular pressure up to 50 mmHg.

The usual patient contraindications for an LMA still apply, e.g. obesity, gastro-oesophageal reflux disease, LMA failure and potential for airway soiling (e.g. lacrimal duct surgery). There is reduced access to the patient's airway and the anaesthetist should be mindful of this and have a reliable and secure airway. This avoids the need for intraoperative airway manipulation which can be difficult and not without risks to vision if the eye is open to atmosphere.

During *intra-ocular* surgery, the surgeons require a motionless eye and this is best achieved using neuromuscular relaxation which will require endotracheal intubation, usually with a south facing or flexible ETT. It is important during intra-ocular surgery to control the patient's expired carbon dioxide to allow for a mild hypocapnia, helping reduce the intra-ocular blood volume.

Many ophthalmic surgeries are relatively non-stimulating, particularly after supplemental RA, which can lead to intraoperative hypotension. Vasopressor (e.g. metaraminol) boluses or an infusion may be necessary to maintain blood pressure within the normal range for the patient.

To facilitate surgery, occasionally the surgeons may use intraoperative mydriatics to achieve pupillary dilatation, e.g. phenylephrine 10%. The anaesthetist must be aware that occasionally systemic absorption of these drops can occur and there are case reports of severe hypertension, tachycardia and pulmonary oedema with these medications.

Anaesthesia can be maintained with either inhalation anaesthetic agents or with TIVA. Remifentanyl and propofol TIVA provides excellent conditions for ophthalmic surgery. Remifentanyl, being a potent suppressor of laryngeal reflexes, negates the need for maintenance muscle relaxants and prevents coughing and gagging thus avoiding increases in IOP during intubation and extubation. It has minimal residual effect after stopping infusion, hence reduces PONV. TIVA is an excellent choice for patients at high risk of PONV or undergoing a particularly emetogenic procedure, e.g. strabismus surgery.

Extubation can be performed either awake or deep provided coughing and gagging are avoided. If using ETT, smooth extubation can be aided by administering intravenous lidocaine 1.5 mg/kg or maintaining a remifentanyl target concentration of 1–2

ng/ml before extubation. The surgeon may want patients undergoing vitrectomy with intraocular gas to assume a face down posture once they are 'obeying commands'.

Intravenous fluids

Bleeding is minimal during most ophthalmic surgeries. Euvolaemia is preserved by maintenance rates of IV crystalloid solution and minimizing the fasting interval. A full bladder can cause postoperative hypertension, agitation in elderly patients and increased IOP.

Postoperative nausea and vomiting

Ophthalmic surgeries such as strabismus and vitreoretinal surgery carry an increased risk of PONV. The oculo-emetic reflex is the cause of PONV in strabismus surgery; the trigeminal nerve forms the afferent limb, centre is in the medulla and the vagus forms the efferent limb of the reflex. Regional techniques such as peribulbar block reduce PONV by blocking the afferent limb of the reflex arc. Dehydration, electrolyte imbalance and postoperative diplopia can lead to PONV and should be treated with IV fluids, adequate analgesia and akinesia of the operative eye. In high-risk cases, TIVA with propofol and antiemetics, such as dexamethasone 0.1 mg/kg and ondansetron 0.1 mg/kg are helpful as prophylaxis or treatment of PONV.

Analgesia

In general, the majority of ophthalmic surgical procedures are well tolerated and only produce mild to moderate postoperative pain. Combinations of topical LA or RA with simple analgesics (e.g. paracetamol, ibuprofen) or weak opioids (e.g. codeine) usually suffice to manage postoperative pain. Strong opioids may be needed to manage postoperative pain after evisceration, strabismus and scleral buckling procedures. Severe pain postoperatively may be due to surgical complications such as acute glaucoma, sudden increase in IOP or corneal abrasion. These should be promptly addressed to prevent permanent vision impairment.

Special considerations for specific eye surgeries

Glaucoma

Common procedures are trabeculectomy, drainage procedures with tubes or shunts and cryoablation. Anaesthetic goals are meticulous attention to preventing increases in IOP and complete

akinesia of the globe intraoperatively. The glaucomatous eye is at a higher risk of visual loss if a sight-threatening complication (e.g. retrobulbar haemorrhage) occurs. The anaesthetist should be mindful of the possible systemic effects of medications used to treat glaucoma (Table 2).

Vitreoretinal surgery

Common procedures are vitrectomy and scleral buckling. During vitrectomy intravitreal gas is often injected to tamponade the retina.⁶ In such cases nitrous oxide administration should be avoided or turned off 15 minutes before gas bubble injection. Nitrous oxide is 34 times more soluble in blood than nitrogen and it rapidly diffuses into the gas bubble, causing an acute increase in IOP. Patients should be warned about the risks of future GA with nitrous oxide and flying until the gas bubble is completely absorbed, the duration of which varies with the type of gas used (Table 3).

As with other intraocular procedures, maintaining globe akinesia and normal IOP should be meticulous. Scleral buckling procedures involve traction on the rectus muscles which carries the risk of oculocardiac reflex especially in young patients.

Procedures on the cornea

Penetrating keratoplasty and Descemet's stripping endothelial keratoplasty (DSEK) are common procedures. Avoidance of patient movement and control of IOP are especially important in these open globe procedures.

Orbital surgery: Many orbital surgeries are carried out under GA, e.g. orbital decompression, enucleation, exenteration and brachytherapy (plaque placement and removal). There is a possibility of blood loss with major surgery such as three-wall decompression but transfusion is seldom necessary. Hypotensive anaesthesia and low normal arterial carbon dioxide may be necessary to improve the surgical field and reduce blood loss. These procedures have a high incidence of pain and PONV. Sub-Tenon's block at the end of procedure reduces the need for opioids.

Strabismus surgery

Frequently performed in young patients, perioperative issues are high incidences of the oculocardiac reflex and PONV.

Oculocardiac reflex

Also known as the Aschner reflex, it is described as a greater than 20% reduction in heart rate when pressure is applied to the globe or when there is traction of the ocular muscles. Like the oculomesis reflex, it is a trigemino-vagal reflex. This reflex usually manifests as sinus bradycardia, although other heart rhythms such as junctional rhythms, ectopic beats, atrioventricular block and asystole can occur.

Management of this reflex is by stopping the trigger; therefore notify the surgeon to stop ocular stimulation. Atropine 20 µg/kg or glycopyrrolate 4–8 µg/kg, can be given if the bradycardia does not resolve. In high-risk cases (e.g. squint surgery, enucleation) they can be given as prophylaxis to reduce the incidence of the reflex. Hypoxia, hypercarbia, acidosis and a light plane of anaesthesia can make the prevalence of OCR more likely and severe. Local anaesthetic can be used to block the transmission of this reflex.⁷ OCR is fatigable and tends to decrease with increasing age.

Ocular emergencies

Most ocular procedures need not be done on an emergency basis, allowing adequate time to consider the fasting status of the patient. However anaesthetists may come across patients with an open globe injury with inadequate fasting time, if they have other injuries that need urgent surgery, e.g. polytrauma.

Open globe and full stomach: an open globe results from a penetrating or blunt eye injury causing globe perforation or rupture respectively. Any factor increasing the intraocular pressure in the affected eye risks extrusion of ocular contents which may result in blindness. The goal of anaesthetic management in this circumstance is to prevent any iatrogenic increase in intraocular pressure as well as protecting the patient's airway from aspiration.

Perioperative plan:

- Avoid direct pressure on or around the eye with the facemask
- Avoid the use of suxamethonium and/or ketamine, as both may increase intraocular pressure
- Aim for a smooth induction and emergence; ensure adequate muscle paralysis (Rocuronium 1 mg/kg) to prevent coughing and gagging before attempting intubation by using a neuromuscular block monitor.
- Use of a potent opiate, e.g. remifentanil/alfentanil, to obtund the cardiovascular response to laryngoscopy. Remifentanil can also help suppress the cough and gag reflex during extubation
- Avoiding a tight endotracheal tube tie around the neck and positioning the patient with a slight head-up tilt will assist with venous drainage.
- Intermittent positive pressure ventilation to prevent hypercapnia. ◆

REFERENCES

- 1 Christmas C, Makary MA, Burton JR. Medical considerations in older surgical patients. *J Am Coll Surg* 2006; **203**: 746–51.
- 2 Hartle A, McCormack T, Carlisle J, et al. The measurement of adult blood pressure and management of hypertension before elective surgery: joint guidelines from the Association of Anaesthetists of Great Britain and Ireland and the British Hypertension Society. *Anaesthesia* 2016; **71**: 326–37.
- 3 Thomas H, Turley A, Plummer C. British Heart Rhythm Society Guidelines for the management of patients with cardiac implantable electronic devices (CIEDs) around the time of surgery. 2016, <http://bhrc.com/files/files/Guidelines/160216-Guideline%2C%20Peri->

Intraocular gas and their duration of action

Type of gas	Duration of action
Air	5–7 days
Sulphur hexafluoride SF ₆ 20%	2 weeks
Perfluoroethane C ₂ F ₆ 16%	4–5 weeks
Perfluoropropane C ₃ F ₈ 14%	8 weeks

Table 3

- [operative%20management%20of%20CIEDs.pdf](#) (accessed 2 July 2019).
- 4 James I. Anaesthesia for paediatric eye surgery. *Cont Educ Anaesth Crit Care Pain* 2008; **8**(1): 5–10.
 - 5 Kiire CA, Mukherjee R, Ruparelia N, et al. Managing antiplatelet and anticoagulant drugs in patients undergoing elective ophthalmic surgery. *Br J Ophthalmol* 2014; **98**: 1320–4.
 - 6 Vaziri K, Schwartz SG, Kishor KS, Flynn Jr HW. Tamponade in the surgical management of retinal detachment. *Clin Ophthalmol* 2016; **10**: 471–6.
 - 7 Dunville LM, Kramer J. Oculocardiac reflex [Updated 2019 May 17], [Internet]. In: StatPearls 2019 Jan. Treasure Island (FL): StatPearls Publishing. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK499832/> (accessed 10 July 2019).