Anaesthesia in ocular surgery

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outline the various procedures used in ophthalmology to anaesthetise the eye

Ophthalmic procedures account for a high proportion of surgical workload. Between 2008 and 2009 there were 329,447 cataract operations alone carried out in the UK.[1] The successful outcome of eye surgery relies on a number of factors, not least the quality of the anaesthetic.

Modern-day cataract surgery is largely done under local anaesthetic, facilitating the safe provision of a day-case service. Joint guidelines published by the Royal College of Ophthalmologists (RCOphth) and the Royal College of Anaesthetists (RCoA)[2] state that the goals of ocular anaesthesia are to:

- Provide pain-free surgery
- Facilitate the surgical procedure
- Minimise the risk of systemic complications
- Reduce the risk of surgical complications.

There are a number of techniques used in ocular surgery to provide the safe, effective anaesthesia required. This article aims to provide an overview of current practice in ocular anaesthesia and an understanding of the techniques used.

Applied anatomy

When anaesthetising the eye and the surrounding adnexa, a comprehensive knowledge of the orbit and its contained structures is essential. The orbit consists of the lateral and medial walls, roof and floor and is formed from sections of the frontal, zygomatic, sphenoid, ethmoid, lacrimal, maxillary and palatine bones. The four recti muscles arise from the posterior apex of the orbit (the muscle cone), an area of importance for ocular anaesthesia. Much of the vascular network in the orbit lies in the superomedial aspect.

Effective anaesthesia results from the successful blocking of nervous conduction to the relevant components of the eye. These are the cornea and anterior intraocular structures such as the iris. The nasociliary nerve from the ophthalmic division of the trigeminal nerve (cranial nerve V) produces branches that supply sensory innervation of the cornea, ciliary body, iris, and central and perilimbal conjunctiva. Peripheral conjunctiva is innervated from the lacrimal and frontal nerves from the ophthalmic nerve and also the infraorbital nerve that arises as a branch of the maxillary division of nerve V.

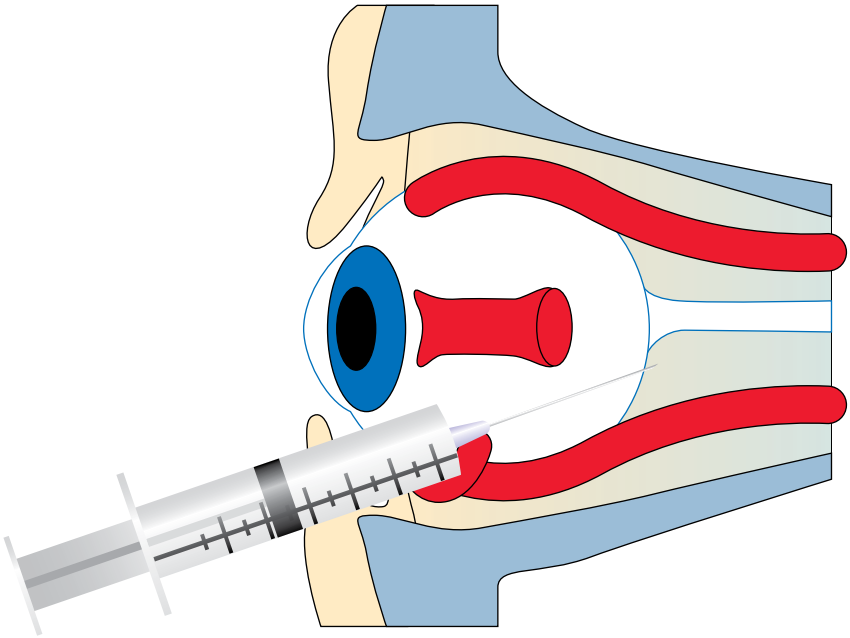

Figure 1 Retrobulbar injection

Motor innervation to the extraocular muscles is via the oculomotor (III), trochlea (IV) and abducens (VI) cranial nerves, and orbicularis oculii innervation is from the temporal and zygomatic branches of the facial nerve (nerve VII).

The target of the anaesthetic depends upon the complexity of the surgery – for example routine cataract surgery may only require anaesthesia of the anterior eye, whereas for more complicated vitreoretinal procedures akinesia (loss of globe movement) is desirable and the extraocular muscles are also targeted.

Methods of anaesthesia

Topical

Optometrists are familiar with the use of topical anaesthetic agents, for example when conducting contact tonometry. Topical methods achieve fast, reliable anaesthesia via a non-invasive technique, making them particularly desirable from a patient safety perspective. The use of topical anaesthetic in cataract surgery dates back as far as 1884, with the use of cocaine as the agent.[3] It was not until the 1990s, however, that its use gained in popularity with the advent of more modern small incision techniques.[4] Since then their use has increased for routine cases and common agents include tetracaine, oxybuprocaine and lidocaine. While the non-invasive technique and excellent safety profile of topical drugs makes their use desirable in routine cataract surgery, the lack of akinesia renders some patient

groups unsuitable candidates. The surgeon must evaluate each patient's suitability for surgery under topical anaesthesia on a case-by-case basis. It is highly effective for procedures involving the superficial anterior structures, notably the cornea and conjunctiva, though some patients report pain during intraocular surgery as nervous conduction is maintained to the iris and ciliary body. An injection of lidocaine into the anterior chamber (intracameral route) helps alleviate this sensation and is often administered by the surgeon during the initial stages of surgery.[5] Stinging on instillation is a common complaint when using topical anaesthetics, though the more serious complication of corneal toxicity is rare when administered prior to surgery and generally more associated with the chronic use of topical local anaesthetics.[6]

Retrobulbar block

Retrobulbar technique was the first 'sharp-needle' method of delivering ocular anaesthesia. It involves the use of a needle inserted through the eyelid, passing around the globe, allowing delivery of around 2ml of anaesthetic agent into the muscle cone at the orbital apex (Figure 1). A successful block achieves full anaesthesia with an akinetic eye, which is achieved rapidly due to the delivery of the agent in close proximity to the nerves.[7] Due to the nature of the procedure and the requirement to inject 'blindly' there is the potential for serious complications to occur such as orbital perforation, retrobulbar haemorrhage, optic nerve damage, and strabismus from extraocular muscle injury. There are also well-described cases of 'brainstem anaesthesia' with associated respiratory depression, arising when anaesthetic agent reaches the central nervous system via sub-meningeal spaces, which surround the optic nerve. The needle used to inject retrobulbar anaesthesia should not be longer than 31mm to reduce the risk of serious complications (Figure 2).[8] In addition, an anaesthetist must be present to provide any resuscitation. A degree of upper eyelid ptosis is a common short-term complication of sharp-needle blocks, and can be permanent in a minority of cases.[9]

Peribulbar block

Peribulbar block was developed to offer a similar level of anaesthesia to retrobulbar block with a reduced complication rate. A shorter, but sharp tipped needle is inserted through the skin and a larger volume of anaesthetic agent is deposited around the globe and outside the muscle cone (Figure 2, 3). The drug must then diffuse posteriorly towards the cone to reach the nerves, and as such the onset of akinesia is not as fast or predictable as that seen following retrobulbar injection.[7] Traditionally, two injections are required at the medial and lateral canthi, targeted to avoid key orbital structures, though successful anaesthesia can be achieved using only the lateral injection. Peribulbar anaesthesia has the potential to cause the same complications seen with retrobulbar injections and an anaesthetist must be present in the UK to treat systemic complications, though its use is now more common and serious complications are rare. There is little evidence to suggest either technique is safer or more effective.[10]

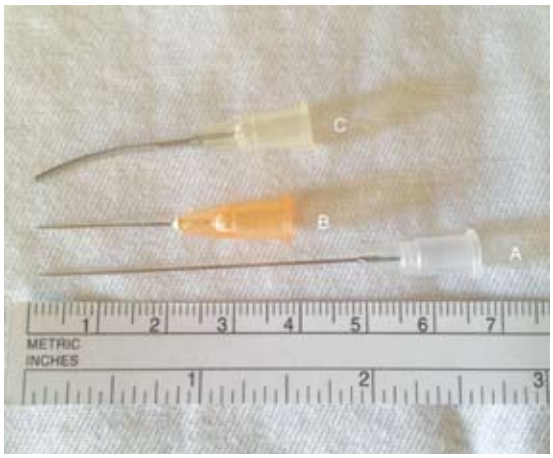

Figure 2 Needles used for cataract anaesthesia, A – retrobulbar; B – peribulbar; C – sub-Tenon

Sub-Tenon's block

Sub-Tenon's method was devised to avoid the use of sharp needles employed in retrobulbar and peribulbar techniques and therefore limit potential serious complications. Tenon's fascia is a layer of connective tissue that covers the sclera, into which the extraocular muscles attach. Between the Tenon's fascia and sclera is a potential space into which anaesthetic can be injected.[7] Delivery of the anaesthetic is carried out following topical administration of anaesthetic and disinfection of the ocular surface with 5 per cent aqueous iodine solution. The patient looks up and in a lateral direction while the eyelid is held open with a speculum. After numbing the conjunctiva with topical anaesthesia, the conjunctiva and Tenon's capsule are pinched with non-toothed forceps, 5-7mm from the limbus in the inferonasal quadrant. Both layers are then cut with scissors, forming a tunnel through which a blunt, curved 19G 25mm cannula (Figure 2) is inserted into the sub-Tenon's space, sliding around the globe over the sclera to a depth 15-20mm. The anaesthetic agent is then injected slowly into this space, taking care to inject beyond the 'equator' of the globe to avoid the leakage of anaesthetic with associated chemosis. The volume of anaesthetic used depends on the intended surgery, with lower volumes of around 4ml for cataract procedures and up to 10ml in vitreoretinal surgery. Following administration of the local anaesthetic, pressure is applied over the closed eye for several minutes and in a successful block complete anaesthesia and akinesia can be achieved, although, perfect akinesia is less common.[11] Onset of anaesthesia is almost instant and the level can be 'topped up' if the surgery is particularly prolonged. The direct visualisation of the technique limits serious complications with the most common adverse effects being chemosis and sub-conjuctival haemorrhage, which are largely cosmetic.[12] Topical adrenaline can be used to reduce the risk of sub-conjunctival haemorrhage.[11] While technically, the same side-effects listed for peribulbar block are possible, it is viewed as a safer procedure and sometimes no anaesthetist is present – with the blocks being performed by the surgeon or a nurse.

General anaesthesia

General anaesthesia (GA) has a role in ophthalmic surgery despite the trend towards local methods. Prior to GA administration the patient must be assessed by the anaesthetist for their suitability, including the presence of pre-existing co-morbidities that may increase the risk of anaesthesia, such as hypertension and diabetes melitus. These are common in the ophthalmic patient as the majority of those undergoing surgery are of an elderly population. This produces a dilemma because local anaesthetic techniques are not as good for patients with extreme health problems – as they often cannot lie flat. The anaesthetic agent is usually administered through an intravenous cannula. Commonly used agents are propofol, fentanyl and sevoflurane.

Eye surgery poses certain airway considerations for the anaesthetist using GA. A patient having a GA must have their airway maintained and protected – usually using a device called a laryngeal mask airway (LMA), inserted through the mouth and

positioned in the back of the larynx. An alternative is to use an endotracheal tube that sits directly in the trachea connecting the lungs. Both methods can interfere with the surgical field and it must be securely fixed and properly working before surgery is allowed to commence. During surgery the patient is at risk of hypotension and reduced heart rate secondary to the anaesthetic agents, as the usual stimulation of the sympathetic nervous system during general surgery is reduced. Systemic sympathomimetics (eg atropine) and vasoconstrictors (eg ephedrine) are used in such cases. Intravenous anaesthesia can also in some patients cause the eye to drift away from the neutral position, usually up or out. The use of muscle relaxant (eg rocuronium) can alleviate this or the surgeon can use a traction suture if muscle relaxants are contraindicated. The oculocardic reflex is a phenomenon whereby heart rate decreases when the extraocular muscles are overly stretched, eg during squint surgery. The action of anaesthetic on the ciliary ganglion alleviates this following regional block, though a GA offers no such protection. Heart rhythm should therefore be monitored for potentially dangerous arrhythmias, which recover following removal of the preceding cause.[13]

There are a number of risks associated with the use of GA. Mechanical injury can occur when passing the tube during intubation eg to the vocal cords. There are also a number of potential undesirable consequences of the anaesthetic itself such as hypotension, respiratory depression, myocardial infarction, cardiac arrest, hypothermia and anaphylaxis. Relative risk of systemic complications are increased in a patient with pre-existing cardiovascular or respiratory disease and in older patients.[14]

Anaesthetic choice

When deciding which anaesthetic technique to use prior to surgery the following factors should be taken into account:

- Nature and complexity of the case
- Potential risks from the anaesthesia
- Experience of the surgeon
- Individual patient suitability
- Patient choice.

From a safety perspective, topical anaesthesia is the preferable method, and is often used for routine cataract procedures. It does not provide adequate anaesthesia, however, for longer intraocular surgery and those involving the posterior segment. A trainee surgeon may also find operating on an eye with functioning extraocular muscles particularly challenging. An anxious patient may also not be the ideal candidate for a topical approach as good patient cooperation is required to achieve optimal surgical outcome.

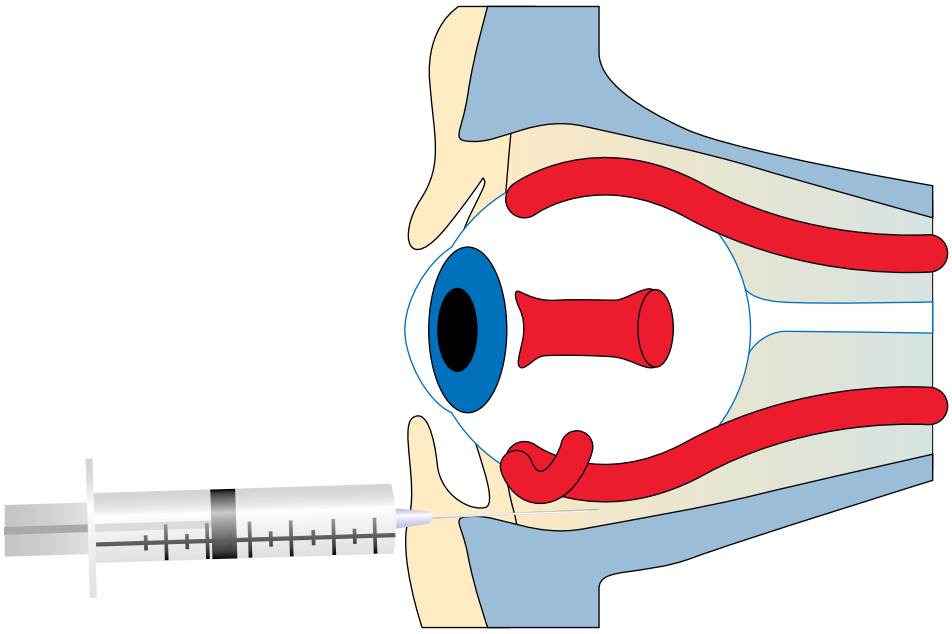

Figure 3 Peribulbar injection

A subject of some debate has been the issue of whether to use sharp needle techniques or a sub-Tenon's approach when more complete anaesthesia and akinesia is required via a regional block. The level of anaesthesia achieved with each technique has been shown to be comparable,[15,16] effectively leaving the decision to individual practitioner preference and the potential for complications. In a multicentre audit of 55,657 cataract procedures in the UK, the incidence of serious complications was found to be 2.5 times greater when a sharp needle technique was used compared with the blunt cannula of a sub-Tenon's block.[17] In view of this the RCOphth guidelines for cataract surgery published in 2010 recommend that sharp needle techniques should be avoided in routine cataract surgery cases.[1]

The widespread use of general anaesthesia in ocular surgery is not compatible with the provision of an efficient, safe day-case service. On the whole, local anaesthetic is used in all but the most demanding of surgical cases and GA is now largely reserved for surgery on children, squint surgery, particularly anxious patients and those with conditions impairing cognitive function eg dementia, Parkinson's disease and learning difficulties.[18]

Sedation

There is a role for sedation in ophthalmic surgery when operating on patients under local anaesthetic who are particularly anxious or who may suffer traits that inhibit the facility of a safe operation such as tremor. A sedated patient should still be able to communicate any discomfort to the surgeon and peri-operative monitoring is required which includes heart tracing, blood pressure, haemoglobin oxygen saturation and expired carbon dioxide levels. Sedation should not be used to supplement an inadequate local block. Risks of sedation include respiratory depression and carbon dioxide retention. A continuous supply of oxygen should be given under the surgical drapes for the patient to inhale to minimise this.[19]

Post surgery

An anaesthetised eye is at greater risk of corneal injury due to loss of sensation and the potential for damage from exposure. It is important to keep the eye fully closed and covered following surgery to prevent drying of the cornea from reduced blinking and the potential for suppressed lacrimal gland function.[9]

Conclusion

The ophthalmic surgeon or anaesthetist ▶

has a variety of methods to choose from to provide anaesthesia to facilitate an effective outcome from ocular surgery. To avoid potentially serious complications a topical approach is desirable when possible, though the level of anaesthesia provided with this method is not suitable for all cases. A solid understanding of ocular anatomy and careful technique is essential to provide safe anaesthesia when using sharp needle techniques, the role of general anaesthesia should be considered when appropriate.

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