Regional anaesthesia for intraocular surgery

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The first recorded use of local anaesthesia for surgery was the instillation of cocaine into the conjunctival sac in 1884 by an Austrian ophthalmologist, Karl Koller (1858–1944), at the suggestion of Sigmund Freud. In the UK, during the past 10 yr, a major change in anaesthetic practice has taken place and the majority of ophthalmic surgical patients now undergo regional rather than general anaesthesia. This change has been driven in part by the pressure to undertake surgical procedures as day cases. It is important to remember, however, that there are specific risks associated with local anaesthesia for intraocular surgery and that serious complications of general anaesthesia have always been uncommon in ophthalmology, despite the advanced age and poor state of health of many patients in this group.

Anatomy

A thorough understanding of anatomy is crucial to successful anaesthesia.1

Bone

The orbit is a pyramidal structure with its apex pointing towards the middle cranial fossa (Fig. 1). The orbital rim overhangs the structures within to provide protection. The depth from orbital rim to optic foramen is 42–54 mm in adults. The optic nerve and large blood vessels are crowded together at the apex of the orbit and may be more vulnerable to damage if injections penetrate to this site. The thin medial walls are parallel to each other and enclose the cavity of the nose. The lateral orbital walls define the axis of the orbit, which differs from the axis of the eye.

Globe

The globe occupies the anterior part of the orbit and has an axial length of 20–25 mm in adults but is elongated in myopic individuals who are also predisposed to staphylomata (thin walled protuberances of the sclera). The axial length of the globe is measured by ultrasound before cataract surgery. Tenon’s capsule is a thin membrane, which covers the globe. It extends from the site of the optic nerve to fuse with the conjunctiva anteriorly. Beneath the membrane is a potential space adjacent to the sclera through which pass the ciliary nerves. The rectus muscles also penetrate the membrane.

Muscles

The rectus muscles congregate at the apex of the orbit to form a fibrotendinous ring passing anteriorly to insert into the globe (Fig. 2). Bands of connective tissue merge with the muscles to form a conical structure. The sensory nerves supplying the globe pass within the cone, as do cranial nerves III and VI. Local anaesthetic injections placed within the cone will therefore have a rapid onset of action. The superior oblique muscle is situated outside the fibrotendinous ring and is the most difficult muscle to anaesthetize completely. Fortunately, small degrees of activity of this muscle are acceptable during surgery (it causes depression, medial rotation and abduction of the globe). Levator palpebrae superioris is also situated outside the cone and has a sympathetic innervation. The small diameter sympathetic nerves fibres are susceptible to anaesthesia from local spread of the injected anaesthetic.

The orbicularis oculi is innervated by the facial nerve. This nerve is painful to block (Van Lint block) and it has been shown that such blocks do not improve quality of anaesthesia.

Nerves

The optic nerve inserts in the medial aspect of the globe and travels medially in the orbit to the optic foramen. In this position it may be vulnerable to damage from deep medial injections.

The sensory supply of the globe is via the long and short ciliary nerves, which are branches of the nasociliary nerve, itself a branch of the ophthalmic division of the trigeminal nerve. It enters the orbit via the superior orbital fissure and enters the fibrotendinous ring (Fig. 2).

Key points

A thorough understanding of anatomy is crucial to successful anaesthesia.

Some techniques cause a transient rise in intra-ocular pressure.

The risk of globe perforation is greater in myopic patients.

The use of longer needles may be associated with increased risk of optic nerve damage.

Cardiorespiratory arrest is a consequence of inadvertent intradural injection.
The motor supply of the extraocular muscles is via the oculomotor (III), trochlear (IV) and abducens (VI) nerves.

**Blood vessels**

The structures within the orbit receive their blood supply from the ophthalmic artery, which arises from the internal carotid artery. The ophthalmic artery enters the orbit via the optic canal within the dural sheath of the optic nerve. The central artery of the retina is one of the smallest branches and runs within the dural sheath of the optic nerve. It is an end-artery.

Venous drainage of the orbital structures is via the superior and inferior ophthalmic veins (Fig. 2). The superior ophthalmic vein passes through the superior orbital fissure and drains into the facial vein. The inferior ophthalmic vein passes through the inferior orbital fissure and connects with either the superior orbital vein or the cavernous sinus.

There is individual variation in the disposition of blood vessels, but they congregate in the apex of the orbit. There is a view that the inferotemporal and medial parts of the orbit are relatively poorly supplied with blood vessels, whereas the superonasal region is relatively vascular.

**Physiology**

Injections of fluid within the orbit will inevitably give rise to pressure on the globe and an increase in intraocular pressure (IOP). The rise in pressure will depend on the absolute volume of local anaesthetic, the volume of the tissue compartment into which the injection was made and time taken for the injectate to be absorbed.
and diffuse into other compartments. Individual variation in the location and nature of connective tissue compartments within the orbit mean that even low volume injections can give rise to increased tension in the eye. Pressure leads to doming of the vitreous into the anterior chamber, which can compromise the success of surgery. During injection, the anaesthetist must be aware of increases in IOP by looking for proptosis and by an assessment based on digital palpation. Pressure invariably reduces with time and patience may be required. Some anaesthetists recommend waiting at least 30 min before starting surgery. External compression (e.g. Honan balloon inflated to 20–30 mm Hg) will result in a reduction in vitreous pressure. Care must be exercised to avoid compromising retinal perfusion with pressures >30 mm Hg.

Because the afferent limb of the oculo-cardiac reflex is blocked by local anaesthesia, bradycardia after activation of this reflex is extremely rare.

**Drugs**

Lidocaine 2%, 5–10 ml will provide about 90 min of anaesthesia. A mixture of lidocaine 2% and bupivacaine 0.75% can be used, as can prilocaine 3% with felypressin. Hyaluronidase may improve local drug distribution. Some anaesthetists use epinephrine 1:200 000 to prolong the duration of local anaesthesia.

**Contraindications to local anaesthesia**

**Absolute**

Absolute contraindications are: (i) patient refusal; (ii) local anaesthetic allergy; and (iii) infection/marked orbital inflammation.

**Relative**

Relative contraindications include: (i) myopic patients; (ii) patients who are unable to lie flat for a sufficient length of time, for example cardiorespiratory disease, learning difficulties, severe tremor or other involuntary movements, confusion or psychiatric illness; (iii) children; (iv) patients with communication difficulties (e.g. profound deafness); (v) patients with a bleeding diathesis (although many anaesthetists will carry out local anaesthetic blocks in patients taking warfarin provided that the international normalized ratio is within the therapeutic range); or (vi) previous scleral buckling or space occupying lesions within the orbit (e.g. thyroid proptosis).

**Needsles**

25G sharp needles are commonly used. Blunt-tipped needles are available but are less comfortable for the patient; proponents of blunt needles argue that they provide a better ‘feel’ and may be safer. There is no evidence that blunt-tipped needles confer any advantage in terms of safety over sharp needles.

Various lengths of needle (16–50 mm) are available. Needles >25 mm in length may be associated with a greater risk of damage to the optic nerve, but shorter needles do not abolish the risk completely.

**Topical anaesthesia**

Topical application of local anaesthetics can result in clouding of the cornea and instillation should be made into the conjunctival sac rather than directly onto the surface of the cornea. Prilocaine 0.5% and oxybuprocaine 0.4% are less irritant than other agents. Significant concentrations of local anaesthetics can be measured in the aqueous humour after topical application and these concentrations are sufficient to provide anaesthesia of the iris. Topical anaesthesia either alone or combined with direct intracameral injection of small volumes of local anaesthetic is sufficient to provide anaesthesia for cataract surgery in co-operative individuals.

**Local anaesthetic blocks**

For many years, the traditional technique was retrobulbar injection with local anaesthetic placed deep within the orbit via a long (up to 50 mm) needle. This type of block is now rarely used owing to concerns about safety. Alternative techniques include modified retrobulbar blocks and peribulbar blocks. Sub-Tenon’s blocks have become increasingly popular in recent years.

A number of modifications to retrobulbar block can be employed; usually the needle is inserted such that the tip does not penetrate deep into the orbit and the injection is made at the level of, or just behind the posterior border of, the globe. Any needle placed behind the globe is, by definition, within the retrobulbar space and could therefore endanger the optic nerve. In some individuals a retrobulbar injection can be achieved with a 16 mm needle.

Peribulbar injections have theoretical advantages over retrobulbar blocks but scleral perforation can still occur, larger volumes of injectate are required and there is a perception that the quality of akinesia is not as reliable as with retrobulbar block. Sub-Tenon’s block is may have advantages, especially in myopic or anticoagulated patients. The optic nerve should not be at risk with this technique.

There have been no large studies comparing the safety or effectiveness between the various techniques and choice of technique remains largely a matter of personal preference. The following are examples of techniques that can be used in patients undergoing intraocular surgery.

**Modified retrobulbar block**

Topical local anaesthetic is a useful adjuvant to this technique. Ensuring that the patient looks straight ahead, a 24 mm, 25G needle is inserted inferotemporally lateral to the lateral limbus either through the conjunctival reflection or percutaneously through the lower eyelid (Fig. 3). With the bevel of the needle facing the globe, the needle is aimed vertically backwards, parallel...
to the floor of the orbit until the equator of the globe is passed (10–15 mm depth measured from the anterior aspect of the globe). The needle is then redirected slightly medially and upwards to enter the muscle cone at the level of the posterior border of the globe. There is often a deficit in the fibromuscular cone at this depth, allowing local anaesthetic, which has been deposited outside the muscle cone, to diffuse into the cone. The optic nerve runs within the medial half of the orbit and it is important to try to ensure that the tip of the needle does not cross medial to the central axis of the globe. After aspiration, 4–5 ml local anaesthetic is injected and pressure applied to the eye. The degree of akinesia is assessed after 5 min. Supplementary blocks (see below) will be required in some patients.

**Peribulbar block**

Topical local anaesthetic is applied. With the patient looking straight ahead, a 16 mm 25G needle is used to inject the local anaesthetic inferotemporally, lateral to the lateral limbus either through the conjunctival reflection or percutaneously (Fig. 3). The needle should be directed vertically backwards, parallel to the floor of the orbit. If contact is made with bone, the needle should be redirected slightly upwards. The tip of the needle should be extraconal, close to the orbital wall beyond the equator of the globe; but should stay anterior to the posterior border of the globe, in the peribulbar space. The optic nerve is thus protected. After aspiration, 5–10 ml of local anaesthetic are injected.

If the conjunctiva swells quickly (chemosis), the needle is too superficial and should be repositioned although some swelling is normal as the full volume is injected. Light pressure is applied to the eye with a soft pad or Honan’s balloon. Muscle movements can be tested after 5 min and supplementary blocks performed if necessary.

**Supplementary blocks**

These injections are peribulbar and therefore there is no necessity for the tip of the needle to be inserted deep to the posterior border of the globe. Volumes of local anaesthetic up to 5 ml are used.

**Superonasal**

The injection is made through the upper eyelid vertically above the medial limbus aiming tangentially away from the globe.

**Medial canthus**

Medial compartment injections can be carried out by inserting the needle through the conjunctiva in the medial canthus, medial to the caruncle. The needle should be parallel to the medial wall of the orbit. Retrobulbar injections at this site may endanger the optic nerve. Single medial compartment injections have been reported to produce satisfactory anaesthesia.

**Sub-Tenon’s (episcleral) block**

Topical local anaesthetic should be instilled into the lower fornix together with a few drops of epinephrine 1:10 000 to minimize subconjunctival haemorrhage. For sterility, a few drops of
aqueous iodine 5% are applied to the conjunctiva. A small lid speculum (Barrequer) is inserted to hold the eyelids apart. The anaesthetist stands at the head of the trolley with the patient looking upwards and outwards. This can be achieved by asking the patient to ‘look at my chin’.

In the inferonasal quadrant, 5–7 mm from the limbus, a deep bite of the conjunctiva and Tenon’s capsule is taken using a non-toothed forceps (Moorfields). A small opening is made, no more than 2 mm wide, halfway between the forceps and the globe, with a round tip spring scissors (Westcotts) in the horizontal plane. It should be possible to see a tunnel disappearing into the fornix. (Some anaesthetists pass the closed scissor tips to a depth of about 10 mm, to form a short tunnel). A blunt, curved 19G, 25 mm sub-Tenon’s cannula is passed into the tunnel and advanced slowly keeping the tip hugging the sclera until the syringe is vertical to a depth of 15–20 mm in the inferonasal quadrant. This delivers anaesthetic posterior to the equator of the globe. Gentle side-to-side movement of the cannula, or a gentle pre-injection may be required if there is obstruction. After aspiration, local anaesthetic is injected slowly and gentle pressure applied to the closed eye for a few minutes. A dose of lidocaine 2%, 4 ml gives reliable anaesthesia and subtotal akinesia, whereas 6 ml gives reliable akinesia.

**Complications of local anaesthesia**

Complications of local anaesthesia are summarized below. There have been no large randomized studies to compare risks of complications between methods of local anaesthesia. Selection of technique therefore remains largely a matter of personal preference and expertise.

**Retrobulbar haemorrhage (1–2% incidence)**

The significance of retrobulbar haemorrhage depends on the increase in intraocular pressure. Gross increases in pressure can cause tamponade and a decrease in blood flow through the retinal artery, which can lead to blindness. The surgeon should be informed immediately. Urgent steps may need to be taken to reduce IOP. Bleeding into the skin and conjunctiva is obvious and may be accompanied by proptosis and a palpable increase in intraocular pressure.

**Globe penetration (<1% incidence)**

This leads, inter alia, to retinal detachment. It is usually associated with pain on injection or a sudden deviation of the globe. Perforation may result in an overtly soft eye and there may be bleeding into the vitreous. Perforation is more likely in myopic patients.

**Optic nerve damage (<1% incidence)**

There is an increased risk if retrobulbar injections are made in the medial compartment of the orbit, if the needle is more than 25 mm in length, or the gaze is directed upwards and inwards during inferotemporal injections. Mechanical damage attributable to direct needle trauma or injection into the nerve can be permanent. Injections into the optic nerve are usually associated with pain and can lead to the sudden onset of central nervous system toxicity.

**Local anaesthetic toxicity (uncommon)**

Local anaesthetic may be inadvertently injected directly into the cerebrospinal fluid via the dural sheath of the optic nerve or into a branch of the inferior orbital vein. This can lead to unconsciousness and cardiorespiratory collapse. For this reason full resuscitation facilities should be available.

**Muscle palsies (uncommon)**

Muscle palsies can be avoided by avoiding direct injection into muscles.

**Chemosis (common)**

Chemosis (swollen conjunctiva) subsides with compression and the passage of time.

**Corneal abrasion**

This can occur from a compression device or postoperatively as the motor effects of the local anaesthetic wear off, allowing the eyelid to open, thus exposing an anaesthetic cornea.

**References**


See multiple choice questions 73–77.