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Ophthalmic blocks for anaesthetists

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INTRODUCTION

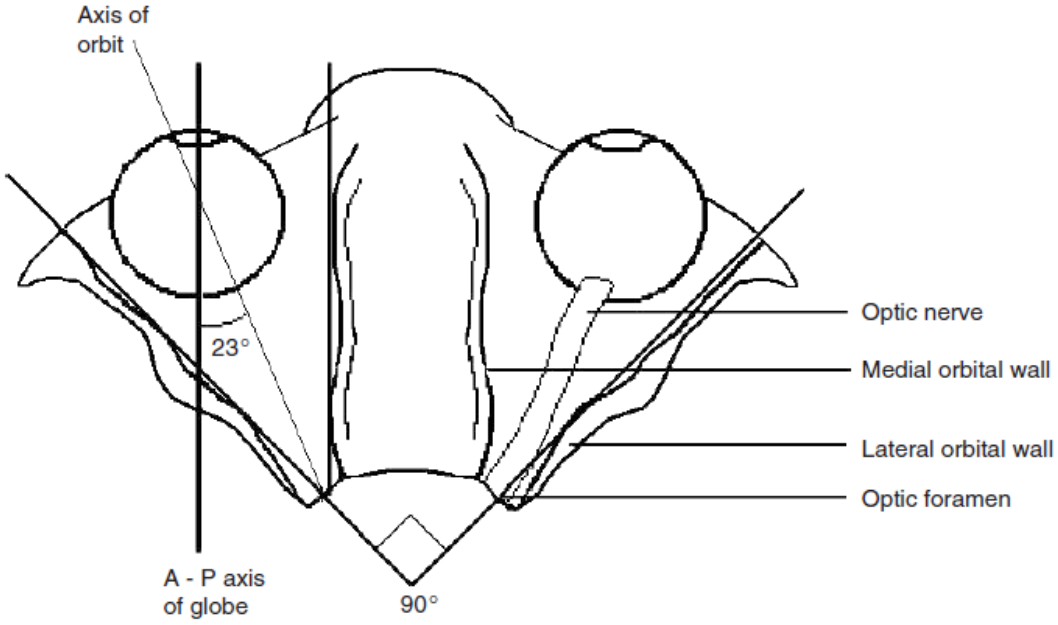
The eye blocks are one of the frequently performed blocks in operating rooms. For many years now there has always been questions in these blocks on the final fellowship exam in anaesthetics. Very little of these blocks are performed by anaesthetists in our unit and as a result it takes effort for young anaesthetists to answer these questions. This is the reason I embarked on this book.

Ophthalmic surgery, being one of the most common surgeries in the world, accounts for a significant number of anaesthetics[1]. Local anaesthesia has been a preferred method for at least 10 decades now since Dr Karl Koller started eye blocks with cocaine in 1885. Proper general assessment of the patients for eye surgery is paramount as the large majority of these patients are an elderly population with comorbidities[2, 3]. With a Gold standard being a retro bulbar block, recently safer forms of local anaesthetics for eye blocks have been described with the former losing its superiority[4]. We shall review the applied anatomy and physiology relevant to eye blocks before dwelling on to the details of these eye blocks.

Specific Anatomy

The orbit

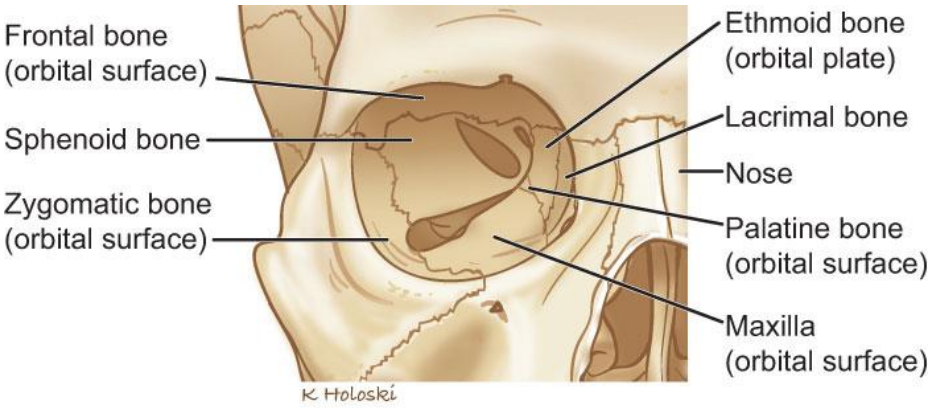
The Orbit being pyramidal in shape consist of Bones and soft tissues. The rims of the orbits are anterior to the soft tissues for protection. The medial walls of both orbits are parallel with each other and with the longitudinal axis of the brain. The lateral walls of both orbits are at 90 Degrees to each other[1]. The soft tissues are clustered together at the apex of the orbit thereby rendering these structures vulnerable to needle injury at this spot. The orbits are on average 42 to 54mm in length. This knowledge is paramount in both the direction and depth of the needle into the cone when performing an eye block[5, 6].



[7] Figure 1

The orbital bones

The floor is formed by 1, the orbital plate of the maxilla, 2, the orbital surface of the zygomatic bone and 3, the orbital process of the palatine bone.
The lateral wall is formed by 1 the orbital surface of the zygomatic bone anteriorly and orbital surface of the greater wing of the sphenoid bone posteriorly.
The roof is formed by maily by the orbital plate of the frontal bone anteriorly and by the lesser wing of the sphenoid bone posteriorly.
Lastly **the medial wall** is formed by 4 bones, the maxilla frontal process, lacrimal bone, ethmoid orbital plate and body of the sphenoid[5, 6, 8, 9].



[10] Figure 2

The soft tissues

The extra-ocular muscles

These are 2 groups, the recti and the oblique muscles. There are 4 recti, that is, inferior, lateral, superior and medial. These insert anterior to the equator of the eye from their common insertional tendon, the annulus of Zinn around the optic canal at the apex. Two oblique muscles, the superior and the inferior oblique aid in the eye movements. Of note is the fifth muscle, the levator pulpebrae superioris which elevates the upper eye lid and the orbicularis oculi which helps with blinking. These have important considerations when it comes to eye blocks as their innervation is outside the cone and may need an additional block[3, 6, 8].

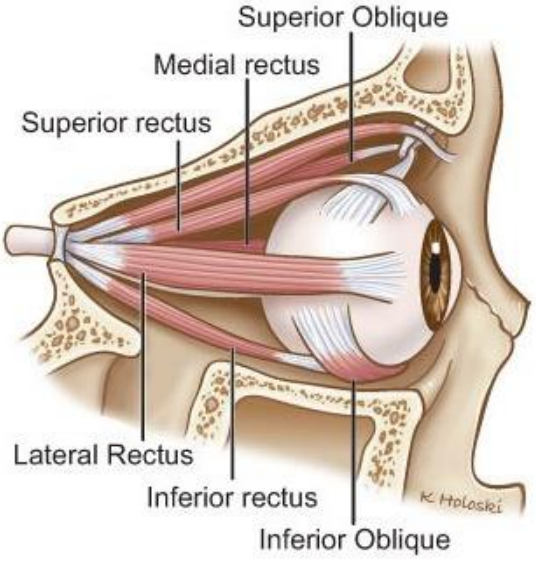


Figure 3

The Globe

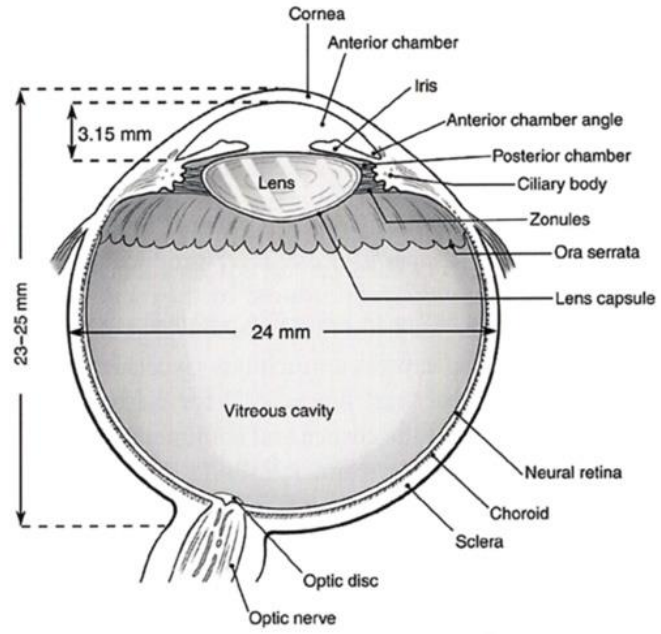


Figure 4a

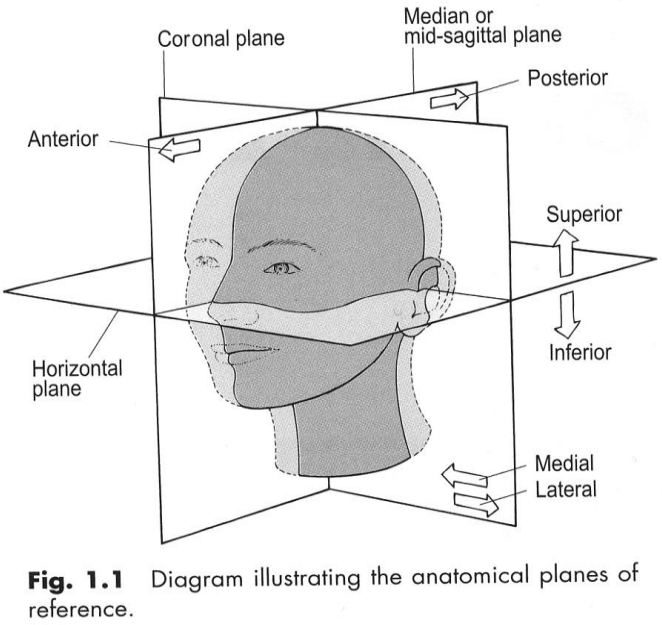


Fig. 1.1 Diagram illustrating the anatomical planes of reference.

Figure 4b

The globe is located on the anterior aspect of the orbit, more towards the supero-lateral aspect of the rim of the orbit. Note the structures in the figure 4a above. Of note is the Tenon's capsule, the episclera, underneath the conjunctiva, covering the sclera. This layer is continuous with the extraocular muscles covering sheath. On average the axial diameter is 24mm, the sagittal diameter being 23.5mm. axial (horizontal) length less than 20mm causes hyperopia and more than 26mm, myopia[6, 8, 11]. See figure 4b for planes reference.

Nerve supply

Motor innervation

A simple pseudo-formula that reminds me of these motor nerves is LR6(SO4)3 which simply illustrates that the superior oblique muscle is innervated by cranial nerve 4 (trochlear), the lateral rectus by cranial nerve 6 (abducent) and all other by cranial nerve 3 (oculomotor). All these nerves are in the cone, except the branch that innervates superior rectus and the facial nerve that innervates the orbicularis oculi[6, 8, 9, 11].

Sensory and autonomic innervation

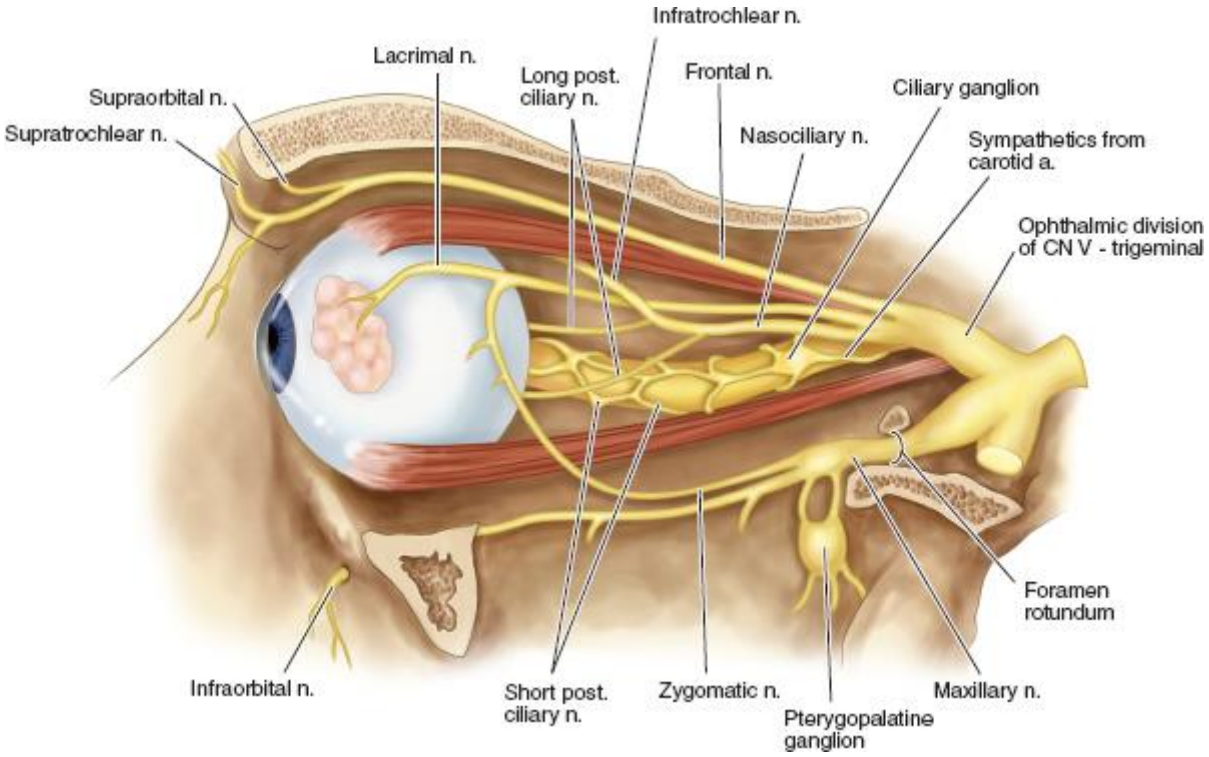


Figure 5

The trigeminal nerve (sensory, motor and parasympathetic), innervated the orbit via its Ophthalmic branch (CN V1) and the maxillary nerve (CN V2) through the zygomatic and the infra-orbital branches. The ophthalmic branch divides to 3 branches , the lacrimal branch (innervates the lateral aspect of the upper eyelid and secretomotor fibres from the pterygopalatine ganglion to the lacrimal glad), the frontal nerve (innervates the medial aspect of the eyelid and the forehead) and the nasocilliary nerve (ciliary branch has sensory innervation of the cornea, ciliary body, iris and the sclera, from the ciliary ganglion sympathetic fibres to vessels and pupillary dilator muscle join the ciliary nerve).

To be clear, sympathetic innervation of the orbit and the globe is from T1, synapsing at the superior cervical ganglion and entering the orbit through long and short ciliary vessels. The parasympathetic innervation is through the oculomotor nerve, synapses at the ciliary ganglion to innervate mainly the sphincter papillae and the ciliary muscles[6, 8, 9, 11].

Blood supply and venous drainage

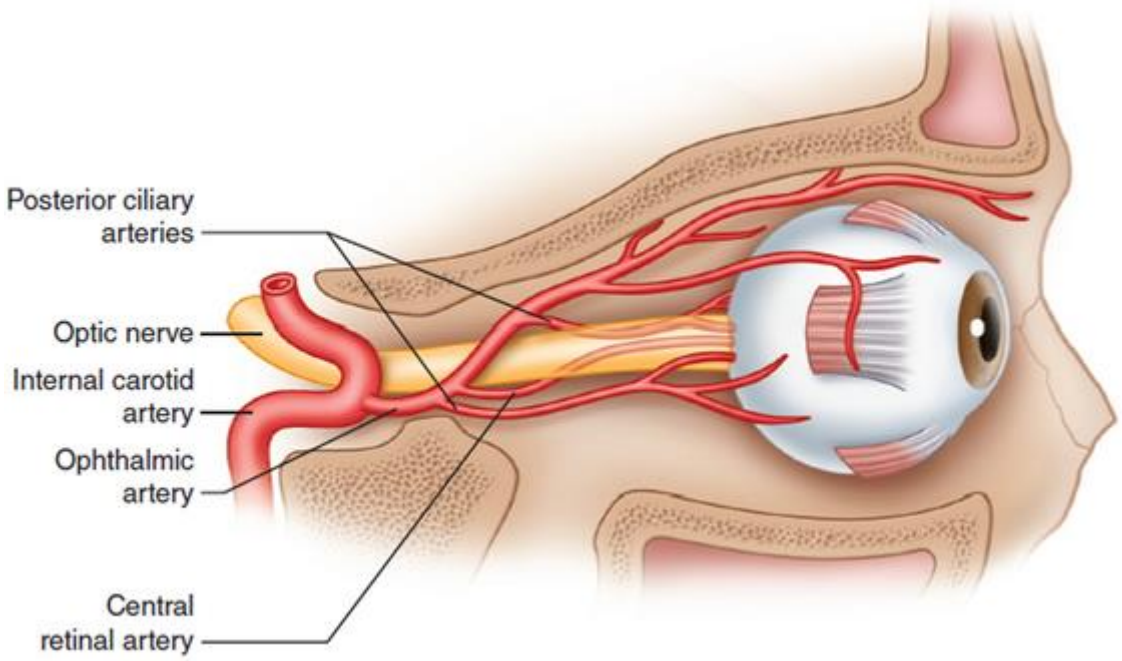


Figure 5

The ophthalmic artery, a branch of the internal carotid artery mainly supplies the globe and the orbit. In elderly this can be tortuous and prone to needle injury, in that case it bleeds profusely forming a retro-orbital haematoma[3, 6, 9, 11].

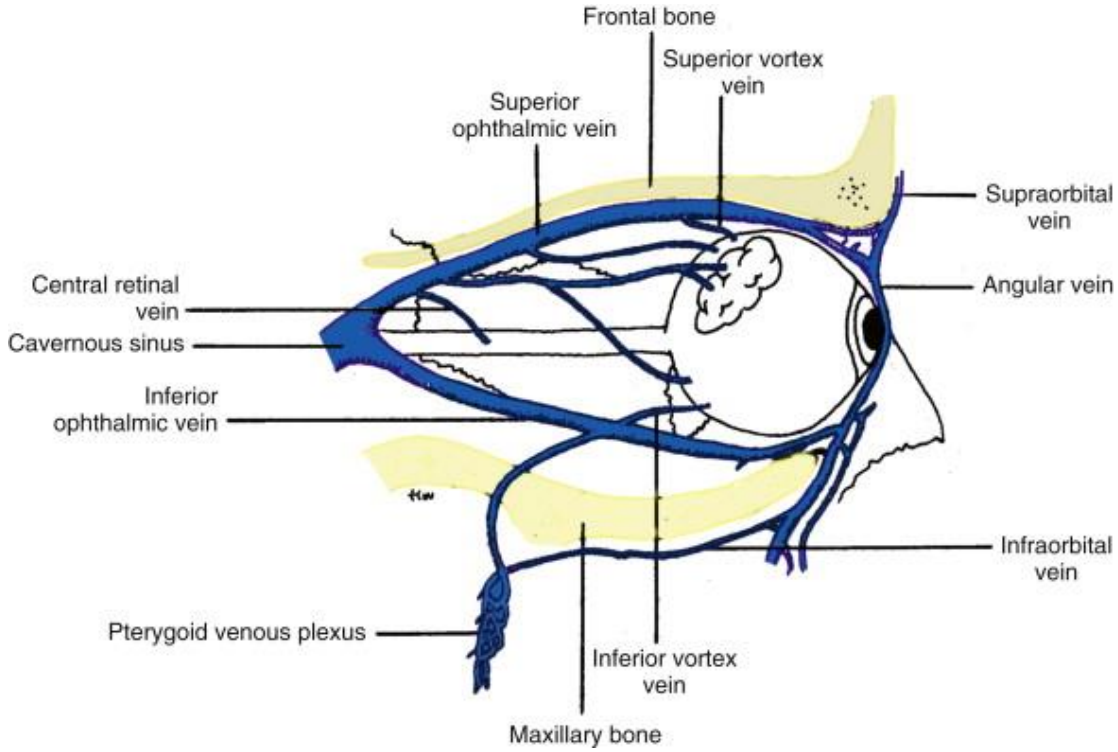


Figure 6

Venous drainage is mainly via the superior and inferior ophthalmic veins to the cavernous sinus. Any obstruction to venous drainage especially at the level of the cavernous sinus will lead to oedema of the orbital soft tissues and the globe[5, 6, 9, 11].

To put the above information into perspective one will note that there are lower chances of injury to important structures of the orbit and the globe if injection is either on the inferotemporal aspect and the superomedial aspect comes next although not as safe.

When performing an eye block one should be weary not to perforate to the neighbouring structures especially the air sinuses to prevent orbital sepsis. See the picture below[1, 3, 5, 6, 8, 9, 11].

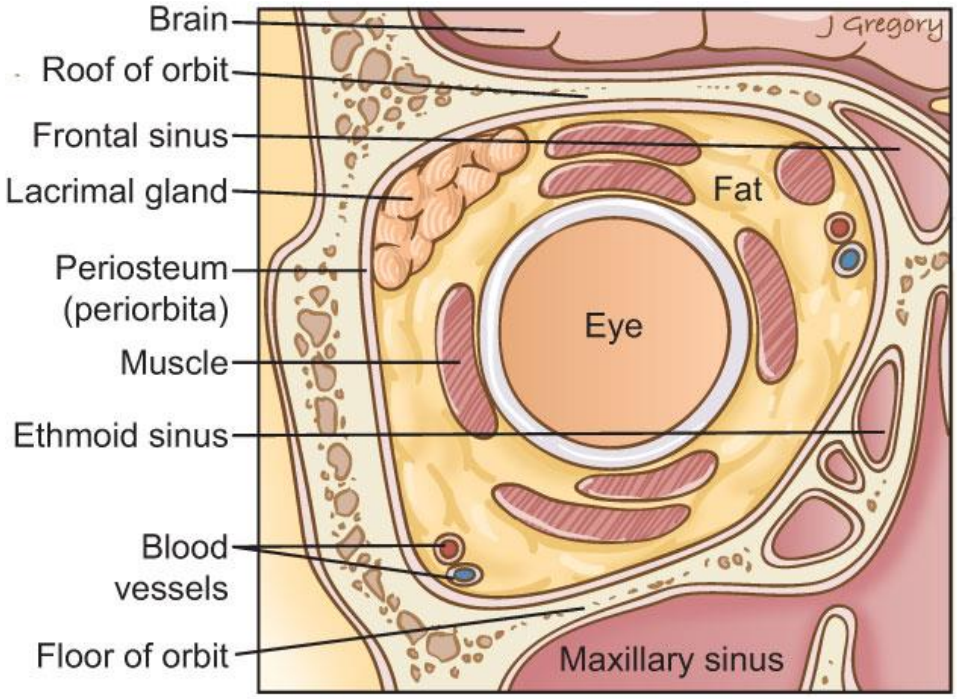


Figure 7

Pre-operative evaluation and preparation

Thorough history and physical examination is mandatory for these patients. Interrogation of core-morbidities especially the severity and the control of the chronic illnesses is mandatory before elective eye surgery. patients on anticoagulants or antiplatelet agents coming for anterior chamber surgery especially cataract surgery should continue their medication uninterrupted. Those coming for an intermediate to high risk surgery to bleeding should warrant a risk vs benefit analyses of stopping medications before the surgery. Previous operations e.g. detachment surgery must not be missed because these are important contra-indications for sub Tenon block. The globe measurement is paramount to avoiding globe injury. Some investigations e.g. ECG (when over 60 years) and blood sugar should remain routine. Further investigations will be directed by chronic illnesses[1, 3, 4, 7, 12, 13].

Premedication is not generally necessary, the patient must remain lucid to aid communication. Patient reassurance is usually sufficient, this is the most useful tool for this purpose. For those who are too nervous minimal sedation is recommended. Benzodiazepines have typically been used[1].

Before embarking on an eye block verify the patient and the surgery to be performed. Patient position is typically supine with the aid of pillows for those who have musculoskeletal disorders causing abnormal body structure. Patient comfort cannot be over emphasized as these blocks necessitate paramount cooperation. The head is supported at a comfortable position. Baseline vital signs taken and recorded. The eyes face forward with at a single point. Topical anaesthetic drops aid especially when transconjunctival approach is to be chosen when doing a nerve block, be careful not to drop it directly on to the cornea as this may be uncomfortable for the patient. Typically two to three drops can be instilled[4, 7].

Specific eye blocks types

These can be Akinetic or Non-Akinetic techniques[4].

Akinetic Techniques **Non-akinetic techniques**

Needle based	Cannula based	
1 Retrobulbar block	1 Sub-Tenon's block	1 Topical anaesthesia
2 Peribulbar block		2 Perilimbar (subconjunctival) anaesthesia

Akinetic techniques

Anaesthetic agent considerations

For anaesthesia a concentrated solution is used. This may increase the chances of local anaesthetic complications which one should be aware of. A 2% lignocaine solution is popularly used for its quick onset, typically its effects last for an hour. For longer operations e.g. vitreoretinal surgery bupivacaine 0.5% is used. A combination of the above agents is used by some units especially in Durban so as to get the advantages of each. It should be noted that the combination of local anaesthetic side effects is inevitable in this case[2, 7, 12]. One percent ropivacane has comparable ocular effects to the above combination at 8 minutes after injection as a result some centres tend to use ropivacane alone.

Adjunctive agents

Hyaluronidase, an enzyme liquefier of interstitial barriers through depolymerisation of hyaluronic acid, 5 to 150 international units/ml to aid the local spread of the local anaesthetic in the tissue planes, typically 15 IU/ml can be added.

Adrenaline, typically 1:100,000 can be added to limit the absorption rate of local anaesthetic thereby prolonging the effect of local anaesthetic. This is better appreciated with the use of lignocaine.

Alkalinization with Sodium bicarbonate to not more than 1% has may decrease the onset time by increasing non-ionized component of the local anaesthetic, which crosses the cell membrane relatively faster. Local anaesthetics are weak bases[7, 12, 13].

Matching surgery and eye block

Topical anaesthesia	Cataract surgery, corneal transplant surgery,
Local injections (retrobulbar, peribulbar, subtenon)	Any complex surgery or lasting more than 30 to 60 minutes
General anaesthetic	-Uncooperative patients e.g. children, the deaf and those with an uncontrolled psychiatric disease, the other groups are those with severe eye trauma. Extensive surgery where local anaesthetic is not practical. -operation on an infected area where local anaesthetic is contraindicated.

Contra-indications to eye blocks

1 patient refusal
2 infected operative site
3 allergy to the local anaesthetic
4 inability to lie supine for required operative time
5 anticoagulation for
6 antocoagulants and antiplatelets for vitrectomy are a relative contraindication. The risk of bleeding needs to be compared to the risk of thrombosis. In all the above medications no statistically significant bleeding and loss of vision was associated with them[1, 4, 14].

Retrobulbar block (Intraconal)

Being one of the oldest blocks, the retrobulbar block has remained a Gold standard as far as achieving good anaesthetic condition. These include excellent analgesia, globe akinesia and abolished oculomedullary reflexes. There may be a need for and additional injection to block nerve supply to the superior oblique muscle because of its extraconal path. To prevent blinking an additional facial nerve block may be needed. A modern modification of this block has been proposed to mitigate common complications of this block[1, 4, 7].

How to

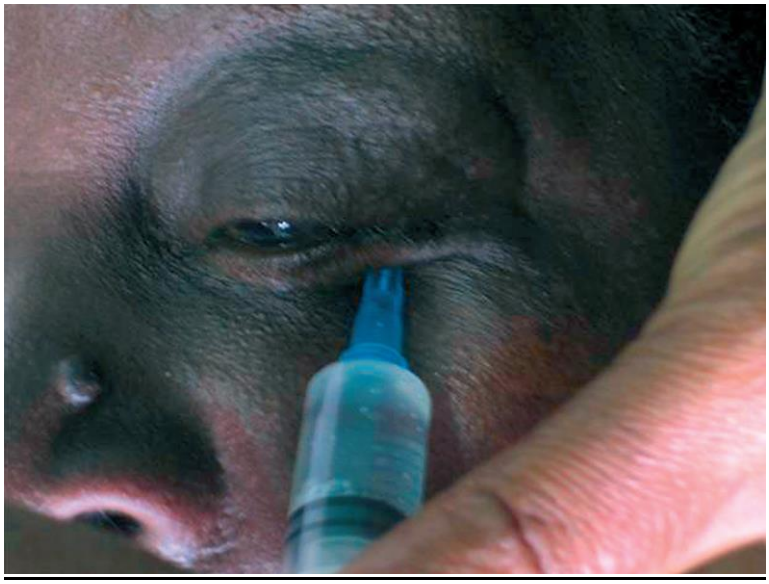


Figure 8

The **conventional technique** includes two injections, one on through the skin on the inferior eyelid at a junction between the lateral third and the medial two thirds, with the needle directed towards the orbital apex, typically 25 to 35mm deep into the cone. The second injection is in the superior eyelid at the junction of the medial third and lateral two thirds, directed towards the orbital apex as well. The gaze of the globe is superomedial. Typically two to four millilitres are injected into the cone in total. The van Lindt technique for facial nerve block can then be used to prevent blinking.

The **modern modification** of this block is performed with the eye at the primary gaze, at the junction between the lateral and inferior walls of the orbit and the primary needle direction is parallel the anteroposterior axis of the globe until just past the equator as directed by the globe size, usually at 15mm. The needle is then directed towards the apex from this point onwards.

The size of the needle used is 23 G, 24 mm needle. This avoids injury to the inferior rectus and the optic nerve. The volume injected does not change[1, 4, 7].

Peribulbar Anaesthesia (Periconal)

In this block the local anaesthetic is injected outside the cone with the gaze facing forward and at a fixed point. The injection can be percutaneous or through the conjunctiva, the latter necessitates topical application of the local anaesthetic prior to injection. This peribulbar requires a bigger volume so as to spread throughout the orbital fat to reach the Intraconal space. Typically five to ten millilitres of local anaesthetic are injected. This volume spreads even to the orbicularis oculi so generally an additional injection is unnecessary. It must be noted that there is significant tissue distortion with this amount of local anaesthetic injected hence any additional injection has higher chanced of complications than the first injection.

Typically an injection is done at the inferotemporal junction close to the orbital rim with less inward and superior angulation. 25mm into the orbit is the usual depth. The original description has the second injection superomedial at the junction of the medial one third and lateral two thirds of the upper eyelid, this increases the risk of injury to important structures and the globe itself.

It is important to apply external pressure for five to ten minutes after the block otherwise the intraocular pressure can increase significantly leading the significant aqueous loss on opening the globe. A Honan's balloon inflated to the pressure of thirty millimetres of mercury is used, or just gentle external pressure.

There has been several modifications to this approach, e.g. injection site at medial canthus, lacrimal curancle, inferior and temporal peribalbar injections at the most lateral aspect of the limbus[1, 3-5, 7, 12, 13].

Figure 9

Retrobulbar vs Peribulbar blocks

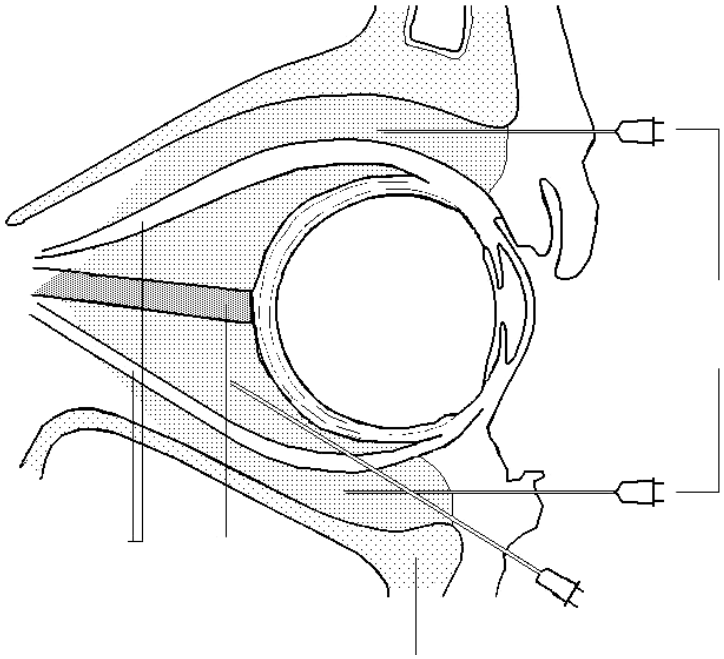


Figure 10

The retrobulbar block has been assumed to have superior anaesthetic conditions compare to peribulbar approach but if sufficient volume of local anaesthetic is instilled in a peribulbar compartment the results are comparable. There are no boundaries between these compartments in-between the muscles so the local anaesthetic spread is not deterred.
Of note is that the retrobulbar block has higher risk of globe perforation, retro orbital haemorrhage, optic nerve injury, muscle injuries and brainstem anaesthesia and a result it has been abandoned by most clinicians[1, 4].

Sub-Tenon's (episcleral) block

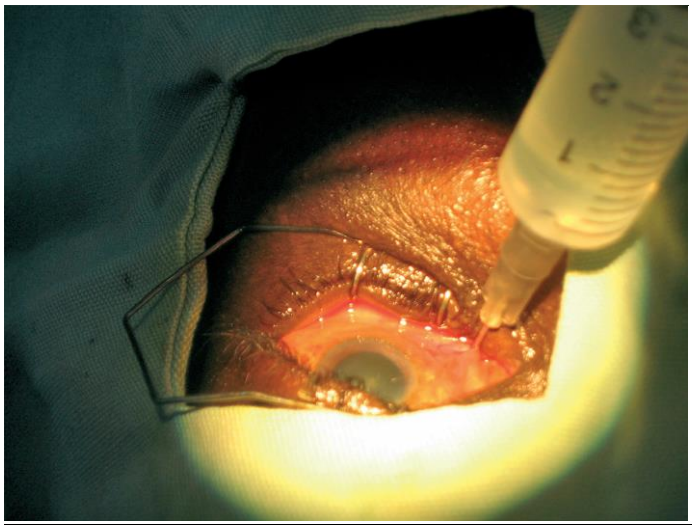


Figure 11a

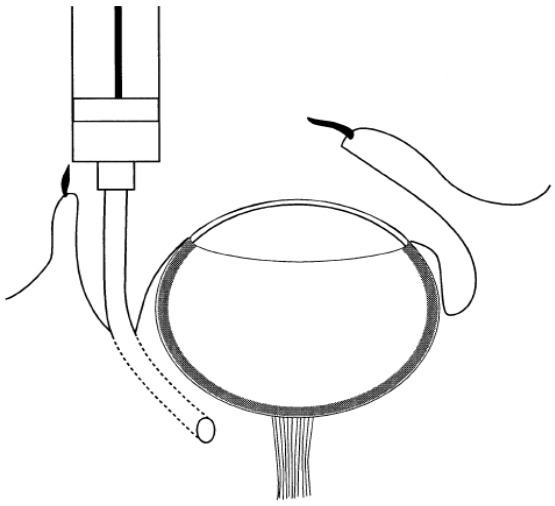


Figure 11b

The patient is positioned supine as above. The anaesthetist sits at the head end of the patient with the chin above the patients face at a reasonable distance. The patient may be asked to look at the chin of the anaesthetist. A drop of local anaesthetic is instilled onto the lower fornix of the conjunctiva. A few drops of povidone iodine to be instilled for sterility.

A Barrequer (small lid speculum) is inserted to splint the eyelids open. With the non-toothed forceps (Moorfield), about 5 mm from the medial side of the limbus on the inferonasal region conjunctiva and Tenon's capsule bite is taken. A small incision (2mm or less) is made with the spring scissors (Westcott's). A short tunnel along the scleral curveture with the closed scissors can be made until about 10mm or just beyond the equator where loss of resistance should be appreciated. A Tenon's cannula (blunt 19G, 25mm, curved) is inserted in the tunnel following the scleral curvature to past the equator. Typically about 15 to 20mm deep. Adequate analgesia and anaesthesia is achieved with 4 mls of lignocaine 2% but partial akinesia, total akinesia may be achieved with 6 mls within a few minutes[1, 2, 4, 7, 12, 13].

Subconjunctival infiltration

Local infiltration can be used for localised injuries of the conjunctiva and the eyelids. Lignocaine 1% to 2% in usually used with adrenaline 1:100,000 solution. This only enables local anaesthesia and has no akinetic effects. For longer effect o.25 to 0.5% bupivacaine can be added[7].

Topical anaesthesia

This technique blocks the trigeminal nerve endings at the conjunctiva and the cornea there by leaving the rest of the anterior chamber structures sensitive. It is done by either instilling local anaesthetic drops onto the conjunctiva or the local anaesthetic gel. Drugs used include 2% to 4% lignocaine, oxybuprocaine hydrochloride, proxymetacaine hydrochloride, tetracaine hydrochloride (amethocaine hydrochloride)[and 0.5% proparacaine hydrochloride solutions. In combination with intracameral block (injection of 1 ml 1% preservative free lignocaine into the anterior chamber after an incision and drainage of aqueous humor) then the iris and ciliary body can be anaesthetised. This enables the anaesthetic to be useful for cataract and glaucoma surgery. Vision is left intact hence the need for proper counselling preoperatively. Sedation may be given to those who are very anxious[7].

Complications of eye blocks

Procedure related	Anaesthetic agent related.
1. Inadequate anaesthesia and analgesia. This may necessitate additional injections	Local anaesthetic toxicity (uncommon). This can be intrathecal, intra-arterial, intravenous or local absorption. The presentation depends on the agent used and the route of toxicity. Typically arterial toxicity will lead to CNS toxicity as injection can reverse the flow into the internal carotid artery. Venous and local spread are likely to cause cardiovascular collapse. Bupivacaine is likely to cause Cardiovascular toxicity than lignocaine.
2 Retrobulbar haemorrhage (1–2% incidence). Bleeding into the skin or conjunctiva may be apparent. This necessitates measurement of the intraocular pressure and if raised a surgeon must be alerted so as to start means to decrease it failing which the retinal artery may block and retinal ischemia may lead to blindness.	
3 Globe penetration (<1% incidence). More likely in myopic patients, likely to lead to retinal detachment and vitreous haemorrhage. A surgeon has to be alerted immediately.	
4 Optic nerve damage (<1% incidence). This may be due to direct needle trauma or injection into the nerve itself. Damage is likely to be permanent, prevention is paramount. Occasionally this may present with Central Nervous System toxicity.	
5 Muscle palsies (uncommon).	
6 Chemosis (common), common and subsides with compression and time.	
7 Corneal abrasion, caused by exposure of the conjunctiva, especially to the compression object.	

[2, 4, 5, 7, 12]

CONCLUSION

Thorough understanding of the anatomy of the orbit is fundamental to all clinicians performing an eye block. As noted above there are several types of eye blocks and one can only be able to decide on what block to be done from the type of surgery to be done, the surgeon's and anaesthetist's comfort and the patient comfort. Either way the least risky procedure but adequate for that type of surgery should be the most likely to be done. Objective training should be done at UKZN with specific end points e.g. eye blocks in the models and in eye theatre with supervision until adequate competence is achieved. This is possible as this department has the SIM centre and at least seven hospitals that operate on eyes. Rotations to these hospitals specifically for eye anaesthesia should be planned. These hospitals are McCord, Prince Mshiyeni, Inkosi Albert Luthuli, Port Shepstone, Stanger, Greys and Edendale hospitals.

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