Chapter 6

Regional Anesthesia in Ophthalmology

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The pioneering work of Jankovic [1] on the anesthetic effect of cocaine in the context of ophthalmic surgery was the historical starting point for local and regional anesthesia. Local anesthesia is commonly used today for majority of ophthalmic surgical procedures. Cataract surgery is the most common surgery and local anesthesia is the norm, but the provision of anesthesia varies worldwide but exact frequency of the use of a particular technique is not known. Patient comfort, safety, and low complication rates are the essentials of local anesthesia. The technique is chosen to provide anesthesia with or without reduction of eye movements. Ophthalmic blocks can be achieved by inserting a needle or a blunt cannula.

Orbital Anatomy

The globe or bulbus oculi lies in front of the orbit and is covered by eyelids. The orbit is an irregular four-sided pyramid with its apex pointing posteromedially and its base facing anteriorly (Figs. 6.1, 6.2, and 6.3). The base is formed by the surface of the cornea, the conjunctiva, and the lids. The medial wall of orbit is parallel to the sagittal plane, but the lateral wall is angled inward at 45°. The roof is horizontal but the floor slopes upward, front to back by 10°. The globe is closer to the roof than the floor of the orbit. The length of orbit varies from 42 to 54 mm. One-fourth of the orbit is filled by the globe (7 ml), and the remainder is filled with fatty tissue, vessels, lacrimal gland, connective tissue, nerves, and extraocular muscles. The transparent cornea lies on the anterior surface of the eyeball (Fig. 6.4).

Underneath this lies the crystalline lens which is located in front of the iris, with its central opening, the pupil. The conjunctiva covers relatively the tough sclera. The optic nerve enters the globe on the hind surface of the globe slightly medial to the axis. The anterior chamber of the eye is bounded by the cornea, the iris, and the lens. The posterior chamber of the eye encircles the lens in a ringlike shape, and the posterior chamber of the eye contains the vitreous body.

The movements of the globe are made possible by four straight muscles, inferior rectus (oculomotor nerve), lateral rectus (abducent nerve), medial rectus (oculomotor nerve), and superior rectus (oculomotor nerve), and two oblique, superior oblique muscle (trochlear nerve) and inferior oblique muscle (oculomotor nerve) (Figs. 6.2, 6.3, and 6.5). The rectus muscles arise from the annulus of Zinn near the apex of the orbit and insert anterior to the equator of the globe thus forming an incomplete cone. Thus, the orbit is divided into two compartments although not completely separate, an extraconal compartment and an intraconal compartment. Injected local anesthetics are easily able to cross the barrier between two compartments by diffusion. Within the annulus and the muscle cone lie the optic nerve (II), the oculomotor nerve (III containing both superior and inferior branches), the abducent nerve (VI nerve), the nasociliary nerve (a branch of V nerve), the ciliary ganglion, and vessels.

The sensory supply of the orbit is provided by lacrimal, frontal, and nasociliary branches of the ophthalmic division of the trigeminal nerve. (See Chap. 10 Trigeminal Nerve, pp. 135–7) Autonomic fibers run from the ciliary ganglion situated within the cone near to the orbital apex (Figs. 6.2 and 6.3). The ciliary ganglion, a tiny collection of nerve cells, lies in the posterior part of the orbit between the optic nerve and the lateral rectus muscle. The sensory and sympathetic roots of the ciliary ganglion are provided by the nasociliary nerve and the neural network around the internal carotid artery but do not always connect to the ciliary ganglion. Their fibers can reach the eye directly via the ciliary nerves. The sympathetic fibers which are already postganglionic after they have switched to the cervical sympathetic trunk ganglia can accompany the ophthalmic artery and its branches on the way to their destination. Stimuli from the cornea, iris, choroid, and intraocular muscles are conducted in the sensory fibers.

The eye and orbital contents receive their main arterial supply from the ophthalmic artery (Fig. 6.6). The ophthalmic artery is a branch of the internal carotid artery. In the orbital cavity, the artery runs forward for a short distance lateral to the optic nerve and medial to the lateral rectus muscle, the abducent and oculomotor nerves, and the ciliary ganglion. The artery then turns medially and crosses above the optic nerve, accompanied by the nasociliary nerve. The venous blood of the orbit is drained by the superior and inferior ophthalmic veins which in turn drain into the cavernous sinus. The superior ophthalmic vein crosses the optic nerve with the ophthalmic artery. The veins of the orbit are tortuous and freely anastomose with one another, and they have no valves. These vessels are known to be damaged when a long needle is inserted deep into the apex.

Tenon capsule (fascial sheath) is a thin membrane that envelops the eyeball and separates it from the orbital fat. The inner surface is smooth and shiny and is separated from the outer surface of the sclera by a potential space the sub-Tenon space. Crossing the space and attaching the fascial sheath to the sclera are numerous delicate bands of connective tissue (Fig. 6.7). Anteriorly, the fascial sheath is firmly attached to the sclera about 3–5 mm posterior to the corneoscleral junction. Posteriorly, the sheath fuses with the meninges around the optic nerve and with the sclera around the exit of the optic nerve. The tendons of all six extrinsic muscles of the eye pierce the sheath as they pass to their insertion on the globe. At the site of perforation, the sheath is reflected back along the tendons of these muscles to form a tubular sleeve. The local anesthetic is injected beneath this part of the sub-Tenon space.

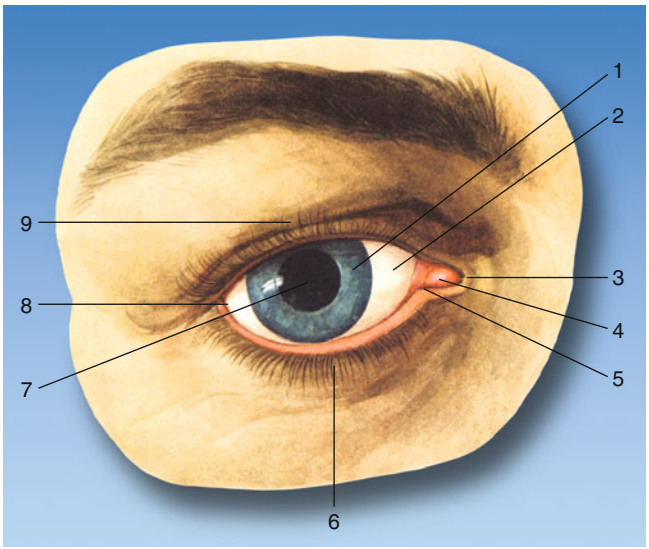


Fig. 6.1 Eyelids and lacrimal apparatus. (*1*) Cornea, (*2*) conjunctiva, (*3*) medial angle of the eye, (*4*) lacrimal caruncle, (*5*) lacrimal papilla, (*6*) inferior eyelid, (*7*) pupil, (*8*) lateral angle of the eye, (*9*) superior eyelid (With permission from D. Jankovic)

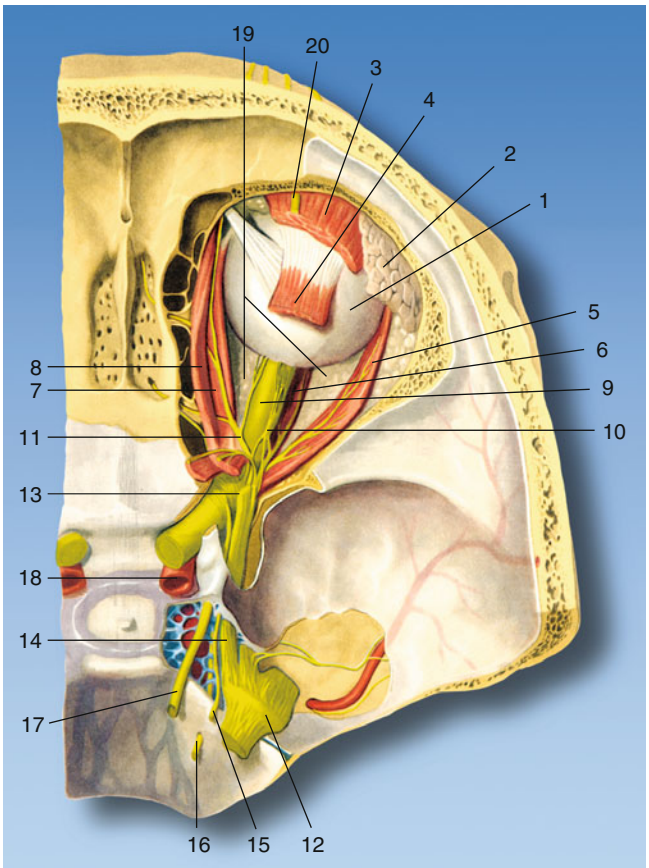


Fig. 6.2 Anatomy of the eye. (*1*) Eyeball, (*2*) lacrimal gland, (*3*) levator palpebrae superioris muscle, (*4*) superior rectus muscle, (*5*) lateral rectus muscle, (*6*) inferior rectus muscle, (*7*) medial rectus muscle, (*8*) superior oblique muscle, (*9*) optic nerve, (*10*) ciliary ganglion, (*11*) nasociliary nerve, (*12*) trigeminal ganglion, (*13*) frontal nerve, (*14*) ophthalmic nerve, (*15*) trochlear nerve, (*16*) abducent nerve, (*17*) oculomotor nerve, (*18*) internal carotid artery, (*19*) retrobulbar fat, (*20*) supraorbital nerve (With permission from D. Jankovic)

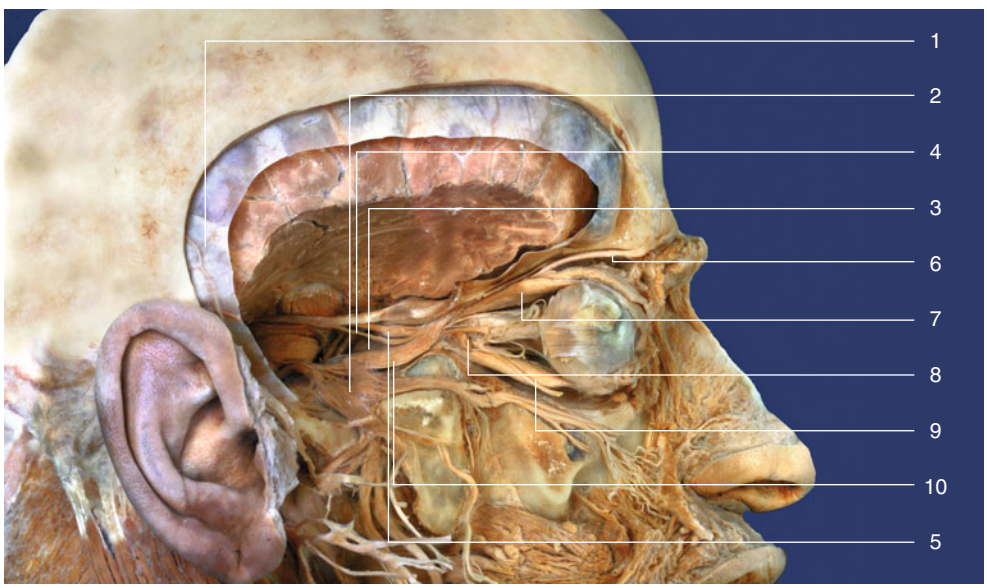


Fig. 6.3 Anatomy. (*1*) Spinal dura mater, (*2*) trigeminal ganglion, (*3*) internal carotid artery, (*4*) trochlear nerve, (*5*) oculomotor nerve, (*6*) supraorbital nerve, (*7*) superior rectus muscle, (*8*) ciliary ganglion, (*9*) inferior rectus muscle, (*10*) ophthalmic nerve (With permission from D. Jankovic)

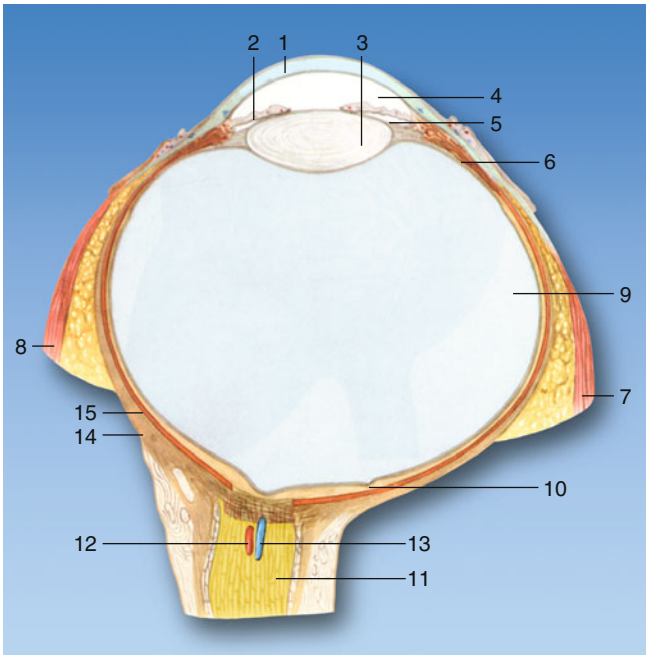


Fig. 6.4 Horizontal section through the eyeball. (*1*) Cornea, (*2*) iris, (*3*) lens, (*4*), anterior chamber of the eyeball, (*5*) posterior chamber of the eyeball, (*6*) ciliary body, (*7*) lateral rectus muscle, (*8*) medial rectus muscle, (*9*) vitreous body, (*10*) central retinal fovea, (*11*) optic nerve, (*12*) central retinal artery, (*13*) central retinal vein, (*14*) sclera, (*15*) choroid (With permission from D. Jankovic)

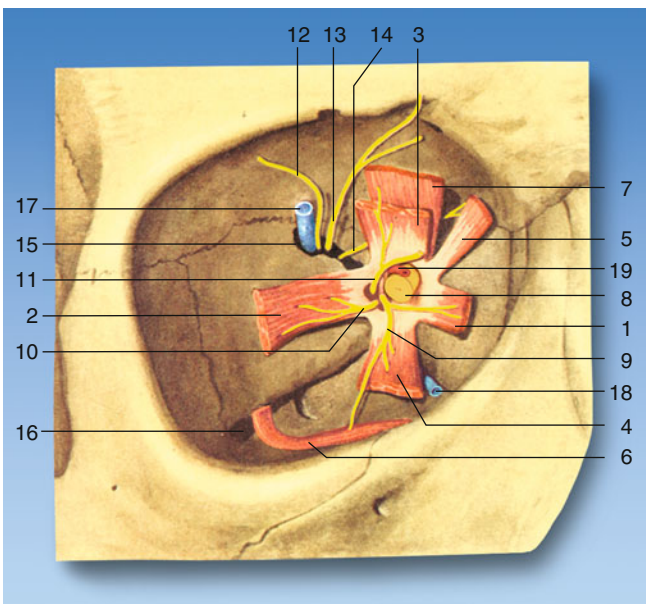


Fig. 6.5 Eye: muscles, nerves, and vessels. (*1*) Medial rectus muscle, (*2*) lateral rectus muscle, (3) superior rectus muscle, (*4*) inferior rectus muscle, (*5*) superior oblique muscle, (*6*) inferior oblique muscle, (*7*) levator palpebrae superioris muscle, (*8*) optic nerve, (*9*) oculomotor nerve, (*10*) abducent nerve, (*11*) nasociliary nerve, (*12*) lacrimal nerve, (*13*) frontal nerve, (*14*) trochlear nerve, (*15*) superior orbital fissure, (*16*) inferior orbital fissure, (*17*) superior ophthalmic vein, (*18*) inferior ophthalmic vein, (*19*) ophthalmic artery (With permission from D. Jankovic)

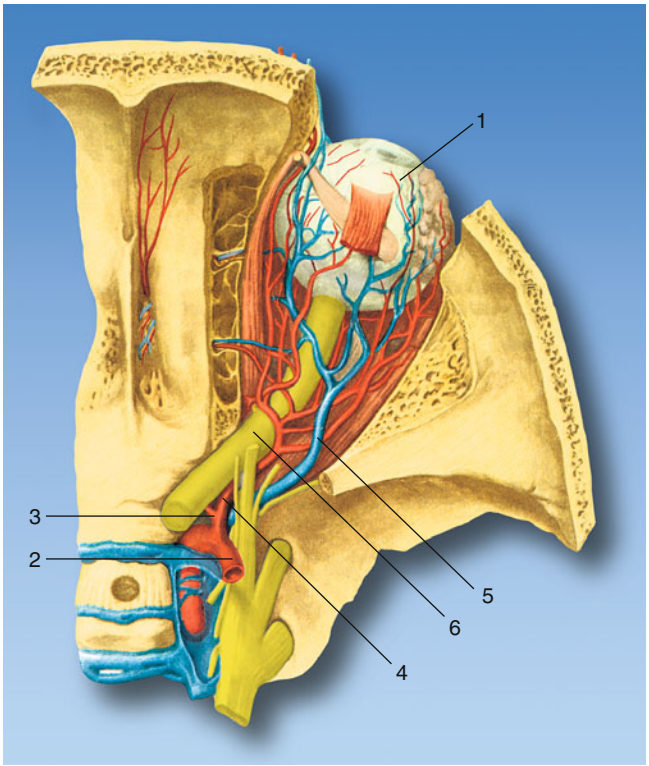


Fig. 6.6 Blood supply in the eye. (*1*) Eyeball, (*2*) internal carotid artery, (*3*) central retinal artery, (*4*) ophthalmic artery, (*5*) superior ophthalmic vein, (*6*) optic nerve (With permission from D. Jankovic)

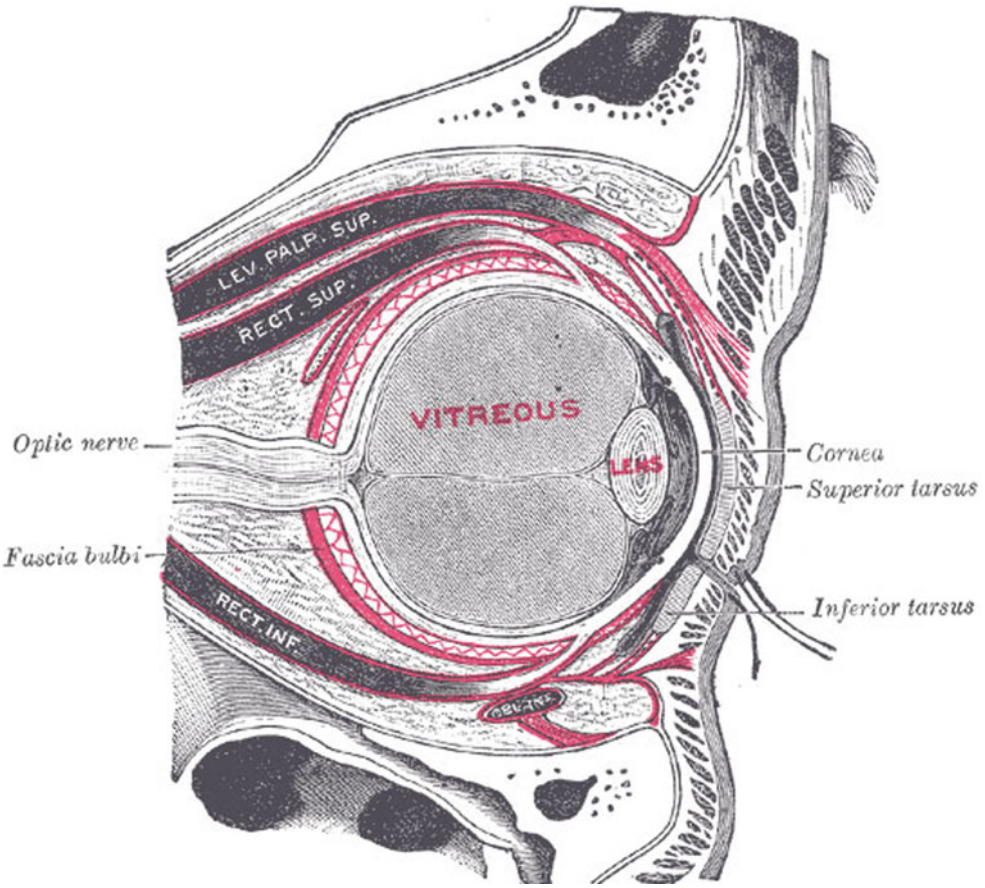


Fig. 6.7 Sub-Tenon space showing multiple connective tissue bands (With kind permission from www.bartleby.com)

Anatomy Relevant to Blocks

The terminology used for regional orbital blocks is controversial. An intraconal (retrobulbar) block involves the injection of a local anesthetic agent into the muscle cone behind the globe formed by four recti muscles and the superior and inferior oblique muscles. An extraconal (peribulbar) block involves the injection of local anesthetic outside the muscle cone. Many studies confirm that there are multiple communications between two compartments, and it is sometimes difficult to differentiate if the injection is intraconal or extraconal. A combination of intraconal and extraconal blocks is described as combined retroperibulbar block.

The average distance between the orbital margin and the ciliary ganglion is approximately 38 mm (range 32–44 mm). If a 38-mm needle is used, it may reach the optic nerve in a large number of patients leading to serious catastrophic events. A needle *<31 mm* must be used to protect the globe, optic nerve, and other major structures behind the globe during both extraconal and intraconal blocks. In cadaver studies, Karampatiakis et al. found that when a retrobulbar block was carried out with a needle 40 mm long, the needle tip would reach the posterior optic nerve in 100 % of cases; even with needles 35 mm long, the covering of the optic nerve would be touched [2].

Average axial length (anteroposterior distance of the globe) of the eye varies from 22 to 24 mm. Eye with axial lengths >26 mm are more prone to globe damage. The axial length measurement is available during cataract surgery. If a patient is scheduled for non-cataract surgery, spherical power of the spectacles may offer some clue. If a patient has very thick prescription glasses, it indicates high myopia. The risk of damage to the globe and optic nerve is also greater when the globe is rotated during injection. Therefore, it is recommended that the globe should be in the neutral gaze during the injection. It is safer to introduce a needle as far lateral as possible because if it is introduced at the junction of medial 2/3rd and lateral 1/3rd of the inferior orbital rim, the inferior rectus and inferior oblique muscles and their nerves may be damaged.

In sub-Tenon block, local anesthetic agent is injected under the Tenon capsule. This block is also known as parabulbar block, pinpoint anesthesia, and medial episcleral block.

Physiology

The physiological pressure (intraocular pressure) interior of the eye is between 10 and 20 mmHg. It is higher in patients with a large-diameter eyeball and in the recumbent position. It is higher in the morning than in the evening. It increases during coughing, physical exertions, and vomiting. An increase in the plasma concentration of carbon dioxide and decrease in oxygen concentration increase the intraocular pressure. Intraocular pressure increases after the needle technique, and this is due to increase in the volume behind the globe. There is little or no increase in intraocular pressure after sub-Tenon block. The anterior and posterior chambers of the eye contain 250 μl of an aqueous liquid (rate of synthesis ca. 2.5 μl/min).

Indications and Contraindications

Both intraocular procedures (cataract extraction, vitrectomy) and extraocular procedures (strabismus surgery, retinal detachment) can be carried out under local anesthesia in suitable patients. There are only a few absolute contraindications such as patient refusal to accept local anesthesia, allergy to local anesthetic agent, local infection, excessive abnormal body movements, severe breathlessness, psychiatric conditions, and in situations where it is difficult to establish a good communication between patients and health-care workers, but the list is shrinking and local anesthesia is increasingly used even in the above group.

Patient's Assessment and Preparation

Most ophthalmic surgical procedures are carried out as outpatient basis. There is debate as to the degree of preoperative assessment and investigation required and they vary worldwide. In the UK, the Joint Colleges Working Party Report recommended that routine investigations are unnecessary and the patients are not fasted [3]. Routine investigation of patients undergoing cataract surgery under regional anesthesia is not essential because it neither improves the

health nor improves the outcome of surgery, but tests can be done to improve the general health of the patient if required [4].

The preoperative assessment should always include a specific enquiry about bleeding disorders and related drugs. There is an increased risk of hemorrhage, and this requires that a clotting profile is available (and recorded) prior to injection (see later) [5, 6]. Patients receiving anticoagulants are advised to continue their medications. Clotting results should be within the recommended therapeutic range. Currently, there is no recommendation for patients receiving antiplatelet agents. Blood pressure should be controlled in hypertensive patients. Diabetic patients are allowed to take their usual medications, and active control of blood sugar is not necessary. There is no need for antibiotic prophylaxis in patients with valvular heart disease, and surgery is not performed if patient has suffered myocardial infarction during the last 3 months [3]. The presence of a long eye, staphyloma, or enophthalmos, the use of faulty technique, a lack of appreciation of risk factors, an uncooperative patient, and the use of unnecessarily long needles are some of the contributing causes. Knowledge of axial length measurement is essential. A precise axial length measurement is usually available for intraocular lens diopter power calculation before cataract surgery [7]. If the block is performed for other surgery and the axial length measurement is not known, close attention to the diopter power of patients' spectacles or contact lenses may provide valuable clues to globe dimension (patients usually provide this history).

General Considerations and Preparation Before Block

The patient and the person performing the block must be involved in full discussion of the proposed technique. The anesthetic and surgical procedures are explained to the patients. Patient is placed in a comfortable position, and oxygen is administered via a suitable device. All monitoring and anesthetic equipments in the operating environments should be fully functional. Blood pressure, oxygen saturation, and ECG leads are connected, and baseline recordings are obtained. Insertion of an intravenous line is a prerequisite for needle block, but its use has been questioned during sub-Tenon injections [2]. It is not unusual to observe adverse medical events in elderly patient, and a working intravenous line could only be a good clinical practice.

Sedation and Analgesia During Ophthalmic Blocks

The use of sedation varies in different parts of the world and may or may not be used. Sedation is used during block procedure, surgical procedure, or during block and surgery. However, sedation is common during topical anesthesia. Selected patients, in whom explanation and reassurance have proved inadequate, may benefit from sedation. Short-acting benzodiazepines, opioids, and small doses of intravenous anesthetic induction agents are favored, but the dosage must be minimal. An increased incidence of adverse intraoperative events is anticipated with sedation in elderly [6].

It is recommended that one of the following drugs is given immediately before carrying out regional anesthesia:

- Midazolam 1 mg (+ remifentanil 0.33 μg/kg)
- Propofol 0.5 mg/kg

Deep sedation should not accompany regional anesthesia; the patient should be capable of cooperating.

Conduction and Infiltration Block

Needle Techniques

Atkinson's classical retrobulbar block involves insertion of a 38-mm-long needle through the skin at the junction of the medial 2/3rd and lateral 1/3rd of the inferior orbital margin in a rotated eye toward the orbital apex. A facial nerve block (7th nerve block) is essential (see Chap. 7).

The classical retrobulbar block has now been superseded by a higher-volume modern retrobulbar and peribulbar blocks.

Modern Retrobulbar Block

The needle is deliberately directed toward the apex and within the muscle cone (see above) while the globe is in neutral gaze.

Indications

Both intraocular and extraocular surgery may include cataract surgery, vitreoretinal surgery, panretinal photocoagulation, trabeculectomy, optic nerve sheath fenestration, delivery of drugs (steroids, neurolytic agents), and sometimes strabismus surgery in willing patients. Retrobulbar block is also performed for the delivery of neurolytic agents for the treatment of chronic orbital pain.

Preparation

See above.

Materials

Equipments such as local anesthetic eyedrop, local anesthetic agent, needle, and syringe (Fig. 6.8) are essential for needle block. Other materials such as syringe, small needle, oculocompression device, gauge swab, hyaluronidase, epinephrine, and balanced salt solution (BSS) may be required.

The short and sharp needles are favored because they reduce the discomfort on insertion but at the expense of a reduced tactile feedback, hence a higher risk of failing to recognize a globe perforation. The blunt or dull needles are favored because it is believed that blood vessels are pushed rather traumatized and tissue planes could be more accurately defined, but these are more likely to cause greater damage when misplaced [8].

Patient Positioning

The best position for the patient is a semi-recumbent position (45°).

Injection Technique

Topical local anesthetic drops and antiseptic drops are instilled to obtain surface anesthesia (Fig. 6.9). A dilute local solution (add 2 ml of concentrated local anesthetic agent to 13 ml of BSS) is helpful before the injection of concentrated local anesthetic agent. Of this dilute solution, 1.5–2 ml is injected through the conjunctiva under the inferior tarsal plate in the inferotemporal quadrant.

A 27-gauge, 1-cm-long needle (Fig. 6.10) is inserted under the inferior tarsal plate through the conjunctiva to deliver dilute local anesthetic. The needle can be introduced through the skin or conjunctiva. A 25-G, 31-mm-long needle is inserted through the skin in the inferotemporal quadrant as far lateral as possible (7 o'clock position on the right eye or the 5 o'clock position on the left eye) below the lateral rectus muscle (Fig. 6.11) while the patient's eye is in the neutral gaze position. It is important that the needle hub is visible and the skin is not indented. The initial direction of the needle is tangential to the globe, then passed below the globe, and, once passed the equator as gauged by axial length of the globe, is allowed to go upward and inward along the floor of the orbit to enter the central space just behind the globe (Figs. 6.12 and 6.13). The globe is continuously observed during the needle placement.

Motility testing of the eye must be carried out before the procedure.

Dosage

- Oxybuprocaine HCl 0.4 % for surface anesthesia if the transconjunctival access route is chosen.
- 3–5 ml local anesthetic (e.g., 0.75 % ropivacaine, 0.5 % bupivacaine, 2 % prilocaine, 2 % mepivacaine, 2 % lidocaine) or combinations of these.
- Possible adjuncts to the local anesthetic:

  Epinephrine (5 μg/ml or 1:200,000)
  Hyaluronidase (150 IU) [7]

The addition of hyaluronidase to local anesthetics leads to improved diffusion and thus to a faster onset. This provides very good conditions for surgical procedures in the eye. Akinesia and anesthesia usually follow but they are dose dependent. If the amount injected is small, anesthesia may follow but akinesia may not occur at all. On the other hand, higher volume can generally guarantee anesthesia and akinesia, but intraocular pressure rises and other complications such as chemosis may occur. Sometimes a supplementary injection such as a medial peribulbar block is required (see later).

Advantages

Anesthesia and akinesia are very predictable and quick. It is easy to learn the technique provided knowledge of basic sciences relevant to block are achieved.

Disadvantages

There are reports of serious complications both sight- and life-threatening.

Side Effects and Complications

1. Hemorrhage in the very well-vascularized orbit, with a frequency of 0.7–1.7 % (known as "compartment syndrome"), can lead to blindness.
2. Conjunctival hemorrhage (20–100 %).
3. Retinal detachment and vitreous hemorrhage after perforation of the eyeball can lead to loss of vision.
4. Subperiosteal hemorrhage due to contact between the needle and the orbital floor.
5. Chemosis (25–40 %) due to fast injection of larger volumes of a local anesthetic.
6. Perforation of the eyeball and intraocular injections can occur, particularly in severely myopic patients. To avoid these, patients should gaze straight ahead throughout the block procedure.
7. Injury to the optic nerve or intraneural injection (immediate blindness).
8. Subarachnoid injection is a severe complication.
9. Intravascular injection, with serious CNS intoxication. See Chap. 1.
10. Oculocardiac reflex: bradycardia due to the vasovagal reflex is observed in younger and frail patients and may be seen both during the block procedure and also intraoperatively.
11. Injury to the extraocular muscles (usually the inferior oblique muscle or inferior rectus muscle) can lead to muscle necrosis, contractions, or disturbances of healing.

Fig. 6.8 Essential equipments for needle block

Fig. 6.9 Surface anesthesia

Fig. 6.12 Initial direction of needle (tangential to the globe) during modern retrobulbar block

Fig. 6.10 27-G, 1-cm-long needle inserted under the inferior tarsal plate through the conjunctiva to deliver dilute local anesthetic

Fig. 6.13 The needle is directed upward and inward during modern retrobulbar block

Fig. 6.11 27-G, 2-cm-long needle is inserted at *the extreme* inferolateral quadrant percutaneously during intended modern retrobulbar block

Peribulbar Block

Inferotemporal Peribulbar Block

This block is used as a main injection alternative to modern retrobulbar block.

Indications, Preparation, and Materials
See above

Patient Positioning
See above.

Injection Technique
Possible approaches of peribulbar injection are presented in Fig. 6.14.

A 25-G, 31-mm-long needle is inserted through the conjunctiva as far laterally as possible in the inferotemporal quadrant. Once the needle is under the globe, it is not directed upward and inward, but it is directed along the orbital floor. Five milliliter of local anesthetic agent of choice is injected. Many patients require a supplementary injection [8, 9].

Medial Peribulbar Injection: The Medial Canthus (Caruncular) Single Injection

A medial peribulbar block is usually performed to supplement inferotemporal, retrobulbar, or peribulbar injection, when akinesia is not adequate. A 27-G, 2.5-cm-long needle is inserted in the blind pit between the caruncle and the medial canthus (Figs. 6.14, 6.15, 6.16, and 6.17) to a depth of 15–20 mm. The needle is inserted at the medial side of the caruncle, at the extreme medial side of the palpebral fissure, and directed at a 5° angle away from the sagittal plane toward the medial orbital wall. The needle should never be introduced more than 20 mm for the caruncular puncture. This technique may require supplementary injection [10]. A medial peribulbar with a 25-G, 31-mm-long needle is used as primary technique in patients with long axial length which may be associated with higher incidence of staphyloma [11].

Dosage
Three to five milliliter of local anesthetic agent of choice is injected if this technique is used as a supplementary injection. However, if this technique is used as a primary injection technique, a volume of 8 ml may be required and this may be very painful during injection.

Advantages of the Caruncular Technique
1. The medial canthus single injection of peribulbar anesthesia is less painful as -efficient as the classic double-injection peribulbar technique.
2. Less local anesthetic agent is required.
3. Reduce the number of punctures and, thus, reduce the risk of injuring an important structure of the eye.
4. Short onset of block.
5. Less volume acquired, less ocular pressure.
6. The diffusion space of anesthetic agents around the globe is segmented by a network of numerous tiny aponeuroses, which may be less dense in the medial canthus region, and this might explain better diffusion and low-volume requirement. Further extraconal space in this compartment is relatively large and avascular, and this may reduce the risk of hematoma or intravascular injection.

Disadvantages
Multiple injections are required during peribulbar block. Caution is required during supplementary injection as the first injection is likely to alter the position of the globe in the orbit.

Complications of Needle Blocks
There are many complications of needle blocks, ranging from simple to serious, that have been reported and published [7]. The complications may be limited to the orbit or may be systemic. Orbital complications include failure of the block, corneal abrasion, chemosis, conjunctival hemorrhage, vessel damage leading to retrobulbar hemorrhage, globe perforation, globe penetration, optic nerve damage, and extraocular muscle damage. The systemic complications, such as local anesthetic agent toxicity, brain stem anesthesia, and cardiorespiratory arrest, may be due to intravenous or intrathecal injections or the spread or misplacement of drug in the orbit during or immediately after injection.

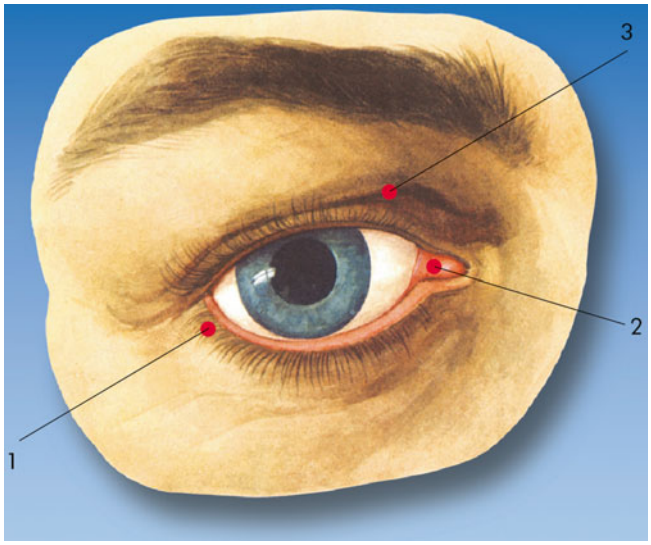


Fig. 6.14 Peribulbar block. Possible approaches: (*1*) inferotemporal, (*2*) medial caruncular, (*3*) superonasal (With permission from D. Jankovic)

Fig. 6.15 Inferotemporal peribulbar block—a needle inserted through the conjunctiva in the extreme inferotemporal quadrant below the lateral rectus muscle

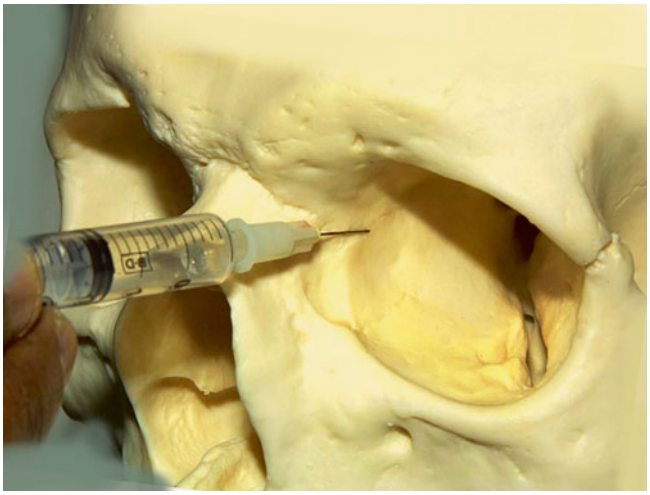


Fig. 6.16 A photography of the skull showing direction of needle during medial (caruncular) peribulbar block

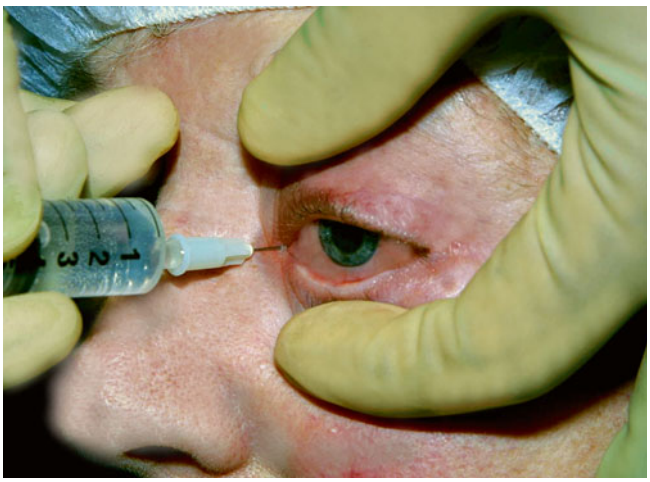


Fig. 6.17 Medial (caruncular) block: 27-G, 2-cm-long needle is inserted between the caruncle and medial canthus during medial peribulbar block

Sub-tenon Block

This block was introduced as a simple, safe, and effective alternative to needle blocks. The technique involves gaining access to the sub-Tenon space, the insertion of a blunt cannula, and the administration of local anesthetic agent into the sub-Tenon space [12].

Anatomy Relevant to Block

Orbital blocks are performed to achieve anesthesia and akinesia during orbital regional blocks. Injection of local anesthetic agent under the Tenon capsule diffuses into the intraconal space. Anesthesia is obtained when the branches of short ciliary nerve are blocked as they pass through the Tenon capsule to the globe. Akinesia occurs when branches of the motor nerves are blocked in the intraconal compartment.

The sub-Tenon space can be accessed from all four quadrants, but the inferonasal quadrant is the most commonly reported site of access in the published studies as the placement of cannula in this quadrant allows good fluid distribution superiorly while avoiding the area of access for surgery and damage to the vortex veins.

Indications

Sub-Tenon block is a versatile and effective technique. Its use has been advocated primarily for cataract surgery but is also effective for vitreoretinal surgery, panretinal photocoagulation, trabeculectomy, strabismus surgery, optic nerve sheath fenestration, and the delivery of drugs. This technique is also increasingly favored in patients who are on anticoagulants, aspirin, and nonsteroidal anti-inflammatory drugs (NSAIDs) [13, 14]. Complications are less severe and relatively fewer.

Materials

Topical local anesthetic agent, povidone iodine (5 %), scissors, forceps, local anesthetic agent, blunt sub-Tenon cannula, and syringe are required (Fig. 6.18). Additional materials such as speculum (Clarke or Screw speculum), gloves, cotton buds, hyaluronidase, and epinephrine may be helpful.

Preparation

Surface Anesthesia and Speculum Placement

All topical local anesthetic drops have been used, but preservative-free topical preparations in single-dose containers (0.4 % oxybuprocaine or tetracaine eyedrop) are usually preferred but they all produce stinging on initial application. Surface anesthesia can also be achieved by the application of a cotton bud soaked with topical agent in the area of dissection. The procedure is carried out under sterile conditions, and no-touch technique is advocated as infections are known to occur. Conjunctiva is cleaned with aqueous 5 % povidone iodine. Some prefer to use a speculum, but if not available, the lower lid is retracted by an assistant.

Position of the Patient and Technique

Anesthetist can approach from the head end or from the side [13]. The patient is positioned supine with comfortable pads and sponges. The patient is asked to look upward and outward (Fig. 6.19). If sedation is used, dissection can be performed in a neutral gaze position. Under sterile conditions, the conjunctiva and Tenon capsule are gripped with non-toothed forceps 5–10 mm away from the limbus (Fig. 6.20a). A small incision is made through these layers with scissors to expose the white area, and a sub-Tenon cannula (2.54 cm curved and blunt) is inserted along the curvature of the globe (Fig. 6.20a, b). It is not unusual to meet a resistance during this procedure especially when the Tenon capsule is not dissected properly or the cannula does not advance because resistance is met by tissues (connective tissue bands, muscles etc.); the cannula should be repositioned or inserted but force is never applied.

Dosage

Three to five milliliter of local anesthetic (2 % lidocaine, 0.5 % bupivacaine, 0.5 % levobupivacaine, 0.75 % ropivacaine) can be used. Addition of hyaluronidase is a subject of debate (see later). The volume of local anesthetic agent for sub-Tenon block varies from 1.5 to 11 ml but 3–5 ml is common.

Disadvantages

It is an invasive and surgical technique. Asepsis is of paramount importance. The technique could be difficult to learn initially but gets easier with experience. Muscle and eyelid akinesia are variable and are volume dependent. Pain during injection and conjunctival hemorrhage are frequently seen. Loss of local anesthetic during this procedure may occur. A syringe should contain at least 5 ml of local anesthetic agent of choice with or without adjuvant.

- About 10 % of patients require supplementation with an additional block of the facial nerve (4 %), surface anesthesia (2.6 %), or retrobulbar block (0.8 %).
- Pain during injection.

Complications

Although sub-Tenon block was introduced as a very safe technique over the years, a number of complications both minor (see above) and major have been reported [2, 13, 14]. Major complications include orbital and retrobulbar hemorrhage, rectus muscle paresis and trauma, globe perforation, the central spread of local anesthetic, orbital cellulitis, and others. Most of these complications have occurred following the use of a 2.54-cm metal cannula, but the exact mechanism and their incidence are not known. Smaller or flexible cannulae appear to be safer, but the incidence of minor complications increases.

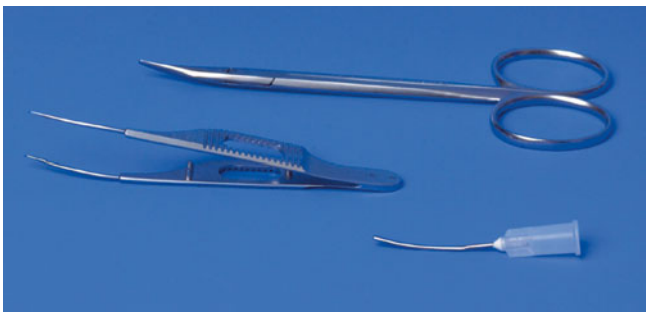


Fig. 6.18 Materials for a sub-Tenon block (With permission from D. Jankovic)

Fig. 6.19 Gaze of the globe (upward and outward) during dissection for inferonasal access for sub-Tenon block. Upward and outward rotation helps to expose the area of dissection

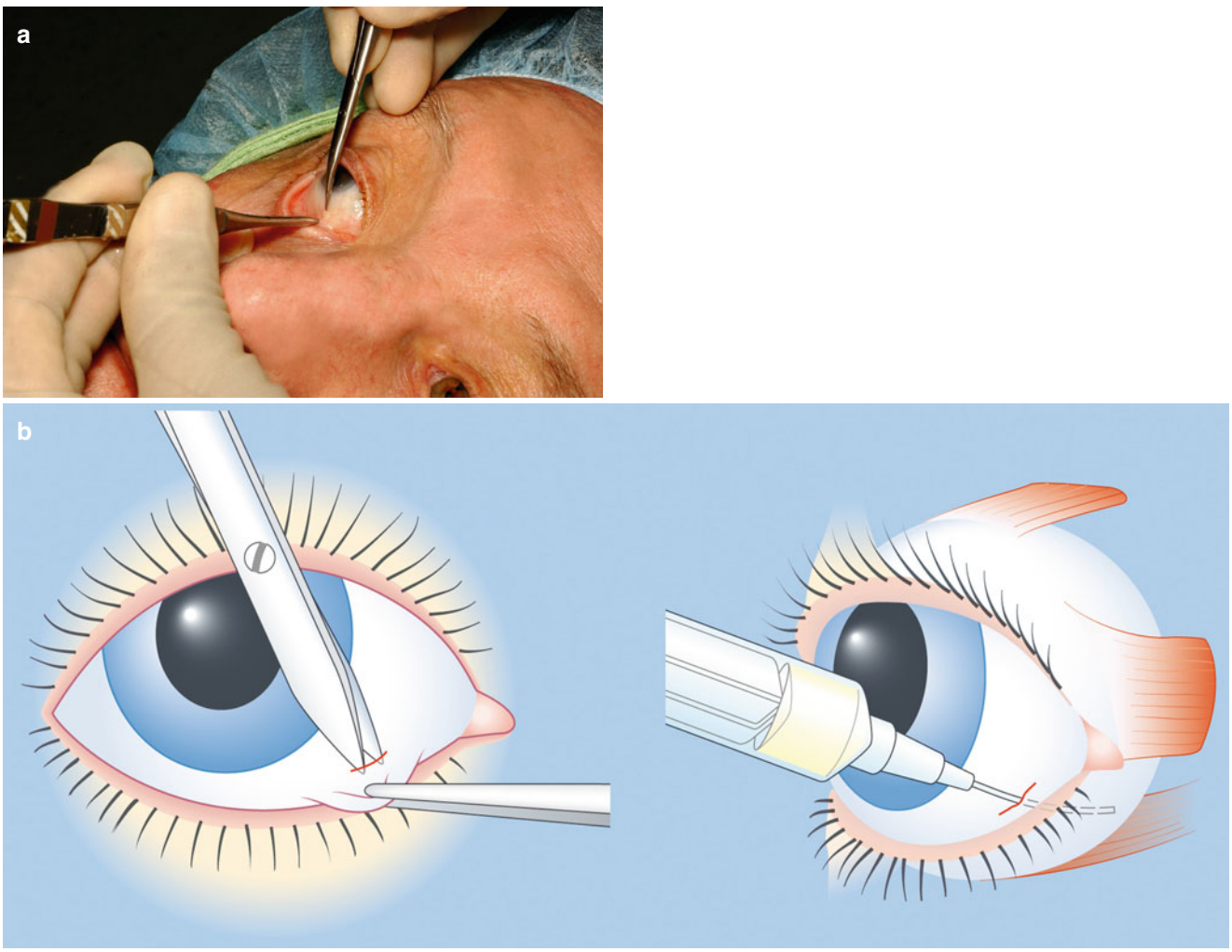


Fig. 6.20 (**a**) Inferonasal dissection for sub-Tenon block with Westcott scissors and Moorfields forceps. (**b**) Carrying out a sub-Tenon block. (**a**) The conjunctiva and Tenon capsule are opened with Westcott scissors. (**b**) The sub-Tenon needle is introduced into the posterior sub-Tenon space (With permission from D. Jankovic)

Topical Anesthesia

Topical anesthesia is increasingly used and preferred by ophthalmic surgeons or non-medical health-care professionals. This is not an invasive technique and different considerations apply. Readers are advised to consult relevant texts.

Checking Adequacy of Anesthesia

There is no objective method of checking anesthesia. It is anticipated that if akinesia is complete or near complete, anesthesia would accompany. If akinesia is not adequate or surgeon prefers complete akinesia, a repeat injection is considered.

Anticoagulation and Eye Block

There is an increased incidence of hemorrhage in patients who receive aspirin, nonsteroidal anti-inflammatory drugs, oral anticoagulants, and newer antiplatelet agents. Clotting profile should be checked and values must be in the therapeutic range. If patient is receiving warfarin, it should not be stopped. INR must be checked. If INR is higher than 3.5, the injection technique is better avoided. Long needles with sharp tips increase the risk of hemorrhage. Smaller needles and single-shot injections appear to be safer, and the sub-Tenon technique is apparently safer still [3].

Local Anesthetic Agents for Ophthalmic Blocks

The ideal agent for ophthalmic block should be safe, painless to inject, and produce a rapid onset of dense motor and sensory block, the duration of which must be sufficient for surgery yet not excessively prolonged. A technique based on higher volume can lead to an increased incidence of chemosis. The speed of onset is partially determined by the properties of the anesthetic, but more directly by the proximity to the nerves. All modern, high-potency local anesthetic agents are suitable for ophthalmic blocks and numerous studies have shown little difference in the quality of anesthesia, analgesia, and akinesia [15]. A complete blockade of nerves may not occur, and this is manifested by various visual sensations and experiences reported during ophthalmic regional anesthesia. Muscles regain their full activities after a few hours, and double vision may be experienced. It is important to inform the patient that while local anesthetic is present, it is important to avoid rubbing the eye.

Role of Vasoconstrictor

Vasoconstrictor (epinephrine) is commonly mixed with local anesthetic solution to increase the intensity and duration of block and minimize bleeding from small vessels. A concentration of 1:200,000 has no systemic effect. However, epinephrine may cause vasoconstriction of the ophthalmic artery, compromising the retinal circulation [15]. The use of epinephrine-containing solutions is avoided in elderly patients suffering from cerebrovascular and cardiovascular diseases. If anesthesia for longer duration is required, an agent which lasts longer such as bupivacaine, ropivacaine, or levobupivacaine should be used.

Role of Hyaluronidase

Hyaluronidase is an enzyme, which reversibly liquefies the interstitial barrier between cells by depolymerization of hyaluronic acid to a tetrasaccharide, thereby enhancing the diffusion of molecules through tissue planes. It is available as a powder readily soluble in local anesthetic solution. Hyaluronidase has been shown to improve the effectiveness and the quality of needle as well as sub-Tenon block, but its use remains controversial. The amount of hyaluronidase used varies from 5 to 150 IU/ml. The UK data sheet limits the concentration to 15 IU/ml [16]. Orbital swelling and allergic reactions can occur. Excellent blocks can be achieved without hyaluronidase, but there are reports of muscle dysfunction when it is not used during needle block. It is generally believed that local anesthetic agents stay in contact with thin muscles for a longer period leading to myotoxicity [7, 16].

Intraocular Pressure and Ophthalmic Blocks

Rise in intraocular pressure is observed immediately after retrobulbar and peribulbar injections, but no such rise is reported after sub-Tenon block [8]. Oculocompression devices such as Honan's balloon and McIntyre mercury bag may be necessary to reduce the intraocular pressure. However, when an oculocompression device is used, the pressure should not exceed 25 mmHg and it should be removed every 5 min.

Retained Visual Sensations During Ophthalmic Blocks

Many patients experience intraoperative visual sensations that include light, colors, movements, and instruments during surgery under all forms of local ophthalmic anesthesia

[17]. Although the majority of patients feel comfortable with the visual sensations they experience, a small proportion found the experience to be unpleasant or frightening. Therefore, patients receiving orbital blocks should receive preoperative advice as this may alleviate an unpleasant experience and the sedative may stop recall.

Intraoperative Care

The patient should be comfortable and soft pads are placed under the pressure areas. All patients undergoing major eye surgery under local anesthesia are monitored with pulse oximetry, ECG, noninvasive blood pressure measurement, and the maintenance of verbal contact. Patients should receive an oxygen-enriched breathing atmosphere to prevent hypoxia at a flow rate enough to prevent rebreathing and the ensuing hypercarbia once draped. ECG and pulse oximetry should be continued. Once the patient is under the drapes, verbal and tactile contacts are maintained [3].

Advantages and Disadvantages of Different Techniques

There are conflicting reports on the relative effectiveness of akinetic blocks [4]. The evidence indicates that peribulbar and retrobulbar anesthesia produce equally good akinesia and equivalent pain control during cataract surgery. There is insufficient evidence in the literature to make a definite statement concerning the relative effectiveness of sub-Tenon block in producing akinesia when compared with peribulbar or retrobulbar block. However, there was moderate evidence that sub-Tenon block produced better pain control than retrobulbar and peribulbar block. Finally, there was weak evidence that sub-Tenon block produces better pain control than topical anesthesia.

Choosing a Technique

There are numerous studies illustrating the diversity of preference for anesthetic technique by surgeons. The choice of the technique will always depend on a balance between the patient's wishes, the operative needs of the surgeon, the skills of the anesthetist, and the place where such surgery is being performed [8]. The practice of local anesthesia varies around the world. Although akinesia is not desirable during modern phacoemulsification surgery, other ophthalmic surgeries will require a still complete and anesthetized eye (viscocanalostomy). Needle blocks are single short techniques, and anesthesia and akinesia will depend on the choice of local anesthetic agent used. However, a sub-Tenon block can be repeated through the initial dissection should the need arise.

Conclusion

Eye blocks provide excellent anesthesia for ophthalmic surgery and success rates are high. Satisfactory anesthesia and akinesia can be obtained with both needle and cannula. At present, there is no perfect technique. Although rare, orbital injections may cause severe local and systemic complications. Knowledge of orbital anatomy and training are essential for the practice of safe orbital regional anesthesia.

Conduction anesthesia for intraocular procedures

Block ☐ Right ☐ Left

Name: _____ Date: _____

Diagnosis: _____

Premedication: ☐ No ☐ Yes _____

Purpose of block: ☐ *Surgery*

Needle: ☐ _____ *G* ☐ *Sharp* ☐ *Blunt*

☐ *Other* ☐ _____ *G* _____ *mm long*

i. v. access: ☐ *Yes*

Monitoring: ☐ *ECG* ☐ *Pulse oximetry*

Ventilation facilities: ☐ *Yes (equipment checked)*

Emergency equipment (*drugs):* ☐ *Checked*

Patient: ☐ *Informed*

Position: ☐ *Supine* ☐ *Sitting* ☐ *Semi-Sitting*

Approach: ☐ *Retrobulbar* ☐ *Peribulbar* ☐ *Sub-Tenon*

☐ *Surface anesthesia* ☐ *Other (facial nerve, trigeminal nerve)*

Sedoanalgesia before block: ☐ *Midazolam* _____ *mg* ☐ *Propofol* _____ *mg/kg*

☐ *Remifentanil* _____ *µg/kg* ☐ *Other* _____

Local anesthetic: _____ *mL* _____ *%* _____

Patient's remarks during injection:

Addition to injection solution: ☐ *No* ☐ *Yes*

☐ *None* ☐ *Pain* ☐ *Paresthesias* ☐ *Warmth*

Objective block effect after 15 min:

☐ *Akinesia* ☐ *Mydriasis* ☐ *Exophthalmos* ☐ *Incomplete block*

Monitoring after block: ☐ *< 1 h* ☐ *> 1 h*

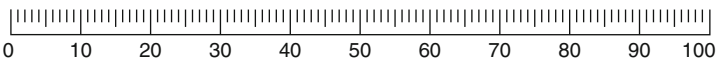
Time of discharge: _____

Complications: ☐ *None*

☐ *Yes (hematoma, intravasculatr injection, other)*

_____

VISUAL ANALOG SCALE



Special notes:

_____

_____

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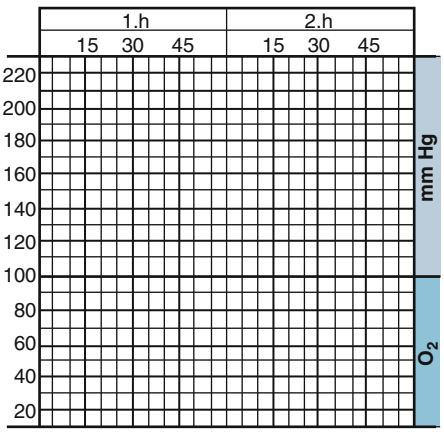
With permission from Danilo Jankovic

Record and checklist



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