

Local anesthesia for the ophthalmic surgery

Select the best technique for your patient

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ABSTRACT

يتم إجراء معظم عمليات العين الجراحية تحت التخدير الموضعي وتعطي وضع جراحي ممتاز لمثل هذه العمليات. تعد تقنية التخدير الموضعي سهلة الإجراء وذات معدل نجاح عالي، لكنها يمكن أن تترافق مع خطورة حدوث مضاعفات مهددة للحياة والرؤية. ولتقليل مضاعفات التخدير الموضعي لجراحة العين فإنه من المهم تحديث المعلومات والمعرفة حول هذه التقنية. هدف هذا المقال إعطاء المعلومات الأساسية لإنجاز الحصار بشكل آمن وتزودنا بالإتجاهات الحديثة في تقنية التخدير الموضعي. بالإضافة لذلك يؤكد هذا المقال على ضرورة العناية الجيدة قبل العملية لتقليل من معدل المضاعفات. يفيد هذا المقال أطباء العيون، والتخدير، والممارسين.

The majority of the ophthalmic surgical procedures are performed under local anesthesia as it provides excellent operating conditions for the surgery. The local anesthetic techniques are easy to perform and have high success rate, but carry inherent risk of life threatening and vision threatening complications. To reduce complications of local anesthesia for ophthalmic surgery, it is essential to have an up to date knowledge of the techniques. The objective of this review article is to provide the essential knowledge for safe performance of the block and current trends in ophthalmic local anesthesia techniques. Additionally, this review emphasizes the need of proper perioperative care to reduce the incidence of complications. Anesthesiologists, ophthalmologists, and clinicians may also benefit from this article.

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Local anesthesia is a commonly used technique for the ophthalmic surgery.¹ It is safe, has high success rate and is preferred by most of the patients.² It has many advantages over general anesthesia such as avoidance of difficult airway, less intraoperative bleeding, greater cardiovascular stability, reduced metabolic disturbances, minimum chances of postoperative nausea, vomiting, coughing, and respiratory complications. It avoids the need of analgesia in the immediate postoperative period and is also cost effective. Additional advantages are early mobilization, return to oral diet, and discharge from hospital.³ These factors have special advantage in geriatric patients with multiple co-morbidities. Although local anesthesia has many advantages over general anesthesia for ophthalmic surgery, all these advantages can be annulled by improper selection and performance of the block. For safe performance of any local anesthesia techniques, it is essential to have up to date knowledge on the subject that will help to tailor the technique on individual basis. The objective of this review article is to provide the essential knowledge for safe execution of the block and current trends in ophthalmic local anesthesia techniques. Additionally, this review emphasizes the need of proper perioperative care to reduce the incidence of complications.

History of ophthalmic local anesthesia. Topical anesthesia (TA) and retrobulbar (RB) block are in practice for more than a century. Over this period, RB block enjoyed popularity as sole orbital anesthetic technique with high success rate. The disadvantages of this block are higher complication rate including globe perforation, brain stem anesthesia and death.⁴⁻⁷ In 1971, peribulbar (PB) anesthesia was introduced.⁸ In this block, local anesthetic agent (LAA) is administered outside the cone of muscles and theoretically, avoiding some of the complications of RB anesthesia.

Classification of ophthalmic local anesthesia. The terminology used for local anesthesia techniques for ophthalmic surgery is pretty confusing and controversial.^{9,10} A commonly accepted method of

classification of the block is a name based on the likely anatomical placement of the needle.¹¹ In RB block, LAA is injected into the part of the orbital cavity behind the globe and inside the cone of ocular muscles and is also called intraconal block. In PB block, the placement of needle tip and LAA is outside the muscle cone and is also called extraconal block. A combination of PB and RB blocks is described as combined retroperibulbar block. Computed tomography studies after intra and extraconal injections of radio contrast material have demonstrated that the division into extra and intraconal placement of LAA is arbitrary as there is the existence of multiple communications between these 2 compartments that allow the injected material to diffuse from one to the other.¹² Sub-Tenon's anesthesia refers to the injection of LAA beneath the tenon capsule, into a potential space called sub-Tenon's space. This block is also known as parabolbar block, pinpoint anesthesia and episcleral block. Regional anesthesia for the ophthalmological surgery can also be classified on the basis of whether the needle has been used for the performance of block or not. The blocks in which needles are used are RB and PB. Sub-Tenon's anesthesia is accomplished by using needle or a blunt cannula. The block in which no needle is used is called TA.¹³

Anatomical considerations. Knowledge of anatomy of the contents of the orbit is essential for safe and successful performance of ophthalmic regional block.

The orbit. It is of the shape of a cone with base at the front of the skull. Its apex is directed posteromedially. It is connected to cranial cavity through optic foramen and 2 orbital fissures (superior and inferior). Optic foramen is situated at the apex of the orbit and transmits the optic nerve (N) and accompanying vessels. The superior orbital fissure transmits lacrimal, frontal, trochlear, nasociliary, oculomotor and abducent Ns along with superior and inferior divisions of ophthalmic vein.¹⁴ The inferior orbital fissure transmits maxillary nerve and its branches. The contents of the orbit are the globe of the eye, orbital muscles, Ns, blood vessels, fat and part of the lacrimal apparatus. The depth of the orbit in adults is approximately 45-57 mm.¹⁵ The distance measured from the posterior surface of the eyeball to the apex is approximately 25 mm (range 12-35 mm). As the orbital cavity is conical in shape and the space is narrower close to the apex, the contents are tightly packed in the posterior half of the orbit. The chances of causing damage to these structures are high if the injection is placed deeply. The inferotemporal quadrant is relatively avascular and is the safest approach for orbital injections.¹⁶ The axial length of the eyeball is the distance from the corneal surface to the retina. It is often measured preoperatively. If the axial length of the eye is 26 mm or more, it is called a large eye. One has to

be extremely vigilant during placement of an eye block in such patients, as globe is longer and has greater risk to be perforated. Equator of the eyeball is an imaginary line drawn around the eyeball midway between the poles.

The extraocular muscles. There are 6 extraocular muscles for the control of the eye movements (4 rectus muscles and 2 oblique muscles). The recti muscles arise from a fibrous ring called annulus of Zinn situated near the apex of the orbit and inserted into the globe. These recti muscles form an incomplete cone around the globe of the eye and divide the orbit into 2 compartments.¹⁷ The compartment inside the muscle cone is called intraconal or RB and the part outside the muscle cone is called extraconal or PB.

Tenon capsule. It is also called fascia bulbi or bulbar sheath. It is a thin fascial membrane around the globe and separates it from the orbital fat. Its inner surface is smooth and shiny and is separated from the outer surface of the sclera by a potential space called the episcleral or sub-Tenon's space. Tenon capsule is firmly attached to the sclera, approximately 3-5 mm posterior to the corneoscleral junction.¹⁸ Sub-Tenon's space is divided into anterior and posterior segments at the insertion of the extra-ocular muscles and their associated fasciae. Posterior Tenon's capsule degenerates with age and helps diffusion of LAA into the RB space.¹⁶

Nerve supply. The motor N that supply the lateral rectus is by abducent cranial N, superior oblique by trochlear and the remainder muscles are supplied by branches of the oculomotor N. The sensory supply is mainly from the ophthalmic division of the trigeminal N. The lacrimal N (a branch of trigeminal) innervates the conjunctiva and the nasociliary N (a branch of trigeminal) innervates the cornea, sclera, iris, and ciliary body. The optic N conveys vision.¹⁷ The structures lying inside the muscle cone are optic, oculomotor, abducent, and nasociliary Ns along with the ciliary ganglion and vessels. The lacrimal, frontal and trochlear Ns lie outside the cone of muscles.

Local anesthetic techniques. Topical anesthesia. It is attained by instillation/application of LAA over the conjunctiva and cornea.¹⁸ The most frequently used drugs for this technique are lignocaine 4%, tetracaine 0.5%, proparacaine 0.5% in the solution form, and lignocaine 2-4% as gel. Topical non-steroidal anti-inflammatory drugs (NSAIDs) can also be used to improve intraoperative analgesia.¹⁹ Topical anesthesia is accomplished without the use of any injection into the orbit, and patients' acceptance is high for this type of anesthesia. For successful surgery under TA, patient selection is very important. It should only be used in cooperative patients to avoid the use of heavy sedation/analgesia that may be life threatening.²⁰

Uses. Currently, it is the most commonly used anesthesia technique for cataract surgery.²¹ It is also used for excision of superficial lesions such as cysts or naevi, removal of foreign bodies and sutures from cornea, debridement of the corneal epithelium after recurrent erosions/herpetic keratitis, corneal scrapings/biopsy, dissolution of calcium salts in band keratopathy, removal of pterygia, conjunctival autograft surgery and refractive surgery.

Advantages. It provides good analgesia as cornea, iris, sclera, and conjunctiva are rapidly anesthetized via direct action of LAA on sensory receptors. One major advantage of TA is that it can be supplemented during operation by direct injection of preservative free LAA like 1% lignocaine into the anterior chamber of the eye (intracameral injection).^{22,23} For cataract surgery, patient comfort and surgery related complications are comparable under TA or PB anesthesia.²⁴ Administration of TA is less painful than sub-Tenon's anesthesia.^{25,26} It provides superior postoperative pain relief in children undergoing cataract surgery compared to that achieved by narcotic analgesics.²⁷ It can be also used safely in patients on oral anticoagulants or with factor XI deficiency (Rosenthal syndrome, and hemophilia C), undergoing cataract surgery.^{28,29} Topical anesthesia maintains retinal perfusion pressure that is essential in glaucoma surgery (trabeculectomy, deep sclerectomy, aqueous shunt surgery and combined procedures).³⁰ Moreover, TA in combination with systemic sedation and analgesia, can be used effectively in patients undergoing posterior vitrectomy procedures needing no scleral buckling and with short predicted operating time.³¹

Disadvantages. It is not suitable for the patients with dementia, deafness or language barrier as verbal contact with the patient is important to assess the need for supplementation of the block. Total akinesia of the eye may not be obtained with this block.³² The duration of analgesia is brief and often requires repeated topical supplementation. Eyelid sensations are retained and there is stinging sensation at the time of instillation of LAA. Vision is retained and the patient may be frightened by bright operating lights and vision of surgical instruments.³³ Potentially, lack of IOP control, absence of akinesia, ability to close the lids, and temporary clouding of the cornea are inconvenient stage to the surgeons. In some patients, maneuvers like iris manipulation, globe expansion and insertion of intraocular lens may be difficult under this anesthesia.

Retrobulbar anesthesia. This technique was first described in nineteenth century. It was considered a gold standard for anesthesia of the eye and orbit. It is commonly used for anterior segment surgery of less than 2 hours duration. It can also be used for vitreoretinal

surgery in selected patients.³⁴ The duration of the block can be prolonged by leaving a small catheter in RB space and repeating administration of LAA.³⁵

Technique. In this technique, a small volume of LA solution (3-5 ml) is injected inside the muscular cone, at the depth of approximately 25-32 mm. For this block, a transcutaneous or transconjunctival route may be used, though the latter is less painful. Transcutaneous route can be used by raising a skin wheal with LAA and insertion of needle through the skin at the junction of medial two-third and lateral one-third of the lower orbital margin. To decrease the chances of globe perforation, the needle is inserted with the bevel facing the globe, directed posteriorly along the floor of the orbit, until it has crossed the equator of the globe. After that, the needle is directed upward and inward to lie within the muscle cone (**Figure 1**). If transconjunctival route is used, 3-4 drops of topical LAA can be instilled into the conjunctival fornix, 1-2 minutes before the main injection. The entry point of the needle is close to lower orbital margin between the lateral limbus and lateral canthus. The insertion of the needle should be slow and careful, continuously observing the globe which should not move. If the globe starts to move, there is a possibility that the needle has contacted the sclera and it should be removed. Intermittent digital assessment of ocular pressure should also be carried out while injecting the LAA. To rule out intravascular or subarachnoid placement of the needle tip, injection of the drug should always be carried out after careful aspiration. As LAA is injected inside the cone of the muscles, the Ns lying inside the cone are first to be blocked. To reduce the complications due to needle placement, ultrasound guided RB block is being practiced. Ultrasound is helpful in improving the precision of the block due to direct visualization of the needle placement. Another advantage of the technique is that the volume of

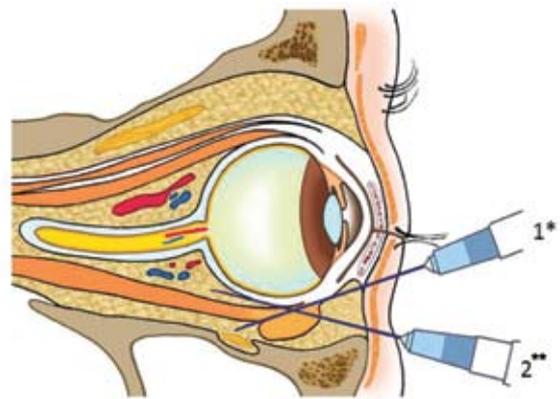


Figure 1 - Position of needle for sharp needle blocks. *Position of needle for peribulbar block and initial direction for retrobulbar block. **Final position of needle for retrobulbar block.

injected LAA can be reduced as it is injected close to the Ns to be blocked. Additionally, smaller volume of LAA will reduce the incidence of complications in case of accidental intravascular absorption.³⁶ Ptosis and proptosis are commonly seen during injection of LAA. After the block, ocular compression with Honan's balloon is attained, keeping the pressure between 25-30 mm Hg and not longer than 20 minutes. It helps to spread the LAA within the orbit.^{37,38} Commonly used LAA are lignocaine and bupivacaine. Incidence of toxicity due to the use of bupivacaine can be reduced by replacing it with levobupivacaine or ropivacaine. These are relatively newer LAAs with better safety profile compared to bupivacaine.³⁹ The duration of sensory and motor block is longer with levobupivacaine in comparison to bupivacaine. Prolonged duration of block due to levobupivacaine has special advantage in patient undergoing relatively lengthy operations like vitreoretinal surgery.⁴⁰

Position of eye during the block. For RB block, the traditional teaching was to ask the patient to look upwards and inwards during needle placement. Unsold et al⁴¹ used CT scan to document the position of optic N in this position and warned that this position can increase the risk of optic N injury by placing it near the path of the needle. The current recommendation is to ask the patient to maintain his primary gaze as it keeps the optic N away from the tip of the needle reducing the chances of its injury.

Advantages. The onset of this block is rapid and has high success rate. A small volume of LAA is required for this block. The incidence of anterior hemorrhage is low.

Disadvantages. Retrobulbar block is a blind technique. It requires lot of skill for safe performance and has high complication rate.^{36,42} The complications may be major or minor. The major complications may be life or vision threatening. These include corneal injury, rise in IOP, direct nerve trauma, ocular penetration/perforation, retinal detachment, globe rupture, RB hemorrhage, seizures, oculocardiac reflex, myotoxicity and brain stem anesthesia. Minor complications are

chemosis (subconjunctival edema), venous hemorrhage, allergic reaction to LA and systemic complications. The comparison of the incidence of complications of different techniques of regional ophthalmic blocks is shown in Table 1.

Total akinesia is not attained in this block as superior oblique muscle may remain functional because of its extraconal motor control. Similarly, orbicularis oculi muscle is also not affected by this block and a separate facial N block is required that is quite painful. Retrobulbar block placement is itself a painful procedure. The pain can be reduced by intravenous (i/v) injection of ultra short acting narcotic analgesic remifentanyl or a small dose of ketamine or propofol.^{43,44} Retrobulbar anesthesia induces reduction in velocity of blood flow in the RB vessels that may be hazardous in patients with glaucoma where maintenance of ocular perfusion pressure is important.⁴⁵

Peribulbar (periocular or pericone) anesthesia. Theoretically, it is safer than RB because LAA is injected outside the cone of the muscles and away from the apex of the orbit and vital structures.⁴⁶

Technique. For this block, the needle can be inserted through the conjunctiva or skin. The point of entry is at the junction of lateral one-third and medial two-third of the lower orbital margin. The direction of the needle insertion is kept along the floor of the orbit to avoid injury to the globe (Figure 1). The depth of the needle placement is kept not more than 25 mm so that its tip should not be beyond the equator of the globe. Increasing the needle depth would be expected to change the PB block to RB block. The commonly used needle is 25G and 25-31 mm long. The injected volume of LAA is approximately 6-12 ml.⁴⁷ This larger volume of LAA helps it to spread into the whole orbital fat, including the intraconal space containing the Ns to be blocked. Some LAA also spreads anteriorly and blocks the orbicularis oculi muscle and the lid muscle to avoid the need for additional facial N block. In case of failure or incomplete effect, the block may be supplemented by a repeat injection at the same site. The other supplementary blocks are superomedial PB

Table 1 - Comparison of incidence of complications of different ophthalmic regional blocks.

Complications	Topical anesthesia	Retrobulbar block	Peri bulbar block	Sub-Tenon's block
Globe perforation	-	0.1 ⁴³	0.006 ⁴⁴	Occasional case reports ^{45,46}
Retrobulbar hemorrhage	-	0.7-1 ^{47,48}	0.4 ⁴⁷	0 ⁴⁷
Grand mal seizure	-	0.001 ⁹²	0.006 ⁴⁷	Occasional case report ⁹³
Central spread of local anesthetic	-	0.2-0.3 ⁹⁴	0.015 ⁹⁴	0.0228 ⁴⁸
Chemosis	0 ⁹⁵	Less than peribulbar ⁴⁴	6.7 ⁹⁶	6-100 ⁶¹
Subconjunctival hemorrhage	-	Less than peribulbar ⁹⁴	18.0 ⁴³	7-100 ⁶¹
Diplopia	0 ⁹⁷	0.093 ⁹⁸	0.6 ⁹⁸	Occasional case report ⁹⁹

Values are expressed as percentage.

or medial canthus PB.^{38,48} To increase the success rate, many anesthetists/surgeons routinely use 2 injections. Peribulbar block can also be performed by a single medial approach injection, between medial canthus and caruncle, using 5-6.5 ml volume of LAA. This approach provides satisfactory anesthesia and can be used as an alternative to classical approach particularly in patients with longer axial length of the eye.⁴⁹ Although the needles used for PB are of shorter length compared to that used for RB, there is still potential risk of complications similar to that of long needles. The risk can be reduced by the use of even shorter needles (15 mm long) without compromising the quality of block.^{50,51}

Advantages. Peribulbar block is easy to perform and safer than RB block. In this block, reasonable akinesia and anesthesia is attained and there is minimum anterior hemorrhage. Compared to RB block the risk of RB hemorrhage, optic N injury, central retinal artery occlusion, globe perforation and intradural injection is reduced as the needle tip is placed away from the key orbital structures.⁵²

Disadvantages. This block is slow in onset (5-25 min) and has a high failure rate (up to 50%). In this block, although the needle is inserted outside the cone of muscle and away from the vital structures, all the complications of RB block (including death) have been reported. However, the incidence of life threatening complications is comparatively low.⁸ In PB block, a larger volume of LAA is injected compared to RB block that increases the chances of systemic toxicity if accidentally injected into a vein. Larger volume of LAA injected in the orbit can produce rise in IOP. In some patients, the rise in IOP has been reported to be above 50 mm Hg, jeopardizing retinal artery flow.^{53,54} A common minor complication of this block is periorbital ecchymosis.

Uses. It is used for all type of anterior segment surgery in adult patients and for perioperative pain relief after ophthalmic surgery in children. It can also be used for vitreoretinal surgery alone or in conjunction with general anesthesia.⁵⁵⁻⁵⁷

Combined retro-peribulbar block. In this block, 2 injections are routinely made one intraconal and one extraconal (medial compartment block). It produces anesthesia and akinesia better than other techniques but may also double the chance of complications. It can be useful in patients with penetrating eye injury who are high risk for general anesthesia.⁵⁸

Sub-Tenon block. The concept of sub-Tenon's anesthesia is more than a century old. This block did not gain acceptance until 1989, when Mein and Flynn recommended it as a perioperative supplement to RB anesthesia.^{59,60} This block is accomplished by injecting LAA into the sub-Tenon's space. Injection of LAA into this space blocks sensation from the eye by action on

the short ciliary Ns as they pass through the sub-Tenon's space to the globe and akinesia is produced by direct blockade of motor Ns. This block is becoming popular worldwide, in anticipation of reduction in major and serious complications due to traditional sharp needle blocks.⁶¹

Technique. Surface anesthesia of the conjunctiva is obtained by instillation of LA drops and cleaned with aqueous povidine iodine. A small surgical scissors is used to cut a small hole in the conjunctiva and the underlying Tenon's capsule. Traditionally, a blunt metallic cannula (2.54 cm in size) is used to accomplish this block (**Figure 2**). It is inserted aseptically into the sub-Tenon's space and LAA is administered through it. Commonly used site for access to sub-Tenon's space is inferomedial quadrant. However, all other quadrants such as superotemporal, superonasal, inferotemporal and medial have been used in this block.⁶² At present, there is no data to compare the advantages or ease of access to any particular quadrant.⁶³ To reduce the risk of trauma to soft tissues due to use of rigid metallic cannula, flexible polyethylene cannulae of different lengths have been devised.⁶⁴ However, a standard i/v cannula (22 G Venflon) can also be used.⁶⁵ The commonly used LAA are lignocaine and bupivacaine alone or as mixture. Addition of epinephrine to LAA, prolongs the duration of block, decreases the incidence of toxicity due to reduced absorption and decreases intraoperative bleeding. For cataract operation, there is no advantage of addition of epinephrine due to short duration of surgery. Epinephrine may cause vasoconstriction of the ophthalmic artery, resulting in reduction in retinal blood flow and should be avoided in elderly patients suffering from cardiovascular diseases.³

Advantages. Sub-Tenon's anesthesia placement is simple, safe and relatively pain free. It is fast in onset, has no effect on IOP and well tolerated by the majority of the patients.^{66,67} As the cannula used in this block is blunt,

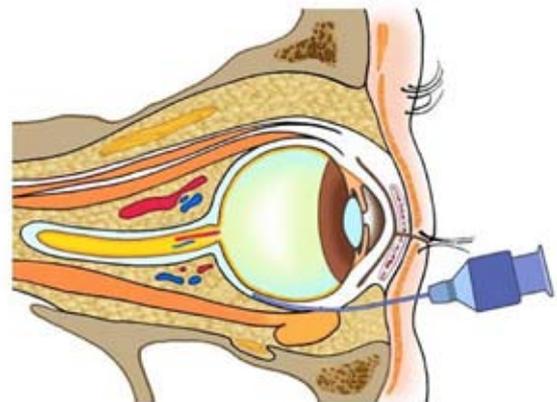


Figure 2 - Placement of curved cannula in sub-Tenon space.

it avoids most of the complications seen in RB and PB anesthesia. It may be an alternative to the blocks using sharp needles.⁶⁸ The chances of perforation of the globe are very low. This block is especially useful in patients with long axial length of the eye. Small volume of LAA (3-5 ml) provides good total globe analgesia along with akinesia that is appropriate for most anterior chamber surgeries. Increasing the volume of LAA (5-12 ml) provides motor block as well. Sub-Tenon's anesthesia can be repeated during operation if surgery is prolonged unexpectedly and a small cannula can be used for this purpose.⁶⁹ This block reduces the need for intraoperative sedation and the incidence of oculocardiac reflex during surgery. One major advantage of this block is that it can be safely used in patients receiving oral anticoagulant drugs such as warfarin or those who are on anti-platelet drugs like aspirin or clopidogrel. Sub-Tenon's anesthesia can be used to reduce perioperative pain in patients undergoing strabismus surgery under general anesthesia. This can also reduce the need of narcotic analgesics and avoid complications due to their use.^{40,70-73} Sub-Tenon's anesthesia is fast acting and a single injection with the mixture of lignocaine, adrenaline and hyaluronidase is effective in 3 minutes. Sub-Tenon's anesthesia can be used safely in patients undergoing vitreoretinal surgery if the injected volume of LAA is kept between 3-5 ml.⁷⁴ Due to the blunt tip of the cannula, complications like intravascular, intraneural or intradural injection are unlikely and the risk of scleral perforation is reduced.³²

Disadvantages. The block requires surgical skills and a potential risk of infection is there. Orbicularis oculi muscle is not blocked in this technique and some surgeons require an additional block of the zygomatic branch of the facial N. This block is difficult to perform in patients with previous sub-Tenon's anesthesia in the same quadrant, previous eye trauma, retinal detachment or strabismus surgery and in the presence of orbital infection.

During the blunt dissection, RB hemorrhage can develop occasionally due to the rupture of a vortex vein in the sclera, but the incidence is lower than other needle blocks.⁷² Rectus muscle trauma or paresis, orbital cellulites and central spread of LAA are the major complications reported with this block. Most of these complications have occurred using 2.54 cm metallic cannula and can be avoided by the use of smaller, flexible, polyethylene cannulae.⁶⁵ Some surgeons dislike sub-Tenon's anesthesia for glaucoma surgery due to chemosis, however, this block has been used successfully for this surgery. Incidence of chemosis can be reduced by fashioning a radial conjunctival incision, or with the use of standard i/v cannula in place of curved cannula.⁷⁵

Uses. Sub-Tenon's anesthesia has been used for ophthalmic surgical procedures like cataract surgery,

strabismus surgery, trabeculectomy, panretinal photocoagulation, vitreoretinal surgery, optic N sheath fenestration, postoperative pain management in pediatric patients, chronic pain management and therapeutic delivery of drugs.^{76,77}

Comparison of sub-Tenon's anesthesia with other types of block. For cataract surgery, sub-Tenon's anesthesia and TA provide adequate analgesia, however, patients having surgery under TA have more intraoperative and postoperative discomfort than patients receiving sub-Tenon's anesthesia and patient's satisfaction is higher in those receiving sub-Tenon's block.^{26,77-82} In comparison to the patients receiving RB block for cataract surgery, patient satisfaction is higher in those who receive sub-Tenon's anesthesia.⁷⁸ Lai et al⁸³ compared the effectiveness of sub-Tenon's anesthesia with RB block for vitreoretinal surgery and found that sub-Tenon's anesthesia was as effective as RB injection. Similarly, Kansal et al⁸⁴ found that a combination of TA, sub-Tenon's anesthesia, and intracameral anesthesia was a reasonable alternative to RB anesthesia for trabeculectomy, phacotrabeculectomy, and aqueous shunt surgery. Azmon et al⁸⁵ found that sub-Tenon's anesthesia led to less IOP elevation than PB anesthesia and provided similar good globe immobilization and almost the same pain levels intraoperatively.⁸⁶ Ripart et al⁸⁵ compared medial canthus single-injection of sub-Tenon's anesthesia with 2 injections used in PB anesthesia and found better akinesia, with a quicker onset and more constancy in effectiveness in the former.

Recent trends in ophthalmic local anesthesia. According to a recent report published in 2009, local anesthesia is commonly practiced in approximately 95% of the patients undergoing cataract surgery (TA alone 22.3%, TA plus intracameral 4.7%, sub-Tenon's anesthesia 46.9%, PB 19.5%, and RB 0.5%). Local block was administered by an ophthalmologist in 56.7% of the cases and by an anesthetist in 42.6% of the cases. The incidence of one or more minor complications was 4.3% in 38,058 local blocks. Minor complications were 2.3 times more common with sub-Tenon's anesthesia compared to other needle blocks. Sight or life threatening complications occurred in 25 cases undergoing sharp needle or sub-Tenon's cannula blocks. Sharp needle techniques had a 2.5 times increased risk of serious complications compared with sub-Tenon's cannula techniques.⁸⁷

Perioperative management of patients undergoing surgery under local anesthesia. Perioperative management consists of preoperative, intraoperative and postoperative care. Proper preoperative assessment is essential for better surgical outcome. The majority of patients undergoing eye surgery under local anesthesia are older and frequently have comorbid diseases such as

diabetes mellitus, hypertension, coronary artery disease, or cardiac insufficiency. Most of the ophthalmic surgical procedures are elective and there is sufficient time to optimize the medical condition. A medical advice is of great help to know the recent status and optimization of medical condition before surgery. Many old patients are on anticoagulants that can lead to derangement of clotting profile. There is an increased risk of hemorrhage if clotting profile is deranged. Clotting results should be within the recommended therapeutic range. However, the patients on anticoagulants and aspirin can undergo surgery under TA or sub-Tenon's anesthesia if bleeding profile is not grossly deranged.⁸⁸ To reduce the risk of globe perforation in patients with long axial length of the eye, it is of the utmost importance to know the axial length in advance of needle placement. Eye surgery under local anesthesia carries a low risk of perioperative morbidity and mortality compared to general anesthesia provided that heavy sedation is avoided. Sedation should be used judiciously. It should be used to allay the anxiety only. Patient should be comfortable, calm and cooperative during the surgery. Sedation should not be used to supplement an incomplete block. The advantages of local anesthesia can be quickly negated with the use of excessive sedation.⁸⁹ The use of i/v anesthetic agents or narcotic analgesics administered to reduce pain and anxiety are associated with an increased incidence of side effects and adverse medical events.⁹⁰ Excess sedation may result in sleeping, snoring, respiratory depression, restlessness or agitation. Pain due to incomplete regional anesthesia should be managed with a block supplementation. To operate in the presence of an apparent block failure is unjust and will be an unpleasant, stressful and horrible experience for the patient.

Eye block should only be administered in a place where all the resuscitation drugs and equipment are available. An i/v access should always be available for resuscitation. According to the recommendation of joint working party on anesthesia for ophthalmic surgery from Royal College of Anaesthetists and College of Ophthalmologists, an anesthetist should be available during the operation in case of resuscitation.⁹¹ The patient should be positioned on the operating table as comfortably as possible, with sufficient space to allow free breathing. During the block placement and operation, monitoring should include electrocardiogram, pulse oximetry and automated non-invasive blood pressure measurement.

In conclusion, eye surgery is among the most frequent surgical procedures performed under local anesthesia. By tradition, the block is performed by an ophthalmologist. During the past 2 decades, anesthesiologists have assumed a growing role in

performing eye blocks. The requirement for a deep anesthetic block with total akinesia has been decreased due to the use of phacoemulsification for cataract surgery. Block selection should be tailored according to patient on individual basis. Needle blocks are responsible for a low, but the real risk of serious complications because of needle misplacement. The major patient risk factor is the presence of a myopic staphyloma. Sub-Tenon's anesthesia reduces the risks of needle blocks, but does not completely prevent complications. Needleless block is the safest of all and should be used wherever possible. Knowledge, training, practice, and selection of appropriate technique suited for each patient is required to prevent complications. This review does not cover the pharmacology of the LAA and there is a need of spreading the knowledge regarding the use of LAA with better safety profile.

References

1. Nouvellon E, Cuvillon P, Ripart J, Viel EJ. Anaesthesia for cataract surgery. *Drugs Aging* 2010; 27: 21-38.
2. Friedman DS, Reeves SW, Bass EB, Lubomski LH, Fleisher LA, Schein OD. Patient preferences for anaesthesia management during cataract surgery. *Br J Ophthalmol* 2004; 88: 333-335.
3. Mc Lure HA, Rubin AP. Local anesthesia for ophthalmic surgery. *Current anaesthesia and critical care* 1999;10:40-47
4. Fahmi A, Bowman R. Administering an eye anaesthetic: principles, techniques, and complications. *Community Eye Health* 2008; 21: 14-17.
5. Arance GM, Fernández JP, Pérez TM, Varela LR. Loss of consciousness and respiratory depression after a retrobulbar intraorbital block for eye surgery: a case report. *Rev Esp Anesthesiol Reanim* 2009; 56: 641-642.
6. Gunja N, Varshney K. Brainstem anaesthesia after retrobulbar block: a rare cause of coma presenting to the emergency department. *Emerg Med Australas* 2006; 18: 83-85.
7. Moorthy SS, Zaffer R, Rodriguez S, Ksiarez S, Yee RD. Apnea and seizures following retrobulbar local anesthetic injection. *J Clin Anesth* 2003; 15: 267-270.
8. Davis DB, Mandel MR. Posterior peribulbar anesthesia: an alternative to retrobulbar anesthesia. *J Cataract Refract Surg* 1986; 12: 182-184.
9. Van den Berg AA. An audit of peribulbar blockade using 15 mm, 25 mm and 37.5 mm needles, and sub-Tenon's injection. *Anaesthesia* 2004;59:775-780.
10. Thind GS, Rubin AP. Local anaesthesia for eye surgery-no room for complacency. *Br J Anaesth* 2001; 86: 473-476.
11. Kumar CM, Dodds C, Faanning GL, editors. *Ophthalmic Anaesthesia*. The Netherlands: Swets and Zeitlinger; 2002.
12. Ripart J, Metge L, Prat-Pradal D, Lopez FM, Eledjam JJ. Medial canthus single-injection episcleral (sub-tenon anesthesia): computed tomography imaging. *Anesth Analg* 1998; 87: 42-45.
13. Gayer S, Kumar CM. Ophthalmic regional anesthesia techniques. *Minerva Anesthesiol* 2008; 74: 23-33.
14. Erdmann AG. *Concise Anatomy for Anaesthesia*. London (UK): Greenwich Medical Media; 2001
15. Karampatakis V, Natsis K, Gigis P, Stangos NT. Orbital depth measurements of human skulls in relation to retrobulbar anesthesia. *Eur J Ophthalmol* 1998; 8: 118-120.

16. Kumar C, Dodd C, Fanning G, editors. Ophthalmic anesthesia. Edition? The Netherlands: Swets and Zeitlinger; 2002.
17. Barry ZM, Glenn WJ, editors. Surgical anatomy of the orbit. 2nd ed. Philadelphia (PA): Lippincott, Williams & Wilkins; 2006.
18. Robert K Stoelting and Ronald D Miller, editors. Basics of anesthesia. 7th ed. Philadelphia (PA): Churchill Livingstone; 2007.
19. Mirshahi A, Djalilian A, Rafiee F, Namavari A. Topical administration of diclofenac (1%) in the prevention of miosis during vitrectomy. *Retina* 2008; 28: 1215-1220.
20. Gupta SK, Kumar A, Kumar D, Agarwal S. Manual small incision cataract surgery under topical anesthesia with intracameral lignocaine: study on pain evaluation and surgical outcome. *Indian J Ophthalmol* 2009; 57: 3-7.
21. Stürmer J. Cataracts - trend and new developments. *Ther Umsch* 2009; 66: 167-171.
22. Omulecki W, Laudanska-Olszewska I, Synder A. Factors affecting patient cooperation and level of pain perception during phacoemulsification in topical and intracameral anesthesia. *Eur J Ophthalmol* 2009; 19: 977-983.
23. Tseng SH, Chen FK. A randomized clinical trial of combined topical-intracameral anesthesia in cataract surgery. *Ophthalmology* 1999; 106: 1644-1645.
24. Sauder G, Jonas JB. Topical versus peribulbar anaesthesia for cataract surgery. *Acta Ophthalmol Scand* 2003; 81: 596-599.
25. Srinivasan S, Fern AI, Selvaraj S, Hasan S. Randomized double-blind clinical trial comparing topical and sub-Tenon's anaesthesia in routine cataract surgery. *Br J Anaesth* 2004; 93: 683-686.
26. Zafirakis P, Voudouri A, Rowe S, Livir-Rallatos G, Livir-Rallatos C, Canakis C, Kokolakis S, Baltatzis S, Theodossiadis G. Topical versus sub-Tenon's anesthesia without sedation in cataract surgery. *J Cataract Refract Surg* 2001; 27: 873-879.
27. Sinha R, Subramaniam R, Chhabra A, Pandey R, Nandi B, Jyoti B. Comparison of topical lignocaine gel and fentanyl for perioperative analgesia in children undergoing cataract surgery. *Paediatr Anaesth* 2009; 19: 371-375.
28. Fabian ID, Sachs D, Moisseiev J, Alhalel A, Grinbaum A, Seligsohn U, et al. Cataract extraction without prophylactic treatment in patients with severe factor XI deficiency. *Am J Ophthalmol* 2009; 148: 920-924.
29. Barequet IS, Sachs D, Priel A, Wasserzug Y, Martinowitz U, Moisseiev J, et al. Phacoemulsification of cataract in patients receiving Coumadin therapy: ocular and hematologic risk assessment. *Am J Ophthalmol* 2007; 144: 719-723.
30. Paletta Guedes RA, Paletta Guedes VM, Assis de Castro Paletta J, Pereira da Silva AC. Anesthesia in glaucoma surgery. *Fr Ophthalmol* 2009; 32: 221-225.
31. Bahçecioglu H, Unal M, Artunay O, Rasier R, Sarici A. Posterior vitrectomy under topical anesthesia. *Can J Ophthalmol* 2007; 42: 272-277.
32. Canavan KS, Dark A, Garrioch MA. Sub-Tenon's administration of local anaesthetic: a review of the technique. *Br J Anaesth* 2003; 90: 787-793.
33. Prasad N, Kumar CM, Patil BB, Dowd TC. Subjective visual experience during phacoemulsification cataract surgery under sub-Tenon's block. *Eye (Lond)* 2003; 17: 407-409.
34. Lim TH, Humayun MS, Yoon YH, Kwon YH, Kim JG. The efficacy of retrobulbar block anesthesia only in pars plana vitrectomy and transconjunctival sutureless vitrectomy. *Ophthalmic Surg Lasers Imaging* 2008; 39: 191-195.
35. Falcó-Molmeneu E, Sorlí-Clemente E, Ramos-Martí F, Cabrera-Peset A, Andrés-Calvo G, Peris-Molés M. Anesthesia for vitreoretinal surgery using a retrobulbar catheter technique. *Arch Soc Esp Ophthalmol* 2007; 82: 147-152.
36. Luyet C, Eichenberger U, Moriggl B, Remonda L, Greif R. Real-time visualization of ultrasound-guided retrobulbar blockade: an imaging study. *Br J Anaesth* 2008; 101: 855-859.
37. Bowman R, Liu C, Sarkies N. Intraocular pressure changes after peribulbar injections with and without ocular compression. *Br J Ophthalmol* 1996; 80: 394-397.
38. Kumar CM, Dodds C. Ophthalmic regional block. *Ann Acad Med Singapore* 2006; 35: 158-167.
39. Foster RH, Markham A. Levobupivacaine: a review of its pharmacology and use as a local anaesthetic. *Drugs* 2000; 59: 551-579.
40. Steib A, Karcenty A, Calache E, Franckhauser J, Dupeyron JP, Speeg-Schatz C. Effects of subtenon anesthesia combined with general anesthesia on perioperative analgesic requirements in pediatric strabismus surgery. *Reg Anesth Pain Med* 2006; 31: 182.
41. Unsöld R, Stanley JA, DeGroot J. The CT-topography of retrobulbar anesthesia. Anatomic-clinical correlation of complications and suggestion of a modified technique. *Albrecht Von Graefes Arch Klin Exp Ophthalmol* 1981; 217: 125-136.
42. Eke T, Thompson JR. Serious complications of local anaesthesia for cataract surgery: a 1 year national survey in the United Kingdom. *Br J Ophthalmol* 2007; 91: 470-475.
43. Hamilton RC, Gimbel HV, Strunin L. Regional anaesthesia for 12,000 cataract extraction and intraocular lens implantation procedures. *Can J Anaesth* 1988; 35: 615-623.
44. Davis DB 2nd, Mandel MR. Efficacy and complication rate of 16,224 consecutive peribulbar blocks. A prospective multicenter study. *J Cataract Refract Surg* 1994; 20: 327-337.
45. Frieman BJ, Friedberg MA. Globe perforation associated with subtenon's anesthesia. *Am J Ophthalmol* 2001; 131: 520-521.
46. Rüschen H, Bremner FD, Carr C. Complications after sub-Tenon's eye block. *Anesth Analg* 2003; 96: 273-277.
47. Eke T, Thompson JR. The National Survey of Local Anaesthesia for Ocular Surgery. II. Safety profiles of local anaesthesia techniques. *Eye (Lond)* 1999; 13: 196-204.
48. Feibel RM. Current concepts in retrobulbar anesthesia. *Surv Ophthalmol* 1985; 30(2): 102-110.
49. Rizzo L, Marini M, Rosati C, Calamai I, Nesi M, Salvini R, et al. Peribulbar anesthesia: a percutaneous single injection technique with a small volume of anesthetic. *Anesth Analg* 2005; 100: 94-96.
50. Riad W. Peribulbar blockade with a short needle for phacoemulsification surgery. *Acta Anaesthesiol Scand* 2009; 53: 247-250.
51. Ghali AM, Hafez A. Single-injection percutaneous peribulbar anesthesia with a short needle as an alternative to the double-injection technique for cataract extraction. *Anesth Analg* 2010; 110: 245-247.
52. Weindler J, Weindler M, Ruprecht KW. Local anesthesia in ophthalmic surgery. *Ophthalmologe* 2004; 101: 847-864.
53. Joshi N, Reynolds A, Porter EJ, Rubin AP, Kinnear PE. An assessment of intraocular pressure during fractionated peribulbar anaesthesia. *Eye (Lond)* 1996; 10: 565-568.
54. Morgan JE, Chandna A. Intraocular pressure after peribulbar anaesthesia: is the Honan balloon necessary? *Br J Ophthalmol* 1995; 79: 46-49.
55. Deb K, Subramaniam R, Dehran M, Tandon R, Shende D. Safety and efficacy of peribulbar block as adjunct to general anaesthesia for paediatric ophthalmic surgery. *Paediatr Anaesth* 2001; 11: 161-167.

56. Ghali AM, El Btarny AM. The effect on outcome of peribulbar anaesthesia in conjunction with general anaesthesia for vitreoretinal surgery. *Anaesthesia* 2010; 65: 249-253.
57. Morel J, Pascal J, Charier D, De Pasquale V, Gain P, Auboyer C, et al. Preoperative peribulbar block in patients undergoing retinal detachment surgery under general anaesthesia: a randomized double-blind study. *Anesth Analg* 2006; 102: 1082-1087.
58. Niemi-Murola L, Immonen I, Kallio H, Maunuksela EL. Preliminary experience of combined peri- and retrobulbar block in surgery for penetrating eye injuries. *Eur J Anaesthesiol* 2003; 20: 478-481.
59. Soufia F. Sub-tenon anaesthesia; an efficient and safe technique for cataract surgery. *Professional Med J* 2005;12: 300-303.
60. Jeganathan VS, Jeganathan VP. Sub-Tenon's anaesthesia: a well tolerated and effective procedure for ophthalmic surgery. *Curr Opin Ophthalmol* 2009; 20: 205-209.
61. Guise PA. Sub-Tenon anesthesia: a prospective study of 6,000 blocks. *Anesthesiology* 2003; 98: 964-968.
62. Kumar CM, Williamson S, Manickam B. A review of sub-Tenon's block: current practice and recent development. *Eur J Anaesthesiol* 2005; 22: 567-577.
63. Roman SJ, Chong Sit DA, Boureau CM, Auclin FX, Ullern MM. Sub-Tenon's anaesthesia: an efficient and safe technique. *Br J Ophthalmol* 1997; 81: 673-676.
64. Li HK, Abouleish A, Grady J, Groeschel W, Gill KS. Sub-Tenon's injection for local anesthesia in posterior segment surgery. *Ophthalmology* 2000; 107: 41-46.
65. Amin S, Miniham M, Lesnik-Oberstein S, Carr C. A new technique for delivering sub-Tenon's anaesthesia in ophthalmic surgery. *Br J Ophthalmol* 2002; 86: 119-120.
66. Budd JM, Brown JP, Thomas J, Hardwick M, McDonald P, Barber K. A comparison of sub-Tenon's with peribulbar anaesthesia in patients undergoing sequential bilateral cataract surgery. *Anaesthesia* 2009; 64: 19-22.
67. Munir SM, Hashim I, Hanif M, Ashraf M. Efficacy of Peribulbar (Sub-Tenon) versus Retrobulbar local anesthesia in cataract surgery. *Al-Shifa Journal of Ophthalmology* 2008; 4: 69-73.
68. Kumar C, Dowd T. Ophthalmic regional anaesthesia. *Curr Opin Anaesthesiol* 2008; 21: 632-637.
69. Mather CM. Comparison of i.v. cannula and Stevens' cannula for sub-Tenon's block. *Br J Anaesth* 2007; 99: 421-424.
70. Ghosh YK, Goodall KL. Postoperative pain relief in vitreoretinal surgery with subtenon Bupivacaine 0.75%. *Acta Ophthalmol Scand* 2005; 83: 119-120.
71. Ghai B, Ram J, Makkar JK, Wig J, Kaushik S. Subtenon block compared to intravenous fentanyl for perioperative analgesia in pediatric cataract surgery. *Anesth Analg* 2009; 108: 1132-1138.
72. Calenda E, Muraine M, Quintyn JC, Brasseur G. Sub-Tenon infiltration or classical analgesic drugs to relieve postoperative pain. *Clin Experiment Ophthalmol* 2004; 32: 154-158.
73. Kumar N, Jivan S, Thomas P, McLure H. Sub-Tenon's anesthesia with aspirin, warfarin, and clopidogrel. *J Cataract Refract Surg* 2006; 32: 1022-1025.
74. Sohn HJ, Moon HS, Nam DH, Paik HJ. Effect of volume used in sub-Tenon's anesthesia on efficacy and intraocular pressure in vitreoretinal surgery. *Ophthalmologica* 2008; 222: 414-421.
75. Ripart J, Benbabaali M, Muller L. Sub-Tenon's anesthesia. *Ophthalmology* 2002; 109: 215-216.
76. Farmery AD, Shlugman D, Rahman R, Rosen P. Sub-Tenon's block reduces both intraoperative and postoperative analgesia requirement in vitreo-retinal surgery under general anaesthesia. *Eur J Anaesthesiol* 2003; 20: 973-978.
77. Inoue M, Takeda K, Morita K, Yamada M, Tanigawara Y, Oguchi Y. Vitreous concentrations of triamcinolone acetonide in human eyes after intravitreal or subtenon injection. *Am J Ophthalmol* 2004; 138: 1046-1048.
78. Ryu JH, Kim M, Bahk JH, Do SH, Cheong IY, Kim YC. A comparison of retrobulbar block, sub-Tenon block, and topical anesthesia during cataract surgery. *Eur J Ophthalmol* 2009; 19: 240-246.
79. Rodrigues PA, Vale PJ, Cruz LM, Carvalho RP, Ribeiro IM, Martins JL. Topical anesthesia versus sub-Tenon block for cataract surgery: surgical conditions and patient satisfaction. *Eur J Ophthalmol* 2008; 18: 356-360.
80. Mathew MR, Williams A, Esakowitz L, Webb LA, Murray SB, Bennett HG. Patient comfort during clear corneal phacoemulsification with sub-Tenon's local anesthesia. *Journal of Cataract & Refractive Surgery* 2003; 29: 1132-1136.
81. Rajesh S, Prakashchand A, and Kumar C. Small incision cataract surgery: Review of journal abstracts. *Indian J Ophthalmol* 2009; 57: 79-82.
82. Davison M, Padroni S, Bunce C, and Rüschen H. Sub-Tenon's anesthesia versus topical anesthesia for cataract surgery. *Anesth Analg* 2008; 106: 345-346.
83. Lai MM, Lai JC, Lee WH, Huang JJ, Patel S, Ying HS, et al. Comparison of retrobulbar and sub-Tenon's capsule injection of local anesthetic in vitreoretinal surgery. *Ophthalmology* 2005; 112: 574-579.
84. Kansal S, Moster MR, Gomes MC, Schmidt CM Jr, Wilson RP. Patient comfort with combined anterior sub-Tenon's, topical, and intracameral anesthesia versus retrobulbar anesthesia in trabeculectomy, phacotrabeculectomy, and aqueous shunt surgery. *Ophthalmic Surg Lasers* 2002; 33: 456-462.
85. Azmon B, Alster Y, Lazar M, Geyer O. Effectiveness of sub-Tenon's versus peribulbar anesthesia in extracapsular cataract surgery. *J Cataract Refract Surg* 1999; 25: 1646-1650.
86. Ripart J, Lefrant JY, Lalourcey L, Benbabaali M, Charavel P, Mainemer M, et al. Medial canthus (caruncle) single injection periocular anesthesia. *Anesth Analg* 1996; 83: 1234-1238.
87. El-Hindy N, Johnston RL, Jaycock P, Eke T, Braga AJ, Tole DM, et al. The Cataract National Dataset Electronic Multi-centre Audit of 55,567 operations: anaesthetic techniques and complications. *Eye (Lond)* 2009; 23: 50-55.
88. Konstantatos A. Anticoagulation and cataract surgery: a review of the current literature. *Anaesth Intensive Care* 2001; 29: 11-18.
89. Höhener D, Blumenthal S, Borgeat A. Sedation and regional anaesthesia in the adult patient. *Br J Anaesth* 2008; 100: 8-16.
90. Katz J, Feldman MA, Bass EB, Lubomski LH, Tielsch JM, Petty BG, et al. Adverse intraoperative medical events and their association with anesthesia management strategies in cataract surgery. *Ophthalmology* 2001; 108: 1721-1726.
91. A working party of the Royal College of Anaesthetists and the Royal College of Ophthalmologists was convened to update the 1993 'Guidelines on Anaesthesia in Ophthalmic Surgery, 2001 [Updated 2004 April. Access date 2010 Mar 17]. Available from: <http://www.rcophth.ac.uk/docs/publications/published-guidelines/LocalAnaesthesia.pdf>
92. Pragt E, van Zundert AA, Kumar CM. Delayed convulsions and brief contralateral hemiparesis after retrobulbar block. *Reg Anesth Pain Med* 2006; 31: 275-278.
93. Alhassan MB, Kyari F, Ejere HO. Peribulbar versus retrobulbar anaesthesia for cataract surgery. *Cochrane Database Syst Rev* 2008; 16: CD004083.

94. Hamilton RC. Brain-stem anesthesia as a complication of regional anesthesia for ophthalmic surgery. *Can J Ophthalmol* 1992; 27: 323-325.
95. Said K, Hassan M, Qahtani F, Mansoori FA. A comparative study of topical versus peribulbar anesthesia in phacoemulsification and implantation of foldable intraocular lens in cataract surgery. The Internet Journal of Ophthalmology and Visual Science 2003 Volume 2 Number 1 [Updated 2009 February 13. Access date 2010 Mar 17]. Available from: http://www.ispub.com/journal/the_internet_journal_of_ophthalmology_and_visual_science/volume_2_number_1_46/article/a_comparative_study_of_topical_versus_peribulbar_anesthesia_in_phacoemulsification_and_implantation_of_foldable_intraocular_lens_in_cataract_surgery.html
96. Clausel H, Touffet L, Havaux M, Lamard M, Savean J, Cochener B, et al. Peribulbar anesthesia: efficacy of a single injection with a limited local anesthetic volume. *J Fr Ophthalmol* 2008; 31: 781-785.
97. Arnau G, Yangüela J, González A, Andrés Y, García DV, Gili P, Guisasola FJ, Arias A. Anaesthesia-related diplopia after cataract surgery. *Br J Anaesth* 2003; 90: 189-193.
98. Costa PG, Debert I, Passos LB, Polati M. Persistent diplopia and strabismus after cataract surgery under local anesthesia. *Binocul Vis Strabismus Q* 2006; 21: 155-158.
99. Faure C, Faure L, Billotte C. Globe perforation following no-needle sub-Tenon anesthesia. *J Cataract Refract Surg* 2009; 35: 1471-1472.

Related topics

Bamashmus MA, Al-Akily SA, Saleh MF. Prophylactic measures used for the prevention of postoperative endophthalmitis after cataract surgery. a survey of routine practice in Yemen. *Saudi Med J* 2010; 31: 293-298.

Zhu NX, Meng YQ, Feng BH, Wang XH, Li XY, Yang M, Zhu SG, Li ST. Study on surgical approaches and electrode implantation of oculomotor nerve and inferior obliquus in beagle dogs. *Saudi Med J* 2009; 30: 358-364.

Cok OY, Ertan A, Bahadir M. Remifentanyl versus fentanyl in combination with midazolam for retrobulbar block in cataract surgery. *Saudi Med J* 2008; 29: 544-548.

Gokce BM, Ozkose Z, Tuncer B, Pampal K, Arslan D. Hemodynamic effects, recovery profiles, and costs of remifentanyl-based anesthesia with propofol or desflurane for septorhinoplasty. *Saudi Med J* 2007; 28: 358-363.