

Local Anaesthesia in Cataract Surgery

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ABSTRACT

There has been a significant evolution in surgical technique of cataract extraction. The technical advances in phaco machines, phacotips, and availability of ophthalmic viscoelastic devices have played a great role in cataract surgery to be faster and more controlled now than before. Similarly, local anesthesia techniques in cataract surgery have also advanced significantly from retrobulbar, peribulbar, sub-Tenon's, to topical anaesthesia. Even though, the sub-Tenon's anesthesia technique reduced the risk of complications of peribulbar/retrobulbar anesthesia but the technique is still associated with a possibility of damage to optic nerve, retrobulbar hemorrhage, and ocular muscle injury. Topical anesthesia is used to block the afferent

nerves of the cornea and the conjunctiva (long and short ciliary nerves, nasociliary nerves). This technique eliminates the possible complications of injectable anesthesia. However, it does not eliminate pain sensitivity of the iris, the zonule, and the ciliary body which is achieved by intracameral technique of anesthesia with preservative free 1% lidocaine.

In a constantly evolving arena, the sub-Tenon's block has gained popularity while the deep angulated intraconal (retrobulbar) block has been largely superseded by the shallower extraconal (peribulbar) approach. Hyaluronidase is a useful adjuvant because it promotes local anesthetic diffusion and hastens block onset time but there is a possibility of getting an allergic reaction. Ultrasound-guided eye blocks afford real-time visualization of needle position and local anesthetic spread. An advantage of sonic guidance is that it may eliminate the hazard of globe perforation by identifying abnormal anatomy, such as staphyloma.

Key words: Cataract surgery; Anaesthesia; Retrobulbar; Peribulbar; Sub-Tenon's; Topical; Complications

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INTRODUCTION

The ideal anaesthesia would be one that provides adequate pain relief during surgery and postoperatively, be easy to administer and have minimal complications. For doing cataract surgery, the anaesthesia could be local or general. Majority of cataract patients are operated under local anaesthesia (infiltration, topical, intracameral). The infiltration anaesthesia is given as retrobulbar or peribulbar or sub-Tenon's block. Carl Koller first used cocaine as a topical anaesthetic for eye surgery in 1884^[1]. The general anaesthesia has its own complications in elderly cataract patients and most of them may have diabetes or hypertension or heart diseases or combination of them. No need of fasting before or after surgery, no need of intubation, no need of using any systemic medications are the advantages of local anaesthesia. However, cataract in children, patients with parkinsonism, deaf mute patients, mental retardation patients, patients

under active psychiatric treatment need general anaesthesia in order to perform cataract surgery safely and comfortably. Other indications for this anaesthesia would be the previous occurrence of retrobulbar haemorrhage, patient's request in spite of explaining the advantages of local anaesthesia.

This paper deals with different types of local anaesthesia for performing cataract surgery. The published data on various aspects of anaesthesia in cataract surgery for the past five years in the PubMed was reviewed using the key words such as cataract surgery, phacoemulsification, retrobulbar, peribulbar, sub-Tenon's, topical anaesthesia, effect of sedatives before anaesthesia, pain score, akinesia, patient's experience during operation, outcome, and complications.

RETROBULBAR ANAESTHESIA

The technique was first described in 1884 by Knapp. The main goal of this procedure is to obtain anaesthesia of the cornea, uvea, and conjunctiva, as well as akinesia of the extraocular muscles by blocking the ciliary nerves and the II, III, VI cranial nerves, which all go through the retroconal space^[2]. This was the oldest mode of local anaesthesia practiced all over the world for cataract surgery. The anaesthetic solution (2-3 mL) is injected into the retrobulbar space of the orbit by passing a thin (25 gauge) long (38 mm) needle through the lower eyelid at the level of temporal limbus. Intermitant pressure is applied with the closed eyelids for the dispersion of anaesthetic solution. Complications from retrobulbar block occur in 1-3%, ranging from mild to severe. The following are the complications described in literature: retrobulbar hemorrhage, ocular perforation, rarely subarachnoid or intradural injection, postoperative ptosis, diplopia secondary to myotoxicity, cardiorespiratory distress, injury to optic nerve, vascular retinal occlusion^[2].

Life threatening complications include brainstem anaesthesia (central block), acute seizure activity, and cranial nerve block. Sight threatening complications include retro- and peribulbar hemorrhage, ocular penetration and perforation, retinal vascular spasm, optic nerve injury, and ocular myotoxicity^[3]. In an audit of 12,000 retrobulbar blocks, Edge and Nicoll^[4] found that patients with acquired vascular disease were at a significantly greater risk of periocular bleeding, whereas diabetics presented only a marginal risk of serious hemorrhage. He was able to subcategorize block-induced periocular bleeding into three groups: (1) minor hemorrhage caused by damage to a vein or small artery that produces a palpable elevation in intraocular pressure (IOP); (2) arterial hemorrhage producing rapid proptosis and raised IOP; and (3) concealed hemorrhage in which blood remains within the muscular cone and produces elevations in IOP without visible evidence of orbital hemorrhage. In a review of 50,000 eye blocks, Edge and Navon^[5] found that myopia is only a significant risk factor for inadvertent perforation when associated with staphyloma.

PERIBULBAR ANAESTHESIA

Peribulbar anaesthesia was discovered late in the 1980s by David and Manda. The anaesthetic solution is injected into the extraconal compartment of the eye. Thus, most of the complications associated with retrobulbar anaesthesia are avoided^[1]. In a retrospective review of 33,363 peribulbar blocks, Riad and Akbar^[6] discovered that globe perforations occurred in 8 of the 23 needle-related complications (0.023%). The risk of needle injury to the globe is not limited to block technique alone because patient moving the eye during performance of the block is a real risk factor and the basis for litigation^[7].

Addition of clonidine to ropivacaine not only decreases the

total volume of peribulbar anaesthetic solution to be used but also augments early onset and prolonged offset of sensory analgesia as well as provides smooth operating conditions with a good sedation level as well by providing a wider safety margin of anaesthesia^[8]. Addition of dexmedetomidine to lidocaine and bupivacaine in peribulbar block shortens the onset time and prolongs the duration of the block and postoperative analgesia. It also provides sedation which enables full cooperation and potentially better operating conditions^[9]. In addition to this, it also decreases the intraocular pressure significantly^[10].

Adekoya *et al*^[11] reported that currently the most common technique of local anaesthesia for an ophthalmic procedure in Nigeria was peribulbar anaesthesia, followed by retrobulbar anaesthesia. Twelve months prior to the study, 25.9% of the respondents (ophthalmologists) had experienced at least one complication from retrobulbar anaesthesia and 16.1% from peribulbar anaesthesia. Retrobulbar hemorrhage was the most common complication reported. In a Cochrane database systematic review on peribulbar versus retrobulbar anaesthesia for cataract surgery, Alhassan *et al*^[12] included six trials involving 1438 participants. There was no evidence of any difference in pain perception during surgery with either retrobulbar or peribulbar anaesthesia. Both were largely effective. There was no evidence of any difference in complete akinesia or the need for further injections of local anaesthetic. Conjunctival chemosis was more common after peribulbar block and lid haematoma was more common after retrobulbar block. Retrobulbar haemorrhage was uncommon and occurred only once, in a patient who had a retrobulbar block.

SUB-TENON'S ANAESTHESIA

Stevens^[13] described sub-Tenon's anaesthesia for cataract extraction in 1992. A small incision is made in the conjunctiva below the lower limbus in the temporal quadrant, exposing the sclera. The anaesthetic solution (2 mL) taken in a syringe is injected using a special blunt tipped curved needle (configuring the globe curvature) into the peribulbar space beyond the equator. Because of its easy administration under direct visibility of the needle insertion, it became more popular than the previous methods of giving anaesthesia for cataract surgery.

The sub-Tenon's anaesthesia is less painful at the time of its administration, provides better akinesia and leads to smaller rise in intraocular pressure just after the injection than peribulbar anaesthesia^[14]. The addition of clonidine 1 µg/kg to 2 % lidocaine in sub-Tenon's anaesthesia for cataract surgery increased the duration of sensory anaesthesia, ocular akinesia, and the duration of analgesia^[15].

In a Cochrane database systematic review on sub-Tenon's versus topical anaesthesia for cataract surgery for cataract surgery, Guay and Sales^[16] included seven studies on 742 operated eyes of 617 participants. Topical anaesthesia (with or without intracameral injection) for cataract surgery increases intraoperative pain but decreases postoperative pain at 24 hours when compared with sub-Tenon's anaesthesia. The amplitude of the effect although statistically significant, was probably too small to be of clinical relevance. There was not enough evidence to say that one technique would result in a higher or lower incidence of intraoperative complications compared with the other.

TOPICAL ANAESTHESIA

Fichman^[17] reintroduced topical anaesthesia for cataract surgery in 1992. Topical anaesthesia is used to block the afferent nerves of the

corneal and the conjunctiva (long and short ciliary nerves, nasociliary nerves). This technique eliminates the possible complications of injectable anesthesia. Advantages of topical anesthesia include no risk of ocular perforation, extraocular muscle injury, or central nervous system depression. Vision returns almost immediately, and patients are able to leave the operating room without being patched because no eyelid block is used. However, it does not eliminate pain sensitivity of the iris, the zonule, and the ciliary body. Gills^[18] introduced intracameral technique of anesthesia with, wherein 0.25 mL of preservative free 1% lidocaine anaesthetic solution is injected into the anterior chamber on the surface of iris. Topical and intracameral techniques are not absolutely safe as epithelial and endothelial toxicities are reported with them^[19].

Today different agents are available in the market for topical anesthesia like Procaine (1%/2%/10%), Proparacaine (0.5%), Oxybuprocaine (0.4%), Tetracaine (0.5%/1%), Bupivacaine (0.25%/0.5%), Etidocaine (1%), Lidocaine (0.5%/1%), Prilocaine (4%), and Ropivacaine (0.2%/1%). All these agents have different time of onset and duration of anesthesia^[19]. Combined topical and intracameral anesthesia without sedatives is well tolerated for most phacoemulsification patients. It is also effective in cases when complications or adverse events occur^[20]. Although topical anesthesia alone provides acceptable anesthesia for manual small-incision cataract surgery, combined topical and intracameral anesthesia decreased patients' discomfort and increased their cooperation during the operation^[21]. Most of the pain during cataract surgery under topical anaesthesia was due to extension of the anterior chamber by irrigation such as too much hydration during hydrodissection or after infusion before aspiration^[22].

NO ANAESTHESIA

Amar Agarwal^[23] introduced the technique of "no anesthesia" for cataract extraction in 1998. In this technique, no topical or intracameral drugs are used. Although without any side effects, the stress for the surgeon is increased. A question that arises is - cornea is supplied by a dense plexus of sensory nerves. Then how it is possible to do cataract surgery without any anesthesia? Possible explanations are: peripheral and superior cornea is less sensitive than central cornea; dark-brown eyed Indians, Chinese, and blacks have a corneal sensitivity that is four times less than blue-eyed Caucasians; people in developing countries like India are more exposed to ultraviolet rays which may result in a significant loss of corneal sensitivity. Due to increased stress on surgeon, the "no anesthesia" technique has not gained popularity in the western world.

Gutierrez-Carmona^[24] modified "no anesthesia" technique and introduced cryoanalgesia for cataract surgery. In this technique, all solutions to be used during surgery are cooled to 4°C except povidone drops. Before surgery, an eye mask of cold gel is placed over the eye for 10 min. During the surgery, the eye is irrigated with cold balanced salt solution. The advantage of performing phaco with irrigation at low temperature is that it partially avoids the heat generated by the phaco tip, eliminating pain. Further, using cold fluids reduces postop inflammation, the risk of endophthalmitis and the endothelial trauma caused by the heat of the phaco tip. Although showed to be a safe technique for clear cornea phacoemulsification with acceptable level of pain, it is not suitable for all cataracts and all patients.

Compared with retrobulbar/peribulbar, topical anaesthesia does not provide the same excellent pain relief in cataract surgery; however, it achieves similar surgical outcomes. Topical anesthesia reduces injection-related complications and alleviates patients' fear of injection. The choice of topical anaesthesia is not suitable for patients

with a higher initial blood pressure or greater pain perception^[25]. Peribulbar anesthesia provided significantly better patient satisfaction in comparison with topical anesthesia when used for cataract surgery^[26].

COMPARISON OF PAIN SCORE

In a comparative study of topical, intracameral and sub-Tenon anesthesia, Hosada *et al*^[27] 2016 reported that intracameral (0.1-0.2 cc) infusion of 1% preservative-free lidocaine into the anterior chamber through the side port combined with topical drops of lidocaine provides sufficient pain suppressive effects in eyes without high myopia, while sub-Tenon anesthesia is better for cataract surgery in eyes with high myopia. Pandey *et al*^[28] reported no difference in pain score between with topical anaesthesia and no anaesthesia during cataract surgery ($p = 0.610$) though patient discomfort and surgeon stress were greater in the no anaesthesia group. Pain scores were higher but anxiety scores were lower in second eye surgeries when operated under topical anaesthesia^[29].

There is no difference in the intensity of pain during phacoemulsification with the use of topical anesthesia with use of intraocular irrigation solution at room temperature in 1 eye or topical anesthesia associated with cryoanalgesia in the contralateral eye^[30]. In a randomized clinical trial, Dole *et al*^[31] reported that patients who underwent surgery with topical anaesthetic experienced lower complications but more pain compared to patients who underwent peribulbar anaesthesia. Topical anaesthetic supplemented with analgesic medications could help the patient and surgeon during cataract surgery.

Pain score varied among types of cataracts and was highest in mature cataracts and least in posterior subcapsular cataracts^[32]. Subtenon was superior to intravenous Fentanyl for perioperative anaesthesia in infants undergoing cataract surgery measured by cries pain score^[33]. In a hospital based case series study to evaluate the efficacy and safety profile of the use of aqueous topical/intracameral anesthesia in manual small incision cataract surgery, Uche *et al*^[34] reported that the mean pain score in this study was low, there was no correlation between perception of pain with gender or age and surgeons experience was excellent in most of the cases.

AKINESIA

Using a mixture of rocuronium and lidocaine provides optimal globe akinesia and faster establishment of suitable conditions to start eye surgery and shortens the block onset time as compared with the addition of hyaluronidase to lidocaine^[35]. Onset of akinesia was shorter in alkalised preparation of lidocaine^[36]. Akinesia was less with a metal subtenon canula compared to flexible medium or flexible posterior cannulas^[37]. In a hospital-based randomized comparative interventional study of uncomplicated cataract surgery who received either peribulbar block or posterior sub-tenon block, Igana *et al*^[38] reported that both routes of administering anaesthetic substances is comparable in providing adequate akinesia and analgesia for cataract surgery with minimal complications, and both techniques are effective and safe.

EXPERIENCE OF PATIENTS DURING OPERATION

Patients undergoing surgery under topical anaesthesia experience a variety of visual sensations such as light perception, different colours and shapes^[39]. Combined topical and intracameral anaesthesia

without sedation was well tolerated for phacoemulsification^[20]. Moderate to severe postoperative pain was experienced by patients operated under local anaesthesia but only few needed paracetamol or ibuprofen analgesics^[40]. No difference in patient satisfaction was experienced between Subtenon and Topical anaesthesia^[41]. Feeling of pain, pressure and discomfort scores during administration of topical anaesthesia were all significantly lower compared to peribulbar anaesthesia^[26].

In a study of 20,000 cataract surgeries under topical anaesthesia, Wenzel *et al*^[42] in Germany received 45 pictures which had been painted to reflect intraoperative their visual impressions. A further 98 patients were questioned postoperatively about their intraoperative visual impressions; 36 patients saw mainly blue, 32 red/pink and 27 saw yellow colors. Out of the 45 pictures 30 (67%) were identified as being similar to their own visual images. The surgeon can use this knowledge to explain these experiences while talking to the patient intraoperatively. This may reassure patients during surgery.

TRENDS

In an 8 year analysis, Thevi and Godinho^[43] found that topical anaesthesia showed an upward trend while subtenon anaesthesia showed a downward trend. Topical anaesthesia was the common practice pattern for cataract surgery among United States Veteran Health Administration^[44] and Canadian ophthalmologists^[45]. Palte opined that with the changing paradigm of regional blocks, in future Anaesthesiologists will have to perform blocks and in the holding area and Residents would have to become skilled in performing blocks due to larger patient volumes^[3].

COMPLICATIONS

Although peribulbar anaesthesia is considered to be a safer alternative to retrobulbar anaesthesia for cataract surgery, transient or serious complications have been reported in the literature such as amaurosis and contralateral cranial nerve III (ptosis, and medium-sized pupils unresponsive to light stimulus) and VI nerve paralysis after peribulbar block which recovered completely after four hours^[46], Purtscher-like retinopathy (ischemic retinal whitening in a peripapillary pattern)^[47], central retinal artery occlusion^[48-50], transient complete visual loss and a partial third nerve palsy in the contralateral eye (probably due to trans optic nerve sheath spread of injected anaesthetic drug)^[51], Periocular necrotizing fasciitis after local retrobulbar anaesthesia injection and facial block for cataract surgery in the left eye and canthotomy/cantholysis for treatment of moderate retrobulbar hemorrhage in the same eye was reported by Gelaw and Abateneh^[52].

A retrospective analysis of 12992 patients from National Eye Database, who underwent cataract surgery over a period of eight years, Thevi and Godinho^[43] reported that sub-Tenon anaesthesia showed more intraoperative and postoperative complications than topical anaesthesia. Kim *et al*^[53] reported the occurrence of horizontal diplopia in a patient with 12 PD (prism diopter) exotropia that increased to 60 PD a year later due to injury to lateral recti by retrobulbar injection. The patient improved with bilateral lateral recti recession. Vertical diplopia with hypotropia of 30 PD possibly due to myotoxicity of sub-Tenon local anaesthesia was reported by Blum *et al*^[54].

Retrobulbar haematoma following retrobulbar anaesthesia was reported in 2 patients on dual antiplatelet medications, and hence topical anaesthesia or general anaesthesia is preferred for this group^[55]. Severe adverse events including sight threatening conditions like globe perforations, ciliary artery occlusion and

severe corneal oedema were reported in all techniques of local anaesthesia except topical-intracameral and subconjunctival local anaesthesia^[56]. The increasing order of quality scores (central eye position, anaesthesia, akinesia of the eye and or body, soft tissue or orbital hemorrhage, and absence of vitreous bulge) were in sub-Tenon's, peribulbar, retrobulbar and finally general anaesthesia^[57].

Long-term visual compromise secondary to needle misadventure, resulting in penetration or perforation of the globe, is the most feared complication in ophthalmic anaesthesia. The potential benefits of ultrasound guidance include real-time visualization of needle trajectory and spread of injected local anaesthetic, resulting in blocks of improved quality and safety. Najman *et al*^[58] (2015) performed a randomized controlled human trial of periconal eye blocks with and without ultrasound guidance. One hundred and twenty-nine patients were assigned to undergo periconal block, with or without ultrasound guidance, using a 25 mm (shorter than retrobulbar) needle. Although there was no difference in the complication rate, sonic guidance was considered beneficial because it resulted in shallower depths of needle insertion and reduced incidences of intraconal needle placement.

A case of orbital and facial cellulitis that occurred after routine cataract operation with peribulbar anaesthesia was reported by Mukherjee *et al*^[59]. There were no preoperative systemic or ocular risk factors for postoperative infection. Therefore, the most likely cause of cellulitis is surgical trauma during administration of the peribulbar block. This case illustrates the need for adequate skin preparation before the administration of peribulbar anaesthesia and minimal tissue trauma during the procedure.

An observational study showed that cataract surgery was performed safely without anaesthetic services^[60]. Peribulbar anaesthesia has been reported to cause raised blood pressure and generalized tonic-clonic seizures^[61], brain stem anaesthesia and contralateral 3rd nerve palsy^[62]. Subtenon anaesthesia caused significant redness due to subconjunctival haemorrhage compared to topical anaesthesia ($p < 0.001$)^[63]. A randomized controlled trial showed no change in central foveal thickness following intracameral lidocaine injection^[64]. Subconjunctival haemorrhage was the commonest complication caused by subtenon anaesthesia^[65].

Case reports of retrobulbar hemorrhage^[66], globe perforation^[67], muscle trauma^[68], and death^[69] have been reported after sub-Tenon's anaesthesia. The death has been postulated due to brainstem anaesthesia which occurred secondary to retrograde spread of local anaesthesia within the optic nerve sheath. A systematic review showed no difference in efficacy between peribulbar and subtenon anaesthesia but potential complications of peribulbar were more serious^[70].

HYALURONIC ACID ALLERGY

The enzyme hyaluronic acid (HA) is an adjuvant added to local anaesthesia solution in order to improve the efficacy and onset of nerve blocks. Allergic reactions to HA are a rare but recognized complication of its use such as conjunctival injection with chemosis, periorbital edema, pruritus, pain, and restriction of extraocular muscle motility^[3], orbital inflammatory signs and symptoms^[71], delayed periorbital haemotoma and orbital cellulitis^[72] delayed orbital inflammation associated with raised intraocular pressure^[73].

CONCLUSIONS

The type of anaesthesia has to be decided on the type of cataract surgery to be performed in the patient. Topical with

intracameral anaesthesia appears to be safe mode of practice for phacoemulsification procedure for experienced surgeons. Otherwise, sub-Tenon's anaesthesia is safe for phacoemulsification procedure. Peribulbar/sub-Tenon's anaesthesia is better for extracapsular cataract extraction. In view of the dangerous complications of retrobulbar anaesthesia, it is practiced much less currently. The surgeon should try to avoid the possible complications of needle block anaesthesia, even though they are rare in occurrence.

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