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Anaesthetic Management in Cataract Surgery

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1. Introduction

Cataract surgery is one of the most commonly performed surgical procedures in our ageing world. The majority of patients have concurrent disorders including hypertension, diabetes mellitus and coronary artery disease. The anaesthetic management varies between topical anaesthetic applications, regional blocks to general anaesthesia. The patients' medical/mental condition and current medications are of prime importance in terms of their implications for anaesthesia. It is also prudent to define and prevent drug interactions of ocular medication that are required during the perioperative or postoperative period. The type of intervention and skill of the surgeon are variables that influence the selection of the anaesthetic regimen. Preoperative evaluation is therefore as important as anaesthetic care for this surgical population.

Cataract surgery performed in the setting of an office-based, day case surgical set-up is considered in this chapter. Unsutured incisions and less invasive techniques are increasingly popular. Extraocular muscle akinesia is important for an optimum operating field.

Topical anaesthesia includes local anaesthetic applied to the cornea as drops or ointment. Benoxinate, tetracaine, ametocaine, lignocaine, and bupivacaine are common ester and amide types of local anaesthetic used for this purpose. Lack of ocular akinesia and insufficient analgesia are considered as disadvantages of topical methods.

Retrobulbar block was one of the most frequently implemented techniques. It is performed via introduction of a needle at the infero-lateral rim of the lower eyelid passing through the muscle cone with advancement in a medial and superior direction at about 10° and injecting 4-8 mL of local anaesthetic / hyaluronidase mixture behind the globe. Maintaining a short advancement distance and use of blunt-tipped needles are advised for this practice. Besides the advantages, including obtaining ocular akinesia and sufficient analgesia, the procedure can for this reason still be considered and useful where other procedures are unsuitable, though this is rare. There is a risk of damage to surrounding structures including globe perforation, as well as penetration into the cerebrospinal fluid and vascular structures behind the eye, causing respiratory depression and cardiovascular collapse. While rare these are significant and limit its use in practice, especially in view of newer 'blunt needle' techniques.

Peribulbar block is performed as a retrobulbar block with straight advancement of a short needle from the infero-lateral border of the lower eyelid. This technique is infrequently utilized due to the disadvantages such as high rate of chemosis, lower quality of akinesia, increased local anaesthetic requirements and longer latent period requirement for akinesia.

Sub-Tenon's block (a type of 'blunt needle' block) is performed by introducing a cannula between the conjunctiva and Tenon's capsule after delicate but mainly blind dissection of the sub-Tenon's space. Advantages are reduction of complication rates especially in myopic eyes and it offers the option of re-injections to top up the anaesthetic during surgery. Local anaesthetic leakage, need for dissection and possible need for sutures are limitations.

Gentle pressure application on the globe for local anaesthetic spread after regional blocks are useful for avoiding the oculocardiac reflex. Local anaesthetic infiltration for facial nerve branches might be indicated for eyelid akinesia.Sedation and analgesia may be required during topical anaesthesia or regional blocks. In continuum and during surgery verbal contact between the anaesthetist and the surgeon is important for reducing complications at an early a stage as possible. Depending on the operation it might be preferable to use sedatives/hypnotics or opioid analgesics with a shorter half-life. In the case of repeated drug administrations, accumulating drugs should be avoided and/or a specific antidote should be given if necessary. It is not always possible to approximate additive effects of drug combinations in elderly patients and patients with co-morbidities, and using the lower doses might be important for preventing unforeseen complications though must be balanced with the need to prevent pain or awareness of surgery. Midazolam, propofol and dexmedetomidine, might be frequently used alone as a bolus or infusion, or in combination with fentanyl or remifentanil.

General anaesthesia might be preferred in patients with limited co-operation or advanced co-existing disorders. With a few exceptions, all general anaesthetics decrease intraocular pressure. Laryngeal mask insertion with a smooth induction using etomidate, propofol or thiopentone with or without a non-depolarizing muscle relaxant is frequently chosen. Propofol infusion with fentanyl or remifentanil might be delivered alone or with volatile anaesthetics. Besides the anti-emetic effects of propofol, the emetic and depressive effects of opioids should be remembered in the postoperative period. General anaesthesia may offer almost motionless optimal surgical conditions (though the Bell's reflex can persist at lower doses), allows bilateral surgery (rarely needed in intraocular surgery) and possesses virtually no major complication risk related to the injection. On the other hand it needs anaesthetic staff and equipment during administration and is increasingly expensive.

Analgesics and anti-inflammatory drugs might be combined with topical local anaesthetic during the postoperative period. It is important to ensure patients are free from side-effects or residual drug effects of medications to prevent further complications and re-hospitalisation.

Cataract surgery is one of the most common interventions made in day-case surgery (Cullen et al., 2009). Although lens opacification is generally a time-related process, it can be observed at an earlier period of life such as in newborns related to congenital metabolic errors and in all age groups due to trauma. The majority of the patients have concurrent disorders including hypertension, diabetes, rheumatoid arthritis, coronary artery or chronic pulmonary disease and take medication. Pre-operative evaluation, including anaesthetic and surgical planning should be performed as per the demands of co-morbidities. Cataract surgery is major surgery as it is intra-ocular surgery, technically challenging, with abundant scope for devastating complications like loss of sight, but it is from an anaesthetic perspective limited in terms of stress to the body overall. Advances in techniques including phacoemulsification and intraocular foldable silicone lens implantation through suture-less mini incisions decrease the surgical recovery period with lower complication rates and improved surgical outcomes.

2. Preoperative evaluation

The responsibility of the anaesthetist is to ensure that the patient is in an optimal condition before undergoing surgery. Pre-operative interview with anaesthetic and surgical staff may reduce anxiety and stress concerning the operation. Patients may also be informed about unexpected visual experiences during anaesthesia and surgery in order to prevent undesirable outcomes (Tan et al., 2006).

The pre-operative visit includes determinations concerning the patient's history, habits, current disease with medications, complete systemic physical evaluation, and occult disease if not diagnosed. Patients may be referred to other physicians when concurrent pathology is not stable. Potential airway problems with a difficult airway must be evaluated and an anaesthetic plan should also be explained with informed consent. Patients may be categorized according to the American Society of Anesthesiologists (ASA) Physical Classification System that is shown in Table 1 to document their status before surgery (Davenport et al., 2006). Mild asthma or well controlled hypertension are examples of ASA Class II patients that are unlikely to have an impact on anaesthesia and surgery. More advanced disease such as renal failure on dialysis or class II congestive heart failure indicates ASA class III patients and is likely to have an impact on anaesthesia and surgery. Patients are classified as ASA class IV if disease requires special medical care e.g., acute myocardial infarction, and respiratory failure that requires mechanical ventilation with major impact on anaesthesia and surgery. The physical condition of patient over ASA III generally requires hospitalization even when performing surgery with otherwise comparatively limited potential for major systemic stress like cataract surgery.

Class	Description
I	Healthy patient without organic, biochemical, or psychiatric disease.
II	A patient with mild systemic disease. No significant impact on daily activity.
III	Significant or severe systemic disease that limits normal activity. Significant impact on daily activity.
IV	Severe disease that is a constant threat to life or requires intensive therapy. Serious limitation of daily activity.
V	Moribund patient who is likely to die without surgery.
VI	Brain-dead organ donor.

Table 1. American Society of Anaesthesiologists physical status (ASA PS) classification

The history of the patient may include social habits, cigarette and alcohol consumption, illicit drug use, allergies, past medical history including operations with enquiries about possible adverse outcomes, current medications, and questioning relatives on whether there is a family history of attack from malignant hyperthermia – thus halogenated volatile anaesthetic agents, which may trigger malignant hyperthermia, may be avoided.

Systemic evaluation must include careful examination for a difficult airway, including jaw and neck movements, mouth opening, and intra-oral pathology. Special precautions or devices must be prepared to be used for patients who are likely to have an airway problem. Patients, especially with increased body mass index, must also be questioned about snoring during their sleep and evaluated for possible sleep apnoea syndrome. The physical capacity of patients can be determined with simple questions on for instance being able to do daily activities, climbing stairs, swimming or other sports.

Physicians may require symptom-oriented laboratory investigations instead of ordering a battery of tests (Schein et al., 2000). Laboratory results and an electrocardiogram (ECG) performed within 6 months is sufficient to determine the gravity of most cardiac conditions. The consensus is to obtain an ECG from all elderly patients to determine the baseline cardiac condition. Haemoglobin levels may also be necessary to exclude anaemia that can precipitate cardiac events. Levels under 7 g/dL require transfusion therapy.

Chronic medical conditions such as congestive heart failure or chronic obstructive pulmonary disease must be optimized before surgery. Patients with a recent attack of angina, arrhythmia, ischemia or infarction must be identified and elective cataract surgery may be postponed for month(s). A recent cerebrovascular attack or exacerbation of a chronic cerebral disorder e.g. multiple sclerosis is also a reason for postponing elective surgery. For patients with chronic renal failure it is necessary to determine the status of the ECG, plasma electrolytes, blood urea nitrogen (BUN) and creatinine levels. In the case of acute hepatitis or its exacerbation, surgery must be postponed until return to systemic baseline levels, requiring monitoring using a liver enzyme profile.

Hypertension must be controlled and blood pressure must be decreased to the acceptable levels, 140/90 mmHg if possible. Blood pressure of 200/110 mmHg or more before the operation requires postponement of elective surgery.

It is not usually necessary to discontinue current medication but herbal medicines should be withdrawn due to possible drug interference or due to the possibility of postoperative complications at least 1 week beforehand. Patients on anticoagulation therapy may also continue their medication as the risk of cessation of treatment outweighs the risk of bleeding (Hirschman & Morby, 2006) though clotting needs to be checked before surgery to ensure patients are not over-anticoagulated. Patients receiving aspirin, clopidogrel or warfarin may switch to low molecular weight or regular heparin should they be felt to be at risk of deep vein thrombosis during prolonged general anaesthesia.

Patient who are unable to lie flat due to their disorder, musculoskeleteal disease such as kyphoscoliosis, paediatric patients, those with claustrophobia, altered cognitive function or orientation such as in Alzheimer's Disease, deafness, language problems that affect co-operation and abnormal movements or tremor such as in Parkinson's Disease are often unable to undergo surgery under local or regional anaesthesia.

Most physicians seem to allow eating or drinking ad libitum before cataract surgery under topical and regional blocks (Steeds & Mather, 2001). However many wisely prefer to limit this. Nausea and vomiting may occur with serious consequences such as aspiration into the airways. Therefore, the safe way is to perform the surgery on an empty stomach even with local or regional anaesthesia, and it may be necessary for some units to change their anaesthetic plan in view of this danger. Patient undergoing general anaesthesia must follow instructions about fasting regimens, which are simply allowing clear fluids up to two hours before induction, light meals up to four hours before, and regular meals up to six hours before induction. However, this may not guarantee an empty stomach in certain patients such as those with diabetes mellitus, oesophageal hernia and obstruction of the gastrointestinal passages. Metoclopramide 0.07 mg/kg intravenously (IV) can be administered in such patients at least 10 min before the operation to facilitate gastric passage. Placing and securing an intravenous line and intravenous premedication instead of painful intramuscular injections is preferred. Patients with dentures are allowed to wear them in order to decrease stress and not to interfere with communication during topical or regional block, but they may be removed in the case of general anaesthesia.

The anaesthetic options and possible complications must be explained in detail to the patient or to their relatives. Question sheets, consent forms and physical examination cards are a simple and efficient method for documentation. Physician must prescribe a short acting benzodiazepine such as lorazepam to the anxious patient, which may be recommended before and on the day of the surgery.

2.1 Monitored anaesthesia care

Monitored anaesthesia care (MAC) defines patients who require sedation and analgesia under the care of anaesthesia personnel with a monitor and oxygen supplementation in the operating theatre or in remote locations. Cataract surgery performed under local or regional anaesthesia is one of the classical examples of MAC that necessitates an anaesthetist who is familiar with the procedure. Equipment must be available in the case of airway emergencies and drugs should be prepared and ready for use in the case of hemodynamic consequences such as lignocaine, ephedrine, epinephrine, and atropine. The American Society of Anesthesiologists (ASA) determined the minimum requirements of monitoring during MAC that indicates the ECG, pulse oximetry, non-invasive blood pressure, temperature, end-tidal CO_2, and monitoring respiratory rate (Standards for Basic Anesthetic Monitoring). Oxygen must be administered with a face mask or nasal cannula at a rate of at least 6 L/min. One side of the sterile drapes may be raised in order to observe the patient, prevent CO_2 retention and claustrophobia, instead of a tight closure of the drapes. Continuous assessment of the level of sedation is mandatory in order to maintain contact with the patient and to prevent respiratory or hemodynamic side effects. The level can commonly be determined by using the Ramsay sedation score (Ramsay et al., 1974) categorized as:
Patient awake, anxious/restless, or both
Patient awake, cooperative, oriented and tranquil
Patient awake, responds to commands only
Patient asleep, brisk response to light glabellar tap or loud auditory stimulus
Patient asleep, sluggish response to light glabellar tap or loud auditory stimulus
Patient asleep, no response to light glabellar tap or loud auditory stimulus
The Observer's Assessment of Alertness/Sedation Scale (OAA/S) shown in Table 2 is used to determine the change of consciousness during the procedure, which may help to avoid deeper levels of sedation and their probable consequences (Chernik et al., 1990).

Subscore	Responsiveness	Speech
5	Responds readily to name in normal tone	Normal
4	Lethargic response to name spoken loudly repeatedly	Mild slowing or thickening
3	Responds only after name spoken loudly or repeatedly	Slurring or slowing
2	Responds after mild padding or shaking	Few recognized words
1	Does not respond to mild padding or shaking	

Table 2. Observer's Assessment of Alertness/Sedation Scale

Midazolam, a short acting and water soluble form of benzodiazepine is frequently used during premedication and for the maintenance of sedation. Mini bolus doses such as 0.5 mg

in increments are frequently administered to maintain co-operation and to prevent adverse effects on respiration. Continuous infusion can also be used with success.

Propofol in lipid emulsion is a shorter acting hypnotic, sedative with anti-emetic properties. Bolus doses such as 20-30 mg are usually sufficient for the majority of patients. Propofol is unique for infusion with its context-sensitive half-life, longer metabolism and lack of residual effects. It can also be administered carefully and in certain surroundings by patients themselves in patient controlled sedation (PCS). However a danger is the level of sedation cannot be ascertained despite computerized systems in use even in healthy volunteers let alone patients (Murdoch et al., 2000).

Fentanyl, a semi-synthetic opioid derivative is frequently needed for premedication or during surgery in cases of insufficient analgesia, either on its own or in combination with sedatives or hypnotics. Co-administration with a sedative or hypnotic has additive depressive effects on respiration and hemodynamic variables, which requires dose adjustments. The half-life of fentanyl is longer and accumulation may ensue especially when repeated doses are administered, requiring attention before discharging the patient. The emetic potential and effects on other systems should also be kept in mind for special circumstances such as gallbladder stones or prostate hypertrophy. Doses of 25 to 50 µg repeated in the case of pain are usually sufficient for the majority of patients (Aydin et al., 2002).

Alfentanil and promazine in combination produce a superior quality of sedation, operating conditions and a milder side effect profile when compared with meperidine-promazine (el-Bassiouny et al., 1992). Remifentanil, a shorter acting opioid derivate, which undergoes metabolism by plasma esterase can be used solely or as a complementary drug. Lower doses of 0.25-0.5 µg/kg may be advised as needed (Rewari et al., 2002). Piritramide is another analgesic available in certain countries that has been found to be efficient against retrobulbar block-induced pain, hemodynamic changes and stress responses (Reinhardt et al., 2002).

A combination of fentanyl with a major tranquilizing drug droperidol, which is available commercially as Innovar, induces anaesthesia/analgesia without complications when concurrently used with topical anaesthesia and facial nerve block in a large number of patients (Hodgkins et al., 1992). Droperidol is also a potent anti-emetic. However this technique is no longer used due to the longer period of cognitive impairment and limitations in patients such as those with Parkinson's disease (Chung et al., 1989).

A low dose of ketamine (0.3 mg/kg) for sedation does not increase intraocular pressure and reduces pain from injection when combined with diazepam and droperidol (Cugini et al., 1997). Clonidine, an alpha-2 agonist, has sedative, anxiolytic, and analgesic properties through spinal and cortical pathways. It has been used during premedication and has been demonstrated to decrease preoperative anxiety, intraocular pressure, and neuroendocrine responses, but the potential of reducing heart rate and blood pressure limits its widespread use (Weindler et al., 2000). Dexmedetomidine, another alpha-2 agonist, is an optic isomer of medetomidine with a shorter elimination half-life and requires infusion during maintenance. It is also used with success (Apan et al., 2009).

Elderly patients require careful titration of lower doses of sedatives, hypnotics and opioids because these drugs can frequently produce over-sedation, apnoea, hypoxia, hypotension and bradycardia. The sedation level that allows communication with the patient is usually appropriate. Benzodiazepines, opioids and alpha-2 agonists have special antagonists that may increase their safety profile. These drugs may be required in the case of slower metabolism or unexpected delay in recovery.

A large proportion of patient requires sedative and analgesics during the regional block. Frequently it is not possible to identify the apprehensive patient till after they have entered the operating area. Hypnotics or sedatives alone usually augment excitement with disappearing cortical suppression and combination with an opioid is usually necessary to manage such patients with extremes of fear during surgery. This is frequently encountered in patients with coronary artery disease. The sedation requirement in cataract surgery is demonstrated to be lower and similar between patients receiving either topical anaesthesia or retrobulbar block when using patient-controlled sedation devices (Balkan et al., 2004). On the other hand, sedative and analgesic supplementation may be associated with adverse outcomes and the clinician should weigh the risks and benefits for individual patients (Katz et al., 2001).

2.2 Local anaesthetics and adjuvants

Local anaesthetic drugs act by producing reversible conduction block in exposed nerves by acting on sodium channels. A benzene ring is connected to another molecular group comprising a carbon chain with an ester or amide which thereby creates the two diverse groups of local anaesthetic agents. These different molecular structures also give rise to the main diversity in the metabolism of local anaesthetic agents. The amide group of local anaesthetics undergo metabolism in the liver, but the ester group of local anaesthetics are degraded by plasma esterase. Ester local anaesthetics have increased allergic potential due to para-aminobenzoic acid-like constituents in their molecules and their half-life is commonly brief when compared with the amide group. Interest has focussed on optical and stereo-isomers with reduced severity of side effects. Local anaesthetics can be used alone or combined with another local anaesthetic in order to produce a faster onset of action and longer duration of anaesthesia in ophthalmic practice. Lidocaine is the most commonly used local anaesthetic, and ropivacaine and levobupivacaine may be added instead of the older agent bupivacaine. The characteristics of local anaesthetics commonly used in ophthalmic surgery are shown in Table 3. Local anaesthetics with prolonged effect can also produce long lasting muscle paralysis that can distress the patient and clinician (Cass, 2006).

Agent	Duration of onset	Potency	Toxicity	Duration
Amide local anaesthetics				
Bupivacaine	Intermediate	High	High	Long
Levobupivacaine	Intermediate	High	Intermediate	Long
Etidocaine	Fast	High	High	Long
Lidocaine	Fast	Intermediate	Low	Intermediate
Mepivacaine	Fast	Intermediate	Low	Intermediate
Prilocaine	Fast	Intermediate	Low	Intermediate
Ropivacaine	Intermediate	Intermediate	Intermediate	Long
Esther local anaesthetics				
Cocaine	Slow	High	Very high	Long
Amethocaine	Slow	Intermediate	Intermediate	Intermediate
Procaine	Slow	Low	Low	Short

Table 3. Clinical properties of local anaesthetics

Hyaluronidase is commonly added to the local anaesthetic solution to decrease the time to onset and to perform homogenous dispersion. It is also believed to increase local anaesthetic

metabolism or spread and thereby also decreases the period of contact with muscles hence decreasing paresis, which is otherwise increased when local anaesthetics are used solely. 15-30 U per mL is commonly added to the local anaesthetic solution but some authors advocate using as low as 1 U/mL in order to reduce the cost (Fanning, 2006). Within reason the more given the better the effects, though manufacture from animal sources gives rise to concerns about the possibility of non-infectious encephalopathy (Ripart et al., 2005).

Epinephrine use is controversial. In local anaesthetics, it is believed to increase the non-ionic form by increasing pH, therefore decreasing the duration between injection and onset of effect and also enhances penetration into nerves. It also decreases metabolism of local anaesthetics by performing vasoconstriction and delaying systemic uptake and degradation. However, it seems unwise to use it for regional blocks for cataract surgery because of long-acting local anaesthetics which are commercially available. Further, addition to the local anaesthetic mixture has been demonstrated to increase the myotoxicity in experimental models. In addition to the pressure effect of the local anaesthetic mixture, which arrests circulation to the eye namely pulsatile ocular blood flow for a brief period, epinephrine may further reduce blood flow due to vasoconstriction, which may be harmful in susceptible individuals. Addition of epinephrine may not increase the duration of anaesthesia and if indicated it should be avoided in a concentration of more than 1: 200 000 (Hamilton, 1996).

Clonidine, an alpha-2 agonist, has been mixed with local anaesthetics at the dose of 1 µg/kg in order to increase duration of analgesia (Madan et al., 2001). Vecuronium, a non-depolarizing muscle relaxant has also been added to the local anaesthetic solution (Reah et al., 1998). However, the latter drugs have increased potential for serious systemic adverse effects and injection into the orbit generally constitutes a non-retrieval route of administration, which may be dangerous.

The myotoxicity of local anaesthetics is controversial. It is suggested that they occur with long term exposure of the extra-ocular muscles to local anaesthetics when they are administered in a closed intra-orbital environment. Local anaesthetic injection into the muscle belly produces damage probably through needle trauma or pressure effect. Injection must not be performed when resistance is felt and if may be necessary to change needle position. Local anaesthetic may be administered slowly and incrementally with gentle aspirations after checking for possible vessel entry.

3. Topical anaesthesia

Topical anaesthesia of the eye, as demonstrated by the anaesthetic effect of cocaine on the cornea and its initiation of use in ophthalmic surgery, started with Karl Koller as early as 1886. Its popularity declined after initial enthusiasm according to the addiction potential and side effects of cocaine that complicated the surgery (Bacon, 2006). Topical anaesthesia regained popularity, this time without cocaine, since it removed complications from regional anaesthesia, increasing confidence and patient safety owing to improvements in monitored anaesthesia care and short-acting anaesthetic use (Chandradeva et al., 2010). It can be performed using local anaesthetic drops, gels or sponges that are applied to the conjunctival sac and gentle pressure applied to prevent loss from the nasolacrimal duct (Page & Fraunfelder, 2009). Benoxinate, ametocaine, lignocaine, and bupivacaine are examples of commercially available local anaesthetics. It has been demonstrated that intraocular pressure (IOP) can decrease after instillation (Almubrad & Ogbuehi, 2007). Topical anaesthesia may be insufficient to obtain complete analgesia. Supplemental blocks including intracameral injection

of 0.1-0.5 mL of preservative-free 1% lignocaine or 0.5% bupivacaine in 1:100 000 epinephrine mixture, may cause sensory blockade of the iris and ciliary body and increase comfort during intraocular lens placement. It may also dilate the pupil. Subconjunctival and eyelid infiltrations are other blocks that can be used to increase the quality of analgesia.
The duration of the anaesthesia is brief and usually requires repeat drops after 0.5 hours. Toxic potential is questioned during long term use. Topical anaesthesia is increasingly used – it is convenient. However pain during the surgery is frequently encountered and therefore opioid administration may be required in these patients. It requires close co-operation with the patient during the operation (Weindler et al., 2004).

4. Regional anaesthesia

Regional anaesthesia is preferred in ophthalmic surgery - it allows day-case procedures, facilitates co-operation by the patient and has fewer systemic effects especially in geriatric patients with accompanying disease. The optimum size of needle including its diameter is one of the debated issues. Serious complications such as perforation of the globe and intra-orbital haemorrhage may occur due to use of very fine needles during retrobulbar and peribulbar block, related to the lower potential for sensation to be felt from a very fine needle during inadvertent insertion into the globe. On the other hand, use of blunt and larger calliper needles was criticized owing to potentially increased pain and trauma during insertion. It was also speculated that vessel trauma, if encountered, would easily be managed from a fine bore needle (Hamilton et al., 1988). The majority of complications are believed to be prevented by using a fine (27-30 G) and short (32 mm) needle. Warm local anaesthetic use and slow administration could greatly decrease the pain. Light sedation or analgesia may frequently be necessary, especially in anxious patients before giving the block.
A pressure device such as a Honan's cuff or gentle finger compression of the globe is advisable and should be applied for at least few minutes in order to obtain uniform dispersion of anaesthetic and to decrease intraocular pressure after performing the regional block.

4.1 Retrobulbar block

Retrobulbar block is a widely accepted regional technique for globe anaesthesia that was re-introduced to ocular surgery by Atkinson in 1936 (Atkinson, 1936). The aim of the block was to inject local anaesthetic into connective tissue inside the extra-ocular muscle cone behind the globe. Conic structure formed by the muscles around the eye surrounded by a loose connective tissue allows the dispersion of local anaesthetic agents (Ripart et al., 2001).
Insertion of the needle is onto the inferior orbital rim, two-thirds lateral from the inner canthus since it is free from vascular and neural components. A skin wheal is made with a 30 G needle on the lower eyelid at the temporal border of the inferior rim. 'Atkinson gaze' or an up and inner deviation of the globe is no longer used because of the risk of advancing the optic nerve and vascular supply into the path of the needle. Therefore, the eye must be kept in the neutral position. The globe may be displaced nasally with the finger of the free hand. The needle is advanced directly then angulated about 10° medially and superiorly. It is generally advisable not to introduce the needle more than 25 mm in order to prevent complications. A local anaesthetic volume of 2-4 mL is usually sufficient but this may be increased up to 8 mL. The analgesia and akinesia of the globe is higher than with other techniques and the technique is considered to be efficient for cataract surgery. Figure 1 depicts the needle direction in the orbit (See Figure 1 and Figure 3).

Pain from the injection is a common complaint that may be reduced by using fine needles. Rare but serious complications may be observed during the block including globe perforation, ipsilateral or contralateral vision loss due to retrograde spread of local anaesthetic solution, palsies, and cardiac or respiratory arrest (Ramsay & Knobloch 1978, Freidberg & Kline, 1986). Amaurosis and panophthalmia may occur after injecting the local anaesthetic solution into the eye (Ramsay & Knobloch 1978). The use of atraumatic, very fine needles (26-30 G) during performing the block, may be a possible reason for patients not feeling perforation. The incidence of perforation can increase with necessity of re-injection in the case of insufficient anaesthesia (Ripart et al., 2000). Constitutional increase in axial curvature in myopia (> 27 mm) and relatively thinner sclera with weak scleral tissue (staphylomata) behind the globe increase risk of perforation (Vohra & Good, 2000, Kallio et al., 2000), emphasizing the importance of careful evaluation of such eyes. The dural sac around the optic nerve is accepted as a path for retrograde leakage (Nicoll et al., 1987). Complications related to local anaesthetic mixing with the cerebrospinal fluid may occur within minutes and it is advised to keep patient for up to 10 min close to emergency equipment and drugs (Hamilton et al., 1988). Persistent diplopia is a rare but serious complication encountered predominantly after retrobulbar block and it can occur with a direct injury to the inferior rectus muscle and to a lesser extent to the inferior oblique muscle (Gómez –Arnau et al., 2003).

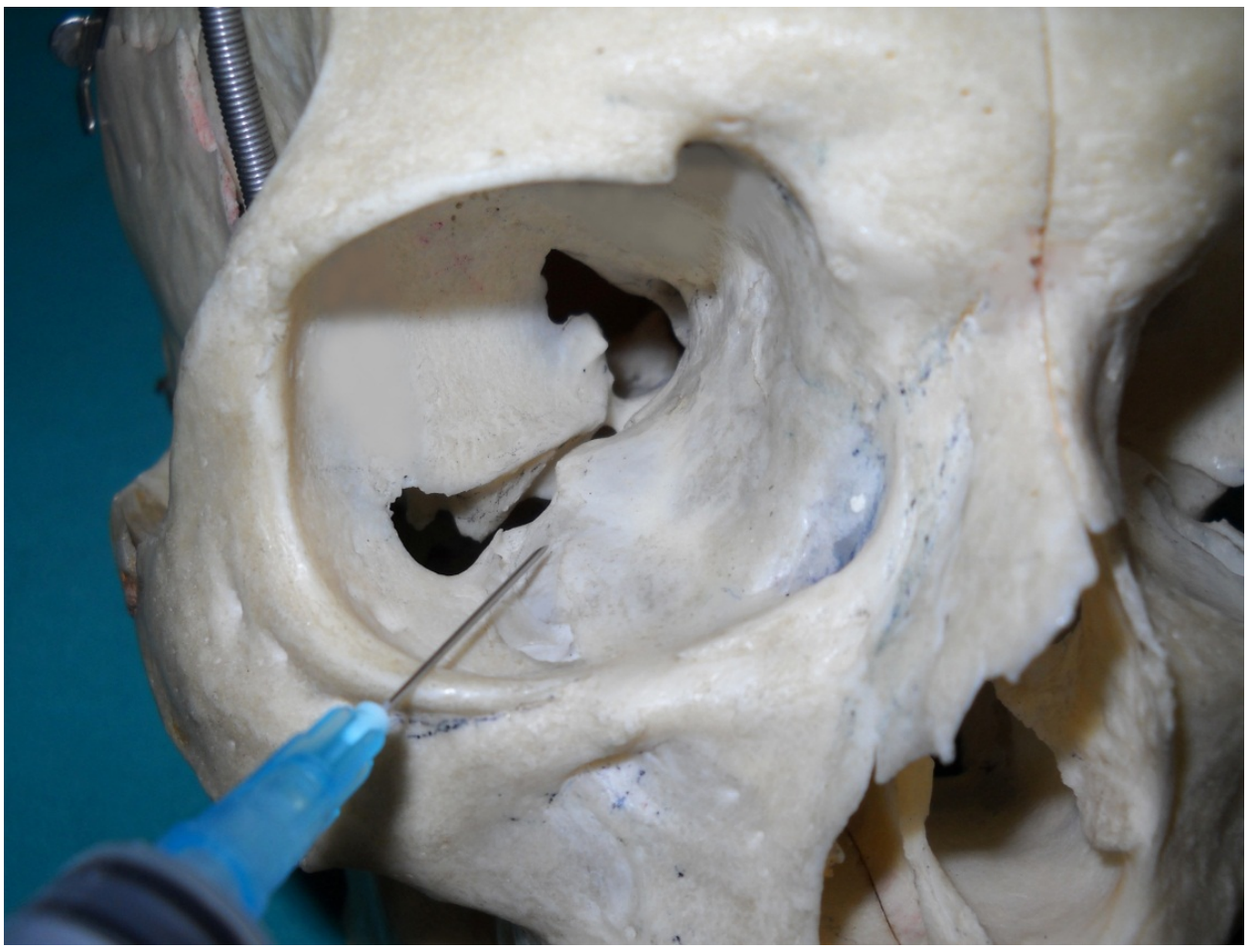


Fig. 1. The needle position for retrobulbar block

4.2 Peribulbar block

The peribulbar technique is another widely employed block that has been introduced in ocular anaesthetic practice more recently (Fry & Henderson, 1989). This technique involves the injection of local anaesthetic mixture externally to the muscle cone – hence it is also called the 'extraconal' block.

The needle entry point is the same as that of retrobulbar block, which is from two-thirds lateral to the inferior rim of the lower conjunctiva. The needle may be advanced from the lower lid with a skin wheal or through the conjunctiva after topical anaesthetic drops have been applied. The needle is introduced directly and is shorter than in the former technique. It is advised to use 26 G 25 mm needles (See Figure 2 and Figure 3).

The complication rate of the peribulbar block is considered to be lower than that of the retrobulbar technique. A larger volume of local anaesthetic solution is required compared to the other regional blocks. A longer duration of onset and repeated need for re-injection are other limitations (Frow et al., 2000). Efficient and satisfactory blocks can be performed even using lower volumes (Rizzo et al., 2005). A modified peribulbar technique was described with injection with a more superficial needle placement, which decreased the incidence of

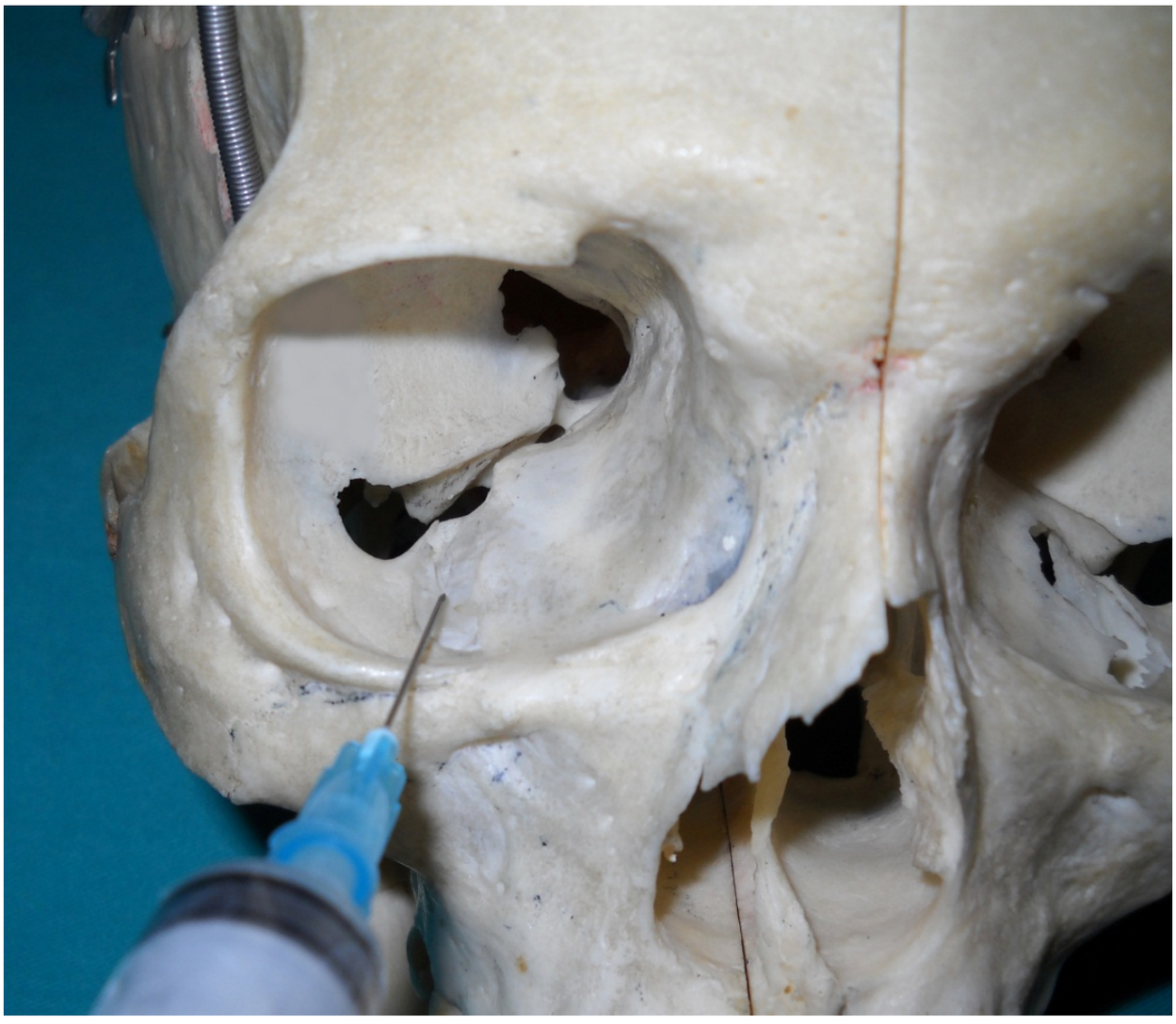


Fig. 2. The needle position for peribulbar block

re-injection but with a higher degree of subconjunctival haemorrhage (Mahfouz & Kalberi, 2007). Rare but serious complications including brainstem anaesthesia may also occur during the block (Gomez et al., 1997). Aside the important issue of safety there are no other advantages over retrobulbar block as complete anaesthesia and further injections are needed; an increased rate of subconjunctival haemorrhage instead of lid haematoma with retrobulbar block was observed in a large scale of review (Alhassan et al., 2008).

4.3 Sub-Tenon's block

Sub-Tenon's block is defined as a local anaesthetic injection into the tissues of the episcleral area under the Tenon's sheath. It was established in ocular surgery in about the mid-1950s (Swan, 1956). Tenon's fascia covers the globe and envelopes the ocular muscles from attaching sites to the sclera. More recently the technique was re-established as a sole anaesthetic block for eye surgery (Stevens, 1992). It was the most popular and commonly performed technique in the UK (Chandradeva et al., 2010).

The block can be performed with a surgical manipulation to reach the Tenon's sheath. Local anaesthetic drops or ointment are placed on the conjunctiva and the eye must be prepared by cleansing with povidone-iodine solution. The patient is asked to look upward and outward. The technique requires making a little hole in the conjunctiva, positioned 3-5 mm infero-nasally away from the limbus. Blunt Westcott scissors are required during careful dissection. Various types of metal and plastic curved or blunt tipped cannulas are in use for injection. A volume of local anaesthetic solution of 3-5 mL is generally sufficient for globe anaesthesia, but larger volumes may be required for akinesia. Many other techniques have been described in different sites of the globe, including a medial canthus episcleral technique from Ripart and colleagues (Ripart et al., 2000), which requires needle insertion. The patient is instructed to look inwards and downward during insertion of the needle through slightly shifting medially and advancing strictly to the posterior. The globe is changed to the neutral position after a small loss of resistance is felt. The needle is advanced 10-15 mm and up to 10 mL of local anaesthetic may be injected (See Figure 3).

The incidence of pain during the injection is higher. Loss of local anaesthetic during injection is frequent. Chemosis is increased with short needle use and incomplete akinesia and other limitations of this block are commonly encountered. In this 'blunt needle technique' complications from sharp needle techniques are reduced. However in addition to the complications occurring with retrobulbar block such as retrobulbar haemorrhage, cardiorespiratory arrest related to central spread, scleral perforation was observed in a patient who had previously undergone retinal surgery (Kumar et al., 2005).

All regional techniques produce cosmetic complications such as local bruising, haemorrhage, oedema and subconjunctival ecchymosis near the needle entry site and long-acting muscle paresis that distress the patient. Comparative studies show no benefit over each other. There is a lower requirement for sedation in the retrobulbar anaesthesia group but patient satisfaction is greatest with sub-Tenon's block (Ryu et al., 2009). It is convenient to perform blocks at the lower half of the globe in order to decrease complications. Owing to the thin lamina papyracea of the orbit care must be exercised when a medial approach is used. The incidence of nausea and vomiting are lower with phacoemulsification performed under topical or retrobulbar anaesthesia and no technique-related difference has been found (Chan et al., 2002). However, in spite of defined limitations, a survey indicated that in general patients predominantly prefer scenarios using blocks to topical anaesthesia and oral sedation regimens instead of IV medications (Friedman et al., 2004).

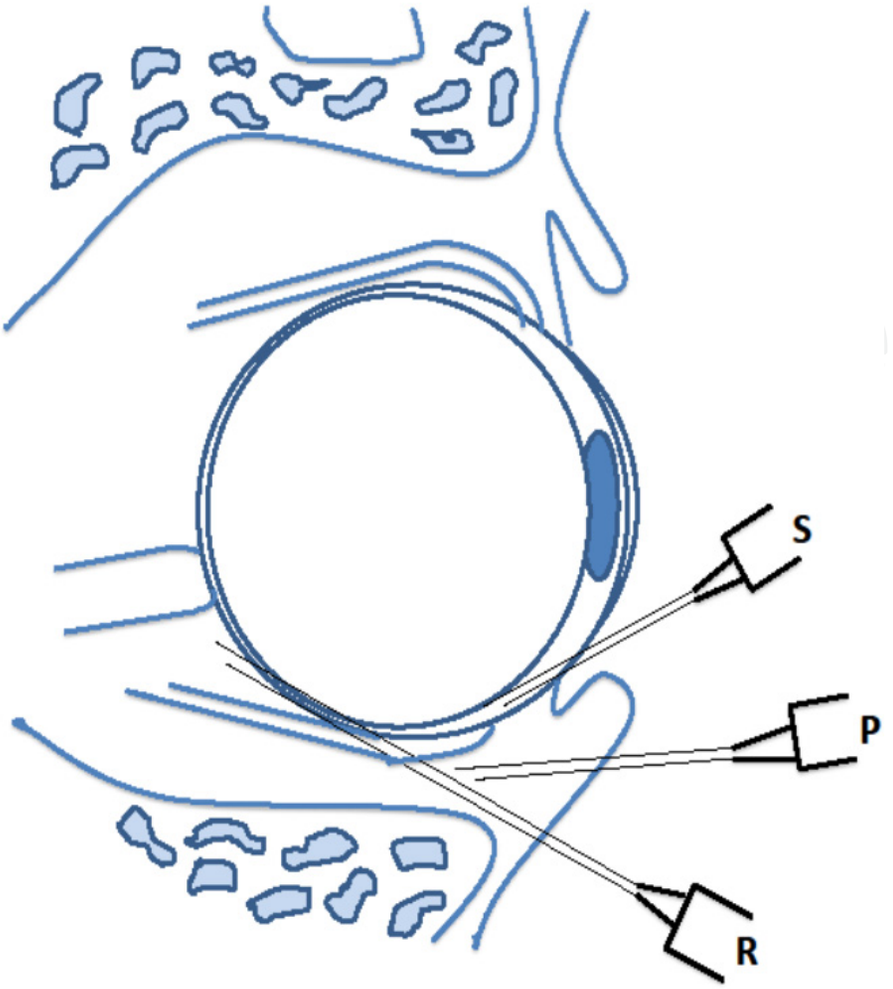


Fig. 3. Schematic drawing for regional anaesthetic techniques of the eye, R: retrobulbar, P: peribulbar, and S: sub Tenon's block

4.4 Oculocardiac reflex

The oculocardiac reflex is a trigeminovagal reflex response initiated by pain, compression or traction of eye muscles. The afferent pathway starts in the ciliary nerves, ciliary body and Gasserian ganglion through the ophthalmic division of the trigeminal nerve to reach the nucleus of the trigeminal nerve at the floor of the fourth ventricle. The efferent pathways are cardiac vagal nerves that induce hypotension and bradycardia. Nausea and vomiting may also be induced with decrease in the blood pressure. Surgical manipulation or stretching of muscles must be stopped when it is observed during an operation. Atropine or IV glycopyrrolate are effective for the treatment (Feldman & Patel, 2010).

4.5 Post-cataract ptosis

Ptosis after cataract surgery is observed with an incidence as high as 13%. Multiple factors have been implicated in the aetiology, including local anaesthetic injection to the upper eyelid to obtain akinesia, sutures and traction of the upper components of the eye, retrobulbar injection, peribulbar anaesthesia through the upper eyelid at the 12 o'clock position, excessive ocular compression, placement of the eyelid speculum, performing large conjunctival flaps, eyelid oedema, and tight or long term patching in the postoperative

period. Local anaesthetic injection cannot be accepted per se as the primary source, because this complication is also observed after general anaesthesia (McGoldrick & Gayer, 2006).
The measures that possibly decrease such complications are limiting the local anaesthetic volume to 6 mL during regional block, avoiding injection to the upper eyelid or muscles, and gentle tractions when necessary.

5. General anaesthesia

General anaesthesia offers motionless optimal surgical conditions including ocular akinesia with decreased intraocular pressure. Standard anaesthetic care including ECG on V5 or D II derivation, peripheral oxygen saturation, non-invasive arterial blood pressure, end-tidal CO_2 and temperature measurement is implemented to all patients as performed in monitored anaesthesia care. End tidal inspired anaesthetic gas concentrations may be estimated to assess the depth and timing during the anaesthesia. Venous access is mandatory and usually found on the dorsum of the hand.
Congenital cataract can be detected at earlier periods of life, even in the intrauterine period in pregnancies at risk of the condition which may be screened. Controversies exist on the optimal timing for congenital cataract surgery. Intervention before four weeks was associated with increasing glaucoma and secondary membrane formation, on the other hand incidences of nystagmus and diplopia were increased after this period (Birch et al., 2009). Therefore surgery for congenital cataract is advised to be performed between 5-8 weeks of life or before the 10th week to ensure optimal visual acuity (Lambert et al., 2006).
Deep sedation or general anaesthesia is required for patients in the paediatric age group. Mask induction can be achieved with sevoflurane starting from 8-7% and the anaesthetic concentration may be slowly decreased to the desired level. Flavoured masks such as those smelling of strawberry or banana may facilitate the procedure. This may be sufficient for short procedures such as examination, diagnosis or foreign body removal. Airway control with endotracheal intubation is a safe alternative for babies who already have venous access. On the other hand laryngeal mask use is also performed with success in this surgical subpopulation. A eutectic mixture of local anaesthetic (EMLA) cream that is applied on the dorsum of the hand about one hour before the procedure can facilitate painless venous puncture in infants and toddlers. In addition to the usual anaesthetic care temperature monitoring and heating or measures undertaken to prevent heat loss are especially important for patients under 1 year in age. Although intramuscular ketamine injection is another option the nystagmus which it causes may preclude eye examination. In congenital cataract surgery, a sub-Tenon's block performed during general anaesthesia has been demonstrated to be superior to fentanyl in terms of postoperative pain relief, reducing anxiety and helping induce calmer behaviour in patients in recovery, and a lower incidence of the oculocardiac reflex during surgery (Ghai et al., 2009).
All general anaesthetics except ketamine and succinylcholine decrease intraocular pressure. Propofol may be desirable for day case surgery during induction and maintenance of anaesthesia owing to advantages including faster onset and offset time, no residual effect, and reduction in nausea and vomiting. Etomidate can require a stable hemodynamic circulation during induction. In the case of neuromuscular blocking agents, concurrent disorders should be borne in mind. Cisatracurium can be used safely in patients with renal insufficiency. Rocuronium bromide may be indicated in emergence situations and facilitates endotracheal intubation as fast as succinylcholine. Having ready access to sugammadex, an

inactivation substrate that is specific for rocuronium, is another advantage in the case of residual neuromuscular blockade – the drug is available in many countries (Chambers et al., 2010). Lignocaine and beta blockers such as esmolol may be preferred to opioids for decreasing neuroendocrine responses to endotracheal intubation because of potential to increase postoperative nausea and vomiting. However, remifentanil, an opioid of shorter half-life can be used for this purpose. Laryngeal mask insertion may decrease possible complications related to endotracheal intubation. Propofol and opioid infusions or bolus doses may be administered during the maintenance- namely for total intravenous anaesthesia. The modern inhalation anaesthetics including sevoflurane or desflurane, have a comparable recovery period that can also be chosen. Recovery from anaesthesia must be as smooth as induction. The agents that are administered during induction may be repeated during recovery to prevent complications related to a sudden increase in blood pressure that can increase the risk of intra-ocular complications. Postoperative keratitis may be prevented by closing the opposite eye with a tape to prevent dehydration of the tear film such as with petroleum-based ointments in patients in whom the expected surgery exceeds one hour. An air-oxygen mixture may be preferred instead of nitrous oxide, a volatile anaesthetic agent that has emetic properties.

General anaesthesia provides optimal surgical conditions including an immobile eye and patient. The Bell's reflex can be present during light anaesthesia. Patients who refuse or have extreme fear of regional blocks require general anaesthesia. It also indicated in patients with allergy to local anaesthetic agents and in patients unable to control their movements such as those with Parkinson's Disease, those who cannot lie supine, or those with advanced concurrent disease. Other advantages are in offering bilateral surgery to patients in vulnerable conditions at a single session and refraining from complications due to needle insertion during regional anaesthesia.

Loss of communication with the patient during surgery and the requirement for an anaesthesia team, delay in recovery, and increasing expense, are disadvantages. Patients with advanced concurrent disorders under general anaesthesia should be managed as inpatients in order to stabilize their systemic pathologies.

5.1 Postoperative care

A patient may be discharged when regaining full consciousness - in the presence of stable vital signs in a calm patient who has no complaints. Patients should be observed carefully for residual drug effects and possible adverse outcomes should be explained to them. Pain is usually minimal and can be managed easily with non-steroidal anti-inflammatory (NSAID) drugs which also have topical ophthalmic solutions for use. These drugs are also efficient against intraocular inflammation after surgery and long-term complications such as cystoid macular oedema (Kim et al., 2010). On the other hand, drugs should be withheld in susceptible individuals such as patients with asthma. Eye drops containing corticosteroids can be used efficiently for the same purpose. Local anaesthetic solutions may also be combined for postoperative pain originating from causes like oedema or chemosis. While injection of intracameral antibiotic may decrease the risk of endophtalmitis, the benefit of perioperative NSAIDs over corticosteroids and the efficacy of combination in short or long term use remains to be demonstrated (DeCroos & Afshari, 2008). Patients with increased IOP preoperatively have been shown to be at risk of postoperative IOP spikes, which some authors feel makes it necessary to recommend surgery in the earlier period of the day so there is follow-up prior to discharge of at least a few hours (O'Brien et al., 2007).

6. Conclusion

Cataract surgery is increasingly becoming safer, faster and non-invasive. There is an increasing trend toward utilizing topical anaesthesia. Decisions on the type of anaesthesia to be used depend largely on the patient, the expected duration of the operation and preferences of the surgeon. For patients on anticoagulation therapy and who have previously had ocular surgery it is best to avoid needle trauma. General anaesthesia may be reserved only for special circumstances. Thorough knowledge including of drugs, anatomy of the orbit, and techniques are fundamental for implementing sound regional anaesthetic practice. Meticulous patient selection, careful pre-operative evaluation, selecting the anaesthetic technique properly and with care, along with increasing knowledge and skill may decrease peri- and postoperative complications and improve patient experience. The success of intervention may also be increased by optimizing collaboration between the surgical and anaesthetic team.

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