Recent improvements in technique have made cataract surgery a popular procedure in the outpatient setting. One of those advances has been the use of retrobulbar block instead of general anesthesia. This article explains the anatomy, pharmacology, technique and complications of retrobulbar block.

Introduction

The history of retrobulbar block reflects the history of local anesthesia itself. In 1884, Hermann Knapp, hearing of Carl Koller's success earlier in the year using cocaine as a topical anesthetic of the eye, injected it into the retrobulbar space in order to perform an enucleation. But cocaine's side effects limited its use as an injectable local anesthetic, and ophthalmologists soon returned to topical instillation for anesthesia of the eye. Retrobulbar anesthesia did not gain common use again until the 1930s. CRNAs have been administering retrobulbar blocks since the early 1970s. Richard Coleman, CRNA, wrote an excellent review of the subject in the October 1980 AANA Journal. This review will attempt to bring the reader up to date concerning current practice.

Anatomy

In order to understand what makes a retrobulbar block and its many variants successful, it is first necessary to review the nerves of the eye. Because it is usually necessary to have akinesia (immobility), as well as anesthesia, of the eye, it is important to review motor and sensory nerves. Cranial nerves will be referred to by both their common names and Roman numerals.

- Sensory: Ophthalmic nerve and ciliary ganglion. The ophthalmic nerve is a major branch of the trigeminal (V) nerve (Figure 1). Just before entering the orbit through the superior orbital fissure, the ophthalmic nerve divides into three portions: the lacrimal, nasociliary and frontal nerves. These are responsible for supplying sensation to the cornea, ciliary body, iris, lacrimal gland, conjunctiva, eyelid, eyebrow, forehead and nose. As can be seen by this list, the ophthalmic nerve and its branches is the main target for a successful retrobulbar block.
The ciliary ganglion is located near the rear of the orbit, lying between the optic nerve and the lateral rectus muscle. It is a branch of the oculomotor nerve (III) and supplies both autonomic and sensory fibers to the cornea, iris and choroid through delicate filaments known as the short ciliary nerves. These nerves are very small and easily blocked.

- Motor: Oculomotor (III), trochlear (IV), abducens (VI) and facial (VII). The motor innervation of the six rectus muscles, which are responsible for moving the eye, is supplied by three cranial nerves (III, IV, VI). Clinically, this is why one can often get complete sensory block of the eye without complete loss of movement. These nerves also enter the orbit through the superior orbital fissure.

The facial nerve (VII) supplies motor innervation to the orbicularis muscle and can be easily blocked at several sites after it exits the stylomastoid foramen at the base of the skull. It is usually sufficient, however, to block the nerve close to the lids. The optic nerve (II) is not mentioned in this discussion because it is not necessary to block the optic nerve for a successful retrobulbar block, although block of the nerve usually results when other nerves are successfully blocked. If the optic nerve is not blocked, the patient may be able to see lights and shapes, although the bright light of the microscope usually obliterates this sensation.

Another point to consider in a discussion of the anatomy of the eye is the origin of the retrobulbar space. The rectus muscles and their associated fascial investments form a loose cone tapering off from the globe, creating the "retrobulbar space." The aim of retrobulbar anesthesia is to place the tip of a needle into this space in order to deposit the local anesthetic most directly onto the nerves. Previously, it had been thought that this cone was rather "watertight," decreasing the effectiveness of local anesthetic injected outside the cone. However, recent anatomical investigations by Dr. Leo Korneef of Amsterdam demonstrate that the sheath formed by the muscles is rather loose, with gaps in many areas, accounting for the effectiveness of peribulbar (outside the cone) blocks. It also explains why one will often get bulging (chemosis) of the conjunctiva immediately after a retrobulbar block. Given sufficient volume, the local anesthetic will work its way out and around the globe as well.

Local anesthetics

The factors affecting a decision about which local anesthetic to use when performing a retrobulbar block are similar to that of any other regional anesthetic: onset and duration of action. Any local anesthetic agent in common clinical use is appropriate for the block; however, for clarity, discussion will be limited to two of the most commonly used agents: lidocaine and bupivacaine. Both are amide local anesthetics and consequently do not have the same potential for sensitivity as do ester-based agents.

- **Lidocaine.** Lidocaine has been used in concentrations of 2% and 4%; the most commonly used concentration is 2%. Lidocaine has the advantage in that it has a faster onset than bupivacaine. It has a mean onset of analgesia and akinesia of 3 minutes and a duration of surgical anesthesia of approximately 2 hours. The author's experience has been that lidocaine will produce reliable surgical anesthesia for 60 to 90 minutes, with loss of sensation for about 2 to 3 hours.

- **Bupivacaine.** Bupivacaine was synthesized in 1957 and was first used for retrobulbar anesthesia in 1966. It has been used in both 0.5% and 0.75% concentrations, with the 0.75% concentration preferred for its ability to produce reliable akinesia. Its onset is 5 to 10 minutes, and it has a duration of surgical anesthesia of approximately 6 hours. Reliable surgical anesthesia has been obtained by the author for about 2½ to 3 hours, with loss of sensation continuing for 6 to 8 hours.

Many practitioners make a combination of equal amounts of bupivacaine 0.75% and lidocaine 2% or 4% for retrobulbar anesthesia. The rationale for this varies, but generally it is to provide a more rapid onset than plain bupivacaine and a longer duration of action than lidocaine. The shortened duration of action (compared to plain bupivacaine) has not been found to be a problem clinically. Some of the problems associated with the occasional patient who has received plain bupivacaine and whose eye is still anesthetized 24 hours later are also avoided.

Adjuvants

- **Epinephrine** has been used in combination with local anesthetics to prolong the effect of the anesthetic and to act as a "marker" for accidental intravascular injection. However, it does not significantly prolong the effects of bupivacaine, and the use of a potentially arrhythmogenic drug as a marker in elderly patients does not seem clinically wise.

- **Hyaluronidase**, an enzyme which dissolves interstitial membranes, aids in the spread of the anesthetic after injection and helps to soften the eye, aiding the surgeon. Seventy-five units (0.5 ml) per 10 ml of anesthetic solution is sufficient to produce this effect.
Sedation

Small amounts of fentanyl and midazolam can be used for sedation. In this manner, apnea (brought on by short-acting barbiturates), can be avoided and yet amnesia for the block can be achieved. Anesthetists who pride themselves on never having to sedate a patient for retrobulbar blocks are to be admired; however, the author believes in the Golden Rule and would rather have a small amount of sedation before an anesthetist approached him to perform a block.

An important consideration before administering sedation is that the block should ideally be performed 20 to 30 minutes before draping the patient, thus avoiding the danger of entirely draping off from view a sedated, elderly patient. This delay will allow the block to take effect, the intraocular pressure to be reduced and most of the effects of sedation to wear off. Pulse oximetry is, of course, mandatory both after the block and during the entire procedure.

Equipment: Sharp versus blunt or bullet-tipped needles

Some controversy exists in the literature concerning the use of sharp versus blunted needles for retrobulbar blocks. Most of the disastrous complications associated with retrobulbar blocks (hemorrhage, respiratory arrest, perforation of the globe, etc.) are due to the inadvertent perforation of some delicate structure by a needle tip, followed by either injection or leakage of local anesthetic into the area. The author believes that just like the surgeon who chooses blunt dissection over sharp in certain instances, a blunted needle is preferred over a razor-sharp one when blindly probing the many delicate structures which exist in the retrobulbar space. This is a controversy that practitioners will have to resolve for themselves, as data and opinions on both sides abound.1,11,12

The author has used the 5 cm bullet-tipped needle shown in Figure 2 (The Hamacher Ophthalmic Bullet Point Infusion Needle®, available from RJ Doyle Inc., Spokane, Washington) in more than 5,500 blocks without a single incident of respiratory arrest, retrobulbar hemorrhage or other serious complication. Other types of blunted needles, such as the Atkinson retrobulbar needle, are in common use but have the drawback of having sharp edges.

Blunted needles have the disadvantage of being uncomfortable to the unsedated patient during placement. This problem can be solved in two ways: sedation of the patient, which is commonly done prior to cataract surgery, or preceding the use of the bullet-tipped needle with a small injection of dilute local anesthetic into the first 1½ to 2 cm of the needle track using a sharp needle.

Technique

The following is a description of the retrobulbar block technique, with some modifications used by the author on more than 5,500 patients during the last four years. This technique is taken from the Spokane Eye Surgery Center’s policy manual and is used as a guide by other anesthetists who administer anesthesia at the Center. There are as many different techniques for retrobulbar and peribulbar blocks as there are anesthetists performing them. The main emphasis is to get the proper amount of local anesthetic surrounding the globe without doing any damage. For an alternate method, see the article by Coleman.4

I. Sedation

A. Before sedating the patient, apply the pulse oximeter sensor to the finger to obtain a baseline SaO2. If baseline is less than 90%, supply supplemental O2 through nasal prongs at 2 L/min.

B. Sedation should be appropriate to the patient’s health status. The following is a “recipe” which should only be used as a guide and not as absolute. Titration to effect is the key.
1. Fentanyl 1 ml (50 μg)
2. Midazolam 1-3 mg (in younger patients this may go to 6-8 mg)

II. Retrobulbar block

A. Draw up in a 10 ml syringe
1. A dose of 4.75 ml 0.75% bupivacaine
2. A dose of 4.75 ml 2% lidocaine
3. A dose of 0.5 ml (75 units) hyaluronidase to dissolve the interstitial membranes which helps the spread of the medications and decreases the buildup of intraocular pressure.
B. Using the Hamacher bullet-tipped ophthalmic needle, insert the needle at the lateral one-third of the lower lid, about 1 cm inferior to the lid margin, and direct it to the retrobulbar space (Figure 3). The anesthetist’s hand should be stabilized on the patient’s face, so sudden movement will not cause injury.

C. Have the patient look directly ahead or slightly upward and inward while advancing the needle and watch for “jerking” of the eye if the sclera is caught by the needle. Remember that the sclera is a very tough structure and would require some force to enter, particularly with a bullet-tipped needle. (Figure 4).

D. If jerking is noticed, withdraw the needle slightly and redirect it.
E. A loss of resistance or “pop” is usually felt as the muscle cone formed by the rectus muscles is penetrated.

F. Aspirate for blood or vitreous before depositing 4-5 ml of anesthetic in the retrobulbar space.
G. Withdraw the tip of the needle to just beneath the skin, and then redirect and infiltrate the lateral corner of the eye with 3 ml to make a bubble extending back toward the temple. This will block the facial nerve (Figures 5 and 6).

H. Apply gentle but firm pressure to the eye with a 4 x 4 gauze for 1 to 2 minutes. Observe for signs of retrobulbar hemorrhage.
I. Apply the Honan® balloon to the eye, check to make sure the lids are closed and inflate to 25 mmHg.
J. Check the eye in 10 minutes.

1. If necessary, due to lack of motor blockade, reinject at position of 1 o’clock with 3 ml of local anesthetic, going 2.5 to 3.5 cm straight back through the lid just below the orbital rim. This will usually suffice to block the superior and medical rectus muscles, which are commonly more difficult to block.
2. If this does not give good results in another 10 minutes, repeat the retrobulbar block with 3 ml of local anesthetic.

III. Observe the patient closely for signs of:
A. Retrobulbar hemorrhage
B. Apnea-hypoxia (observe the pulse oximeter)
C. Cardiovascular problems (observe ECG)

Peribulbar block
Dr. David Davis has recently popularized a variation of the retrobulbar block known as the posterior peribulbar block. It involves a two-stage procedure with 6 injections at various sites around the eye, 2 of which are placed 1-inch deep in the peribulbar space. It is these latter 2 injections, one positioned at 1 o'clock and one at 7 o'clock, that are responsible for the effects of the block. The main advantage cited by Davis for the technique is that one is not entering the retrobulbar space.

As pointed out in the discussion of anatomy of the eye and orbit, given the nature of the fascial investments of the eye muscles, if one injects a large enough volume of anesthetic anywhere in the orbit, it will eventually infiltrate and have an effect on the eye itself. The situation is somewhat analogous to caudal versus epidural anesthesia, and the disadvantages are similar: a larger volume of local anesthetic is required (Davis recommends 10.5 ml to begin and another 3 to 4 ml if the block needs augmenting), and the block requires longer set-up time with somewhat unpredictable results.

The author believes peribulbar blocks are a good way to learn the block (indeed, beginners often use peribulbar even when they intend to use retrobulbar); however, the repeated needling of the eye is a disadvantage. As seen in the technique described above, the block can generally be accomplished with one insertion point and two injection sites: one in the retrobulbar space and one to block the facial nerve.

Complications
The literature is full of references to major complications due to retrobulbar anesthesia. A review of 6,000 retrobulbar blocks in 1987 by Nicoll showed the incidence of life-threatening complications as 1 in 750. These can be divided into two classes: those arising from the local anesthetic and those caused by the needle.

1. **Toxic effects.** The most common serious complication following retrobulbar block is respiratory arrest. In most of the case reports, the patient loses consciousness and becomes apneic, without the seizures one might associate with toxic levels of local anesthetic. This is usually self-limiting, and resolves in 15 to 20 minutes with positive-pressure ventilation. The mechanism of action, which is still unclear, is presumably infiltration of the local anesthetic to the brainstem through the optic nerve sheath, either by direct injection or diffusion. The other toxic effects commonly associated with local anesthetics (seizures and cardiac arrest) are also seen following retrobulbar blocks.

2. **Retrobulbar hemorrhage.** This is a dramatic complication. If it is an arterial hemorrhage, the globe becomes rock hard and begins to protrude, the lids are unable to close and bright red blood stains the conjunctiva and lids. Treatment consists of applying pressure to the eye, either manually or with a pressure device such as the Honan balloon and periodically checking for cessation of the hemorrhage. The ophthalmologist should check to see that there is blood flow through the central retinal vessels. If not, surgical decompression may be necessary.

3. **Perforation of the globe.** If perforation of the sclera is suspected, the eye should be examined immediately for signs of damage. In most cases accidental injection of the globe with local anesthetics has not caused permanent blindness. The surgeon may elect to close the entry hole with cryopexy or photocoagulation.

4. **Retinal vascular occlusion.** Either the central retinal artery or vein or both may become occluded after retrobulbar injection. This will cause optic nerve atrophy, which is not usually noted until followup. The only way to detect this immediately is through inspection of the optic disc with an ophthalmoscope immediately following cataract surgery. In the event of unexplained optic nerve atrophy after cataract surgery, it should be remembered that this complication also may follow cataract extraction under general anesthesia.

Summary
The retrobulbar block is easily achieved given enough time and volume of local anesthetic. As with all regional anesthesia, patience is a virtue. The block is not without serious complications, and it requires vigilance on the part of the anesthetist.
REFERENCES


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