Complications of Retrobulbar Blocks

Over two dozen reports of retrobulbar hemorrhages and at least three cases of respiratory arrest have been submitted to PA-PSRS since the program’s inception in June 2004. These reports represent complications of the retrobulbar block, an anesthetic technique used for intraocular surgery that many practitioners are abandoning in place of topical anesthetics.

Declining Use of Retrobulbar Blocks

A recent survey indicates a move away from retrobulbar blocks, while topical anesthesia is gaining greater acceptance.1 A 2003 survey of physician members of the American Society of Cataract and Refractive Surgery in the United States revealed this trend, presented in Table 1.2 Whereas in 1985, 76% of survey respondents used retrobulbar blocks with facial block, in 2003 only 17% of respondents used this modality. The use of topical anesthesia has increased from 8% in 1995 to 61% in 2003. Interestingly, the use of topical anesthesia appears to be associated with the volume of cataract procedures performed. Those respondent surgeons performing one to five procedures per month used topical anesthesia in 38% of their cases while those doing more than 75 procedures monthly used it 73% of the time.

Each anesthesia modality, however, has unique benefits and risks. Table 23 displays this information for various anesthesia techniques used in ocular surgery.

### Table 1. Cataract Surgery Anesthesia Trends

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Retrobulbar block without facial block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11%</td>
</tr>
<tr>
<td>Retrobulbar block with facial block</td>
<td>76%</td>
<td>32%</td>
<td>14%</td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td>Peribulbar block</td>
<td>38%</td>
<td></td>
<td></td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td>Topical Anesthesia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61%</td>
</tr>
<tr>
<td>- with intracameral lidocaine</td>
<td></td>
<td></td>
<td></td>
<td>81%</td>
<td>73%</td>
</tr>
<tr>
<td>- 1-5 cataract procedures/month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38%</td>
</tr>
<tr>
<td>- more than 75 procedures/month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>73%</td>
</tr>
</tbody>
</table>


### Indications

If a retrobulbar block is considered, several factors will reduce the risk of complications.

### Cooperation

The patient must be able to follow instructions and cooperate with the surgical team.3,4 In order to follow directions, patients should not be hearing impaired or deaf, nor should there be a language barrier between the patient and surgical team.3,5,6 Hearing aids, sign language interpreters, and/or foreign language interpreters may enhance cooperation.

### Positioning

The patient must be able to lie flat on his/her back.3,5 As a result, diagnoses that prevent such a position would be contraindications, such as severe back pain,4 postural problems,4 or chronic cardiac or respiratory problems.5

The ability to lie still is critical.3 Therefore, conditions such as the following might make a patient an inappropriate candidate for the block: involuntary movements/tremors,3,6,7 uncontrolled convulsive disorder,5 uncontrolled cough,6 excessive anxiety and claustrophobia.5

Patients should be older than 15 years, because young patients are not as likely to remain still throughout the block and surgical procedure.5,6 Likewise, oriented patients, without significant mental impairment produced by psychiatric disorders or dementia, are more likely to stay still and follow instructions.3,5 Moreover, oriented patients are more likely to be able to understand and tolerate the effects of a retrobulbar block on eye movement and vision during and for some time after surgery.3

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Complications of Retrobulbar Blocks (Continued)

Coagulation
This block is appropriate for patients with no significant bleeding or coagulation disorders. There is a difference of opinion concerning whether anticoagulants, NSAIDS, aspirin, or clopidogrel bisulfate should be stopped prior to this block. One perspective is that patients receiving such medications are at greater risk of developing a retrobulbar hemorrhage. Another perspective is that it is acceptable to perform a retrobulbar block if the patient’s INR does not exceed twice the normal values.

Globe
Anatomical abnormalities (e.g., a myopic axial length greater than 26 to 32mm) should not be present. There must be enough room between the globe and the bony orbit to safely perform the block. Normal intraocular pressure and absence of glaucoma are appropriate indications. The block should not be completed if the globe is perforated. The patient must have no known allergy/cross sensitivity to the local anesthetic to be used in the block.

Complications of Retrobulbar Blocks (Continued)

vascular disease, hypertension, coronary artery disease, peripheral or cerebral vascular disease, or diabetes mellitus.10

Length of Surgical Procedure
Retrobulbar blocks may be appropriate if the surgical procedure is expected to last less than 90 minutes.5

Anatomy
To understand the technique of retrobulbar block and its complications, one must understand the eye’s basic anatomy and its relationship to surrounding/supporting structures.

The orbit is a pyramid-shaped cavity in the skull1,7 with a posterior apex and an anterior base. The orbit is filled predominantly with adipose tissue, and the globe (eyeball) is in the anterior portion of the cavity. Four rectus muscles are attached around the equator of the globe. These muscles come together at the apex of the orbit, affixed by the tendon of Zinn.7 At this point, the optic nerve enters the orbit. The retrobulbar cone is defined by these four rectus muscles.

The following nerves innervate the globe.1,7
- The ophthalmic nerve (V) (i.e., the first branch of the trigeminal nerve), which controls sensory innervation of the globe.
- The abducens nerve (VI), which regulates motor control to lateral rectus muscle.
- The oculomotor nerve (III), which regulates motor control to all other extraocular muscles.
- The trochlear nerve (IV), which regulates motor control to superior oblique muscles.

All of these nerves except the trochlear pass through the retrobulbar muscle cone. As a result, injecting a local anesthetic inside this cone provides anesthesia and akinesia of the globe, as well as the extraocular muscles.1,7

In addition to motor, sensory, and autonomic innervation of the globe, there are many other structures within the retrobulbar muscle cone that can be at risk during retrobulbar injection including the optic nerve and many arteries and veins of the orbit, including the optic artery.1,7

Technique
The goal of retrobulbar anesthesia is to direct the tip of the needle toward the orbital apex and into the retrobulbar muscle cone to diffuse the anesthetic within this space. This blocks the ocular motor nerves (III and VI) and sensory nerves (V), producing akinesia and anesthesia.1

Retrobulbar Block: Insert needle inferior to the maximum diameter of the globe and perpendicular to the plane of the face. Once past the axis of the globe, angle the needle medially and superiorly. Final needle position is within the muscle cone.
Complications of Retrobulbar Blocks (Continued)

To perform a retrobulbar block, a small amount of local anesthetic is injected inside the retrobulbar muscle cone (see Figure 1). The conventional technique involves the following steps:

- Asking the patient to gaze in its primary position or a “downward and outward” position.  
- Introducing the needle through the skin below the inferior lid at a point between the lateral one-third and medial two-thirds of the inferior orbital edge.
- Directing the needle to the apex of the orbit in a medial and cephalad direction
- Advancing the needle to a depth of 25 to 30mm
- Injecting 2 to 5cc of local anesthetic

Performing a facial block to prevent blinking. The technique most commonly used is the van Lindt block, involving infiltration of local anesthesia in the areas of the terminal branches of the facial nerve (VII). Previously, Atkinson’s “up and in” gaze was used for this block, but it is no longer advised because Liu et al. and Unsold et al. determined that this globe position increased the risk of optic nerve injury. Because the optic nerve passes near the path of the needle, it can be stretched or injured by the needle, rather than pushed aside as intended. This gaze position also places the needle near other structures such as the ophthalmic artery, superior orbital vein, and the posterior pole of the globe. Unsold et al. recommends that the patient gaze with the globe in its primary position or in a down and outward position. These positions place the optic nerve, blood vessels, and the inferior oblique muscle outside the needle’s path.

Retrobulbar anesthesia is a blind technique. As a result, damage can result to the globe, orbital tissues, and neurovascular structures. Near the apex, many structures are packed in a small area and fixed by the tendon of Zinn; therefore, the structures cannot move away from or be pushed aside by the needle.

Complications

The literature describes several complications of retrobulbar blocks, including chemosis, bruising, retrobulbar hemorrhage, globe penetration and perforation, optic nerve damage and atrophy, extracocular muscle malfunction and injury, brain stem anesthesia, globe ischemia, and complications of nerve VII. Table 3 displays these complications with information concerning mechanism of injury, risk factors, incidence, prevention, and treatment.

Two types of complications are evident in the PA-PSRS data: (1) central nervous system spread of anesthesia and (2) retrobulbar hemorrhages.

Central Nervous System Spread of Anesthesia

Unintentional intra-arterial injection of the anesthetic agent during retrobulbar block may result in reverse flow of the agent from the ophthalmic artery to the cerebral or internal carotid artery. Seizures can result from injection of as little as 4cc. Rapid recovery occurs with symptomatic treatment.

The anesthetic can also be inadvertently injected under the dura mater sheath of the optic nerve or directly through the optic foramen, resulting in subarachnoid spread of the local anesthetic. The local anesthesia spreads directly to the brain from the orbit causing partial or complete brain stem anesthesia. Symptoms include cranial nerve palsy or bilateral block, sympathetic activation, restlessness, confusion, total spinal anesthesia with tetraparesis, arterial hypotension, bradycardia, and respiratory arrest. Symptoms begin within about two minutes after injection and peak within 20 minutes. Recovery occurs in two to three hours. Symptomatic treatment may include oxygen, vasopressors, tracheal intubation, and ventilation.

There are at least three cases of respiratory arrest following retrobulbar blocks that have been reported to PA-PSRS.

Retrobulbar Hemorrhage

Over two dozen reports of retrobulbar hemorrhage have been reported to PA-PSRS. The overall incidence of this complication varies from between 0.1% to 3%. Hemorrhage is caused by needle penetration of either the venous or arterial vessels in the orbit.

Venous

Most retrobulbar hemorrhages are venous, and bleeding is slow. Venous hemorrhages do not ordinarily threaten vision, the consequences are less severe than arterial hemorrhages, and they require no intervention other than postponing the surgery for which the block was administered.
Complications of Retrobulbar Blocks (Continued)

Arterial

Arterial hemorrhages, however, can be more serious. An arterial hemorrhage is evident within a few minutes; symptoms include proptosis and tight eyelids, ecchymosis, chemosis (i.e., conjunctival blood vessel engorgement), blood staining of periorbital tissues, lid swelling, and a dramatic increase in intraocular pressure. Late optic atrophy may also result if the microvasculature of the optic nerve becomes occluded. A compressive retrobulbar hematoma may threaten retinal perfusion by causing central retinal artery occlusion.

The cause of retrobulbar hemorrhage is misplacement of the needle during this “blind” procedure. The risk of retrobulbar hemorrhage depends on the experience of the person performing the block; for example, the complication is more likely if the person performing the retrobulbar block has limited experience.

Patient-related risk factors include elderly patients receiving anticoagulants, NSAIDS, aspirin or steroids. However, it is considered acceptable to perform this block if the INR does not exceed twice the normal value. Patients with acquired vascular disease are at risk, as are those with diseases promoting arterial fragility such as diabetes or atheroma. Hypertensive patients may also be at risk for this complication. Those at higher risk include patients with a history of previous eye surgery and those with pathological abnormalities of the globe, such as extreme myopia, myopic staphyloma, coloboma, or scleral buckle.

Timely, effective treatment for retrobulbar hemorrhage can prevent permanent impairment of vision. Most retrobulbar hemorrhages can be successfully treated conservatively. Immediate oculocompression helps limit the extent and severity of the hemorrhage. The goal of treatment is to reduce compartment pressure, thereby reducing intraocular pressure, which in turn reduces negative outcomes on retinal circulation. The ophthalmologist will evaluate the extent of the hemorrhage and determine whether further interventions are necessary. Interventions may include measuring intraocular pressure and checking retinal circulation. Intracocular pressure can be lowered with acetazolamide. Immediate lateral canthotomy/cantholysis may be required to relieve orbital pressure caused by the retrobulbar hemorrhage. Emergency orbital decompression surgery may be necessary if the optic nerve is compromised.

Risk Reduction Strategies

Addressing the following issues can help achieve safe and successful retrobulbar blocks (and any akenetic block of the eye):

- Education and competencies
  - Ensuring knowledge of anatomy and the relationship between the globe, orbit, and other ocular-related structures.
  - Having training and checking competencies in performing the technique.

- Patient condition
  - Evaluating the globe for pathological abnormalities (e.g., abnormal axial length of the globe).
  - In severely hypertensive patients, consider postponing surgery until blood pressure is under greater control.

- Technique
  - Using techniques based upon anatomical knowledge and existing ophthalmic pathology, including the following:
    - Using a small gauge needle (25 gauge) no longer than 31 mm in length. (This reduces the risk of both retrobulbar hemorrhage and brain stem anesthesia.)
    - Inserting the needle when the eye is in primary gaze.
    - Placing the needle tangential to the globe.
    - Avoiding placement of the needle into the vascular quadrant or muscle belly by smoothly and gently inserting the needle into a relatively avascular area.
    - Aspirating before injecting the local anesthetic agent, to check for blood.
    - Consider repositioning the needle if resistance occurs during injection.

- Anesthesia/sedation
  - Considering other anesthesia modalities that may have fewer complications.

Finger Index

The Finger Index (FI) is a grading system (0 to 3; see below) used in the Helsinki University Eye
Complications of Retrobulbar Blocks (Continued)

Hospital in Finland that can determine the accessibility of the retrobulbar/peribulbar space in advance of needle injection. The tighter the globe is situated near the wall of the orbit, the more difficult the needle insertion. One finger palpates the space between the orbit and globe.

**FI=0:** Globe lies tightly on the rim of the orbit and cannot be lifted at all by the fingertip. (Retrobulbar/peribulbar blocks are contraindicated in such patients.)

**FI=1:** Only the tip of the finger fits between the globe and orbit. (Patients require an expert medical staff member to perform the block.)

**FI=2:** Finger easily fits between the orbit and globe. (Patients are suitable for retrobulbar/peribulbar anesthesia; the block may be administered by an appropriately educated and supervised physician in training.)

**FI=3:** Finger reaches the level beyond the equator of the globe. (Patients are suitable for retrobulbar/peribulbar anesthesia; the block may be administered by an appropriately educated and supervised physician in training.)

Further study is needed to determine whether this grading system can be scientifically validated. However, it may provide a supplemental screening.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Mechanism</th>
<th>Risk Factors</th>
<th>Incidence</th>
<th>Prevention</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemosis</td>
<td>Anterior spread of local anesthetic agent</td>
<td>Injection with smaller needles</td>
<td>Not known</td>
<td>Avoid anterior injection</td>
<td>Usually resolves on oculocompression</td>
</tr>
<tr>
<td>Bruising</td>
<td>Damage to superficial blood vessels during injection</td>
<td>Elderly receiving steroids, NSAID, aspirin</td>
<td>1-2.75%</td>
<td>Avoid injection through visible blood vessels</td>
<td>Usually resolves and spread can be limited by oculocompression</td>
</tr>
<tr>
<td>Retrobulbar hemorrhage</td>
<td>Damage to arterial or venous blood vessels behind the globe</td>
<td>Elderly receiving steroids, NSAID, aspirin</td>
<td>0.1-3%</td>
<td>Limit insertion of needle to less than 31mm in the relatively avascular area</td>
<td>Immediate oculocompression, ophthalmologic opinion and decompression surgery</td>
</tr>
<tr>
<td>Globe penetration and perforation</td>
<td>Penetration of globe (wound of entry) and perforation (wounds of entry and exit)</td>
<td>Myopic eye, uncooperative user, inexperienced user, poor technique, previous surgery</td>
<td>0-1%</td>
<td>Use of technique based on sound anatomical principles</td>
<td>Immediate senior ophthalmologic opinion</td>
</tr>
<tr>
<td>Optic nerve damage</td>
<td>Direct damage to nerve or compression of the nerve secondary to hemorrhage or vascular occlusion</td>
<td></td>
<td>Rare</td>
<td>Surgical decompression may be required</td>
<td></td>
</tr>
<tr>
<td>Optic nerve atrophy</td>
<td>Direct damage to nerve, central retinal artery or secondary to hemorrhage</td>
<td></td>
<td>Rare</td>
<td>Careful needle placement</td>
<td>Delayed complication</td>
</tr>
<tr>
<td>Damage to the motor nerve of the inferior rectus and inferior oblique muscles</td>
<td>Direct trauma to the nerve</td>
<td>Insertion of needle at the junction of medial 2/3 and lateral 1/3 of inferior orbital margin</td>
<td>Not known</td>
<td>Careful needle placement avoiding the nerve</td>
<td></td>
</tr>
<tr>
<td>Inadvertent subarachnoid anesthesia (brain stem anesthesia)</td>
<td>Subject to debate but spread through optic nerve sheath or through the orbital foramina</td>
<td>Placement of long needle into the apex</td>
<td>0.3-0.8%</td>
<td>Avoid using long needle</td>
<td>Extensive cardiorespiratory support</td>
</tr>
<tr>
<td>Globe ischemia</td>
<td>Interruption of blood flow</td>
<td>Prolonged oculocompression</td>
<td>Rare</td>
<td>Use pressure limiting oculocompression device</td>
<td></td>
</tr>
<tr>
<td>Prolonged extraocular muscle malfuncion</td>
<td>Prolonged exposure of fine muscle fibers, injection of local anesthetic agent into the muscle</td>
<td>May be associated with non-use of hyaluronidase</td>
<td>Not known</td>
<td>Proper placement of needle</td>
<td></td>
</tr>
<tr>
<td>Complications of 7th nerve block</td>
<td>Direct damage to the nerve or neurogenic in origin</td>
<td></td>
<td>Rare</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Complications of Retrobulbar Blocks (Continued)

method in addition to other risk reduction strategies to determine: (1) patients’ appropriateness of such procedures and (2) the level of expertise required for the performance of the procedure.

Conclusion
The key to selecting the most appropriate anesthesia technique is for the surgeon, anesthesiologist, and the patient to work together during the anesthesia selection process, prior to surgery, and during anesthesia instillation. Describing to the patient what he/she will experience before, during, and after surgery will reduce fear and anxiety and promote patient cooperation. While ophthalmologists routinely perform retrobulbar blocks, anesthesia staff can perform such blocks, as well as provide support to the patient by adjusting IV sedation to reduce discomfort.

Resources
Resources concerning anesthesia alternatives for cataract surgery include:


A review of complications of ophthalmic regional blocks includes:


Notes
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