APPENDIX A—Anesthesia techniques

**Overview of techniques**

*Topical anesthesia*

Topical analgesia is the simplest technique to anesthetize the eye and can be used as the sole anesthetic for cataract surgery. Local anesthetic gel or eye drops are placed on the cornea and conjunctiva shortly before starting surgery. Topical anesthesia does not alter vision, avoids the need for local anesthesia to be injected near the eye, and no or minimal sedation is usually required. However, topical analgesia does not provide akinesia of the eye.

*Retrobulbar block*

Retrobulbar blocks are often performed by first administering a topical eye anesthetic, such as proparacaine 0.5%, onto the surface of the eye, followed by an antiseptic, such as 10% povidone-iodine, swabbed over the closed lower eyelid. The antiseptic solution should contact the skin for several minutes to provide optimal antibacterial effect. The patient is usually lightly sedated before the block with short duration intravenous medications (e.g., remifentanil or fentanyl with midazolam) but ideally still able to respond to commands. Standard patient monitors should be used during block placement, with supplementary oxygen if sedation is used. Patients should be instructed to look straight ahead during the block (primary gaze position).1

A palpating gloved finger identifies the lower part of the globe and the inferior lateral orbital rim. A needle 32mm or less (author JB prefers a 22mm 25g needle) is inserted through the skin, just over the inferior orbital rim, a few mm lateral to the “traditional” insertion point, defined as the junction of the middle and lateral third of the lower eyelid just above the orbital rim,2 as shown in Figure 1 of our accompanying brief report.3 Inserting the needle several mm lateral to the traditional insertion point may reduce the risk of injury to the inferior rectus and the neurovascular bundle supplying the inferior oblique muscle.4,5

The needle is inserted very slowly with the bevel facing the globe so that the sharpest point on the needle tip is farthest from the globe. Always watch the globe to ensure it does not move during needle advancement. If it does, the needle may have touched the sclera and should be withdrawn.6

Some of our panel members modify this technique to reduce the risk of the needle perforating the globe, by wiggling the needle several mm per second (parallel to the surface of the globe) during needle advancement after penetrating the skin. (If touched, the globe would likely move in tandem with the wiggling needle, and the needle should be withdrawn.)7

Initially, the needle is advanced horizontally to the orbital floor. There may be slight resistance as the needle pierces the skin, and a slight “pop” after penetration through the orbital septum several mm deep to the skin if a blunt Atkinson needle (JB’s preference) is used.

The needle tip, after judged to pass under the inferior portion of the globe, is directed superiorly, usually at about a 45 degree angle, and medially into the intraconal space. Kumar and Fanning recommend that the needle tip, when fully inserted, lie in an imaginary vertical plane from the lateral limbus (the junction of the colored iris and the white sclera) projecting posteriorly.6

After the needle is inserted to the desired depth, use the wiggle technique described above or confirm that the patient is able to look in different directions, as an indication that globe perforation is not likely. The barrel of the syringe is then withdrawn to assure no blood is aspirated (a sign of an intravascular insertion) and, if none seen, local anesthesia is slowly injected. The volume required for an effective retrobulbar block has been reported to be 1.5 – 4 ml range.6 When shorter needles are used (25mm or less), several additional ml of local anesthesia may be needed to obtain a successful block.

*Peribulbar block*

The initial steps of peribulbar block technique, including sedation, initial position of the needle tip (bevel facing the globe), location of the initial insertion of needle through the skin, and local anesthetics that can be used, are identical to retrobulbar technique. Needles 25mm or less are commonly used for a peribulbar block. (JB uses a 22mm 25g Atkinson needle). After the needle penetrates the skin, use one of the techniques described in the “Retrobulbar block” section to confirm that the needle is not in contact with the globe. The needle is then advanced horizontally under the globe, but not more than 32mm. See Figure 1 of our accompanying brief report.3 The syringe is aspirated, and if no blood is seen, the local anesthesia (commonly 6-10 ml) is injected.

*Sub-Tenon’s block*

Sub-Tenon’s block is accomplished by injecting local anesthetic into the episcleral space (the space between the sclera and the overlying sub-Tenon’s capsule) via a blunt cannula or needle, as shown in Figure 1. The technique is most often performed in the infero-medial or nasal quadrant. After sterile preparation, application of topical anesthetic drops or gel to the surface of the globe, and topical application of 5% betadine solution to the conjunctiva, the conjunctiva is held 3-5 mm from the limbus. Blunt Westcott scissors are then used to create an opening in the conjunctiva and Tenon’s capsule to access the episcleral space. Specially designed blunt, often curved, cannulas are advanced into the episcleral space, and the local anesthesia mixture (commonly 3–5 ml) is injected. Three ml of local anesthesia typically provides analgesia to the globe, and 5 ml will spread to extraocular muscles and provide akinesia.

*General anesthesia*

General anesthesia in cataract surgery is typically reserved for patients who are unable to communicate, cooperate, or remain still during eye surgery. It is critical that the patient does not move during the procedure to prevent eye injury. This may be accomplished by either maintaining a continuous deep level of anesthesia or administering muscle relaxants.8

Comparative risks

Complications of retrobulbar and peribulbar blocks include strabismus, retrobulbar/peribulbar hemorrhage, globe perforation, inadvertent brain stem anesthesia, and direct needle trauma to the optic nerve.9,10,11,12,13 One recent survey put the incidence of serious complications from needle-based blocks at about one in 5,000 cases.12 Rates of complications resulting in blindness vary among studies. For example, retrobulbar hemorrhage rates range from 0.1 - 3.0%.9,10 Globe perforation rates range from 1 in 874 to less than 1 in 16,000, with half of cases not recognized at the time of occurrence.14 Retrobulbar blocks have a higher rate of posterior globe perforation injuries in patients with axial lengths greater than 25 mm,15 staphalomas,16 or enophthalmos,16 and an increased risk of other complications including brainstem anesthesia17,18 and optic nerve injury if needles longer than 32mm are used.1,19,20 Differences between types of sharp-needle blocks are less clear: while a few small studies report that retrobulbar blocks have higher rates of globe perforation,9,21 lid haematoma,22 and severe systemic complications14 than peribulbar blocks, larger studies and systematic reviews report that the two blocks have similar complication rates.22,12

Topical anesthesia has the lowest risk of serious anesthetic complications in cataract surgery.12,23 A 2012 meta-analysis compared outcomes between topical anesthesia and retrobulbar/peribulbar blocks using data from 15 randomized control trials, and found that blocks had higher complication rates, including chemosis, periorbital hematoma and subconjunctival hemorrhage, than topical anesthesia.23 While one study reported that topical anesthesia led to higher rates of endophthalmitis (0.87%) than retrobulbar block (0.13%),24 others found no statistically significant difference in the rates of endophthalmitis.23 A 2015 study of over 21,000 office-based cataract surgeries performed with topical anesthesia without intravenous sedation, reported no intraoperative or perioperative vision-threatening AEs and no cases of endophthalmitis.25

Sub-Tenon’s block carries a lower risk of serious complication than retrobulbar and peribulbar blocks. While sight-threatening and life-threatening complications are 2.5 times more likely with needle-based blocks than blunt cannula-based sub-Tenon’s block,9,26 many of the same complications that have been shown to occur with sharp-needle blocks have also been reported with sub-Tenon’s blocks.27-30

**Practice trends**

Anesthesia techniques for cataract surgery have shifted over time and remain diverse across states, institutions, and even within facilities. Retrobulbar block was the predominant technique for most of 20th century, preferred by over 70% of U.S. ophthalmologists in 1985.31 But with the introduction of phacoemulsification, a quicker and less invasive means of lens extraction,preferences began to shift towards other forms of anesthesia.32 In 2012, only 6.1% of ophthalmologists preferred retrobulbar blocks for cataract surgery.33 Increased use of peribulbar block accounts for part of the shift.10 Yet preference for peribulbar blocks in cataract surgery has also trended downward in recent decades from 38% in 199531 to 12.4% in 2012.33

Topical anesthesia is the most common technique for cataract surgery in the U.S. today, following its progressive increased use over the last two decades, with 8% of cataract surgeons using it in 1995, 51% in 2000, 61% in 2003, and 77.6% in 2012.31,33 Of surgeons who use topical anesthesia, 79.6% supplement with intracameral lidocaine,33 which has been shown to achieve better anesthesia.34 International anesthesia preferences vary further. For example, in the United Kingdom, ophthalmologists report using sub-Tenon’s blocks for 50% of cataract procedures.12

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