

Sub-Tenon Anesthesia

A Prospective Study of 6,000 Blocks

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Background: An initial pilot study of 300 sub-Tenon local anesthetic blocks (STBs) for intraocular surgery established the effectiveness and patient acceptability of the technique. Following this, a decision was made in 1995 to change from sharp needle techniques to STB for all eye surgeries performed during local anesthesia at Auckland Hospital (Auckland, New Zealand) by reeducation of anesthetists and surgeons. At this point, sufficient data were not available to confirm that STB would avoid the complications associated with the passage of sharp needles into the orbit or would cause a different set of serious complications.

Methods: A prospective study of the next 6,000 consecutive STBs performed at Auckland Hospital was carried out over a period of 6 yr (from 1995 to 2000).

Results: Sub-Tenon block is very effective, with a surgeon and patient acceptability rate of 98.8%. Insertion of the sub-Tenon cannula and administration of the anesthetic produces minimal discomfort, being completely painless in 68.8% of cases. There were no serious block-related complications in this series, supporting the safety of the sub-Tenon technique.

Conclusion: The experience at Auckland Hospital provides further support for the avoidance of passing sharp needles into the orbit.

DAMAGE to the globe resulting from the use of sharp needles for peribulbar and retrobulbar anesthesia is well recognized¹⁻³ and, although relatively uncommon, can be catastrophic when it does occur. Furthermore, the large number of patients undergoing eye surgery every year means that a significant number of people suffer sight-threatening complications from these techniques.

Sub-Tenon block (STB) offers potential advantages over other anesthetic techniques for eye surgery. After its description by Stevens⁴ in 1992, several other small studies have appeared in the anesthesia literature.⁵⁻⁷ Although these studies have shown that STB is an effective technique for eye surgery, sample sizes were insufficient to confirm that the quality of the block was maintained when performed by a wider range of opera-

tors or that using a sub-Tenon technique instead of a sharp needle technique was not merely exchanging one set of sight-threatening complications for another.

Materials and Methods

After the first pilot study of 300 STBs performed at Auckland Hospital (Auckland, New Zealand),⁵ ethics committee approval (Auckland Ethics Committee, Auckland, New Zealand) and appropriate patient consent were obtained, and a prospective study was conducted collecting data from all local anesthetic eye blocks performed at Auckland Hospital from 1995 to 2000. During this period, all anesthetic specialists and registrars involved in eye surgery were trained to perform STB as previously described by Guise.⁵ In brief, this involved establishment of intravenous access, monitoring with pulse oximetry, and application of topical 0.5% proxymetacaine drops (Ophthetic; Allergan New Zealand Ltd., Auckland, New Zealand) to the conjunctiva. After placement of a Kratz-Barraquer lid speculum, the conjunctiva was cleansed with 4% povidone iodine solution. The fused conjunctiva and anterior Tenon capsule was picked up at an inferonasal point 7-10 mm from the limbus, midway between the insertions of the medial and inferior rectus muscles, and the sub-Tenon space was accessed using blunt Westcott scissors to create a thin channel to the posterior sub-Tenon space (fig. 1).

A blunt-tipped sub-Tenon cannula was then inserted into the posterior sub-Tenon space (fig. 2), and approximately 4 ml of local anesthetic was introduced (fig. 3). An intraocular pressure-lowering device (*e.g.*, a mercury weight) was applied for 5 min after performing the block. (Additional information regarding this is available in the Web Enhancement.)

During the transition to STB, retrobulbar blocks were performed in a traditional manner, using an inferotemporal approach with the eye fixed in the primary gaze. All intraocular procedures performed at Auckland Hospital are monitored by an anesthetist, and it is customary for most of the eye blocks to be performed by anesthesia personnel.

There were no specific patient exclusions in this study other than surgeon or patient preference for general anesthesia at the preoperative clinic visit. For each patient undergoing surgery during local anesthesia, an eye block data sheet was completed, which consisted of four sections: (1) the block technique and anesthetic agents

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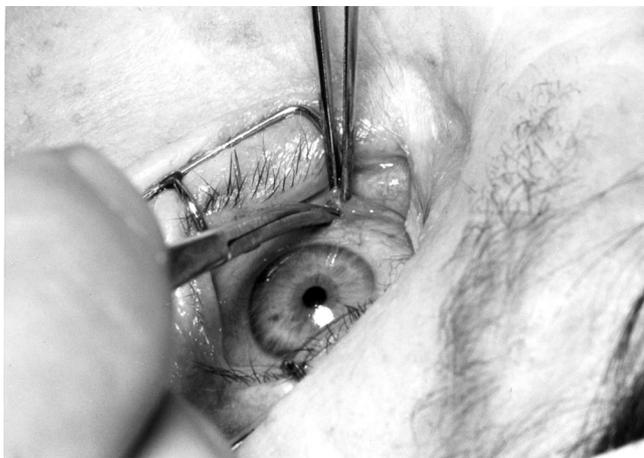


Fig. 1. Accessing the sub-Tenon space with blunt-tipped Westcott scissors.

employed, filled in by the anesthetist; (2) the block score, completed by the surgeon at the end of surgery; (3) the patient's assessment of the comfort and effectiveness of the block, completed by the PACU nurse; and (4) any perioperative complications that occurred during insertion or during the period of block onset or any events that were considered to be associated with the block.

The block score was calculated as described previously⁵ by the surgeon, who rated nine aspects, including the analgesia, akinesia, and operating conditions for the procedure, each on a 0 to 4-point scale. A total score of 0 indicated perfect operating conditions, and a maximum of 36 points corresponded to a totally ineffective block.

Although the study was not randomized or blinded, the assessments by the surgeon and patient or PACU nurse in the absence of the anesthetist were considered to provide a reasonable degree of objectivity. Data sheets were collected, and data were entered into a database for analysis.



Fig. 2. Passage of sub-Tenon cannula into the posterior sub-Tenon space.

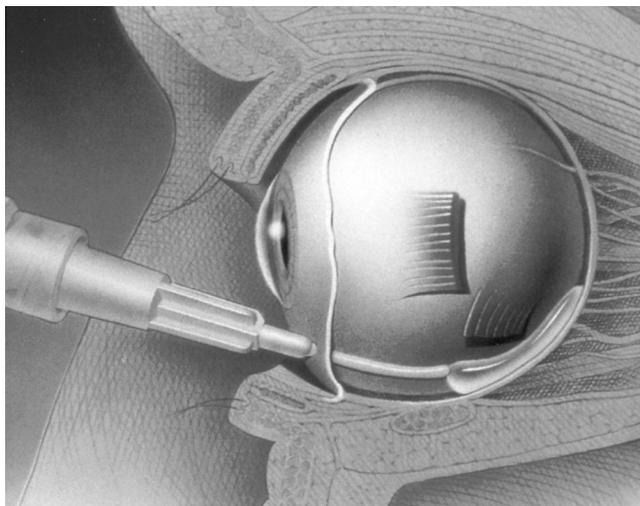


Fig. 3. Injection of local anesthetic into the posterior sub-Tenon space. Reprinted with permission from Alcon Laboratories, Fort Worth, Texas.

For the sake of clarity, the block score results as assessed by the surgeon were categorized such that 0 represented a perfect block; 1-5, a good block; 6-10, a fair block; and less than 10, a poor block, which correlates well with the clinical impression.

Perioperative events that were considered to be associated with performance of the block or occurring during the period of block onset (the first 15 min after insertion) were classified as either major events (procedure abandoned, block related; procedure abandoned, not block related; and cardiovascular event requiring treatment, procedure completed) or minor events.

Results

A total of 7,915 data sheets were collected from 1995 to 2000, yielding a total of 6,000 STB cases. Retrobulbar blocks were performed in the remaining 1,915 cases. From analysis of theater records, this corresponds to a 93% capture of all blocks performed during the study period. In the majority of cases, the operative procedure was cataract surgery, but a small percentage of glaucoma and vitreoretinal cases also were included.

The blocks were performed by 22 specialist anesthetists (4,175 blocks), 30 registrar anesthetists (1,751 blocks), and 5 surgeons (74 blocks). STBs were performed in 3,531 women and 2,469 men (female to male ratio, 1.4:1). Average patient age was 72 yr (range, 16-101 yr).

The local anesthetic agents used are shown in table 1, which consisted of a mixture of 2% lignocaine (Xylocaine; Astra Zeneca Ltd., Auckland, New Zealand) and 0.5% bupivacaine (Marcain; Astra Zeneca Ltd. Auckland, New Zealand) with 150 IU hyaluronidase (Hyalase; CP Pharmaceuticals, Wrexham, UK) in the majority of cases. The average injectate volume was 3.8 ml (range, 3-8 ml).

Table 1. Local Anesthetics Used

Agents	n
2% Lignocaine–0.5% bupivacaine–150 IU hyaluronidase	4,600
1% Ropivacaine–150 IU hyaluronidase	1,031
2% Lignocaine–150 IU hyaluronidase	361
Other (no hyaluronidase)	8

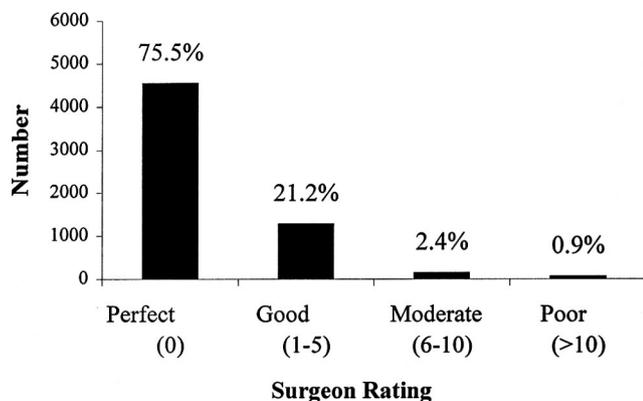
The distribution of block scores is shown in figure 4. Over 75% of the blocks were rated as perfect, and over 96% were rated as perfect or good by the surgeon. The requirements for anesthesia and analgesia in addition to a STB immediately prior to or during surgery are shown in table 2. The majority of these cases (4.1%) required an additional facial nerve block for persistent orbicularis tone. Most of these 246 facial nerve blocks were associated with a lower than average injectate volume. Only 18 facial blocks were performed in the 3,249 patients who received an injectate volume of 4 ml or more—an incidence of less than 0.6%.

A total of 456 (7.6%) patients received a sedative to allay their anxiety regarding the surgical procedure: 439 received midazolam (a maximum of 2 mg), and 17 received propofol (a maximum of 40 mg) intravenously. When questioned, more than 68% of the patients said that the insertion of the sub-Tenon cannula and administration of the anesthetic was painless. Only 7% of patients experienced more than mild discomfort (fig. 5).

Ninety-three percent of the patients had no pain during surgery, but 20% experienced some discomfort from the subconjunctival antibiotic at the end of the procedure. With regard to future anesthesia, 5,929 (98.8%) patients said that they would have the same block again if required, with 1.2% preferring to have a general anesthetic.

Major Events

Procedure Abandoned. Block Related. Surgery was abandoned in 1 of the 6,000 patients because of a large subconjunctival hemorrhage. However, this was

**Fig. 4.** Sub-Tenon block scores as assessed by surgeon.**Table 2. Additional Anesthesia Required**

	n	%
Facial nerve block	246	4.1
Amethocaine drops	157	2.6
Retrobulbar top-up	51	0.8

not sight threatening. The patient was not taking any anticoagulant medication, and the block was 1 of the 74 blocks performed by a surgeon.

Not Block Related. Six other patients had their procedures canceled for reasons not related to the block: five patients became uncooperative or had panic attacks, and one patient developed a supraventricular tachyarrhythmia with cardiovascular compromise.

Cardiovascular Event Requiring Treatment, Procedure Completed. Five patients were reported to have cardiovascular events that occurred during performance of the block or during its onset. These consisted of one episode each of rapid atrial fibrillation, bradycardia, ventricular ectopics, left ventricular failure, and angina. However, in these cases, surgery was completed after appropriate therapeutic intervention.

Minor Events

The minor events experienced by the patients in the study essentially consisted of subconjunctival hemorrhage, which was noted in 7% (421). In 6.3% of cases, the surgeon noted that there was a small subconjunctival hemorrhage that did not interfere with surgery (being confined to the inferonasal quadrant of the conjunctiva); the hemorrhage was rated as a slight interference in 0.6% and as a marked interference in 0.1%. A total of 337 patients (5.6%) were noted to have conjunctival edema, but it was considered to interfere significantly with surgery in only 4 (0.06%) patients.

In the last 2 yr of the study, a specific question relating to the intake of anticoagulants was added to the data sheet. This identified 103 patients who were taking aspirin and 33 who were taking warfarin, with a prothrombin ratio in the therapeutic range, at the time of surgery. In comparison to the overall percentages, there appears

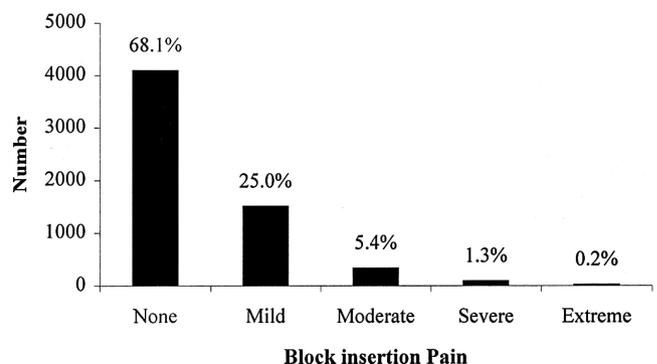
**Fig. 5.** Sub-Tenon block insertion pain.

Table 3. Incidence and Severity of Subconjunctival Hemorrhage with and without Anticoagulation

	Overall, %	Aspirin, % (n = 103)	Warfarin, % (n = 33)
Noticeable, no interference	6.3	17.4	15.1
Slight interference	0.6	3.8	0.0
Marked interference	0.1	0.0	0.0

to be an increase in the incidence of minor subconjunctival hemorrhage in patients taking aspirin and warfarin but no increase in major hemorrhages (table 3). No other minor complications were noted on the data sheet.

In contrast, of the 1,915 retrobulbar blocks performed during this study, 13 patients had their procedure abandoned due to block-related, sight-threatening complications: 10 retrobulbar hemorrhages, 2 scleral perforations, and 1 brainstem anesthetic (table 4).

Discussion

Complications resulting from sharp needle anesthetic techniques are uncommon but, when they do occur, can be catastrophic. Perforating ocular injuries caused by the use of sharp needle techniques are well documented in the literature,¹⁻³ with a frequency that varies, ranging from 1.1 in 1,000⁸ to 1 in 16,000 procedures.⁹ However, the risk of scleral perforation increases dramatically with increasing axial length and has been reported by Duker *et al.*² to be as high as 1 in 140 procedures if the axial length is greater than 26 mm. The presence of a posterior staphyloma, which has been reported to have a prevalence of 10.7% in cataract patients by Edge *et al.*,¹⁰ also increases the risk of scleral perforation to approximately 1 in 760 procedures.

Because of the association between axially myopic eyes and staphyloma, there is some debate as to whether myopia in the absence of staphyloma is a risk factor *per se*. Ripart¹¹ states that the aforementioned study by Edge *et al.*¹⁰ concludes that myopia without staphyloma is not a risk factor for inadvertent perforation. However, Vohra and Good¹² believe that axial myopia increases the risk of perforation, and that this risk is further increased in the presence of a coexisting staphyloma.

The majority of staphylomas appear to be located inferior to the posterior pole of the globe,¹³ and, therefore, the medial canthal approach may pose a lower risk of

scleral perforation than the traditional inferotemporal approach.^{11,13,14} However, I believe that a technique that entirely avoids the passage of sharp needles into the orbit provides the lowest risk of scleral perforation, especially when the block is performed by operators with a variable level of experience, as is the case at Auckland Hospital.

In this study, 4.1% of patients received an additional facial nerve block for persistent orbicularis tone. The majority of these supplemental injections occurred in the early stages of the study, as other anesthetists were learning the technique, and lower injectate volumes were used in an attempt to prevent chemosis and to minimize volume effects in the orbit. Spread of local anesthetic into the eyelids to produce an orbicularis block appears to be volume dependent, with a higher injectate volume being associated with a lower incidence of supplementary facial block. In this study, the frequency of facial nerve block was only 0.6% in patients with an injectate volume greater than 4 ml. In other sub-Tenon studies that used an average injectate volume of 10 ml, the investigators reported a very low incidence of persistent orbicularis tone.¹⁴

There is a case report of scleral perforation following a STB in a patient who had undergone previous vitreoretinal surgery.¹⁵ Contributory factors were considered to be compromised sclera from previous surgery, scar tissue necessitating a cutting action by the surgeon with scissors, and the use of sharp-tipped Westcott scissors. The technique taught at Auckland Hospital uses blunt-tipped Westcott scissors and, apart from the initial snip to the conjunctiva and Tenon layer, involves only blunt dissection with the tips closed, avoiding a cutting action. In my experience, it is possible to successfully perform STB in patients with previous vitreoretinal surgery without having to actively cut through scar tissue.

Retrobulbar hemorrhage, which was not related to vortex vein rupture and was thought to be due to the infusion of fluid behind the orbit displacing and rupturing a sclerotic blood vessel, following a STB has also been reported.¹⁶ This appears to be an isolated report.

Topical anesthesia is an alternative way of avoiding sharp needles in the orbit but does not appear to provide as good analgesia as STB.^{17,18} For example, Zafirakis *et al.*¹⁷ found that 86% of STB patients had no pain or only

Table 4. Change in Block Type with Time at Auckland Hospital and Associated Sight-threatening Complications

	1995	1996	1997	1998	1999
RBB performed, n	1,195	513	110	46	51
RBB complications, n	9	3	0	1	0
RBB complications, %	0.75	0.58	0	1.6	0
Sub-Tenon block performed, n	101	592	891	1,450	1,463
Sub-Tenon complications	0	0	0	0	0

RBB = retrobulbar block.

slight discomfort during surgery compared with only 72% of patients in the topical anesthesia group.

In the Auckland Hospital series, the complication profile for STB compares very favorably to that of other block techniques, particularly with regard to the absence of sight-threatening complications. In this series, only 1 in 6,000 patients had the surgery canceled due to a block-related complication, and the complication was not sight threatening. Other significant events occurring around the time of block insertion appear to be related to the patient's preexisting medical conditions rather than to the block itself. Minor events included subconjunctival hemorrhage and chemosis, which were essentially cosmetic and were not detrimental to patient outcome.

Patients taking anticoagulants appear to have a higher incidence of minor subconjunctival hemorrhage with no increase in major complications, which supports the use of STB in these patients. This study also supports the policy of continuing anticoagulant medications prior to cataract surgery performed during STB since the complications of stopping anticoagulation far outweigh those seen here.¹⁹

At Auckland Hospital prior to 1994, virtually all local blocks performed were retrobulbar. This technique was associated with a 1% incidence of sight-threatening complications. Over the course of this study, the block technique changed from retrobulbar to virtually all STB. This was associated with a marked decrease in local anesthesia-associated, sight-threatening complications, giving further support to the premise that STB has a lower potential for serious complications than traditional sharp needle techniques. However, a much larger series than this would be required to statistically show that perforating ocular injuries are less common with STB.

For the purposes of this study, only the events that were considered to be caused by or related in time to the STB were included. Other events that required intervention by the anesthetist but were not considered to be block related were not included. Hence, the low number of adverse events described here indicates the safety of the STB rather than that of the surgical procedure itself.

The properties of an ideal eye block technique include globe analgesia, akinesia, absence of pain during performance, absence of external pressure on the globe, minimal injectate volume, and absence of serious complications. This study confirms that STB is highly effective and

has shown no sight-threatening complications in a large, prospective review, even when performed by operators with a variable range of experience. Because the technique uses blunt dissection along tissue planes and avoids sharp needles, it is of particular value in patients with long axial length or posterior staphylomas and in those taking anticoagulants. STB closely approaches the ideal eye block, and this study provides further support to the view that this technique poses a very low risk for injury to the globe.

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