

## Techniques of orbital regional anaesthesia

R. C. HAMILTON

Knowledge of the basic science disciplines (pharmacology of the ocular and local anaesthetic drugs, physiology of the eye, anatomy of the orbit and its contents) is essential for safe practice of orbital regional anaesthesia [10]. Observation of, and subsequent initial supervision by, personnel with wide clinical experience and knowledge is recommended. The goal for each practitioner is to build up an experiential database from which increasingly good judgement can result.

The anaesthetist should have a good understanding of the operating ophthalmologist's preferred conditions for surgery. Anaesthesia requirements are dictated by the type and operative technique of the proposed surgery, the surgeon's particular preferences and the wishes of the patient.

### Current techniques

The requirements for intraocular surgery using regional anaesthesia, as established in the 1950s and 1960s are threefold: globe and conjunctival anaesthesia; globe, lid and periorbital akinesia; and intraocular hypotonia. Desirable operating conditions are attainable safely using relatively large volumes of hyaluronidase-containing local anaesthetics injected appropriately within the orbit. Mechanical orbital decompression devices are used frequently for efficient production of globe hypotonia [3, 6].

#### APPLIED ANATOMY

A matrix of connective tissues, which supports and allows dynamic function of the orbital contents, also controls the mode of injectate spread [17]. Globe and conjunctival anaesthesia (conduction block of the intraorbital sensory divisions of the ophthalmic branch of the trigeminal nerve) are achieved more easily than globe akinesia (conduction block of intraorbital portions of the oculomotor cranial nerves III, IV and VI).

The oculomotor nerves enter the muscle bellies of the four rectus muscles from their conal surface,

1.0–1.5 cm from the apex of the orbit. Local anaesthetics, in blocking concentrations, have to reach an exposed 5–10-mm segment of these motor nerves in the posterior intracone space for conduction block of those nerves and akinesia of their supplied muscles to occur. Retained activity of the superior oblique muscle is frequently seen after intraconal local anaesthetic injection because its motor nerve, the trochlear, runs an extraconal course. There is insufficient space between the lateral rectus muscle and adjacent lateral orbit wall, and between the inferior rectus muscle and adjacent orbit floor, to consider placing injectate in either location without risking injury to the respective muscles.

Corneal and perilimbal conjunctival sensation is mediated via the nasociliary nerve which lies within the cone of muscles; intracone blocks therefore produce anaesthesia of the cornea and the conjunctiva immediately surrounding it. However, the sensation of the peripheral conjunctiva is supplied through the lacrimal, frontal and infraorbital nerves coursing outside the muscle cone [2]; intraoperative pain may be experienced in this area after a solely intracone block [11].

#### Globe position

The traditional teaching of having patients look "up and in" during retrobulbar block needle placement [1] has been superseded by instruction to direct their eyes in primary gaze [14, 19, 25, 36]. With the globe in primary gaze the optic nerve assumes a much safer location, totally on the medial side of the mid-sagittal plane (fig. 1).

#### Site and depth of injection

Relatively avascular areas suitable for injection are the anterior half of the orbit in the inferotemporal quadrant, and the compartment on the nasal side of the medial rectus muscle; needles must never be inserted deeply to the orbital apex.

#### ANAESTHESIA MIXTURE

Any of the full potency local anaesthetics may be used, the eventual choice depending on availability, patient age and desired duration of effect. Concen-

---

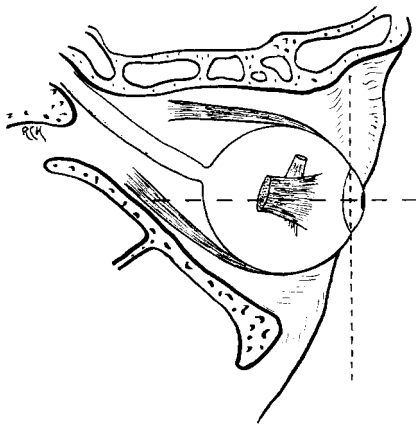
(*Br. J. Anaesth.* 1995; 75: 88–92)

#### Key words

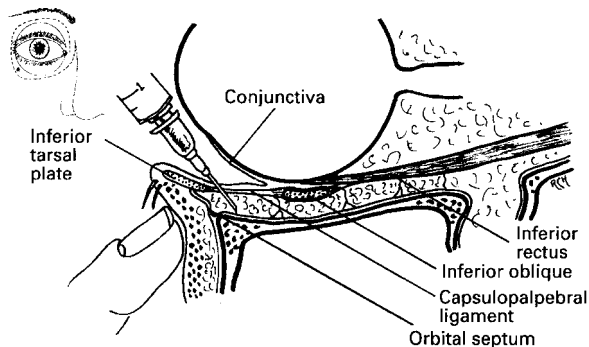
Surgery, ophthalmological. Anaesthetic techniques, regional.

---

ROBERT C. HAMILTON, MB, BCH, FRCPC, Gimbel Eye Centre, 4935 Fortieth Avenue NW, Calgary T3A 2N1, Alberta, Canada.



*Figure 1* Plane of the iris, mid-sagittal plane of the globe. View from above. Globe in primary gaze. Fine broken line indicates the plane of the iris (useful in gauging depth of needle advancement); coarse broken line indicates the mid-sagittal plane of the eye and the visual axis through the centre of the pupil. The optic nerve lies on the nasal side of the mid-sagittal plane of the eye (with permission from Gimbel Educational Services).



*Figure 2* Injection of "painless local" in inferotemporal quadrant. View from lateral side. After gently retracting the lower eyelid with a finger, the tip of a 30-gauge, 12-mm needle enters transconjunctivally and inferotemporally just posterior to the inferior tarsal plate with the shaft of the needle arranged tangentially to the globe. Following test aspiration, the initial injection is of 1.0 ml "painless local" to a depth of 1 cm from the conjunctiva. The needle has easily and painlessly (because of preliminary topical anaesthesia drops) penetrated the conjunctiva, and deep to it the capsulopalpebral fascia. The needle entry point is at the lower end of the lateral orbit rim (small insert). Landmarks for transcutaneous injection of "painless local" are the same, but without lower eyelid retraction. The needle in this case passes inferior to the inferior tarsal plate but otherwise follows an identical path with its shaft tangential to the globe and directed towards the orbit floor (with permission from Gimbel Educational Services).

trations up to but not exceeding 2% lignocaine (or agent of equivalent potency) are appropriate. Adrenaline is used commonly for prolongation of block duration and to increase the extent of block, but may be contraindicated if orbital vascular pathology is present; a concentration of 1:200 000, given the volume of injectate used in ophthalmic regional anaesthesia, is devoid of systemic effects [30]. More effective anaesthesia results from the higher pH of freshly prepared adrenaline admixtures, compared with commercially available adrenaline-containing mixtures [22]. Hyaluronidase is a desirable component for promotion of spread within the orbit and for hypotonia [24].

### *Differences between younger and older adult patients*

Younger adult patients present more of a challenge in achieving total akinesia than the elderly [23] because of more dense connective tissues hindering access of anaesthetics to the oculomotor nerves.

### NEEDLE TYPE AND SYRINGE SIZE

Traditional teaching favoured blunt-tipped, intermediate-gauge needles with the supposed advantages that blood vessels were pushed aside rather than traumatized and that tissue planes could be more accurately defined. Although a commonly held belief among ophthalmologists [16], it is not true that it is more difficult to penetrate the globe, the optic nerve sheath or blood vessels with a blunt needle [10]. Larger blunt needles compared with fine disposable ones cause more serious damage if the globe is penetrated [10]. Because disposable cutting needles produce minimal tissue distortion, little or no pain results. Tactile discrimination is progressively reduced with increasing needle size [9]. Special attention should be paid to the length of needle entering beyond the orbital rim; 31 mm as measured from the orbit rim should never be exceeded in order to exclude optic nerve impalement [15]. All needles used for intracone or pericone placement should be orientated tangentially to the globe with the bevel opening faced towards the globe [11].

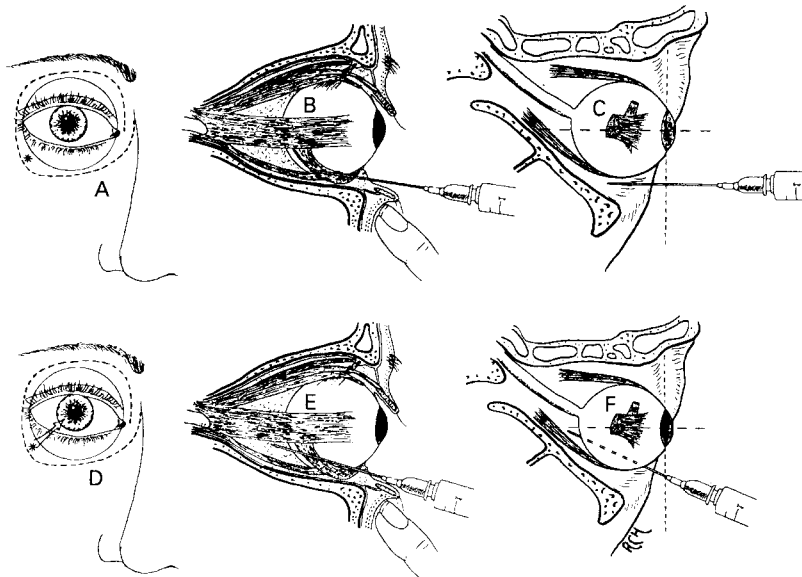
Because less force has to be exerted, a change in resistance to injectate flow is detected more easily by the injecting hand when using a needle mounted on a smaller syringe compared with a larger size. This ability to detect more easily changes in resistance to injection is important in the avoidance of complications.

### TRANSCUTANEOUS SEVENTH NERVE BLOCK

Various methods of seventh nerve conduction block were in common use in earlier decades; local anaesthetics were deposited at some point along the distribution of the nerve from its emergence from the base of the skull at the stylomastoid foramen to its terminal branches on the deep surface of the orbicularis oculi muscle. However, when hyaluronidase is mixed with local anaesthetic, injected into the orbit in higher volume and used in combination with orbital decompression devices, effective spread from the orbit through the orbital septum occurs to produce eyelid akinesia [21], without resorting to painful percutaneous seventh nerve blocking techniques.

### PREBLOCK INSPECTION OF THE GLOBE AND EYELIDS

Most, but not all, inferotemporal injections may be made with transconjunctival entry. If on digital retraction of the patient's lower eyelid in a downward and outward direction the eyelid margin is found to be tightly held against the globe, if the globe is deeply recessed within the orbit, if there is a wide



*Figure 3* Inferotemporal intracone block. A, D = Views from in front; B, E = views from lateral side; C, F = views from above (27-gauge, 31-mm sharp disposable needle). The figure illustrates the transconjunctival approach but is equally applicable to transcutaneous injection (if the transcutaneous route were used the lower lid would not be retracted and needle tip entry would be inferior to the tarsal plate). The globe is in primary gaze. The needle tip enters at the lower temporal orbit rim, slightly up from the orbit floor (A) and very close to the bone. The needle track passes initially backwards in the sagittal plane (C) and parallel to the orbit floor, that is with a  $10^\circ$  elevation from the transverse plane (B, C). (If the needle were advanced further in the sagittal plane, contact with the lateral wall of the orbit would occur.) Following this the needle is directed with medial and slightly upward components (D) aiming for an imaginary point behind the globe on the axis formed by the pupil and the macula, so that the needle tip approaches but does not pass the mid-sagittal plane of the globe (F). The needle enters the intracone space by passing through the intermuscular septum just inferior to the lower border of the lateral rectus muscle (E). The globe is observed continuously during needle placement to detect globe rotation that would indicate engagement of the sclera by the needle tip. During needle placement, continuing observation of the relationship between the needle/hub junction and the plane of the iris establishes an appropriate depth of orbit insertion (E, F). In a globe with normal axial length, as illustrated here, when the needle/hub junction has reached the plane of the iris, the tip of the needle lies 5–7 mm beyond the hind surface of the globe (E, F). After test aspiration, up to 4 ml of anaesthetic solution injected very slowly (with permission from Gimbel Educational Services).

lateral canthal fold, or if the patient is blinking uncontrollably, a transcutaneous approach is often the safest choice. In all cases the axial length measurement of the globe is carefully noted; in the presence of high myopia, pericone, as opposed to intracone, placement or even general anaesthesia may be more prudent.

#### “PAINLESS LOCAL”

A solution made up by adding 1.5 ml of any full-strength local anaesthetic to a 15-ml plastic bottle of balanced salt solution (available for intraocular use in ophthalmologists' offices) [5] produces a virtually pain-free initial injection (fig. 2).

#### INTRACONE (RETROBULBAR) BLOCK

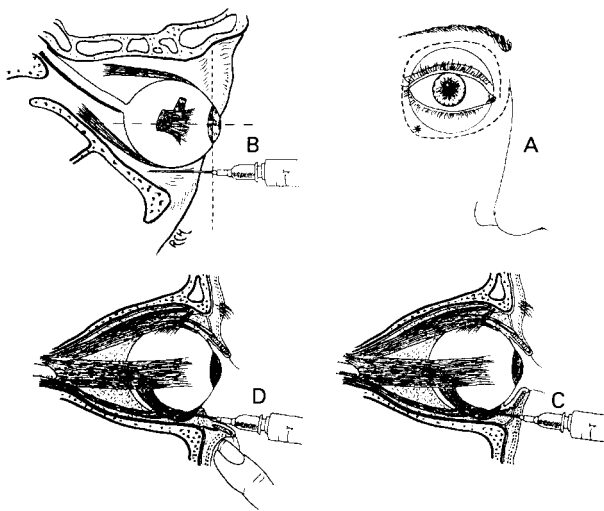
Although there is commonality between the fat compartments within and outside the geometric confines of the cone of the rectus muscles, injectate placed in mid-orbit intraconally compared with periconally is more effective in producing globe akinesia. Precision placement is the key to avoidance of complications (fig. 3).

#### PERICONE (PERIBULBAR, PERIOCCULAR) BLOCKS

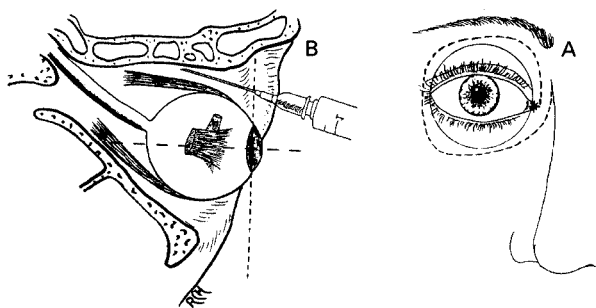
Although injectate deposited within the orbit but not entering within the geometric confines of the cone of the rectus muscles was introduced as being safer than intraconal blocking for avoidance of serious complications [4], nevertheless problems have been reported. Knowledge of orbital anatomy is as important as with intracone techniques.

A failure rate to achieve akinesia with periconal blocking of up to 50% has been reported [20]. There are many variations of the pericone technique, a common one being placement in two locations, one in the inferotemporal quadrant (fig. 4) and one in the superonasal quadrant. A preferable alternative to the latter site of injection is the fat compartment on the nasal side of the medial rectus muscle (fig. 5) [13]. Access of local anaesthetics to the motor nerve supply of the superior oblique muscle and, by spread through the orbital septum, of the orbicularis muscle, are promoted [28]. Additionally enhanced peripheral conjunctival anaesthesia eliminates intraoperative discomfort, sometimes encountered in low volume solely intracone techniques [11].

The routine combination of inferotemporal intracone injection with complementary pericone



**Figure 4** Inferotemporal pericone injection. A = View from in front; B = view from above; C = view from lateral side (transcutaneous injection); D = view from lateral side (transconjunctival injection). The globe is in primary gaze. A 27-gauge, 20–25 mm sharp disposable needle enters the orbit at the junction of its floor with the lateral wall (A) and very close to the bony rim. The needle passes backwards in a sagittal plane (B) and parallel to the orbit floor (C, D), passing the globe equator to a depth controlled by observing the needle/hub junction reach the plane of the iris (B). After test aspiration, up to 10 ml of anaesthetic solution may be injected slowly (single needle technique) or up to 5 ml (if combined with complementary pericone block). The technique is equally applicable to the transcutaneous (C) or transconjunctival (D) route (with permission from Gimbel Educational Services).



**Figure 5** Medial pericone injection. A = View from the front; B = view from above. The globe is in primary gaze. A 27-gauge, 20–25 mm sharp disposable needle enters transconjunctivally on the medial side of the caruncle at the extreme medial side of the palpebral fissure (A). With the bevel facing the orbit wall, it passes backward *in the transverse plane*, directed at a 5° angle away from the sagittal plane and towards the medial orbit wall (B). Depth of insertion is controlled by observing the needle/hub junction reach the plane of the iris (B). If the medial wall of the orbit is contacted, the tip is slightly withdrawn and needle redirected. After test aspiration, up to 5 ml of anaesthetic solution is injected very slowly (with permission from Gimbel Educational Services).

injection (medial compartment block recommended) produces globe anaesthesia/akinesia, intraoperative patient comfort and eyelid akinesia better than other techniques [11, 20].

### Recent innovations

Reports of rare but serious complications of intraconal anaesthesia stimulated separate editorials in 1988 in the United Kingdom and USA [18, 31] which introduced the concept of non-akinetic

methods of regional anaesthesia for cataract extraction surgery. The techniques published subsequently fall into three groups: subconjunctival (perilimbal); injection of local anaesthetic by needle or cannula within Tenon's capsule; and solely topical corneconjunctival anaesthesia.

#### SUBCONJUNCTIVAL (PERILIMBAL) INJECTION OF LOCAL ANAESTHETICS

Articles published in 1990 and 1991 [26, 27, 32] advocated subconjunctival injection of local anaesthetics in small volume near the superior limbus mainly for anterior segment surgery.

#### SUB-TENON'S BLOCK

Needle injection into sub-Tenon's space produces better iris and anterior segment anaesthesia than subconjunctival injection [34]. The technique has been used extensively since 1990 [35]. More recently it evolved into anaesthesia produced by blunt cannula insertion after surgical dissection into the sub-Tenon's space [33]. The degree of abolition of extraocular muscle movement is proportional to the volume and depth of injectate.

#### CATARACT EXTRACTION AND INTRAOCULAR LENS IMPLANTATION UNDER SOLELY TOPICAL CORNEOCONJUNCTIVAL ANAESTHESIA

The most recent step in the evolution of regional anaesthesia for cataract extraction has been the re-introduction [12] of a technique previously used in the last century and the first decade of the 20th century [29]. Exclusion of some patients (dementia, deafness, language barrier) is important as there must be continuous dialogue between the surgeon and the patient throughout operation. Patients with dense or trauma-induced cataracts, those with small pupils which fail to dilate and those with macular degeneration, are best managed with other forms of anaesthesia.

Surgeons experienced in the technique of intercapsular phacoemulsification with the appropriate personal psychological traits with good communication skills and the willingness to talk to their patients through the process are most suited to the method. The author finds that patients undergoing cataract surgery under topical anaesthesia require more psychological preparation and more frequent anxiolytic premedication than patients, having anaesthetic blocks. The most useful topical agents are 4% lignocaine [8] and 0.75% bupivacaine [7]. The iris and ciliary muscle retain their sensitivity, especially in the young and anxious patient [8].

### References

1. Atkinson WS. Local anaesthesia in ophthalmology. *Transactions of the American Ophthalmological Society* 1934; 32: 399–451.
2. Atkinson WS. Local anaesthesia in ophthalmology. *American Journal of Ophthalmology* 1948; 31: 1607–1618.
3. Davidson B, Kratz R, Mazzocco T. An evaluation of the Honan intraocular pressure reducer. *American Intra-ocular Implant Society Journal* 1979; 5: 237–238.

4. Davis DB, Mandel MR. Posterior peribulbar anesthesia: an alternative to retrobulbar anesthesia. *Journal of Cataract and Refractive Surgery* 1986; **12**: 182–184.
5. Farley JS, Husted RF, Becker KE. Diluting lidocaine and mepivacaine in balanced salt solution reduces the pain of intradermal injection. *Regional Anesthesia* 1994; **19**: 48–51.
6. Gills JP. Constant mild compression of the eye to produce hypotension. *American Intra-ocular Implant Society Journal* 1979; **5**: 52–53.
7. Gills JP, Williams DL. Advantage of Marcaine for topical anesthesia. *Journal of Cataract and Refractive Surgery* 1993; **19**: 819.
8. Grabow HB. Topical anaesthesia for cataract surgery. *European Journal of Implant and Refractive Surgery* 1993; **5**: 20–24.
9. Grizzard WS. Ophthalmic anesthesia. In: Reinecke RD, ed. *Ophthalmology Annual*. New York: Raven Press, 1989; 265–294.
10. Grizzard WS, Kirk NM, Pavan PR, Antworth MV, Hammer ME, Roseman RL. Perforating ocular injuries caused by anesthesia personnel. *Ophthalmology* 1991; **98**: 1011–1016.
11. Hamilton RC, Gimbel HV, Strumin L. Regional anaesthesia for 12,000 cataract extraction and intraocular lens implantation procedures. *Canadian Journal of Anaesthesia* 1988; **35**: 615–623.
12. Harr D. Topical eyedrops replace injection for anesthesia. *Ocular Surgery News* 1991; **10**: 1, 20.
13. Husted RF, Hamilton RC, Loken RG. Periocular local anesthesia: medial orbital as an alternative to superior nasal injection. *Journal of Cataract and Refractive Surgery* 1994; **20**: 197–201.
14. Javitt JC, Addiego R, Friedberg HL, Libonati MM, Leahy JJ. Brain stem anesthesia after retrobulbar block. *Ophthalmology* 1987; **94**: 718–723.
15. Katsev DA, Drews RC, Rose BT. An anatomic study of retrobulbar needle path length. *Ophthalmology* 1989; **96**: 1221–1224.
16. Kimble JA, Morris RE, Witherspoon CD, Feist RM. Globe perforation from peribulbar injection. *Archives of Ophthalmology* 1987; **105**: 749.
17. Koornneef L. Orbital septa: Anatomy and function. *Ophthalmology* 1979; **86**: 876–880.
18. Lichter PR. Avoiding complications from local anesthesia. *Ophthalmology* 1988; **95**: 565–566.
19. Liu C, Youl B, Moseley I. Magnetic resonance imaging of the optic nerve in extremes of gaze. Implications for the positioning of the globe for retrobulbar anaesthesia. *British Journal of Ophthalmology* 1992; **76**: 728–733.
20. Loots JH, Koorts AS, Venter JA. Peribulbar anesthesia. A prospective statistical analysis of the efficacy and predictability of bupivacaine and a lignocaine/bupivacaine mixture. *Journal of Cataract and Refractive Surgery* 1993; **19**: 72–76.
21. Martin SR, Baker SS, Muenzler WS. Retrobulbar anesthesia and orbicularis akinesia. *Ophthalmic Surgery* 1986; **17**: 232–233.
22. Moore DC. The pH of local anesthetic solutions. *Anesthesia and Analgesia* 1981; **60**: 833–834.
23. Morsman CD, Holden R. The effects of adrenaline, hyaluronidase and age on peribulbar anaesthesia. *Eye* 1992; **6**: 290–292.
24. Nicoll JMV, Treuren B, Acharya PA, Ahlen K, James M. Retrobulbar anesthesia: the role of hyaluronidase. *Anesthesia and Analgesia* 1986; **65**: 1324–1328.
25. Pautler SE, Grizzard WS, Thompson LN, Wing GL. Blindness from retrobulbar injection into the optic nerve. *Ophthalmic Surgery* 1986; **17**: 334–337.
26. Petersen WC, Yanoff M. Subconjunctival anesthesia: an alternative to retrobulbar and peribulbar techniques. *Ophthalmic Surgery* 1991; **22**: 199–201.
27. Redmond RM, Dallas NL. Extracapsular cataract extraction under local anaesthesia without retrobulbar anaesthesia. *British Journal of Ophthalmology* 1990; **74**: 203–204.
28. Ropo A. Orbicular muscle akinesia: a comparison, using electromyography, of three techniques. *Ophthalmic Surgery* 1992; **23**: 414–417.
29. Rosen E. Editorial review: Anaesthesia for cataract surgery. *European Journal of Implant and Refractive Surgery* 1993; **5**: 1–3.
30. Sarvela J, Nikki P, Paloheimo M. Orbicular muscle akinesia in regional ophthalmic anaesthesia with pH-adjusted bupivacaine: effects of hyaluronidase and epinephrine. *Canadian Journal of Anaesthesia* 1993; **40**: 1028–1033.
31. Smith RJH. Why retrobulbar anaesthesia. *British Journal of Ophthalmology* 1988; **72**: 1.
32. Smith RJH. Cataract extraction without retrobulbar anaesthetic injection. *British Journal of Ophthalmology* 1990; **74**: 205–207.
33. Stevens JD. A new local anaesthesia technique for cataract extraction by one quadrant sub-Tenon's infiltration. *British Journal of Ophthalmology* 1992; **76**: 670–674.
34. Swan KC. New drugs and techniques for ocular anesthesia. *Transactions of the American Academy of Ophthalmology and Otolaryngology* 1956; **60**: 368–375.
35. Tsuneoka H, Ohki K, Taniuchi O, Kitahara K. Tenon's capsule anaesthesia for cataract surgery with IOL implantation. *European Journal of Implant and Refractive Surgery* 1993; **5**: 29–34.
36. Unsöld R, Stanley JA, DeGroot J. The CT-topography of retrobulbar anesthesia. *Albrecht von Graefes Archiv für Klinische und Experimentelle Ophthalmologie* 1981; **217**: 125–136.