Update on Regional Anaesthesia in Intraocular Surgery

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Update on Regional Anaesthesia in Intraocular Surgery

Regionalanästhesie bei intraokularen Eingriffen

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Schlüsselwörter
- Retrobulbär-Anästhesie
- Peribulär-Anästhesie
- Sicherheit
- fibrinolytisch wirksame Medikamente/Fibrinolytika
- Thrombozyten-Aggregationshemmer
- Methoden zur Nervenblockade

Key words
- retrobulbar anesthesia
- peribulbar anaesthesia
- safety
- fibrinolytic agents
- thrombocyte aggregation inhibitors
- nerve block methods

Zusammenfassung

Hintergrund: Die Retrobulbäranästhesie ist eine wertvolle Alternative zur Allgemeinanästhesie nicht nur für polymorbide Patienten. Komplikationen sind selten, aber wenn, dann schwer.
Methoden: Grundsätzlich kann jeder intraokulare Eingriff in Retrobulbäranästhesie durchgeführt werden. Zu den wenigen Kontraindikationen gehören die Ablehnung der Patienten, Allergie gegen Lokalanästhetika, lokale Infektionen, Atemnot und nicht sicher kontrollierte psychiatrische Erkrankungen sowie Operationen bei kleinen Kindern und nicht kooperativen Patienten.
Ergebnisse: Die Erfolgsrate von Retrobulbäranästhesien bezüglich intraoperativer Beschwerdefreiheit liegt bei annähernd 100%. Eine intrakonale Injektion ist bei korrekter Technik in 94% und eine Verteilung der Anästhetica in den intrakonalen Raum in 97% zu erreichen.
Schlussfolgerung: Basierend auf der verfügbaren jüngeren Literatur vergleicht die vorliegende Übersicht die verschiedenen Techniken der periokulären Anästhesie, stellt mögliche Komplikationen und bei Fehlen evidenzbasierter Studien Vorschläge zum Umgang mit Patienten unter Thrombozytenaggregationshemmer-Therapie, Vitamin-K-Antagonisten und Antikoagulation vor.

Abstract

Background: Retrobulbar anaesthesia is a valuable alternative not only for polymorbid and haemodynamically compromised patients. Complications are rare but may be devastating.
Methods: Principally, any intraocular surgery can be made under local anaesthesia. There are only a few contraindications to regional anaesthesia such as denial against regional anaesthesia, allergy to local anaesthetics, local infection, severe orthopnea, insufficiently controlled psychiatric disorders or small children and non-cooperative patients.
Results: The success rate of retrobulbar anaesthesia in terms of control of intraoperative discomfort approaches 100% with an intraconal injection in 94% and a distribution of fluid into the intraconal space in 97%.
Conclusion: Based on the recent literature, the present review compares techniques, describes possible complications and in the absence of evidence-based studies provides suggestions for the handling of patients under thrombocyte aggregation inhibitor and vitamin K antagonist therapy and anticoagulation.

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Introduction

In intraocular surgery, anesthesia can be ensured either by local, regional or general anesthesia. Regional anesthesia is a valuable alternative not only for polymorbid and haemodynamically compromised patients, and used depending on surgical preference. Each technique has its own pros and cons (**Table 1**).
Retrobulbar blockade is the most frequently applied technique of regional anesthesia for ophthalmologic interventions. This technique was first performed in 1884 by Hermann Knapp [1]. He utilized 4% cocaine solution and achieved adequate anesthesia for enucleation. Subsequent injections even of small volumes of cocaine were observed to result in a fatal outcome. Until procaine, a safer injectable anesthetic that was discovered in 1930, the use of retrobulbar anesthesia decreased temporarily [2]. Atkinson popularized needle-based retrobulbar anesthesia in the 20th century [3,4]. In recent years, it has mainly been performed blindly by experienced ophthalmic surgeons or anesthesiologists. Complications are

Table 1 Advantages and disadvantages in anesthesia procedures for ophthalmic surgery.

Anesthesia	Advantage	Disadvantage
Topical	▸ No damage from needle ▸ No chemosis/hemorrhage ▸ No postoperative diplopia or ptosis	▸ No akinesia ▸ Possible distraction for surgeon if patient talks/is nervous ▸ Insufficient anesthesia if surgery lasts longer/complications happen ▸ Allergy of the epithelia against the drops
Retrobulbar	▸ Excellent anesthesia ▸ Excellent akinesia ▸ Fast effect ▸ Rarely chemosis	▸ Transitory visual loss ▸ Muscle damage (M. rectus inferior paralysis) ▸ Optic nerve damage (scotoma) ▸ Hemorrhage ▸ Globe perforation
Peribulbar	▸ Good anesthesia ▸ Good akinesia	▸ Same as retrobulbar with a lower risk ▸ Slow effect (30 min) ▸ Chemosis in 80 %
▸ Sub-tenon	▸ Less painful than retrobulbar block ▸ No severe complications ▸ Fast effect ▸ 60 min anesthesia	▸ Often chemosis and hyposphagma ▸ Akinesia less reliable (56–95 %)
▸ General	▸ Good for long operations ▸ Good for nervous patients ▸ Bilateral surgery possible ▸ Teaching situations ▸ No injections into the eye needed	▸ Costs ▸ Systemic stress

rare but may be devastating, such as central nervous complications or globe perforations [5].

Indications and Contraindications

The wide majority of intraocular (cataract and glaucoma surgery, vitreoretinal surgery) as well as extraocular procedures can be performed in regional anesthesia in most patients. There are only a few contraindications to regional anesthesia such as denial against regional anesthesia, allergy to local anesthetics, local infection, strong orthopnea (patient won't be able to lie during complete surgery), insufficiently controlled psychiatric disorders and unability to cooperate as well as intraocular sugery in small children. For these patients general anesthesia has to be considered as a valuable alternative.

Intraocular pressure and regional anesthesia

After regional anesthesia the intraocular pressure is increased depending on the volume of local anesthetic injected [6], which may be relevant for the choice of the anesthetic procedure. For this reason, regional anesthesia is considered for open globe surgery as in penetrating keratoplasty.

Platelet inhibitors or oral anticoagulants

Anticoagulants are frequently used for antithrombotic treatment in patients after arterial or arteriovenous thromboembolic events. Hemorrhagic risk has to be balanced against the thromboembolic risk in each patient, considering the options of transitory interruption with or without heparine bridging or continuing the treatment [7]. Anesthesiologists as well as ophthalmic surgeons working in the field of ophthalmology should collaborate with colleagues from cardiology to minimize risk to their patients in these cases [7,8].

A recent study carried out by the department of anesthesiology in Rouen, France postulated that discontinuation of oral anticoagulants was not necessary when peribulbar anesthesia was performed in vitroretinal surgery [7]. However, in a study for cataract surgery clopidogrel was associated with a higher risk of subconjunctival hemorrhage in comparison to the warfarin and aspirin groups when using Sub-Tenon anesthesia [9].

Narendran and Williamson [10] analyzed seven patients who underwent vitreoretinal surgery while receiving warfarin therapy. They concluded that warfarin anticoagulation was associated with an increased risk of bleeding complications and should be stopped if the patient's thromboembolic risk was low. They outlined 60 patients treated with aspirin and found little effect on bleeding during posterior segment surgery. They concluded that aspirin should not be stopped before surgery [10]. However different opinions can be found in the actual literature. Each patient should be considered individually to determine which anesthetic procedure is appropriate and whether medication should be changed before intervention.

The risk of thrombosis-related complications on disruption of anticoagulation may be higher than the risk of significant bleeding by continuing its use for most types of ophthalmic surgery [11, 12].

Recent ophthalmosurgical trends indicate that combination therapies targeting different coagulation mechanisms may have their unpredictabilities so that one of the combination drugs should be stopped in due time prior to surgery. Vitamin K antagonist therapy and new oral anticoagulants should be stopped 24 hours prior to surgers [13,14]. After our personal experience over longer time and many surgeries cumarins must – in contrast to broadly applied practice – not be stopped but it may be wise to test blood coagulation immediately prior to surgery to estimate the inheritent risk. In the absence of evidence, the international normalized ratio (INR) would ideally be below 2.5 (INR ≤ 2.5) for retrobulbar injection, if not, sub-tenon or parabulbar anesthesia might be considered as the probably safer methods in order to escape the risk of a potentially blinding orbital apex hematoma (see below). Any halted anticoagulation may be reinitiated 12 hours after surgery in order to escape unnecessary heparin therapy. Given the risks associated with stopping these therapies, we strongly recommend that patients generally continue their current therapeutic regimen without cessation.

For many years retrobulbar anaesthesia has been performed blindly, meaning that the needle was inserted into the muscle cone for close injection of local anesthetic near the optic nerve. A recent cadaver study has shown that safety could possibly improved using ultrasound guidance for the regional anesthesia [16]. With this technique the needle can be advanced inline with the transducer and be visualized without penetrating any important structures [15]. Nevertheless special physical parameters have to be considered for the use of ophtalmic ultrasound to escape safety concerns by thermal or mechanical bio-effects. Parameters for mechanical and thermal indices have therefore been imposed by the FDA and Health Canada to a strict maximum of 0.23 and less than 1.0 [16].

Complications of Regional Anesthesia

Complications issuing from orbital anesthesia may be of a local nature or manifest systemically [17,18]. They depend on the method of administration and the local anesthetic used as well as the patients preconditions – they may happen immediately or delayed [17].

Retrobulbar hemorrhage

Retrobulbar hemorrhage is a serious complication which can happen in both the intraconal and extraconal blocks. It may be either of venous or arterial origin and may be concealed or revealed. The spread of blood into the periorbital tissues increases the tissue volume and therefore the pressure [17]. In a study done by Katz and Feldman [19] they reported about 19 000 patients undergoing peribulbar and retrobulbar blocks with an incidence of only about 0.03 %. From the literature the most described range of incidence of a retrobulbar hemorrhage lies between 0.4 % and 1.7 % [20,21]. In a national survey interestingly a comparision of retrobulbar versus peribulbar anesthesia showed a difference in incidence of retrobulbar hemorrhage; the incidence was 0.4 % with the peribulbar technique and 0.7 % with the retrobulbar technique [20]. Cases in which blindess occurred have been reported [22], but most of the patients with retrobulbar hemorrhage have a good visual outcome [20,21].

There are significant differences in management of venous or arterial hemorrhage; venous hemorrhage is slow in onset and presents as blood stained chemosis and raised intraocular pressure. Arterial hemorrhage is quickly in onset and more difficult to control – urgent measures must be taken such as firm digital pressure or surgical procedure to reduce intraocular pressure as fast as possible [23]. The literature describes that the risk of developing retrobulbar hemorrhage is increased when a long (≥ 38 mm) needle is advanced deeply into the orbit (vascular structures are tighter packed here). Longer needles with a larger diameter may also be more likely to cause damage to vessels as discussed by Kumar and Carneiro [24,25], and blunt needles may be at a lower risk of damaging orbital apex structures than sharp ones [26].

Globe damage

Damage to the globe is a rare but often a devastating complication; it is reported following both intraconal and extraconal block [17,20,27–29]. A globe perforation means a double puncture wound (wound of entry and exit) whereas globe penetration has only a wound of entry. The incidence of globe damage is described as similar in peribulbar and retrobulbar technique [20, 29] – incidence varies from 0 % [30,31] to 0.1 % [32]. Many anesthesiologists perform peribulbar block introducing the needle in a similar direction as the retrobulbar block. This may explain the similar rates of globe perforation with the peribulbar and retrobulbar techniques.

Special considerations have to be taken when planning regional anesthesia for ophthalmic surgery in patients who suffer high myopia. Patients with an axial lenght of 26 mm or more do have a disposition for globe perforation [28,29,33,35]. Duker et al. [28] describe that 45 % of globe perforations ocurred in patients who had an axial length of 26 mm and more – they postulated a 30 fold increased risk for perforation during intraconal injections [28]. There are other risk factors for globe perforations including enophtalmus, repeated injections, posterius staphyloma, uncooperative patients, bevel of the needle turned away from the globe, lack of knowledge of orbital anatomy or technique and previously operated patients [26,34]. 50 % of patients do not have any symptoms or signs of a perforation whereas intense ocular pain, sudden loss of vision and hypotonus can be signs or symptoms [28].

Optic nerve injury

Damage to the optic nerve and therefore the central retinal artery within is described as a rare complication [26,34]. It occurs from direct needle injury to the optic nerve or due to a hemorrhage within or around the optic nerve. Pressure necrosis from the volume of a local anesthetic agent within or around the nerve is possible as well [17,26]. A loss of vision or blindness is a possible finding after such a complication.

There are certain risk factors for an optic nerve injury outlined in literature: Small orbits and placement of long needles deep into the apex [34–36]. In 20 % of 120 skulls in which measurements were performed distance between the insertion point of needle techniques to the optic foramen was 45 mm or less [36]. Katsev et al. postulated then that needles of 38 mm could injure the optic nerve – they recommended using shorter needles such as 31 mm or less [36]. 2 cases of blindness from optic nerve injuries are documented, they were performed with a 38 mm needle for a retrobulbar block [37]. Importantly, retrobulbar anesthesia is well comparable to intrathekal anesthesia with respect to its toxicity. The use of local anesthetics containing preseveratives will result in an increased incidence of vascular occlusions which may result from neurotoxic effects or by affecting the vascular endothelium with activation of thrombocytes, thus increasing the chance for intravasal thrombus formation [38]. Consequently, the use of conservative-containing anesthetic preparations is forbidden due to the inheritent risk of vascular occlusions.

Muscle damage

If damage to the extraocular muscles from orbital regional anesthesia happens, it can result in strabismus, ptosis and entropion [39]. The possible mechanisms discussed are direct needle trauma, ischemic pressure necrosis caused by a large volume of the injected anesthetic agent or direct myotoxic effect of the anesthetic agent with Bupivacaine being more toxic than Ropivacaine and Mepivacaine [34,39–43]. An experiment done with elderly human patients showed permanent damage to the extraocular muscles after having injected local anesthetic agent directly into the muscles [44]. The most common permanently injured muscle from orbital regional anesthesia is the inferior rectus, but other muscles can be involved. Transient strabismus and ptosis are common on the first postoperative day; ptosis is described with

an incidence of up to 50% [44]. This incidence is the same with needle orbital blocks and general anesthesia [44]. There is a study which postulates that ptosis can be caused by dehiscence of the levator aponeurosis and is associated with large volume of local anesthetic [41]. In this case, it should not be observed after general anesthesia, so that a local tissue trauma, i.e. in the context of the use of lid specula, has to be assumed.

Central spread of local anesthetic agent and brain stem anesthesia

The central spread of local anesthetic agents is well described in various publications so far [45,46]. The optic nerve is in a cerebral dura sheath as it passes through the optic foramen. If the needle tip perforates the optic nerve sheath and an injection is made central spread occurs [47,48]. Another rare possibility would be if an orbital artery is punctured by the needle tip. A retrograde flow of anesthetic agent to the midbrain can occur and result in fatal seizure and cardiovascular instability. To reduce this risk aspirating before injecting a local agent is always performed. If blood is aspirated the needle should be redirected [49].

The incidence of central venous complications is described between 0.2 und 0.3% with 38 mm retrobulbar needles [45,46]. The time of onset of symptoms usually begins in the first 15 minutes after the injection. If arterial injection was accidentally performed the onset is instantaneous [34]. Different signs/symptoms are possible, involving the cardiovasuclar and respiratory system or neurologic symptoms such as vomiting, temporary hemiplegia, aphasia and convulsions [17]. Palsy of contralateral oculomotor (III) and trochlear (IV) nerves with amaurosis after injection is charactersistic for central nervous spread [17]. The necessary treatment consists of respiratory and cardiac support accompanied by the administration of intrathecallipid emulsion to reverse local anesthetic induced toxicity [48,50].

Oculocardiac reflex

The oculocardiac reflex is mostly seen during general anesthesia for eye surgery, especially in children and young adults [51]. It is a vagus mediated reaction with the afferent pathway via the ciliary nerves to the ciliary ganglion [26], and causes bradycardia and hypotension after stimulation of the globe. By administering atropine or stopping the stimulation of the globe it can usually be easily reverted [51]. The oculocardiac reflex is not only described during the eye surgery but it is also known as a common complication of intraconal block [52].

Discussion

The success rate of retrobulbar anesthesia in terms of intraoperative comfort approaches 100% in experienced hands. This includes a well trained anesthesist or ocular surgeon, who guaranties the selection of patients that are compliant enough to have ocular surgery performed under local anesthesia, and an escape setting if intraoperative issues like lack of cooperation or uncontrolled pain imply the need for extension of the anesthesy, the use of blunt, short and fine needles, a local anesthetic volume which is adapted to the individual surgical needs not exceeding 4 milliliters, and control of blood pressure and stress before injection. For this, we have excellent experience with the short acting injection of propofol which can be titrated according to individual needs, offers amnesia to the patient with regard to the injection procedure and a more readily controlled situation for the injecting physician.

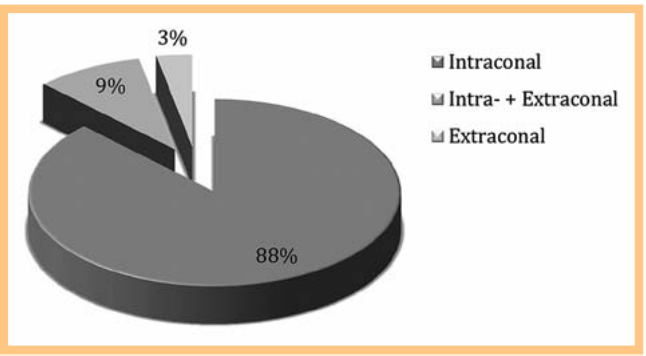

Fig. 1 Distribution of contrast dye after presumed intraconal injection.

We performed a study placing a retrobulbar catheter under ultrasonographic control injecting dyes into the retrobulbar space of cadaver eyes (n = 36) and found with CT scans that an intraconal injection was achieved in 88% and a distribution of dye into the intraconal space was found in an additional 9%, adding to 97%. Extraconal distribution of the dye was detected in 12%. In one eye, however, dye distribution into the optic nerve was found (**Fig. 1**) [53].

Data comparing patient comfort during and in the early phase after surgery are not available. According to our experience with retrobulbar and systemic anesthesia even in complex vitreoretinal surgical cases, pain and discomfort are lower under local anesthesia, which exerts its effect usually over a period of 3–4 hours after its placement. This duration of effect exceeds surgical times so that patients can recover from surgical stress prior to upcoming of pain so that they experience less stress when the anesthetic effect disappears. In this phase, pain relief may be titrated according to individual patient needs which gives the chance for a significantly better perioperative stress experience.

In conclusion, the retrobulbar needle placement is usually a highly reliable and safe procedure which might be applied to the best of the patient in over 95% of ocular surgeries in experienced hands. Nevertheless, the mentioned high success rates refer to physicians with experience of many hundred or thousand injections. Less experienced physicians might ask for guidance to elaborate an optimal personal technique. The addition of an ultrasound guided technique [14,15] might in difficult anatomic situations additionally increase the completeness of perioperative analgesia.

Conflict of Interest

None of the authors has financial interests associated with this manuscript.

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