Effect of the volume of anesthetic solutions and patient's age on the efficacy of retrobulbar anesthesia

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Purpose
The aim of this study was to monitor the effect of different anesthetic volumes and patients' age on the efficacy of bulbar akinesia and analgesia induced by retrobulbar anesthesia (RBA).
Patients and methods
This was a prospective, comparative, and interventional study that enrolled 478 patients who had consecutive cataract surgery and received RBA. Patients were divided randomly into two groups according to the volume of anesthetic solutions used. In group 1, patients received 2.50 ml of RBA, whereas in group 2, patients received 4 ml of RBA. Each group was then subdivided according to the age of the patients less than 45 years and greater than or equal to 45 years (1a, 1b, 2a, and 2b, correspondingly). The efficacy of anesthesia was evaluated by the degree of ocular motility in both groups.
Results
The study included 478 eyes of 478 patients. Group 1a included 94 patients: 51 eyes showed no movement regarding globe akinesia, 27 eyes showed flicker movement, 10 eyes showed partial movement, and six eyes showed full movement. Group 1b included 131 patients: 84 eyes showed no movement, 30 eyes showed flicker movement, 10 eyes showed partial movement, and seven eyes showed full movement. Group 2a included 103 patients: 80 eyes showed no movement, 17 eyes showed flicker movement, four eyes showed partial movement, and two eyes showed full movement. Group 2b included 150 patients: 109 eyes showed no movement, 28 eyes showed flicker movement, eight eyes showed partial movement, and five eyes showed full movement.
Conclusion
This comparison of different injection anesthetic volumes showed significant differences regarding bulbar akinesia, where the larger volume of anesthetic solution (4 ml) yielded better ocular akinesia with no significant effect of age of the patient on the efficacy of RBA.

Keywords:
bulbar akinesia, intraocular pressure, retrobulbar anesthesia

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Introduction

Surgeons show a diverse preference regarding akinesia during cataract surgery; although some consider akinesia not to be an important requirement, others prefer to operate with eye movements completely blunted [1]. So, there are different routes in administering local anesthesia: nonakinetic techniques (intracameral, subconjunctival, or topical) and ophthalmic blocks such as retrobulbar, peribulbar, and sub-Tenon's anesthesia [2]. The first attempts at a specific block of the ciliary ganglion were described by Knapp in 1884 [3].

Retrobulbar procedure achieves good ocular akinesia and analgesia. Akinesia is achieved through conduction blockage of the oculomotor and abducent nerves on the intraconal side of the muscles whereas anesthesia is achieved by paralyzing the short and long ciliary nerves through the nasociliary nerve [4,5].

Injection should be intraconal with a variable amount of anesthetic solution of 2.5–4 ml depending on the anticipated cone volume [6]. This route may have the advantage of rapid onset of analgesia and akinesia

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with the use of relatively smaller volumes of anesthetic agent [7].

Disadvantages of a retrobulbar block have been widely reported, which include risk of traumatic injury of the optic nerve especially in myopic eyes [8], increase of intraocular pressure (IOP) [9], and globe perforation [10]. Yet good knowledge of the anatomy of the orbit and following a strict protocol decreases such risks.

We are aware about one study that compared two volumes of anesthetic agent in peribulbar anesthesia and its effect on hemodynamics and IOP [11]. To our knowledge, no study has evaluated the effect of different volumes of anesthetic agent and age on the efficacy of bulbar akinesia and analgesia induced by retrobulbar anesthesia (RBA).

We need to know if there is a change in the efficacy of bulbar akinesia and analgesia with RBA with different volumes of anesthetic solution and different age groups. So, the aim of this study was to monitor the effect of different anesthetic volumes and patients' age on the efficacy of bulbar akinesia and analgesia induced by RBA.

Patients and methods

The study included 478 patients who were enrolled in a prospective, comparative, and interventional study. RBA was administered before consecutive cataract surgery in the form of phacoemulsification in the Ophthalmology Department, Sohag University, Egypt, between September 2016 and June 2017. Exclusion criteria were other ocular or retinal diseases or surgery and history of coagulation abnormalities or bleeding diathesis. Patients for whom general anesthesia was indicated were also excluded from the study along with cases of deafness, claustrophobia, and dementia. Written informed consent was obtained from all patients. This study followed the tenants of declaration of Helsinki and was approved by the Ethical Committee of the Faculty of Medicine, Sohag University, Egypt.

The patients were divided randomly into two groups. The randomization was done according to the laterality of cataract. Cataracts in the right eye were considered the first group and cataracts in left eye were considered the second group. The two groups received two different volumes of anesthetic solution. Group 1 patients received 2.50 ml of RBA and group 2 patients received 4 ml. Each group was then subdivided according to the age of the patients less than 45 years and greater than or equal to 45 years (1a, 1b, 2a, 2b, correspondingly). Both groups were age matched. The rationale behind comparing age groups was the evaluation if there is an effect of age on efficacy of bulbar akinesia and analgesia induced by RBA.

The anesthesia technique was done under the main monitoring parameters, which included pulse oximetry (SpO_2) and noninvasive measurement of blood pressure. All retrobulbar blocks had been given by the same surgeon (A.M.). After disinfection with povidone iodine topical solution 10% and removal of any excess antiseptic solution and with the eye in primary gaze, a 35 mm, 25 gauge sharp needle was used to enter the orbit at the junction of the lateral and middle thirds of the inferior orbital rim parallel to the floor of the orbit to a depth of 25 mm where the equator of the globe was reached. The needle was then angled up and medially and advanced toward the apex to the hub of the needle to enter the cone. Before injection, an initial aspiration to rule out intravascular placement was done. The anesthetic solution used was a 0.5% bupivacaine hydrochloride (Marcaine; Pfizer, Hospira, Illinois, USA). Mechanical compression by the palm of the hand was applied for 5 min after injection. In all cases, a single injection was used with no separate injections performed for lid akinesia. In addition, the Van Lint lid block of the seventh cranial nerve was performed with 5 ml of the solution.

If any motion of the globe was noted, then a supplemental anesthesia was administered. The supplement consisted of 1 ml of the same anesthetic solution given in the same manner described. Incomplete spread of the anesthetic solution to the superonasal/posterior aspect of the orbit, where the IV cranial nerve supplies the superior oblique muscle, has been previously reported [12].

No patient in the study required intravenous sedation during the surgical procedure. A different surgeon unaware of the amount of anesthetic solution injected (E.M.M.) checked for globe akinesia and total inability to squeeze the lids after 10 min of administration. The efficacy of anesthesia was evaluated by the degree of ocular motility in both groups: grade 0–no movement (akinesia), grade 1–ocular movements (flicker) less than 1 mm, grade

2–markedly reduced ocular movements greater than 1 mm and less than 3 mm, grade 3–partially reduced ocular movements greater than 3 mm, and grade 4–greater than 3 mm with full movement. We also monitored the incidence of the need for additional anesthetic supplementation and the incidence of complications along with the difference of IOP before and after injection of different volumes.

Statistical analysis using SPSS for Windows version 10.0 software (SPSS Inc., Chicago, Illinois, USA) was used to compare both groups, with a *P* value of less than or equal to 0.05 being considered significant.

Results

The study included 478 eyes of 478 patients; 280 were male and 198 were female patients. Table 1 shows the demographics of both groups.

Table 2 shows the difference between both groups in IOP and in akinesia, whereas Table 3 shows the difference between patients aged younger and older than 45 years in both groups.

The number of cases was determined by the randomization, so there was a difference between both groups in the number.

The main complications that occurred in all cases were chemosis and retrobulbar hemorrhage. Table 4 summarizes the number of complications and additional supplements of anesthesia in both groups.

There was a statistically significant difference between groups regarding globe akinesia (*P*=0.05) with group 2 showing more eyes reaching complete akinesia as well as other grades of movement along with fewer patients needing supplements.

There was a statistically significant difference between groups regarding IOP (*P*=0.05) with group 2 showing higher IOP with the larger volume of anesthetic solution.

Table 1 Demographics of both groups of anesthetic volume

Data	Group 1: anesthetic volume 2.5 ml (*N*=225)		Group 2: anesthetic volume 4 ml (*N*=253)	
Age (years)	<45 Group 1a *N*=94	≥45 Group 1b *N*=131	<45 Group 2a *N*=103	≥45 Group 2b *N*=150
Male/female	20/40	75/90	28/55	75/95

Table 2 Difference between both groups in intraocular pressure and in akinesia

Parameters	Group 1: anesthetic volume 2.5 ml (*N*=225)	Group 2: anesthetic volume 4 ml (*N*=253)	*P*
IOP (mmHg)			
Before injection	12.2	12.8	0.82
After injection	12.5	13.2	0.05
Degree of globe akinesia			
Full movement	13	7	0.05
Partial movement	20	12	0.05
Flicker	57	45	0.02
No movement	135	189	0.05

IOP, intraocular pressure.

Table 3 Effect of age on intraocular pressure and globe akinesia in both groups

Parameters	Group 1: anesthetic volume 2.5 ml (*N*=225)		*P* value	Group 2: anesthetic volume 4 ml (*N*=253)		*P*
IOP (mmHg)	Age <45 years Group 1a *N*=94	Age ≥45 years Group 1b *N*=131		Age <45 years Group 2a *N*=103	Age ≥45 years Group 2b *N*=150	
Before injection	2±13.1	2.3±13.7	0.19	2.2±13.1	2.5±14.1	0.11
After injection	2.7±13.2	2±13.8	0.23	3±14.9	3±15	0.05
Degree of globe akinesia (*n*)						
Full movement	6	7	0.32	2	5	0.22
Partial movement	10	10	0.37	4	8	0.41
Flicker	27	30	0.22	17	28	0.28
No movement	51	84	0.12	80	109	0.11

IOP, intraocular pressure.

Table 4 Complications and additional supplements of anesthesia in four groups

	Group 1		Group 2	
	1a	1b	2a	2b
Retrobulbar hemorrhage	1	2	1	3
Chemosis	1	4	2	4
Supplementation	5	4	2	2

Supplementation of anesthetic agent was 4% in group 1 compared with 1.6% in group 2.

Age had no effect on akinesia in any of the groups, with no statistically significant difference. Yet there was a subtle but significant increase in IOP before and after injection in group 2.

Discussion

Anesthesia is a very important part of any surgical procedure including ophthalmic procedures. Ophthalmic surgery is unique as most of adult ophthalmic procedures are done under local anesthesia [13]. Over the past two decades, anesthetic techniques in ophthalmology have evolved worldwide [14–16].

Despite the increasing popularity of topical anesthesia and other less invasive techniques, RBA remains the procedure of choice for long cases, resulting in ideal operating conditions for intraocular and orbital procedures [17].

We consider the RBA the block of choice in ophthalmic anesthesia especially in long cases owing to its good ocular akinesia and analgesia effect with rapid onset and efficient results.

In the present study, the effect of two volumes of anesthetic solution on ocular akinesia was monitored. In addition, the role of the patient's age on the efficacy of RBA was evaluated.

There was a statistically significant difference regarding globe akinesia in group 2 with the higher volume of anesthetic solution (4 ml). In addition, there was a subtle but significant increase in IOP before and after injection in group 2. This is in accordance with Hessemer *et al.* [18] who reported that IOP increased by ~3.2 mmHg after the 5 ml injection, whereas no changes in the IOP was observed after injection of 2 ml. In another study by Bowman *et al.* [9], IOP increased immediately after injection of the anesthetic agent, but the difference was related to the type of anesthesia, which was peribulbar and not retrobulbar block. There are several studies comparing topical anesthesia with regional block with controversial results [19,20]. In addition, different studies tried to compare different regional blocks [21,22]. In a large retrospective study, Hamilton *et al.* [23] reported that block supplementation was 19.8% after retrobulbar block and 24% after the peribulbar block. In another study, the respective values were 12 and 19% [7]. Both studies are higher than the rates of the current study.

The debate among ophthalmic surgeons about the best anesthesia for patients with cataract is influenced by three main variables: the patient and his/her preference and cooperation, the surgeon and his skills, and the type of cataract and associated ocular difficulties such as corneal opacity and pupillary constriction. We believe that careful attention to the technique and the knowledge of orbital anatomy would lead to safe and reliable retrobulbar blocks.

In conclusion, RBA efficacy was higher with larger volumes of anesthetic solution. However, the efficacy was not affected by the age of the patient.

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Conflicts of interest

There are no conflicts of interest.

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