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Research article

Magnesium sulphate versus dexmedetomidine as an adjuvant to local anesthetic mixture in peribulbar anesthesia

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1. Introduction

Regional anesthesia is the preferred type of anesthesia for eye surgeries because it is more safe especially in elderly patients who are candidates for the ophthalmic surgeries and usually they have multiple systemic diseases making them more liable for anesthetic complications [1]. Also it is associated with less incidence of nausea and vomiting so it is more suitable for day case surgery and it prevents endocrinal metabolic response associated with the surgery [2].

Increased incidence of complications associated with retrobulbar anesthesia such as brainstem anesthesia, globe perforation, and retrobulbar hemorrhage made the peribulbar anesthesia more preferred in ophthalmic operations, but it is not free from disadvantages such as its slow onset, its short duration, and its need to high volume of local anesthetic which may increase the intraocular pressure [3]. Many additives were added to the local anesthetic in peribulbar anesthesia to overcome these disadvantages such as hyaluronidase [4], and clonidine [5].

Magnesium is a non-competitive N-methyl-D-aspartate (NMDA) receptors antagonist and it can decrease the excitatory post synaptic currents produced by activation of NMDA receptors and it inhibits voltage gated calcium channels [6]. Many studies found that adding magnesium sulphate to the local anesthetics increased the quality and intensity of different regional anesthetic blocks [7] and it could accelerate onset of peribulbar anesthesia [8].

Dexmedetomidine alpha-2 agonist, which stimulates both central and peripheral alpha-2 receptors which inhibits neuronal firing and inhibits release of C-fibers transmitters such as norepinephrine which inhibits nerve fiber action potential and explains the antinociceptive effects of dexmedetomidine [9]. Recently it was administered successfully with the local anesthetics to prolong its duration of action in brachial plexus block, epidural anesthesia, intrathecal anesthesia [10], and peribulbar anesthesia [11].

We hypothesized that adding magnesium sulphate or dexmedetomidine as adjuvant in peribulbar anesthesia will enhance the quality of the block and prolong the effect of the local anesthetic. The aim of this prospective randomized double blinded study was to compare between the effect of adding dexmedetomidine versus magnesium sulphate to the local anesthetic mixture in peribulbar anesthesia on onset of sensory block, motor block of the lid and the globe, duration of sensory and motor block, satisfaction of the patients and the surgeon, and the possible side effects of the two drugs.

2. Patients and methods

This prospective, randomized, double blinded study was carried out in the hospital of El-Minia university from November 2016 to March 2017. The ethics committee gave us its approval of the research plan then informed written consents were obtained from 66 patients, ASA physical status I or II of both sexes scheduled for phacoemulsification of cataract and intraocular lens implantation under peribulbar anesthesia, their age ranged between 40 and 60 years. The researchers excluded patients with axial length of the globe more than 28 mm or with posterior staphyloma, patients on anticoagulant drugs, patients with uncontrolled hypertension, diabetes mellitus, or with body mass index >35, patients with tremors or agitation, patients with communication difficulty such as mental retardation, deafness, and disturbed conscious level, patients with history of allergy to the test drugs, and patients who refused to participate in the study. Patients were randomly

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allocated into three equal groups each one was 22 patients, the allocation ratio was 1:1 and the method of randomization was computer generated randomized numbers, and it was hidden in sealed opaque envelopes to conceal the allocation.

- Group I (control group): received 4 ml of lidocaine 2% with 120 international unit (IU) of hyaluronidase + 4 ml of bupivacaine 0.5% + 1 ml of 0.9% saline in 10 ml syringe.
- Group II (magnesium sulphate group): received 4 ml of lidocaine 2% with 120 IU of hyaluronidase + 4 ml of bupivacaine 0.5% + 50 mg magnesium sulphate 10 % in 1 ml of 0.9% saline in 10 ml syringe.
- Group III (dexmedetomidine group): received 4 ml of lidocaine 2% with 120 IU of hyaluronidase + 4 ml of bupivacaine 0.5% + 25 μg dexmedetomidine in 1 ml of 0.9% saline in 10 ml syringe.

The local anesthetic mixture was prepared by anesthesiologist not included in the study so the anesthesiologist, the surgeon, and the patient don't know the type of the anesthetic mixture. All patients were fasted 6 h before the operation, and they received 150 mg oral ranitidine on the morning of the surgery. No sedatives were administered to the patients. At the operation room, 22 gauge cannula was inserted in the dorsum of the non dominant hand and the patients were attached to a multi-channel monitor (Hewlett-Packard, Viridia 24, Germany) to record base line Electrocardiogram (ECG), heart rate (beats/min), systolic, diastolic blood pressure, and oxygen saturation (SpO_2). Patients lied in supine position with nasal cannula which delivered oxygen at 3 L/min.

Anesthetic technique: The injection was carried out using a (25G) needle with a length of 25 mm being connected to the syringe contained the anesthetic solution. The patient lied supine and look directly ahead focusing on a fixed point on the ceiling, so that the eyes were in the neutral position. After sterilization of the lower eye lid, the globe was pushed up by the non dominant hand of the anesthetist while the needle was introduced at a point 1–1.5 cm medial to the lateral canthus, on the inferior eyelid and directed slightly medially (20°) and cephalad (10°) until the needle hub contact the skin. After negative aspiration, the local anesthetic mixture according to patient's group was injected guarded by no overcrowding of the eye, then soft intermittent digital pressure by the middle three fingers on the eye was applied for 5 min to decrease the intraocular pressure, help spread of the anesthetic solution and promote akinesia of the periorbital muscles, time to complete the injection was considered as 0 time.

The following parameters were recorded:

- Hemodynamic parameters such as heart rate (beats/min), non invasive blood pressure (mmHg) and oxygen saturation were recorded just before peribulbar injection (base line), and every five minutes till the end of the surgery.
- Onset of sensory block in minutes which was calculated from the time of complete injection till complete loss of corneal sensation which was assessed by gentle touching of the cornea with a cotton swab.
- Onset and duration of motor blockade of the eye globe (globe akinesia) were assessed using three point scale [12] ranged from 0 to 2 in each one of the four directions. Akinesia score is equal to the sum of the scores in the four directions ranging from 0 to 8. It was performed by asking the patient to look superior, inferior, medial and lateral every minute till 10 min. Onset of globe akinesia was calculated from the time of complete injection of the local anesthetic till the complete akinesia (akinesia score 0) while the duration was calculated from the injection time till complete recovery of motor power (akinesia score 8).
- Onset and duration of lid akinesia were assessed by testing the ability of the patient to open, and to close the eye. Where 0 = Complete akinesia, 1 = Partial movement in either or both eyelid margins, 2 = Normal movement in either or both eyelid margins [12]. Onset of lid akinesia was calculated from the time of complete injection of the local anesthetic till the occurrence of complete lid akinesia. Duration of the lid akinesia was calculated from the time of complete injection of the anesthetic solution till complete recovery from the block. A second dose (3 ml) of the local anesthetic solution may be needed if the block was incomplete after 10 min from the first injection as manifested by the full movement in any direction or ocular akinesia score $\geq$6. It was given at the medial canthus, where the needle passed posterior between the medial canthus and the caruncle with the bevel facing the globe. Number of patients who needed second injection was recorded in each group.
- Total volume of the local anesthetic solution which used to obtain adequate akinesia.
- Time for adequate conditions to start the operation (corneal anesthesia plus globe akinesia score $\leq$1 and eyelid akinesia score of 0).
- Duration of surgery.
- Quality of the operative conditions assessed by the surgeon at the end of the surgery and it was as follow: 0 = unsuccessful (failed to work), 1 = poor (inadequate for surgery) 2 = acceptable (block is incomplete but the surgeon could proceed) 3 = perfect (effective block).
- Patient satisfaction score: it was assessed by the patient at the end of the surgery, it was as follow: 1 = Complete dissatisfaction, 2 = some dissatisfaction, 3 = Complete satisfaction.
- The time to 1st analgesic request (calculated from the time of complete injection of the local anesthetic) was recorded. The patients received intravenous ketorolac 30 mg on request.
- Sedation was measured by inverted observer assessment of alertness/sedation scale [13] in which unarousable = 5 and awake = 1.
- Complications of the anesthetic technique such as brain stem anesthesia, retrobulbar hemorrhage, globe perforation or side effects related to the test drugs such as bradycardia, hypotension, excessive sedation, nausea, vomiting, and dizziness were recorded and treated.

At the end of the surgery, patients were transported to the post anesthesia care unit (PACU) till stable vital signs, and absence of nausea and vomiting or any side effects, then they were transported to the ward.

2.1. Statistical analysis

Sample size calculation: before the study, the number of patients required in each group was determined after a power calculation according to data obtained from pilot study. Pilot study reported a mean duration of globe akinesia of 121 min in control group, 160 min in magnesium group, and 170 min in dexmedetomidine group; SD within each group was 50. A sample size of 20 patients in each group was determined to provide 80% power for one way ANOVA test at the level of 5% significance using G Power 3.1 9.2 software. 10% (2 patients) were added to each group to compensate for drop out ratio, so the total number of each group was 22 patients.

Data were analyzed with Statistical Program SPSS version 21 (SPSS Inc., Chicago, IL, USA). Numerical results were expressed as mean ± SD, while categorical results were expressed as numbers and percentages. Results were tested for normal distribution by Kolmogorov-Smirnov test. One-way analysis of variance (ANOVA) was used to compare the numerical data between the three groups.

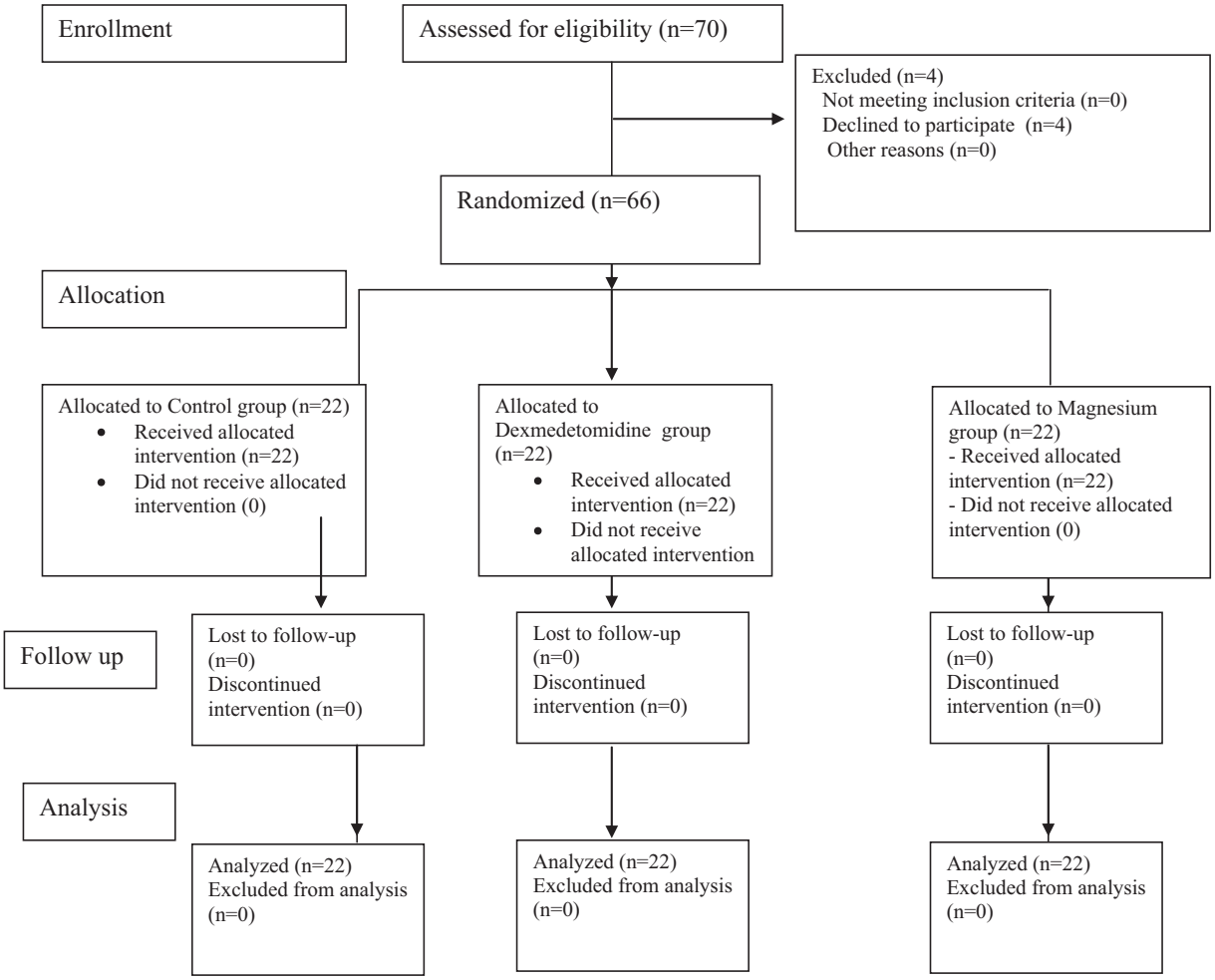

Fig. 1. Flow chart in the study.

Categorical results were analyzed by Chi-square test. All tests were two-tailed and *P* value of <0.05 was considered significant.

3. Results

Seventy patients were checked for eligibility to the study, four of them refused to participate in the research, and the remaining sixty-six patients continued the study to be analyzed, they were divided into three equal groups (Fig. 1).

There was no significant difference between the three groups as regards the demographic data, axial length, and duration of the surgery (Table 1).

As regards the characteristics of the block (Table 2):

Table 1
Demographic data of the patients, duration of surgery, and axial length.

Item	Group I Control (n = 22)	Group II Magnesium (n = 22)	Group III Dexmedetomidine (n = 22)	*P* value		
Age	58 ± 6.4	57.1 ± 4.8	57.6 ± 6.2	0.878		
				I vs II	I vs III	II vs III
				0.611	0.821	0.778
Sex ♂/♀	11/11	12/10	10/12	0.834		
				I vs II	I vs III	II vs III
				0.763	0.763	0.547
Weight (kg)	74.6 ± 6.3	73.4 ± 5.6	75.1 ± 6.2	0.633		
				I vs II	I vs III	II vs III
				0.512	0.785	0.354
Axial length (mm)	24.1 ± 1.3	24.4 ± 1.35	23.8 ± 1.15	0.300		
				I vs II	I vs III	II vs III
				0.436	0.436	0.122
Duration of surgery (min)	33.7 ± 5.4	33.0 ± 5.7	34 ± 5.1	0.821		
				I vs II	I vs III	II vs III
				0.669	0.855	0.542

Numerical data are expressed as mean ± SD. Categorical data as sex are expressed as numbers. P < 0.05 considered significant. No significant difference between groups.

Table 2
Characteristics of the peribulbar block.

	Group I Control (n = 22)	Group II Magnesium (n = 22)	Group III Dexmedetomidine (n = 22)	P value		
Onset of sensory block (min)	3.17 ± 0.5	2.24 ± 0.7	1.88 ± 0.71	<0.001*		
				I vs II	I vs III	II vs III
				<0.001*	<0.001*	0.068
Onset of globe akinesia (min)	4.65 ± 0.73	3.23 ± 0.82	3.0 ± 0.64	<0.001*		
				I vs II	I vs III	II vs III
				<0.001*	<0.001*	0.302
Duration of globe akinesia (min)	115.7 ± 24.6	174.6 ± 25.1	187.4 ± 26.8	<0.001*		
				I vs II	I vs III	II vs III
				<0.001*	<0.001*	0.101
Onset of lid akinesia (min)	3.81 ± 0.62	3.1 ± 0.78	2.87 ± 0.46	<0.001*		
				I vs II	I vs III	II vs III
				<0.001*	<0.001*	0.233
Duration of lid akinesia (min)	97.8 ± 21.6	154.1 ± 21.2	161.6 ± 22.3	<0.001*		
				I vs II	I vs III	II vs III
				<0.001*	<0.001*	0.256
Time to start surgery (min)	9.25 ± 1.1	7.25 ± 1.33	6.64 ± 1.5	<0.001*		
				I vs II	I vs III	II vs III
				<0.001	<0.001*	0.130
Time to 1st analgesic request (min)	156 ± 21.3	238 ± 24.6	244 ± 27.1	<0.001*		
				I vs II	I vs III	II vs III
				<0.001*	<0.001*	0.419

Data are expressed as mean ± SD. $P < 0.05$ considered significant.
* Significant to control group.

- It was found that adding magnesium (group II) or dexmedetomidine (group III) to the local anesthetic accelerated the onset of sensory block in comparison to the control (group I) but without significant difference between them.
- Onset of globe akinesia, lid akinesia, and time for suitable conditions to start surgery were accelerated significantly in magnesium (group II) (3.23 min, 3.1 min, and 7.25 min respectively) and dexmedetomidine (group III) (3 min, 2.87 min, and 6.64 min respectively) in comparison to the control (group I) (4.65 min, 3.81 min, and 9.25 min respectively) but without significant difference between them.
- Duration of globe akinesia, lid akinesia, and time to 1st analgesic request were prolonged significantly in magnesium (group II) (174.6 min, 154.1 min, and 238 min respectively) and dexmedetomidine (group III) (187.4 min, 161.6 min, and 244 min respectively) in comparison to the control (group I) (115.7 min, 97.8 min, and 156 min respectively) but without significant difference between them.

There was no significant difference between the three groups as regards the volume of the used local anesthetic, while there was significant high incidence of patients who required 2nd injection in the control group (group I) in comparison to the other two groups (group II) (group III) (Table 3).

As regards the satisfaction of the patients, it was significantly higher in magnesium (group II) and dexmedetomidine (group III) in comparison to the control group (group I) (Table 4).

As regards the quality of the block which was assessed by the surgeon, the incidence of perfect block was significantly higher in magnesium (group II) and dexmedetomidine (group III) in comparison to the control group (group I) (Table 5).

There was no side effects related to the test drugs such as bradycardia, hypotension, excessive sedation, nausea, and vomiting were recorded during the study.

Results:

4. Discussion

This study was done to compare between the effect of administration of magnesium versus administration of dexmedetomidine in peribulbar anesthesia and it found that administration of 50 mg magnesium sulphate 10% or 25 μg dexmedetomidine to a mixture of lidocaine 2% and bupivacaine 0.5% in peribulbar anesthesia for phacoemulsification of cataract and intraocular lens implantation accelerated the onset time of sensory block, globe akinesia, lid akinesia, and time for suitable conditions to start surgery, prolonged the duration of globe akinesia, lid akinesia, and time to 1st analgesic request, increased satisfaction of the patients

Table 3
Volume of local anesthetic and percentage of patients needed 2nd injection.

	Group I Control (n = 22)	Group II Magnesium (n = 22)	Group III Dexmedetomidine (n = 22)	P value		
Volume of LA (ml)	6.3 ± 0.8	6.1 ± 1.1	6.2 ± 0.9	0.781		
				I vs II	I vs III	II vs III
				0.484	0.726	0.726
Need for second injection	9 (40.9%)	3 (13.4%)	1 (4.5%)	0.007*		
				I vs II	I vs III	II vs III
				0.042*	0.004*	0.294

Volume are expressed as mean ± SD. Need for 2nd injection is expressed as number and percentage.
$P < 0.05$ considered significant.
* Significant to control group.

Table 4
Satisfaction of the patient.

Patient satisfaction score	Group I Control (n = 22)	Group II Magnesium (n = 22)	Group III Dexmedetomidine (n = 22)	P value		
Dissatisfaction	1 (4.54%)	0 (0%)	0 (0%)	0.362		
				I vs II	I vs III	II vs III
				0.312	0.312	0.312———
Some dissatisfaction	8 (36.36%)	3 (13.63%)	1 (4.54%)	0.019*		
				I vs II	I vs III	II vs III
				0.082	0.009*	0.294
Complete satisfaction	13 (59.09%)	19 (86.36%)	21 (95.45%)	0.007*		
				I vs II	I vs III	II vs III
				0.042*	0.004*	0.294

Data are expressed as numbers and percentages. $P < 0.05$ considered significant.
* Significant to control group.

Table 5
Quality of the block assessed by the surgeon.

Quality of block	Group I Control (n = 22)	Group II Magnesium (n = 22)	Group III Dexmedetomidine (n = 22)	P value		
Unsuccessful	0 (0%)	0 (0%)	0 (0%)	–		
				I vs II	I vs III	II vs III
				–	–	–
Poor	2 (9.1%)	0 (0%)	0 (0%)	0.127		
				I vs II	I vs III	II vs III
				0.148	0.148	–
Acceptable	9 (40.9%)	6 (27.3%)	3 (13.6%)	0.127		
				I vs II	I vs III	II vs III
				0.340	0.088	0.262
Perfect	11 (50 %)	16 (72.7%)	19 (86.4%)	0.030*		
				I vs II	I vs III	II vs III
				0.122	0.010*	0.262

Data are expressed as numbers and percentages. $P < 0.05$ considered significant.
* Significant to control group.

and enhanced the quality of operative conditions without any marked side effects.

The results of this study goes with the results of Sinha et al. [8] in their study on 60 patients to examine the effect of adding 50 mg magnesium sulphate to a mixture of lidocaine 2% and bupivacaine 0.5% in peribulbar anesthesia for ophthalmic surgeries, and they found that adding magnesium sulphate to the anesthetic mixture accelerated onset of anesthesia and shortened the time for suitable conditions to start surgery without any side effects.

It also coincides with the findings of Abd Elhamid [14] who reported that administration of magnesium as a co factor to the local anesthetic in peribulbar anesthesia accelerated the onset of sensory and motor block without any side effects.

Abu Elyazed and Mostafa [15] in their study on 90 patients scheduled for cataract surgery under peribulbar anesthesia, compared between 50 mg of magnesium sulphate and 20 μg fentanyl as additives to a mixture of lidocaine 2% and bupivacaine 0.5% plus 150 IU of hyaluronidase and they found that both fentanyl and magnesium prolonged the duration of globe akinesia, lid akinesia, and post operative analgesia. Magnesium could accelerate the onset of globe anesthesia, akinesia, and lid akinesia in comparison to the control group but still significantly slower than the fentanyl group.

On the other hand Hamawy and Bestarous [16] in their study on 75 patients scheduled for cataract surgery aged between 40 and 80 years, found that adding 50 mg magnesium sulphate to the local anesthetic mixture in peribulbar anesthesia had no beneficial effects on the onset of the block or akinesia score.

This study agrees with the results of Channabasappa et al. [17] who examined two doses of dexmedetomidine 25 μg and 50 μg as adjuvant to a mixture of 3 ml lidocaine 2% and 3 ml bupivacaine 0.5% in peribulbar anesthesia for cataract surgery on 90 patients and they found that administration of dexmedetomidine accelerated the onset of the peribulbar anesthesia, prolonged its duration, and prolonged postoperative analgesia. They found that the dose of 50 μg dexmedetomidine produce sedation which make the patient more cooperative.

This study in agreement with the results of Hafez et al. [18] who evaluated the effect of three doses of dexmedetomidine 15 μg, 20 μg, 25 μg when added to a mixture of lidocaine 2%, bupivacaine 0.5%, and 120 IU of hyaluronidase for peribulbar anesthesia in vitreoretinal surgeries on 160 patients and they found that dexmedetomidine accelerated onset of sensory and motor block and increased its duration and the analgesia time. They found that the best dose was 25 μg dexmedetomidine. It also in line with Hala et al. [19] who examined the effect of adding two different doses of dexmedetomidine 25 μg and 50 μg to levobupivacaine/hyaluronidase mixture in peribulbar anesthesia and they found that dexmedetomidine accelerated onset of sensory and motor block.

Abdelhamid et al. [11] in their study on 90 patients scheduled for cataract surgery under peribulbar anesthesia and they compared the effect of dexmedetomidine 50 μg as an adjuvant to the local anesthetic mixture versus intravenous dexmedetomidine, and they found that dexmedetomidine 50 μg as an adjuvant to the local anesthetic accelerated onset of anesthesia, and akinesia, and prolonged their duration without producing sedative effects which appeared in the intravenous group.

There were no side effects noticed in this study which could be explained by the small doses of magnesium and dexmedetomidine.

Limitations: This study was limited by the few number of patients in the study, the single type of ophthalmic operation, cat-

aract, which is associated with little postoperative pain, and single dose of magnesium and dexmedetomidine.

5. Conclusion

Addition of 50 mg of magnesium 10% or 25 μg of dexmedetomidine to local anesthetic mixture for peribulbar anesthesia in the operations of phacoemulsification of cataract and intraocular lens implantation accelerated onset of globe anesthesia, akinesia of the globe and the lid, prolonged the duration of globe akinesia, lid akinesia, time to 1st analgesic request, and enhanced the satisfaction of the patients and quality of the operative conditions.

Conflict of interest

The authors declared no conflict of interest. The fund was from the university budget.

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