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RESEARCH ARTICLE

Effectiveness and Safety of Single Percutaneous Peribulbar Block Using Magnesium Sulphate as an Adjuvant to Local Anesthetics *Versus* the Standard Peribulbar Block for Strabismus Surgery in Adults

Norhan Aly Sherif[1,*], Mayada Khairy Mohamad[1], Sameh Galal Taher[2], Ahmed Abdou Hannon[2] and Hesham Mohamed Salem[1]

[1]*Department of Anesthesia, Research Institute of Ophthalmology, Cairo, Egypt.*
[2]*Department of Pediatric Ophthalmology and Strabismus, Research Institute of Ophthalmology, Cairo, Egypt.*

Abstract:

Background:

Peribulbar anesthesia in ophthalmic surgeries is limited by delayed and/or incomplete orbital akinesia and inadequate operative and postoperative analgesia.

Objective:

The aim of this study was to assess the safety and effectiveness of a single percutaneous peribulbar block technique with 100 mg magnesium sulphate added to the local anesthetics used compared with the standard peribulbar block technique in adult strabismus surgery.

Methods:

A total of 54 consecutive patients undergoing strabismus surgery were included in the study. They were divided into two equal groups (27 patients each). In group I, 1 ml (100 mg/ml) magnesium sulphate added to a mixture of 2 ml lidocaine 2%, 2 ml bupivacaine 0.5% and 1 ml hyaluronidase (150 units/ml) was administered through a single percutaneous peribulbar injection with a short (1 inch) needle, while in group II, a mixture of 1 ml saline added to 2 ml lidocaine 2%, 2 ml bupivacaine 0.5% and 1 ml hyaluronidase (150 units/ml) was administered using the standard peribulbar block technique. The collected data included patient's baseline characteristics, perioperative and early postoperative outcomes and follow-up data.

Results:

The elapsed time before the onset of anesthesia and akinesia of the globe was significantly shorter in group I compared with group II (1.9 ± 0.7 *vs.* 3.9 ± 1.0 min, $p < 0.001$; 2.3 ± 0.7 *vs.* 4.4 ± 1.2 min, $p < 0.001$ respectively), and the duration of anesthesia was significantly longer in group I compared with group II (180.0 ± 0.0 *vs.* 43.0 ± 8.5 min, $p < 0.001$). The median VAS pain score was significantly lower in group I compared with group II (1.0 *vs*. 4.0, $p < 0.001$), and the patient's satisfaction was significantly higher in group I compared with group II (100.0% *vs*. 25.9%, $p < 0.001$).

Conclusion:

Co-administration of 100 mg magnesium sulphate with the local anesthetics was effective and safe. It achieved suitable conditions to start surgery rapidly. Further, it improved the quality of operative conditions and patient satisfaction.

Keywords: Adult, Akinesia, Analgesia, Magnesium sulphate, Peribulbar block, Strabismus.

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1. INTRODUCTION

Regional anesthesia has been considered the standard method of anesthesia in ophthalmic surgery. It has shown high success rate and safety in different ocular procedures including difficult and extended time surgeries [1]. Compared with general anesthesia, the use of regional anesthesia has the advantages of quick patient recovery and shorter hospital stay [2].

Retrobulbar and peribulbar blocks are considered the two main approaches of regional anesthesia in eye surgery. They

* Address correspondence to this author at the Department of Anesthesia, Research Institute of Ophthalmology, Cairo, Egypt;
E-mail: anesth.sherif@gmail.com

can achieve suitable conditions for intraocular surgeries, including analgesia and profound akinesia of the globe [3]. However, retrobulbar block technique has many complications such as brainstem anesthesia, globe perforation and retrobulbar hemorrhage [4]. Hence, the Peribulbar Block Anesthesia (PBA) has gained wide acceptance in ophthalmic anesthetic practice [5].

The peribulbar block is a needle-based technique that varies from the retrobulbar block in terms of the depth and angulation of needle placement within the orbit [2]. The rate of major complications under peribulbar anesthesia was reported to be 0.006%. However, its main disadvantage is the need for a larger volume of local anesthetic agent [6].

Rizzo *et al*. [7] evaluated the efficacy and safety of a single medial percutaneous injection technique using a small volume of anesthetic for ocular peribulbar anesthesia, and they reported that it was simple and effective in producing an adequate motor block and surgical anesthesia.

To address the drawbacks of PBA, many additive drugs to local anesthesia have been investigated. These include hyaluronidase, adrenaline and sodium bicarbonate [8], clonidine [9], corticosteroids [10] and neuromuscular blocking agents [11, 12]. However, these agents are also associated with some side-effects such as allergic reactions, bradycardia, sedation, dryness of mouth and systemic neuromuscular blockade [13].

Magnesium has been used with a local anesthetic solution in different regional anesthesia techniques to decrease the onset time of block and to increase the quality and duration of anesthesia [14 - 16]. Few studies evaluated magnesium sulphate as an adjuvant with the local anesthetic for a peribulbar block in different eye surgeries [17 - 19], but no previous studies evaluated it specifically in strabismus surgery.

Currently, no ideal adjuvant for the peribulbar block has been reported. Therefore, the aim of this study was to assess the safety and effectiveness of a single percutaneous peribulbar block technique with 100 mg magnesium sulphate added to the local anesthetics used compared with the standard peribulbar block technique in adult strabismus surgery.

2. PATIENTS AND METHODS

2.1. Study Type and Setting

This single center, prospective cohort study was carried out at the Anesthesia Department, Research Institute of Ophthalmology, Cairo, Egypt during the period from January 2018 to January 2019.

2.2. Inclusion Criteria

- Age more than 16 years old.
- ASA I and II (Physical status, American Society of Anesthesiologists).
- Concomitant strabismus.
- Patients with previous complications and those refusing general anesthesia.

2.3. Exclusion Criteria

- Age less than 16 years old.
- ASA III and IV.
- Uncooperative patients.
- Previous extraocular or strabismus surgery.
- Allergy to local anesthesia.
- Patient refusal of local anesthesia.

2.4. Data Collection

A total of 54 consecutive patients undergoing strabismus surgery were included in the study. They were divided into two equal groups (27 patients each). In group I, 1 ml (100 mg/ml) magnesium sulphate added to a mixture of 2 ml lidocaine 2%, 2 ml bupivacaine 0.5% and 1 ml hyaluronidase (150 units/ml) was administered using single percutaneous peribulbar injection with a short (1 inch) needle as described by Rizzo *et al*. [7]. While in group II, a mixture of 1 ml saline added to 2 ml lidocaine 2%, 2 ml bupivacaine 0.5% and 1 ml hyaluronidase (150 units/ml) was administered using the standard peribulbar block technique. The collected data included patients' baseline characteristics, perioperative and early postoperative outcomes and follow-up data.

2.5. Outcome Parameters

2.5.1. Primary

- Ocular anesthesia, akinesia (onset & duration)
- Forced duction test
- Muscle stretch
- Pain score: The intensity of pain was recorded using a numeric pain rating Visual Analog Scale (VAS).
- Postoperative alignment
- Need for intraoperative sedation or local anesthesia supplement

2.5.2. Secondary

- Incidence of Oculo-Cardiac Reflex (OCR)
- Postoperative nausea and vomiting
- Hemodynamic parameters
- Patient satisfaction (numerically from 0 to 10)
- Surgical satisfaction (postoperative alignment)

2.6. Statistical Analysis

Data analysis was carried out using SPSS version 22. All numerical variables were checked for normality by Shapiro Wilk test. Normally distributed numerical variables were presented as mean ± Standard Deviation (SD), and differences between the two groups were tested using Independent T-test. Abnormally distributed numerical variables were expressed as the median and interquartile range (25^{th} - 75^{th} percentile) and differences between the two groups were tested using Mann-Whitney test. Categorical variables were summarized as frequencies and percentages, and the association between the variables was tested using X^2 tests (Pearson's Chi square for

independence or Fisher Exact Tests as appropriate). A *p*-value of < 0.05 was considered statistically significant.

3. RESULTS

Age and ASA physical status of the studied patients were comparable between the two groups ($p > 0.05$) as shown in Table **1**.

The mean elapsed time before the onset of anesthesia and akinesia of the globe was significantly shorter in group I compared with group II (anesthesia: 1.9 ± .7 min and 3.9 ± 1.0 min, akinesia: 2.3 ± 0.7 min and 4.4 ± 1.2 min, respectively). Additionally, the mean duration of anesthesia was significantly higher in group I (180.0 ± 0.0 min) than in group II (43.0 ± 8.5 min) (Table **2**).

During surgery, a positive forced duction test was significantly lower in group I ($p = 0.046$). Muscle stretch was normal in 24 (88.9%) patients in group I compared to only 5 (18.5%) patients in group II with a statistically significant difference ($p < 0.001$). There was no need for sedation in group I compared to 17 (63.0%) patients in group II with a statistically significant difference ($p < 0.001$). Concerning oculo-cardiac reflex, it did not occur in group I (0.0%) but occurred in 9 (33.3%) patients in group II with a statistically significant difference ($p = 0.002$). The operation was performed successfully in all patients with no significant difference regarding postoperative alignment between both the groups ($p = 1.0$). During postoperative follow-up, the median VAS pain score was significantly lower in group I compared with group II (<0.001). The need for postoperative analgesia was significantly lower in group I (0.0%) than group II (48.1%). Patient's satisfaction was significantly higher in group I compared to group II (100.0% *vs.* 25.9% respectively) (Table **3**).

Table 1. Baseline characteristics of the studied patients.

			Groups		Tests of Significance
			Group I N = 27	**Group II N =2 7**	***P* value**
Age	Minimum-Maximum		18.0-67.0	18.0-67.0	1.00
	Mean ± SD		40.6 ± 13.4	40.6 ± 13.3	
ASA	I	N	16	14	0.584
		%	59.3%	51.9%	
	II	N	11	13	
		%	40.7%	48.1%	

ASA: American Society of Anesthesiologists

Table 2. Comparison of anesthesia and akinesia between the studied groups.

		Groups		Tests of Significance
		Group I N = 27	**Group II N = 27**	***P* value**
Anesthesia Onset (Min)	Minimum- Maximum	1.0-3.0	2.0-6.0	< 0.001*
	Mean±SD	1.9 ±0.7	3.9 ±1.0	
Anesthesia Duration (Min)	Minimum- Maximum	180.0-180.0	30.0-60.0	< 0.001*
	Mean±SD	180.0 ±0.0	43.0 ±8.5	
Akinesia Onset (Min)	Minimum- Maximum	1.0-4.0	3.0-7.0	< 0.001*
	Mean±SD	2.3 ±0.7	4.4 ±1.2	

*significant at $p<0.05$

Table 3. Comparison of operative and postoperative outcomes between the studied groups.

		Groups				Tests of Significance
		Group I N=27		**Group II N=27**		
		N	**%**	**N**	**%**	***P* value**
Forced Duction Test	Negative palsy	13	48.1%	6	22.2%	0.046*
	Positive Mechanical restriction: resistance	14	51.9%	21	77.8%	
Muscle Stretch	Abnormal	3	11.1%	22	81.5%	<0.001*
	Normal	24	88.9%	5	18.5%	
Need for Sedation	No	27	100.0%	10	37.0%	<0.001*
	Yes	0	0.0%	17	63.0%	

(Table 3) contd.....

Oculo-Cardiac Reflex	No	27	100.0%	18	66.7%	0.002*
	Yes	0	0.0%	9	33.3%	
Postoperative Alignment	Aligned	27	100.0%	26	96.3%	1.00
	Not aligned	0	0.0%	1	3.7%	
Patient Satisfaction	No	0	0.0%	20	74.1%	<0.001*
	Yes	27	100.0%	7	25.9%	
Postoperative Analgesia	Need	0	0.0%	13	48.1%	<0.001*
	No	27	100.0%	14	51.9%	
Pain Score	Minimum-Maximum	0.0-2.0		3.0-5.0		<0.001*
	Median	1.0		4.0		
	IQR	0.0-2.0		3.0-5.0		
	Mean rank	14.0		41.0		

*significant at $p<0.05$

4. DISCUSSION

This study demonstrated favorable effects of 100 mg magnesium sulphate as an adjuvant to a mixture composed of 2 ml lidocaine 2%, 2 ml bupivacaine 0.5% and 1 ml hyaluronidase (150 units/ml) in peribulbar anesthesia for strabismus surgery in adults. It accelerated the onset of sensory block and globe akinesia and prolonged the duration of globe anesthesia. Thus, time for suitable conditions to start surgery was enhanced. Moreover, magnesium sulphate addition enhanced the quality of operative conditions. It was associated with more normal muscle stretch, with no need for intraoperative sedation and complete prevention of the life-threatening oculocardiac reflex. Also, it increased the patient's satisfaction with no need for postoperative analgesia, besides the absence of any marked side effects.

Magnesium is an important cation, which is necessary for enzymatic reactions in the human body [20]. The anesthetic and analgesic effects of magnesium observed in this study could be explained by its function as a physiological calcium channel blocker and noncompetitive antagonist of N-methyl-D-aspartate receptors [21]. Also, magnesium sulphate has a high therapeutic index and cost-effectiveness [20]. Accordingly, appropriate use of magnesium sulphate would improve surgical outcome and patients' satisfaction in strabismus surgery.

In agreement with our findings, Sinha *et al*. [13] concluded that the addition of 50 mg magnesium sulphate to the lidocaine-bupivacaine mixture for peribulbar block in adult patients scheduled for elective ophthalmic surgery accelerates the onset of akinesia without any obvious side effect. Likewise, effective and safe use of 50 mg magnesium sulphate in patients who underwent elective posterior segment surgery was reported. Impact of magnesium addition was evidenced by fast onset of globe block, long duration of akinesia and analgesia with excellent patient and surgeon satisfaction, besides the absence of systemic or local complication [18]. Similarly, Abd El-hamid [17] reported that the administration of magnesium as a co-factor to the local anesthetic in peribulbar anesthesia for posterior segment eye surgeries accelerated the onset of sensory and motor block without any side effects.

A recent study assessed the efficacy and safety of addition of dexmedetomidine *versus* magnesium sulphate to the local anesthetic mixture for peribulbar block in cataract surgery. Both the drugs enhanced the onset of globe anesthesia and akinesia with no significant changes in the hemodynamic measurements [22].

On the other hand, the addition of 50 mg magnesium sulphate to local anesthesia in older (40-80 years-old) patients who underwent cataract surgery did not show any benefit regarding the onset of block or akinesia score [23]. AbdAlali *et al*. [19] reported better analgesic and anesthetic effects of rocuronium as an additive to local anesthetic drugs in the peribulbar block than magnesium sulphate. Additionally, Abu Elyazed and Mostafa compared 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. They found that magnesium could accelerate the onset of globe anesthesia, akinesia and lid akinesia in comparison to the control group, but still can significantly slower than the fentanyl group [24].

Mogahed *et al*. [25] compared 50 mg *versus* 100 mg of magnesium sulphate in peribulbar block in cataract surgery. They observed more rapid onset and prolonged duration of akinesia and reduction of the postoperative analgesic requirements with a higher dose of magnesium sulphate. This supports our findings, and together they provide an evidence for using 100 mg regimen of magnesium sulphate to achieve better outcomes. Fortunately, the use of 100 mg magnesium sulphate in the present study was safe with no noticed adverse effects.

Supporting evidence of anesthetic effects of magnesium sulphate was previously recorded. Gunduz *et al*. [16] found prolonged sensory and motor block of the axillary nerve when 150 mg magnesium was added to prilocaine without any side effects. When added to bupivacaine, magnesium sulphate improved the onset and the level of the epidural block as well [26].

Strabismus surgery is frequently associated with OCR, and unfavorable consequences of the reflex such as cardiac arrest and sudden death might occur. So, it is essential to accurately control the heart rate during ophthalmic surgeries [13]. Different modalities of treatments have been investigated to prevent or alleviate OCR with conflicting findings [27]. This was considered in our study, and it was observed that magnesium sulphate addition completely inhibited the occurrence of OCR reflex. It is known that OCR reflex is triggered by pressure on the globe, conjunctiva and orbital

structures and traction on the extraocular muscles, and its complete inhibition with magnesium sulfate addition to the local anesthetic might be attributed to the deep globe anesthesia and analgesia [28].

CONCLUSION

Co-administration of 100 units magnesium sulphate with the local anesthetic was effective and safe. It achieved suitable conditions to start surgery rapidly and improved the quality of operative conditions and patient satisfaction.

LIST OF ABBREVIATIONS

PBA	=	Peribulbar Block Anesthesia
ASA	=	American Society of Anesthesiologists
VAS	=	Visual Analog Scale
OCR	=	Oculo-Cardiac Reflex
SD	=	Standard Deviation

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The protocol of this study was approved by the Research Ethics Committee of the Research Institute of Ophthalmology, Cairo, Egypt. All patients' data were kept confidential after assigning a code number to each patient, known only by the researchers.

HUMAN AND ANIMAL RIGHTS

No animals were used in the study. All humans research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2008.

CONSENT FOR PUBLICATION

Informed consent was obtained from each patient.

AVAILABILITY OF DATA AND MATERIALS

Not applicable

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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