Evaluation of the Effect of Using Magnesium Sulphate as an Adjuvant to Regional Anesthesia for Ophthalmic Surgery Using Peribulbar Block

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Abstract

Background: Peribulbar block is commonly used for different ophthalmic surgeries. It is safe, inexpensive, and provides excellent anesthesia and akinesia [1]. It has become a common practice to use polypharmacy approach to enhance the onset and prolong the duration of the block, because no drug has yet been identified that specifically inhibits nociception without associated side effects [2]. Research continues concerning different techniques and drugs that could provide better anesthesia and postoperative pain relief, one of these drugs is magnesium sulphate [3].

Introduction: Magnesium sulphate is a physiological calcium antagonist and competitive N-Methyl-D-Aspartate (NMDA) receptor antagonist. Studies evaluated its effect as an additive to local anesthetics in different regional techniques. Effect of magnesium sulfate supplementation was evaluated by degree of globe and lid akinesia, degree of postoperative pain, time to full motor recovery and duration of analgesia.

Aim of the Work: Is to evaluate the effect of magnesium sulphate as an adjuvant to regional anesthesia for ophthalmic surgery using peribulbar block.

Methods: The present study involved 2 groups; each group included 20 patients undergoing elective posterior segment surgery of the eye under local anesthesia.

- Group (M50) received 50mg of magnesium sulphate in addition to the local anesthetic (2% lidocaine + 0.5% bupivacaine + hyaluronidase).
- Control group (Group C) received only the local anesthetic (2% lidocaine + 0.5% bupivacaine + hyaluronidase).

Results: The addition of 50mg of magnesium sulphate, a competitive NMDA antagonist are safe and effective adjuvant to local anesthetic mixture of bupivacaine and lidocaine in peribulbar eye evidenced by fastening the onset of globe block, increasing duration of akinesia and analgesia with excellent patient and surgeon satisfaction and with the no systemic or local complication. Intraocular pressure was reduced below baseline after 15 minutes of the block, suggesting that magnesium sulphate in a dose of 50mg is a safe adjunct to local anesthetic mixture in peribulbar block.

Conclusion: It was found that the addition of 50mg of magnesium sulphate, a competitive NMDA antagonist is safe and effective as an adjuvant to local anesthetic mixture of bupivacaine and lidocaine in peribulbar eye evidenced by fastening the onset of globe block, increasing duration of akinesia and analgesia with excellent patient and surgeon satisfaction and with no systemic or local complication.

Key Words: Magnesium sulphate – Regional anaesthesia – Ophthalmic surgery – Peribulbar block.

Introduction

MANY ophthalmic procedures, such as cataract extraction, corneal transplants, trabeculectomy, lid surgery, and even vitrectomy or repair of a detached retina, can be performed safely in an outpatient setting, using regional anesthesia and mild sedation. The number of outpatient ophthalmic procedures will increase as health-care costs are contained and the population continues to age, local anesthesia is becoming the ideal technique for most types of ophthalmic procedures, patient comfort, safety and low complication rates are the essentials of local anesthesia. Peribulbar block is a safe and inexpensive technique with advantage of providing efficient anesthesia with good lid and globe kinesis, it's also effective in the treatment of postoperative pain, it has become a common practice to use poly-pharmacy approach to enhance the onset and increase the duration of the block. Local anesthetics are agents that reversibly block action potentials at the level of the sodium channels, thereby interrupting axonal conduction local anesthetics actions are nonspecific: They work on any nerve with a functioning sodium channel.
Knowledge of the structural components of local anesthetics will aid in better understanding how these interesting compounds work. Local anesthetics are composed of a lipophilic/hydrophobic group (an aromatic ring) connected by an amide or ester intermediate chain to a hydrophilic or ionizable group (a secondary or tertiary amine). Those compounds with highly lipophilic/hydrophobic moieties are more potent, more long lasting, and more toxic. This appears to be related to the site of action on the nerve cell membrane.

Adjuvants to local anesthetics are used to improve the quality of local anesthesia (speeds the onset, shortens the duration, decrease the need for post-operative analgesia) for example: Vasoconstrictors such as epinephrine. Hyaluronidase, sodium bicarbonate, clonidine, opioids, atracurium and magnesium sulphate added to lidocaine-bupivacaine mixture of peri-bulbar block.

Magnesium sulphate has been used for many years as an adjuvant to local anesthetics in intrathecal and epidural blocks, magnesium is the fourth most prevalent cation in the body and activates approximately 300 enzyme systems, including many involved in energy metabolism. [Because the biological basis for its potential antinociceptive effect is promising.

These effects are primarily based on physiological calcium antagonism, that is voltage-dependent regulation of calcium influx into the cell, and non-competitive antagonism of N-Methyl-D-Aspartate (NMDA) receptors.

Safe, comfortable and effective akinesia and analgesia of the eye can be obtained using peribulbar block; that is, local anesthetic is injected outside the muscle cone. Complications occur at a very low rate, including; brain-stem anesthesia, retrobulbar hemorrhage, atrophy of optic nerve, spread to anesthetic to contralateral orbit. Disadvantages of peribulbar blocks include large injected volumes, slower onset, possible globe perforation, myotoxicity of anesthetic on inferior rectus muscle causing vertical diplopia.

Patients and Methods

Sixty patients were recruited from the Research Institute of Ophthalmology and the Kasr Einy Anesthesia Department during 2014. The 60 patients were divided into 2 groups, each group has 20 patients, randomly assigned to each group by using a table of random numbers and sealed closed envelopes in a randomized fashion. Patients’ age ranged between 20 to 60 years. Inclusion criteria were normal axial length (18-25mm), ASA I and ASA II. No history of adverse reaction to any study medication.

Exclusion criteria were patients with ASA III and IV, coagulation disorders, communication difficulties preventing reliable assessment, high myopia more than 28mm, staphyloma, marked uncontrolled tremors as parkinsonian head tremors and known or suspected allergies or sensitivity to amide local anesthetics.

After division of the patients in to three groups:

Group 0 (control group):

The local anesthetic prepared in the form of 4.5ml of 2% lidocaine + 4.5ml of 0.5% bupivacaine + hyaluronidase in concentration of 10 units/ml saline + 1ml saline.

Group M 50:

Received magnesium with concentration of 50mg. The magnesium in this group is prepared by adding 0.5ml magnesium with concentration of 50mg/ml + 0.5ml saline. The local anesthetic is prepared in the form of 4.5ml of 2% lidocaine + 4.5ml of 0.5% bupivacaine + hyaluronidase in concentration of 10units/ml + 50mg magnesium in 1ml of saline.

All patients in both groups received the same volume of the local anesthetic mixture.

Patients were subjected to assessment of time to full motor recovery and duration of analgesia, measurements of intraocular pressure at 5 and 15 minutes after the block, measuring of VAS score of postoperative pain and finally the degree of akinesia was assessed at 1, 3 and 5 minutes after the block using a 0-2 score.

Results

Time to full motor recovery and duration of analgesia was significantly longer in group M50 compared to the control groups (p<0.001) (Table 1).

There was significant difference between the two studied groups regarding intraocular pressure at 5 and 15 minutes after the block. However, all levels were within the clinically normal range (Table 2).

Degree of akinesia was assessed 1, 3 and 5 minutes after the block using a 0-2 score. Globe akinesia was significantly higher in group M50 after 1 minute as 60% of cases had score 0 and 8 had score 1 (p<0.001), while all cases of control...
group had score 2. Similarly, globe akinesia was significantly higher in group M50 after 3 minutes; all cases had score 0. After 5 minutes all cases of groups 50 had score 0 (Table 3).

Lid akinesia was significantly higher in group M50 after 1 minute as all cases had score 1 (\(p<0.001\)), while all cases of control group had score 2. Similarly, lid akinesia was significantly higher in group M50 after 3 minutes; 13 cases had score 0. After 5 minutes all of group M50 had score 0 (Table 4).

That VAS score of postoperative pain was significantly lower in group M50 compared to control group immediately after surgery and after 6 hours (Table 5).

**Discussion**

Peribulbar block is commonly used for different ophthalmic surgeries. It is safe, inexpensive, and provides excellent anesthesia and akinesia [1]. It has become a common practice to use polypharmacy approach to enhance the onset and prolong the duration of the block, because no drug has yet been identified that specifically inhibits nociception without associated side effects [2]. Research continues concerning different techniques and drugs that could provide better anesthesia and postoperative pain relief, one of these drugs is magnesium sulphate [3].

Magnesium sulphate is a physiological calcium antagonist and competitive N-Methyl-D-Aspartate (NMDA) receptor antagonist. Studies evaluated its effect as an additive to local anesthetics in different regional techniques e.g.: Intrathecal as an adjunct to local anesthetic in pre-eclamptic patients undergoing cesarean section [4], epidural as an adjuvant to bupivacaine in elective cesarean section [5], and pre-incisional as local infiltration in patient undergoing hysterectomy [6], also it has been used as an adjuvant to prilocaine in axillary brachial plexus block [7] and as an adjuvant to lignocaine for intravenous regional anesthesia [8]. It improves the quality of the anesthesia, increase duration of analgesia and hastens onset of the block in all the above studies.

In the present study we evaluated the effect of magnesium sulphate 50mg as an adjuvant to regional anesthesia for ophthalmic surgeries via peribulbar block was compared to standard technique. The study investigated: degree of globe and lid akinesia (onset of the block), time to full motor recovery, duration of analgesia (defined as time to first analgesic request) and intraocular pressure.

In our study with regard to the onset of globe akinesia the magnesium sulphate groups (50mg) showed a faster onset compared to control group. The onset of akinesia was significantly faster for Group M50 where 60% of the cases got globe akinesia after 1 minute scored 0 and the remaining 40% scored 1. When Group C were evaluated after one minute, all cases scored 2. For all cases to reach complete block (100%) akinesia it took 3 minutes for Group M50 and 5 minutes for control group.

Our results regarding Group M50 coincides with El-Hamidi et al., who measured the onset of

### Table 1: Time to full motor recovery and duration of analgesia in the three studied groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Time to full motor recovery (hrs.)</th>
<th>Duration of analgesia (hrs.)</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2.0±0.2</td>
<td>2.0±0.0</td>
<td>0.010</td>
</tr>
<tr>
<td>M50</td>
<td>1.7±0.2</td>
<td>2.0±0.2</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*: Statistically highly significant compared to (C) group (\(p<0.001\)).

### Table 2: Intraocular pressure at baseline, 5 and 15 minutes after the block in the studied groups.

<table>
<thead>
<tr>
<th>Intraocular pressure</th>
<th>Group C</th>
<th>Group M50</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>16±1</td>
<td>17±2</td>
<td>0.106</td>
</tr>
<tr>
<td>5 minutes after block</td>
<td>24±2</td>
<td>20±2*</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>15 minutes after block</td>
<td>22±2</td>
<td>17±1*</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*: Statistically highly significant compared to (C) group (\(p<0.001\)).

### Table 3: Globe akinesia score 1, 3 and 5 minutes after block in studied groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>1 minute after block</th>
<th>3 minute after block</th>
<th>5 minute after block</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2 (2)</td>
<td>0 (0-1)</td>
<td>0 (0-1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>M50</td>
<td>0 (0-1)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### Table 4: Eye lid akinesia score 1, 3 and 5 minutes after block in the studied groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>1 minute after block</th>
<th>3 minute after block</th>
<th>5 minute after block</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2 (2)</td>
<td>0 (0-1)</td>
<td>0 (0-1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>M50</td>
<td>0 (0-1)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### Table 5: Degree of postoperative pain (VAS score) in the studied groups.

<table>
<thead>
<tr>
<th></th>
<th>Group C</th>
<th>Group M50</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td>3 (2-4)</td>
<td>2 (1-3)*</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>After 6 hours</td>
<td>3 (1-4)</td>
<td>2 (1-2)*</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*: Statistically highly significant compared to (C) group (\(p<0.001\)).
globe akinesia in three groups. All patients had peribulbar anesthetic block using 10ml of bupivacaine 0.5% and lidocaine 2% 1:1 ratio and hyaluronidase (150 units): Control group (previous local anesthetic mixture + 1ml saline), Group M (previous local anesthetic mixture + magnesium sulphate 50mg in 1ml saline 0.9%) and Group C (previous local anesthetic mixture + clonidine 30mic in 1ml saline 0.9% saline).

Their results regarding onset of globe akinesia showed that Group M (50mg magnesium sulphate) was the most rapid, 5% of the cases scored 0 after 1 min, at 3 mins 75% scored 0 where in the present study 100% scored 0 at 3mins this better result may be due smaller volume of local anesthetic used with the same volume of hyaluronidase (150 units) to speed tissue penetration.

Research continues concerning different drugs that could provide faster onset when added as adjuvant to local anesthetics such as atracurium, cisatracurium, clonidine and adrenaline.

In a double blinded randomized study [9] found that addition of low dose of atracurium and cisatracurium to anesthetic drug is recommended in order to accelerate the onset of akinesia resulted by peribulbar block, they noticed that the onset of akinesia in the 1 st and 3 rd minute in the cisatracurium group was better than atracurium and placebo as (66.7% and 81.5%) respectively of the patients underwent total akinesia and the quality of akinesia in the atracurium group (number of patients reaching total akinesia) in 5 and 10 minutes was better, it scored (88.9% and 92.6%) respectively [10]. They also noticed a small percentage of relaxation in extraocular and fascial muscles and they recommended not using hyaluronidase in the upcoming studies for the fear of systemic spread. In contrast to magnesium sulphate who has no effect on the onset or the duration of both lid akinesia and globe akinesia.

The results of the study made by Ehab Saed Bakry 2008, showed that the addition of fentanyl to local anesthetic mixtures in peribulbar block has no effect on the onset or the duration of both lid akinesia and globe akinesia.

In the present study, time to full recovery of motor power and duration of analgesia was significantly longer in Group M50 (5.3±0.8 hours and 5.7±0.5 hours respectively, p<0.001), compared to the control group suggesting that the addition of magnesium to local anesthetic mixture showed clinical and statically significance in duration of motor block and first time to require rescue analgesia than control group (2.0±0.2 hours and 2.0±0.0 hours respectively. The prolongation in the duration of motor block and in duration of analgesia is important in prolonging the paralysis of orbicularis preventing corneal abrasions in vitrectomy surgeries, produce less postoperative restlessness, less bleeding and providing ideal situation for beginner surgeons.

The results of the present study were different than results of study by [9] in regard of duration to full motor recovery they compared magnesium sulphate in one dose of 50mg to clonidine in 30mic, with a finding that Group M in their study (magnesium group) prolonged the duration to full motor recovery (220.7 minutes ±5.8) p<0.05 which is yet less than 5hrs. The present study showed that duration to full motor recovery was longer than 5 hours in Group M50 and Group M50 was clinically and statistically significant than control group.

Our results regarding duration of analgesia was different than Ehab saed bakry, 2008 et al., whom compared the effect of addition of different concentrations of fentanyl (1 µg/ml, 2 µg/ml and 3 µg/ml) to local anesthetic mixtures (lidocaine 2% and hyaluronidase 15IU/ml) on the duration of postoperative analgesia in peribulbar block for cataract surgery. The results of the study showed that the addition of fentanyl to local anesthetic mixtures in peribulbar block prolongs duration of
analgesia, the 2 fentanyl groups (2 µg/ml and 3 µg/ml) showed a significantly prolonged duration of analgesia (116±19.19 mins and 144±0.01 mins) respectively, more than the control and the fentanyl 1 µg/ml group (100.00±13.49 mins and 103.66±15.52 mins) respectively.

Another reported study by A.A Van Den Berg and L.F Montoya-Pelaez, 2001, made a prospective audit of the efficacy of two of the most readily available agents, the short acting lignocaine 2% (with added adrenaline 1:200,000 to enhance its duration of action, the longer acting bupivacaine 0.5% (with or without hyaluronidase to assess the effect of hyaluronidase on speeding its onset of action and the popular mixture of lignocaine/hyaluronidase/bupivacaine. All four agents provided adequate analgesia during cataract extraction lasting approximately 95-100 mins after peribulbar anesthesia injection. In the present study the magnesium sulphate Groups (M25 and M50) was comparatively better as regard duration of analgesia (3.5±0.5 hours and 5.7±0.8 hours) respectively.

The present study also compared the addition of magnesium sulphate to local anesthetics on postoperative pain measurement, the VAS score of postoperative pain was significantly lower in Group M50 compared to control group immediately after surgery and after 6 hours (p<0.001).

In this aspect our results were in line to a study done by Hamidi et al., who showed statistical significant difference between the control group and the other two groups as regard the median VAS at 1, 2, 3, 4, 5, 6 hours. Control group had higher median pain score than the other two groups.

Intraocular pressure differences was shown between the two groups used in our study. At preoperative baseline, Group M50 showed the highest value (17±2) compared to the control group (16±1). Whears, at 5 minutes after block the two groups showed increase at intraocular pressure Group M50 (20±2) and Group C (23±2) and after 15 minutes Group M50 showed the most decrease (17±1) compared to Group C (22±2).

These findings suggest that magnesium sulphate at a dose of 50mg cause decrease in intraocular pressure compared to control group which is important in reducing the pressure effect of the local anesthetic mixture which arrest the circulation to the eye namely pulsatile ocular blood flow for more studies to reveal its role and possible mechanism.

From this study we can conclude that the addition of 50mg of magnesium sulphate, a competitive NMDA antagonist are safe and effective adjuvant to local anesthetic mixture of bupivacaine and lidocaine in peribulbar eye evidenced by fastening the onset of globe block, increasing duration of akinesia and analgesia with excellent patient and surgeon satisfaction and with the no systemic or local complication. Intraocular pressure was reduced below baseline after 15 minutes of the block, suggesting that magnesium sulphate in a dose of 50mg is a safe adjunct to local anesthetic in peribulbar block. Further studies are recommended to evaluate other doses of magnesium sulphate in ophthalmic surgeries.

References
الملخص العربي

إن من الشائع استخدام التخدير الموضعي ما حول العين في جراحات العين حيث أنه آمن، غير مكلف، ويوفر قدر ممتاز من تسكين الألم.

أحد المآلات، فقد أصبح استخدام طريقة العقارات المتعددة ممارسة شائعة من أجل سرعة البدء وإطالة زمن التخدير للعصب، وذلك لأنه ليس له تأثير احتمالي مختصري.

عقار بعينه يمكن إستقبال الألم من دون آثار جانبية مصاحبة.

استمر البحث بخصوص تقنيات وعقارات مختلفة بإمكانها أن تمنع تخفير وتسكين الألم بعد العملية بشكل أفضل، وحده هذه العقارات هو سائلات الماغنسيوم.

بعد سائلات الماغنسيوم مضاد فسيولوجي للكالسيوم ومنافس مضاد للمستقبل NMDA، وقامت دراسات بتقييم أثره كإضافة للتخدير الموضعي في مختلف التحاليف، وتم تقييم تأثير إضافة سائلات الماغنسيوم بحسب درجة ثبات حركة العين والعين، درجة تسكين الألم بعد العملية، الوقت اللازم لعودة الحركة كاملة وفترة ثبات الحركة.

وكائستفاد لهذه الدراسة تم إثبات أن إضافة 0.5 مجم سائلات ماغنسيوم كمضاد منافس للمستقبل NMDA آمن ومؤثر كمساعد لخليط التخدير الموضعي من البيبوفاكتين والليجنيكون في التخدير الموضعي ما حول العين، ويرجع ذلك هو سرعة بدء تخفير العصب للعين، إطالة مدة ثبات الحركة وتفسكين الألم مع رضاء ممتاز من المريض والجراح وبدون مضاعفات جهازية أو موضعية.

وتم إنخفاض ضغط العين تحت المستوى الأساسي بعد 15 دقيقة من تخدير العصب بما يرجع أنه سائلات الماغنسيوم بجرعة 0.5 مجم هو مساعدة آمن لخليط التخدير الموضعي حول العين.