

The Effect of Adding Two Different Doses of Magnesium Sulphate as Adjuvant to Ropivacaine in Peribulbar Block for Cataract Surgery

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Abstract

Background: This study was designed to compare the effects of adding two different doses of magnesium sulphate to the local anesthesia during peribulbar block.

Patients and methods: The study comprised 105 patients undergoing cataract surgeries. The patients were divided randomly into three groups (35 patients in each group): Group I (Control group): patients received peribulbar anesthesia using a mixture of 6 ml of 0.5% ropivacaine, 1 ml (150 IU) hyaluronidase and 1 ml of normal saline, Group II (Mg 50): patients received peribulbar anesthesia using a mixture of 6 ml of 0.5% ropivacaine, 1 ml (150 IU) hyaluronidase and 50 mg of magnesium sulphate in 1 ml saline and Group III (Mg 100): patients received peribulbar anesthesia using a mixture of 6 ml of 0.5% ropivacaine, 1 ml (150 IU) hyaluronidase and 1 ml of 100 mg magnesium sulphate. Corneal sensation and motor block were evaluated, total amount of local anesthetic, duration sensory and motor block were assessed, analgesia was assessed by using visual analogue score (VAS) at the end of surgery, 1 h, 2 h, 4 h and 6 h.

Statistical analysis was done using ANOVA test, Kruskal Wallis test And Chi-square test (χ^2) to study association between qualitative variables. Whenever any of the expected cells were less than five, Fischer's Exact test with Yates correction was used. P- value of <0.05 was considered statistically significant.

Results: Patients received magnesium sulphate showed significantly rapid onset of lid and globe akinesia ($P<0.0001$) and significantly prolonged duration of akinesia than the control ($P<0.0001$). First analgesic requirement is significantly delayed in group II and group III comparison with the control group (group I) ($P<0.0001$). There were statistically significant differences between the three groups as regard the mean VAS in 4 and 6 hours, group II and group III have lower median pain score than group I (control group) ($P<0.0001$).

Conclusion: Addition of 50 mg or 100 mg of magnesium sulfate to ropivacaine in peribulbar block led to rapid onset and prolonged the duration of sensory and motor blockade without adverse effects with reduction of the postoperative analgesic requirements. The results were more significant on using 100 mg magnesium sulfate.

Keywords: Local anesthesia of the eye; Magnesium; Peribulbar block

Introduction

Topical, regional or general anesthesia can be used for ocular surgery. Among regional blocks, peribulbar block is a good choice as it provides efficient anesthesia with good lid and globe akinesia with low incidence of complications [1]. However it has a slow onset of action and frequent supplementations may be needed [2]. So many additives have been used in peribulbar block to hasten the onset of akinesia and increase tissue diffusion such as hyaluronidase, [3] adrenaline, [4] clonidine, [5] corticosteroids, [6] sodium bicarbonate [7] and neuromuscular blocking agents [8]. These agents have many side-effects like allergic reaction, bradycardia, sedation, dryness of mouth, systemic neuromuscular blockade, etc.

Ropivacaine is an aminoamide local anesthetic with less central nervous system and cardiovascular toxicity but with less potent motor block as compared with bupivacaine [9].

Magnesium is the fourth most prevalent cation in the body; it has the properties of noncompetitive inhibition of NmethylDaspartate (NMDA) receptor channels and blocking of calcium influx [10]. Thus, it has been used with local anesthetics in various regional anesthesia techniques to hasten the onset time of block and to improve the quality and duration of anesthesia. [11-13].

This study was designed to examine the effect of adding two different doses of magnesium sulphate 50 mg and 100 mg to local anesthetics in peribulbar block on the onset and duration of lid and globe akinesia and postoperative analgesia to find out which dose is more efficacious in improving the quality of peribulbar block.

Patients and Methods

The study design was a prospective, double-blind, randomized, and controlled trial. Approval was obtained from the local research ethical committee. Patients were eligible for inclusion if they were ASA I-III and undergoing routine cataract extraction surgery. This study was conducted in Tanta University Hospital between June 2016 and

November 2016. The procedure of the peribulbar block and the use of visual analog scale were explained to the patients. Exclusion criteria included communication or language problems, history of allergy to amide local anesthetic agents or hyaluronidase, known anatomical abnormalities or pre-existing extra-ocular muscle palsy, severe systemic disease, active ocular infection, single eye, pregnancy, coagulopathy, taking anti-coagulants, anti-epileptic drugs, anti-psychotic medication, anti-glaucoma drugs, atrioventricular block, and obstructive apnea.

The patients were randomized through a computer-generated randomization sequence into the three groups by using 105 sealed opaque envelopes and each patient chose the envelope which determined his group. Patients were randomly allocated into one of the three following groups: Group I (Control group) (35 patients): patients received peribulbar anesthesia using a mixture of 6 ml of 0.5% ropivacaine, 1 ml (150 IU) hyaluronidase and 1 ml of normal saline. Group II (Mg 50) (35 patients): patients received peribulbar anesthesia using a mixture of 6 ml of 0.5% ropivacaine, 1 ml (150 IU) hyaluronidase (Hyalase[®] 1500 IU, Wockhardt, UK) and 50 mg of magnesium sulphate in 1 ml saline. And Group III (Mg100) (35 patients): patients received peribulbar anesthesia using a mixture of 6 ml of 0.5% ropivacaine, 1 ml (150 IU) hyaluronidase and 1 ml of 100 mg magnesium sulphate.

On arrival at the operating room, an IV line was placed. Routine monitoring including the electrocardiogram, pulse oximetry and noninvasive blood pressure were applied in all patients. A nasal cannula was applied and supplemental oxygen was given throughout the procedure at 2-3 L/min. The eye was prepared with a 5% povidone iodine solution.

The study solutions were prepared by anesthesiologists not participating in the study. According to the randomizing table, the drug to be injected in the peribulbar block was prepared in 10 ml syringes to equal volume of 8 ml in all three groups and labeled indicating only the serial number of the patient. The peribulbar anesthesia was performed by a senior anesthesiologist. Both the anesthesiologist performing the anesthesia and the patient were masked the composition of the anesthetic mixture.

Peribulbar anesthesia was done through single transcutaneous inferolateral injection technique using a 25-gauge, 25 mm bevel disposable needle. Patients were asked to maintain the eye in the primary position. The injection site was identified at the junction of the lateral one-third and medial two-third of the inferior orbital rim in the inferotemporal quadrant. The needle was advanced in an antero-posterior, slightly medial, and cephalad direction. After aspiration, the anesthetic solution was injected in approximately 30 seconds; the local

anesthetic was injected until the presence of a complete drop and fullness of the upper eyelid. Slight external manual pressure with of 4-5 layers of gauze piece was applied over the eye immediately after injection for 5 minutes to promote the spread of local anesthetics and softening of the globe. IOP was measured using indentation tonometry at 5 min before injection and 1, 5 and 10 minutes after injection. Corneal sensation was evaluated using cotton wick at 1, 2, 3, 5 and 10 minutes till the onset of anesthesia, it was assessed on 0-2 scale where 0=no anesthesia, 1=partial but acceptable anesthesia, 2=complete anesthesia. Ocular movement were evaluated before blocking, then 3, 5, and 10 minutes after the block in all four directions using 3-point scale (0-complete akinesia, 1-limited movement, 2- normal movement) for each direction. Optimal time to start the surgery was defined as presence of corneal anesthesia together with the total ocular movement score ≤ 1 and eyelid squeezing score of 0. If one or more of the components of ocular movement showed inadequate motor blockade (akinesia score >3) 10 min after block, supplementary anesthesia (2-3 mL) was injected into the involved quadrant using the same length needle as for the primary block. After that, an additional assessment was performed 5 min later. Any complications were recorded. The total volume of LA solution injected (mL) was calculated. Duration of operation, duration sensory and motor block were assessed by onset of pain and recovery of eyeball movement respectively. Degree of pain was assessed at the end of surgery, 1 h, 2 h, 4 h and 6 h postoperatively by using VAS (0-10 cm; zero cm representing no pain and 10 cm representing the most severe pain). A tablet of paracetamol 500 mg was given if VAS >4 . Total analgesic requirement in 6 hours were recorded.

Statistical analysis of the collected data: Results were collected, tabulated and statistically analyzed by an IBM compatible personal computer with SPSS statistical package version 20 (SPSS Inc. Released 2011. IBM SPSS statistics for windows, version 20.0, Armonk, NY: IBM Corp.). Two types of statistical analysis were done: a) Descriptive statistics e.g. was expressed in: Number (No), percentage (%) mean (\bar{x}) and standard deviation (SD). b) Analytic statistics e.g. ANOVA test was used for comparison of quantitative variables between more than two groups of normally distributed data with LSD test as post Hoc test while; Kruskal Wallis test was used for comparison of quantitative variables between more than two groups of not normal distributed data with Tamhane's test as post hoc test. And Chi-square test (χ^2) was used to study association between qualitative variables. Whenever any of the expected cells were less than five, Fischer's Exact test with Yates correction was used. P- value of <0.05 was considered statistically significant.

Results

	Group I (n=45) Mean \pm SD	Group II (n=45) Mean \pm SD	Group III (n=45) Mean \pm SD	ANOVA	P value
Age	58.93 \pm 5.65	59.13 \pm 4.59	58.91 \pm 5.15	0.02	0.97
Weight	74.53 \pm 4.94	74.88 \pm 5.55	74.56 \pm 5.53	0.15	0.85

Table 1: Mean age and weight distribution among the studied group.

Table 1 Shows mean age and weight showed no significant difference between the 3 groups.

	Group I (n=45)		Group II (n=45)		Group III (n=45)		χ^2	P value
	No.	%	No	%	No.	%		
Gender								
Male	24	53.3	25	55.6	24	53.3	0.06	0.97
Female	21	46.7	20	44.4	21	46.7		

Table 2: Percentage distribution of gender among the studied groups.

Table 2 shows there was no significant difference between male and female distribution between the three groups.

	Group I (n=45) Mean \pm SD	Group II (n=45) Mean \pm SD	Group III (n=45) Mean \pm SD	Kruskal Wallis test	P value
Axial length	24.86 \pm 0.90	24.72 \pm 0.99	24.79 \pm 0.92	F=0.25	0.77
ASA	1.82 \pm 0.61	1.73 \pm 0.61	1.57 \pm 0.62	3.82	0.14
(median)	-2	-2	-3		

Table 3: Mean axial length and ASA among the studied group.

Table 3 shows the axial length and ASA showed no significant difference between the 3 groups.

	Group I (n=45) Mean \pm SD	Group II (n=45) Mean \pm SD	Group III (n=45) Mean \pm SD	Kruskal wallis test	P value	Post Hoc
Motor akinesia score of the 4 intraocular muscles at 3 min	6.31 \pm 2.26 (8.00)	3.13 \pm 0.78 (3.00)	2.44 \pm 0.96 (3.00)	70.26	<0.0001	P1<0.0001 P2<0.0001 P3 0.001
Motor akinesia score of the 4 intraocular muscles at 5 min	1.06 \pm 1.73 (0.00)	0.00 \pm 0.00 (0.00)	0.00 \pm 0.00 (0.00)	28.48	<0.0001	P1<0.0001 P2<0.0001
Motor akinesia score of the 4 intraocular muscles at 10 min	0.44 \pm 1.03 (0.00)	0.00 \pm 0.00 (0.00)	0.00 \pm 0.00 (0.00)	19.11	<0.0001	P1 0.01 P2 0.01
Lid squeeze at 3 min	1.80 \pm 0.40 (2.00)	0.84 \pm 0.36 (1.00)	0.86 \pm 0.34 (1.00)	98.18	<0.0001	P1<0.0001 P2<0.0001 P3 0.98
Lid squeeze at 5 min	2.8 \pm 0.50 (0.00)	0.00 \pm 0.00 (0.00)	0.00 \pm 0.00 (0.00)	26.34	<0.0001	P1 0.001 P2 0.001
Lid squeezing score at 10 min	0.24 \pm 0.52 (0.00)	0.00 \pm 0.00 (0.00)	0.00 \pm 0.00 (0.00)	19.28	<0.0001	P1 0.01 P2 0.01

Table 4: Mean motor akinesia score at different time measures among the three groups.

Table 4 shows P1 for comparison between group I and group II, P2 for comparison between group I and group III, p3 for comparison between group II and group III

This table shows regarding the motor akinesia score at 3 min; group I was significantly higher than both group II and group III, also group II was significantly higher than group III, however, at 5 and 10 min,

group I was significantly higher than both group II and group III. And regarding lid squeezing score, group I was significantly higher than both group II and group III at 3, 5 and 10 min.

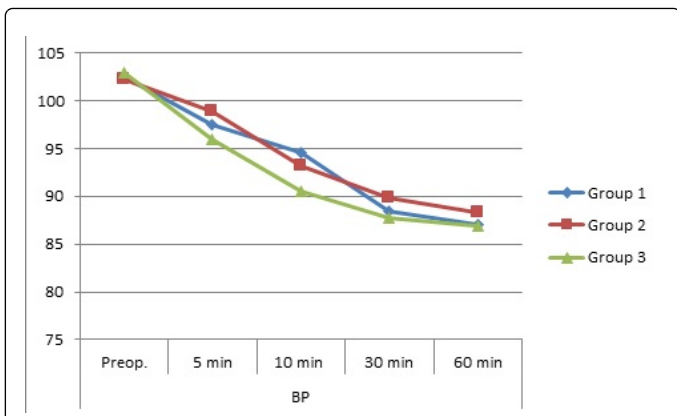


Figure 1: Blood pressure at different time measures in the 3 groups.

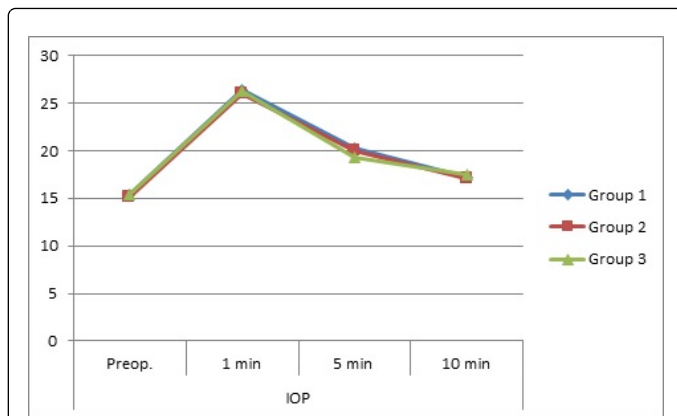


Figure 3: IOP at different time measures in the 3 groups.

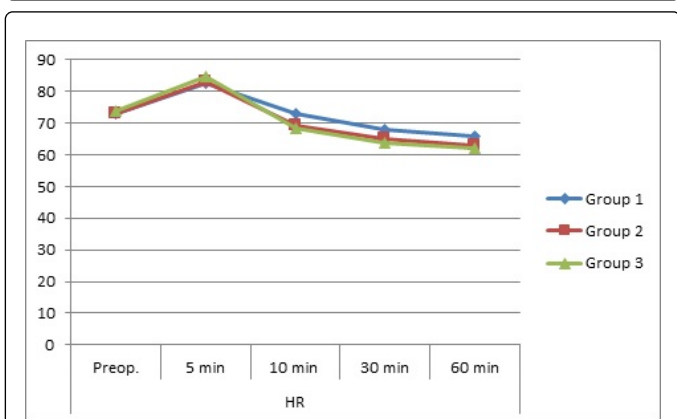


Figure 2: Heart rate at different time measures in the 3 groups.

Table 5 shows that the mean of corneal sensation at 1 min was significantly lower in group I than group III, at 2 min was significantly lower in group I than both group II and III, also group II was significantly lower than group III. And at 3 and 5 min was significantly lower in group I than both group II and III. Blood pressure, heart rate and IOP at different time measures in the 3 groups are shown in Figures 1-3, respectively.

Table 6 shows that there was no significant difference between the 3 groups regarding post-operative pain score at the end of surgery, post-operative pain score at 1h, post-operative pain score at 2h and duration of operation, regarding volume of anesthetic, optimal time to start surgery, postoperative pain score at 4 h and total amount of paracetamol; group I was significantly higher than both groups II and III. While regarding postoperative pain score at 6 h, group I was significantly higher than both group I and II and also group II was higher than group III, and regarding duration of sensory block and motor block, group I was significantly lower than both group I and II. Also, group II was lower than group III.

	Group I (n=45) Mean ± SD	Group II (n=45) Mean ± SD	Group III (n=45) Mean ± SD	Kruskal wallis test	P value	Post Hoc
Corneal sensation at 1 min	0.95 ± 0.36	1.08 ± 0.51	1.22 ± 0.42	7.93	0.01	P1 0.40 P2 0.006 P3 0.45
Corneal sensation s at 2 min	1.42 ± 0.58	1.77 ± 0.42	2.00 ± 0.00	34.35	<0.0001	P1 0.004 P2 <0.001 P3 0.03
Corneal sensation s at 3 min	1.66 ± 0.52	2.00 ± 0.00	2.00 ± 0.00	30.98	<0.0001	P1 <0.001 P2 <0.001 P3 1.00
Corneal sensation s at 5 min	1.75 ± 0.52	2.00 ± 0.00	2.00 ± 0.000	19.12	<0.0001	P1 0.01 P2 0.01 P3 1.00
Corneal sensation s 10	1.86 ± 0.45	2.00 ± 0.00	2.00 ± 0.00	8.18	0.01	P1 0.04 P2 0.04

						P3 1.00
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Table 5: Mean corneal sensation at different time measures.

	Group I (n=45) Mean ± SD	Group II (n=45) Mean ± SD	Group III (n=45) Mean ± SD	Kruskal wallis test	P value	Post hoc
Total volume of anesthetic mixture	8.33 ± 0.95	8.00 ± 0.00	8.00 ± 0.00	F=5.50	0.005	P1 0.005 P2 0.005 P3 1.00
Optimal time to start surgery	6.51 ± 2.75	3.93 ± 0.25	3.77 ± 0.42	112.37	<0.0001	P1<0.001 P2<0.001 P3 0.10
Post-operative pain score at the end of surgery:	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	-----	-----	-----
Post-operative pain score at 1 h	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	-----	-----	-----
Post-operative pain score at 2 h	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	-----	-----	-----
Post-operative pain score at 4 h	3.35 ± 0.90	0.00 ± 0.00	0.00 ± 0.00	124.5	<0.0001	P1<0.001 P2<0.001 P 3 -
Post-operative pain score at 6 h	4.20 ± 0.89	1.75 ± 0.98	0.44 ± 0.58	104.66	<0.0001	P1<0.001 P2<0.001 P3<0.001
Total amount of Paracetamol:	322.22 ± 414.99	22.22 ± 104.20	0.00 ± 0.00	37.19	<0.0001	P1<0.001 P2<0.001 P3 0.40
Duration of sensory block	232.37 ± 8.78	315.31 ± 11.86	360.55 ± 12.80	F=1493.2	<0.0001	P1<0.001 P2<0.001 P3<0.001
Duration of motor block	209.28 ± 8.45	283.33 ± 15.46	330.11 ± 11.71	F=1118.5	<0.0001	P1<0.001 P2<0.001 P3<0.001
Duration of operation	54.24 ± 6.92	52.02 ± 8.59	51.40 ± 7.34	F=1.71	0.18	-----

Table 6: Mean Post-operative pain score at different time measures.

Discussion

The goal of this study was to compare the effect of two different doses of magnesium sulphate as an adjuvant to ropivacaine in the peribulbar block in cataract surgery. Few studies used magnesium as an additive in the peribulbar block [14-16]; however, to our knowledge no one compared between the effects of adding different concentration of magnesium sulphate to the local anesthetic in the peribulbar block.

Magnesium is an additive drug with analgesic and antinociceptive characters. It is used with local anesthetic to prolong the analgesia by blocking NmethylDaspartate (NMDA) channels in voltage dependent fashion and prevent the induction of central sensitization by peripheral nociceptive stimulation [17]. These properties have prompted using

magnesium as an adjuvant for local anesthetics in different techniques as magnesium improves the effect of local anesthetics on peripheral nerve [18,19].

Our study showed significant enhancement of the motor and sensory blocks between the three groups; mean score of motor movement of the four ocular muscles was 6.31 ± 2.26 in the group I, 3.13 ± 0.78 in group II and 2.44 ± 0.96 in group III, but after 5 min it was 1.06 ± in the first group while the second and third groups showed complete motor block. Mean score of lid squeezing of the 1.80 ± 0.40 in the group I, 0.84 ± 0.36 in group II and 0.86 ± 0.34 in group III, but after 5 min it was 2.8 ± 0.50 in the first group while the second and third groups showed complete motor block.

At 2 min, complete block of the corneal sensation occurred in group III, and at 3 min in group II. So, the optimal time to start surgery was shorter in group III (3.77 ± 0.42 min), and group II (3.93 ± 0.25 min) in comparison with group I (6.51 ± 2.75 min).

These results were in agreement with Sinha R et al. [16] who found that adding magnesium sulfate as an adjuvant in peribulbar block results in the earlier onset of akinesia and establishment of suitable conditions to start the ophthalmic surgeries. On the other hand, Tamer Y et al. [14] showed that adding rocuronium to the local anesthetic mixture provides a better akinesia score and faster establishment of suitable conditions to start ophthalmic surgery compared with those in the magnesium and placebo groups. El-Hamid AM et al. [15] found that co-administration of peribulbar magnesium local anesthetic provides predictable rapid onset of anesthesia without any side-effects.

Dogru et al. who added magnesium to levobupivacaine for axillary brachial plexus block in chronic renal failure patients scheduled for arteriovenous fistula surgery and found statistically shorter motor and sensory block onset times [20].

Ekmekci P found that magnesium can reduce the use of non-steroidal anti-inflammatory drugs that causes side effects in postoperative pain management [21].

This was in consistency with our results in which total paracetamol rescue analgesia in the first 6 hours postoperatively was much higher in group I (322.22 ± 414.99), than what was needed in group II (22.22 ± 104.20) while no analgesia was needed in group III.

Our results showed longer durations of sensory and motor blocks in group III (360.55 ± 12.80) and (330.11 ± 11.71), they were (315.31 ± 11.86) and (283.33 ± 15.46) in group II and (232.37 ± 8.78) and (209.28 ± 8.45) respectively.

This was in consistency with many studies that have shown that magnesium associated with decreasing the total analgesic requirements and reducing pain postoperatively by different routes [22-24]. When magnesium sulphate was added as an adjuvant to bupivacaine in ultrasoundguided transversus abdominis plane block in patients underwent total abdominal hysterectomy by subarachnoid block there was a decrease in VAS score postoperatively, and a prolongation in the duration of analgesia and decrease the total amount of rescue analgesia [25]. Also, magnesium sulphate was added to local anesthetic for femoral nerve block and better postoperative pain control was obtained; as it prolongs the sensory and motor block duration without increasing side effects, enhances the quality of postoperative analgesia and increases the time of motor block and decreases the requirements of the rescue analgesic [21], Malleeswaran et al. [26] found that the addition of magnesium to spinal local anesthesia increased the duration of spinal anesthesia by 42 min, Turan et al. [27] made a study on patients who were scheduled for elective hand surgery, they added 10 ml of 15% magnesium to lidocaine in intravenous regional anesthesia (IVRA) and found that the addition of magnesium to lidocaine in IVRA decreased sensory and motor block onset, prolonged the duration of the block and the time to first analgesic requirement but decreased postoperative pain and total amount of rescue analgesic consumption, Hossam A et al. found that adding magnesium sulfate to bupivacaine during femoral nerve block provided a marked prolongation of the duration of both sensory and motor block, and a significant decrease in postoperative pain scores and total dose of analgesic requirements in the first postoperative day. [28] Aytac et al. [29] concluded that the use of magnesium with prilocaine during the block causes pronounced prolongation of

sensory and motor block without side effects, they are suggesting the magnesium as a useful adjuvant to local anesthetics.

Bondok et al. [30] showed that Intra-articular magnesium is effective for postoperative analgesia in arthroscopic knee surgery; as it provided a significant decrease in the postoperative VAS in the first 24 h and a significant decrease in the dose of postoperative rescue analgesia concluding that intra-articular magnesium can be a good alternative for postoperative analgesia. Furthermore, Kashefi et al. [31] Added magnesium sulphate to lidocaine for intravenous regional anesthesia and showed that magnesium sulfate improves the quality of anesthesia and analgesia during regional intravenous anesthesia without causing side effects. Also, it was proved that adding the dose of 100 mg, magnesium in comparison with fentanyl showed better hemodynamic stability with fewer side effects [32].

Many studies compared different doses of magnesium sulphate as an adjuvant to local anesthetics in different surgeries rather than ocular surgery. Nety LK et al. compared three different doses 50, 75, or 100 mg of magnesium sulphate as adjuvant to bupivacaine in spinal anesthesia and noticed prolongation of the duration of sensory and motor blockade without major side effects [33], Also Jabalameli M et al. [34] added three different doses of magnesium i.e. 50, 75 and 100 mg to 0.5% bupivacaine in caesarean section and found that the 100 mg group provided maximum duration of sensory and motor block, Sayed JA et al. [35] compared two different doses of intrathecal magnesium sulphate to bupivacaine fentanyl spinal anesthesia in mild preeclamptic patients undergoing caesarean section. And found the prolongation of onset as well as time to regression of sensory block was more with 100 mg of magnesium as compared to 50 mg.

Jabalameli M et al. added different doses 50, 75, or 100 mg of intrathecal magnesium sulfate to hyperbaric bupivacaine for spinal anesthesia in the cesarean section in a prospective double blind randomized trial and found significant delay in the onset of both sensory and motor block, and prolonged the duration of sensory and motor blockade without increasing side effects [36].

Conclusion

Co-administration of 50 mg or 100 mg of magnesium sulfate to ropivacaine in peribulbar block enhances the onset and prolong the duration of sensory and motor blockade without adverse effects with reduction of the postoperative analgesic requirements. The results were more significant on using 100 mg magnesium sulfate.

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