Original Article

The role of magnesium sulfate in tracheal intubation without muscle relaxation in patients undergoing ophthalmic surgery

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Background: Muscle relaxant agents usually use to facilitate tracheal intubation; however, sometimes limitations exist. Magnesium (Mg) sulfate is a candidate for muscle relaxant substitute. This study was designed to determine the effect of Mg sulfate accompanied with propofol and fentanyl in patients undergoing ophthalmic surgery. **Materials and Methods:** In a double-blind randomized protocol and before tracheal intubation, Mg sulfate 40, 45, or 50 mg/kg in 100 ml of saline (Groups 1–3, respectively) or saline alone (Group 4) were administrated intravenously in 100 patients ($n = 25$ in each group) with the American Society of Anesthesiologist (ASA) physical Status I, II, or III. The patients' intubation condition in all subjects were determined and described. **Results:** The patients' demographic data including age, ASA, systolic and diastolic blood pressures, intraocular pressure, and body mass index were not significantly different between the groups. A better mask ventilation feasibility in Mg sulfate 45 group (Group 2) was observed when compared with Mg sulfate 50 (Group 3) ($P = 0.022$) and saline group (Group 4) ($P = 0.021$). In addition, the vocal cord movement and muscle relaxant requirement in saline group were significantly different from others groups ($P < 0.05$). The laryngoscopic time in saline group was greater than other groups significantly ($P < 0.0001$). **Conclusion:** Intravenous administration of Mg sulfate accompanied with propofol and fentanyl facilitates the tracheal intubation without neuromuscular blocking agents. To avoid Mg level increasing in plasma; however, the low dose of Mg sulfate is suggested.

Key words: Anesthesia, magnesium sulfate, tracheal intubation

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INTRODUCTION

Magnesium (Mg) is one of the most common cations in the intracellular fluid space that inhibits calcium entry into cell via blockade of N-methyl-D-aspartate (NMDA) receptor.[1] Mg has analgesic, anesthetic, and muscular relaxant effects.[2-4] NMDA receptor and Mg play an important role in pain pathway and control.[5] The previous studies have been demonstrated that Mg sulfate had effective role in eclampsia,[6-8] and intravenous administration of Mg sulfate also has preventive role in postoperative hyperalgesia.[9-11]

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Neuromuscular blocking agents are usually used during anesthesia to facilitate tracheal intubation. However, they are accompanied with some side effect, and it is extremely important for the anesthesiologist to have an appropriate tracheal intubation without using neuromuscular blocking agents. Aissaoui *et al*. designed a double-blind study in patient with American Society of Anesthesiologists (ASAs) I and II, and they reported that Mg sulfate improved intubation without using the neuromuscular blocking drug.[12] Hans *et al*. concluded that intravenous administration of 50 mg/kg of Mg reduced the train-of-four ratio in patients when compared with control group.[13]

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In patient undergoing thyroidectomy, 30 mg/kg of Mg sulfate administration prevented remifentanil-induced hyperalgesia[14] while in patient undergoing thoracotomy, a bolus dose of 30–50 mg/kg of Mg sulfate followed by continuous dose of 500 mg/h during the operation reduced intraoperative analgesic requirement.[15] It is suggested to find the role of Mg intracheal intubation old patients.[12] Therefore, this study was designed to determine the effect of Mg sulfate accompanied with propofol and fentanyl as anesthesia induction in 60–85-year-old patients undergoing ophthalmic surgery.

MATERIALS AND METHODS

This study was designed as a double-blind clinical trial in 100 patients undergoing ophthalmic surgery in Feiz Hospital during the year of 2013, and it was approved by Isfahan University of Medical Sciences Ethic Committee. Written informed consent was obtained from each patient after introduce them with study detail and design. The including criteria was 60–85 years old, physical Status of I, II, or III based on ASA, Class of 1, 2, or 3 from modified Mallampati test, Class of 1, 2, or 3 from upper lip bite test (ULBT), body mass index (BMI) between 20 and 30, and thyromental distance (TMD) >6.5 cm. As excluding criteria, the patients with a history of hyper reactive airways disease, treatment with calcium channel blockers, renal, cardiovascular, respiratory or hepatic diseases, or allergy to any of study drugs were excluded from the study. All patients were in non per oral (NPO) condition for 8 h, and during this period they were received 1/3–2/3 crystalloid solution based on 4, 2, 1 law. They were subjected to Mallampati test, ULBT and TMD determination. The Mallampati class was assessed by asking the patients in sitting posture to open his/her mouth and protrude the tongue as much as possible. The Mallampati classes were classified as Class 1: Soft palate, uvula, fauces, pillaris visible; Class 2: Soft palate, uvula, fauces visible; Class 3: Soft palate, base of uvula visible, and Class 4: Only hard palate visible. ULBT was achieved by asking the patients to bite their upper lip with lower incisor, and it was categorized as Class 1: Lower incisor can hide mucosa of the upper lip; Class 2: Lower incisor can partially hide mucosa of the upper lip, and Class 3: Lower incisor unable to touch mucosa of upper lip. The TMD was measured from the thyroid notch to the tip of the jaw with head extended. Blood samples were obtained before the operation for determination of serum Mg. Before and during the operation, all patients were monitored via electrocardiogram, heart rate (HR), oxygen saturation, and noninvasive blood pressure; systolic blood pressure (SBP) and diastolic blood pressure (DBP) determination.

The patients were randomly divided into four groups using the random table numbers list. The first number was assigned to the first group and so on. The randomization and drug infusion were blind for the anesthesiologist. Before infusion of any drugs, intraocular pressure (IOP) was measured and recorded (Applanation Tono-Pen, Avia, Reichert Inc., Depew, NY, USA). The patients (total = 100) received 40 (Group 1, n = 25), 45 (Group 2, n = 25), 50 (Group 3, n = 25) mg/kg of Mg sulfate in 100 ml of saline, and saline alone (Group 4, n = 25). The infusion time for Mg sulfate/or saline was 10 min, and 7 min after the beginning of Mg sulfate infusion fentanyl (3 µg/kg) was administrated intravenously in the period of 3 min accompanied with oxygenation. Finally, propofol (2.5 mg/kg) was infused intravenously in 15 s, and 1 min later, the patient was subjected to tracheal intubation. The time from laryngoscope entrance to the end of tracheal intubation was recorded. Ten min after tracheal intubation, the second blood sample for Mg determination was obtained. The serum level of Mg was measured by an autoanalyzer using Pars Azmoon (Tehran, Iran) kit.

Statistical analysis

Based on the previous study, the acceptable intubation condition (IC) in was 60%[12] and need to improve to 90% by Mg sulfate. Therefore, at 5% level of significant and 75% power, using the following formula including $Z_{1-\alpha/2} = 1.96$, $Z_{1-\beta} = 0.67$, $P_1 = 0.9$ and $P_2 = 0.60$, to estimate the sample size.

$$n = (Z_{1-\alpha/2} + Z_{1-\beta})^2 (P_1 [1 - P_1] + P_2 [1 - P_2])/(P_1 - P_2)^2$$

Accordingly, at least 25 patients were needed in each group. Data for age, BMI, IOP, TMD, SBP, DBP, HR, and laryngoscopic time (LT) [Tables 1 and 2], and for Mg [Figure 1] were reported as a mean ± standard deviation. These data were analyzed using one-way analysis of variance (ANOVA) and least significance difference as post. Other data reported as percent of occurrences. Based on analysis needs test. Chi-square, Kruskal–Wallis test or Mann–Whitney U-test, $P < 0.05$ was considered statistically significant.

RESULTS

Patients' characteristics and demographic data

The patients' characteristics and demographic data in four groups of patients are tabulated in Table 1. There are no significant differences between the groups. The patients from all groups were candidate for surgery of cataract, strabismus, retina, dacryocystorhinostomy, deep vitrectomy or corneal transplantation with no significant difference between the groups in kind of surgery (P = 0.59).

Patients' intubation condition

The patients' IC in four groups of patients is tabulated in Table 2. A better mask ventilation feasibility (MVF)

Table 1: The patients' characteristics and demographic data in four groups of patients

Parameter	Group 1 Mg sulfate 40 (%)	Group 2 Mg sulfate 45 (%)	Group 3 Mg sulfate 50 (%)	Group 4 saline (%)	*P*
Age (year)	70.2±7.8	68.5±7.7	68.7±6.9	67.5±9.7	0.70
Sex (female/male)	10/15 (40/60)	13/12 (52/48)	13/12 (52/48)	10/15 (40/60)	0.69
BMI (kg/m^2)	24.5±3.5	24.8±2.7	24.5±3.2	24.3±3.5	0.69
ASA (I/II/III)	6/17/2 (24/68/8)	4/19/2 (16/76/8)	4/20/1 (16/80/4)	1/22/2 (4/88/8)	0.43
IOP (mmHg)	17.7±3.9	18.2±4.0	16.9±3.6	16.6±3.7	0.47
Mallampati classes (I/II/III)	12/12/1 (48/48/4)	14/11/0 (56/44/0)	13/12/0 (52/48/0)	11/14/0 (44/56/0)	0.59
ULBT (I/II/III)	18/6/1 (72/24/4)	17/7/1 (68/28/4)	16/9/0 (64/36/0)	17/6/2 (68/24/8)	0.68
TMD (cm)	7.0±0.4	7.2±0.6	7.1±0.6	7.3±0.7	0.39
SBP (mmHg)	147.4±31.5	134.0±16.9	139.0±23.0	132.8±17.8	0.10
DBP (mmHg)	85.0±15.2	81.3±15.5	80.8±10.6	78.3±8.5	0.33
HR (beat/min)	79.5±14.1	77.9±12.2	82.7±14.2	77.2±11.8	0.46

ANOVA test was used for the parameters of age, BMI, IOP, TMD, SBP, DBP, and HR. For others parameters, Chi-square was applied. BMI = Body mass index; ASA = American Society of Anesthesiologists; IOP = Intraocular pressure; ULBT = Upper lip bite test; TMD = Thyromental distance; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; HR = Heart rate; ANOVA = Analysis of variance; Mg = Magnesium

Table 2: The patients' intubation condition in four groups of patients

Parameter	Group 1 (%)	Group 2 (%)	Group 3 (%)	Group 4 (%)	*P*
MVF (I/II/III)	23/2/0 (92/8/0)	24/1/0 (96/4/0)	18/7/0$^{\#}$ (72/28/0)	18/6/1$^{\#}$ (72/24/4)	0.03
LD (I/II/III)	17/7/1 (68/28/4)	19/5/1 (76/20/4)	18/6/1 (72/24/4)	15/7/3 (60/28/12)	0.58
CL (I/II/III/IV)	17/7/1/0 (68/28/4/0)	17/8/0/0 (68/32/0/0)	20/4/1/0 (80/16/4/0)	20/3/1/1 (80/12/4/4)	0.71
IC (I/II/III)	15/10/0 (60/40/0)	14/9/2 (56/36/8)	11/14/0 (44/56/0)	11/8/6 (44/32/24)	0.32
VCM (I/II/III)	14/11/0 (56/44/0)	14/11/0 (56/44/0)	13/10/2 (52/40/8)	5/9/11$^{*,\#,\dagger}$ (20/36/44)	<0.0001
ITR (0/I/II/III)	1/3/8/13 (4/12/32/52)	12/7/3/3 (48/28/12/12)	6/10/5/4 (24/40/20/16)	8/6/4/7 (32/24/16/28)	0.15
MRR, *n* (%)	0	0	1 (4)	11 (44)$^{*,\#,\dagger}$	<0.0001
LT (s)	8.6±2.3	9.2±3.3	9.7±2.2	14.2±5.8$^{*,\#,\dagger}$	<0.0001

Significant difference from *Group 1, #Group 2, or †Group 3 (P<0.05). ANOVA test followed by LSD as posttest for LT, Kruskal-Wallis test, and Mann-Whitney U-test (to compare each two groups) tests for MRR and Chi-square for the other parameters were used. MVF = Mask ventilation feasibility; LD = Laryngoscopic difficulty; CL = Cormack-Lehane; IC = Intubation condition; ITR = Intubation response; VCM = Vocal cord movement; MRR = Muscle relaxant requirement; LT = Laryngoscopic time; LSD = Least significance difference; ANOVA = Analysis of variance

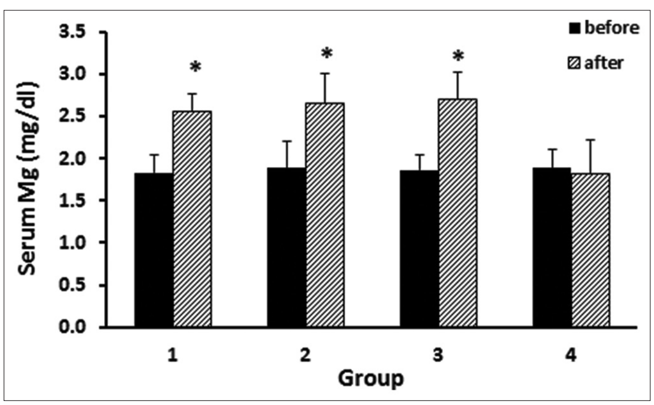

Figure 1: The serum level of magnesium before and after tracheal intubation in patients. The star indicates significant difference from Group 4 using one-way analysis of variance (P < 0.0001)

in Mg sulfate 45 group (Group 2) was observed when compared with Mg sulfate 50 group (Group 3) (P = 0.022) and Group 4 (saline group) (P = 0.021). No significant differences were detected in laryngoscopic difficulty (LD), Cormack–Lehane (CL) classifications, IC classifications, and intubation response (ITR) classifications between the groups. However, the vocal cord movement (VCM) and muscle relaxant requirement (MRR) in Group 4 was significantly different from others groups (P < 0.05); that mean MRR was greater in Group 4 than other groups. The LT in Group 4 also was greater than other groups significantly (P < 0.0001).

Patients' hemodynamic condition

The average reduction of IOP after tracheal intubation was 5.2 ± 4.1 mmHg with no significant differences between the groups. The data for SBP, DBP, and HR in all the patients were tabulated in Table 1, and no significant differences were observed between the groups.

Patients' serum level of magnesium

The serum level of Mg before and 10 min after the end of Mg sulfate or saline infusion is demonstrated in Figure 1. Before infusion, the serum level of Mg were 1.86 ± 0.18, 1.89 ± 0.32, 1.83 ± 0.22, 1.89 ± 0.21 mg/dl in Groups 1–4, respectively. However, it reached to 2.70 ± 0.32, 2.65 ± 0.35, 2.56 ± 0.21, and 1.82 ± 0.0.40 mg/dl accordingly. No significant differences were obtained before Mg sulfate/or saline infusion between the groups. However, the serum level of Mg in saline group (Group 4) was less than other groups significantly after intubation (P < 0.0001).

DISCUSSION

The main objective of this study was to determine the effect of different dose of Mg accompanied with propofol and fentanyl as anesthesia induction in 60–85-year-old patients undergoing ophthalmic surgery. Our finding indicated that MVF qualification was better in Mg sulfate 45 group (Group 2). This factor was not determined in Aissaoui *et al*. study.[12] However, similar result to Aissaoui *et al*. study was found for VCM data indicating the positive effect role of Mg sulfate during laryngoscopy. Each dose of Mg sulfate caused the lesser needs of MRR. Similar to our study, Hans *et al*. used rocuronium for tracheal intubation, and they reported that administration of Mg reestablishes the degree of muscle paralysis.[13] Other study demonstrated that 10 and 20 mg/kg of Mg before rocuronium reduced the overall movement in patients.[16] On the contrary, some of our findings such as LD, CL, IC, or ITR are different from other studies,[12,13] and possibly the non-similarity is related to our study power. Regarding hemodynamics response, we did not find a significant decrease in SBP, DBP, or HR after drugs infusion and after anesthesia induction while Puri *et al*. showed that Mg sulfate infusion reduced mean arterial pressure by 17%.[17] Similar to our results, Aissaoui *et al*. study also did not indicate any significant difference in HR and mean arterial pressure between Mg sulfate receiver and control groups.[12] Mg sulfate administration increased the serum level of Mg after intubation. However, no significant difference in serum level of Mg was observed when different doses of Mg sulfate (40, 45, or 50 mg/kg) were infused. Aissaoui *et al*. did not measured the serum level of Mg,[12] but other studies demonstrated that Mg sulfate (50 mg/kg) increase the serum level of Mg.[18,19] In our study, the serum level of Mg was increased about 40% which is not clinically significant with any adverse effect.[11]

CONCLUSION

When clinical limitation is existed to use muscle relaxant, intravenous infusion of Mg sulfate could be a choice to facilitate tracheal intubation, and the infused Mg sulfate does not elevate the plasma level of Mg to clinical significant.

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Conflicts of interest

There are no conflicts of interest.

AUTHORS' CONTRIBUTION

HAS was involved in study design, collecting the data and in preparing the article. SJH was involved in study design, collecting the data and in preparing the article and data analysis. KM and AD contributed equally for data collection and preparing the article. MN was involved in study design, part of laboratory data collection, data analysis and preparing the final draft of the article.

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