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Magnesium sulfate administration in difficult laryngoscopy: An effective and safe method

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ABSTRACT

Purpose: Difficult laryngeal exposure during laryngeal microsurgery and laser surgery is a major concern for otolaryngologists. This study evaluated the efficacy and safety of magnesium sulfate administration in difficult laryngeal exposure patients.
Study design: Quasi-experimental design.
Materials and methods: Forty adult patients scheduled for laryngeal microsurgery with difficult laryngeal exposure according to Cormack-Lehane (CL) classification were included. Magnesium sulfate 50% (20–30 mg/kg) *w*as administered as a bolus injection. Laryngeal exposure and hemodynamic stability were evaluated before and after the intervention.
Results: CL grading was shown a statistically significant improvement after magnesium sulfate administration. There are no clinically significant changes in the mean arterial pressure, heart rate, and oxygen saturation levels in the patients who received magnesium sulfate for better laryngeal exposure.
Conclusion: Magnesium sulfate is an effective and safe drug for better viewing in difficult laryngeal exposure patients.

1. Introduction

One of the challenges for otolaryngologists' indirect laryngoscopy (DL) is full access to the larynx for laryngeal microsurgery (LMS) and transoral laser microsurgery (TLM). This lack of access, especially in the anterior glottis, causes an incomplete surgery and even termination of the operation with a poor outcome [1].

Possible reasons of this lack of access to the larynx that makes this operation difficult and sometimes unsuccessful are due to problems in the head and neck such as short neck, retrognathia, macroglossia, stiffness of cervical spine and prominent incisors. Inadequate relaxation of pharyngeal and neck muscles is another factor leading to difficult laryngeal exposure [2,3].

There are several ways to overcome difficult access to the larynx during direct laryngoscopy. These include adding and increasing neuromuscular blocking agents [4], position adjustment to head extension and elevation with neck flexion (sniffing) [5], and using a variety of laryngoscopes such as a curved video-assisted laryngoscope [6].

Magnesium sulfate inhibits muscle fiber contractility by competitive blocking of intracellular calcium channels and reducing cytosolic calcium concentration. It also inhibits acetylcholine (ACh) release at the motor endplates that, causes reducing muscle fiber excitability in response to neural signals. Magnesium competitively blocks the entry of calcium into the pre-synaptic membrane. In addition to reducing the release of ACh from the pre-synaptic membrane, magnesium reduces the stimulatory effect of ACh on the postsynaptic muscle fiber receptors. As a result, the axonal stimulation threshold is increased [7,8].

Magnesium also blocks N-Methyl-D-aspartate (NMDA) glutamate receptors. This receptor block inhibits central sensitization to pain stimuli and attenuates pain sensitivity [9].

In this study, we evaluated the efficacy of magnesium sulfate on

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improving visualization in difficult laryngeal exposure patients during direct laryngoscopy. We designed a non-randomized trial to achieve this goal.

2. Materials and methods

This study was approved by the Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.MED.REC.1400.127) and the Iranian Registry of Clinical Trials (IRCT2021712051865N1). Informed consent was obtained from all patients scheduled for LMS about the possibility of difficult exposure and magnesium sulfate intervention.

In this study, 40 adult patients aged between 16 and 65 years who underwent laryngeal microsurgery (LMS) and had difficult access to the larynx according to the Cormack-Lehane (CL) scoring system were included. Initially, we conducted a pilot study with 16 patients after ethical approval. The success rate defined by improving in CL score in that study was over 85%. Therefore, after statistical consultation, 40 patients were considered for the study. Due to the administration of a standard dose of muscle relaxant and optimization of position in all difficult cases, we did not have another known option for assigning a control group in this study.

In preoperative assessment, height, weight, and vital signs were measured and recorded by an anesthesiologist. All patients had grade 1 or 2 of physical status according to the American Society of Anesthesiologists (ASA) classification. During the operation and in the recovery room, monitoring of mean arterial pressure (MAP), heart rate (HR), oxygen saturation, and electrocardiogram (ECG) was done.

After getting the intravenous line in the operating room, all patients initially received midazolam (30–70 μg/kg) and fentanyl (2 μg/kg) as premedication. For anesthesia induction we used propofol (2.5 mg/kg) and atracurium (0.6 mg/kg) over a period of 20 s. Anesthesia was maintained using 1–1.5% isoflurane and 50% nitrous oxide in oxygen if the laser was not used. In laser surgery cases, anesthesia was maintained with propofol infusion (100–200 μg/kg/min). Intubation was done for all patients with cuffed endotracheal tubes of internal diameter 5.5 to 6 mm.

Laryngoscopy was done through a long-blade Holinger anterior commissure laryngoscope and a fulcrum type suspension device to get better exposure to the larynx 4 to 10 min after the induction of anesthesia (Fig. 2). This delay in laryngoscopy was due to the reaching of sufficient depth of anesthesia and muscle relaxation following anesthesia induction. All Laryngoscopic procedures were performed by an experienced laryngologist in the presence of an anesthesiologist familiar with difficult airway management. The laryngeal view was assessed using the modified CL classification. It is one of the most practical scoring system for laryngeal view [10–12] Laryngoscopic view according to modified CL includes grade1: full view of the glottis, grade2a: partial view of the glottis, grade2b: only arytenoids seen, grade3: only epiglottis seen, grade4: neither glottis or epiglottis seen.

Patients with grade 2 or higher according to modified CL classification were included in this study. These difficult laryngeal viewing patients received 20–30 mg/kg of magnesium sulfate 50% (DarouPakhsh, Iran) as a bolus injection. Patients with drug hypersensitivity and cardiovascular, respiratory, renal, and neuromuscular diseases were excluded.

Mean arterial pressure, HR, and oxygen saturation levels were recorded at three predetermined times of the anesthesia induction, 3 to 5 min after magnesium sulfate injection, and at the recovery room to determine the hemodynamic stability following magnesium sulfate administration.

2.1. Statistical analysis

The normality of the data was checked with the Shapiro-Wilk test, as well as the values of kurtosis and skewness. Continuous variables were presented by mean ± standard error of the mean (Mean (SEM)), and those related to the quantitative or categorical data were shown by frequency and percentage. We used repeated-measures analysis of variance (Re ANOVA) and Bonferroni post hoc test to compare quantitative data such as the mean of arterial pressure (MAP), heart rate (HR), and O_2 saturation (O_2 sat) at three different times. Wilcoxon test was used for comparison of non-parametric data. The values of $P < 0.05$ were considered statistically significant. The statistical analysis was performed by Statistical Package for Social Sciences version 16 (SPSS Inc., Chicago, IL, USA).

3. Results

Our study's demographic data, Mallampati, and ASA classification were presented as frequency, percentage, and Mean (SEM) (Table 1).

We used the Wilcoxon test since the CL grading didn't have a normal distribution. The results showed a statistically significant difference between before and after magnesium sulfate injection for CL classification. According to the median of the data (first quartile - third quartile), the distribution of scores after drug administration was statistically reduced ($p < 0.001$). CL classification was shown improvement for thirty-nine of forty patients (97.5%), and only one person remained unchanged (Table 2).

For MAP, we tested the validity of the sphericity assumption by Mauchly's sphericity test. The results are summarized in Table 3. Bonferroni post hoc test was used for multiple comparisons at three times. The results were shown that there was a statistically significant difference in the MAP at three different times ($P < 0.001$). Bonferroni post hoc test showed that MAP at times 1 and 2 and 1 and 3 were statistically significant ($p < 0.001$). But the difference between time 2 and 3 wasn't significant ($p > 0.999$) (Fig. 1. A).

To compare HR at three different times, Mauchly's test of sphericity indicated that the assumption of sphericity had been violated; therefore, a Greenhouse-Geisser correction was used. The results were statistically significant ($p = 0.036$). Bonferroni post hoc test represented that the difference between HR at times 1 and 2 and 2 and 3 were statistically significant, and p values were 0.003 and 0.033, respectively. But the difference between time 1 and 3 wasn't significant ($p > 0.999$) (Table 3, Fig. 1B).

The sphericity assumption is satisfied for comparison of O_2 sat at three times. The results were shown that there was no statistically significant difference at three times (Table 3 & Fig. 1C).

No clinically significant changes were observed in the MAP, HR, and O_2 sat in the patients who received magnesium sulfate during anesthesia and post-operation.

Table 1
Demographic data, Mallampati, and ASA classification in the patients who received magnesium sulfate.

Variables	Value Total, $N = 40$
Sex	
Male, n (%)	29 (72.5)
Female, n (%)	11 (27.5)
Age (year), mean (SEM)	50.48 (1.63)
BMI[a] (kg m^{-2}), mean (SEM)	26.58 (0.71)
Mallampati class (I, II, III, IV), n (%)	I: 19 (47.5)
	II:18 (45)
	III: 3 (7.5)
	IV:0 (0)
ASA class (1,2,3,4), n (%)	1: 17 (42.5)
	2: 23 (57.5)
	3: 0 (0)
	4: 0 (0)

[a] Body mass index (BMI).

Table 2
CL grading in the patients on time 1 (before magnesium sulfate injection), time 2 (about 3 to 5 min after magnesium sulfate injection).

Variables	Time		p-Value
	1	2	
CL grading	IIb (Q25%: IIa, Q75%: IIb)	I (Q25%: I, Q75%: IIa)	<0.001

Data were presented as median (IQR) for CL grading. IQR: Interquartile Range.

Table 3
Distribution of the MAP, HR, and O_2 sat in the patients on time 1 (during induction of anesthesia), time 2 (about 3 to 5 min after magnesium sulfate injection), and time 3 (in the recovery room).

Variables	Time			p-Value
	1	2	3	
MAP (mm Hg)	99.37 (1.65)	88.67 (1.57)	90.40 (1.40)	<0.001
HR (bpm)	81.87 (2.32)	76.37 (1.57)	81.22 (1.25)	0.036
O_2 sat (%)	98.15(0.21)	98.05 (0.24)	97.65 (0.19)	0.145

Data were presented as Mean (SEM) for mean arterial pressure (MAP), heart rate (HR), and O_2 saturation (O_2 sat).

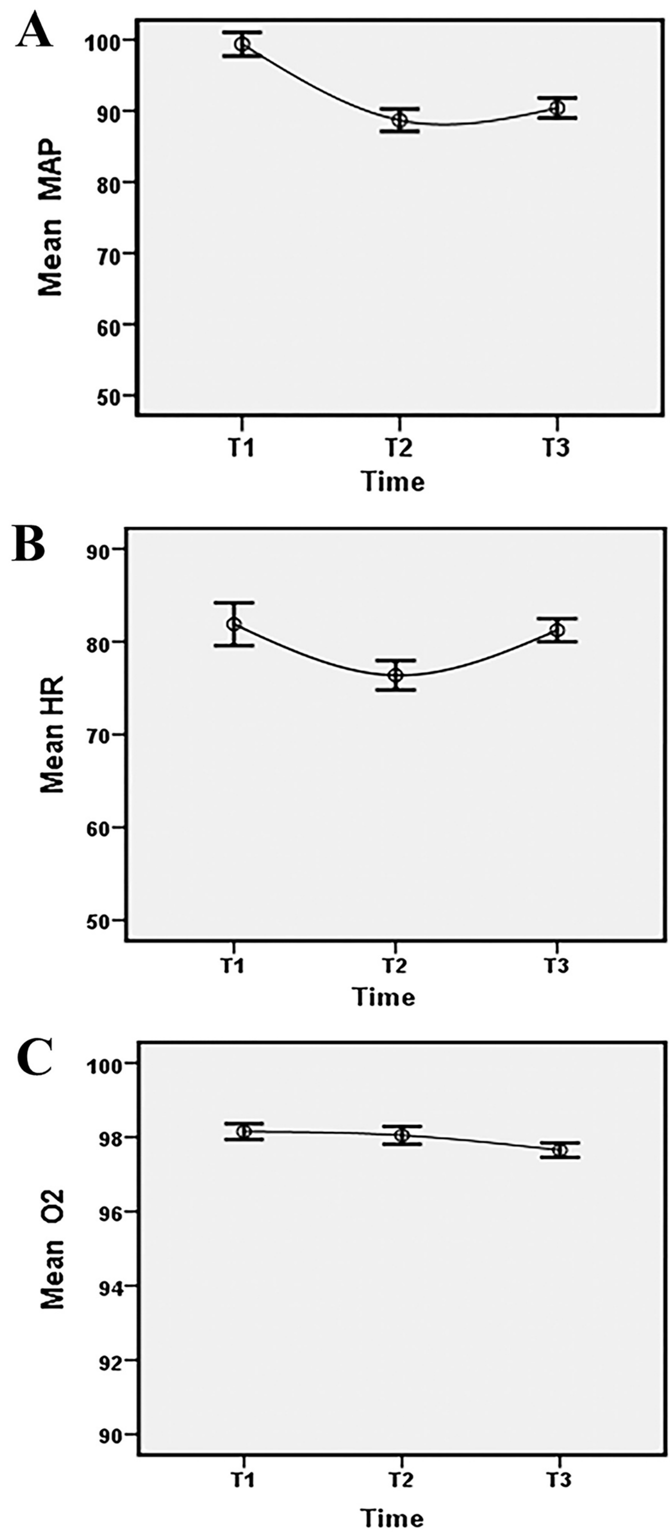

Fig. 1. Data were demonstrated as Mean (SEM) for mean arterial pressure (MAP), heart rate (HR), and O_2 saturation (O_2 sat) in 3 times (T1: during induction of anesthesia, T2: about 3 to 5 min after magnesium sulfate injection, and T3: in the recovery room).

4. Discussion

Our study shows that magnesium sulfate improves laryngeal accessibility in difficult laryngeal exposure patients during direct laryngoscopy and laryngeal microsurgery (Table 2). Our results also indicate the safety of this drug without adverse hemodynamic effects during laryngoscopy in prescribed doses (Table 3, Fig. 1).

There are different clinical situations that magnesium sulfate is administrated. Some common magnesium sulfate clinical indications include preeclampsia [13], eclampsia [14], preterm labor [15], and bronchial asthma [16]. Magnesium sulfate is also used as an adjuvant drug in anesthesia. The role of magnesium sulfate as a pain reliever and also anesthetics that reduces the need for medications with more efficient anesthesia has been proven [17,18].

Evidence also has shown the effect of muscle relaxation following magnesium sulfate administration. Blocking intracellular calcium channels and inhibiting pre-synaptic acetylcholine release are the mechanisms that cause this effect [19,20]. Some studies have demonstrated the facilitation of tracheal intubation following magnesium sulfate administration in general anesthesia [21,22].

In our study, due to the muscle relaxant properties of magnesium sulfate, we showed a significant effect on access to the larynx in difficult exposure patients. This study showed a significant improvement in CL grades in difficult laryngeal exposure patients following magnesium sulfate administration. After magnesium sulfate administration during laryngoscopy, better exposure and access to the larynx can be due to relaxation of the jaw, neck, and pharyngeal muscles. Magnesium sulfate can also enhance the effect of non-depolarizing neuromuscular blocking agents, which are routinely used in the anesthesia induction of LMS [22–24].

In our study, although the changes in the MAP and HR were significant at times after the magnesium sulfate administration, these changes were not noticeable or clinically significant and also within the normal range. Our findings showed the safety of magnesium sulfate administration at the prescribed dose on hemodynamic parameters. In addition, magnesium sulfate can control hemodynamic disturbances in some surgeries [25,26]. During laryngoscopy, like tracheal intubation, there is some increase in mean arterial pressure and heart rate due to airway stimulation [21,23]. The results of this study also showed the effect of magnesium sulfate administration in controlling hemodynamic disorders caused by laryngoscope placement.

A limitation of this study is the lack of a control group. However, we think it is not a significant weakness of the trial. This limitation was inevitable because we did not know a proven drug or another option for difficult laryngeal exposure to compare. If we wanted to give magnesium sulfate to one group and not to another, we might have inadequate outcomes for some patients. Indeed, our study was a pre-and post-intervention in patients with difficult laryngeal exposure during LMS.

Fig. 2. Holinger anterior commissure laryngoscpe for better laryngeal exposure

5. Conclusion

Difficult laryngeal exposure is a major concern for otolaryngologists during laryngeal microsurgery and TLM. Magnesium sulfate administration is an effective and safe method to overcome this problem without an apparent hemodynamic change.

Funding statement

Not applicable.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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