Effect of intravenous magnesium sulfate infusion in attenuating hemodynamic response during extubation: A prospective comparative study

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Abstract

Background: Tracheal extubation is associated with transient, significant, and undesirable hemodynamic changes by epi-pharyngeal and laryngopharyngeal stimulation. There is need to study drugs which can attenuate these parameters for patient safety.

Objective: To evaluate effects of intravenous magnesium sulfate on attenuating hemodynamic response during tracheal extubation.

Methods: Sixty patients of ASA I and II, aged 20-50 years scheduled for elective surgeries were divided in two groups. Group A received 30mg/kg IV Mgso4 in 100 ml normal saline (NS) and group B received plain 100 ml normal saline, administered over 10 minutes at the end of surgery before skin closure. Standard Anesthesia protocol was followed. Hemodynamic parameters (Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure) were observed 1, 3 and 5 minutes after drug administration, during extubation and at 1,3,5,10, and 15 minutes after extubation. Quality of extubation was observed on five-point scale and post-operative sedation on six-point Ramsay sedation scale.

Results: Both groups were comparable for baseline characteristics. Heart rate, systolic blood pressure, diastolic blood pressure, mean blood pressure were significantly more from extubation onwards till 15 min in group B compared to group A patients ($p<0.05$). Extubation score and Ramsay sedation score was significantly higher in group B cases compared to group A cases ($p<0.05$). Side effects were very few in both groups and comparison was not statistically significant ($p>0.05$).

Conclusion: Magnesium sulfate has been found to attenuate the hemodynamic response compared to the control group. The extubation and sedation was also better with MgSO4 with minimal side effects. Hence, MgSO4 should be used in elective surgeries.

Key words: magnesium sulfate, hemodynamic response, extubation, prospective study

Introduction:

Endotracheal extubation is always associated with hemodynamic changes due to reflex sympathetic discharge caused by epipharyngeal and laryngopharyngeal stimulation. This results in increase in heart rate, blood pressure and arrhythmias. These changes are transient, variable but may be of concern for patients with Hypertension, coronary artery disease, cerebrovascular disease. [1-3] Various drugs and techniques have been used to attenuate these dynamic response during extubation. Among them few are narcotics, local anesthetic, alpha-2-agonists, calcium channel blockers and adrenoceptor blockers, topical spray. [4-7]

Magnesium is a naturally occurring calcium antagonists and noncompetitive antagonist of N-methyl-D-aspartate (NMDA) receptor. [8] Magnesium sulfate (MgSO4) inhibits the release of catecholamines from both adrenal glands, adrenergic nerve terminals in response to sympathetic stimulation. [9] MgSO4 attenuates the pressor response associated with endotracheal intubation. [10]

Objective of the present study was to study the efficacy of magnesium sulfate (MGSO4) 30 mg/kg body weight in 100 ml normal saline given as an infusion to attenuate the hemodynamic response to extubation after general anesthesia.

Materials and Methods:

Present study was single center, hospital based, prospective comparative study carried out among 60 patients undergoing elective surgeries over a period of one year from January 2021 to December 2022 at Department of Anesthesiology, Malla Reddy Medical College for Women, Hyderabad, Telangana, India. The study was approved by Institutional Ethics Committee. Written informed consent was taken from all eligible patients included in the study.

Sixty patients of American Society of Anesthesiologists (ASA) grade I and II, age group 20-50 years of either gender, scheduled for elective surgeries of ENT, Gynecological and General surgery cases under the general anesthesia were included in this study. Patients with Hypertension, Uncontrolled diabetes, cardiopulmonary diseases, hepatic dysfunction, renal dysfunction, psychiatric illness, pregnant and lactating patients, emergency procedures and patient who required postoperative ventilation were excluded from the study.

Patients were divided into two groups of 30 each. Group A (Study group) patients received Inj. Magnesium sulfate (30 mg/kg) in 100 ml Normal saline over 10 minute). Group B patients (Control group) received 100 ml Normal saline IV infusion over a period of 10 minute).

Patients who were scheduled for surgery was subjected to pre-anesthetic check-up a day before the scheduled surgery. Complete physical examination was done. Routine investigations like complete blood picture, blood grouping and typing, blood urea, serum creatinine, bleeding time, clotting time, blood sugar, ECG and chest radiography were done.

Patients were kept Nil per oral for six hours before procedure. After shifting the patient to operating room baseline preoperative heart rate (HR), SBP (Systolic Blood Pressure), DBP (Diastolic Blood pressure), MAP (mean arterial pressure), RR (respiratory rate), ECG, SPO2 (Oxygen saturation) were recorded. Vitals of all patients were monitored.

Standard Anesthesia techniques were followed for all the patients. Patients were induced with propofol (1,2 mg/Kg) and Vecuronium 0.1 mg/kg. Appropriate endotracheal tube was used for intubation. Anesthesia was maintained with Oxygen, air, Isoflurane and intermittent vecuronium. At the end of the surgery isoflurane was disconnected and patients were given the study drugs over 10 minutes. Patients were reversed with myopyrrolate 0.05 mg/kg and were extubated after patients met the adequate extubation criteria. Vitals like Heart rate, systolic and diastolic blood pressure were recorded at the drug injection and thereafter 1,3,5,10 and 15 minutes after extubation.

Quality of extubation was assessed with extubation quality score [4] based on coughing. No cough is grade I, minimal cough is grade II, inadequate cough is grade III, severe cough is grade IV, laryngospasm and coughing more than ten minutes is grade V.

Post-operative sedation was evaluated by Ramsay sedation score [11] as: Grade 1 - Anxious or agitated or restless; Grade 2 - Co-operative, oriented and calm; Grade 3 - Responsive to commands only; Grade 4 - Exhibiting brisk response to light tap / auditory stimulus; Grade 5 - Exhibiting sluggish response to light tap / auditory stimulus; Grade 6 - unresponsive

Patients were monitored for bradycardia, hypotension, desaturation. Side effects like nausea, vomiting, respiratory depression and shivering were also recorded.

Statistical analysis:

The data was entered in the Microsoft Excel worksheet and later exported to SPSS version 22 statistical software. The data was presented as proportions, absolute numbers and means with standard deviations. Student's t test was used to compare means in two groups. Chi square test was used to compare proportions. In case of very small sample for chi square test, Fisher exact test was applied. Probability p value of less than 0.05 was taken as statistically significant.

RESULTS

Table 1: Comparison of demographic profile in two groups

Parameters	Group A (MgSO4) N=30	Group B (control) N=30	p
Age (years)	37.62 ± 15.31	33±6.93	0.1376
Height (cm)	155.68 ± 7.14	154.79±6.25	0.6260
Weight (kg)	59.87 ± 12.73	62.43±6.84	0.3359
Sex M : F	16, 14	10, 20	0.1930
ASA grade I/II	13, 17	18, 12	0.3032

Both the groups were comparable for baseline demographic characteristics and ASA grade. (p>0.05) (Table 1)

Table 2: Comparison of heart rate response in two groups

Timings	**Group A Mean ± SD**	**Group B Mean ± SD**	***p* value**
Baseline	84.13 ± 7.68	84±8.990	0.9522
1 min	83.07 ± 7.5	84.60±8.017	0.4484
2 min	81.37 ± 6.95	86.07±8.229	**0.02012**
3 min	79.53 ± 7.2	86.47±7.977	**0.00081**
Extubation	79.07 ± 6.25	86.60±7.596	**0.00009**
1 min	83.2 ± 6.12	92.67±8.458	**<0.0001**
3 min	84.2 ± 6.48	94.20±7.416	**<0.0001**
5 min	82.4 ± 6.33	92.87±6.511	**<0.0001**
10 min	80.6 ± 6.28	91.47±6.642	**<0.0001**
15 min	79.47 ± 5.53	89.67±6.687	**<0.0001**

The heart rate at baseline and at one min was comparable in two groups (p>0.05). From two min onwards and at extubation and further till 15 min, the heart rate was consistently more in control group (group B) compared to study group (group A) and this was found to be statistically significant (p<0.05). (Table 2)

Table 3: Comparison of Systolic Blood Pressure (SBP) response in two groups

Timings	**Group A Mean ± SD**	**Group B Mean ± SD**	**p value**
Baseline	121.53 ± 6.34	121.40±6.891	0.9396
1 min	120.4 ± 5.57	120.80±5.933	0.7881
2 min	117.73 ± 5.91	120.67±6.133	0.05609
3 min	116.47 ± 5.06	121.33±5.616	**0.0008**
Extubation	115.6 ± 4.34	121.13±5.625	**<0.0001**
1 min	119.6 ± 5.54	126.13±5.823	**<0.0001**

3 min	119.33 ± 5.52	125.40±5.334	**<0.0001**
5 min	117.27 ± 5.05	123.12±5.575	**<0.0001**
10 min	116.2 ± 5.1	121.20±4.999	**<0.0001**
15 min	115.13 ± 4.83	119.73±5.626	**<0.0001**

The SBP at baseline, at one and two min was comparable in two groups (p>0.05). At three min, then at extubation and thereafter till 15 min, it was more in the group B patients compared to group A patients and this difference was found to be statistically significant (p<0.05). (Table 3)

Table 4: Comparison of Diastolic Blood Pressure (DBP) response

Timings	Group A Mean ± SD	Group B Mean ± SD	p value
Baseline	71.33 ± 3.34	70.00±19.518	0.7140
1 min	74.11 ± 3.97	74.20±4.437	0.9335
2 min	72.67 ± 4.25	73.53±4.091	0.1374
3 min	75.53 ± 5.11	76.60 ± 3.450	0.3480
Extubation	70.73 ± 3.62	75.73±3.704	**<0.0001**
1 min	73.13 ± 3.7	79.27±3.769	**<0.0001**
3 min	72.27 ± 4.92	79.13±3.589	**<0.0001**
5 min	70.73 ± 3.51	77.80±3.690	**<0.0001**
10 min	70.27 ± 3.27	76.33±3.407	**<0.0001**
15 min	70.33 ± 3.53	75.53±3.431	**<0.0001**

The DBP at baseline and till three min was not significantly different in two groups (p>0.05). But from extubation onwards till 15 min, it was consistently more in patients belonging to group B compared to patients from group A and it was also statistically significant (p<0.05). (Table 4)

Table 5: Comparison of Mean Arterial Pressure (MAP) response

Timings	Group A Mean ± SD	Group A Mean ± SD	*P* value
Baseline	90.71±4.15	89.97±3.728	0.4719
1 min	89.33±3.84	90.30±3.436	0.3046
3 min	87.87±4.36	90.53±3.481	**0.0121**
5 min	86.37±3.45	91.43±2.956	**<0.0001**
Extubation	85.63±3.25	90.93±3.226	**<0.0001**
1 min	88.27±3.91	94.77±3.319	**<0.0001**
3 min	88.34±4.13	94.57±2.881	**<0.0001**
5 min	86.37±3.31	93.00±3.434	**<0.0001**
10 min	85.81±3.19	91.37±3.135	**<0.0001**
15 min	85.13±3.36	90.23±3.036	**<0.0001**

The MAP at baseline, and at one min was found to be similar in two groups (p>0.05). At three and five min from baseline as well as at extubation and till 15 min further, it was significantly more in patients of group B compared to patients of group A (p<0.05). (Table 5)

Table 6: Comparison of Extubation score

Extubation score	**Group A (30)**		**Group B (30)**		**P value**
	No.	**%**	**No.**	**%**	
1 & 2	25	83.3	10	33.3	**0.000246**
3	5	16.7	20	66.7	

There were 83.3% of patients in group A with extubation score of one and two compared to only 33.3% in group B. Those with extubation score of three were significantly lesser in group A compared to group B. (p<0.05) There were no cases having extubation score of more than three. (Table 6)

Table 7: Comparison of Sedation score

Ramsay sedation score	**Group A (30)**		**Group B (30)**		**P value**
	No.	**%**	**Number**	**%**	
1	9	30%	2	6.6%	**0.0453**
2	21	70%	28	93.3%	

Patients with Ramsay sedation score of two were significantly more in group B (93.3%) compared to group A (70%) (P<0.05). (Table 7)

Table 8: Comparison of Side effects

Side effects*	**Group A (30)**		**Group B (30)**		**P value**
	No.	**%**	**Number**	**%**	
Present	1	3.3	4	13.3	0.3533
Absent	29	96.7	26	86.7	

*one case of vomiting in group A; two cases of tachycardia and two cases of vomiting in group B

There was only one case with side effects in group A compared to four cases in group B, but the difference was not found to be statistically significant. (Table 8)

DISCUSSION

In the present study, both the groups were comparable for baseline demographic characteristics and ASA grade (p>0.05). The heart rate at baseline and at one min was comparable in two groups (p>0.05). From two min onwards and at extubation and further till 15 min, the heart rate was consistently more in control group (group B) compared to study group (group A) and this was found to be statistically significant ($p<0.05$). The SBP at baseline, at one and two min was comparable in two groups ($p>0.05$). At three min, then at extubation and thereafter till 15 min, it was more in the group B patients compared to group A patients and this difference was found to be statistically significant ($p<0.05$). The DBP at baseline and till three min was not significantly different in two groups ($p>0.05$). But from extubation onwards till 15 min, it was consistently more in patients belonging to group B compared to patients from group A and it was also statistically significant ($p<0.05$). The MAP at baseline, and at one min was found to be similar in two groups ($p>0.05$). At three and five min from baseline as well as at extubation and till 15 min further, it was significantly more in patients of group B compared to patients of group A ($p<0.05$). There were 83.3% of patients in group A with extubation score of one and two compared to only 33.3% in group B. Those with extubation score of three were significantly lesser in group A compared to group B. ($p<0.05$) There were no cases having extubation score of more than three. Patients with Ramsay sedation score of two were significantly more in group B (93.3%) compared to group A (70%) ($P<0.05$). There was only one case with side effects in group A compared to four cases in group B, but the difference was not found to be statistically significant.

Nooraei N et al [12] used MgSO4 in the dose of 60 mg/kg whereas we used it in the dose of 30 mg/kg. They compared their findings with lidocaine group whereas we had placebo in the present study. They found that the hemodynamic parameters like SBP, DBP and MAP were better attenuated in the MgSO4 group cases compared to the patients who belonged to lidocaine group. We also found that MgSO4 group cases had better hemodynamic parameters than their control counterparts. The authors concluded that MgSO4 was more effective than lidocaine in the control of hemodynamics.

Shukla S et al [13] compared hemodynamic parameters in three groups using dexmedetomidine (0.6 μg/kg), fentanyl (2 μg/kg), and $MgSO_4$ 30 mg/kg among a total of 105 cases. They found that for blood pressure and heart rate, there were significant differences in cases belonging to dexmedetomidine and fentanyl groups in comparison to cases belonging to MgSO4 group. They concluded that dexmedetomidine should be used as an alternative to fentanyl as low doses of dexmedetomidine effect was comparable to MgSO4.

Zhang J et al [14] carried out a meta-analysis using four randomized controlled trials having 208 patients to study effect of MgSO4 on hemodynamic parameters in patients undergoing laparoscopic cholecystectomy. They concluded that MgSO4 is effective in reducing blood pressure. We also found that the cases belonging to MgSO4 group had lower levels of SBP, DBP and MAP.

Kalra NK et al [15] involved 120 cases scheduled for elective laparoscopic cholecystectomy and randomized them in four groups of 30 each. One group received 50 ml normal saline, second groups was given MgSO4 in the dose of 50 mg/kg, third group received 1 μg/kg clonidine and the fourth group was given 1.5 μg/kg clonidine.

They found that SBP was well attenuated in all three groups but was significantly more in saline group. SBP was comparable in MgSO4 and 1 μg/kg clonidine groups at all time intervals. 1.5 μg/kg clonidine groups had best control of SBP. Hypotension was not seen in any case. MgSO4 group had taken longer time for extubation and also eye opening compared to clonidine groups. Authors concluded that MgSO4 was comparable to 1 μg/kg clonidine but 1.5 μg/kg clonidine was more effective than MgSO4. The longer time for extubation and eye opening observed in this study could be due to higher dose of 50 mg/kg for MgSO4. In the present study we used 30 mg/kg of MgSO4 and we did not observe any such longer time taken for extubation though we did not study eye opening time.

Honarmand A et al [16] compared effect of different doses of MgSO4 in four groups right from 30 mg/kg; 40 mg/kg; 50 mg/kg and last control group in a randomized controlled study involving 120 patients scheduled for elective surgery and divided into four groups of 30 each. They found that heart rate was not significantly different in four groups. SBP, DBP and MAP were significantly lesser at 1,3 and 5 minutes in all three groups compared to control group. These findings are in accordance with the findings of the present study. The authors also concluded that MgSO4 can be used in the routine anesthesia practice in doses lesser than 50 mg/kg. we also used MgSO4 in the dose of 30 mg/kg.

Paul S et al [17] carried out a similar study resembling to the present study with 60 cases divided in two groups of 30 each and MgSO4 group received the same dose as we used to compare to normal saline. They found that MAP and HR were statistically significantly lesser in MgSO4 group compared to the control saline group at all time intervals. This finding is similar to the finding of the present study. They concluded that MgSO4 is useful in lower doses in attenuating the hemodynamic responses.

Limitations:

Present study was single center study with limited sample size. But, the results are comparable to the literature in that the magnesium sulfate is effective. Eye opening time was not studied here and also the time to extubation was not considered in the present study. Randomization was not possible due to resource limitation. But, as the findings are comparable to even meta-analysis, it probably may not have affected the overall results.

CONCLUSION:

Magnesium sulfate has been found to attenuate the hemodynamic response compared to the control group. The extubation and sedation was also better with MgSO4 with minimal side effects. Hence, MgSO4 can be used in elective surgeries so that the patients sensitive to changes in the hemodynamics can tolerate the extubation in a better manner.

REFERENCES:

1. Tandon N, Goyal S. Comparison of dexmedetomidine and magnesium sulphate in attenuation of airway and pressor responses during extubation in patients undergoing craniotomies. Int J Contemp Med Res. 2017; 4(5):1033–7.

2. Nishina K, Mikawa K, Maekawa N, Obara H. Attenuation of cardiovascular responses to tracheal extubation with diltiazem. Anesth Analg. 1995; 80(6):1217–22.

3. Miller KA, Harkin CP, Bailey PL. Postoperative tracheal extubation. Anesth Analg. 1995; 80(1):149–72.

4. Sharma VB, Prabhakar H, Rath GP, Bithal PK. Comparison of dexmedetomidine and lignocaine on attenuation of airway and pressor responses during tracheal extubation. J Neuroanaesthesiol Crit Care. 2014; 1:50-5.

5. Mikawa K, Nishina K, Maekawa N, Obara H. Attenuation of cardiovascular responses to tracheal extubation; Verapamil v/s Diltiazem. Anesth Analg 1996; 82:1205- 10.

6. Menda F, Koner O, Sayin M, Ture H, Imer P, Aykac B. Dexmedetomidine as an adjunct to anesthetic induction to attenuate hemodynamic response to endotracheal intubation in patients undergoing fast-track CABG. Annals of Cardiac Anesth 2010; 13:16-21.

7. Talke P, Chen R, Thomas B, Aggarwall A, Gottlieb A, Thorborg P et al. The hemodynamic and adrenergic effects of perioperative dexmedetomidine infusion after vascular surgery. Anesth Analg 2000; 90:834-9.

8. Fawcett WJ, Haxby EJ, Male DA. Magnesium: physiology and pharmacology. Br J Anesth. 1999; 83:302–20.

9. Douglas WW, Rubin RP. The mechanism of catecholamine release from the adrenal medulla and the role of calcium in stimulus-secretion coupling. J Physiol 1963; 167:288-310.

10. Puri GD, Marudhachalam KS, Chari P, Suri RK. The effect of magnesium sulphate on hemodynamics and its efficacy in attenuating the response to endotracheal intubation in patients with coronary artery disease. Anesth Analg. 1998; 87:808–11.

11. Ramsay MAE, Savege TM, Simpson BRJ, Goodwin R. Controlled sedation with alphaxalone - alphadolone. Br Med J 1974; 2:656–9

12. Nooraei N, Dehkordi ME, Radpay B, Teimoorian H, Mohajerani SA. Effects of intravenous magnesium sulfate and lidocaine on hemodynamic variables following direct laryngoscopy and intubation in elective surgery patients. Tanaffos. 2013;12(1):57-63

13. Shukla S, Kadni RR, Chakravarthy JJ, Zachariah KV. A comparative study of intravenous low doses of dexmedetomidine, fentanyl, and magnesium sulfate for attenuation of hemodynamic response to endotracheal intubation. Indian J Pharmacol. 2022 Sep-Oct;54(5):314-320.

14. Zhang J, Wang Y, Xu H, Yang J. Influence of magnesium sulfate on hemodynamic responses during laparoscopic cholecystectomy: A meta-analysis of randomized controlled studies. Medicine (Baltimore). 2018 Nov;97(45): e12747.

15. Kalra NK, Verma A, Agarwal A, Pandey H. Comparative study of intravenously

administered clonidine and magnesium sulfate on hemodynamic responses during laparoscopic cholecystectomy. J Anesthesiol Clin Pharmacol. 2011 Jul;27(3):344-8.

16. Honarmand A, Safavi M, Badiei S, Daftari-Fard N. Different doses of intravenous Magnesium sulfate on cardiovascular changes following the laryngoscopy and tracheal intubation: A double-blind randomized controlled trial. J Res Pharm Pract. 2015 Apr-Jun;4(2):79-84.

17. Paul S, Biswas P, Bhattacharjee DP, Sengupta J. Effects of magnesium sulfate on hemodynamic response to carbon dioxide pneumoperitoneum in patients undergoing laparoscopic cholecystectomy. Anesth Essays Res. 2013 May-Aug;7(2):228-31.