Original Research

ASSESSMENT OF HEMODYNAMIC RESPONSE MODULATION DURING EXTUBATION USING INTRAVENOUS MAGNESIUM SULFATE: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background: Extubation is associated with significant hemodynamic stress responses due to sympathetic stimulation, which may be harmful in susceptible patients. Magnesium sulfate, owing to its vasodilatory and sympatholytic properties, may attenuate these responses.

Aim: To evaluate the effectiveness of intravenous magnesium sulfate in attenuating hemodynamic responses during extubation.

Methods: This prospective, randomized comparative study was conducted on 60 patients (ASA I–II), aged 20–50 years, undergoing extubation in emergency medicine department and critical acre icu at Sree Mookambika College of Medical Sciences. Patients were divided into two groups: Group A received magnesium sulfate (30 mg/kg in 100 ml normal saline), and Group B received 100 ml normal saline. Hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at baseline, during extubation, and up to 15 minutes post-extubation. Extubation quality, sedation score, and adverse effects were also assessed.

Results: Baseline demographic characteristics were comparable between the groups ($p>0.05$). From 2 minutes onwards and up to 15 minutes post-extubation, heart rate and blood pressure parameters (SBP, DBP, MAP) were significantly lower in the magnesium sulfate group compared to the control group ($p<0.05$). Extubation quality was better in Group A, with 83.3% of patients having favorable scores compared to 33.3% in Group B ($p<0.05$). Sedation scores were higher in the control group, while adverse effects were minimal and comparable between groups.

Conclusion: Magnesium sulfate at a dose of 30 mg/kg effectively attenuates hemodynamic responses to extubation, improves extubation quality, and has a favorable safety profile, making it a useful adjunct in anesthetic practice.

Keywords: Magnesium Sulfate, Extubation, Hemodynamic Response, General Anesthesia, Blood Pressure, Heart Rate.

INTRODUCTION

Endotracheal extubation is frequently associated with significant hemodynamic alterations due to reflex sympathetic stimulation triggered by mechanical irritation of the epipharyngeal and laryngopharyngeal structures. This stimulation leads to a surge in catecholamine release, resulting in tachycardia, hypertension, and, in some cases, cardiac arrhythmias (1–3). Although these responses are usually transient and self-limiting, they may pose serious risks in patients with pre-existing cardiovascular or cerebrovascular conditions such as hypertension, coronary artery disease, and intracranial pathology. In such patients, even short-lived increases in heart rate and blood pressure can precipitate myocardial ischemia, left ventricular failure, or cerebrovascular accidents.

Attenuation of the hemodynamic response during extubation has therefore become an important aspect of anesthetic management. Various pharmacological agents and techniques have been studied for this purpose, aiming to provide a smooth and stable emergence from anesthesia. Among these, opioids (narcotics) are widely used due to their ability to blunt sympathetic responses, though they may cause respiratory depression. Local anesthetics, administered intravenously or topically, reduce airway reflexes and minimize stimulation. Alpha-2 adrenergic agonists, such as clonidine and dexmedetomidine, have gained popularity for their sedative and sympatholytic properties. Calcium

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channel blockers and beta-adrenergic blockers are also employed to control tachycardia and hypertension associated with extubation (4–7).
In recent years, magnesium sulfate has emerged as a potential agent for attenuating extubation responses due to its ability to inhibit catecholamine release and block calcium channels, thereby providing both vasodilatory and antiarrhythmic effects. Its role in modulating hemodynamic responses during extubation is being increasingly explored. Therefore, the present study aims to evaluate the effectiveness of intravenous magnesium sulfate infusion in attenuating the hemodynamic response during extubation and to assess its potential benefits in improving perioperative cardiovascular stability.

Aim

To evaluate the effectiveness of intravenous magnesium sulfate infusion in attenuating the hemodynamic response during endotracheal extubation.

Objectives

To assess changes in heart rate during and after extubation following administration of intravenous magnesium sulfate.

METHODOLOGY

The present study was a single-center, hospital-based, prospective comparative study conducted among 60 patients over a period of one year from January 2021 to December 2022 at the extubation in emergency medicine department and critical acre icu at Sree Mookambika College of Medical Sciences, Sree Mookambika College of Medical Sciences, Kulasekharam, Tamil Nadu, India. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants.
Patients with hypertension, uncontrolled diabetes mellitus, cardiopulmonary diseases, hepatic dysfunction, renal dysfunction, psychiatric illness, pregnant or lactating women, those undergoing emergency procedures, and patients requiring postoperative ventilation were excluded.
Patients were randomly divided into two groups of 30 each:
Group A (Study group): Received intravenous magnesium sulfate 30 mg/kg diluted in 100 ml normal saline over 10 minutes
Group B (Control group): Received 100 ml normal saline intravenously over 10 minutes
Upon arrival in the operating room, baseline parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), respiratory rate (RR), ECG, and oxygen saturation (SpO_2) were recorded.
patients were extubated after meeting standard extubationcriteria.Hemodynamic parameters including heart rate, systolic blood pressure, and diastolic blood pressure were recorded at the time of drug administration and at 1, 3, 5, 10, and 15 minutes following extubation.
Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software (version XX). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.
Comparison between the two groups was performed using:Independent Student’s t-test for continuous variablesChi-square test or Fisher’s exact test for categorical variables
Repeated measures within the groups (hemodynamic parameters over time) were analyzed using repeated measures ANOVA, followed by post hoc analysis where applicable.A p-value of <0.05 was considered statistically significant.

RESULT

Table1: Comparison of Demographic Profile in Two Groups

Parameters	GroupA(MgSO4) N=30	GroupB(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
SexM :F	16, 14	10,20	0.1930
ASAgrade 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)

Table2: Comparison of Heart Rate Response in Two Groups

Timings	Group A Mean±SD	GroupB 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 consistentlymore in control group (group B) compared to study group (group A) and this was found to be statistically significant ($p<0.05$). (Table 2)

Table3: Comparison of Systolic Blood Pressure (SBP) Response in Two Groups

Timings	**GroupA Mean±SD**	**GroupB Mean±SD**	**p value**
Baseline	121.53 ± 6.34		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 base line, atone and two m in was comparable in two groups ($p>0.05$).Atthreemin, 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 best artistically significant ($p<0.05$).(Table3)

Table4: Comparison of diastolic blood pressure (DBP) Response

Timings	**Group A Mean±SD**	**GroupB 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 DBPat baseline and till three min was not significantlydifferent 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 Aand it was also statistically significant ($p<0.05$). (Table 4)

Table5: Comparison of Mean Arterial Pressure (MAP) Response

Timings	**GroupA Mean±SD**	**GroupA 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 base line, and atone min was found to be similar in two groups (p>0.05). At three and five min from base line as well as atextubation and till 15 min further, it was significantly more in patients of group B compared to patients of groupA(p<0.05). (Table 5)

Table6: Comparison of Extubation Score

Extubationscore	**GroupA(30)**		**GroupB (30)**		**Pvalue**
	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 Awith extubation score of one and two compared to only33.3%ingroupB.Thosewithextubationscoreofthreeweresignificantlylesseringroup Acompared to group B. (p<0.05) There were no cases having extubation score of more than three. (Table 6)

Table7: Comparison of Sedation Score

Ramsaysedationscore	**GroupA(30)**		**GroupB(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)

Table8: Comparison of Side effects

Side effects	**GroupA(30)**		**GroupB(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 TherewasonlyonecasewithsideeffectsingroupAcomparedtofourcasesingroupB, butthe difference was not found to be statistically significant. (Table 8)

DISCUSSION

The present study evaluated the effect of intravenous magnesium sulfate ($MgSO_4$) on attenuation of hemodynamic responses during extubation and demonstrated that $MgSO_4$ significantly reduces cardiovascular responses compared to placebo, particularly in the post-extubation period. Both groups were comparable with respect to demographic variables such as age, sex, height, weight, and ASA grade, with no statistically significant differences (p > 0.05), thereby ensuring that the observed hemodynamic variations were attributable to the intervention rather than confounding factors. Heart rate remained similar between groups at baseline and at 1 minute; however, from 2 minutes onward, including during extubation and up to 15 minutes post-extubation, it was significantly higher in the control group, indicating effective suppression of sympathetic stimulation by magnesium sulfate. These findings are consistent with studies by Nooraei N et al. and Shukla S et al., which demonstrated attenuation of heart rate responses with magnesium sulfate.

Systolic blood pressure (SBP) was comparable initially but became significantly elevated in the control group from 3 minutes onward and during extubation, suggesting that magnesium sulfate effectively blunts the pressor response, likely due to its vasodilatory effects mediated through calcium channel antagonism and inhibition of catecholamine release, as supported by Zhang J et al. Similarly, diastolic blood pressure (DBP) did not differ significantly until 3 minutes but was significantly higher in the control group thereafter, reflecting reduced systemic vascular resistance in the magnesium group.

Mean arterial pressure (MAP) followed a similar pattern, with significantly higher values in the control group during extubation and the post-extubation period, further confirming the role of magnesium sulfate in maintaining hemodynamic stability. The quality of extubation was also superior in the magnesium group, with a higher proportion of patients demonstrating smoother extubation profiles, consistent with previous findings. Sedation scores revealed that magnesium sulfate did not produce excessive sedation, maintaining adequate consciousness while ensuring hemodynamic control.

The incidence of adverse effects was minimal and comparable between groups, indicating a favorable safety profile. Overall, the study confirms that intravenous magnesium sulfate at a dose of 30 mg/kg is effective and safe in attenuating hemodynamic responses to extubation. Although other agents like dexmedetomidine and fentanyl may provide stronger attenuation, magnesium sulfate remains a cost-effective and practical alternative, particularly in resource-limited settings.

CONCLUSION

Intravenous magnesium sulfate at a dose of 30 mg/kg effectively attenuates the hemodynamic responses associated with extubation, as evidenced by significantly lower heart rate, systolic, diastolic, and mean arterial pressures compared to the control group. It also improves the quality of extubation without causing significant adverse effects. Magnesium sulfate is a safe, effective, and economical agent for achieving hemodynamic stability during extubation and can be considered a useful adjunct in routine anesthetic practice.

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