Journal of Rawalpindi Medical University

Open Access Original Article

DOI: 10.37939/jrmc.v29i2.2723

# Hemodynamic Effects Of Intravenous Magnesium Sulfate In Direct Laryngoscopy And Intubation In Elective Surgery

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## Abstract

**Objective:** To determine the efficacy of 20 mg/kg of IV MgSO4 in blunting laryngoscopic stress response.

**Methods:** A single-blind randomized control trial was carried out Department of Anesthesia and Critical Care Medicine, Pakistan Institute of Medical Sciences (PIMS), Islamabad. 122 patients were included and divided into two groups with the help of computer-generated random numbers. Group A patients received 20 mg/kg of MgSO4 while group B patients received a similar volume of Normal saline. Baseline hemodynamics were recorded. General anaesthesia was induced in both groups using Midazolam, Propofol and Atracurium given IV. Following intubation hemodynamics were noted.

**Results:** Baseline parameters and hemodynamics following intubation were similar in both groups apart from DBP in the immediate post-intubation period which was lower in group A.

**Conclusion:** IV MgSO4 at a dose of 20 mg/kg is ineffective in blunting laryngoscopic stress response. Therefore, higher doses should be utilized to reach this therapeutic effect.

**Keywords:** MgSO4, Airway Management, Laryngoscopy

**Contributions:**
R.U.K, M.B - Conception of study
- Experimentation/Study Conduction
M.A, A.Z, A.R, A.I - Analysis/Interpretation/Discussion
M.B, A.R, A.I - Manuscript Writing
R.U.K, M.A, A.Z - Critical Review

All authors approved the final version to be published & agreed to be accountable for all aspects of the work.

**Conflicts of Interest:** None
**Financial Support:** None to report
**Potential Competing Interests:** None to report

**Institutional Review Board Approval**
F. 1-1/2015/ERB/SZABMU
18-01-2018
Shaheed Zulfiqar Ali Bhutto Medical University

Review began 18/09/2024
Review ended 03/06/2025
Published 30/06/2025


**How to cite this article:** Khan RU, Bilal M, Amjad M, Zareen A, Rahna A, Iqbal J. Hemodynamic Effects Of Intravenous Magnesium Sulfate In Direct Laryngoscopy And Intubation In Elective Surgery. JRMC. 2025 Jun. 30;29(2). https://doi.org/10.37939/jrmc.v29i2.2723

## Introduction

Induction of General Anesthesia results in loss of respiratory drive and protective airway reflexes. This predisposes the person to respiratory failure and aspiration. As a result, the airway has to be secured and mechanical ventilation is required. There are numerous ways to ensure an airway; the most popular being endotracheal tube placement with the help of a laryngoscope. Laryngoscopy provides a line of sight from the operator's eye to the glottis of the patient so that an endotracheal tube can be placed. Laryngoscopy is associated with several complications or side effects. These can be traumatic and damage the teeth, oral cavity, pharynx, larynx and vocal cords. The non-traumatic side effects include aspiration of gastric contents, hypoxia and end-organ damage such as brain injury.[1] Laryngoscopy is associated with intense sympathetic discharge as the larynx has rich innervation and laryngoscopy is one of the most painful stimuli experienced by the patient. This can lead to tachycardia, hypertension, myocardial ischemia and infarction.[1] The sympathetic discharge associated with laryngoscopy has to be attenuated so that adverse cardiovascular effects can be avoided which are detrimental to the patients suffering from cardiovascular co-morbid. Several drugs and techniques have been used over a long time to blunt this sympathetic response. It has been shown that using the McCoy laryngoscopic blade for endotracheal tube placement resulted in better attenuation of hemodynamic stress response which can be due to less lifting force required to move epiglottis out of the way of vocal cords.[2] McCoy blade was found to be associated with better hemodynamics in the peri-intubation period as compared to the Miller blade.[3] However, the above-mentioned study did not account for the depth of anesthesia at the time of laryngoscopy during intubation which could have resulted in the hemodynamic differences noted. In a study when intubation using Macintosh McCoy or C-MAC laryngoscope was compared at similar/constant depth of anaesthesia, no significant difference was found among the three groups concerning peri-intubation hemodynamics.[4] This means that the depth of anaesthesia is more important than the technique or type of laryngoscope being used in maintaining hemodynamic stability during the peri-intubation period. However, in resource-limiting settings, the depth of anaesthesia cannot be monitored and therefore we have to face the hemodynamic instability in the peri-intubation period. This can be prevented or attenuated by prophylactic administration of certain drugs. These drugs include beta-blockers, IV local anaesthetics (lignocaine), Opioids (fentanyl), MgSO4, and Dexmedetomidine. Esmolol is a cardio-selective beta blocker having a half-life of 9 minutes. It blunts the tachycardia and hypertensive response of laryngoscopy. It is given intravenously.[5] IV lignocaine can be given at a dose of 1-1.5 mg/kg about 1.5 minutes before intubation can blunt these responses.[6] When IV Esmolol was compared with IV lignocaine in blunting hemodynamic stress response during the peri-intubation period it was found that Esmolol is a safer and more effective medication.[7,8] Unfortunately, Esmolol is an expensive medication that is not widely available. Therefore, we need other suitable alternatives to the blunt peri-intubation hemodynamic stress response. One of the suitable alternatives is IV Dexmedetomidine. It is an alpha 2 agonist and centrally acting sympatholytic and analgesic agent.[9] However, Dexmedetomidine is associated with bradycardia and hypotension particularly when administered with IV anaesthetic agents at the time of induction of anaesthesia or when administered pre-operatively at the time of administration of anxiolytic medications.[9] Therefore, theoretically, the use of IV Dexmedetomidine to blunt hemodynamic perturbation at the time of endotracheal tube placement can result in bradycardia and hypotension which can again adversely affect the peri-operative outcomes. This theoretical concern emphasizes that IV Dexmedetomidine is not an ideal agent to blunt hemodynamic stress response. Furthermore, the drug is expensive and not widely available. An ideal drug would be cheap, widely available and have minimal side effects. One of the drugs which is cheap and widely available is MgSO4. It has an excellent safety profile and has been used to blunt sympathetic discharges and hemodynamic intubations in the peri-operative period. It was found that MgSO4 when given at a dose of 30 mg/kg as a bolus just before the creation of pneumoperitoneum protects against its adverse hemodynamic effects.[10] Similarly, a bolus dose of MgSO4 before laryngoscopy can protect against hypertension and tachycardia following intubation. IV MgSO4 was found to be superior to IV Lignocaine in blunting hemodynamic stress response to laryngoscopy.[11] It was also seen that 30 mg/kg of IV MgSO4 blunts peri-intubation stress response similar to IV Dexmedetomidine.[12] Traditionally 50 mg/kg of IV MgSO4 was used to blunt hemodynamic stress response to intubation. However, it was found that doses less than 50 mg/kg can be equally effective in blunting hemodynamic stress response to intubation.[13] This study looked at the effectiveness of 20 mg/kg of IV MgSO4 in blunting hemodynamic stress response of laryngoscopy.

## Materials And Methods

After ethical approval, this single-blind randomized control trial was carried out at the Department of Anesthesia and Critical Care Medicine from 1st July 2023 to 31st December 2023. Patients fulfilling the inclusion criteria i.e. patients admitted for elective surgery with American Society of Anesthesiologists (ASA) class I and II and aged 13 years and above were enrolled in the study. Patients excluded from the study were obese with body mass index > 30 kg/m$^2$, difficult airway, serum creatinine level > 2 mg/dl, Pregnant women and those having an allergy to MgSO4. The sample size is calculated by using the WHO sample size calculator level of significance = 5 %, Power of test = 80 %, Population standard deviation = 10, Test value of population Mean (Heart Rate in the intervention group) = 93.9(14), Test value of population Mean (Heart Rate in Normal saline group) = 97.5(14), Total sample size = 122. The participants were divided into two groups using computer-generated random numbers. Group A was rendered with magnesium sulfate, whereas, Group B was given normal saline (placebo). The hemodynamic parameters were noted for each patient before induction of general anaesthesia. Group A was given 20 ml of magnesium sulfate in an infusion pump intravenously for 15 minutes with a dosage of 20 mg/ kg of body weight. On the other hand, Group B was given 20 ml of normal saline intravenously. Induction with intravenous anaesthetic drugs - midazolam 0.02 mg/ kg of body weight, Propofol 2 mg/ kg of body weight and atracurium 0.5 mg/ kg of body weight was initiated to achieve sufficient sedation, anaesthesia and muscle relaxation. After 3 minutes of bag-mask ventilation with oxygen, direct laryngoscopy or endotracheal intubation was performed on the patient. The hemodynamic parameters of patients were recorded after endotracheal intubation and laryngoscopy. All patients were given multimodal analgesia with morphine and paracetamol after 5 minutes of intervention.

Hemodynamic stability was determined as changes between -20 % to +20 % from baseline mean arterial pressure, systolic blood pressure, diastolic blood pressure and heart rate. Adverse effects and cardiovascular events that were either a rise in heart rate or blood pressure greater than 20% from baseline were noted.

## Results

Baseline parameters were comparable among the two groups. In group A, 30 patients were male while the rest were female. In group B, 31 were male while the rest were female. The mean age of presentation in group A was 27.22 ± 5.26 years while in group B it was 29.78 ± 4.22 years. The baseline hemodynamic parameters are shown in Table 1.

 DOI: 10.37939/jrmc.v29i2.2723

**Table 1: Comparison of baseline hemodynamics**

| Variable | Group A | Group B | p-value |
|---|---|---|---|
| **Systolic blood pressure (mean ± SD)** | 118.87 ± 12.76 | 120.11 ± 12.01 | 0.655 |
| **Diastolic blood pressure (mean ± SD)** | 74.56 ± 7.55 | 76.36 ± 8.78 | 0.211 |
| **Heart rate (mean ± SD)** | 94.41 ± 15.88 | 90.13 ± 14.76 | 0.323 |
| **Mean arterial pressure (mean ± SD)** | 91.1 ± 7.4 | 91.6 ± 7.1 | 0.433 |

Following intervention and laryngoscopy, the comparison of vitals is shown in Table 2.

**Table 2: Comparison of post-intubation hemodynamic parameters**

| Parameter | Time frame | Group A | Group B | P value |
|---|---|---|---|---|
| **Systolic Blood Pressure** | Immediately Post intubation | 141.34 ± 11.1 | 142.22 ± 12.4 | 0.52 |
| | 1 minute after intubation | 132.33 ± 6.7 | 135.35 ± 5.4 | 0.12 |
| | 2 min after intubation | 123.35 ± 3.1 | 124.28 ± 2.3 | 0.55 |
| | 3 min after intubation | 121.22 ± 12.4 | 123.46 ± 12.6 | 0.24 |
| **Diastolic Blood Pressure** | Immediately Post intubation | 90.12 ± 7.3 | 96.11 ± 7.6 | 0.03 |
| | 1 minute after intubation | 85.19 ± 6.4 | 87.10 ± 6.6 | 0.43 |
| | 2 min after intubation | 81.22 ± 6.3 | 83.18 ± 6.7 | 0.51 |
| | 3 min after intubation | 76.18 ± 7.1 | 78.37 ± 7.5 | 0.24 |
| **Mean Arterial Pressure** | Immediately Post intubation | 93.10 ± 5.1 | 92.01 ± 6.3 | 0.38 |
| | 1 minute after intubation | 93.48 ± 6.2 | 91.19 ± 6.7 | 0.18 |
| | 2 min after intubation | 93.01 ± 6.5 | 91.01 ± 7.2 | 0.22 |
| | 3 min after intubation | 92.79± 7.3 | 90.17 ± 7.5 | 0.31 |
| **Heart Rate** | Immediately Post intubation | 117.32 ± 6.8 | 112.31 ± 6.2 | 0.17 |
| | 1 minute after intubation | 105.24 ± 7.3 | 101.55 ± 7.1 | 0.37 |
| | 2 min after intubation | 95.25 ± 4.2 | 94.29 ± 5.2 | 0.43 |
| | 3 min after intubation | 92.15 ± 6.2 | 90.39 ± 6.8 | 0.28 |

The hemodynamic parameters were comparable among the two groups apart from diastolic blood pressure immediately post-intubation. Diastolic blood pressure was significantly lower in patients treated with MgSO4 as compared to those receiving placebo

## Discussion

Blunting laryngoscopic stress response is technically challenging. Various techniques such as the use of different types of laryngoscopic blades are found to be ineffective.[4] The depth of anaesthesia during the time of laryngoscopy seems to be more important. However, it is technically challenging to measure and maintain it. Furthermore, excessive depth of anaesthesia can lead to side effects such as hypotension, bradycardia or tachycardia which can complicate the peri-operative course. Therefore, utilizing depth of anaesthesia as a sole measure to maintain hemodynamic stability during the peri-induction period is not an ideal technique. Various drugs have long been utilized to prevent the adverse hemodynamic effects of laryngoscopy and placement of ETT. Some of these drugs work by blocking adrenergic receptors while others blunt the laryngeal reflexes. One of the drugs which blunts the laryngeal reflexes and has long been used for preventing laryngoscopic stress response is Lignocaine. The drug can be given by IV or by nebulization. In a study, it was found that the outcomes are not significantly different no matter which route of administration is utilized.[15] Another route of Lignocaine administration is transtracheal which was found to be more effective than IV Lignocaine.[16] However, the administration of Lignocaine transtracheal is technically challenging and comes with its ethical dilemmas making it a less practical route of drug administration. Furthermore, Lignocaine is considered a high-risk medication and its administration should take into consideration the risk-to-benefit ratio.[17] Literature has questioned Lignocaine's efficacy in preventing laryngoscopic stress response. In several studies, IV lignocaine has been found inferior to several other drugs preventing laryngoscopic stress response.[18,19] The other drugs which are commonly utilized to blunt laryngoscopic stress response are Esmolol and Dexmedetomidine which are expensive and not widely available making their practical application difficult. On the other MgSO4 is a widely available drug which can be successfully utilized in our clinical settings to blunt laryngoscopic stress response. In several studies utilizing IV MgSO4, it was found that the drug was more effective than IV Lignocaine in blunting laryngoscopic stress response.[20,21] However, in our study as compared to control group IV MgSO4 was not successful in blunting laryngoscopic stress response apart from a lower Diastolic Blood Pressure immediately following intubation. The difference from the previous studies could be due to the lower dose of MgSO4 i.e. 20 mg/kg utilized in our study. In the study done by Wadud et al. 40 mg/kg of IV MgSO4 was found to be effective in blunting laryngoscopic stress response. The difference in hemodynamic parameters was most significant at 1 min following intubation and vitals being returned to baseline by the 5$^{th}$ minute following intubation.[21] Similarly in a study done by Ram Manohar Reddy P et al. 30 mg/kg of IV

DOI: 10.37939/jrmc.v29i2.2723

MgSO4 was found to be effective in blunting laryngoscopic stress response. The heart rate and mean arterial pressure following intubation were significantly lower among patients treated with MgSO4 at 1,3 and 5 minutes following intubation.[20] Similarly, Misganaw A et al. utilized 30 mg/kg of MgSO4 in blunting laryngoscopic stress response and found that heart was significantly lower among patients treated with MgSO4 throughout the study duration while Systolic, diastolic and mean blood pressure was significantly lower at 2$^{nd}$ and 5$^{th}$ minute following intubation.[11] Similarly, when different doses of MgSO4 i.e. 30 mg/kg, 40 mg/kg and 50 mg/kg were compared all were found to be equally effective in blunting laryngoscopic stress response. However, our study has revealed that at a dose of 20 mg/kg, MgSO4 loses its therapeutic efficacy by preventing hemodynamic alterations of laryngoscopy and endotracheal tube placement.

## Conclusions

IV MgSO4 at a dose of 20 mg/kg is ineffective in blunting laryngoscopic stress response. Therefore, higher doses should be utilized to reach this therapeutic effect.

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