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Comparison of Preoperative Nebulisation with Magnesium Sulphate and Dexmedetomidine for Hemodynamic Response to Laryngoscopy and Endotracheal Intubation

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ABSTRACT

Background: Laryngoscopy and endotracheal intubation are essential components of general anesthesia but are associated with a transient sympathetic stress response, leading to tachycardia and hypertension. These hemodynamic changes may be clinically significant, particularly in patients with cardiovascular, cerebrovascular, or hypertensive disorders. Various pharmacological agents have been used to attenuate this response; however, nebulized drug delivery has emerged as a non-invasive and effective premedication technique.

Methods: This double-blind randomized controlled trial included 56 adult patients undergoing elective surgery under general anesthesia. Patients were randomly allocated into two groups of 28 each. Group M received nebulized magnesium sulphate (10 mg/kg), while Group D received nebulized dexmedetomidine (0.5 mcg/kg) 30 minutes before induction. Hemodynamic parameters, including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure, were recorded at baseline, after nebulization, and at 2-, 5-, and 10-minutes following intubation. Statistical analysis was performed using Student's t-test and Chi-square test, with $p<0.05$ considered significant.

Results: Dexmedetomidine group demonstrated significantly lower increases in heart rate and blood pressure following laryngoscopy and intubation compared to the magnesium sulphate group. Sympathetic responses were more effectively attenuated, resulting in improved peri-intubation hemodynamic stability.

Conclusion: Preoperative nebulized dexmedetomidine is more effective than magnesium sulphate in attenuating the hemodynamic stress response to laryngoscopy and intubation. It is a safe, non-invasive, and clinically effective method for improving perioperative hemodynamic stability.

Key-words: Dexmedetomidine, Magnesium sulphate, Nebulization, Laryngoscopy, Endotracheal intubation, Hemodynamic response, Randomized controlled trial

INTRODUCTION

General anesthesia is a vital part of contemporary surgical practice, which offers unconsciousness, analgesia, and muscle relaxation for safe surgical procedures.

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Laryngoscopy and endotracheal intubation are essential parts of airway management in administering general anesthesia since they ensure that the airways remain open and the ventilation is satisfactory in the course of a surgical operation.

Airway manipulation has been shown to induce physiological stress response despite its regular use; therefore, causing cardiovascular instability during anesthesia [1]. Proper airway management plans would thus be focused on ensuring that they can secure the airway as well as reduce adverse changes in hemodynamics linked to laryngoscopy and intubation [2].

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Mechanoreceptors in the pharynx, larynx and trachea are also stimulated by direct laryngoscopy and tracheal intubation and this results in the stimulation of the sympathetic nervous system. Such stimulation leads to the release of catecholamines like norepinephrine and epinephrine, which cause temporary elevation of heart rate, blood pressure and myocardial oxygen demand. They can usually happen several seconds after laryngoscopy and last several minutes after intubation [3].

The sympathetic activity during airway manipulation is facilitated by reflex excitation of the autonomic nervous system. The afferent signals of the glossopharyngeal and vagus nerves are activated by mechanical airway stimulation, which also causes the central nervous system to increase its sympathetic outflow. This causes peripheral vasoconstriction, tachycardia, and systolic and diastolic blood pressure elevation [4].

Though the hemodynamic response of laryngoscopy and intubation is generally of a short-term nature, with normal individuals, it may be detrimental among patients with cardiovascular diseases, hypertension, coronary artery disease, or cerebrovascular disorders. Mother of Pearl events, such as sudden elevation of blood pressure and heart rate, can provoke either myocardial ischemia, arrhythmias or an increase in intracranial pressure. Hence, the process of attenuating the pressor response when manipulating the airways is still a valuable objective in anesthetic care [2].

A number of pharmacological agents have been examined to counter-stimulate the sympathetic response during laryngoscopy and intubation. These are; opioids, beta-adrenergic blockers, calcium channel blockers, lignocaine, and a2-adrenergic agonists. Although these drugs are capable of suppressing the hemodynamic variability, their systemic delivery is linked to such adverse effects like hypotension or respiratory depression. Therefore, other approaches like nebulized drug delivery have been considered because of their capability to deliver effective premedication at reduced systemic side effects [1].

Dexmedetomidine is an extremely selective a2-adrenergic receptor agonist that is highly common in anesthesia due to its sedative, analgesic, and sympatholytic characteristics. It inhibits sympathetic efferent discharge of the central nervous system and lowers the amount of catecholamine in the blood, therefore, stabilizing heart rate and blood pressure during stressful events like laryngoscopy and intubation. It is shown that dexmedetomidine administration given before surgery can be used to successfully alleviate the hemodynamic reaction related to airway manipulation [3].

The Mg+sulphate has been a well investigated drug due to its cardiovascular stabilizing properties. It is a calcium channel blocker and N-methyl-D-aspartate (NMDA) receptor antagonist, leading to vasodilation and decreased catecholamine release. Magnesium also blocks calcium influx into vascular smooth muscle cells, which lowers the peripheral vascular resistance and enhances stability of the hemodynamics during the induction of anesthesia [2].

Nebulization is a non-invasive pharmaceutical delivery method that enables quick absorption through the respiratory mucosa. Nebulised drugs can have effective local and systemic actions compared with intravenous administration and have fewer chances of systemic adverse actions. Dexmedetomidine and magnesium sulphate have demonstrated encouraging outcomes in case of airway reflexive and hemodynamic reaction attenuation during intubation when administered either through nebulization [4].

Increasing interest in the anesthetic practice has been given to the development of non-invasive premedication strategies. The benefits of nebulized drug delivery include ease of administration, increased patient comfort and decreased premedication requirement via the use of intravenous delivery. It can also be effective in modulating airway reflexes and sympathetic reactions prior to inducing anesthesia and thereby increasing the stability of hemodynamics during the perioperative period [1].

MATERIALS AND METHODS

Study Design and Setting- This study was conducted as a double-blind randomized controlled trial at the Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru, to evaluate the comparative effectiveness of nebulized magnesium sulphate and dexmedetomidine in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation.

Study Population and Sample Size- Adult patients scheduled for elective surgery under general anesthesia were considered. A total of 56 patients were enrolled after preoperative assessment and informed consent and were randomly allocated into two groups of 28 each.

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Inclusion Criteria- Patients aged between 18 and 60 years, belonging to ASA physical status I or II, of either gender, and scheduled for elective surgery under general anesthesia with endotracheal intubation were included in the study.

Exclusion Criteria- Patients with a body mass index greater than 30, pregnant or lactating women, individuals with known cardiovascular diseases, patients with hypersensitivity to the study drugs, and patients with an anticipated difficult airway, such as Mallampati grade III or IV, were excluded from the study.

Study Groups- Participants were randomly divided into two groups. Group M received nebulized magnesium sulphate at a dose of 10 mg/kg, while Group D received nebulized dexmedetomidine at a dose of 0.5 mcg/kg.

Procedure- All patients underwent preoperative evaluation and baseline hemodynamic parameters were recorded. Nebulization with the respective study drug was administered 30 minutes before induction of anesthesia. Standard anesthesia protocol was followed using propofol for induction, fentanyl for analgesia, midazolam for sedation, glycopyrrolate as an anticholinergic, and vecuronium as a muscle relaxant. Endotracheal intubation was performed using a standard laryngoscopy technique. Hemodynamic parameters were recorded at baseline, after nebulization, and at defined intervals following intubation.

Parameters Measured- The primary parameters measured included heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure.

Statistical Analysis- Statistical analysis was performed using SPSS version 22. Continuous variables were expressed as mean±standard deviation. Student's independent t-test was used for comparison of continuous variables between the two groups, while the Chi-square test was used for categorical variables. A p-value<0.05 was considered statistically significant.

Ethical Approval- The study was approved by the Institutional Ethics Committee of Sapthagiri Institute of Medical Sciences and Research Centre (Ref No: SIMS & RC / EC-13/PG-07 / 2025-26). The trial was registered prospectively with the Clinical Trials Registry of India (CTRI/2025/09/095174). Written informed consent was obtained from all participants.

RESULTS

The baseline demographic characteristics were comparable between the two groups. There was no statistically significant difference in age, gender distribution, body weight, or ASA physical status between the magnesium sulphate and dexmedetomidine groups. This indicates that both groups were well matched before the intervention, ensuring that any differences in hemodynamic parameters observed later were likely due to the study drugs rather than demographic variations (Table 1).

Table 1: Demographic Characteristics of Study Participants

Variable	Group M (Magnesium Sulphate) n=28	Group D (Dexmedetomidine) n=28	p-value
Age (years)	39.6±9.8	38.9±10.2	0.78
Gender (M/F)	15 / 13	16 / 12	0.79
Weight (kg)	66.4±8.5	67.1±7.9	0.71
ASA I (%)	17 (60.7%)	18 (64.3%)	0.79
ASA II (%)	11 (39.3%)	10 (35.7%)	

Heart rate increased in both groups following laryngoscopy and intubation; however, the increase was significantly greater in the magnesium sulphate group. Patients receiving dexmedetomidine showed better control of tachycardia after intubation, demonstrating a more stable hemodynamic profile during the peri-intubation period (Table 2).

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Table 2: Comparison of Heart Rate (beats/min)

Time Interval	Group M	Group D	p-value
Baseline	82.5±8.1	81.9±7.8	0.76
After Nebulization	80.6±7.5	76.4±6.8	0.04
2 min after Intubation	98.3±9.2	88.1±7.4	0.001
5 min after Intubation	92.6±8.4	84.3±7.1	0.003
10 min after Intubation	88.1±7.9	82.5±6.6	0.02

Systolic blood pressure increased markedly after intubation in both groups. However, patients who received dexmedetomidine had significantly lower systolic blood pressure than those receiving magnesium sulphate, indicating more effective attenuation of the pressor response (Table 3).

Table 3: Comparison of Systolic Blood Pressure (mmHg)

Time Interval	Group M	Group D	p-value
Baseline	124.6±10.5	123.9±9.8	0.81
After Nebulization	122.4±9.7	118.3±8.9	0.05
2 min after Intubation	148.1±11.2	135.4±10.1	0.001
5 min after Intubation	140.3±10.6	130.7±9.4	0.003
10 min after Intubation	134.5±9.8	127.2±8.5	0.01

Mean arterial pressure increased significantly immediately after intubation in both groups. The dexmedetomidine group showed significantly lower MAP values at all post-intubation intervals, suggesting better hemodynamic stability compared with magnesium sulphate (Table 4).

Table 4: Comparison of Mean Arterial Pressure (MAP)

Time Interval	Group M	Group D	p-value
Baseline	92.4±7.2	91.8±6.9	0.74
After Nebulization	90.1±6.8	87.2±6.1	0.06
2 min after Intubation	108.7±8.5	99.6±7.4	0.001
5 min after Intubation	104.2±7.9	96.8±7.1	0.002
10 min after Intubation	100.3±7.4	94.1±6.5	0.01

Postoperative complications were minimal in both groups. The incidence of sore throat, nausea, and vomiting was slightly lower in the dexmedetomidine group, although the difference was not statistically significant (Table 5).

Table 5: Postoperative Complications

Complication	Group M (n=28)	Group D (n=28)	p-value
Sore Throat	6 (21.4%)	3 (10.7%)	0.27
Nausea	4 (14.3%)	2 (7.1%)	0.39
Vomiting	2 (7.1%)	1 (3.6%)	0.55

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DISCUSSION

The present study evaluated the comparative effectiveness of preoperative nebulization with magnesium sulphate and dexmedetomidine in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation. The findings demonstrated that patients receiving nebulised dexmedetomidine showed significantly better control of heart rate and blood pressure than those receiving magnesium sulphate, indicating superior attenuation of the sympathetic stress response [5-7]. This effect was observed consistently across all peri-intubation time points, suggesting that dexmedetomidine provides more stable cardiovascular conditions during airway manipulation, which is clinically important for patients undergoing elective surgery.

Dexmedetomidine is a highly selective α2-adrenergic receptor agonist that exerts its action by reducing central sympathetic outflow and inhibiting catecholamine release, thus providing stable hemodynamic conditions [6-9]. Its sympatholytic properties make it particularly useful in reducing the transient tachycardia and hypertension associated with laryngoscopy and endotracheal intubation. Previous studies have demonstrated similar benefits, showing that both intravenous and nebulized dexmedetomidine effectively attenuate the pressor response, but nebulization offers a non-invasive route with fewer systemic adverse effects [8-10]. The present study corroborates these findings and further confirms the clinical efficacy of nebulized administration in maintaining perioperative hemodynamic stability.

Magnesium sulphate, on the other hand, acts as a calcium channel blocker and N-methyl-D-aspartate (NMDA) receptor antagonist, resulting in vasodilation and reduced catecholamine release [10-12]. While magnesium sulphate provides some degree of hemodynamic control, its effect was comparatively less pronounced than that of dexmedetomidine in this study. Previous literature supports this observation, indicating that magnesium sulphate is effective in moderating pressor responses but may not provide the same level of attenuation as α2-adrenergic agonists [11-13]. Its clinical utility remains important, particularly when dexmedetomidine is contraindicated or unavailable.

The superior effect of dexmedetomidine observed in this study can be attributed to its dual action of sedation and sympatholysis, which blunts both the physiological and psychological stress associated with airway manipulation [14,15]. Maintaining stable hemodynamics during induction of anesthesia is particularly critical in patients with preexisting cardiovascular disease, hypertension, or cerebrovascular disorders, where sudden elevations in heart rate or blood pressure can lead to ischemic events, arrhythmias, or increased intracranial pressure [16-18]. By effectively attenuating the sympathetic response, dexmedetomidine can reduce the likelihood of such complications, improving patient safety during perioperative management [16,19].

Nebulized administration of premedication offers practical advantages. It is non-invasive, easy to administer, well tolerated by patients, and allows rapid absorption through the respiratory mucosa, resulting in efficient modulation of airway reflexes [1,2,15]. Compared with intravenous administration, nebulization minimizes systemic side effects while maintaining therapeutic efficacy, making it a convenient choice for preoperative sedation and hemodynamic stabilization [3,5,12,14]. In addition, nebulization enhances patient comfort and compliance, which is particularly advantageous in day-care surgeries or in patients apprehensive about intravenous premedication [5,6].

The present study also emphasizes the importance of selecting appropriate pharmacological interventions to optimize perioperative hemodynamic stability. While both magnesium sulphate and dexmedetomidine are effective, dexmedetomidine demonstrated superior outcomes in controlling heart rate, systolic and diastolic blood pressure, and mean arterial pressure during the critical peri-intubation period [7-9]. These findings align with previous research highlighting dexmedetomidine as a first-line agent for attenuating the hemodynamic response to laryngoscopy and intubation, particularly in high-risk populations [10,16,18].

Furthermore, the safety profile of nebulized dexmedetomidine is noteworthy. No significant adverse events were observed in the study population, corroborating earlier reports of its minimal systemic side effects when administered via the respiratory route [6,12,19,20]. Magnesium sulphate was also well tolerated, but its comparatively modest efficacy underscores the clinical preference for dexmedetomidine in situations where maximal attenuation of the sympathetic response is desired.

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SUMMARY

The present study compared preoperative nebulization with magnesium sulphate and dexmedetomidine for attenuating the hemodynamic response to laryngoscopy and endotracheal intubation. The findings showed that dexmedetomidine provided better control of heart rate and blood pressure, indicating superior attenuation of the sympathetic response and improved cardiovascular stability. Its selective α2-adrenergic action reduces sympathetic outflow and catecholamine release, helping maintain stable hemodynamics during airway instrumentation. Additionally, nebulized drug delivery is non-invasive, well tolerated, and allows effective absorption, making dexmedetomidine a safe and effective preoperative option for controlling hemodynamic changes.

CONCLUSIONS

In conclusion, the results of this study demonstrate that preoperative nebulized dexmedetomidine is more effective than magnesium sulphate in controlling the hemodynamic stress associated with laryngoscopy and endotracheal intubation. Its ability to maintain cardiovascular stability, coupled with the practical advantages of nebulized administration, make it an ideal choice for routine anesthesia practice, especially in patients at risk of cardiovascular complications. Incorporation of nebulized dexmedetomidine as a preoperative intervention can enhance patient safety, improve perioperative outcomes, and provide a reliable strategy for mitigating the adverse hemodynamic effects of airway manipulation.

CONTRIBUTION OF AUTHORS

Research concept- Dr. Prashanth Prabhu J

Research design- Dr. Prashanth Prabhu J**,** Dr. Venkatesh Soundarya

Supervision- Dr. Prashanth Prabhu J

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