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Original Research Article

A Comparative Study to Evaluate the Attenuation of Pressor Response During Laryngoscopy and Tracheal Intubation under General Anaesthesia with Intravenous Magnesium Sulphate (20mg/kg) Versus Intravenous Dexmedetomidine (1 mcg/kg): A Prospective, Randomized and Double Blinded Study

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Conflict of interest: Nil

Abstract

Background: A comparative study to evaluate the attenuation of pressor response during laryngoscopy and tracheal intubation under general anaesthesia with intravenous magnesium sulphate (20mg/kg) versus intravenous dexmedetomidine (1 mcg/kg): a prospective, randomized and double blinded study

Methodology: After taking institutional ethical committee approval, fifty adult patients of either sex aged between 20 - 50 years of ASA- I/II will be included in the study. Written and informed consent will be obtained and patients are randomly divided into two groups (Group M and Group D) each group consisting of twenty five patients, undergoing various surgeries like Neurosurgery, Thyroid Surgery, Breast surgeries and Orthopedic surgeries under general Anaesthesia. Patients were premedicated with inj glycopyrrolate 0.2 mg, inj ondansetron 4 mg and inj midazolam 1 mg IV given. Inj fentanyl 1 mcg/kg given Group-D: Patients received intravenous Dexmedetomidine 1 mcg/kg which is diluted with 10 ml normal saline given slowly over a period of 10 mins, before induction. Group-M: Patients were administered 20 mg/kg of Magnesium Sulphate in which is diluted with 10 ml normal saline given slowly over a period of 10 mins, before induction.

Results: This study was a prospective (forward-looking), randomized, double-blinded, comparative study involving 50 ASA I and II patients, both male and female, aged 20-50 years. These individuals were set to undergo elective noncardiac surgeries with general anesthesia. The main goal of the study was to compare the efficacy of intravenous Dexmedetomidine ($C_{13}H_{16}N_2$) and Magnesium Sulfate ($MgSO_4$) in mitigating the pressor response during laryngoscopy and endotracheal intubation. In both the groups, Heart Rate (HR), Systolic Blood Pressure (DBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), adverse effects, and sedation levels (assessed by the Modified Ramsay Sedation Score) were recorded.

Conclusions: Based on our study, we conclude that IV Dexmedetomidine (1 µg/kg) significantly attenuated the pressor response to laryngoscopy and tracheal intubation in comparison with IV Magnesium Sulfate (20 mg/kg) in various surgeries posted under general Anaesthesia without significant side effects.

Keywords: IV Dexmedetomidine, IV Magnesium Sulfate, Laryngoscopy and Tracheal intubation, Pressor Response, Hemodynamic parameters.

Introduction

Laryngoscopy and endotracheal intubation are essential for the safe administration of general

anesthesia. These procedures can trigger noxious stimuli that provoke hemodynamic stress responses, such as laryngo-sympathetic stimulation[8,9].

This response is often characterized by hypertension, tachycardia, and arrhythmias. While healthy individuals can generally tolerate these hemodynamic changes.

King in 1951 was the first to describe the circulatory-response to laryngoscopy and the intubation. These includes:

1. Increase in Heart rate
2. Increase in Arterial Pressure
3. Increase in Intracranial Pressure
4. Increase in Intraocular Pressure
5. Cardiac Dysrhythmias
6. Cardiac asystole
7. Coronary and cerebral infarction and haemorrhage

The most recent techniques are

1. α_2 agonist
   a. I.V. Dexmedetomidine, I.V. Clonidine
      - Oral
      - Transdermal
   b. Nitroglycerine: Topical
   c. Ointment
   d. Transdermal patches
2. I.V. Labetalol / Esmolol
3. I.V. Fentanyl / Alfentanil / Sufentanil
4. IV Magnesium Sulphate [12,13,14,]

Intravenous dexmedetomidine [2], a central alpha-2 agonist, used as a premedicant in anesthesia. Its advantages include providing sedation, analgesia, anxiolysis, and improved hemodynamic stability. Due to these beneficial properties, dexmedetomidine significantly reduces the minimum alveolar concentration (MAC) of volatile anesthetic agents by up to 90%, thereby decreasing the overall requirement for anesthetics [3]. Additionally, dexmedetomidine has been found to attenuate the hemodynamic response to laryngoscopy and intubation [4,5]. Magnesium sulfate inhibits the release of catecholamines from adrenergic nerve terminals, and elevated magnesium levels can further suppress catecholamine release.

Additionally, magnesium induces vasodilation by directly acting on blood vessels. This study was conducted to compare the effectiveness of intravenous magnesium sulfate and dexmedetomidine in attenuating the stress response to laryngoscopy & endotracheal intubation.[10,11]

Autonomic Nervous System Innervation

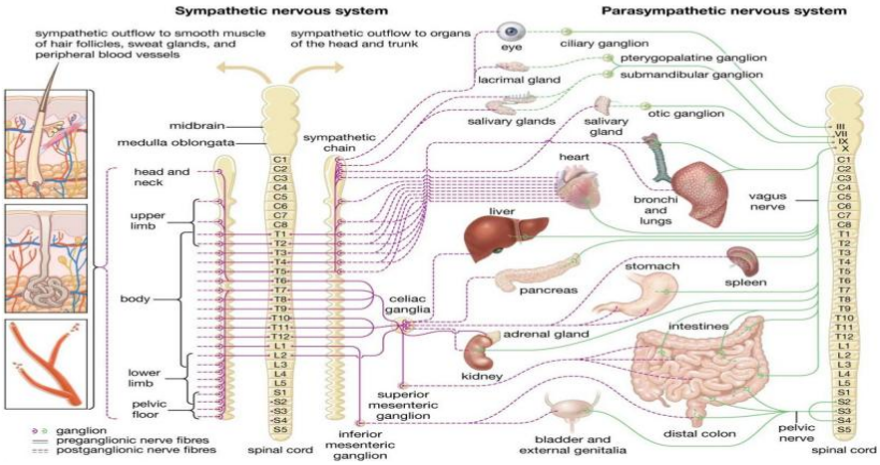

Figure 1: The Autonomic Nervous System

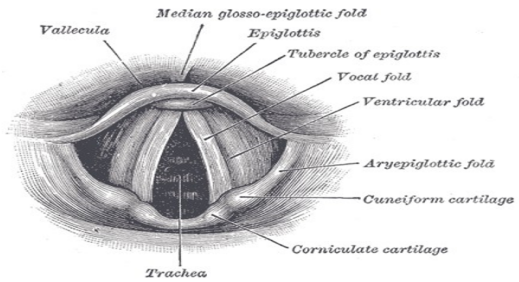

Figure 2: Laryngoscopic view of vocal cords

Laryngoscopy & endotracheal intubation stimulate nerves along this pathway, leading to the hemodynamic-response observed during these procedures.

Chemical Structure

Figure 3: Chemical structure and Ampoule of Magnesium Sulphate[15]

Aim of the Study: A comparative study to evaluate the attenuation of pressor response during laryngoscopy and tracheal intubation under general anaesthesia with intravenous Magnesium Sulphate (20 mg/kg) vs Intravenous Dexmedetomidine (1 mcg/kg): a prospective, randomized and double blinded study under the following parameters:

1. Heart rate
2. Systolic blood pressure
3. Diastolic blood pressure
4. Mean arterial pressure
5. Level of sedation upon recovery
6. Adverse effects

Materials & Methods

Type of study: Prospective randomized comparative and double blinded study.

Source of data: The study/trial was performed in the "Department of Anaesthesiology" at Siddhartha Medical College, Government General Hospital, Vijayawada, and Andhra Pradesh, India.

Duration: Jan 2023 - December 2024.

Method of collection of data - Patients of both genders aged between 20-50 yrs of ASA- I & II, undergoing various surgeries like Neurosurgery, Thyroid Surgery, Breast surgeries and orthopedic surgeries under general Anaesthesia. It has categorized into two groups:

- Group M:- Received IV Magnesium Sulphate (20 mg/kg)
- Group D:- Received IV Dexmedetomidine (1 µg/kg)

Inclusion Criteria

1. ASA grade I or II patient
2. Elective noncardiac surgery
3. Patients of either sex
4. Aged 20-50 years
5. Weight of the patient between 50-70 Kgs

Exclusion Criteria

1. Patient refusal
2. Patients < 20 years and > 50 years of age
3. Systolic blood pressure < 70 mmhg and > 150 mmhg
4. Mallampati Grading iii and iv
5. Difficult airway
6. ASA grade III or IV patients
7. Impaired renal function and electrolyte imbalance.

Patients with systemic disorders like left ventricular failure, any degree of heart block, ischemic heart disease, aortic stenosis and bronchial asthma

Methodology

After taking institutional ethical committee approval, fifty adult patients of either sex aged between 20 - 50 years of ASA- I/II will be included in the study. Written and informed consent will be obtained and patients are randomly divided into two groups (Group M and Group D) each group consisting of twenty-five patients.

Once the patient enters into the OT room, IV Line secured with 18 G needle and monitors were

connected (heart rate, NIBP, oxygen saturation, ECG) and baseline vital parameters like HR, SBP, DBP, MAP, SPO2, sedation scores, and finally the adverse effects were recorded.

Patients were premedicated with inj glycopyrrolate 0.2 mg, inj ondansetron 4 mg and inj midazolam 1 mg IV given. Inj fentanyl 1 mcg/kg given.

Group-D: Patients received intravenous Dexmedetomidine 1 mcg/kg which is diluted with 10 ml normal saline given slowly over a period of 10 mins, before induction.

Group-M: Patients were administered 20 mg/kg of Magnesium Sulphate in which is diluted with 10 ml normal saline given slowly over a period of 10 mins, before induction Patients induced with inj Propofol 2 mg/kg followed by intravenous succinylcholine 2 mg/kg given and intubation was done.

Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Mean Arterial Pressure (MAP) were recorded as follows

- 1 minute prior to laryngoscopy and intubation.
- 1, 2, 3, 5 & 10 mins after intubation

Anesthesia was maintained using a mix of O2, N2O, sevoflurane and nondepolarizing muscle relaxant inj. Vecuronium. Throughout the procedure patients vitals were stable. After the surgery, patients were extubated using a reversal combination of 0.05 mg/kg neostigmine and 0.001 mg/kg glycopyrrolate.

Adverse Effects: In our trial/study, the following adverse effects after administering Magnesium Sulphate and Dexmedetomidine: nausea, vomiting, hypotension, and bradycardia were observed.

Observations & Results

This study was a prospective (forward-looking), randomized, double-blinded, comparative study involving 50 ASA I and II patients, both male and female, aged 20-50 years. These individuals were set to undergo elective noncardiac surgeries with general anesthesia.

The main goal of the study was to compare the efficacy of intravenous Dexmedetomidine ($C_{13}H_{16}N_2$) and Magnesium Sulfate ($MgSO_4$) in mitigating the pressor response during laryngoscopy and endotracheal intubation.

Age

Comparison of groups on the basis of Age

Table 1: Comparison of Age between the groups, M and D

Group	N	Mean ± SD	P-Value
M	25	39.0 ± 7.90	0.8492 (Not Significant)
D	25	39.4 ± 6.86	

The mean age in both groups was 39.5 years. The p-value was not statistically significant (p = 0.8492)

Weight Distribution

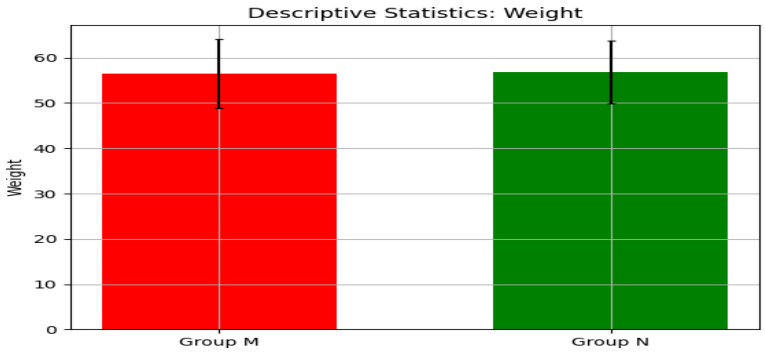

Figure 4: Weight comparison

The mean weight in both groups was 57 KGs. The p-value was not statistically significant (p = 0.8743)
ASA Status

Comparison of groups on the basis of ASA

Table 1: Comparison of ASA status between the groups, M and D

Group	N	Mean ± SD	P-Value
M	25	1.64 ± 0.48	0.5729 (Not Significant)
D	25	1.56 ± 0.50	

The p value for ASA status was not statistically significant

Mallampati Grading: Comparison of groups on the basis of Mallampati Grading

Table 3: Comparison of Mallampati grades between the groups, M and D

Group	N	MPG I	MPG II	P-Value
M	25	16 (64%)	9 (36%)	0.4004 (Not Significant)
D	25	13 (52%)	12 (48%)	

The p value for Mallampati Grading was not statistically significant (p=0.4004) in both groups.

Hemodynamic Data

Heart Rate: Comparison of groups on the basis of HR

Table 4: Comparison of Heart Rates between the groups, M and D

Time in Mins	Heart Rate		P Value	Significance
	Group M (Mean ± SD)	Group D (Mean ± SD)		
Baseline	89.51 ± 15.2	85.92 ± 12.23	0.72	Not Significant
1 min before laryngoscopy & intubation	77.68 ± 6.89	74.8 ± 9.20	0.216	Not Significant
1 min after intubation	79.04 ± 5.968	74.44 ± 8.930	0.0373	Significant
2 mins after intubation	75.56 ± 5.774	71.96 ± 6.522	0.0442	Significant
3 mins after intubation	73.8 ± 5.986	69.8 ± 7.0415	0.0354	Significant
5 mins after intubation	71.44 ± 6.58	68.24 ± 5.86	0.076	Not Significant
10 mins after intubation	68.24 ± 5.86	65.72 ± 8.39	0.224	Not Significant

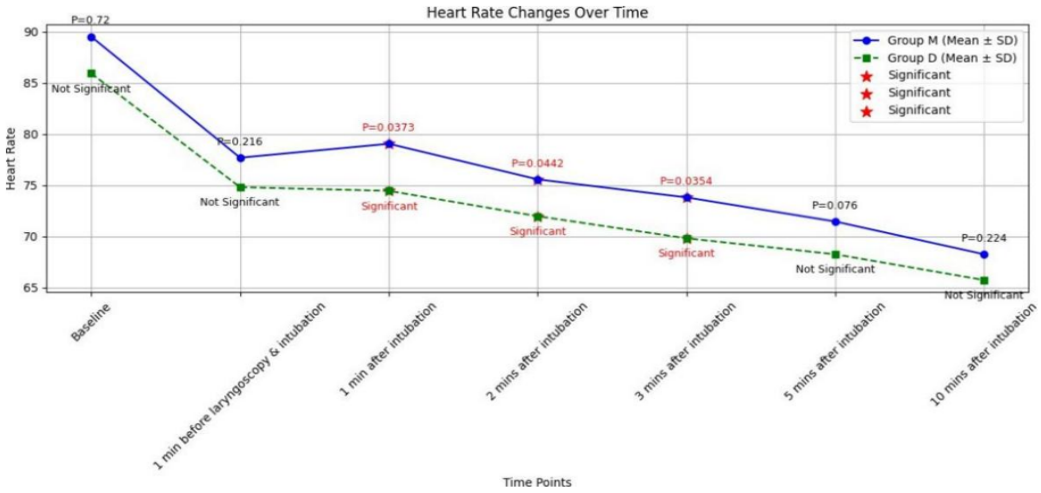

Figure 5: Heart Rate comparison between Group M & Group D

Statistical analysis shows that the p-values of 0.0373, 0.0442, and 0.0354 at 1, 2, and 3 minutes after intubation were statistically significant between the groups

Systolic Blood Pressure: Comparison of groups on the basis of SBP

Table 5: Comparison of Systolic blood pressure between the groups, M and D

Time in Mins	Systolic Blood Pressure		P Value	Significance
	Group M (Mean ± SD)	Group D (Mean ± SD)		
Baseline	170.74 ± 12.2	126.93 ± 15.27	0.057	Not Significant
1 min before laryngoscopy & intubation	123.32 ± 8.92	124.08 ± 7.60	0.747	Not Significant
1 min after intubation	124.16 ± 7.79	118.64 ± 6.78	0.0102	Significant
2 mins after intubation	121.12 ± 6.66	115.04 ± 5.69	0.0011	Significant
3 mins after intubation	119.36 ± 5.71	114.48 ± 5.17	0.0027	Significant
5 mins after intubation	115.0 ± 8.58	112.88 ± 7.82	0.366	Not Significant
10 mins after intubation	115.12 ± 7.27	113.92 ± 7.11	0.558	Not Significant

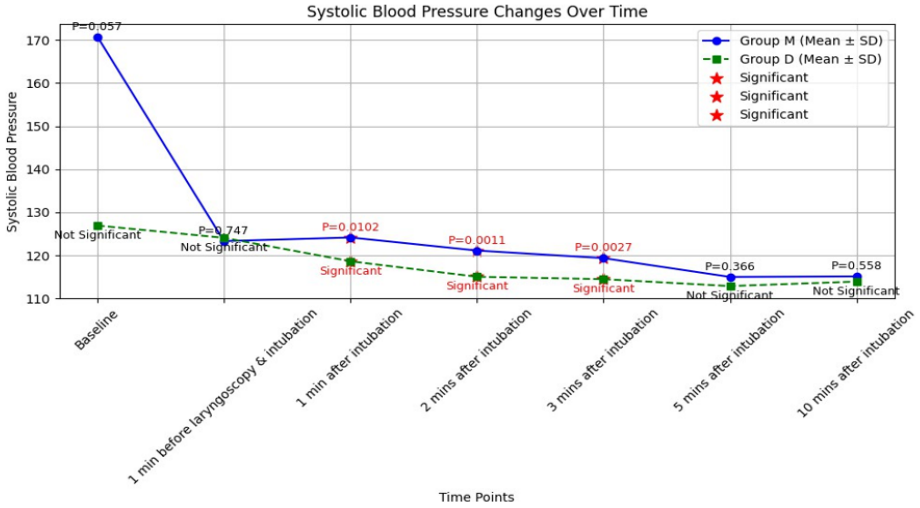

Figure 6: Systolic Blood Pressure comparison between Group M & Group D

Statistical analysis shows that the p-values of 0.0102, 0.0011, and 0.0027 at 1, 2, and 3 minutes after intubation were statistically significant between the groups.

Diastolic Blood Pressure: Comparison of groups on the basis of DBP

Table 6: Comparison of Diastolic blood pressure between the groups, M and D

Time in Mins	Diastolic Blood Pressure		P Value	Significance
	Group M (Mean ± SD)	Group D (Mean ± SD)		
Baseline	73.79 ± 9.34	77.78 ± 8.59	0.148	Not Significant
1 min before laryngoscopy & intubation	77.8 ± 7.43	75.68 ± 6.03	0.274	Not Significant
1 min after intubation	78.48 ± 7.19	73.20 ± 4.97	0.004	Significant
2 mins after intubation	76.80 ± 6.68	71.36 ± 4.61	0.0016	Significant
3 mins after intubation	75.36 ± 6.08	70.96 ± 4.00	0.004	Significant
5 mins after intubation	70.84 ± 5.65	69.0 ± 5.33	0.242	Not Significant
10 mins after intubation	68.2 ± 5.16	66.04 ± 5.47	0.157	Not Significant

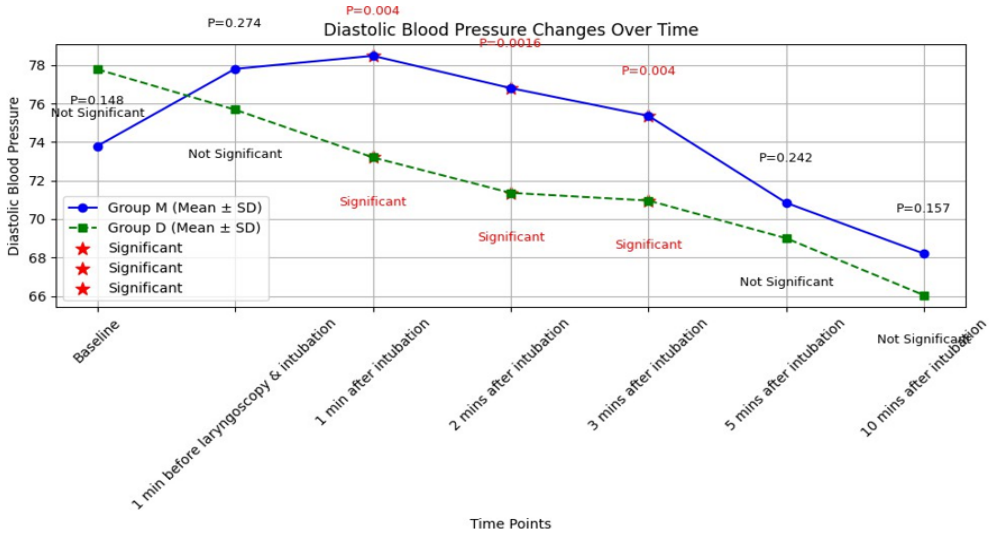

Figure 7: Diastolic Blood Pressure comparison between Group M & Group D

Statistical analysis shows that the p-values of 0.004, 0.0016, and 0.0040 at 1, 2, and 3 mins after the intubation were statistically significant between the groups.

Mean Arterial Pressure: Comparison of groups on the basis of MAP

Table 7: Comparison of Mean arterial pressure between the groups, M and D

Time in Mins	Mean Arterial Pressure		P Value	Significance
	Group M (Mean ± SD)	Group D (Mean ± SD)		
Baseline	86.88 ± 9.34	90.33 ± 8.59	0.076	Not Significant
1 min before laryngoscopy & intubation	93.28 ± 5.66	92.68 ± 5.40	0.703	Not Significant
1 min after intubation	93.48 ± 7.17	88.24 ± 5.90	0.0069	Significant
2 mins after intubation	91.64 ± 6.35	85.60 ± 4.86	0.0004	Significant
3 mins after intubation	89.92 ± 5.82	84.72 ± 3.95	0.0006	Significant
5 mins after intubation	85.28 ± 4.88	83.32 ± 8.39	0.318	Not Significant
10 mins after intubation	82.8 ± 7.14	80.64 ± 6.81	0.279	Not Significant

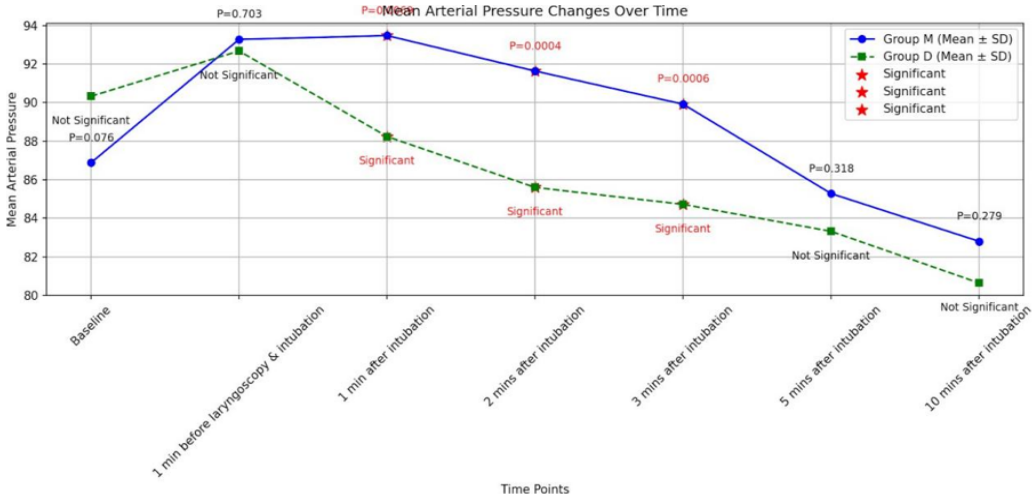

Figure 8: Mean Arterial Pressure comparison between Group M & Group D

Statistical analysis shows that the p-values of 0.0069, 0.0004, and 0.0006 at 1, 2, and 3 minutes after intubation were statistically significant between the groups.

Modified Ramsay Sedation Score

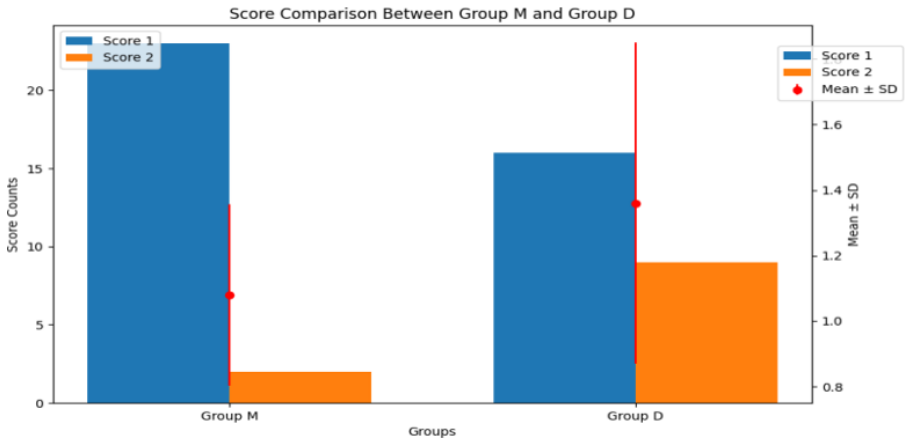

Figure 9: Sedation score comparison between Group M & Group D

Statistically significant differences were observed in the Modified Ramsay Sedation Score between the two groups. Magnesium sulfate was found to have significantly lesser sedation than Dexmedetomidine at the time of extubation.

Adverse Effects

Table 8: Adverse effects between the groups, M and D

Adverse Effects	Group - M		Group - D	
	No.	%	No.	%
Bradycardia	0	0	3	12%
Hypotension	0	0	2	8%
Nausea	0	0	0	0
Vomiting	0	0	0	0
Total	25	100	25	100

In our study, we observed bradycardia which was noted in 12% and hypotension was in 8% as the side effects of the Dexmedetomidine group.

Discussion

The hemodynamic response to laryngoscopy has been a topic of discussion since 1940. In normal patients, an increase in heart rate and blood pressure is typically observed during laryngoscopy and intubation. These healthy individuals can generally tolerate the hemodynamic changes associated with these procedures. Therefore, controlling this perioperative stress response remains an important goal in anesthesia management.

Various drugs have been evaluated for use during premedication or induction to blunt pressor responses.

Most studies have compared the effects of intravenous dexmedetomidine or magnesium sulfate against a control. Therefore, we planned “a prospective, randomized, double-blind study” at “Siddhartha Medical College”, GGH, Vijayawada to compare the effects of dexmedetomidine and magnesium sulfate in attenuating the pressor response during laryngoscopy and intubation.

50 ASA physical status I and II patients, aged 20-50 years, scheduled for elective non cardiac surgeries. They were randomly allocated into two groups: Group D (dexmedetomidine group) and Group M (magnesium sulfate group).

Patient Characteristics across the Groups

The demographic characteristics, including age, weight, and ASA status, were similar in both groups, with no statistically significant difference.

In the Magnesium sulfate group, the mean age was 39.0 ± 7.90 years, while in the Dexmedetomidine group, it was 39.4 ± 6.86 years. The mean weight in the Magnesium sulfate group was 57.16 ± 6.63 kg, compared to 57.44 ± 5.79 kg in the Dexmedetomidine group.

Patients belonged to either ASA I or ASA II status. The Mallampati grading of patients was similar in both groups.

Dosage of Drugs

In Group M, Magnesium sulfate at a dosage of 20 mg/kg diluted in 10 ml of normal saline was used. In Group D, Dexmedetomidine at a dosage of 1 μg/kg, also diluted in 10 ml of normal saline, was administered. Both drugs were given over a period of 15 minutes before induction.

Our study compared with the study conducted by Krishna Chaitanya [1].

Patients in both groups remained hemodynamically stable throughout the procedure. Additionally, both drugs reduced the requirements for opioids, muscle relaxants, and volatile anesthetic agents. Recovery in both groups was uneventful, indicating a favorable safety profile for both interventions.

Our study compared with the study conducted by K. Montazeri et al. (2005) .

In our study, we used Magnesium sulfate at a dose of 20 mg/kg. This dose showed a lower incidence of Hypotension, Bradycardia, sedation, and other side effects were also not present compared to the 50 mg/kg dose used by Montazeri et al. We administered Dexmedetomidine at 1 μg/kg, only a few patients got Hypotension and Bradycardia [6].

Hemodynamic stability

The variation in hemodynamic parameters like heart rate, systolic blood pressure, diastolic blood pressure and MAP was observed in the following intervals; baseline, 1-min before laryngoscopy and 1-min, 2-minutes, 3-minutes, 5-minutes, and 10-minutes after intubation.

Heart Rate

In our study, the heart rate values were significantly lower in the dexmedetomidine group than in the magnesium sulfate group. This difference was statistically significant at 1, 2, and 3 minutes after intubation, with p-values of 0.002, 0.001, and 0.010, respectively.

Thus, our findings are consistent with those of Dr. Anju Mohan7 and Dr. Gautham Saha, as both studies demonstrate that dexmedetomidine effectively reduces heart rate. Our study highlights that dexmedetomidine is more effective in controlling heart rate during the immediate post-intubation period.

Gautham Pillai et al [9]. Used a 30 mg/kg bolus of magnesium sulfate before induction, followed by a continuous infusion of 10 mg/kg/hr, and compared it with normal saline.

They found that the mean arterial pressure and heart rate just after intubation were significantly lower in the magnesium group ($p<0.05$). In our study, we used magnesium sulfate (20 mg/kg) and we observed that there were not much changes in heart rate and blood pressure. Certainly! In our study, similar to Saraf et al, we administered dexmedetomidine but at a slightly higher dose of 1 µg/kg to evaluate its efficacy in attenuating the pressor responses during intubation. Our findings align with Saraf et al.'s observations, where dexmedetomidine administration resulted in a significant decrease in heart rate.

Systolic Blood Pressure

Krishna Chaitanya et al [1] Used magnesium sulfate at 30 mg/kg and dexmedetomidine at 1 mcg/kg. They observed no significant difference among the drugs at 0, 1, 3, 5, and 10 minutes for systolic blood pressures ($p>0.005$). However, in our study, we observed that Systolic Blood Pressure was decreased (↓) at 1, 2, 3 mins after intubation and there was a statistically significant difference across the two groups.

In our study, we compared the effects of magnesium sulfate (20 mg/kg) and dexmedetomidine (1 µg/kg) on the cardiovascular pressor responses[6,7] to intubation. We observed a statistically significant difference in SBP in the two groups. Specifically, dexmedetomidine was highly effective in controlling SBP compared to magnesium sulfate. This was reflected in our statistical analysis, where the p-values indicated significant differences at various intervals post-intubation.

As a result, our findings concur with those of Dr. Anju Mohan and Dr. Gautham Saha, as both studies demonstrate that dexmedetomidine is more effective than magnesium sulfate in attenuating the rise in SBP during laryngoscopy and endotracheal intubation. This correlation strengthens the evidence that dexmedetomidine is a superior agent for managing cardiovascular pressor responses compared to magnesium sulfate in the perioperative setting.

In our study, a statistically significant variation in systolic blood pressure was observed at various intervals, specifically at 1, 2, and 3 minutes after intubation between the two groups.

Diastolic Blood Pressure

In our study, we evaluated the effects of magnesium sulfate (20 mg/kg) and dexmedetomidine (1 µg/kg) on the cardiovascular reactions to intubation. We noted a significant difference in diastolic blood pressure (DBP) between the groups. Dexmedetomidine proved more effective at managing DBP than magnesium sulfate. This was evident in our statistical analysis, which showed notable p-values at different time points post-intubation.

This study was compared with Krishna Chaitanya et al and Dr. Anju Mohan and Dr. Gautham Saha. Hence, our results match with those of Dr. Anju Mohan and Dr. Gautham Saha, as both studies show that Dexmedetomidine is more effective than the "Magnesium sulfate" in attenuating the rise in DBP during laryngoscopy and endotracheal intubation. This correlation further supports the conclusion that dexmedetomidine is superior in managing cardiovascular pressor responses compared to magnesium sulfate in the perioperative setting.

Mean Arterial Pressure

In our study, we compared the effects of magnesium sulfate (20 mg/kg) and dexmedetomidine (1 µg/kg) on the cardiovascular pressor responses to the intubation. We observed a statistically significant difference in MAP between the groups. Dexmedetomidine was more effective in controlling MAP in the comparison of magnesium sulfate. This was reflected in our statistical analysis, where the p-values indicated significant differences at different intervals post-intubation.

Therefore, our findings were aligned with those of Dr. Anju Mohan and Dr. Gautham Saha, as both studies show that dexmedetomidine demonstrates greater efficacy compared to magnesium sulfate in attenuating the rise in MAP during laryngoscopy and endotracheal intubation. This correlation further supports the conclusion that dexmedetomidine is superior in managing cardiovascular pressor responses compared to magnesium sulfate in the perioperative setting.

Montazeri et al. performed a randomized control study using "Intravenous Magnesium Sulfate" at a dosage of 30 mg/kg administered 10-mins before induction, and they also observed a significant difference in MAP across the groups. In our study/trial we have taken the Magnesium Sulfate of 20 mg/kg and we haven't observed any side effects and the recovery of the patient was good.

Level of Sedation

Both magnesium sulfate & dexmedetomidine are known to produce sedation. In our study, we evaluated the sedative effects of these drugs using the Modified Ramsay Sedation-Scale at the time of extubation.

In the group of magnesium sulfate, 23 out of 25 patients scored 1, while 2 patients scored 2. In the dexmedetomidine group, 16 out of 25 patients scored 1, and the remaining 9 patients scored 2.

This difference in sedative effect can be attributed to the prolonged sedative action of dexmedetomidine compared to magnesium sulfate. The p-value of < 0.0163 indicates that this difference is statistically significant.

Adverse Effects

In our study/trial we noticed adverse effects such as bradycardia, hypotension, nausea, & vomiting. In the Magnesium group, no patients experienced any adverse effects. In the Dexmedetomidine group, Bradycardia in 3 out of 25 patients (12%) and Hypotension in 2 out of 25 patients (8%) observed.

Conclusion

Based on our study, we conclude that IV Dexmedetomidine (1 µg/kg) significantly attenuated the pressor response to laryngoscopy and tracheal intubation in comparison with IV Magnesium Sulfate (20 mg/kg) in various surgeries posted under general Anaesthesia without significant side effect

References

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