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A Comparative Study Of 2% Intravenous Lignocaine Vs 50% Intravenous Magnesium Sulphate in Attenuation of Hemodynamic Stress Response to Endotracheal Intubation

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ABSTRACT

Introduction: Endotracheal intubation causes sympathetic stimulation with transient rise in HR and BP. IV lignocaine and magnesium sulphate are used to attenuate this response. This study compares IV 2% lignocaine with 50% magnesium sulphate for hemodynamic attenuation during intubation.
Aims and Objectives: The study was aimed at comparing the efficacy of lignocaine vs magnesium sulphate in attenuation of hemodynamic stress response to laryngoscopy and intubation in patients posted for elective surgery under general anaesthesia.
Materials and Methods: This randomized study included 60 ASA I patients receiving either IV lignocaine (1.5 mg/kg) or IV magnesium sulphate (50 mg/kg) before induction. Haemodynamic parameters were recorded at peri-intubation time points, along with assessment of adverse effects.
Results: Baseline HR, SBP, DBP, MAP and RPP were comparable between Magnesium Sulphate and Lignocaine groups ($p > 0.05$). At intubation, Magnesium Sulphate showed significantly lower HR (74.17 ± 2.29 vs 81.83 ± 3.11), SBP (89.10 ± 5.40 vs 129.80 ± 5.69), DBP (51.07 ± 1.96 vs 83.87 ± 3.62), MAP (63.74 ± 2.49 vs 99.18 ± 3.00), and RPP (6612.17 ± 505.62 vs 10620.90 ± 596.96) compared to Lignocaine ($p < 0.001$), with similar adverse effects ($p = 0.865$).
Conclusion: Intravenous 50% magnesium sulphate 30 mg/kg intravenous infusion over 3 minutes 10 minutes prior to induction effectively attenuate the hemodynamic response compared to of intravenous 2% lignocaine 1.5mg/kg bolus over 1 minute, 10 minutes prior to induction.

Keywords: *Endotracheal intubation, haemodynamic response, intravenous lignocaine, magnesium sulphate, general anaesthesia.*

INTRODUCTION

In modern day anaesthesia practice rigid laryngoscopy and tracheal intubation still remain the gold standard in airway management. The influence of airway manipulation on heart rate and blood pressure was recognized more than 50 years ago. [1]. It is now well established that laryngoscopy and endotracheal intubation violate patient's protective airway reflexes and invariably cause hemodynamic changes associated with increased heart rate, increased blood pressure and occasional disturbances in cardiac rhythm.[2,3] These hemodynamic changes arise as a form of sympathoadrenal reflex and due to release of norepinephrine and, to a lesser extent, of epinephrine.[4] In normotensive subjects these hemodynamic changes are short lived [5] and probably of little significance. However, these hemodynamic alterations are hazardous to the patients with hypertension, ischemic heart disease or cerebrovascular disease. [6] In patients with coronary artery disease it may lead to myocardial ischemia because, increase in heart rate and blood pressure associated with laryngoscopy and endotracheal intubation may result in an increase in myocardial oxygen demand and also demand for increased coronary flow. In hypertensive patients these exaggerated responses may lead to left ventricular failure, pulmonary edema and congestive cardiac failure. In patients with intracranial aneurysm or dissecting aneurysm of the aorta, the increase in systemic blood pressure may cause rupture of vessels with life threatening consequences. The magnitude of response is greater with increasing force and duration of laryngoscopy. Elevation of blood pressure and heart rate typically starts within 5 seconds of laryngoscopy, peaks in 1 to 2 minutes and return to baseline level within 5-10 minutes. So, effective attenuation of the sympathoadrenal stress response is an important goal in anaesthesiology. Various pharmacologic and nonpharmacological method have been tried to limit the pressor response following the insertion of endotracheal tube [7]. The success rate is variable with different methods because each method has its own merits and demerits. In several trials drugs like opioids, lidocaine, nitrates, calcium channel blockers, alpha-2 adrenergic agonists, beta blockers and magnesium have been used orally or parenterally to obtund these sympathoadrenal responses. Lignocaine is an aminoethylamide and prototype of amide local anesthetic group. [8] It is the most widely used local anesthetic drug having membrane stabilizing action, so it is commonly used as an anti-arrhythmic drug in patients with ventricular ectopics. In 1961, Bromage showed that its intravenous (IV) use blunted pressure response to intubation. An IV dose of lignocaine 1.5mg/kg [9] has been proved to attenuate stress responses during laryngoscopy and intubation when given prior to induction. Magnesium is the fourth most abundant cation in the body and the second most abundant intracellular cation. It activates many of the enzyme system. Magnesium sulphate inhibits the release of catecholamines from the adrenal medulla and adrenergic nerve endings and is effective in attenuating the blood pressure (BP) response to tracheal intubation[10] Both lignocaine and magnesium sulphate have been used for the attenuation of adrenergic response to laryngoscopy and tracheal intubation. But there are only a few studies comparing lignocaine and magnesium sulphate as an attenuating agent for pressor response. In this randomized, unicentric, prospective, comparative study an attempt has been made to observe, assess and compare the efficacy of 2% lignocaine(1.5 mg/kg body weight) intravenous bolus over 1min, 10 mins prior to induction and 50% magnesium sulphate (30mg/ kg body weight) intravenous bolus over 3 minutes 10 mins prior to induction, in attenuating the haemodynamic response following laryngoscopy and endotracheal intubation in 2 groups of adult patients of either sex undergoing various elective surgeries under general anaesthesia. The study was aimed at comparing the efficacy of lignocaine vs magnesium sulphate in attenuation of hemodynamic stress response to laryngoscopy and intubation in patients posted for elective surgery under general anaesthesia.

MATERIALS AND METHODS

Study design: prospective, randomized study.

Study setting: Ramakrishna Mission Seva Pratishthan, Vivekananda Institute of Medical Sciences.

Period of study: November 2017 to January 2019

Study population: 60 ASA I–II adult patients undergoing elective surgery under general anaesthesia requiring endotracheal intubation, randomly divided into two groups (n=30 each): Group L (2% IV lignocaine) and Group M (50% IV magnesium sulphate).

Sample size: 60

Inclusion criteria:

- ASA I–II patients aged 18–45 years undergoing elective surgery under general anaesthesia requiring endotracheal intubation.
- Patients giving informed written consent.

Exclusion criteria:

- Age less than 18 years and more than 45 years
- Known allergy to anaesthetic agents
- History of a major psychiatric disorder
- History of substance abuse and current opioid use
- Compromised renal, hepatic, pulmonary, and cardiac status
- Diabetes (treated or untreated), Hypertension
- Anticipated difficult intubation
- Duration of laryngoscopy more than 15 secs
- Compensatory tachycardia
- Baseline pulse less than 60 beats per minute
- Baseline systolic blood pressure (SBP) less than100 mm Hg
- Those on medicines with cardiovascular effects
- Pregnancy

Statistical analysis: For statistical analysis data were entered into a Microsoft Excel spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Z-test (Standard Normal Deviate) was used to test the significant difference of proportions. Once a t value is determined, a p-value can be found using a table of values from Student's t-distribution. If the calculated p-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favor of the alternative hypothesis. P-value ≤ 0.05 was considered for statistically significant.

RESULT

Table 01: Comparison of Heart Rate (HR) between Magnesium Sulphate and Lignocaine Groups at Different Time Intervals

Time Point	Magnesium Sulphate (Mean ± SD)	Lignocaine (Mean ± SD)	p value	Significance
HR Baseline	95.97 ± 6.84	94.97 ± 4.59	0.509	Not Significant
HR 5 mins after start of drug	102.20 ± 5.92	104.80 ± 4.07	0.052	Not Significant
HR 10 mins after start of drug	101.13 ± 3.54	110.00 ± 3.70	<0.001	Significant
HR at Induction	76.17 ± 2.53	84.07 ± 3.19	<0.001	Significant
HR at Intubation	74.17 ± 2.29	81.83 ± 3.11	<0.001	Significant
HR 1 min after intubation	96.20 ± 3.17	105.33 ± 5.27	<0.001	Significant
HR 2 mins after intubation	96.97 ± 3.13	108.20 ± 4.82	<0.001	Significant
HR 4 mins after intubation	96.00 ± 4.73	111.37 ± 3.98	<0.001	Significant
HR 6 mins after intubation	87.77 ± 3.79	95.97 ± 3.95	<0.001	Significant
HR 8 mins after intubation	90.00 ± 2.77	96.83 ± 3.58	<0.001	Significant
HR 10 mins after intubation	93.97 ± 3.89	98.97 ± 3.24	<0.001	Significant

Table 02: Comparison of SBP and DBP between Magnesium Sulphate and Lignocaine at Different Time Points

Time Point		Magnesium Sulphate (Mean ± SD)	Lignocaine (Mean ± SD)	p value	Significance
SBP	**SBP Baseline**	114.60 ± 6.07	113.87 ± 7.25	0.673	Not Significant
	SBP 5 mins after start of drug	114.37 ± 7.01	115.70 ± 8.51	0.51	Not Significant
	SBP 10 mins after start of drug	119.43 ± 6.34	122.77 ± 6.33	0.046	Significant
	SBP at Induction	112.33 ± 8.10	127.80 ± 5.63	<0.001	Significant
	SBP at Intubation	89.10 ± 5.40	129.80 ± 5.69	<0.001	Significant
	SBP 1 min after intubation	108.07 ± 10.67	139.73 ± 5.52	<0.001	Significant
	SBP 2 mins after intubation	115.23 ± 5.66	134.83 ± 3.96	<0.001	Significant
	SBP 4 mins after intubation	109.20 ± 7.05	122.07 ± 5.03	<0.001	Significant
	SBP 6 mins after intubation	92.33 ± 5.38	118.27 ± 5.99	<0.001	Significant
	SBP 8 mins after intubation	109.17 ± 5.38	116.03 ± 6.07	<0.001	Significant
	SBP 10 mins after intubation	107.20 ± 4.13	114.97 ± 8.02	<0.001	Significant
DBP	**DBP Baseline**	74.03 ± 3.79	74.83 ± 4.58	0.464	Not Significant
	DBP 5 mins after start of drug	64.03 ± 3.37	71.90 ± 4.40	<0.001	Significant
	DBP 10 mins after start of drug	67.03 ± 2.65	78.03 ± 5.09	<0.001	Significant
	DBP at Induction	59.07 ± 2.85	79.80 ± 3.83	<0.001	Significant

	DBP at Intubation	51.07 ± 1.96	83.87 ± 3.62	<0.001	Significant
	DBP 1 min after intubation	62.07 ± 5.93	89.77 ± 5.12	<0.001	Significant
	DBP 2 mins after intubation	67.07 ± 2.53	88.83 ± 4.86	<0.001	Significant
	DBP 4 mins after intubation	67.93 ± 2.68	80.17 ± 6.52	<0.001	Significant
	DBP 6 mins after intubation	54.20 ± 2.30	78.43 ± 5.92	<0.001	Significant
	DBP 8 mins after intubation	73.37 ± 3.22	75.93 ± 5.64	0.035	Significant
	DBP 10 mins after intubation	69.13 ± 2.29	73.87 ± 6.60	<0.001	Significant

Table 03: Comparison of MAP and RPP between Magnesium Sulphate and Lignocaine at Different Time Points

Time Point		**Magnesium Sulphate (Mean ± SD)**	**Lignocaine (Mean ± SD)**	**p value**	**Significance**
MAP	**MAP Baseline**	87.56 ± 2.85	87.84 ± 3.97	0.747	Not Significant
	MAP 5 mins after start of drug	80.81 ± 3.41	86.50 ± 4.25	<0.001	Significant
	MAP 10 mins after start of drug	84.50 ± 2.72	92.94 ± 4.38	<0.001	Significant
	MAP at Induction	76.82 ± 3.49	95.80 ± 3.18	<0.001	Significant
	MAP at Intubation	63.74 ± 2.49	99.18 ± 3.00	<0.001	Significant
	MAP 1 min after intubation	77.40 ± 6.31	106.42 ± 4.21	<0.001	Significant
	MAP 2 mins after intubation	83.12 ± 2.33	104.17 ± 3.60	<0.001	Significant
	MAP 4 mins after intubation	81.69 ± 3.11	94.13 ± 5.28	<0.001	Significant
	MAP 6 mins after intubation	66.91 ± 2.46	91.71 ± 4.52	<0.001	Significant
	MAP 8 mins after intubation	85.30 ± 2.97	89.30 ± 4.27	<0.001	Significant
	MAP 10 mins after intubation	81.82 ± 2.01	87.57 ± 4.89	<0.001	Significant
RPP	**RPP Baseline**	11000.63 ± 1024.60	10820.33 ± 947.71	0.482	Not Significant
	RPP 5 mins after start of drug	11689.97 ± 1005.78	12122.53 ± 975.73	0.096	Not Significant
	RPP 10 mins after start of drug	12082.03 ± 811.37	13506.63 ± 870.29	<0.001	Significant
	RPP at Induction	8554.43 ± 664.88	10741.80 ± 591.28	<0.001	Significant
	RPP at Intubation	6612.17 ± 505.62	10620.90 ± 596.96	<0.001	Significant
	RPP 1 min after intubation	10393.90 ± 1077.46	14714.73 ± 860.77	<0.001	Significant
	RPP 2 mins after intubation	11174.00 ± 668.46	14586.73 ± 735.40	<0.001	Significant
	RPP 4 mins after intubation	10474.83 ± 738.19	13591.90 ± 701.81	<0.001	Significant
	RPP 6 mins after intubation	8104.10 ± 588.18	11352.27 ± 779.47	<0.001	Significant

	RPP 8 mins after intubation	9824.93 ± 571.09	11235.87 ± 719.14	<0.001	Significant
	RPP 10 mins after intubation	10075.53 ± 602.42	11379.73 ± 902.62	<0.001	Significant

Table 04: Comparison of Demographic Variables (Age, Sex, and ASA Status) between Magnesium Sulphate and Lignocaine Groups

		Magnesium Sulphate	Lignocaine	Total	p value	Significance
Age (in years)	**20–29**	10 (33.33%)	10 (33.33%)	20 (33.33%)	0.854	Not Significant
	30–39	11 (36.67%)	13 (43.33%)	24 (40%)		
	40–45	9 (30%)	7 (23.33%)	16 (26.67%)		
	Total	30 (100%)	30 (100%)	60 (100%)		
Sex	**Female**	15 (50%)	16 (53.33%)	31 (51.67%)	0.796	Not Significant
	Male	15 (50%)	14 (46.67%)	29 (48.33%)		
	Total	30 (100%)	30 (100%)	60 (100%)		
ASA	**I**	30 (100%)	30 (100%)	60 (100%)	NA	NA
	Total	30 (100%)	30 (100%)	60 (100%)		

Table 05: Distribution of Surgical Procedures between Magnesium Sulphate and Lignocaine Groups

Surgery	Magnesium Sulphate	Lignocaine	Total	p value	Significance
Lap Cholecystectomy	0 (0%)	1 (3.33%)	1 (1.67%)	0.989	Not Significant
Lap Ovarian Cystectomy	0 (0%)	1 (3.33%)	1 (1.67%)		
Appendicectomy	5 (16.67%)	5 (16.67%)	10 (16.67%)		
Diagnostic Laparoscopy	3 (10%)	2 (6.67%)	5 (8.33%)		
FESS	2 (6.67%)	4 (13.33%)	6 (10%)		
Incisional Hernioplasty	2 (6.67%)	1 (3.33%)	3 (5%)		
Lap Cholecystectomy	6 (20%)	4 (13.33%)	10 (16.67%)		
Lap Ovarian Cystectomy	1 (3.33%)	2 (6.67%)	3 (5%)		
Mastoidectomy	4 (13.33%)	3 (10%)	7 (11.67%)		
MRM	2 (6.67%)	1 (3.33%)	3 (5%)		
Myomectomy	2 (6.67%)	3 (10%)	5 (8.33%)		
Open Cholecystectomy	3 (10%)	3 (10%)	6 (10%)		
Total	30 (100%)	30 (100%)	60 (100%)		

Table 06: Comparison of Adverse Effects between Magnesium Sulphate and Lignocaine Groups

Adverse Effects	Magnesium Sulphate	Lignocaine	Total	p value	Significance
Hypoxemia	2 (6.67%)	2 (6.67%)	4 (6.67%)	0.865	Not Significant
PONV	3 (10%)	5 (16.67%)	8 (13.33%)		
Shivering	2 (6.67%)	3 (10%)	5 (8.33%)		
None	23 (76.67%)	20 (66.67%)	43 (71.67%)		
Total	30 (100%)	30 (100%)	60 (100%)		

Figure 1: Comparison of Heart Rate (HR) between Magnesium Sulphate and Lignocaine Groups at Different Time Intervals

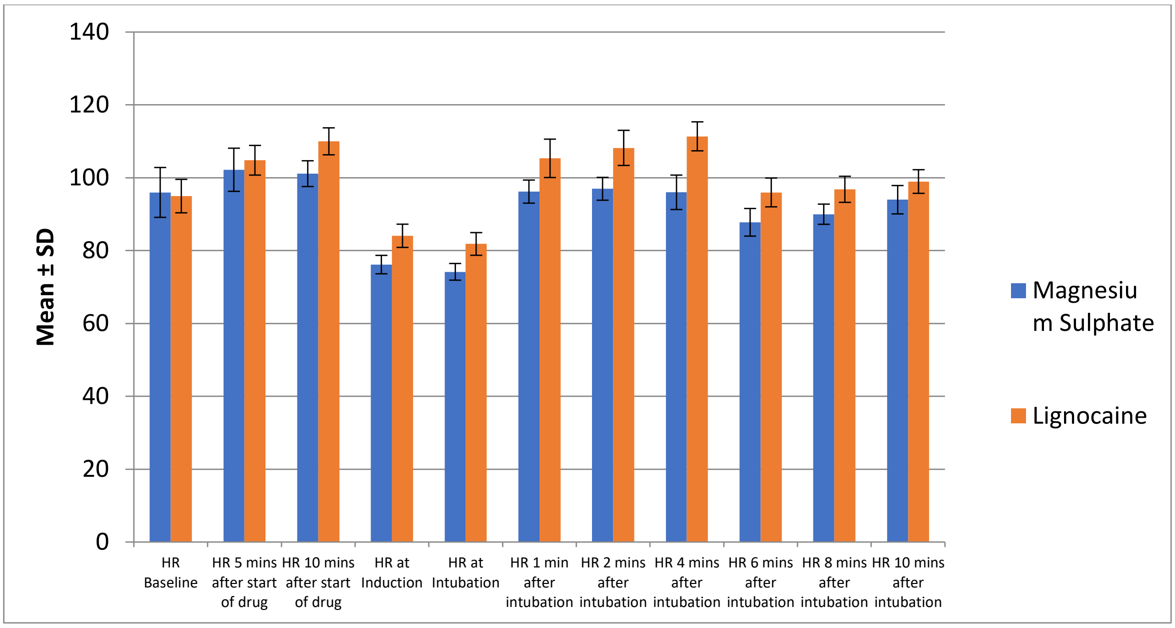
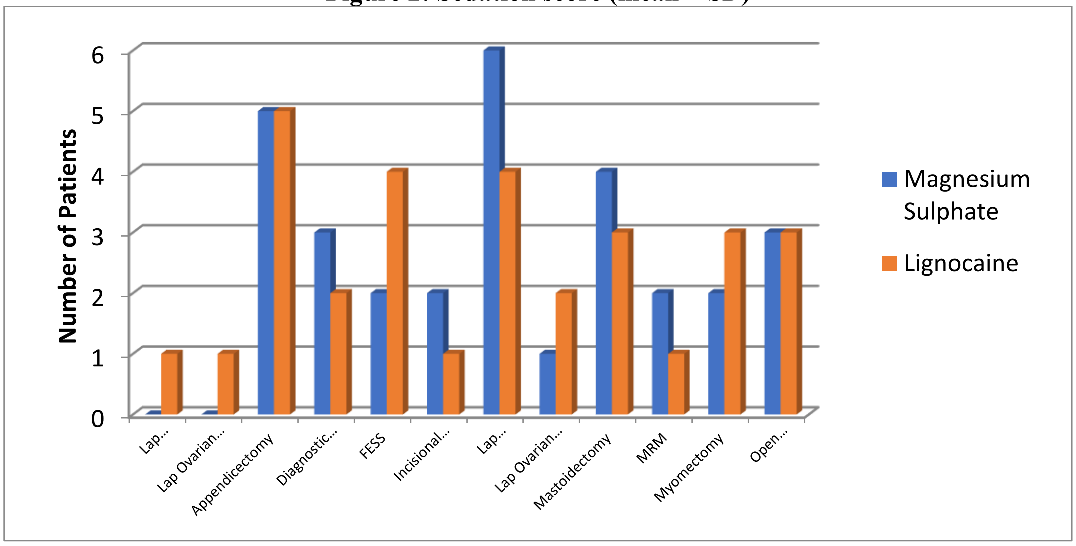


Figure 2: Sedation score (mean ± SD)



Heart Rate (HR)

Result:

At baseline, the mean heart rate was comparable between the Magnesium Sulphate group (95.97 ± 6.84) and the Lignocaine group (94.97 ± 4.59), with no statistically significant difference (p = 0.509). At 5 minutes after drug administration, the difference remained not significant (p = 0.052). From 10 minutes after drug administration onwards, a significant reduction in HR was observed in the Magnesium Sulphate group compared to the Lignocaine group (101.13 ± 3.54 vs 110.00 ± 3.70; p < 0.001). At induction and intubation, HR was significantly lower in the Magnesium Sulphate group (76.17 ± 2.53 vs 84.07 ± 3.19 at induction; 74.17 ± 2.29 vs 81.83 ± 3.11 at intubation; p < 0.001). Similarly, post-intubation HR (1–10 minutes) remained significantly lower in the Magnesium Sulphate group at all time points (p < 0.001).

Interpretation:

Magnesium Sulphate provides superior attenuation of heart rate response to laryngoscopy and intubation compared to Lignocaine.

Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP)

SBP

Result:

Baseline SBP was comparable between groups (114.60 ± 6.07 vs 113.87 ± 7.25; p = 0.673). At 5 minutes after drug administration, no significant difference was observed (p = 0.51). However, at 10 minutes, SBP became significantly lower in the Magnesium Sulphate group (119.43 ± 6.34 vs 122.77 ± 6.33; p = 0.046). At induction and intubation, SBP was significantly lower in the Magnesium Sulphate group (112.33 ± 8.10 vs 127.80 ± 5.63; 89.10 ± 5.40 vs 129.80 ± 5.69; $p < 0.001$). This trend continued throughout all post-intubation time points (1–10 minutes), with highly significant differences ($p < 0.001$).

DBP

Result:

Baseline DBP showed no significant difference (74.03 ± 3.79 vs 74.83 ± 4.58; $p = 0.464$). From 5 minutes after drug administration onwards, DBP was significantly lower in the Magnesium Sulphate group ($p < 0.001$). At induction and intubation, DBP was markedly reduced in the Magnesium Sulphate group (59.07 ± 2.85 vs 79.80 ± 3.83; 51.07 ± 1.96 vs 83.87 ± 3.62; $p < 0.001$). The difference remained significant throughout the post-intubation period up to 10 minutes.

Interpretation:

Magnesium Sulphate significantly attenuates both systolic and diastolic blood pressure responses to laryngoscopy and intubation compared to Lignocaine.

Mean Arterial Pressure (MAP) and Rate Pressure Product (RPP)

MAP

Result:

Baseline MAP was comparable (87.56 ± 2.85 vs 87.84 ± 3.97; $p = 0.747$). However, from 5 minutes onwards, MAP was significantly lower in the Magnesium Sulphate group ($p < 0.001$). At intubation, MAP was markedly reduced in the Magnesium Sulphate group (63.74 ± 2.49 vs 99.18 ± 3.00; $p < 0.001$). Similar significant reductions persisted during the post-intubation period (1–10 minutes).

RPP

Result:

Baseline RPP was comparable (11000.63 ± 1024.60 vs 10820.33 ± 947.71; $p = 0.482$). At 5 minutes, the difference remained not significant ($p = 0.096$). From 10 minutes onwards, RPP was significantly lower in the Magnesium Sulphate group ($p < 0.001$). At induction and intubation, RPP showed a marked reduction in the Magnesium Sulphate group (8554.43 ± 664.88 vs 10741.80 ± 591.28; 6612.17 ± 505.62 vs 10620.90 ± 596.96; $p < 0.001$). This significant difference persisted throughout all post-intubation time points.

Interpretation:

Magnesium Sulphate provides superior myocardial stress attenuation compared to Lignocaine as evidenced by lower MAP and RPP.

Demographic Variables (Age, Sex, ASA Status)

Result:

Age distribution was comparable between groups with no significant difference ($p = 0.854$). Most patients were in the 30–39 years age group. Sex distribution was also comparable ($p = 0.796$), with near equal male and female representation. All patients belonged to ASA Grade I in both groups.

Interpretation:

Both study groups were demographically comparable, ensuring baseline homogeneity.

Surgical Distribution

Result:

The distribution of surgical procedures was comparable between groups with no statistically significant difference ($p = 0.989$). Both groups included a similar mix of laparoscopic, ENT, general, and gynecological surgeries.

Interpretation:

Both groups were well matched in terms of surgical characteristics.

Adverse Effects

Result:

There was no statistically significant difference in adverse effects between the groups ($p = 0.865$). Hypoxemia occurred equally in both groups (6.67%). PONV was slightly higher in the Lignocaine group. Shivering was also slightly more frequent in the Lignocaine group. Most patients had no adverse effects (76.67% in Magnesium Sulphate vs 66.67% in Lignocaine).

Interpretation:
Both drugs had comparable safety profiles with no significant difference in adverse events.

DISCUSSION

Endotracheal intubation is a well-established noxious stimulus that provokes a marked sympathetic response, resulting in tachycardia, hypertension, and increased myocardial oxygen consumption. This hemodynamic stress response is mediated by catecholamine release due to laryngoscopy and tracheal stimulation and may be particularly hazardous in patients with limited cardiovascular reserve. The present study compared the efficacy of intravenous Magnesium Sulphate and Lignocaine in attenuating this response during induction and intubation. Both groups in the present study were comparable with respect to demographic variables and surgical characteristics, ensuring adequate baseline homogeneity. Such comparability is essential to eliminate confounding factors while assessing pharmacological modulation of stress response, as highlighted in previous perioperative studies [11,12]. In the present study, Magnesium Sulphate demonstrated superior attenuation of heart rate response compared to Lignocaine. From induction onwards, heart rate was significantly lower in the Magnesium group. This effect can be attributed to its physiological properties, including inhibition of catecholamine release, calcium channel antagonism, and suppression of sympathetic nervous system activity [13,14]. Lignocaine, while effective in blunting airway reflexes, provides a comparatively transient effect on sympathetic stimulation due to its limited duration of action and primarily local anesthetic mechanism [15]. Similar findings have been reported in earlier studies where Magnesium Sulphate was associated with better control of hemodynamic responses during intubation [16,17]. With respect to systolic and diastolic blood pressure, Magnesium Sulphate consistently showed significantly lower values at induction, intubation, and post-intubation periods compared to Lignocaine. The vasodilatory effect of magnesium is mediated through calcium influx inhibition in vascular smooth muscle, resulting in reduced systemic vascular resistance and improved hemodynamic stability [18,19]. In contrast, Lignocaine primarily suppresses airway reflexes without exerting sustained peripheral vascular effects, which explains its comparatively lesser efficacy in blood pressure control [20]. Overall, the findings of this study suggest that Magnesium Sulphate provides more effective attenuation of the sympathetic hemodynamic response to laryngoscopy and intubation compared to Lignocaine. This makes it a potentially superior agent for use in situations where cardiovascular stability is critical, particularly in patients with underlying cardiac risk factors.

CONCLUSION

In this study, both Magnesium Sulphate and Lignocaine were effective in attenuating the hemodynamic stress response to laryngoscopy and endotracheal intubation; however, Magnesium Sulphate demonstrated superior efficacy in controlling heart rate, systolic and diastolic blood pressure, mean arterial pressure, and rate pressure product at most peri-intubation time points. Although baseline parameters and adverse effects were comparable between the groups, Magnesium Sulphate provided more consistent and sustained cardiovascular stability during induction, intubation, and the post-intubation period. Thus, Magnesium Sulphate can be considered a more effective agent than Lignocaine for attenuation of the sympathoadrenal response to laryngoscopy and intubation, with a comparable safety profile.

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