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EFFECTIVENESS OF DEXMEDETOMIDINE VS LIGNOCAINE 4% NEBULIZATION TO ATTENUATE HAEMODYNAMIC RESPONSE DURING LARYNGOSCOPY

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ABSTRACT

Background: The laryngoscopy and endotracheal intubation procedure produces short-lived sympathoadrenal response leading to a significant rise in the haemodynamics. This study aimed to compare the effects of nebulized Dexmedetomidine and Lidocaine in attenuating haemodynamic response during laryngoscopy and to assess the level of sedation using on Ramsay sedation score.

Materials and Methods: 120 patients of American society of anaesthesiologists' physical status 1-2, aged 18–60-yearundergoing elective surgery under general anaesthesia (GA). They were randomly assigned into two groups of 60 each. Patients in group D were nebulized with dexmedetomidine 2µg/kg, with lignocaine 3 mg/kg in group L with 3ml of normal saline. Vital parameters such as HR, SBP, DP and MAP were recorded, at baseline upto 20 mins after intubation. The primary objective was to compare attenuated haemodynamic responses. The secondary objectives were to study the side effects (if any) and level of sedation using Ramsay Sedation Score (RSS) up to 60 mins postoperatively.

Results: This study demonstrated comparable demographic characteristics, with no significant differences. Following intubation, Group D exhibited remarkable haemodynamic stability compared to Group L. Pulse rate remained near baseline in group D while increasing substantially in group L. Group D maintaining systolic, diastolic, and mean arterial pressure values closer to baseline compared to Group L. No significant differences were observed in SpO2, sedation scores and side effects between the two groups.

Conclusion: Nebulized dexmedetomidine (2µg/kg) is significantly more effective than nebulized lignocaine 4% (3mg/kg) in attenuating haemodynamic stress response during laryngoscopy and intubation.

KEYWORDS: Nebulization, laryngoscopy, heart rate, Dexmedetomidine, Lignocaine 4%

INTRODUCTION

Endotracheal intubation is an essential skill acquired by an Anaesthesiologist and they play an important role in securing the airway while providing general anaesthesia to the patient [1]. Direct laryngoscopy and intubation are known to provoke harmful stimuli that can lead to transient, unpredictable, and variable haemodynamic alterations, primarily due to heightened sympathoadrenal activity caused by stimulation of the upper respiratory tract. This response occurs within 30 sec after intubation and lasts less than 15 min. A typical pressor response can lead to an average increase in blood pressure by 40-50% and heart rate by 20%, as well as an elevation of both epinephrine and norepinephrine levels. [2]

It is important to control these aggravated haemodynamic responses in patients with pre-existing conditions with cardiovascular disease, hypertension, recent myocardial infarction, preeclampsia, or elevated intracranial pressure and in geriatric population with an increased risk of morbidity and mortality. Suppressing a hypertensive response to intubation is one of the important prerequisites for a properly administered general anaesthesia. Clinicians have used various drugs via various routes, such as beta blockers, opioids, calcium channel blockers, and lignocaine, to blunt these haemodynamic changes. [3]

With the recent advances, dexmedetomidine is now being used in nebulized form and has also proved effective to blunt haemodynamic responses to laryngoscopy and intubation, with lesser-known side effects. Dexmedetomidine cause bradycardia and hypotension when administered via intravenous bolus. To avoid these side-effects, the nebulization route has been preferred. Moreover, nebulized dexmedetomidine has a bioavailability of 65% through the nasal mucosa and 82% through the buccal mucosa. [2] Lignocaine has been successfully used and time-tested in controlling the haemodynamic surge to laryngoscopy and intubation via the

intravenous route, spray, and nebulization. Topical use of lignocaine rarely causes many side-effects. Common adverse effects of lignocaine include headache, dizziness, drowsiness, confusion, visual disturbances, tinnitus, tremor, and paraesthesia [4].

Nebulization is a process by which medications are added to inspired air and converted into a mist that is inhaled by the patient into their respiratory system. Nebulization offers the potential to achieve both a high local drug concentration and a lower systemic toxicity. With this background information and limited studies available, we aimed to compare the effect of nebulized dexmedetomidine (2µg /kg) and nebulized lignocaine 4% (3 mg/kg) in blunting the haemodynamic response to laryngoscopy and intubation along with Ramsay sedation score.

RESEARCH METHODOLOGY

This prospective, randomized, double blinded, study was approved by the Institutional Ethics Committee (PDUMCR/IEC/124/2023, dated 26/09/23), and written informed consent was obtained from each subject. Prospective registration of the study was conducted in the Clinical Trials Registry of India (CTRI) (trial registration number: CTRI/2023/12/060744, dated 26/12/23).

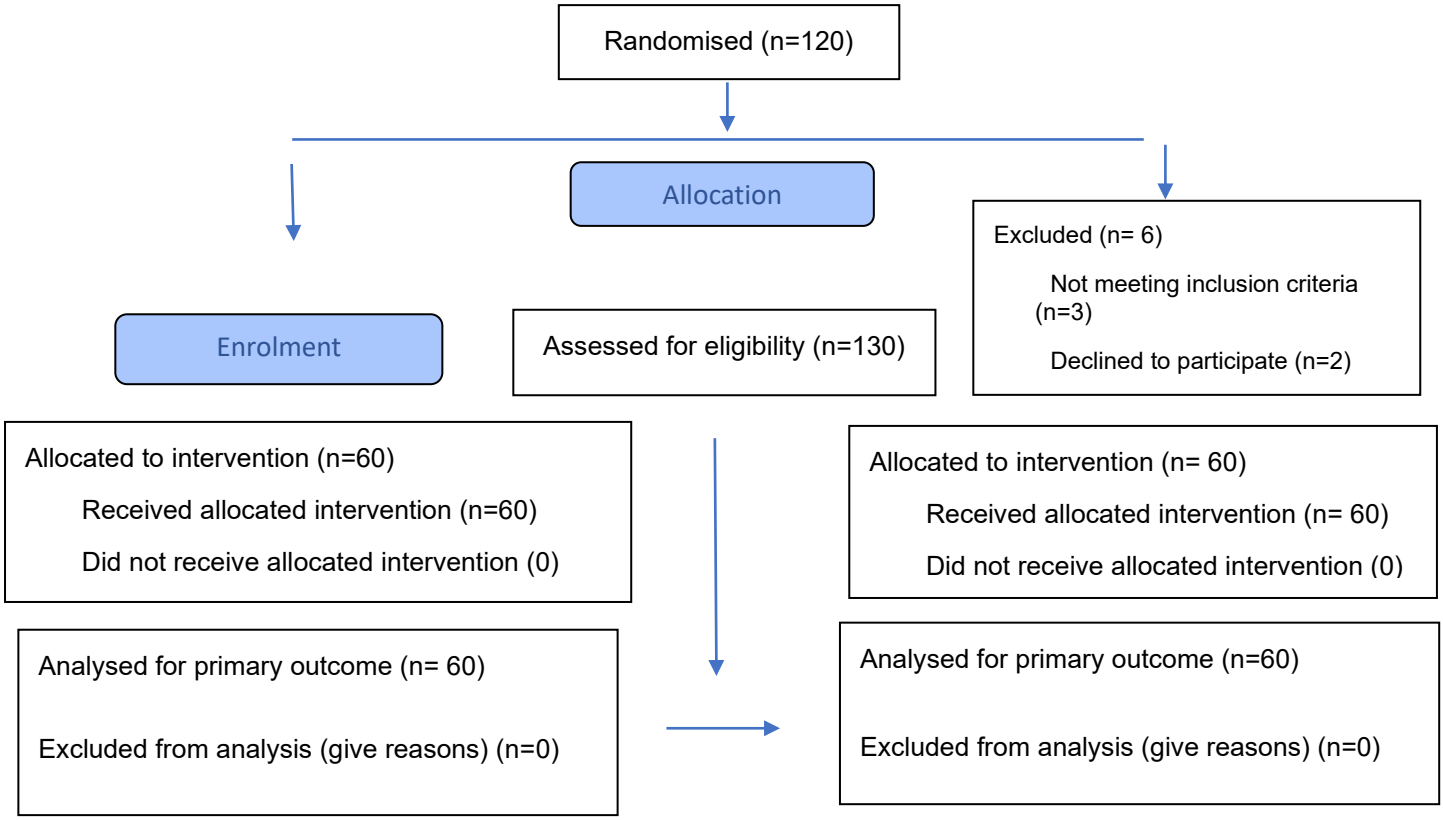
SAMPLE SIZE CALCULATION

After obtaining the approval of the hospital scientific and ethics committee and informed written consent, 120 patients, in the age group of 18–60 years, with the American Society of Anaesthesiologists (ASA) physical status (PS) 1–2, who were scheduled to undergo elective surgical procedures under general Anaesthesia (GA) with endotracheal intubation were enrolled in this prospective, double-blind, randomized study. Exclusion criteria were patients not giving consent for the study, emergency surgeries, patients with an anticipated difficult airway, seizure disorders, body Mass Index (BMI) >30 kg/m2, known drug allergies, diabetics, patients with poor cardiopulmonary reserve, elderly and pregnant patients.

The sample size was calculated from the study conducted by Sravanthi, P. et al. [5] with mean arterial blood pressure in dexmedetomidine group (Group-D) at intubation as 110.9±32.59 mmHg and in lignocaine group (Group-L) as 93.56±7.91 mmHg. With 95% confidence level and power of study at 90%, the minimum sample size required was found to be 56 in each group. Assuming 20% drop outs, 60 participants in each group, making a total of 120 patients were randomly allocated in two groups using a computer-generated randomization technique, opaque sealed sequentially numbered envelopes were prepared by an anaesthesia resident who was not part of the study, by which patients were randomized into two groups. After opening the envelopes, anaesthesia resident prepared the nebulization solution according to group allocation and did not participate in the subsequent assessment of these patients. Patients were blinded as both the preparations were colourless and tasteless.

The data was coded and entered into a Microsoft Excel spreadsheet. Analysis was conducted using Statistical Package for Social Sciences (SPSS) version 20.0 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included calculating percentages, medians, and standard inter-quartile range. The Mann-Whitney U test, also known as the Wilcoxon rank-sum test was applied to compare two independent groups. The Chi-square test was used for quantitative data comparison of all clinical indicators, with a p-value of ≤ 0.05 considered significant.

Flow diagram of the progress through the phases of a randomised trial of two groups (that is, enrolment, intervention allocation, follow-up, and data analysis)



STUDY PROCEDURE

The patients recruited for the study were kept fasted for 8 hrs prior to surgery. On arrival at the operating room baseline haemodynamic parameters: HR, SBP, and DBP, MAP, and SpO2) were noted in preoperative room. Dexmedetomidine at a dose of 2 µg/kg (mixed with normal saline to a total volume of 4 mL) nebulisation was administered if the patient belonged to group D before the induction of anaesthesia. Group L patients received nebulisation with 4% lignocaine 3 mg/kg mixed with normal saline to a total volume of 4 mL for 10 minutes.

After nebulisation for 10 minutes, the patient was shifted to the Operation Table (OT). On the OT table, all standard monitors were attached, and values were noted before the induction of anaesthesia.

Premedication was done with Inj. Ondansetron 80µg/kg IV and Inj. Fentanyl (1µg/kg) IV and pre oxygenation was done for 3-5 mins. Induction was done with Inj. Propofol-2 mg/kg IV and Inj. Vecuronium, as a muscle relaxant in the dose of -0.08 mg/kg IV to facilitate intubation.

Direct laryngoscopy (appropriate size Macintosh blade) and intubation was done using an appropriately sized endotracheal tube by an experienced consultant anesthesiologist and patient was connected to the ventilator after fixing the ET tube.

The patient was left undisturbed for a period of 20 mins after intubation. heart rate (HR), systolic blood pressure (systolic (SBP), diastolic pressure (DBP), mean arterial pressure (MAP), pulse oximetry (SpO2), side effects at the following time points: Before nebulization, after nebulization, after induction, after intubation, 2 mins,5 mins, 10 mins, 15 mins, 20 mins post intubation.

Maintenance of anaesthesia was done using O2, N20, Sevoflurane / Isofulrane (0.5-1.0%) and inj. Vecuronium bromide (0.02 mg/kg) IV. After the surgical procedure, neuromuscular blockade was reversed with injections of Inj. Glycopyrrolate and Inj. Neostigmine (0.05mg/kg), and the patient was extubated upon meeting extubation criteria before shifted to the Post anaesthesia Care Unit (PACU). Ramsay sedation score (RSS) was recorded 10,20 mins after nebulization and post operatively at 10,30 and 60 mins in PACU. Any complications such as sore throat, bradycardia, nausea/vomiting, excessive secretions, giddiness, delirium were recorded throughout the study period.

RESULTS

Demographic profile: There was no significant difference in age, gender, and ASA PS grade among two groups.

Variables		GROUP D (n=60)		GROUP L (n=60)		Test Statistics	
		No.	%	No.	%		
Age groups (years)	<= 20	14	23.3	9	15.0	Fisher exact value=3.007	p value=0.56
	21 - 30	19	31.7	24	40.0		
	31 - 40	14	23.3	11	18.3		
	41 - 50	12	20.0	13	21.7		
	51 - 60	1	1.7	3	5.0		
Gender	Male	29	48.3	28	46.7	χ^2 =0.03 df=1,	p value=0.85
	Female	31	51.7	32	53.3		
ASA grade	I	26	43.3	25	41.7	χ^2 =0.034, df=1,	p value=0.85
	II	34	56.7	35	58.3		

TABLE/FIGURE2: Demographic data

HAEMODYNAMIC PARAMETERS

Heart rate (beats/min)

Baseline HR was comparable in all the groups (p-value=0.23). A notable divergence began after induction (median: 84 bpm in Group D vs. 87 bpm in Group L, p=0.004), which became apparent immediately after intubation. While Group D maintained haemodynamic stability with minimal fluctuation (median pulse rate: 82.5 bpm), Group L exhibited a pronounced sympathetic surge (median pulse rate: 94 bpm), representing a statistically significant difference (p<0.001). At 20 minutes post-intubation, Group D maintained a steady, controlled heart rate (median: 81 bpm), while Group L, showed gradual recovery, still demonstrated significantly elevated values (median: 87 bpm, p<0.001) than baseline values.

TABLE/FIGURE 3 : Comparison of pulse rate(PR) at different intraoperative phase

Systolic Blood Pressure

Intraoperative Phase	GROUP D (n=60)		GROUP L (n=60)		Test Statistics – Mann Whitney U Test		
	Median	IQR	Median	IQR	Z value	p value	95% CI
Baseline	84.00	16	85.00	17	-1.035	0.301	0.296-0.314
After Nebulization	84.00	16	84.00	14	-1.225	0.221	0.215-0.231
After Induction	84.00	14	87.00	13	-2.893	0.004*	0.002-0.003
After Intubation	82.50	14	94.00	19	-5.346	<0.001*	0.000-0.000
2 mins After Intubation	82.00	14	94.00	20	-5.561	<0.001*	0.000-0.000
5 mins After Intubation	82.00	12	92.50	22	-5.226	<0.001*	0.000-0.000
10 mins After Intubation	81.50	12	91.50	19	-4.724	<0.001*	0.000-0.000
15 mins After Intubation	81.50	13	90.00	18	-4.715	<0.001*	0.000-0.000
20 mins After Intubation	81.00	13	87.00	18	-4.312	<0.001*	0.000-0.000

Baseline SBP was comparable in both the groups. The critical divergence emerged immediately after intubation, where Group L exhibited a pronounced hypertensive response (median SBP: 136 mmHg) compared to the remarkably stable haemodynamic profile in Group D (median SBP: 122 mmHg), representing a highly significant statistical difference (p=0.002). The post-intubation monitoring revealed significant differences at 2 minutes (p=0.038), 5 minutes (p=0.015), 10 minutes (p=0.025), and 20 minutes (p=0.017), with Group D consistently maintained lower and more stable SBP values. Interestingly, by 15 minutes post-intubation, the difference narrowed slightly (p=0.058), suggesting gradual recovery in the lignocaine group.

TABLE/FIGURE4: Comparison of systolic blood pressure (SBP) at different intraoperative phase

Diastolic Blood Pressure

Intergroup comparison showed a statistically insignificant p-value. The divergence manifested immediately after intubation, where Group L experienced a substantial diastolic pressure surge (median: 80 mmHg) compared to the more controlled response in Group D (median: 75 mmHg), representing a highly significant difference (p<0.001). This pattern aligned with the previously observed trends in pulse rate and systolic blood pressure, consistently demonstrating dexmedetomidine's superior efficacy in attenuating the pressor response.

This significant separation between groups persisted throughout the post-intubation period at 2 minutes (p<0.001), 5 minutes (p<0.001), 10 minutes (p=0.012), and 15 minutes (p=0.021). By 20 minutes post-intubation, although Group D still maintained lower DBP values (72 mmHg vs. 75 mmHg), but in Group L, the difference narrowed to statistical non-significance (p=0.144), suggesting gradual recovery and stabilization.

Intraoperative Phase	GROUP D (n=60)		GROUP L (n=60)		Test Statistics – Mann Whitney U Test		
	Median	IQR	Median	IQR	Z value	p value	95% CI
Baseline	120.00	20	120.50	18	-1.028	0.309	0.300-0.318
After Nebulization	118.50	18	120.00	19	-0.800	0.429	0.419-0.439
After Induction	120.00	22	126.00	23	-0.997	0.319	0.310-0.328
After Intubation	122.00	27	136.00	24	-3.031	0.002*	0.001-0.003
2 mins After Intubation	121.00	27	127.00	20	-2.075	0.038*	0.035-0.042
5 mins After Intubation	120.00	20	128.00	20	-2.451	0.015*	0.012-0.017
10 mins After Intubation	118.00	17	126.00	24	-2.244	0.025*	0.022-0.028
15 mins After Intubation	114.00	20	122.00	23	-1.926	0.058	0.053-0.063
20 mins After Intubation	113.50	21	123.50	22	-2.384	0.017*	0.015-0.020

Intraoperative Phase	GROUP D (n=60)		GROUP L (n=60)		Test Statistics – Mann Whitney U Test		
	Median	IQR	Median	IQR	Z value	p value	95% CI
Baseline	74.00	9	74.00	12	-1.416	0.159	0.152-0.166
After Nebulization	71.50	9	74.00	10	-0.974	0.332	0.323-0.341
After Induction	72.00	8	74.00	10	-0.688	0.498	0.488-0.508
After Intubation	75.00	10	80.00	14	-3.809	<0.001*	0.000-0.000
2 mins After Intubation	72.00	10	78.00	11	-3.802	<0.001*	0.000-0.000
5 mins After Intubation	72.00	10	77.50	10	-3.715	<0.001*	0.000-0.001
10 mins After Intubation	72.00	9	76.00	10	-2.564	0.012*	0.009-0.014
15 mins After Intubation	71.00	7	73.50	12	-2.266	0.021*	0.018-0.024
20 mins After Intubation	72.00	7	75.00	11	-1.462	0.144	0.137-0.151

TABLE/FIGURE 5: Comparison of diastolic blood pressure (DBP) at different intraoperative phase

MEAN ARTERIAL PRESSURE (MAP)

The significant haemodynamic divergence occured immediately after intubation, with Group L demonstrating elevation in MAP (97 mmHg) compared to the stable profile in Group D (91 mmHg), showing a highly significant difference ($p<0.001$). This pattern aligned with previous trends in other haemodynamic parameters, providing consistent evidence of dexmedetomidine's superior efficacy in blunting the pressure response to laryngoscopy and intubation.The significant MAP difference between groups persisted throughout the entire post-intubation monitoring period, at 2 minutes ($p=0.002$), at 5 minutes ($p=0.001$), 10 minutes ($p=0.001$), 15 minutes ($p=0.009$), and at 20 minutes post-intubation ($p=0.010$).

Intraoperative Phase	GROUP D (n=60)		GROUP L (n=60)		Test Statistics – Mann Whitney U Test		
	Median	IQR	Median	IQR	Z value	p value	95% CI
Baseline	89.00	9	91.00	13	-1.565	0.115	0.109-0.121
After Nebulization	87.00	10	89.00	9	-1.586	0.111	0.104-0.117
After Induction	89.00	12	91.50	15	-1.592	0.109	0.103-0.115
After Intubation	91.00	10	97.00	16	-3.626	<0.001*	0.000-0.001
2 mins After Intubation	90.00	16	95.00	10	-3.048	0.002*	0.001-0.003
5 mins After Intubation	89.00	12	93.00	10	-3.445	0.001*	0.000-0.001
10 mins After Intubation	86.00	10	91.00	13	-3.216	0.001*	0.000-0.001
15 mins After Intubation	87.00	10	91.00	13	-2.593	0.009*	0.008-0.011
20 mins After Intubation	85.50	11	91.00	11	-2.562	0.010*	0.008-0.012

TABLE/FIGURE6: Comparison of mean arterial pressure (MAP) at different intraoperative phases

Oxygen Saturation (SpO2) (%): The p-value at all times was statistically insignificant, showing that SpO2 remained comparable in both groups at all time points.

Ramsay Sedation Score

Intraoperative Phase	GROUP D (n=60)		GROUP L (n=60)		Test Statistics – Mann Whitney U Test		
	Median	IQR	Median	IQR	Z value	p value	95% CI
Before Nebulization	1.50	1	2.00	1	-1.216	0.245	0.236-0.253
After Nebulization	2.00	1	2.00	1	-1.160	0.262	0.253-0.271
1 min After Nebulization	2.50	1	2.50	1	-0.172	0.892	0.886-0.898
10 min After Nebulization	2.00	1	2.00	1	-1.508	0.148	0.141-0.155
20 min After Nebulization	2.00	0	2.00	1	-1.404	0.176	0.168-0.183
Before Induction	3.00	1	3.00	0	-1.224	0.218	0.210-0.226
Post operative							
10 min	3.00	1	3.00	0	-1.378	0.175	0.167-0.182
30 min	3.00	1	3.00	0	-1.183	0.252	0.243-0.260
60 min	2.00	0	2.00	0	-1.371	0.187	0.180-0.195

TABLE/FIGURE 7: Comparison of Ramsay Sedation Score at different phases (N=120)

The initial slight numerical difference in ramsay sedation score before nebulization (median RSS: 1.5 in Group D vs. 2.0 in Group L, $p=0.245$) narrowed to identical median scores after nebulization (2.0 in both groups). Both groups displayed a comparable increase in sedation level at 1 minute after nebulization (median RSS: 2.5 for both groups), followed by consistent sedation maintenance at subsequent time points. The post-operative sedation profile similarly revealed no significant differences between two groups.

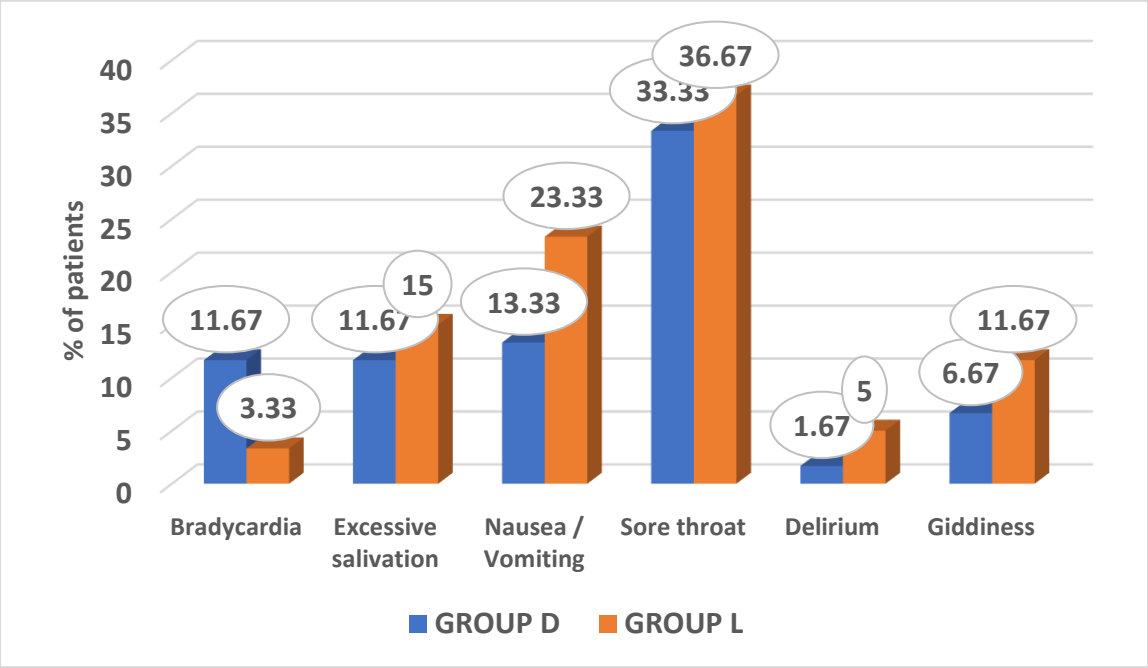
Side effects

Sore throat was the most common side effect for both treatments, affecting about one-third of all patients. (33.33% in Group D vs 36.67% in Group L).

Delirium was uncommon but occurred more often with Group L (5% versus 1.67%).

Giddiness occurred more often with Group L (11.67%) compared to Group D (6.67%).

Despite these numerical differences, statistical testing (shown by p-values all greater than 0.05) indicates that none of these differences were statistically significant.



TABLE/FIGURE 8 : Comparision of side effects between both groups of patients

DISCUSSION

Endotracheal intubation is often associated with a sudden rise in catecholamine levels resulting in an increase in haemodynamic parameters. A similar response is seen at the time of extubation. Various factors are responsible for haemodynamic response following laryngoscopy and intubation, which include epiglottis elevation, displacement of the tongue, and increased duration in laryngoscopy. The resultant rise in blood pressure and heart rate may adversely affect patients with myocardial infarction, cardiac arrhythmias, internal hemorrhage, etc. Various methods and drugs have been mentioned in the literature, which attenuates the rise. α2 agonists, opioids, local anaesthetics (lignocaine), and beta-blockers are given prophylactically at the time of both intubation and extubation to obtund the haemodynamic pressor response, but most of the drugs are associated with unwanted systemic side effects, which delay the process of the extubation, especially due to sedation.[6,7] Various local anaesthetics such as lignocaine were used systemically to obtund the pressor response where statistically significant results were seen.[8] Later on, topical application (spray, nebulization, and lozenges) of local anaesthetics also showed promising results. Lignocaine, owing to its short duration of action, did not show any effect at the time of extubation. Various studies found a significant reduction in pressor response both at intubation and at extubation.

Dexmedetomidine, an alpha-2A receptor agonist, acts on the receptors, which are located in various regions of the brain (locus coeruleus and noradrenergic nuclei in upper brain stem), and it leads to inhibition of noradrenaline release. It has been extensively studied (when given by intravenous route) to attenuate the haemodynamic pressor response after intubation, but very few studies have concluded on its use through other routes. [9,10] Nebulization as a novel route was considered as an alternative recently. Through this route, the bioavailability of drug is better (nasal mucosa—65% and buccal mucosa—82%).[11] Dexmedetomidine has been used with many other drugs through nebulization such as ketamine, midazolam, and lignocaine, especially in the pediatric population, mainly as a premedication, but very few studies have seen its effect on pressor response. [12-14]

Lignocaine nebulization is an effective, non-invasive technique for providing topical anaesthesia to the upper and lower respiratory tract, commonly used to facilitate awake fiberoptic intubation. This method has a high safety profile, with peak plasma concentrations well below the recognized toxic threshold.

A recent study by Singh V et al., comparing intravenous vs nebulized dexmedetomidine to blunt the laryngoscopy stress response found that the nebulized form provides greater haemodynamic stability and less

sedation in the postoperative period. [15] Hence, both dexmedetomidine and lignocaine have been used in nebulized form. A study done by Ganesan, Priya et. al to compare the efficacy of nebulized lignocaine versus intravenous (IV) lidocaine in suppressing the pressor response to laryngoscopy and intubation showed an increase in HR and BP from baseline in both the groups and the increase is significantly less in NL ($P < 0.05$). The parameters in both the groups attained the baseline values at the 3rd min postintubation. However, the 4th- and 5th-min readings showed values below baseline in the nebulization group. [16]
Hussain *et al.* also documented the effect of dexmedetomidine through nebulization on pressor response, and the dose of dexmedetomidine (2 mics/kg) was similar to our study.[17] Shrivastava *et al.* published in their study that nebulized dexmedetomidine at a dose of 1 mics/kg led to attenuation in the haemodynamic response to laryngoscopy and intubation, while avoiding hypotension, bradycardia, and sedation, which is half the dose compared to our study.[18]
In contrast to our study, a study conducted by Perumalla Sravanthi *et al,.*[5] in which patients under Group D received nebulized Dexmedetomidine with the dose of 1 µg/kg diluted up to 5 ml NS for 10 minutes prior to induction. Group L received Lignocaine 4%, at the dose of 3mg/kg body weight for 10 mins before induction found that Group L had more decrease in blood pressure than Group D(SBP = 21.2 vs 11.5 mean) (DBP = 16.92 vs 4.5 mean).
All two groups in the present study were comparable with respect to age, gender profile, and ASA physical status. These results were similar to the study done by Misra *et al.*[19]
In our study, one of the most significant findings was the marked difference in heart rate response to laryngoscopy and intubation between the two groups. While both groups demonstrated comparable baseline pulse rates (median: 84 bpm in Group D vs. 85 bpm in Group L), the divergence became apparent immediately after intubation. Group D maintained remarkable haemodynamic stability (median post-intubation pulse rate: 82.5 bpm), whereas Group L exhibited a pronounced sympathoadrenal surge (median: 94 bpm), representing a statistically significant difference ($p<0.001$).

Misra et al. published that dexmedetomidine through the nebulization showed significantly lower trend of increase in HR in the dexmedetomidine group versus saline ($p= 0.012$) [19] . Sumayya E.*et al.* in a similar study noted that the increase in HR was more pronounced in the lignocaine group compared to the dexmedetomidine group, specifically, at 10 minutes post-intubation, HR was significantly higher in the lignocaine group compared to the dexmedetomidine group ($p=0.036$). [20].

Systolic blood pressure during intubation up to 15 minutes showed a significant increase in Group L (median: 136 mmHg, $p= 0.002$) compared to Group D (median: 122 mmHg, $p=0.002$). This difference persisted through most of the post-intubation monitoring period, with Group D maintaining systolic blood pressure closer to baseline. A study by Anju Rani *et al.* also had a similar conclusion that nebulized dexmedetomidine led to a decrease in the haemodynamic response to laryngoscopy and intubation as compared to nebulized lignocaine [2]

Diastolic blood pressure manifested surge immediately after intubation, where Group L experienced a substantial diastolic pressure surge (median: 80 mmHg) compared to the more controlled response in Group D (median: 75 mmHg), representing a highly significant difference ($p<0.001$). By 20 the difference narrowed to statistical non-significance ($p=0.144$), suggesting gradual recovery and stabilization. Mahajan et al. [21], found that, there was a significant fall in HR and SBP and DBP in the dexmedetomidine group (1 µg/kg) versus the placebo group, and that this effect lasted until 30 min following drug administration.

MAP after intubation showed significant haemodynamic divergence with Group L demonstrating elevation in MAP (97 mmHg) compared to the stable profile in Group D (91 mmHg), showing a highly significant difference ($p<0.001$). This is because lignocaine is short lived and do not last for 20–30 min. Similarly, Shrivastava *et al.* [18] observed that there was a significant difference in the MAP at time intervals before laryngoscopy ($p < 0.047$), after intubation ($p = 0.042$), after one minute ($p = 0.001$), after five minutes ($p < 0.006$), and after 10 minutes ($p = 0.018$) of intubation when compared between the two groups.

Oxygen saturation (SpO_2) remained persistent throughout the perioperative period in both groups, with no clinically significant differences observed. A similar study conducted by Sumayya E.*et al.*and Anju Rani *et al.* [20,2] also reported no significant differences were observed in SpO2 in either of the two groups.
The Ramsay Sedation Scores showed comparable sedation levels between both groups throughout the perioperative period, with no statistically significant differences at any measurement point in either of the two groups. This finding is particularly important as it demonstrates that nebulized dexmedetomidine's superior haemodynamic effects were achieved without producing excessive sedation [18] Unlike Lawrence and De Lange et al, who found a significant sedative effect with 2 µg/kg intravenous dexmedetomidine on baseline sedation.[22]
The nebulized route of administration in our study likely resulted in lower systemic absorption and consequently less sedation, while still providing sufficient drug concentrations at the target site (airway) to achieve the desired haemodynamic effects.

Although not reaching statistical significance, there were consistent trends toward higher rates of all other adverse effects in the group L, including nausea/vomiting (23.33% vs. 13.3%), excessive salivation (15% vs 11.6%), emergence delirium (5% vs. 1.6%) and giddiness (11.6% vs 6.6%). Sore throat was the most common side effect for both groups (36.6% vs. 33.3%), affecting about one-third of all patients. The reduced incidence of sore throat in Group D, although not statistically significant, may be attributed to dexmedetomidine's anti-inflammatory properties which can reduce pro-inflammatory cytokines like IL-6, IL-8, and TNF-α, indicating its potential to alleviate inflammation in various conditions. Specifically, dexmedetomidine has been observed to reduce inflammatory markers in sepsis, surgery, and even in animal models of severe inflammation which have been documented in previous studies. [23] This effect could potentially reduce mucosal inflammation caused by laryngoscopy and intubation. Dexmedetomidine lowers postoperative nausea and vomiting (PONV) by sparing opioids, reducing sympathetic tone, and directly stopping vomiting through alpha-2 receptor activation. [24]

Limitations

Being a single-centre study limits generalizability to other healthcare settings with different patient populations and clinical practices. The ASA physical status III and IV patients and patients with a difficult airway were not included. The sample size was small. The follow-up duration of only 60 minutes postoperatively as all the normal airway patients of ASA grade I and II were included in the study and intubation was done by experienced hand; precluded assessment of delayed adverse effects or recovery profiles. The time required for laryngoscopy and intubation was not taken into account. Results cannot be extrapolated to high-risk patients with co-morbidities. Also, complications were assessed only until the immediate postoperative period as the nebulization of drug was done 20 minutes prior to surgery and average half-life of drugs like lignocaine (4%) is 90 to 120 mins and dexmedetomidine is 100-120 mins. Thus, further studies are required to establish its safety and superiority for this purpose.

Future research directions

Future research should build upon these findings by conducting multicentre trials with larger, more diverse patient populations, including those with higher ASA grades and cardiovascular comorbidities. Dose-optimization studies exploring various concentrations of nebulized dexmedetomidine would help establish ideal dosing regimens. Investigating combination therapies—pairing dexmedetomidine with other agents like lidocaine or opioids—might yield synergistic benefits with reduced side effects. Extended follow-up periods would provide insights into long-term recovery profiles and delayed complications. Mechanistic studies incorporating plasma catecholamine measurements, inflammatory markers, and detailed pharmacokinetic analyses would enhance our understanding of nebulized dexmedetomidine's precise mode of action. Finally, comparative cost-effectiveness analyses would help position this intervention appropriately within perioperative care protocol.

CONCLUSION

This prospective, randomized, double-blind, comparative study demonstrates that nebulized dexmedetomidine (2μg/kg) is significantly more effective than nebulized lignocaine 4% (3mg/kg) in attenuating the haemodynamic stress response associated with laryngoscopy and endotracheal intubation. Nebulized dexmedetomidine (2μg/kg) represents a valuable addition to the anesthesiologists' armamentarium for safely managing the stress response to laryngoscopy and intubation while enhancing patient comfort.

Source of Funding
None.

Conflict of Interest
None.

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