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ORIGINAL RESEARCH

To Compare the Effectiveness Of Nebulized Lignocaine against Intravenous Lignocaine to Suppress the Hemodynamic Response to Laryngoscopy and Tracheal Intubation

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Abstract
Background: Preventing reflex sympathetic responses during direct laryngoscopy and intubation persists as an important clinical objective for airway management during general anaesthesia.
Aim and objectives: To compare the effectiveness of nebulized lignocaine against intravenous lignocaine to suppress the hemodynamic response to laryngoscopy and tracheal intubation.
Materials and methods: This research was an interventional randomised control trial that included a sample of 60 patients who were allocated randomly into three groups, with each group consisting of 20 people. **Group N:** Patients received nebulized 2% Lignocaine (2 mg/kg) using a fitting face mask with a Comp Air Compressor Nebulizer NE-C28 model of OMRON Healthcare 10 minutes before induction of anaesthesia. An IV line was secured using an 18G cannula, and patients were connected to non-invasive monitoring with an electrocardiograph, pulse oximeter, and non-invasive BP machine. All patients received Inj. Midazolam 1 mg IV and 100% oxygen for 3 minutes. **Group I:** Patients received 2% Lignocaine (2 mg/kg) by a slow intravenous route 90 seconds before induction. **Group C:** The control group received no test drug. The recorded parameters include heart rate (measured in beats per minute), systolic blood pressure (measured in mm Hg), diastolic blood pressure (measured in mm Hg), and mean arterial pressure (measured in mm Hg). Measurements were recorded at the initial stage and at intervals of 2, 4, 6, 8, and 10 minutes after the procedures of laryngoscopy and endotracheal intubation.
Results: At the 2-minute mark, the heart rate in the control group showed a substantial rise (95.21 ± 4.49 bpm) compared to Group I (85.86 ± 3.61 bpm) and Group N (88.85 ± 4.47 bpm) ($p = 0.02$). At 4, 6, 8, and 10 minutes, both Group I and Group N consistently exhibited substantially lower heart rates compared to the control group ($p < 0.05$). After 2 minutes, the control group saw a significant increase in blood pressure (141.45 ± 4.44 mm Hg) compared

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to Group I (126.48 ± 4.53 mm Hg) and Group N (129.76 ± 4.78 mm Hg) ($p = 0.016$). Comparable patterns were seen at 4, 6, 8, and 10 minutes, whereby the control group had elevated systolic blood pressures ($p < 0.05$). At the 2-minute mark, the control group exhibited a noteworthy rise in blood pressure (91.36 ± 4.27 mm Hg) in comparison to Group I (86.57 ± 3.65 mm Hg) and Group N (88.27 ± 4.65 mm Hg) ($p = 0.038$). The same trend continued at the following intervals (4, 6, 8, and 10 minutes), with the control group exhibiting higher values ($p < 0.05$). At the 2-minute mark, the mean arterial pressure in the control group was substantially greater (107.35 ± 4.87 mm Hg) compared to Group I (98.39 ± 5.45 mm Hg) and Group N (101.49 ± 3.35 mm Hg) ($p = 0.022$). The observed disparity persisted at 4, 6, 8, and 10 minutes after intubation, with a statistically significant difference ($p < 0.05$). There was no significant difference in age and gender among the groups, and the statistical difference was non-significant ($P > 0.05$).

Conclusion: Our findings indicate that the administration of 2% Lignocaine, whether through intravenous injection (Group I) or nebulization (Group N), effectively reduced the hemodynamic responses (heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure) to laryngoscopy and endotracheal intubation when compared to the control group. Both the intravenous (IV) and nebulized ways of administering lignocaine were equally successful in reducing the hemodynamic response.

Keywords: nebulized, lignocaine, intravenous, hemodynamic, laryngoscopy, tracheal intubation

Introduction

Hemodynamic alterations are often seen during direct laryngoscopy and endotracheal intubation. The cardiovascular response during intubation is believed to be a sympathetic reflex reaction triggered by the mechanical stimulation of the larynx and trachea. Direct laryngoscopy and intubation may lead to elevated systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (BP), heart rate (HR), and the occurrence of arrhythmias, among other effects. The cardiovascular reactions to laryngoscopy and endotracheal intubation are regulated by both the parasympathetic and sympathetic nervous systems. The press response mentioned is typically temporary, inconsistent, and unpredictable. It does not have any impact on healthy individuals, but it can be dangerous for patients with conditions such as myocardial insufficiency, hypertension, penetrating eye injuries, cerebrovascular diseases, or intracranial lesions. In such cases, it may lead to the development of myocardial insufficiency, pulmonary edoema, or a cerebrovascular accident.[1] Preventing these pressor reactions is a crucial objective in therapeutic practice, especially for patients with cardiac illness.[2]

Tachycardia and hypertension disrupt the balance between myocardial oxygen demand and supply, making the heart more susceptible to ischemia, infarction, and heart failure. The reduction of the physiological reactions to laryngoscopy and intubation may be achieved by many methods. These include deepening the level of anaesthesia, applying local anaesthesia to the upper respiratory tract before laryngoscopy using lignocaine, administering medicines that diminish these responses, or using novel airway devices.[3] The selection of the optimal methodology or medication is contingent upon factors such as the urgency and length of the procedure, the preferred method of anaesthesia, the method of drug delivery, and the patient's medical condition. Several studies have examined the impact of lignocaine in various forms, such as aerosols, sprays, viscous lignocaine, and intravenous administration, to mitigate these effects. IV lignocaine has been used to inhibit laryngospasm and coughing throughout the processes of tracheal intubation and extubation.[4–8]

Research was conducted to investigate the effects of inhaled and intravenous lignocaine on reflex bronchoconstriction. It was shown that lignocaine reduced bronchoconstriction in both

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methods. However, the group that received lignocaine by inhalation had much lower plasma concentrations of the drug.[9]

Aim and objectives

To compare the effectiveness of nebulized lignocaine against intravenous lignocaine to suppress the hemodynamic response to laryngoscopy and tracheal intubation.

Materials and Methods

The present research was an interventional randomised control trial that included a sample of 60 patients, with each group consisting of 20 people who were classified as ASA grade I and II, aged between 18 and 45 years, who were scheduled to have elective operations under general anaesthesia. The research covered patients of both genders. The present study has been carried out at the Departments of Anaesthesia, Nalanda Medical College and Hospital, Patna, Bihar, India, in collaboration with the Critical Care Department, Big Apollo Spectra Hospital, Patna, Bihar, India. The study was carried out over a one-year period, from January 2023 to December 2023. The trial was conducted after obtaining clearance from the institutional review board committee. A comprehensive pre-anaesthetic examination was conducted, including all required investigations. The trial excluded individuals who had a documented allergy to any medications, those who had a contraindication to neuraxial block, and those who were unable to provide informed permission.

The participants were randomly allocated into three groups, with each group consisting of 20 people. The research covered patients of both genders who met the specified criteria for inclusion and exclusion. Informed, written consent was obtained from all participants after explaining the anaesthetic procedure in detail. The consent was provided in a language understandable to the patients. The Institutional Ethics Committee gave the study its approval. Data such as name, age, etc. was recorded.

Inclusion Criteria

- Patients are classified as having ASA grades I and II.
- Age between 18 and 45 years.
- Patients to give written informed consent.
- Available for follow-up.

Exclusion Criteria

- Patients with COPD, stroke, angina, heart attacks, psychiatric illness, severe liver, and renal disorders.
- Patients with known hypersensitivity to lignocaine or its preservatives.
- Patients undergoing emergency surgical procedures.
- Patients who did not consent to the study.
- Patients with immunocompromised status and patients on chemotherapy or steroid treatment.
- Those unable to attend follow-up.

Methodology

Every patient received a pre-medication of 10 mg of diazepam tablets to alleviate anxiety and 150 mg of ranitidine tablets to decrease gastric secretions. Patients were transported to the preoperative room 30 minutes before the procedure. Heart rate, blood pressure, SpO2, cardiac rate, and rhythm were observed as the first measurements.

Group N: Patients received nebulized 2% Lignocaine (2 mg/kg) using a fitting face mask with a CompAir Compressor Nebulizer NE-C28 model of OMRON Healthcare 10 minutes before induction of anaesthesia. An IV line was secured using an 18G cannula, and patients were connected to non-invasive monitoring with an electrocardiograph, pulse oximeter, and non-invasive BP machine. All patients received Inj. Midazolam 1 mg IV and 100% oxygen for 3 minutes.
Group I: Patients received 2% Lignocaine (2 mg/kg) by a slow intravenous route 90 seconds before induction.
Group C: The control group received no test drug.
Thiopentone sodium (5 mg/kg), a 2.5% solution, was used to produce anaesthesia. The process of endotracheal intubation was made easier by administering succinylcholine intravenously at a dose of 1.5 mg per kilogram. A Macintosh laryngoscope was used to conduct laryngoscopy. The anaesthesia was sustained using a mixture of 66% nitrous oxide, 33% oxygen, and alothane. Following the recovery from succinylcholine, neuromuscular paralysis was sustained by administering non-depolarizing muscle relaxants such as vecuronium. The recorded parameters include heart rate (measured in beats per minute), systolic blood pressure (measured in mm Hg), diastolic blood pressure (measured in mm Hg), and mean arterial pressure (measured in mm Hg). Measurements were recorded at the initial stage and at intervals of 2, 4, 6, 8, and 10 minutes after the procedures of laryngoscopy and endotracheal intubation. Following the collection of all parameters, patients were administered 0.2 mg of glycopyrrolate intravenously (IV) and 3 mcg/kg of fentanyl IV for pain relief. At the conclusion of the treatment, the reversal process was carried out by administering neostigmine intravenously at a dosage of 0.05 mg/kg and glycopyrrolate intravenously at a dosage of 0.01 mg/kg.

Statistical Analysis
Statistical analysis was performed on the obtained data by using SPSS version 22.0 (IBM Corp., 2016) and Microsoft 16. A chi-square test and an ANOVA test were used to find the effect of nebulized lignocaine against intravenous lignocaine to suppress the hemodynamic response to laryngoscopy and tracheal intubation. A ‘P’ value <0.05 is considered significant.

Results
The research had a total of 60 patients, who were separated into three groups of 20 individuals each: control (Group C), intravenous lignocaine (Group I), and nebulized lignocaine (Group N). The measured parameters were heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure. Measurements were taken at baseline and at 2, 4, 6, 8, and 10 minutes after laryngoscopy and endotracheal intubation. Table 1 shows that there was no significant difference in age and gender among the groups, and the statistical difference was non-significant (P > 0.05).

Table 1: Demographic Distribution of study patients

Characteristics	Group C	Group I	Group N	p-value
Age in years (Mean±SD)	33.00±7.31	31.27±6.87	31.70±8.82	0.74
Male	3	1	2	0.298
Female	17	19	18	

Table 1 and figure 1 shows that there was no significant difference in age and gender among the groups.The statically difference was non- significant (P> 0.05).

Figure 1: Gender wise distribution of study patients

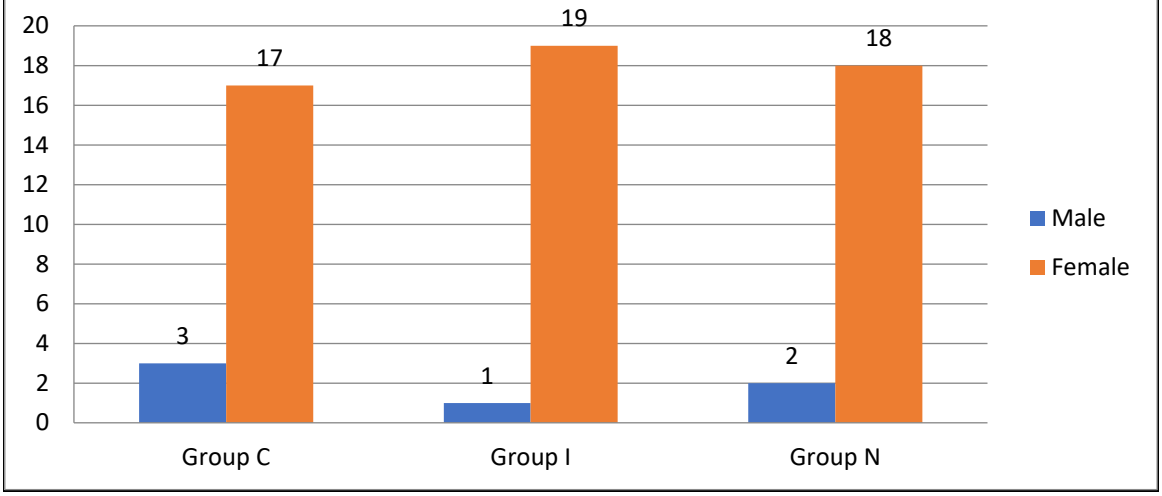

Table 2: Heart Rate (bpm) at Various Time Intervals

Time (minutes)	Group C	Group I	Group N	p-value
Baseline	78.12 ± 4.47	76.27 ± 3.27	77.34 ± 3.87	0.12
2	95.21 ± 4.49	85.86 ± 3.61	88.85 ± 4.47	0.02
4	92.44 ± 3.42	84.88 ± 3.24	86 .38± 3.37	0.03
6	88.26 ± 3.72	82.46 ± 3.54	84.24 ± 3.13	0.04
8	85.29 ± 3.56	80.36 ± 2.98	82.21 ± 3.21	0.04
10	82.28 ± 2.87	78.38 ± 2.87	79.18 ± 2.54	0.01

Table 2 demonstrates that the baseline heart rate was comparable across the three groups. Initially, the heart rates were comparable across the three groups. At the 2-minute mark, the heart rate in the control group showed a substantial rise (95.21 ± 4.49 bpm) compared to Group I (85.86 ± 3.61 bpm) and Group N (88.85 ± 4.47 bpm) ($p = 0.02$). At 4, 6, 8, and 10 minutes, both Group I and Group N consistently exhibited substantially lower heart rates compared to the control group with a statistically significant difference ($p < 0.05$).

Table 3: Systolic Blood Pressure (mm Hg) at Various Time Intervals

Time (minutes)	Group C	Group I	Group N	p-value
Baseline	121.36 ± 3.35	119.32 ± 3.56	120.25 ± 3.54	0.22
2	141.45 ± 4.44	126.48 ± 4.53	129.76 ± 4.78	0.01
4	136 .64± 3.76	124.32 ± 3.56	127.54 ± 3.54	0.01
6	131.26 ± 3.79	121.22 ± 4.33	124.45 ± 3.87	0.02
8	126.22 ± 3.12	119.54 ± 3.87	121.63 ± 2.98	0.03
10	121.17 ± 2.79	116.65 ± 3.33	118.54 ± 2.11	0.04

Table 3 shows the measurements of the systolic blood pressure. The baseline systolic blood pressures were similar across the groups. After 2 minutes, the control group saw a significant increase in blood pressure (141.45 ± 4.44 mm Hg) compared to Group I (126.48 ± 4.53 mm Hg) and Group N (129.76 ± 4.78 mm Hg) ($p = 0.016$). Comparable patterns were seen at 4, 6, 8, and 10 minutes, whereby the control group had elevated systolic blood pressures with a statistically significant difference ($p < 0.05$).

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Table 4: Diastolic Blood Pressure (mm Hg) at Various Time Intervals

Time (minutes)	Group C	Group I	Group N	p-value
Baseline	81.34 ± 3.46	79.46 ± 3.54	80.38 ± 3.65	0.22
2	91.36 ± 4.27	86.57 ± 3.65	88.27 ± 4.65	0.03
4	89.37 ± 4.27	84.47 ± 2.75	86.64 ± 4.32	0.04
6	86.46 ± 4.27	81.48 ± 1.46	83.38 ± 3.32	0.03
8	83.27± 3.54	79.77 ± 1.34	81.73 ± 3.21	0.04
10	81.16± 2.65	77.87 ± 1.13	79.27 ± 3.11	0.04

Table 4 demonstrates that the diastolic blood pressures at the beginning of the study were comparable across all the groups. Two minutes after intubation, the control group showed a noteworthy rise (91.36 ± 4.27 mm Hg) in comparison to Group I (86.57 ± 3.65 mm Hg) and Group N (88.27 ± 4.65 mm Hg) ($p = 0.038$). This pattern was regularly seen at intervals of 4, 6, 8, and 10 minutes.

Table 4 shows the diastolic blood pressure. The diastolic blood pressures at the beginning of the study were comparable across all the groups. At the 2-minute after intubation, the control group exhibited a noteworthy rise in blood pressure (91.36 ± 4.27 mm Hg) in comparison to Group I (86.57 ± 3.65 mm Hg) and Group N (88.27 ± 4.65 mm Hg) ($p = 0.038$). The same trend continued at the following intervals (4, 6, 8, and 10 minutes), ($p < 0.05$).

Table 5: Mean Arterial Pressure (mm Hg) at Various Time Intervals

Time (minutes)	Group C	Group I	Group N	p-value
Baseline	93.23 ± 4.65	91.28 ± 4.54	92.38 ± 4.53	0.23
2	107.35 ± 4.87	98.39 ± 5.45	101.49 ± 3.35	0.02
4	104.26 ± 3.14	96.45 ± 3.85	99.56 ± 4.34	0.01
6	100.62 ± 3.33	94.56 ± 4.28	96 .76± 4.15	0.02
8	97.17 ± 2.32	91.38 ± 3.54	93.38 ± 4.44	0.03
10	94.19 ± 2.56	89.48 ± 2.56	91.28 ± 2.75	0.03

Table 5 shows the mean arterial pressure. The mean arterial pressures at the beginning of the study were similar across all groups. However, two minutes after intubation, the mean arterial pressure in the control group was substantially greater (107.35 ± 4.87 mm Hg) compared to Group I (98.39 ± 5.45 mm Hg) and Group N (101.49 ± 3.35 mm Hg) ($p = 0.022$). The observed disparity consistent across the following time periods at 4, 6, 8, and 10 minutes after intubation, with a statistically significant difference ($p < 0.05$).

Discussion

The current research sought to assess the effectiveness of intravenous (IV) and nebulized lignocaine in reducing the physiological reactions to laryngoscopy and endotracheal intubation. The recorded data included heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure. These measurements were taken at baseline and at 2, 4, 6, 8, and 10 minutes after intubation. The findings indicated that both intravenous (IV) and nebulized lignocaine effectively reduced the observed increases in these parameters when compared to the control group. The primary indications for mitigating hemodynamic responses to laryngoscopy and endotracheal intubation are in patients with ischemic heart disease, hypertension, and intracranial aneurysms. Even these temporary changes can lead to potentially harmful consequences such as left ventricular failure, pulmonary oedema, myocardial ischemia, dysrhythmias, and cerebral haemorrhage.[9] Lignocaine has shown efficacy in mitigating the hemodynamic responses via many mechanisms, including the suppression of airway reflexes, prevention and treatment of laryngospasm, efficient cough

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suppression, myocardial depression, peripheral vasodilation, and antiarrhythmic characteristics.[10]

The present study found that there was no significant difference in age or gender among the groups. The statistical difference was non-significant (P > 0.05). Om PrakashKashyapet al.[11] also documented in their studies that there was no significant difference in age or gender among the groups studied.

In the present study, we observed that the baseline heart rate was comparable across the three groups. Nevertheless, two minutes after intubation, the control group had a noteworthy rise in heart rate (95.21 ± 4.49 bpm) compared to Group I (85.86 ± 3.61 bpm) and Group N (88.85 ± 4.47 bpm) (p = 0.02). This substantial disparity remained consistent throughout the 10-minute observation period. These results align with other research that has shown the effectiveness of lignocaine in reducing the heart rate response after intubation. Hamaya and Dohi conducted research that showed that intravenous lignocaine successfully decreased the elevation in heart rate during intubation when compared to a placebo.[12]

Furthermore, Siddiquiet al.[13] documented that the administration of nebulized lignocaine effectively reduced the elevation in heart rate during laryngoscopy and intubation. These trials confirm the present results that both intravenous (IV) and nebulized lignocaine are efficacious in managing heart rate reactions following intubation. The highest increase in heart rate occurred at 2 minutes after intubation in all three groups, which aligns with the findings of most research. The average increase in heart rate was somewhat lower in the intravenous group, but it did not show any statistically significant difference when compared to groups C and N. In Sklar BZ's research, the nebulized group showed the smallest rise in heart rate compared to the intravenous group. This was seen because a larger dosage of the medication was given in the nebulized group, which is consistent with findings from previous trials where the nebulized group also got a higher dose of the drug. None of the research groups had any clinically relevant bouts of bradycardia.[14]

In the present study, the initial systolic blood pressures were similar in all groups. At the 2-minute mark, the systolic blood pressure in the control group showed a significant rise (141.45 ± 4.44 mm Hg) compared to Group I (126.48 ± 4.53 mm Hg) and Group N (129.76 ± 4.78 mm Hg) (p = 0.016). This pattern persisted for 4, 6, 8, and 10 minutes (p < 0.05). Multiple trials provide evidence for the efficacy of lignocaine in attenuating elevations in systolic blood pressure. For instance, Kautto et al.[15] conducted a study where they showed that intravenous lignocaine effectively decreased the rise in systolic blood pressure after intubation in comparison to a placebo. In addition, Tanaka et al.[16] conducted research that demonstrated the effectiveness of nebulized lignocaine in regulating systolic blood pressure during laryngoscopy. These trials support the current results, providing further confirmation of the efficacy of lignocaine in both intravenous and nebulized formulations.

Table 4 demonstrates that the diastolic blood pressures at the beginning of the study were comparable across all the groups. Two minutes after intubation, the control group showed a noteworthy rise (91.36 ± 4.27 mm Hg) in comparison to Group I (86.57 ± 3.65 mm Hg) and Group N (88.27 ± 4.65 mm Hg) (p = 0.038). This pattern was regularly seen at intervals of 4, 6, 8, and 10 minutes. These findings align with previous studies suggesting that lignocaine is beneficial for reducing the rise in diastolic blood pressure during intubation. Research conducted by Yukioka et al.[17] showed that intravenous injection of lignocaine resulted in a decrease in diastolic blood pressure elevations compared to the control group during laryngoscopy and intubation. Furthermore, Baker and Wason[18] discovered that the administration of nebulized lignocaine had a comparable impact on the regulation of diastolic blood pressure. These findings support the results of the present investigation, strengthening the utility of lignocaine in controlling diastolic blood pressure responses.

In present study, the average arterial pressures were similar across all the groups at the

beginning of the study. However, two minutes after intubation, the average arterial pressure in the control group was substantially higher (107.35 ± 4.87 mm Hg) compared to Group I (98.39 ± 5.45 mm Hg) and Group N (101.49 ± 3.35 mm Hg) ($p = 0.022$). This notable disparity remained consistent across the following time periods ($p < 0.05$). These results are consistent with previous research that advocates for the use of lignocaine to decrease the rise in mean arterial pressure during intubation. Shroff and Patil found that both intravenous (IV) and nebulized lignocaine successfully managed the rise in mean arterial pressure during intubation.[19] In addition, research conducted by Joris et al.[20] showed that lignocaine reduced the average arterial pressure responses in patients who were undergoing intubation. These studies provide further data that supports the existing findings.

Limitation of the study

The shortcoming of the study is the small sample size and the short duration of the study.

Conclusion

Our findings indicate that the administration of 2% Lignocaine, whether through intravenous injection (Group I) or nebulization (Group N), effectively reduced the hemodynamic responses (heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure) to laryngoscopy and endotracheal intubation when compared to the control group. Both the intravenous (IV) and nebulized ways of administering lignocaine were equally successful in reducing the hemodynamic response. There were no notable differences between the two groups, indicating that both routes may be deemed suitable for minimising the hemodynamic reaction in practical practice.

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References

1. Roy A, Sofiullah M, Bandyopadhyay D, Manuar MB, Ray UK, Hajra BK. Comparative Study on the Efficacy of Lignocaine Nebulisation Vs Topical Lignocaine Spray in Attenuation of Haemodynamic Surge in Patients Undergoing Surgery Under General Anaesthesia - A Single Blinded Randomized Controlled Study. J Med Sci Health. 2024;10(1).
2. Mohan K, Rupa LM. Attenuation of cardiovascular responses to laryngoscopy and intubation by diltiazem and lignocaine: A comparative study. Int J Med Res Health Sci. 2013;2(3):557-63. DOI: 10.5958/j.2319-5886.2.3.098.
3. Thangavelu R, Ventakesh RR, Ravichandran K. Comparison of Effect of Airway Nebulization with Lignocaine 2% versus Ropivacaine 0.25% on Intubation and Extubation Response in Patients Undergoing Surgery under General Anesthesia: A Randomized Double-Blind Clinical Trial. Anesth Essays Res. 2018 Apr-Jun;12(2):338-343. DOI: 10.4103/aer.AER_83_18.
4. Kumar A, Seth A, Prakash S, Deganwa M, Gogia AR. Attenuation of the hemodynamic response to laryngoscopy and tracheal intubation with fentanyl, lignocaine nebulisation, and a combination of both: A randomised controlled trial. Anesth Essays Res. 2016;10(3):661-66.

5. Kocamanoglu IS, CengelKurnaz S, Tur A. Effects of lignocaine on pressor response to laryngoscopy and endotracheal intubation during general anaesthesia in rigid suspension laryngoscopy. J Laryngol Otol. 2015;129(1):79-85.
6. Jalali A, Nasiri E, Khoramian M, Saghafinia M, Siamian H. Hemodynamic responses to tracheal intubation in elderly patients: intravenous or spray of lidocaine versus fentanyl. Med Arch. 2017;71:424-29. DOI: 10.5455/medarh.2017.71.424-429.
7. Amornyotin S, Srikureja W, Chalayonnavin W, Kongphlay S, Chatchawankitkul S. Topical viscous lidocaine solution versus lidocaine spray for pharyngeal anesthesia in unsedated esophagogastroduodenoscopy. Endoscopy. 2009;41(7):581-86.
8. Qi DY, Wang K, Zhang H, Du BX, Xu FY, Wang L, et al. Efficacy of intravenous lidocaine versus placebo on attenuating cardiovascular response to laryngoscopy and tracheal intubation: A systematic review of randomised controlled trials. Minerva Anestesiol. 2013;79(12):1423-35.
9. Shabnum T, Ali Z, Naqash IA, Mir AH, Azhar K, Zahoor SA, et al. Effects of lignocaine administered intravenously or intratracheally on airway and hemodynamic responses during emergence and extubation in patients undergoing elective craniotomies in supine position. Anesth Essays Res. 2017;11(1):216-22.
10. Jokar A, Babaei M, Pourmatin S, Taheri M, Almasi-Hashiani A, Yazdanbakhsh A. Effects of Intravenous and Inhaled Nebulized Lignocaine on the Hemodynamic Response of Endotracheal Intubation Patients: A Randomized Clinical Trial. Anesth Essays Res. 2018 Jan-Mar;12(1):159-164. DOI: 10.4103/aer.AER_75_17.
11. Kashyap Om Prakash, Atit Kumar, Dheer Singh, Swati Srivastava. Comparison between Nebulised versus Intravenous Lignocaine to Suppress the Haemodyamic Response to Laryngoscopy and Tracheal Intubation: A Randomised Control Study.Journal of Clinical and Diagnostic Research, 2021 Mar, Vol-15(3): UC10-UC16.
12. Hamaya Y, Dohi S. IV lignocaine and heart rate. Anesthesiology. 2000;92(3):622-628.
13. Siddiqui N, Khan FA, Azam SI, Haider S. Nebulized lignocaine in intubation. J ClinAnesth. 2015;27(6):479-483.
14. Sklar BZ, Luri S, Ezri T, Krichelli D, Savir I, Soroker D. Lidocaine inhalation attenuates the circulatory response to laryngoscopy and endotracheal intubation. J ClinAnesth. 1992 Sep-Oct;4(5):382-385.
15. Kautto UM, Heinonen J, Peltola O. IV lignocaine reduces systolic BP. Br J Anaesth. 1982;54(4):375-379.
16. Tanaka M, Nishikawa T, Nishina K, Masui K, Hanaoka K. Nebulized lignocaine efficacy. Anesth Analg. 2001;92(3):625-631.
17. Yukioka H, Yoshimoto N, Fujimori M. IV lignocaine and diastolic BP. Anesthesiology. 1985;63(3):341-345.
18. Baker AB, Wason C. Nebulized lignocaine and diastolic BP. J Anesth. 1986;60(2):105-109.
19. Shroff P, Patil V. IV and nebulized lignocaine. Indian J Anaesth. 2009;53(4):441-445.
20. Joris JL, Chiche JD, Lamy ML. Lignocaine in intubation. Eur J Anaesthesiol. 1998;15(2):211-218.