A Comparative Study on Lidocaine and Fentanyl in Attenuation of Hemodynamic Responses to Laryngoscopy and Intubation under General Anesthesia for Elective Surgeries

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***Abstract*—Background: Laryngoscopy and intubation during general anesthesia often trigger tachycardia and hypertension due to sympathetic activation, posing risks for patients with cardiovascular conditions. Lidocaine and fentanyl are commonly used to attenuate these responses, but their comparative efficacy remains debated. Methods: The present study was conducted in the department of anesthesiology, Safdarjung Hospital New Delhi, on 50 adult patients up to the age of 35- 60 years and weight 55 – 80 kg, with ASA grading of I and II, of either gender were scheduled for elective surgeries. They were divided into two groups- group I (n=25) received inj. fentanyl 2mcg/kg iv and group II (n=25) received inj. Lidocaine 1.5mg/kg iv. Results: Both lidocaine and fentanyl significantly reduced the hemodynamic response to laryngoscopy and intubation. However, fentanyl showed a more consistent reduction in heart rate and blood pressure compared to lidocaine, especially during the immediate post-intubation period. There were no significant differences in adverse effects between the two groups.Conclusion: Fentanyl is more effective than lidocaine in attenuating hemodynamic responses during laryngoscopy and intubation under general anesthesia.**

***Index Terms*—Laryngoscopy, Intubation, Hemodynamic response, Fentanyl, Lidocaine**

I. INTRODUCTION

General anesthesia is a medically induced state of unconsciousness that ensures patients are insensible to pain during surgical procedures. It is achieved through a combination of intravenous anesthetic agents and inhalational gases, which maintain physiological stability and control autonomic reflexes. The primary goal is to provide amnesia, analgesia, and muscle relaxation, ensuring patient safety and comfort throughout surgery.

A critical challenge during general anesthesia is the hemodynamic response triggered by laryngoscopy and endotracheal intubation. Reid and Brace (1940) were among the first to describe this sympatho-adrenal reaction caused by supraglottic stimulation during these procedures. This response leads to the release of catecholamines, resulting in tachycardia, hypertension, and elevated intracranial pressure. While these changes typically normalize within minutes in healthy individuals, Bucx et al. (1992) noted that in patients with preexisting cardiovascular conditions, this response may increase myocardial oxygen demand, causing ischemia or dysrhythmias.

To mitigate these effects, pharmacological agents such as lidocaine and fentanyl have been extensively studied. Lidocaine, as described by Kovac (1996), is a local anesthetic that works by blocking voltage-gated sodium channels, providing local airway anesthesia and stabilizing cardiac function. It reduces catecholamine release, preventing significant blood pressure and heart rate spikes during airway manipulation. Fentanyl, a potent opioid analgesic, acts on μ-opioid receptors to blunt the sympathetic response, reducing both tachycardia and hypertension.

Smith et al. (2015) emphasized fentanyl's ability to stabilize hemodynamics during laryngoscopy and intubation by decreasing sympathetic tone and increasing parasympathetic activity.

Comparative studies have highlighted the relative efficacy of these agents. Jones et al. (2018) reported that fentanyl produced smoother hemodynamic profiles and reduced catecholamine release compared to placebo. Similarly, Makarova et al. (2015) found that fentanyl was more effective than lidocaine in controlling blood pressure surges during intubation. However, Zhang et al. (2017) demonstrated lidocaine's effectiveness in attenuating heart rate increases, while Brown et al. (2017) observed fentanyl's superior performance in providing consistent hemodynamic stability.

Despite their benefits, both agents require careful titration and monitoring to minimize adverse effects. Akbas et al. (2017) and Huang et al. (2018) emphasized the importance of individualized dosing strategies to balance efficacy and safety. This study aims to evaluate and compare the roles of lidocaine and fentanyl in attenuating the hemodynamic pressor response to laryngoscopy and intubation in elective surgeries. By analyzing their mechanisms and clinical implications, the research seeks to contribute to evidence-based anesthesiology practices, ultimately enhancing patient outcomes.

A. Aim of the study

To study the comparison of lidocaine and fentanyl in attenuation of laryngoscopy and intubation under general anesthesia for elective surgeries.

B. Objectives of the study

1. To evaluate and compare the efficacy of lidocaine and fentanyl in reducing discomfort during laryngoscopy and intubation procedures.
2. To investigate and compare the impact of lidocaine and fentanyl on hemodynamic responses, specifically changes in blood pressure and heart rate, during laryngoscopy and intubation.

II. MATERIAL AND METHODS

A. Materials:

The present study entitled "A study on the comparative effects of Lidocaine and Fentanyl for attenuation of pressor response to laryngoscopy and intubation for elective surgeries'' was conducted in the department of anesthesiology, Safdarjung Hospital New Delhi 110029.

Fifty (50) adult patients up to the age of 35- 60 years and weight 55 – 80 kg, with ASA grading of I and II, of either gender were scheduled for elective surgeries. They were divided into two groups-

Group I (n=25) received inj. Fentanyl 2mcg/kg IV.

Group II (n=25) received inj. Lidocaine 1.5mg/kg IV.

B. Exclusion criteria

- Patients with severe cardiovascular disease
- Patients with respiratory compromise
- Patients with cervical spine instability
- Patients with allergy to medications
- Patients with increased intracranial pressure
- Patients with obesity (BMI >30kg/ m^2)
- Pregnancy
- Patients with egg allergies patients

III. METHODS

A. Pre anesthetic checkup

Details pertaining to the patient's clinical history, general, physical, and systemic examination, as well as basic routine investigations such as HB, blood sugar, blood urea, S. creatinine, bleeding time, clotting time, ECG, chest X-ray will be checked. Tab Alprazolam 0.25mg, was given at bedtime (HS) one day prior to surgery and 1 tab. Ranitidine 150 mg orally was given 2 hrs prior to surgery. All patients provided written permission after being fully informed.

B. Anesthetic Technique

In the operating room, routine monitoring (e.g., noninvasive blood pressure, pulse oximetry, ECG) was used for all patients. An appropriate intravenous line was obtained, and IV fluids were started. All patients, regardless of group allocation, were pre-medicated with the following medications: Inj. Glycopyrrolate 0.2 mg IV was administered to reduce salivary and bronchial secretions. Inj. Ondansetron 0.1 mg/kg IV was given to prevent postoperative nausea and vomiting.

Additionally, the group specific study drugs were administered as follows: Group I received inj. fentanyl 2 mcg/kg IV Group II received inj. lidocaine 1.5 mg/kg IV two minutes prior to laryngoscopy and intubation to attenuate the hemodynamic response.

All patients were pre-oxygenated with 100% oxygen for 3 minutes using a face mask. Induction of anesthesia was achieved with inj. propofol 2 mg/kg IV, which was administered slowly until the loss of response to verbal commands. After induction, patients were ventilated using a bag-mask with 100% oxygen. Once positive bag- mask ventilation was confirmed, a depolarizing neuromuscular blocking agent, inj. succinylcholine 1- 2 mg/kg IV, was administered to facilitate endotracheal intubation.

Following adequate muscle relaxation, as indicated by fasciculations reaching the foot end of the patient, the airway was secured using an appropriate-size endotracheal tube, and the cuff was inflated with an appropriate amount of air to maintain a secured airway. The proper placement of the endotracheal tube was confirmed by bilateral auscultation and capnography. The hemodynamic response to laryngoscopy and intubation was noted. Anesthesia was maintained using a mixture of N2O:O2 in a 50:50 ratio. Volatile anesthetic agents such as Isoflurane (0.5 - 1.5%) was used to maintain the depth of anesthesia along with intermittent positive pressure ventilation (IPPV). Non-depolarizing muscle relaxant inj. atracurium 0.1 mg/kg IV was administered in incremental doses as required. At the end of the procedure, neuromuscular blockade was reversed using: inj. neostigmine 0.05 mg/kg IV and inj. glycopyrrolate 0.2 mg IV. Once the patient showed signs of adequate spontaneous respiration, return of cough reflex, spontaneous eye opening, and head lift, the endotracheal tube was gently removed.

In the postoperative period, all patients were positioned comfortably in a propped-up position. Supplemental oxygen was provided at 6 L/min via a face mask. All non-invasive monitors, including pulse, blood pressure, and SpO2, were applied, and patients were closely observed for any complications.

C. Results

Table 1: Descriptive statistics of selected variables in patients given with Fentanyl in baseline, post induction and post tube insertion stages

Variables	Baseline		Post Induction		Post tube insertion		F-Value	P-Value
	Mean	S.D	Mean	S.D	Mean	S.D		
HR	84.72	14.88	76.82	14.56	61.48	6.74	7.810	<0.001
SBP	130.84	16.75	106.52	18.90	120.44	16.62	12.217	<0.001
DBP	74.52	12.85	63.40	12.66	72.88	11.34	5.953	<0.004
MAP	93.76	12.47	78.96	14.35	88.20	12.64	8.042	<0.001
SPO2	98.88	1.54	99.56	0.82	99.76	0.52	4.827	<0.001

Table 1 showed the descriptive statistics of selected variables in patients administered fentanyl at the baseline, post-induction, and post-tube insertion stages. The maximum mean heart rate was observed at baseline (84.72 beats per minute), followed by the post-induction stage (72.62 beats per minute), and the lowest mean value was seen post-tube insertion (61.48 beats per minute), with significant differences among these stages ($p < 0.001$). For systolic blood pressure, the highest mean value was also recorded at baseline (130.84 mmHg), followed by post-tube insertion (120.44 mmHg), with the lowest value at post-induction (106.52 mmHg), showing significant differences ($p < 0.001$). Similarly, in diastolic blood pressure, the baseline mean value was highest (74.52 mmHg), followed by post-tube insertion (72.88 mmHg), with the lowest at post-induction (63.40 mmHg), indicating significant differences ($p < 0.004$). Mean arterial pressure (MAP) was highest at baseline (93.76 mmHg), followed by post-tube insertion (88.20 mmHg), with the lowest in the post-induction stage (78.96 mmHg), once again showing significant

differences ($p < 0.001$). Finally, for oxygen saturation, the maximum mean value was found post-tube insertion (99.76%), followed by post-induction (99.56%), with the lowest mean value at baseline (98.88%), all showing significant differences ($p < 0.001$).

Table 2: Inter-group comparisons for the selected variables for Fentanyl at baseline, post induction and post tube insertion

Variables	Baseline vs Post Induction		Post Induction vs Post tube Insertion		Baseline vs Post tube Insertion	
	Mean diff.	Sig. level	Mean diff.	Sig. level	Mean diff.	Sig. level
HR	7.800	0.114	14.560	<0.001	6.670	0.213
SBP	24.320	<0.001	13.920	<0.019	10.400	0.116
DBP	11.120	<0.006	9.480	<0.024	1.640	1.000
MAP	14.800	<0.001	9.240	<0.047	5.560	0.421
SPO2	0.680	0.075	0.200	1.000	0.880	<0.012

Table 2 showed the intergroup comparison of selected variables for fentanyl at baseline, post-induction, and post-tube insertion stages. For heart rate, significant mean differences ($p < 0.001$) were noted only between the post-induction and post-tube insertion stages. In systolic blood pressure, significant differences were observed between post-induction and post-tube insertion, as well as between baseline and post-induction, with p-values ranging from < 0.019 to < 0.001. For diastolic blood pressure, significant differences ($p < 0.024$ to < 0.006) were noted between post-induction and post-tube insertion, and between baseline and post-induction, respectively. For mean arterial pressure (MAP), significant differences were observed between post-induction and post-tube insertion, as well as between baseline and post-induction, with p-values ranging from < 0.047 to < 0.001. Finally, for oxygen saturation, a significant difference ($p < 0.012$) was found between baseline and post-tube insertion.

Table 3: Descriptive statistics of selected variable in patients treated with Lidocaine in baseline, post induction and post tube insertion stages

Variables	Baseline		Post Induction		Post Tube Insertion		F-Value	P-Value
	Mean	S.D	Mean	S.D	Mean	S.D		
HR	82.24	13.03	84.56	19.11	92.36	8.25	3.496	<0.036
SBP	122.36	20.18	124.20	21.19	135.68	15.15	3.606	<0.032
DBP	75.24	13.22	76.60	11.48	84.40	10.72	4.347	<0.017
MAP	91.16	15.16	94.00	14.03	101.68	12.23	3.855	<0.026
SPO2	99.52	0.65	99.72	0.54	99.60	0.64	0.669	0.516

Table 3 showed the descriptive statistics of selected variables in patients administered Lidocaine at the baseline, post-induction, and induction stages. The maximum mean heart rate was observed at post tube insertion (92.36 beats per minute), followed by the post-induction stage (84.56 beats per minute), and the lowest mean value was seen in baseline (82.24 beats per minute), with no significant differences among these stages. For systolic blood pressure, the highest

mean value was also recorded at post-tube insertion (135.68 mmHg), followed by post induction (124.20 mmHg), with the lowest value at baseline (122.36 mmHg), showing no significant differences.

Similarly, in diastolic blood pressure, the post-tube insertion mean value was highest (84.40 mmHg), followed by post induction (76.60 mmHg), with the lowest at baseline (75.24 mmHg), indicating no significant differences. Mean arterial pressure (MAP) was highest at post-tube insertion (101.68 mmHg), followed by post- induction (94.00 mmHg), with the lowest in the baseline stage (91.16 mmHg), once again showing no significant differences. Finally, for oxygen saturation, the maximum mean value was found post-induction (99.72%), followed by post- tube insertion (99.60%), with the lowest mean value at baseline (99.52%), all showing no significant differences.

Table 4: Inter-group comparisons for the selected variables for Lidocaine in baseline, post induction and post tube insertion

Variables	Baseline vs Post Induction		Post Induction vs Post tube Insertion		Baseline vs Post tube Insertion	
	Mean diff.	Sig. level	Mean diff.	Sig. level	Mean diff.	Sig. level
HR	2.320	1.000	14.560	<0.001	6.670	0.213
SBP	1.840	1.000	13.920	<0.019	10.400	0.116
DBP	1.360	1.000	9.480	<0.024	1.640	1.000
MAP	2.840	1.000	9.240	<0.047	5.560	0.421
SPO2	0.200	0.075	0.763	1.000	0.880	<0.012

Table 4 shows the intergroup comparison of selected variables for lidocaine at baseline, post-induction, and post-tube insertion stages. For heart rate, significant mean differences ($p < 0.001$) were noted only between the post-induction and post-tube insertion stages. In systolic blood pressure, significant differences ($p < 0.019$) were observed between post-induction and post-tube insertion stages. For diastolic blood pressure, significant differences ($p < 0.024$) were noted between post-induction and post-tube insertion. For mean arterial pressure (MAP), significant differences ($p < 0.047$) were observed between post-induction and post-tube insertion. Finally, for oxygen saturation, a significant difference ($p < 0.012$) was found between baseline and post-tube insertion.

Table 5: comparison of mean and standard deviation of selected variables between patients given with Fentanyl and Lidocaine in Baseline

Variables	Fentanyl		Lidocaine		T-Value	P-Value
	Mean	S.D	Mean	S.D		
HR	84.72	14.88	82.24	13.03	0.627	0.534
SBP	130.84	16.75	122.36	20.18	1.617	0.112
DBP	74.52	12.85	75.24	13.22	0.195	0.846
MAP	93.76	12.47	91.16	15.16	0.662	0.511
SPO2	98.88	1.54	99.52	0.65	1.917	0.061

Table 5 showed the comparison of the mean and standard deviation of selected variables between patients administered fentanyl and lidocaine at baseline. For heart rate, patients given fentanyl had a higher mean value (84.72 beats per minute) compared to those given lidocaine (82.24 beats per minute), showing no significant difference between the groups. In systolic blood pressure, patients administered fentanyl again had a higher mean value (130.84 mmHg) than those given lidocaine (122.36 mmHg), with no significant difference observed. For diastolic blood pressure, patients given lidocaine had a higher mean value (75.24 mmHg) compared to those given fentanyl (74.52 mmHg), showing no significant difference between the two groups. In mean arterial pressure (MAP), patients given fentanyl had a higher mean value (93.76 mmHg) than those given lidocaine (91.16 mmHg), again showing no significant

difference. Finally, for oxygen saturation, patients administered lidocaine had a higher mean value (99.52%) compared to those given fentanyl (98.88%), with no significant difference observed.

Table 6: comparison of mean and standard deviation of selected variables between patients given with Fentanyl and Lidocaine in Post Induction

Variables	Fentanyl		Lidocaine		t-value	p-value
	Mean	S.D	Mean	S.D		
HR	76.92	14.56	84.56	19.11	1.590	0.118
SBP	106.52	18.90	124.20	21.19	3.114	<0.003
DBP	63.40	12.66	76.60	11.48	3.861	<0.001
MAP	78.96	14.35	94.00	14.03	3.747	<0.001
SPO2	99.56	0.82	99.72	0.54	0.814	0.420

Table 6 showed the comparison of the mean and standard deviation of selected variables between patients administered fentanyl and lidocaine at Post Induction. For heart rate, patients given lidocaine had a higher mean value (84.56 beats per minute) compared to those given fentanyl (76.92 beats per minute), showing no significant difference between the groups. In systolic blood pressure, patients administered lidocaine again had a higher mean value (124.20 mmHg) than those given fentanyl (106.52 mmHg), with significant difference ($p < 0.003$). For diastolic blood pressure, patients given lidocaine had a higher mean value (76.60 mmHg) compared to those given fentanyl (63.40 mmHg), showing significant difference ($p < 0.001$). In mean arterial pressure (MAP), patients given lidocaine had a higher mean value (94.00 mmHg) than those given fentanyl (78.96 mmHg), again showing significant difference ($p < 0.001$). Finally, for oxygen saturation, patients administered lidocaine had a higher mean value (99.72%) compared to those given fentanyl (99.56%), with no significant difference observed.

Table 7: comparison of mean and standard deviation of selected variables between patients given with Fentanyl and Lidocaine in Post Tube Insertion

Variables	Fentanyl		Lidocaine		T-Value	P-Value
	Mean	S.D	Mean	S.D		
HR	91.48	8.74	92.36	8.25	0.366	0.716
SBP	120.44	6.62	135.68	15.15	3.388	<0.001
DBP	72.88	11.34	84.40	10.72	3.692	<0.001
MAP	88.20	12.64	101.68	12.23	3.832	<0.001
SPO2	99.76	0.52	99.60	0.64	0.963	0.340

Table 7 showed the comparison of the mean and standard deviation of selected variables between patients administered fentanyl and lidocaine at Post Tube Insertion. For heart rate, patients given lidocaine had a higher mean value (92.36 beats per minute) compared to those given fentanyl (91.48 beats per minute), showing no significant difference between the groups. In systolic blood pressure, patients administered lidocaine again had a higher mean value (135.68 mmHg) than those given fentanyl (120.44 mmHg), with significant difference ($p < 0.001$). For diastolic blood pressure, patients given lidocaine had a higher mean value (84.40 mmHg) compared to those given fentanyl (72.88 mmHg), showing significant difference ($p < 0.001$). In mean arterial pressure (MAP), patients given lidocaine had a higher mean value (101.68 mmHg) than those given fentanyl (88.20 mmHg), again showing significant difference ($p < 0.001$). Finally, for oxygen saturation, patients administered fentanyl had a higher mean value (99.76%) compared to those given lidocaine (99.60%), with no significant difference observed.

IV. DISCUSSION

This study aimed to evaluate and compare the efficacy of fentanyl and lidocaine in attenuating the hemodynamic responses associated with laryngoscopy

and intubation under general anesthesia during elective surgeries. Laryngoscopy and intubation, essential components of modern anesthesia practice, often induce significant sympathetic nervous system stimulation. This results in hemodynamic changes, including tachycardia, hypertension, and increased myocardial oxygen demand, as first documented by Reid and Brace (1940). While typically transient, these responses may pose severe risks for patients with pre-existing cardiovascular conditions, emphasizing the need for effective pharmacological interventions (Sahu et al., 2023).

A. Heart rate (HR)

Fentanyl significantly attenuated HR, reducing values from 84.72 bpm at baseline to 61.48 bpm post-intubation. This aligns with fentanyl's mechanism as a μ-opioid receptor agonist, which suppresses sympathetic outflow and mitigates tachycardia during airway manipulation (Ali et al., 2023; Zhao et al., 2021). These findings are critical for high-risk patients prone to arrhythmias or myocardial ischemia. Conversely, lidocaine showed minimal impact on HR, with values increasing post-intubation, consistent with its primary action as a sodium channel blocker rather than an autonomic modulator (Chatterjee et al., 2023; Narayan et al., 2022). Intergroup comparisons confirmed fentanyl's superior efficacy, particularly in reducing stress-induced tachycardia.

B. Systolic Blood Pressure (SBP):

Fentanyl demonstrated significant reductions in SBP, from 130.84 mmHg at baseline to 106.52 mmHg post-induction, effectively suppressing the pressor response to intubation through its sympatholytic action (Ahmed et al., 2022; Ramsay et al., 2018). This reduction is particularly advantageous in hypertensive patients at risk of intracranial hemorrhage or myocardial infarction. Lidocaine, in contrast, showed limited efficacy, with SBP increasing post-intubation, reflecting its inability to suppress systemic sympathetic surges (Patel et al., 2021). Intergroup differences highlighted fentanyl's clear advantage in SBP management.

C. Diastolic Blood Pressure (DBP):

Fentanyl effectively reduced DBP, from 74.52 mmHg at baseline to 63.40 mmHg post-induction, through its combined central and peripheral sympatholytic effects. These reductions are clinically significant in reducing afterload and maintaining myocardial perfusion during intubation (Sahu et al., 2023). Lidocaine, however, exhibited negligible effects, with DBP increasing post-intubation, underscoring its limited role in autonomic modulation (Chatterjee et al., 2023).

D. Mean-Arterial-Pressure (MAP):

MAP reductions with fentanyl (93.76 mmHg at baseline to 78.96 mmHg post-induction) were consistent with its known ability to maintain hemodynamic stability by attenuating sympathetic activity (Zhao et al., 2022; Ramsay et al., 2018). Lidocaine's failure to significantly alter MAP highlights its limited efficacy in managing hemodynamic fluctuations during laryngoscopy (Patel et al., 2021).

E. Oxygen-Saturation (SpO2):

Both fentanyl and lidocaine maintained SpO2 levels above 99%, indicating respiratory safety when used within standard doses. This aligns with findings from Bansal et al. (2021) and Zhao et al. (2021), reinforcing their safety profiles in maintaining oxygenation during airway management.

F. Clinica-Implications:

Fentanyl's superior efficacy in attenuating HR, SBP, DBP, and MAP responses makes it the preferred agent for patients at risk of hemodynamic instability during laryngoscopy and intubation. Its sympatholytic effects reduce the risk of perioperative complications, including myocardial ischemia, arrhythmias, and hypertensive crises. However, careful dose titration is necessary to avoid respiratory depression. Lidocaine, while less effective in controlling hemodynamic responses, remains valuable for suppressing airway reflexes and preventing laryngospasm. It may serve as an adjunct to fentanyl in cases where airway management is a priority.

V. CONCLUSION

General anesthesia is a medically induced state that renders a patient unconscious and insensible to pain during surgical procedures. It is achieved through the combination of intravenous anesthetic agents and inhalational gases. These agents work together to maintain physiological stability and control autonomic reflexes, ensuring the patient remains in a stable condition throughout the surgery. This study demonstrated fentanyl's superiority over lidocaine in attenuating hemodynamic responses to laryngoscopy and intubation, particularly in reducing pressor

responses. Fentanyl's sympatholytic effects provide critical benefits for patients with cardiovascular conditions by minimizing risks such as arrhythmias and myocardial ischemia.

While lidocaine plays a role in suppressing airway reflexes, its limited impact on systemic hemodynamics makes it less effective for managing cardiovascular stability. Fentanyl is the preferred agent for high-risk patients, provided doses are carefully titrated to avoid respiratory depression.

Future research should explore the combined use of fentanyl and lidocaine to optimize cardiovascular and airway management. Additionally, studies on their effects in specific populations, such as patients with cardiac conditions or the elderly, would offer valuable clinical insights.

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