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Original Research Article

Effect Of Preoperative Nebulization with Fentanyl and Dexmedetomidine on Cardiovascular Response to Laryngoscopy: A Comparative Analysis

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Conflict of interest: Nil

Abstract:

Background: Laryngoscopy and tracheal intubation induce significant hemodynamic changes, which can be detrimental in patients with cardiovascular or neurological conditions. Various pharmacological agents, including fentanyl and dexmedetomidine, have been used to mitigate this response. However, limited studies have compared their efficacy when administered via nebulization.

Aim: This study aims to evaluate and compare the effectiveness of fentanyl and dexmedetomidine nebulization in attenuating the hemodynamic stress response to laryngoscopy and intubation.

Methodology: A prospective study was conducted at the Department of Anesthesia, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India, from October 2023 to October 2024. A total of 85 patients, aged 18–60 years, classified as ASA I and II, were randomized into two groups. Group A received fentanyl nebulization (2 µg/kg), while Group B received dexmedetomidine nebulization (1 µg/kg) before induction. Hemodynamic parameters, including heart rate (HR) and mean arterial pressure (MAP), were recorded at various time points. Statistical analysis was performed using SPSS version 27.

Results: Group B exhibited a significantly lower HR at 1, 5, and 10 minutes post-intubation ($p < 0.0001$). MAP reduction was more pronounced in Group B at 10 minutes ($p < 0.0001$). Propofol consumption was significantly lower in Group B ($p < 0.0001$).

Conclusion: Dexmedetomidine nebulization demonstrated superior efficacy in blunting hemodynamic responses to laryngoscopy and intubation while reducing anesthetic requirements, suggesting a potential advantage over fentanyl nebulization.

Keywords: Anesthesia, Dexmedetomidine, Fentanyl, Hemodynamic Response, Laryngoscopy, Tracheal Intubation.

Introduction

Laryngoscopy and tracheal intubation are potent, unpleasant stimuli that elicit considerable haemodynamic alterations due to reflex autonomic discharge [1]. This response is marked by a rapid escalation in sympathetic activity, resulting in elevated heart rate, blood pressure, and systemic vascular resistance. If not properly managed, these alterations might have harmful consequences, especially in individuals with pre-existing cardiovascular, neurological, or cerebrovascular disorders [2]. Possible risks encompass arrhythmias, cardiac ischaemia, worsening of heart failure, elevated intracranial pressure, and the rupture of cerebral aneurysms. Therefore, it is essential to mitigate this haemodynamic reaction to reduce the risk of negative outcomes and guarantee patient safety throughout the peri-intubation phase.

Several pharmacological medications have been investigated for their effectiveness in reducing the haemodynamic response to laryngoscopy and tracheal intubation. They include intravenous lidocaine, adrenergic-blocking medications including beta and alpha blockers, and vasodilators like hydralazine, sodium nitroprusside, and nitroglycerin. Moreover, opioids like fentanyl, sufentanil, and remifentanil are well acknowledged for their powerful analgesic and sympatholytic effects, rendering them beneficial in alleviating haemodynamic fluctuations. Several studies have demonstrated that a fentanyl dosage of 2 mcg/kg effectively mitigates the cardiovascular reactions linked to laryngoscopy and intubation [3,4]. However, the majority of these investigations have employed thiopentone and propofol as induction agents.

Although the application of fentanyl for haemodynamic stabilisation is well documented with these drugs, few research have investigated the optimal dosage of fentanyl when etomidate serves as an induction agent [7]. Etomidate is a fast-acting, non-barbiturate anaesthetic induction drug that induces hypnosis, forgetfulness, and inhibits nociceptive responses mainly by acting on γ-aminobutyric acid type A (GABAA) receptors [8]. It has a very good haemodynamic profile, retaining myocardial contractility and cardiac output with little cardiovascular depression, making it especially beneficial in patients with reduced cardiac function [9]. However, despite these benefits, etomidate is linked to many adverse effects, including as injection discomfort, myoclonus, postoperative nausea and vomiting, and transitory adrenal suppression. Moreover, etomidate possesses no inherent analgesic qualities, indicating that its use as a singular induction agent may result in insufficient anaesthetic depth for laryngoscopy and intubation, thereby causing notable elevations in heart rate and blood pressure.

Given these limitations, pre-treatment with fentanyl has been suggested as a strategy to mitigate both the hemodynamic perturbations associated with intubation and the undesirable side effects of etomidate [10]. Fentanyl, a potent μ-opioid receptor agonist, has been shown to reduce the sympathoadrenal response to laryngoscopy and intubation by attenuating catecholamine release. By doing so, it helps maintain hemodynamic stability while also reducing the incidence and severity of myoclonus during etomidate induction. However, despite its benefits, the optimal dosing of fentanyl in conjunction with etomidate remains an area of ongoing investigation [11]. Identifying the appropriate fentanyl dose is crucial to achieving adequate attenuation of the hemodynamic response without causing excessive sedation, respiratory depression, or prolonged recovery times [12].

To determine the optimal fentanyl dosage that minimises possible adverse effects while successfully reducing the cardiovascular reactions to laryngoscopy and intubation when combined with etomidate, more study is required. Studies that compare the effects of varying fentanyl concentrations in diverse patient populations especially those with neurological or cardiovascular vulnerabilities would be very helpful in improving anaesthesia guidelines for safer intubation procedures. This study provides the Comparative Analysis of the Effect of Preoperative Fentanyl Timing on Cardiovascular Response to Laryngoscopy.

Methodology

Study Design: This prospective study was conducted over a period of one year in the Department of Anesthesia, Bhagwan Mahavir institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India.

Study duration: The study was conducted over a period of one year, from October2023 to October 2024.

Sample Size: A total of 85 patients were included in the study.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Patients aged 18–60 years of either gender.
- Patients classified under ASA physical status I and II.
- Patients scheduled for elective surgeries under general anaesthesia requiring tracheal intubation.

Exclusion Criteria:

- Patients with anticipated difficult intubation.
- Patients classified under ASA III.
- Patients with allergies to the study' drugs.

Procedure

Patients were randomly assigned into two equal groups: Group A received Fentanyl nebulization (2 μg/kg in 4 ml of 0.9% saline) and Group B received Dexmedetomidine nebulization (1 μg/kg in 4 ml of 0.9% saline) 10 minutes before induction of anaesthesia. All routine multiparameter monitors were attached to the patients. After completion of nebulization, premedication was administered, including Inj. Ondansetron (0.08 mg/kg IV), Inj. Glycopyrrolate (0.004 mg/kg IV), Inj. Midazolam (0.02 mg/kg IV), and Inj. Fentanyl (1–2 mcg/kg IV). Induction was carried out using Inj. Propofol (1.5–2 mg/kg IV), followed by Inj. Succinylcholine (1–2 mg/kg IV) before laryngoscopy. Tracheal intubation was performed, and anaesthesia was maintained using Sevoflurane, Oxygen, and Atracurium. Hemodynamic parameters, including Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Blood Pressure (MBP), were recorded at different time points: before intubation, immediately after intubation, and at 1, 5, and 10 minutes post-intubation. The primary outcome of the study was to evaluate the effectiveness of Fentanyl and Dexmedetomidine nebulization in attenuating the hemodynamic stress response to laryngoscopy and intubation. The secondary outcomes included assessing intraoperative anaesthetic requirements, adverse effects of the study drugs, and sedation scores.

Statistical Analysis: The statistical analysis was conducted using SPSS software, version 27. Either the Chi-square test was used to analyze categorical data. A P-value below 0.05' will indicate the statistical significance of the result.

Result

Table 1 presents a comparison of heart rate (HR) between Group A also Group B at different time points. At baseline and post-nebulization, the mean HR values in both groups were comparable, with no statistically significant differences (P = 0.18 and 0.69, respectively). However, from 1 minute onward, Group B exhibited a significantly lower HR than Group A, with highly significant P-values (<0.0005 at 1 min and <0.0001 at 5 and 10 min). This suggests that the intervention or condition affecting Group B led to a more pronounced reduction in HR over time compared to Group A.

Table 1: Comparison of HR

Time	Group A (Mean ± SD)	Group B (Mean ± SD)	P-value	Significance
Baseline	80.85 ± 9.42	83.92 ± 13.25	0.18	NS
Post- Nebulization	86.45 ± 8.85	87.15 ± 14.92	0.69	NS
1 min	78.92 ± 8.12	70.85 ± 13.32	<0.0005	S
5 min	82.96 ± 9.62	72.92 ± 13.15	<0.0001	S
10 min	85.74 ± 6.58	76.85 ± 11.42	<0.0001	S

Figure 1: Comparison of HR

Table 2 compares the mean arterial pressure (MAP) between Group A and Group B at different time points. At baseline, both groups had similar MAP values, with no significant difference (p = 0.12). Post-nebulization, MAP increased slightly in both groups but remained statistically non-significant (p = 0.09). At 1 minute and 5 minutes, MAP values declined slightly, and no significant difference was observed between the groups (p = 0.38 and p = 0.29, respectively). However, at 10 minutes, a significant reduction in MAP was noted in Group B (87.10 ± 8.85) compared to Group A (95.30 ± 8.25), with a highly significant p-value (<0.0001), indicating a notable difference in MAP between the groups at this time point.

Table 2: Comparison of MAP

Time	Group A (Mean ± SD)	Group B (Mean ± SD)	P-value	Significance
Baseline	95.20 ± 7.85	97.80 ± 9.30	0.12	NS
Post-nebulization	98.50 ± 6.90	101.40 ± 8.85	0.09	NS
1 min	93.30 ± 7.95	92.00 ± 10.60	0.38	NS
5 min	92.10 ± 8.55	91.75 ± 9.20	0.29	NS
10 min	95.30 ± 8.25	87.10 ± 8.85	<0.0001	S

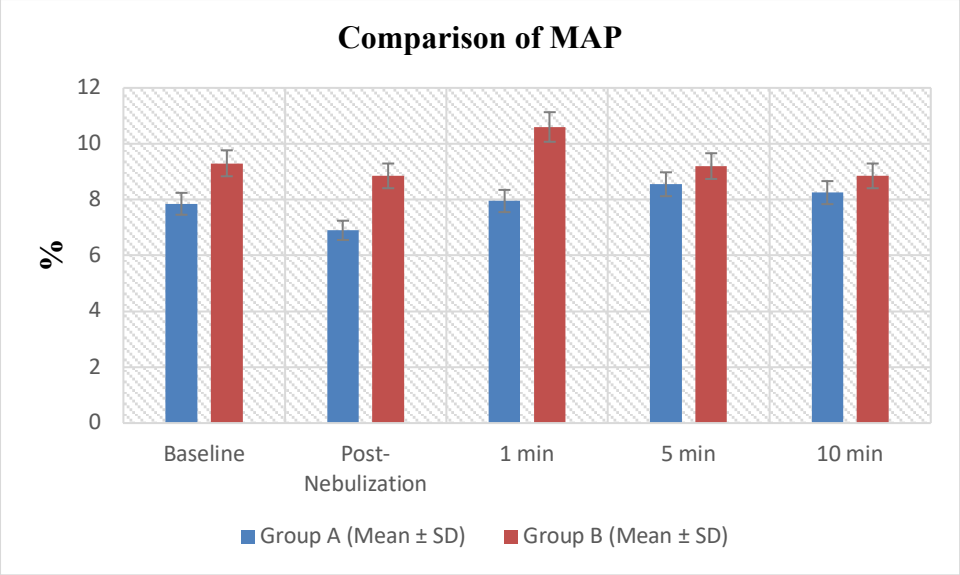

Figure 2: Comparison of MAP

Table 3 presents a comparison of propofol consumption between Group A (n=43) and Group B (n=42). The mean ± SD propofol consumption in Group A was 134.20 ± 22.15 mg, whereas in Group B, it was significantly lower at 76.80 ± 18.90 mg. The P-value for this comparison is <0.0001, indicating a statistically significant difference between the two groups. Additionally, the percentage of total propofol consumption was nearly equal, with Group A accounting for 50.60% and Group B for 49.40%, suggesting a balanced distribution in overall consumption.

Table 3: Comparison of propofol consumption

Consumption of Propofol (mg)	Group A (n=43)	Group B (n=42)	P-value	Significance
Mean ± SD	134.20 ± 22.15	76.80 ± 18.90	<0.0001	S*
Percentage (%)	50.60%	49.40%	-	-

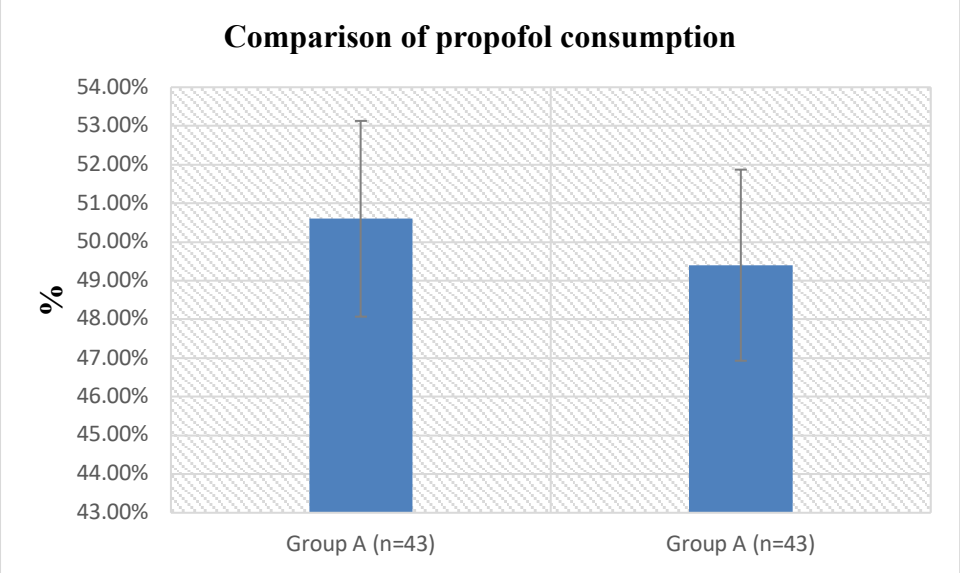

Figure 3: Comparison of propofol consumption

Discussion

The findings of this study provide valuable insights into the effects of different interventions on heart rate (HR), mean arterial pressure (MAP), and propofol consumption between two groups, Group A and Group B.

The results indicate that there were no significant differences between the two groups at baseline and post-nebulization, suggesting that the initial conditions and the effects of nebulization were similar in both groups. However, from 1 minute onward, Group B exhibited a significantly lower

HR than Group A, with highly significant p-values (<0.0005 at 1 min and <0.0001 at 5 and 10 min). This suggests that whatever intervention or condition was applied to Group B led to a more pronounced reduction in HR over time. The substantial difference in HR at 1, 5, and 10 minutes could be indicative of a more effective or more rapidly acting intervention in Group B, or a more pronounced physiological response in this group compared to Group A. This finding may suggest that Group B experienced a greater calming or vasodilatory effect following the intervention, which resulted in a faster and more sustained reduction in HR. The purpose of this research was to assess the effectiveness of fentanyl nebulisation (2 mcg/kg) and dexmedetomidine nebulisation (1 µg/kg) in preventing haemodynamic reactions to endotracheal intubation and laryngoscopy when administered prior to induction of anaesthesia. Higher dosages of dexmedetomidine nebulisation (2 µg/kg) have been used in several trials for preschoolers or patients having dental surgery [13]. According to Shrivastava et al.'s research, nebulised dexmedetomidine at a dose of 1 µg/kg effectively reduces the haemodynamic response to tracheal intubation and laryngoscopy while posing no serious adverse effects. Additionally, this has been a more recent method of administration for reducing the stress reaction to intubation and laryngoscopy [14].

The MAP data (Table 2) reveal no significant differences between the groups at baseline, post-nebulization, or at the 1- and 5-minute time points, suggesting that the interventions had similar effects on MAP in both groups initially and shortly after nebulization. However, a significant reduction in MAP was observed in Group B at the 10-minute time point ($P < 0.0001$). This finding suggests that Group B experienced a more substantial decrease in MAP over time, indicating a more pronounced effect of the intervention on vascular tone or overall circulatory response. The mechanism behind this reduction in MAP in Group B could be related to the same intervention that caused the HR reduction, potentially through vasodilation or other factors affecting blood pressure regulation. The research by Byung et al. [15] found that when ‘fentanyl 1.0 µg/kg (n=30) was administered I min before to induction with etomidate 0.2 mg/kg, there was a rise in SBP and HR of more than 30% of the baseline levels. The infusion was continuous and 0.1 µg/kg/min. Further research into the optimal fentanyl dosage using etomidate as an induction agent was therefore necessary.

Propofol consumption (Table 3) showed a striking difference between the groups. Group A consumed significantly more propofol (134.20 ± 22.15 mg) compared to Group B (76.80 ± 18.90 mg), with a highly significant p-value (<0.0001). This suggests that the intervention in Group B may have led to a reduced need for propofol, potentially’ due to its sedative effects or the calming impact on HR and MAP, which could reduce the need for anesthetic supplementation. Despite this difference in absolute consumption, the percentage of total propofol consumption between the two groups was nearly equal (50.60% in Group A vs. 49.40% in Group B), indicating that the overall distribution of propofol consumption across the groups was balanced, even though the total amount used was lower in Group B.

Kindler et al. found that the rise in blood pressure and heart rate that came with laryngoscopy and endotracheal intubation was much less than that of the control group when they used esmolol at a dose of 1-2 mg/kg [16]. Using 1 mg/kg of esmolol, Trariq et al.. found that esmolol reduced the haemodynamic response to some extent but did not eliminate it entirely. Esmolol reduces tachycardia and hypertension during tracheal intubation when administered at bolus dosages of 100 and 200 mg [17].

In summary, the results suggest that the intervention in Group B led to a more significant reduction in HR and MAP, which might explain ‘the lower consumption of propofol in this group. The observed differences highlight the effectiveness of the intervention in modulating cardiovascular responses and potentially reducing the need for anesthetic agents. Further studies are warranted to explore the underlying mechanisms responsible for these changes and to confirm the clinical implications’ of these findings in similar patient populations.

Conclusion

The findings of ‘this study demonstrate that dexmedetomidine nebulization (1 µg/kg) was more effective than fentanyl nebulization (2 µg/kg) in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation. Group B, which received dexmedetomidine, exhibited a significantly lower heart rate at 1, 5, and 10 minutes post-intubation compared to Group A, indicating a superior hemodynamic stabilizing effect. Additionally, mean arterial pressure remained comparable between the groups in the initial time points, Group B showed a significant reduction at the 10-minute mark, suggesting a sustained antihypertensive effect. The significantly lower propofol consumption in Group B further supports the sedative efficacy of dexmedetomidine, reducing the need for additional anesthetic agents. These results highlight the potential advantages of dexmedetomidine over fentanyl in blunting the hemodynamic stress response. Further research with larger sample sizes and diverse patient populations is recommended to optimize dosing strategies and enhance patient safety’ during intubation.

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