

ISSN (E): 2708-2601

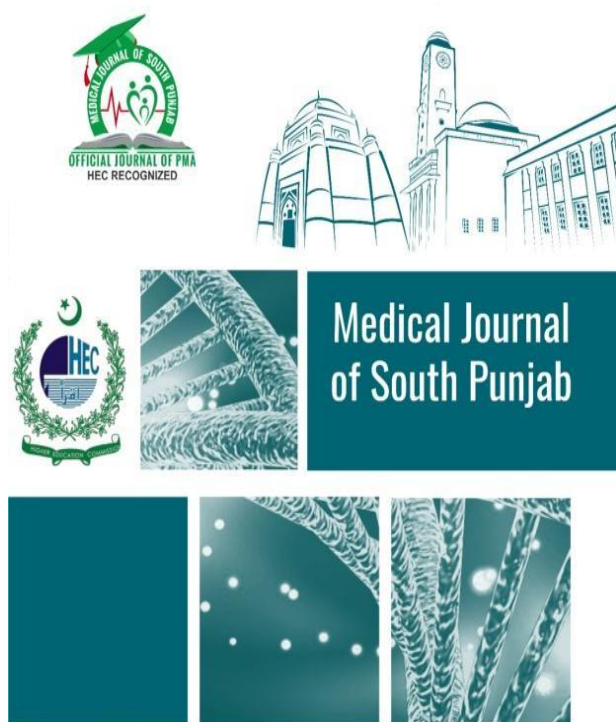
ISSN (P): 2708-2598

Medical Journal of South Punjab

Article DOI:10.61581/MJSP.VOL06/03/02

Volume 6, Issue 3, 2025

Print ISSN: 2708-2598
Online ISSN: 2708-2605



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Publication History

Received: May 27, 2025 Revised: June 29, 2025

Accepted: Aug 01, 2025 Published: Sep 30, 2025

An official publication of

Medteach Private Limited, Multan, Pakistan.

Email: farman@mjsp.com.pk, Website: <https://mjsp.com.pk/index.php/mjsp>

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Conflict of Interest:

Author(s) declared no conflict of interest.

Acknowledgment:

No Funding received.

Citation: Sheeraz S, Farwa KU. Comparison of Effect of Esmolol versus Fentanyl on Attenuation of Hemodynamic Response to Laryngoscopy and Endotracheal Intubation. Medical Journal of South Punjab. 2025 September 30; 6(3):6-12.

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Comparison of effect of Esmolol versus Fentanyl on attenuation of hemodynamic response to laryngoscopy and endotracheal intubation

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ABSTRACT

Objective: To evaluate and compare the efficacy of esmolol and fentanyl in a single bolus dose in terms of attenuating hemodynamic instability at the time of laryngoscopy and endotracheal intubation.

Methodology: This study was carried out at the Department of Anesthesiology, CPEIC Multan, over six months. The subjects were divided into Group A and Group B using randomization. Three minutes before laryngoscopy and intubation, Group A was injected with 0.5 mg/kg esmolol intravenous (IV), and Group B was injected with one mcg/kg fentanyl IV. On arrival at the operating room, all patients were attached to a multipara monitor for monitoring of mean arterial pressure, blood pressure (systolic and diastolic) and baseline heart rate.

Results: Five minutes after intubation, Group A exhibited a significantly lower HR 84.18 ± 6.33 bpm compared to Group B 96.72 ± 5.39 bpm, with a highly significant difference ($p < 0.001$). While SBP and DBP differences post-intubation were not statistically significant between groups ($p = 0.112$ and $p = 0.229$, respectively), MAP was significantly lower in Group B 92.48 ± 8.44 mmHg than in Group A 96.14 ± 6.89 mmHg; $p = 0.001$.

Conclusion: A 2 mg/kg bolus of esmolol effectively attenuated heart rate increases after laryngoscopy and intubation but only partially suppressed the rise in blood pressure, suggesting greater efficacy in controlling tachycardia than hypertension due to differing sympathetic mechanisms. Additional dose adjustments or adjunctive therapies may be needed for full hemodynamic control during intubation.

Keywords: Pressure response, Fentanyl, Esmolol, Laryngoscopy, Endotracheal intubation.

1. INTRODUCTION

Laryngoscopy and endotracheal intubation are critical procedures in anesthesia and emergency medicine, often associated with a significant hemodynamic stress response¹. This response, characterized by tachycardia, hypertension, and increased myocardial oxygen demand, can pose risks, particularly in patients with cardiovascular compromise². Various non pharmacological and pharmacological agents have been investigated to attenuate this response, with opioids and beta-blockers being among the most commonly used³.

The sympathetic surge during laryngoscopy and intubation is primarily mediated by catecholamine release, leading to abrupt increases in heart rate and blood pressure⁴. If uncontrolled, these changes can precipitate myocardial ischemia, arrhythmias, or cerebrovascular events in high-risk patients⁵. Fentanyl, an opioid, acts on central μ -receptors to reduce sympathetic outflow, while esmolol selectively blocks β 1-adrenergic receptors, thereby decreasing heart rate and myocardial contractility. Understanding which agent provides better hemodynamic stability is crucial for optimizing patient outcomes during peri-intubation periods⁶.

Previous studies have explored different agents, including lidocaine, magnesium sulfate, and dexmedetomidine, for attenuating the intubation response^{7,8}. However, esmolol and fentanyl remain widely used due to their rapid onset and short duration of action, making them suitable for brief but intense stimuli like laryngoscopy. While fentanyl is effective in reducing the sympathetic response, it may cause respiratory depression and bradycardia⁹. In contrast, esmolol offers precise heart rate control but may not adequately suppress hypertensive surges. A direct comparison between these two drugs can guide clinicians in selecting the most appropriate agent based on patient-specific factors¹⁰.

Aggarwal et al¹¹ studied 100 normotensive patients undergoing elective surgery under general anesthesia and found that the esmolol group showed a mean reduction in heart rate (-4.52 ± 13.09) and an increase in MAP (13.44 ± 8.51) from pre-induction to 5 minutes post-intubation, whereas the fentanyl group had an increase in both heart rate (5.64 ± 12.70) and MAP (16.98 ± 13.53). Similarly, Hussein et al¹² compared 60 patients and observed that at 5 minutes post-intubation, the esmolol group had a lower mean heart rate (82.83 ± 7.80) and comparable MAP (88.67 ± 6.53) relative to the fentanyl group (97.27 ± 18.48 and 90.10 ± 17.16 , respectively).

The findings of this study will contribute to the existing literature on pharmacologic attenuation of the intubation response, potentially influencing anesthetic protocols. Given the widespread use of both esmolol and fentanyl, a clear understanding of their comparative efficacy can help anesthesiologists tailor their approach, particularly in patients with hypertension, coronary artery disease, or other cardiovascular risks. The results may also prompt further research into combination therapies or alternative agents for high-risk populations.

2. METHODOLOGY

The study was conducted in the Department of Anesthesiology at Chaudhary Pervaiz Elahi Institute of Cardiology (CPEIC), Multan, over a duration of six months following the approval of the synopsis. The sample size was calculated using OpenEpi software based on the formula for mean difference, with mean arterial pressure in the esmolol group recorded as 97.27 ± 18.48 and in the fentanyl group as 90.10 ± 17.16 . The study had a power of 80% and a confidence level of 95%, resulting in a total sample size of 194 patients, with 97 allocated to each group. Non-probability consecutive sampling was employed for patient selection. The hemodynamic response was assessed by monitoring heart rate and

mean arterial pressure. Multipara monitors was attached to the patient once they are on the operating table, and all parameters was recorded at baseline and again five minutes after laryngoscopy and endotracheal intubation. Obesity was defined as a BMI above 27 kg/m².

The inclusion criteria comprised patients aged 20–60 years, of either gender, classified as ASA physical status Grades I or II, and undergoing elective general surgery under general anesthesia. Exclusion criteria were assessed through history and medical record review and included patients with decreased autonomic control (e.g., elderly or diabetic patients), chronic hypertension lasting ≥ 2 years, severe cardiac disease (confirmed via ECG and echocardiography), those on medications such as β -blockers or calcium channel blockers, and pregnant or lactating women.

Prior to data collection, approval was obtained from the institutional ethics review committee, and informed consent was acquired from all participants. Patient characteristics such as age, gender, ASA status, BMI, and obesity were recorded. Using the lottery method, patients were randomly assigned to Group A and Group B. Group A received 0.5 mg/kg esmolol intravenously (IV), while Group B received 1 mcg/kg fentanyl IV 3 minutes before laryngoscopy and intubation. Upon arrival in the operating room, patients were connected to a multipara monitor, and mean arterial pressure, blood pressure (systolic and diastolic) and baseline heart rate. Pre-oxygenation was performed with 100% oxygen for three minutes, followed by anesthesia induction using 6 mg/kg thiopentone sodium and 0.1 mg/kg vecuronium. Laryngoscopy was performed using a Macintosh blade (size 3), and intubation was carried out with a cuffed endotracheal tube (size 7.5–8 mm) by a senior anesthesiologist. All vitals were recorded again five minutes after intubation, with all data documented on a proforma.

Data analysis was conducted using SPSS version 23. Continuous variables were presented as mean and standard deviation. Categorical variables, including gender, ASA status, and obesity, were summarized as frequencies and percentages. An independent samples t-test was used to compare mean arterial pressure between the two groups at the five-minute mark. Post-stratification analysis was performed using an independent samples t-test, with significance set at $p \leq 0.05$.

3. RESULTS

A total number of 114 patients were included in our study. Each group consists of 97 individuals (50%). The mean ages were similar (39.93 ± 8.39 years in Group A and 40.01 ± 8.61 years in Group B, $p=0.946$), with no significant difference in age distribution. Gender distribution was also comparable, with males comprising 62.9% in Group A and 67.0% in Group B ($p=0.547$). ASA physical status I and II were also similarly distributed across both groups ($p=0.465$). Body mass index (BMI) values were not significantly different (25.64 ± 3.07 vs. 26.53 ± 2.84 kg/m², $p=0.801$), and there were (25.8%) obese in Group A and (27.8%) in Group B. ($p=0.746$). (Table. No. I).

The comparative analysis of hemodynamic parameters revealed no significant differences between Group A and Group B at baseline for heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), indicating well-matched pre-intubation values ($p > 0.050$). However, five minutes after intubation, Group A exhibited a significantly lower HR (84.18 ± 6.33 bpm) compared to Group B (96.72 ± 5.39 bpm), with a highly significant difference ($p < 0.001$). While SBP and DBP differences post-intubation were not statistically significant between groups ($p=0.112$ and $p=0.229$, respectively), MAP was significantly lower in Group B (92.48 ± 8.44 mmHg) than in Group A (96.14 ± 6.89 mmHg; $p=0.001$). (Table. No. II).

Table 1:

Demographic characteristics of patients

Characteristics	Group A n=97 (50.0%)	Group B n=97 (50.0%)	Test of sig.
Age (years)	39.93±8.39	40.01±8.61	t=-0.06,p=0.946
20-40	49 (50.5)	52 (53.6)	χ^2 =0.18, d.f=1, p=0.666
41-60	48 (49.5)	45 (46.4)	
Gender			
Male	61 (62.9)	65 (67.0)	χ^2 =0.36, d.f=1, p=0.547
Female	36 (37.1)	32 (33.0)	
ASA status			
I	60 (61.9)	55 (56.7)	χ^2 =0.53, d.f=1, p=0.465
II	37 (38.1)	42 (43.3)	
BMI (Kg/m ²)	25.64±3.07	26.53±2.84	t=0.25, p=0.801
≤27 kg/m ²	72 (74.2)	70 (72.2)	χ^2 =0.11, d.f=1, p=0.746
>27 kg/m ²	25 (25.8)	27 (27.8)	
N (%). Mean ± S.D			

Table 2:**Comparative analysis of hemodynamic parameters in both the groups before and after Intubation**

Parameter	Group A n=97 (50.0%)	Group B n=97 (50.0%)	Test of sig.
HR (bpm)			
At baseline	92.79±4.7 5	92.81±5.3 5	t=-0.03, p=0.977
At 5 minutes after intubation	84.18±6.3 3	96.72±5.3 9	t=-14.85, p<0.001
Test of Sig.	t=10.68, p<0.001	t=6.39, p<0.001	
Systolic BP (mmHg)			
At baseline	124.89±3.63	125.22±3.41	t=-0.65, p=0.515
At 5 minutes after intubation	120.38±5.53	121.59±4.98	t=-1.59, p=0.112
Test of Sig.	t=6.37, p<0.001	t=1.06, p=0.289	
Diastolic BP (mmHg)			
At baseline	90.58±4.59	90.65±4.69	t=-0.11, p=0.914
At 5 minutes after intubation	86.08±4.49	86.90±4.89	t=-1.2, p=0.229
Test of Sig.	t=-5.74, p<0.001	t=5.75, p<0.001	
MAP (mmHg)			
At baseline	97.18±6.64	96.82±6.05	t=38, p=0.701
At 5 minutes after intubation	96.14±6.89	92.48±8.44	t=3.31, p=0.001
Test of Sig.	t=5.26, p<0.001	t=4.11, p<0.001	
Mean ± S.D			

4. DISCUSSION

Laryngoscopy and endotracheal intubation are strong stimuli that trigger the sympathetic nervous system, causing brief but marked rises in mean arterial pressure (MAP), systolic and diastolic blood pressure and heart rate (HR)¹³. These hemodynamic changes can be harmful in patients with cardiovascular conditions, often requiring pharmacological management. Selective β -adrenergic blockers like esmolol are increasingly used to attenuate reflex sympathoadrenal-mediated tachycardia and hypertension during these procedures¹⁴.

In this study mean ages were similar in both groups (Fentanyl: 39.93±8.39 vs. Esmolol: 40.01±8.61, p=0.946), with comparable gender distribution (62.9% vs. 67.0% males, p=0.547), whereas Gupta et al¹⁵ reported younger patients (Fentanyl: 32.83±10.5 vs. Esmolol: 32.66±3.99) and differing gender ratios (Fentanyl: 1:0.87 vs. Esmolol: 1:1.30).

In this study five minutes after intubation, Group A exhibited a significantly lower heart rate (HR) (84.18 ± 6.33 bpm) compared to Group B (96.72 ± 5.39 bpm), with a highly significant difference (p < 0.001). Our findings align with the study by Liu Philip et al¹⁶ who used esmolol infusion in their study and reported decrease in the HR before induction and observed 50% lower rise in esmolol group post intubation compared to patients in placebo.

Kindler et al¹⁷ administered esmolol at a dose of 1-2 mg/kg and found that it significantly reduced the increase in HR and BP associated with laryngoscopy and endotracheal intubation compared to the control group. Similarly, Begum et al¹⁸ used esmolol at 1 mg/kg and observed that it partially attenuated the hemodynamic response without completely abolishing it. Additionally, esmolol given in bolus doses of 100 mg and 200 mg has been shown to effectively attenuate tachycardia and hypertension following tracheal intubation.

Joy et al¹⁹ prospectively evaluated HR, systolic and diastolic BP, and MAP before premedication (baseline), before and during drug infusion, before intubation, and 1, 3, 5,

and 10 min after intubation. The haemodynamic response to laryngoscopy and intubation was blunted in the three groups (the esmolol, lignocaine and fentanyl groups). In our study, we found that esmolol was more effective in attenuating heart rate response during intubation, and laryngoscopy was a finding concordant with that of Parvez et al²⁰. Esmolol offers consistent and prolonged coverage for the stimulation of heart rate that may inevitably increase the risk of myocardial infarction in the presence of underlying cardiovascular disease.

Tamaskar et al²¹ used 1.5 mg/kg esmolol 3 minutes prior to induction to suppress the stress response to laryngoscopy and intubation in ENT operations. The dose was less, and the time from drug to intubation was tighter with that dosing regimen compared to the 10 minutes we waited. Nevertheless, they did notice a drop in systolic and diastolic blood pressure. However, their study did not compare drugs, unlike ours.

Yushi et al²² conducted a study in which they concluded that administering a dose of 2 µg/kg fentanyl effectively suppresses the hemodynamic response—such as increases in heart rate and blood pressure—associated with endotracheal intubation to a greater extent than it suppresses the hemodynamic response elicited by laryngoscopy alone. This finding suggests that fentanyl at this dosage plays a more significant role in attenuating the cardiovascular stress caused by the more intense stimulus of tracheal tube insertion compared to the milder stimulus of laryngoscopy. The study highlights the differential effects of fentanyl on various stages of airway manipulation, emphasizing its utility in managing hemodynamic stability during intubation procedures.

5. CONCLUSION

A 2 mg/kg bolus of esmolol effectively attenuated heart rate increases after laryngoscopy and intubation but only partially

suppressed the rise in blood pressure, suggesting greater efficacy in controlling tachycardia than hypertension due to differing sympathetic mechanisms. Additional dose adjustments or adjunctive therapies may be needed for full hemodynamic control during intubation.

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