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# COMPARATIVE EVALUATION OF NITROGLYCERIN AND ESMOLOL IN ATTENUATING HEMODYNAMIC RESPONSE TO LARYNGOSCOPY AND INTUBATION

**Anaesthesiology**

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## ABSTRACT

**Background:** Laryngoscopy and endotracheal intubation produce a marked sympathetic response resulting in tachycardia and hypertension. These changes may be detrimental in patients with cardiovascular compromise. Nitroglycerin and esmolol are commonly used to attenuate these responses, but their comparative efficacy remains clinically important. **Aim:** To compare the efficacy of nitroglycerin and esmolol in attenuating hemodynamic responses to laryngoscopy and intubation. **Methods:** A prospective randomized comparative study was conducted on 90 patients divided into two groups: Group N (nitroglycerin 400 µg sublingual) and Group E (esmolol 1 mg/kg IV). Hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and $SpO_2$ were recorded at baseline and at 1, 3, 5, 7, and 10 minutes post-intubation. **Results:** Baseline parameters were comparable ($p>0.05$). At 1 minute post-intubation, HR increased to 104.2 ± 9.1 bpm in Group N compared to 88.5 ± 7.8 bpm in Group E ($p<0.001$). SBP was significantly lower in Group N (118.6 ± 11.2 mmHg) compared to Group E (132.4 ± 12.5 mmHg; $p<0.001$). MAP was also significantly lower in Group N at all intervals ($p<0.001$). Hypotension occurred in 13.3% of Group N, while bradycardia occurred in 17.8% of Group E. **Conclusion:** Esmolol is more effective in controlling tachycardia, whereas nitroglycerin better attenuates hypertensive responses. Drug selection should be individualized based on clinical needs.

## KEYWORDS

Nitroglycerin, Esmolol, Hemodynamic Response, Laryngoscopy, Intubation

## INTRODUCTION

Airway management is a fundamental component of safe anaesthesia, with direct laryngoscopy and tracheal intubation being essential procedures for securing the airway during general anaesthesia. These interventions, however, act as potent noxious stimuli capable of provoking significant physiological responses (1). Mechanical stimulation of the oropharyngeal, laryngeal, and tracheal structures activates afferent pathways mediated through the glossopharyngeal and vagus nerves, resulting in reflex sympathetic discharge and catecholamine release. This leads to an increase in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure (2).

The pressor response to laryngoscopy occurs rapidly, typically within 30 seconds to 2 minutes, and may persist for several minutes depending on the duration and difficulty of airway manipulation (3). In healthy individuals, these responses are usually transient; however, in patients with cardiovascular or cerebrovascular disease, such changes may result in serious complications including myocardial ischemia, arrhythmias, or cerebrovascular events (4). Increased heart rate and blood pressure elevate myocardial oxygen demand while reducing coronary perfusion, thereby increasing the risk of adverse cardiac outcomes (5). Similarly, in patients with impaired cerebral autoregulation, sudden hypertensive surges may predispose to intracranial complications (6). Elderly and hypertensive patients often exhibit exaggerated responses due to heightened sympathetic activity (7).

Various strategies have been employed to attenuate these hemodynamic responses. Non-pharmacological approaches include minimizing the duration of laryngoscopy, ensuring adequate depth of anaesthesia, and adopting gentle airway manipulation techniques (8). The use of advanced airway devices such as videolaryngoscopes has also been explored, although their effectiveness in reducing hemodynamic responses remains variable (9).

Pharmacological interventions remain the cornerstone in controlling these responses. Commonly used agents include opioids, local anaesthetics, vasodilators, and beta-adrenergic blockers. Opioids and sedative agents are effective but may be associated with respiratory depression and prolonged sedation, while lidocaine alone provides limited attenuation of the pressor response (10,12).

Nitroglycerin is a potent vasodilator that acts through nitric oxide-mediated pathways, leading to smooth muscle relaxation and reduction in vascular tone. It primarily decreases preload and, at higher doses, reduces afterload, thereby effectively attenuating hypertensive responses during laryngoscopy (5). Due to its rapid onset and short duration of action, it is particularly useful for transient stimuli such as intubation. However, it may be associated with reflex tachycardia and hypotension.

Esmolol is an ultra-short-acting, cardioselective β1-adrenergic blocker that reduces heart rate, myocardial contractility, and myocardial oxygen consumption. It has a rapid onset and short half-life due to metabolism by plasma esterases, making it suitable for perioperative use (6). Esmolol effectively attenuates tachycardia associated with laryngoscopy without causing significant reflex responses, although bradycardia and hypotension may occur.

While nitroglycerin primarily attenuates hypertensive responses through vasodilation, esmolol is more effective in controlling tachycardia. The choice of agent depends on patient-specific factors, including cardiovascular status and the need for heart rate versus blood pressure control. Despite their widespread use, direct comparative evidence between these two agents remains limited.

Given their differing mechanisms of action and clinical effects, a comparative evaluation of nitroglycerin and esmolol is essential to determine the optimal agent for attenuating hemodynamic responses to laryngoscopy. This study aims to provide evidence-based guidance for safer perioperative anesthetic management.

## AIM

To compare the efficacy of nitroglycerin and esmolol in attenuating hemodynamic response to laryngoscopy.

## METHODOLOGY

This prospective randomized assessor-blinded comparative study was conducted in the Department of Anesthesiology at a tertiary care teaching hospital after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to inclusion in the study. A total of 90 adult patients aged 18–65 years, belonging to ASA physical status I and II and scheduled for elective surgeries under general anesthesia, were included. The sample size was calculated based on previous comparable studies, assuming a power of 80% and a significance level of 5%. Patients were randomly allocated into two groups of 45 each using computer-generated randomization. Group N received sublingual nitroglycerin 400 µg, while Group E received intravenous esmolol 1 mg/kg administered 2 minutes prior to laryngoscopy. Standard preoperative assessment and fasting guidelines were followed. In the operating room, monitoring included ECG, non-invasive blood pressure, and pulse oximetry. Baseline hemodynamic

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parameters were recorded after 5 minutes of rest. Premedication consisted of midazolam 0.016 mg/kg and fentanyl 1 µg/kg. Induction was performed using propofol 2 mg/kg and succinylcholine 2 mg/kg. Laryngoscopy and endotracheal intubation were performed using a Macintosh blade by an experienced anesthesiologist within 20 seconds to minimize variability. Hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and $SpO_2$ were recorded at baseline and at 1, 3, 5, 7, and 10 minutes after intubation. Adverse events such as hypotension, bradycardia, and arrhythmias were documented. Statistical analysis was performed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test, while categorical variables were analyzed using chi-square test. A p-value of <0.05 was considered statistically significant.

## RESULTS

A total of 90 patients were included and equally divided into two groups: Group N (nitroglycerin, n=45) and Group E (esmolol, n=45). Baseline demographic characteristics were comparable between both groups (Table 1). The mean age in Group N was 42.3 ± 11.7 years and in Group E was 40.8 ± 12.4 years, with no statistically significant difference (p=0.541), indicating adequate randomization.

Baseline hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and $SpO_2$ were also comparable between groups (Table 2). The mean heart rate was 84.6 ± 9.3 bpm in Group N and 83.9 ± 8.7 bpm in Group E. Similarly, SBP, DBP, and MAP showed no statistically significant difference (p>0.05), confirming homogeneity.

Following laryngoscopy and intubation, both groups showed hemodynamic changes; however, the magnitude differed significantly. Group E demonstrated superior control of heart rate as shown in Table 3. At 1 minute post-intubation, HR increased to 104.2 ± 9.1 bpm in Group N compared to 88.5 ± 7.8 bpm in Group E (p<0.001). This trend persisted at 3 and 5 minutes, indicating sustained attenuation of tachycardia with esmolol.

In contrast, blood pressure parameters were better controlled in Group N (Table 4). SBP at 1 minute post-intubation was significantly lower in Group N (118.6 ± 11.2 mmHg) compared to Group E (132.4 ± 12.5 mmHg; p<0.001). Similarly, MAP was significantly lower in Group N (88.4 ± 8.6 mmHg vs 102.3 ± 9.4 mmHg; p<0.001), demonstrating superior attenuation of hypertensive response by nitroglycerin.

$SpO_2$ remained stable and comparable in both groups throughout the study period, indicating no adverse respiratory effects.

Adverse events differed between groups as shown in Table 5. Hypotension occurred more frequently in Group N (13.3%) compared to Group E (4.4%), whereas bradycardia was more common in Group E (17.8%) compared to Group N (6.7%). Arrhythmias were minimal and comparable in both groups (2.2%).

**Table 1: Baseline Characteristics**

| Parameter | Group N | Group E | p-value |
|---|---|---|---|
| Age (years) | 42.3 ± 11.7 | 40.8 ± 12.4 | 0.541 |

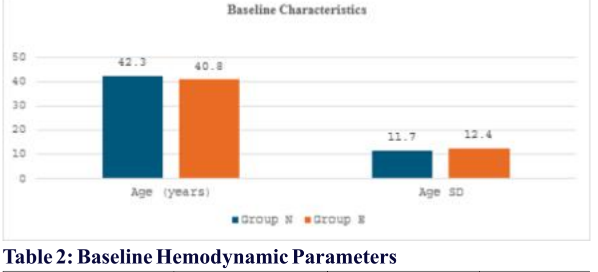



**Table 2: Baseline Hemodynamic Parameters**

| Parameter | Group N | Group E | p-value |
|---|---|---|---|
| HR (bpm) | 84.6 ± 9.3 | 83.9 ± 8.7 | >0.05 |
| SBP (mmHg) | 128.4 ± 10.5 | 126.8 ± 11.2 | >0.05 |
| DBP (mmHg) | 81.2 ± 7.8 | 80.5 ± 8.1 | >0.05 |
| MAP (mmHg) | 96.9 ± 9.5 | 95.9 ± 9.2 | >0.05 |

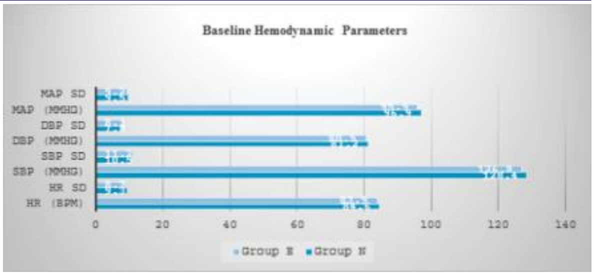



**Table 3: Heart Rate Changes**

| Time | Group N (bpm) | Group E (bpm) | p-value |
|---|---|---|---|
| 1 min | 104.2 ± 9.1 | 88.5 ± 7.8 | <0.001 |
| 3 min | 98.4 ± 8.5 | 85.2 ± 7.4 | <0.001 |
| 5 min | 94.6 ± 7.9 | 82.1 ± 6.9 | <0.001 |

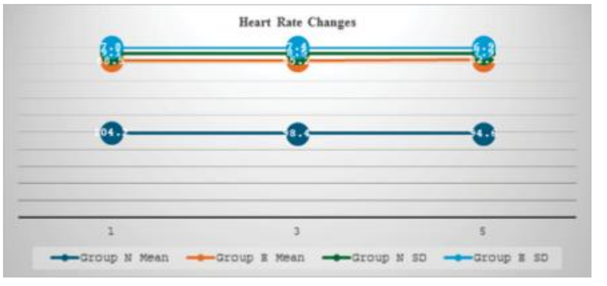



**Table 4: Blood Pressure Changes**

| Parameter | Group N | Group E | p-value |
|---|---|---|---|
| SBP (1 min) | 118.6 ± 11.2 | 132.4 ± 12.5 | <0.001 |
| MAP (1 min) | 88.4 ± 8.6 | 102.3 ± 9.4 | <0.001 |

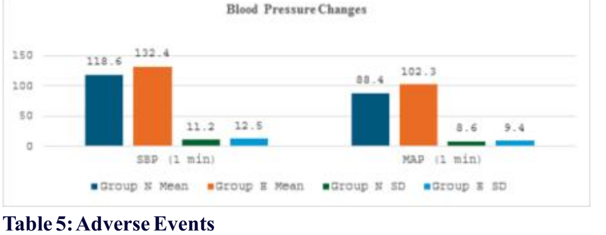
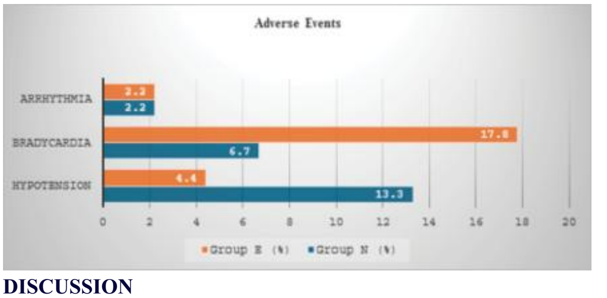



**Table 5: Adverse Events**

| Event | Group N (%) | Group E (%) |
|---|---|---|
| Hypotension | 13.3 | 4.4 |
| Bradycardia | 6.7 | 17.8 |
| Arrhythmia | 2.2 | 2.2 |




## DISCUSSION

The present study was conducted to evaluate and compare the efficacy of nitroglycerin and esmolol in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation. Laryngoscopy is a potent stimulus that induces sympathetic activation through reflex pathways involving the glossopharyngeal and vagus nerves, leading to catecholamine release and resultant tachycardia and hypertension. This physiological response, although transient in healthy individuals, may have significant consequences in patients with cardiovascular or cerebrovascular compromise. The findings of the present study clearly demonstrate differential effects of nitroglycerin and esmolol on various hemodynamic parameters, consistent with their pharmacological profiles.

Baseline demographic and hemodynamic parameters were comparable between the two groups (Tables 1 and 2), ensuring that any observed differences were attributable to the pharmacological intervention rather than confounding variables. Similar baseline

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comparability has been reported by King et al. (2) and Prys-Roberts et al. (4), who emphasized the importance of homogeneity in evaluating hemodynamic responses.

In the present study, esmolol demonstrated superior control of heart rate following laryngoscopy (Table 3). At 1 minute post-intubation, heart rate was significantly lower in the esmolol group (88.5 ± 7.8 bpm) compared to the nitroglycerin group (104.2 ± 9.1 bpm; $p<0.001$). This finding is consistent with Kovac (10), who reported that beta-blockers effectively attenuate tachycardia by blocking sympathetic stimulation at the β1 receptor level. Wiest (6) further explained that esmolol's rapid onset and ultra-short duration of action make it ideal for transient perioperative hemodynamic control. The sustained reduction in heart rate observed at 3 and 5 minutes post-intubation in the present study reinforces the efficacy of esmolol in blunting tachycardic response.

Conversely, nitroglycerin was found to be more effective in controlling blood pressure parameters (Table 4). The significantly lower systolic blood pressure and mean arterial pressure in the nitroglycerin group ($p<0.001$) indicate its superior ability to attenuate hypertensive response. Abrams (5) described that nitroglycerin acts via nitric oxide-mediated vasodilation, leading to decreased preload and afterload, thereby reducing systemic vascular resistance. This mechanism explains the observed reduction in MAP in the present study. Similar findings have been reported by Fox et al. (7), who highlighted the role of vasodilators in controlling perioperative hypertension.

The difference in hemodynamic control between the two drugs reflects their pharmacodynamic properties. While esmolol primarily acts on cardiac β1 receptors to reduce heart rate and myocardial contractility, nitroglycerin acts on vascular smooth muscle to induce vasodilation. This complementary mechanism explains why esmolol is more effective for tachycardia, whereas nitroglycerin is superior for hypertension.

Adverse events observed in the present study were consistent with known pharmacological effects of the drugs (Table 5). Hypotension was more frequent in the nitroglycerin group (13.3%), which can be attributed to excessive vasodilation. On the other hand, bradycardia was more common in the esmolol group (17.8%) due to β1 blockade. Miller (11) reported similar findings and emphasized that these adverse effects are predictable and manageable. Importantly, no severe complications were observed, indicating that both drugs are safe when used appropriately.

The findings of the present study are also in agreement with Stoelting (12), who demonstrated that the magnitude of hemodynamic response is directly related to the duration and intensity of laryngoscopy. In the present study, standardized intubation within 20 seconds ensured uniform stimulus, thereby strengthening the validity of the results.

Clinically, the results suggest that drug selection should be individualized. In patients where tachycardia is the primary concern, such as those with ischemic heart disease, esmolol may be preferred due to its superior heart rate control. Conversely, in patients with hypertension or raised intracranial pressure, nitroglycerin may be more beneficial due to its potent vasodilatory effects. These findings have important clinical implications in guiding anesthetic drug selection, particularly in patients with cardiovascular comorbidities where tailored hemodynamic control is essential.

Overall, the present study provides strong evidence that both nitroglycerin and esmolol are effective agents for attenuating hemodynamic responses to laryngoscopy, but their effects are complementary rather than identical. These findings support the concept of tailored anesthetic management based on patient-specific hemodynamic goals.

### Limitations

1. Single-center study with limited sample size
2. Short follow-up duration (only intraoperative period)
3. No biochemical markers (catecholamines) measured
4. Only ASA I–II patients included
5. No combination therapy evaluated
6. Single-dose drug regimen evaluated without dose variation

## CONCLUSION

Esmolol is more effective in controlling heart rate, whereas nitroglycerin provides superior attenuation of blood pressure response during laryngoscopy. Both drugs are safe and effective, and their selection should be based on patient-specific hemodynamic goals. Thus, both drugs are effective, but their selection should be individualized based on specific hemodynamic goals and patient comorbidities.

## REFERENCES


1. Reid LC, Brace DE. Irritation of the respiratory tract and its reflex effect upon heart rate. Surg Gynecol Obstet. 1940;70:157–162.
2. King BD, Harris LC, Greifenstein FE, Elder JD, Dripps RD. Reflex circulatory responses to direct laryngoscopy and tracheal intubation. Anesthesiology. 1951;12(5):556–566.
3. Forbes AM, Dally FG. Acute hypertension during induction of anaesthesia and endotracheal intubation in normotensive man. Br J Anaesth. 1970;42(7):618–624.
4. Prys-Roberts C, Greene LT, Meloche R, Foex P. Studies of anaesthesia in relation to hypertension II: haemodynamic consequences of induction and endotracheal intubation. Br J Anaesth. 1971;43(6):531–547.
5. Abrams J. Hemodynamic effects of nitroglycerin and long-acting nitrates. Am Heart J. 1985;110(1 Pt 2):216–224.
6. Wiest DB. Esmolol: a review of its therapeutic efficacy and pharmacokinetic characteristics. Clin Pharmacokinet. 1995;28(3):190–202.
7. Fox EJ, Sklar GS, Hill CH, Villanueva R, King BD. Complications related to the pressor response to endotracheal intubation. Anesthesiology. 1977;47(6):524–525.
8. Derbyshire DR, Smith G. Sympathoadrenal responses to anaesthesia and surgery. Br J Anaesth. 1984;56(7):725–739.
9. Xue FS, Zhang GH, Li XY, et al. Comparison of hemodynamic responses to orotracheal intubation with GlideScope videolaryngoscope and direct laryngoscope. J Clin Anesth. 2006;18(4):245–250.
10. Kovac AL. Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. J Clin Anesth. 1996;8(1):63–79.
11. Miller RD. Miller's Anesthesia. 8th ed. Philadelphia: Elsevier; 2015.
12. Stoelting RK. Circulatory changes during direct laryngoscopy and tracheal intubation: influence of duration of laryngoscopy. Anesthesiology. 1977;47(4):381–384.