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Original Research Article

Attenuation of the Pressor Response to Laryngoscopy and Endotracheal Intubation: A Comparative Study of Intravenous Esmolol and Lidocaine

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Abstract

Background: Laryngoscopy and endotracheal intubation are known to evoke intense sympathetic stimulation resulting in tachycardia, hypertension, and increased myocardial oxygen demand. Although transient, these responses can be detrimental in patients with limited cardiovascular reserve. Numerous pharmacological agents have been evaluated to attenuate this pressor response, among which esmolol and lidocaine are commonly used. However, comparative data regarding their efficacy remain inconsistent.

Aim: To compare the effectiveness of intravenous esmolol hydrochloride (1.5 mg/kg) and intravenous lidocaine hydrochloride (1.5 mg/kg) in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation.

Materials and Methods: This prospective, comparative, observational study was conducted on 60 ASA physical status I–II normotensive adult patients undergoing elective surgery under general anesthesia. Patients were allocated into two groups: Group E (esmolol 1.5 mg/kg IV) and Group L (lidocaine 1.5 mg/kg IV). Hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and rate pressure product (RPP) were recorded at baseline, during intubation, and at regular intervals up to 10 minutes post-intubation.

Results: Sixty ASA I–II patients aged 20–60 years undergoing elective surgery under general anaesthesia were assigned to receive intravenous esmolol (1.5 mg/kg) or lidocaine (1.5 mg/kg) prior to laryngoscopy and endotracheal intubation. Demographic variables were comparable between groups ($p > 0.05$). Hemodynamic parameters were similar at baseline and before intubation. Following intubation, heart rate, systolic and diastolic blood pressure, mean arterial pressure, and rate pressure product increased in both groups, with significantly greater rises in the lidocaine group at 1 and 3 minutes ($p < 0.001$) and at 5 minutes ($p < 0.05$). Values returned to baseline by 7–10 minutes. Oxygen saturation remained stable, and no adverse effects were observed.

Conclusion: Intravenous esmolol (1.5 mg/kg) is more effective than intravenous lidocaine (1.5 mg/kg) in blunting the pressor response to laryngoscopy and endotracheal intubation, with superior control of heart rate and myocardial workload.

Keywords: Laryngoscopy, Endotracheal intubation, Esmolol, Lidocaine, Pressor response, Hemodynamic stability.

Introduction

Securing the airway by laryngoscopy and endotracheal intubation is a fundamental step in administering general anesthesia. Despite its routine nature, this maneuver provokes a pronounced sympathoadrenal response due to mechanical stimulation of the pharyngeal, laryngeal, and tracheal structures. The resulting catecholamine surge manifests as tachycardia, hypertension, and increased myocardial oxygen consumption, collectively referred to as the pressor response [1]. In healthy individuals, this response is typically transient and clinically insignificant. However, in patients with ischemic heart disease, hypertension, cerebrovascular disorders, or raised intracranial pressure, these abrupt hemodynamic changes can precipitate myocardial ischemia, arrhythmias, heart failure, or cerebral hemorrhage [2]. Therefore, attenuation of the pressor response has been a major focus of anesthetic research. Multiple pharmacological interventions have been explored, including opioids, vasodilators, calcium channel blockers, α-2 agonists, β-adrenergic

blockers, and local anesthetics [3]. Among these, lidocaine and esmolol are widely used owing to their rapid onset, ease of administration, and favorable safety profiles.

Lidocaine, a sodium channel blocker, is believed to attenuate the pressor response by suppressing airway reflexes and decreasing afferent neural transmission from the upper airway [4]. However, its efficacy in controlling cardiovascular responses has been inconsistent across studies. Esmolol is an ultra-short-acting, cardioselective β-1 adrenergic blocker with rapid onset and short elimination half-life. It effectively blunts sympathetic responses by reducing heart rate and myocardial contractility, making it particularly suitable for transient stimuli such as laryngoscopy and intubation [5].

This study was undertaken to compare the efficacy of intravenous esmolol and lidocaine in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation in adult patients undergoing elective surgery under general anesthesia.

Materials and Methods

Study Design and Setting: This prospective, comparative, observational clinical 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.

Study Population: Sixty adult patients aged 20–60 years, of either sex, belonging to ASA physical status I or II and scheduled for elective surgeries under general anesthesia with endotracheal intubation were included.

Inclusion Criteria

- Age 20–60 years
- ASA physical status I or II
- Normotensive patients
- Mallampati grade I or II airway

Exclusion Criteria

- Known cardiovascular disease
- Hypertension or diabetes mellitus
- Chronic β-blocker therapy
- Anticipated difficult airway
- Allergy to study drugs

Group Allocation

Patients were divided into two groups of 30 each using a computer-generated random number table:

Group	Drug	Dose
Group E	Esmolol	1.5 mg/kg IV
Group L	Lidocaine	1.5 mg/kg IV

Anesthetic Technique: All patients were premedicated with oral alprazolam 0.5 mg the night before surgery. In the operating room, standard monitoring was applied including ECG, non-invasive blood pressure, and pulse oximetry.

All patients were premedicated with Inj. Glycopyrrolate 0.004 mg / kg IV, Inj. Ondansetron 0.08 mg /kg IV, Inj. Midazolam 0.02 mg /kg IV 10 minutes before induction.

Baseline hemodynamic parameters were recorded. The study drug diluted to 10 mL with normal saline was administered intravenously 3 minutes prior to laryngoscopy.

Anesthesia was induced with thiopentone sodium 5 mg/kg IV. Muscle relaxation was achieved with suxamethonium 1.5 mg/kg IV. Direct laryngoscopy and endotracheal intubation were performed by an experienced anesthesiologist within 15–20 seconds.

Hemodynamic Monitoring: The following parameters were recorded at predefined intervals:

- Heart Rate (HR)
- Systolic Blood Pressure (SBP)
- Diastolic Blood Pressure (DBP)
- Mean Arterial Pressure (MAP)
- Rate Pressure Product (RPP = HR × SBP)

Time points:

- Baseline
- After premedication
- Before induction
- At laryngoscopy (L)
- L + 1 (After 1 minute of laryngoscopy)
- L+ 3 (After 3 minutes of laryngoscopy)
- L+ 5 (After 5 minutes of laryngoscopy)
- L+ 7 (After 7 minutes of laryngoscopy)
- L+10 (After 10 minutes of laryngoscopy)

Statistical Analysis: Data were analyzed using statistical software. Continuous variables were expressed as mean ± SD. Intergroup comparisons were performed using Student's t-test. A p-value < 0.05 was considered statistically significant.

Results

The present study was conducted to evaluate and compare the efficacy of intravenous Esmolol hydrochloride (1.5 mg/kg) and Lidocaine hydrochloride (1.5 mg/kg) in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation. A total of 60 patients of either sex, belonging to ASA physical status I and

II, aged between 20 and 60 years, scheduled for elective surgeries under general anaesthesia were included. Patients were randomly allocated into two equal groups of 30 each.

- **Group E:** Esmolol hydrochloride
- **Group L:** Lidocaine hydrochloride

Hemodynamic parameters were recorded at baseline, after premedication, before induction, during laryngoscopy, and at 1, 3, 5, 7, and 10 minutes following laryngoscopy and intubation.

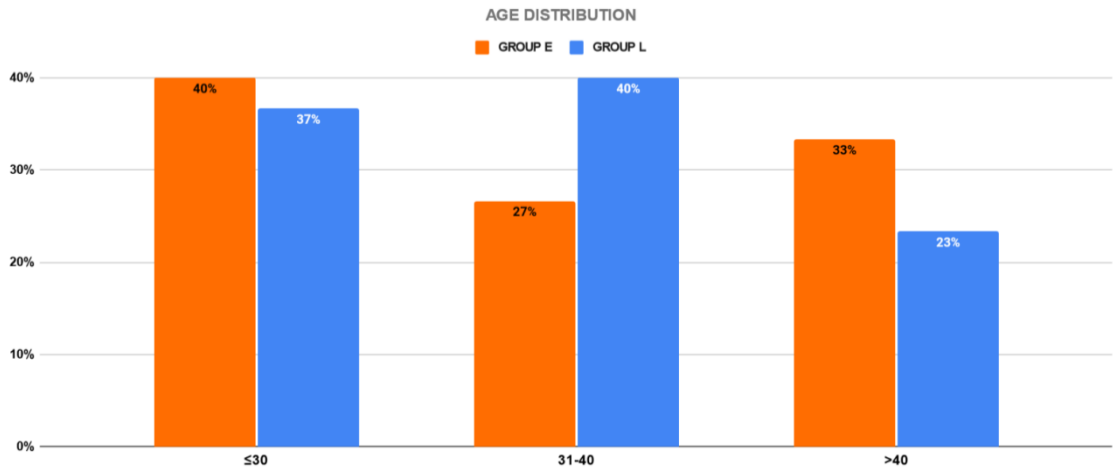
Demographic Characteristics: The demographic variables including age, sex, and body weight were comparable between the two groups.

- The mean age was 34.83 ± 10.73 years in Group L and 35.97 ± 12.59 years in Group E.
- Group L consisted of 15 males and 15 females, while Group E consisted of 14 males and 16 females.
- The mean body weight was 62.50 ± 8.30 kg in Group L and 61.93 ± 7.36 kg in Group E.

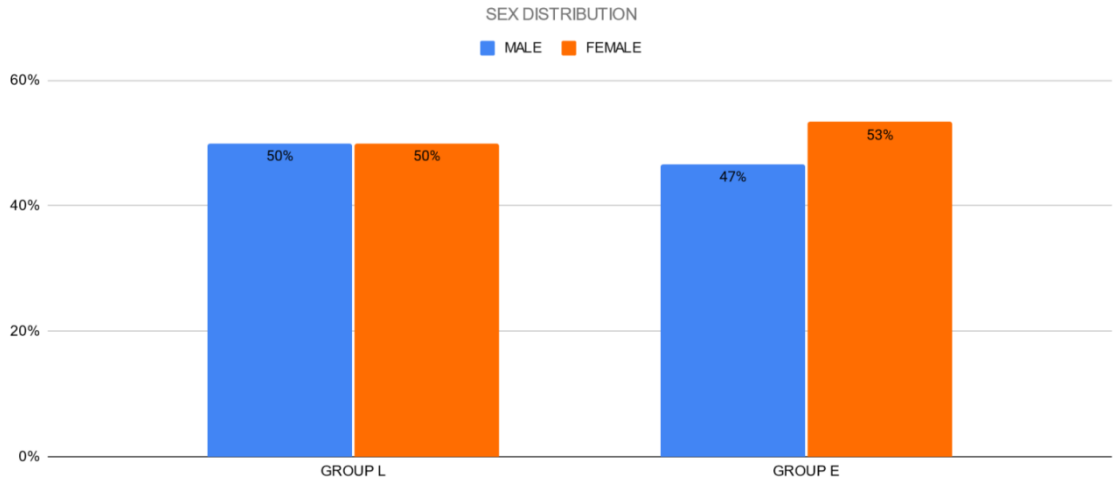
There was no statistically significant difference between the two groups with respect to age, sex, or weight ($p > 0.05$).

Table 1: Demographic Data

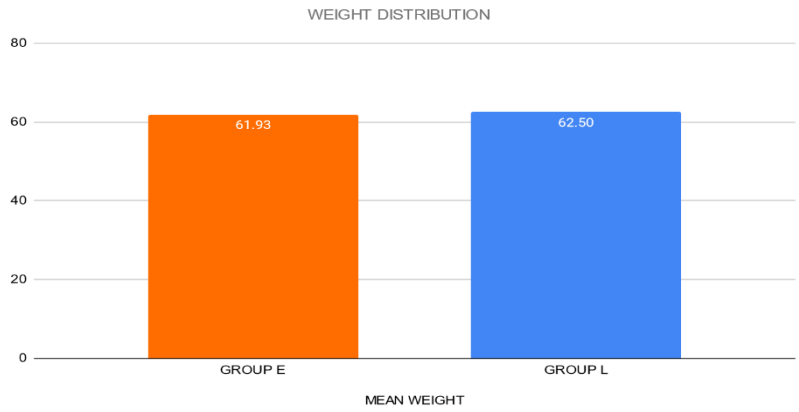
Groups	Age (yrs) Mean + SD	Sex		Weight(kgs) Mean + SD
		Male	Female	
GROUP L	34.83+10.73	15	15	62.5+8.30
GROUP E	35.97+12.59	14	16	61.93+7.36
P VALUE	>0.05	>0.05		>0.05



Graph 1: Age Distribution in Both the Groups



Graph 2: Sex Distribution in Both the Groups

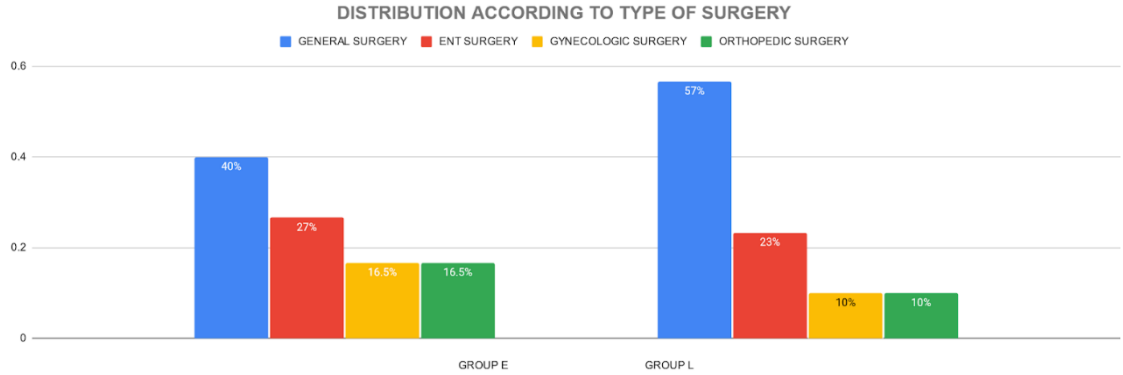


Graph 3: Weight Distribution in Both the Groups

Distribution According to Type of Surgery: Among the 60 patients studied, 29 patients (48.3%) underwent general surgical procedures, 15 patients (25%) underwent ENT surgeries, while 8 patients (13.3%) each underwent gynaecological and orthopaedic procedures. The distribution of surgical procedures was comparable between the two groups and did not show any statistically significant difference.

Table 2: Distribution of Patients According To the Type of Surgeries:

Type Of Surgery	Group L		Group E	
	No. Of Patients	%	No. Of Patients	%
General Surgery	17	57	12	40
Ent Surgery	7	23	8	27
Gynaecological Surgery	3	10	5	16.5
Orthopaedic Surgery	3	10	5	16.5



Graph 4: Type of Surgery in Both the Groups

Heart Rate

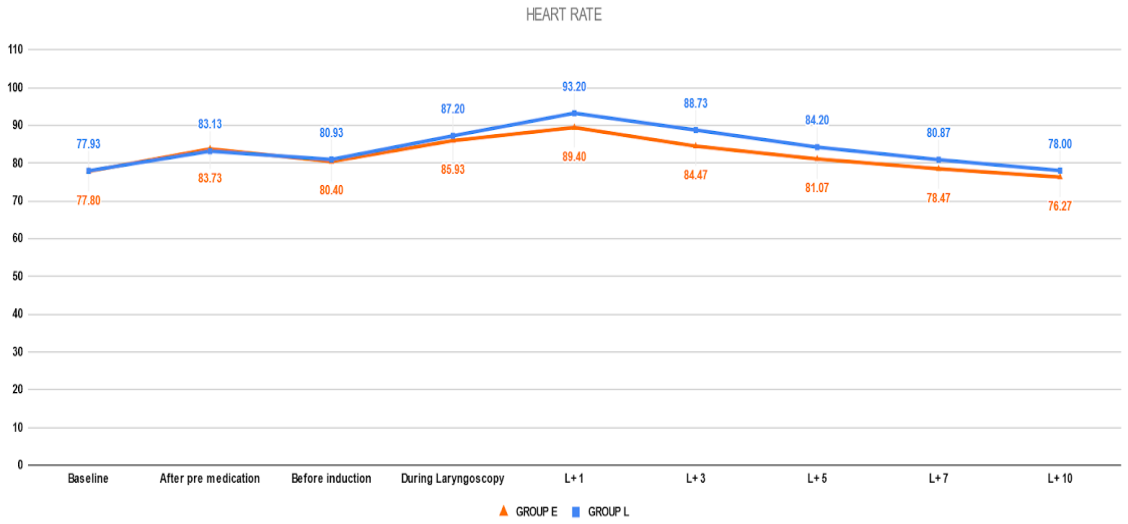
Heart rate values recorded at baseline, after premedication, before induction, and during laryngoscopy were comparable between Group E and Group L, with no statistically significant difference ($p > 0.05$). Following laryngoscopy and intubation, a rise in heart rate was observed in both groups, with the maximum increase occurring at 1 minute (L+1).

- At L+1, the increase in heart rate was significantly higher in Group L compared to Group E ($p < 0.001$).
- At L+3, heart rate values began to decline but remained significantly higher in Group L ($p < 0.001$).
- At L+5, heart rate continued to be significantly higher in Group L ($p < 0.05$).
- At L+7 and L+10, heart rate values returned close to baseline in both groups, and the difference was statistically insignificant ($p > 0.05$).

These findings indicate that Esmolol provided superior attenuation of tachycardia following laryngoscopy and endotracheal intubation.

Table 3: Changes in Heart Rate

Heart Rate	Group E		Group L		P value
	MEAN	SD	MEAN	SD	
Baseline	77.80	5.54	77.93	6.02	>0.05
After pre medication	83.73	4.03	83.13	5.16	>0.05
Before induction	80.40	5.16	80.93	5.11	>0.05
During laryngoscopy	85.93	4.47	87.20	4.19	>0.05
L+ 1	89.40	4.11	93.20	4.35	<0.001
L+ 3	84.47	4.51	88.73	4.08	<0.001
L+ 5	81.07	4.39	84.20	4.18	<0.05
L+ 7	78.47	4.45	80.87	5.96	>0.05
L+ 10	76.27	5.25	78.00	4.81	>0.05



Graph 5: Heart Rate in Both the Groups at Various Time Intervals

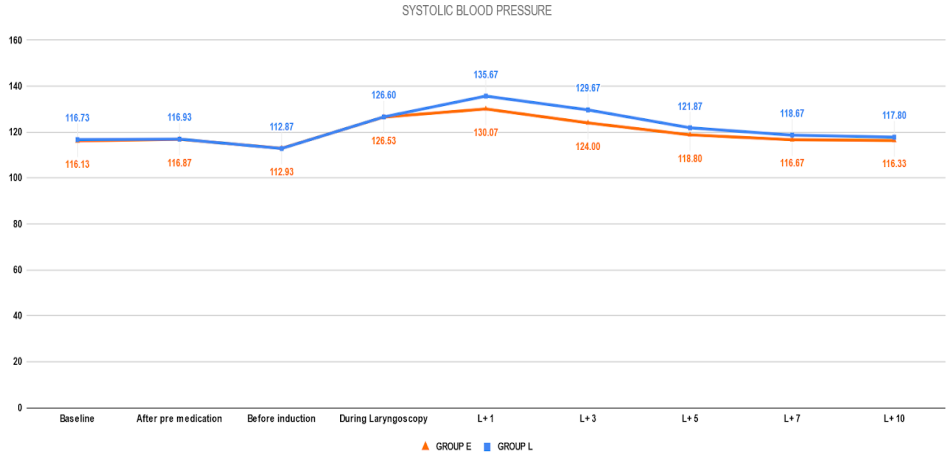
Systolic Blood Pressure: Baseline systolic blood pressure (SBP), values after premedication, before induction, and during laryngoscopy were comparable between both groups ($p > 0.05$).

- A significant rise in SBP was observed at L+1, with Group L showing a greater increase compared to Group E ($p < 0.001$).
- At L+3, SBP values declined but remained significantly higher in Group L ($p < 0.001$).
- At L+5, the difference remained statistically significant ($p < 0.05$).

At L+7 and L+10, SBP values returned close to baseline and were comparable between the two groups ($p > 0.05$).

Table 4: Changes in Systolic Blood Pressure:

SBP	GROUP E		GROUP L		P value
	MEAN	SD	MEAN	SD	
Baseline	116.13	6.01	116.73	5.95	>0.05
After pre medication	116.87	5.11	116.93	5.17	>0.05
Before induction	112.93	5.03	112.87	5.16	>0.05
During Laryngoscopy	126.53	5.09	126.60	5.54	>0.05
L+ 1	130.07	5.69	135.67	6.13	<0.001
L+ 3	124.00	6.06	129.67	6.35	<0.001
L+ 5	118.80	5.29	121.87	5.92	<0.05
L+ 7	116.67	6.35	118.67	5.90	>0.05
L+ 10	116.33	4.33	117.80	5.18	>0.05



Graph 6: Systolic Blood Pressure in Both the Groups at Various Time Intervals

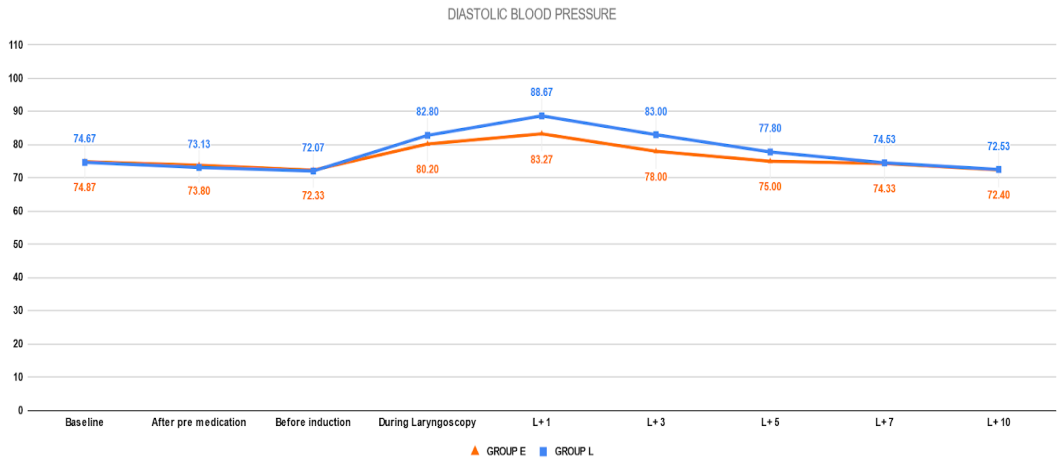
Diastolic Blood Pressure: Diastolic blood pressure (DBP) values at baseline, after premedication, before induction, and during laryngoscopy were comparable between the two groups ($p > 0.05$).

- A significant rise in DBP was observed at L+1 and L+3, with Group L showing higher values than Group E ($p < 0.001$).
- At L+5, the difference remained statistically significant ($p < 0.05$).
- At L+7 and L+10, DBP values returned toward baseline and were comparable ($p > 0.05$).

This indicates better control of diastolic blood pressure with esmolol.

Table 5: Changes in Diastolic Blood Pressure

DBP	GROUP E		GROUP L		P value
	MEAN	SD	MEAN	SD	
Baseline	74.87	5.96	74.67	5.26	>0.05
After pre medication	73.80	4.96	73.13	4.80	>0.05
Before induction	72.33	5.12	72.07	5.05	>0.05
During Laryngoscopy	80.20	6.29	82.80	4.83	>0.05
L+ 1	83.27	6.18	88.67	4.85	<0.001
L+ 3	78.00	4.79	83.00	5.87	<0.001
L+ 5	75.00	4.60	77.80	4.82	<0.05
L+ 7	74.33	4.90	74.53	4.78	>0.05
L+ 10	72.40	4.83	72.53	3.56	>0.05



Graph 7: Diastolic Blood Pressure in Both the Groups at Various Time Intervals

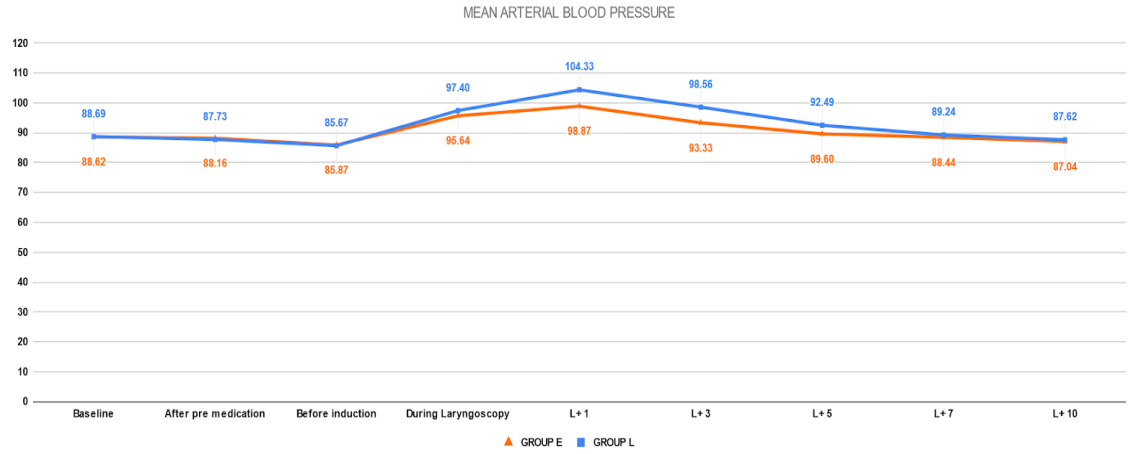
Mean Arterial Pressure: Mean arterial pressure (MAP) values were comparable between both groups from baseline to laryngoscopy ($p > 0.05$).

- The maximum rise in MAP occurred at L+1, with significantly higher values in Group L ($p < 0.001$).

- At L+3, MAP remained significantly higher in Group L ($p < 0.001$).
- At L+5, the difference was statistically significant ($p < 0.05$).
- At L+7 and L+10, MAP values returned close to baseline and were comparable ($p > 0.05$).

Table 6: Changes in Mean Arterial Pressure

MAP	GROUP E		GROUP L		P value
	MEAN	SD	MEAN	SD	
Baseline	88.62	4.16	88.69	3.69	>0.05
After pre medication	88.16	3.78	87.73	3.90	>0.05
Before induction	85.87	4.41	85.67	3.99	>0.05
During Laryngoscopy	95.64	4.81	97.40	3.81	>0.05
L+ 1	98.87	5.18	104.33	3.62	<0.001
L+ 3	93.33	4.13	98.56	4.04	<0.001
L+ 5	89.60	3.91	92.49	3.94	<0.05
L+ 7	88.44	4.15	89.24	3.78	>0.05
L+ 10	87.04	3.21	87.62	2.69	>0.05



Graph 8: Mean Arterial Pressure in Both the Groups at Various Time Intervals

Rate Pressure Product:

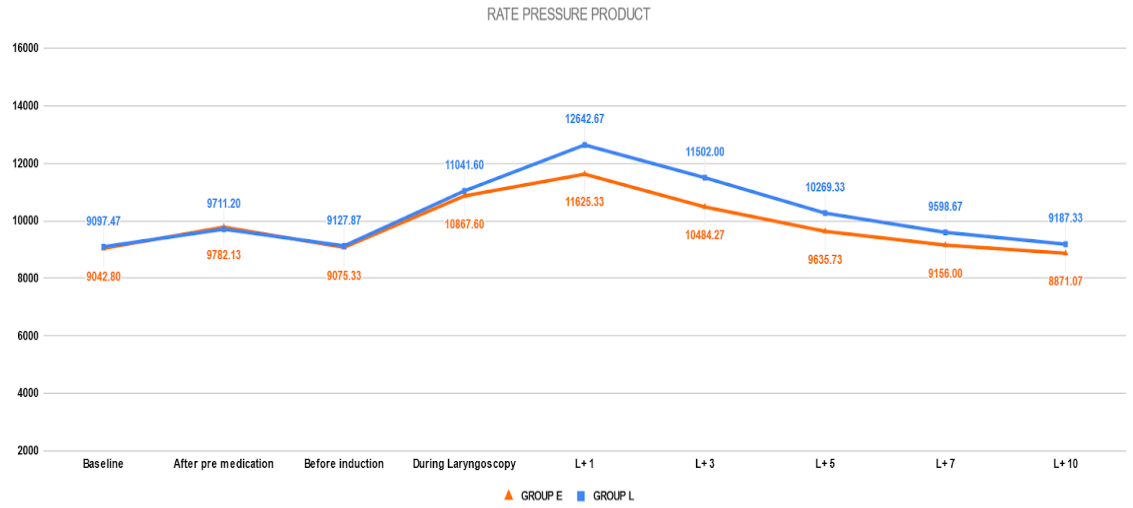
Rate pressure product (RPP) values at baseline, after premedication, before induction, and during laryngoscopy were comparable between the two groups ($p > 0.05$).

- The maximum rise in RPP was observed at L+1, with Group L showing a significantly greater increase than Group E ($p < 0.001$).
- At L+3, RPP values remained significantly higher in Group L ($p < 0.001$).
- At L+5, the difference remained statistically significant ($p < 0.05$).
- At L+7 and L+10, RPP values approached baseline and were comparable ($p > 0.05$).

This reflects better attenuation of myocardial workload with esmolol.

Table 7: Changes in Rate Pressure Product

RPP	GROUP E		GROUP L		P value
	MEAN	SD	MEAN	SD	
Baseline	9042.80	878.21	9097.47	841.92	>0.05
After pre medication	9782.13	583.38	9711.20	593.30	>0.05
Before induction	9075.33	648.38	9127.87	617.20	>0.05
During Laryngoscopy	10867.60	620.31	11041.60	751.62	>0.05
L+ 1	11625.33	687.92	12642.67	806.11	<0.001
L+ 3	10484.27	915.89	11502.00	720.54	<0.001
L+ 5	9635.73	762.10	10269.33	821.76	<0.05
L+ 7	9156.00	744.54	9598.67	878.63	>0.05
L+ 10	8871.07	688.26	9187.33	680.60	>0.05



Graph 9: Rate Pressure Product in Both the Groups at Various Time Intervals

Oxygen Saturation (SpO_2): SpO_2 values remained stable throughout the study period in both groups. There was no statistically significant difference between Group E and Group L at any recorded time interval ($p > 0.05$).

Table 8: Changes in Spo_2:

SpO_2	GROUP E		GROUP L		P value
	MEAN	SD	MEAN	SD	
Baseline	99.27	0.64	99.50	0.51	>0.05
After pre medication	99.03	0.76	98.80	0.61	>0.05
Before induction	99.27	0.69	99.53	0.51	>0.05
During Laryngoscopy	99.40	0.62	99.63	0.49	>0.05
L+ 1	99.07	0.64	98.97	0.76	>0.05
L+ 3	99.13	0.68	98.87	0.68	>0.05
L+ 5	99.43	0.63	99.63	0.49	>0.05
L+ 7	99.33	0.76	99.57	0.50	>0.05
L+ 10	99.20	0.48	99.17	0.83	>0.05

Graph 10: Spo_2 in Both the Groups at Various Time Intervals

Adverse Effects: No adverse effects such as bradycardia, hypotension, bronchospasm, arrhythmias, or allergic reactions were observed in either group during the perioperative period.

Discussion

The pressor response to laryngoscopy and intubation is mediated by reflex sympathetic

activation resulting in catecholamine release [1]. This study demonstrates that esmolol is significantly more effective than lidocaine in attenuating these responses. Esmolol's β-1 selective blockade results in effective suppression of tachycardia and myocardial contractility, leading to reduced myocardial oxygen consumption [5,6]. Lidocaine, while suppressing airway reflexes, lacks consistent cardiovascular control [7]. Our findings align with studies by Singh et al. and Miller et al., who reported superior attenuation with esmolol compared to lidocaine [8,9].

Conclusion

Intravenous esmolol at 1.5 mg/kg provides superior attenuation of the pressor response to laryngoscopy and endotracheal intubation compared to intravenous lidocaine. Esmolol maintains hemodynamic stability and reduces myocardial workload without significant adverse effects.

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