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Original Research

Comparison of the Effects of Intravenous Esmolol and Intravenous Labetolol on the Hemodynamic Changes During Laryngoscopy and Intubation in Patients undergoing Surgery under General Anaesthesia

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ABSTRACT

Background: Laryngoscopy and tracheal intubation commonly trigger a reflex sympathetic pressor response, resulting in elevated heart rate and blood pressure, which can be potentially hazardous in high-risk patients. This study aimed to compare the efficacy of esmolol versus labetalol in attenuating these hemodynamic changes during laryngoscopy and intubation in patients undergoing surgery under general anesthesia.

Methods: A randomized study was conducted on 70 ASA I and II normotensive patients scheduled for elective surgical procedures, divided into two equal groups of 35 each. Group E received intravenous esmolol 1.0 mg/kg (diluted to 10 ml with 0.9% saline) 2 minutes before intubation, preceded by 10 ml normal saline at 5 minutes. Group L received intravenous labetalol 0.5 mg/kg (diluted to 10 ml) 5 minutes before intubation, followed by 10 ml normal saline at 2 minutes. All patients followed an identical anesthetic protocol. Hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure) were recorded at baseline, after induction, and at 1, 3, and 5 minutes post-intubation.

Results; The esmolol group demonstrated significantly lower heart rates at 1, 3, and 5 minutes post-intubation compared to the labetalol group. However, the labetalol group showed significantly better control of systolic blood pressure, diastolic blood pressure, and mean arterial pressure at all measured time points post-intubation compared to the esmolol group.

Conclusion: Labetalol (0.5 mg/kg) administered 5 minutes before laryngoscopy and intubation proved more effective than esmolol (1 mg/kg) in suppressing the overall hemodynamic stress response to laryngoscopy and intubation.

Keywords: Hemodynamic response, Laryngoscopy, Intubation, Beta-blockers.

INTRODUCTION

Airway management is a cornerstone of general anesthesia, and despite significant technological advances in airway devices, rigid laryngoscopy and tracheal intubation remain the gold standard techniques. While these procedures are essential for securing the airway and ensuring adequate gas exchange, they are accompanied by significant hemodynamic perturbations that require careful consideration in anesthetic management[1].

The act of laryngoscopy and endotracheal intubation triggers a profound sympathoadrenal response through stimulation of the epipharyngeal and parapharyngeal regions. This stimulation activates sympathetic and sympathoadrenal responses, resulting in the release of catecholamines from both nerve endings and the adrenal medulla. The subsequent cardiovascular response manifests primarily as tachycardia, hypertension, and various cardiac arrhythmias. While these responses are typically transient and well-tolerated in healthy individuals, Derbyshire et al. and

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Russell et al. demonstrated through their similar work that these hemodynamic fluctuations can have serious implications in patients with underlying cardiovascular conditions[1,2].

The clinical significance of these responses becomes particularly evident in patients with pre-existing conditions such as coronary artery disease, hypertension, or cerebrovascular disease. In such cases, the sudden surge in sympathetic activity can precipitate severe complications including myocardial ischemia, acute heart failure, pulmonary edema, and cerebral hemorrhage. The magnitude of these responses is further influenced by factors such as the duration of laryngoscopy, the skill of the laryngoscopist, and the depth of anesthesia[2].

Over the years, various pharmacological interventions have been investigated to attenuate these potentially hazardous responses. These include the administration of topical and intravenous lidocaine, opioids such as fentanyl, beta-adrenergic blockers, calcium channel blockers, and various vasodilators[3,4,5]. Among these options, beta-adrenergic blocking agents have emerged as particularly effective in modulating the sympathetic response, owing to their ability to directly antagonize the effects of increased catecholamine levels.

In the spectrum of available beta-blockers, esmolol and labetalol have garnered significant attention due to their unique pharmacological profiles. Esmolol, an ultra-short-acting cardioselective beta-1 blocker, offers precise control due to its rapid onset and offset of action. Labetalol, with its combined alpha-1 and non-selective beta-blocking properties, provides a broader spectrum of sympathetic antagonism. Understanding the comparative efficacy of these agents is crucial for optimizing perioperative management[3,4].

The present study aims to compare the effectiveness of intravenous esmolol and labetalol in attenuating the hemodynamic responses associated with laryngoscopy and endotracheal intubation in patients undergoing elective surgeries under general anesthesia. By comparing these two agents, we seek to provide evidence-based guidance for choosing the most appropriate pharmacological intervention for different patient populations and clinical scenarios[5].

AIMS & OBJECTIVES

The primary aim of this study is to compare the efficacy of Esmolol and Labetalol in attenuating the sympathomimetic response during laryngoscopy and endotracheal intubation by assessing hemodynamic changes. The secondary objectives include evaluating the individual efficacy of both Esmolol and Labetalol in controlling these hemodynamic responses during airway instrumentation, and documenting any adverse events associated with their administration. Through this comparative analysis, we seek to determine which of these beta-blocking agents provides better control of the stress response to laryngoscopy and intubation, thereby helping to establish optimal pharmacological management strategies for patients undergoing general anesthesia.

MATERIALS AND METHODS

A randomized double-blinded control study was conducted at the Department of Anesthesiology, Mandya Institute of Medical Sciences, Mandya, following approval from the Institutional Ethics Committee (MIMS/IEC/592) on 13-07-2022. The study period extended from August 2022 to July 2023.

Inclusion Criteria

The study population consisted of ASA physical status I and II patients aged between 18-50 years of both sexes who required general anesthesia with oral endotracheal intubation. Only patients with Modified Mallampati class I and II who provided informed consent were included in the study.

Exclusion Criteria

The study excluded patients with bronchial asthma or cardiovascular diseases, those on beta-blockers, pregnant females, and emergency cases requiring immediate surgical intervention.

Sample Size Calculation

Sample size was calculated based on a previous study by Sarvesh P. Singh et al., using the formula $n = [2(Z\alpha/2 + Z\beta)^2 \sigma^2] / d^2$. With Type I error ($\alpha$) of 5%, 80% power (1-$\beta$), standard deviation ($\sigma$) of 12.53, and allowable error (d) of 8.4, the required sample size was determined to be 35 patients per group, totaling 70 patients.

Randomization

Patients were randomized using a computer-generated randomization table into two groups

- **Group E**-Patients received 10ml 0.9% normal saline IV at 5minutes and IV Esmolol 1.0 mg/kg (diluted with 0.9% saline to 10 ml) 2 minutes prior to intubation.
- **Group L-** Patients received IV Labetolol 0.5 mg/kg (diluted with 0.9% saline to 10ml) at 5 minutes and10 ml 0.9% normal saline at 2 minutes prior to intubation.

Drug Preparation

Anesthesiologist1(Investigator1)preparestwotimelabelled,10 ml syringe, one containing study drug and another containing 0.9% normal saline and hands it to the Anesthesiologist 2 (investigator 2)who administers the drugs who is blinded. The patients are also blinded regarding the study drug being received.

Study Parameters

Hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO2) were recorded at:

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- Baseline (T0)
- Just after induction (T1)
- 1 minute after intubation (T2)
- 3 minutes after intubation (T3)
- 5 minutes after intubation (T4)

Statistical Analysis

Data analysis was performed using SPSS version 17.0 software. Categorical data were presented as frequencies and percentages and analyzed using Fischer exact test. Quantitative data were presented as mean and standard deviation and analyzed using Student's t-test. Statistical significance was set at $p < 0.05$.

RESULTS

Demographic Data

Parameter	Group E (n=35)	Group L (n=35)	Total (n=70)	p-value
Age (Mean ± SD)	34.3 ± 9.7 years	32.8 ± 9.6 years	-	0.538
Sex (Female:Male)	23:12	21:14	44:26	0.621
Height (Mean ± SD)	1.62 ± 0.07 m	1.58 ± 0.12 m	-	0.078
Weight (Mean ± SD)	61.4 ± 6.45 kg	57.1 ± 11.6 kg	-	0.063
BMI (Mean ± SD)	23.4 ± 3.0	22.8 ± 3.7	-	0.483
ASA Class (I:II)	21:14	26:9	47:23	0.309

Table 1: Demographic Distribution of Study Groups

Table 1 Shows the Differences in age, sex, height, weight, BMI, and ASA class between groups were not statistically significant.

Hemodynamic Parameters

Heart Rate (bpm)

Time Point	Group E (Mean ± SD)	Group L (Mean ± SD)	p-value
Baseline	94.4 ± 10.9	90.8 ± 14.8	0.250
Induction	87.7 ± 12.1	90.1 ± 13.7	0.439
1 Minute	89.9 ± 11.5	95.9 ± 12.0	0.039*
3 Minutes	91.1 ± 12.5	95.3 ± 15.1	0.044*
5 Minutes	89.5 ± 10.3	94.9 ± 16.7	0.047*

Table 2: Comparison of Heart Rate (bpm) Between Groups

Table 2 Represents Statistically significant differences noted at 1, 3, and 5 minutes post-intubation.

Systolic Blood Pressure (SBP, mmHg)

Time Point	Group E (Mean ± SD)	Group L (Mean ± SD)	p-value
Baseline	126.1 ± 11.5	124.1 ± 11.8	0.462
Induction	119.3 ± 14.7	118.2 ± 13.2	0.733
1 Minute	119.5 ± 14.7	111.0 ± 17.5	0.022*
3 Minutes	112.7 ± 14.3	101.7 ± 12.7	0.001**
5 Minutes	104.5 ± 16.7	96.5 ± 12.4	0.019*

Table 3: Comparison of Systolic Blood Pressure (SBP, mmHg)

Table 3 shows the statistically significant ($p < 0.05$) values of comparison of systolic blood pressure at different time points.

Diastolic Blood Pressure (DBP, mmHg)

Time Point	Group E (Mean ± SD)	Group L (Mean ± SD)	p-value
Baseline	75.7 ± 7.1	79.1 ± 8.2	0.067
Induction	70.9 ± 11.4	76.3 ± 11.0	0.047*
1 Minute	76.1 ± 9.9	70.7 ± 13.8	0.045*
3 Minutes	70.4 ± 9.8	64.8 ± 8.2	0.008**
5 Minutes	65.8 ± 10.2	61.0 ± 10.8	0.049*

Table 4: Comparison of Diastolic Blood Pressure (DBP, mmHg)

Table 4 shows the statistically significant ($p < 0.05$) values of comparison of diastolic blood pressure at different time points.

Mean Arterial Pressure (MAP, mmHg)

Time Point	Group E (Mean ± SD)	Group L (Mean ± SD)	p-value
Baseline	92.2 ± 8.1	93.8 ± 8.5	0.408
Induction	86.9 ± 10.8	89.9 ± 10.6	0.246

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1 Minute	91.0 ± 11.5	84.1 ± 13.4	0.019*
3 Minutes	84.7 ± 11.9	76.9 ± 8.4	0.002**
5 Minutes	79.1 ± 11.3	73.4 ± 9.5	0.021*

Table 5: Comparison of Mean Arterial Pressure (MAP, mmHg)

Table 5 shows the statistically significant ($p < 0.05$) values of comparison of mean arterial pressure at differenttime points

The results show significant differences between the Esmolol and Labetolol groups in terms of heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure at specific time points post-intubation.

DISCUSSION

The induction of anesthesia, laryngoscopy, and tracheal intubation are associated with marked hemodynamic changes and autonomic reflex activity, which can be concerning in high-risk patients[6]. These changes include rises in heart rate, blood pressure, and cardiac arrhythmias. Although these responses typically disappear within 5 minutes of laryngoscopy onset[7], they may prove detrimental in patients with cardiovascular disease, increased intracranial pressure, or cerebrovascular anomalies[8]. Multiple factors influence these cardiovascular responses, with age being a significant variable. Young patients typically show more extreme changes, while geriatric patients exhibit marked fluctuations in hemodynamic responses[9,10]. Our study focused on the optimal age range of 18-50 years and excluded patients on antihypertensive medications, as these may decrease the pressor response.

Bachofen M[11] established criteria for selecting appropriate drugs to prevent sympathetic response, including patient independence, preservation of cerebral blood flow, and avoiding arousal without affecting anesthesia duration. Both intravenous Esmolol and Labetalol fulfill these criteria and effectively attenuate adrenergic hemodynamic stress responses.

Many previous study have used low doses of Esmolol and Labetolol for attenuation of stress response during intubation and laryngoscopy.[12-15] But very few studies are available that have used high dose of Esmololvs. Labetolol for attenuation of stress response during intubation and laryngoscopy.[16,17] So in our study we have used 1mg/kg of Esmololvs. 0.5 mg/kg of Labetolol for attenuation of stress response during intubation and laryngoscopy.

In our study comparing Esmolol (1mg/kg) with Labetalol (0.5mg/kg), the Esmolol group demonstrated superior heart rate control, showing a decrease post-induction (87.7±12.07) with slight increases at 1 and 3 minutes post-intubation, settling at 89.5±10.34 at 5 minutes. This contrasts with studies by B. Sowbhagya Lakshmi et al[16] who found better heart rate control with Labetalol.

Regarding blood pressure control, the Labetalol group showed statistically significant attenuation of systolic, diastolic, and mean arterial pressure at 1, 3, and 5 minutes post-intubation compared to the Esmolol group. These findings align with studies by B. Sowbhagya Lakshmi et al[16], and Joshua Dhavanum et al[15].

The differential effects can be attributed to their distinct pharmacological properties. Esmolol is a beta-selective (cardioselective) adrenergic blocking agent[18], while Labetalol combines selective alpha-1 and non-selective beta-1 and beta-2 antagonist effects[19]. Labetalol's superior blood pressure control likely stems from its alpha-1 blockade reducing peripheral vascular resistance, with its beta blockade attenuating reflex tachycardia.

LIMITATIONS OF THE STUDY

Our study had several limitations. We excluded ASA III and IV patients, relied on clinical observations for monitoring anesthesia depth and muscle relaxation. Additionally, we did not separately analyze the stages of direct laryngoscopy and tracheal tube passage. The absence of a control group limited our ability to appreciate the magnitude of difference between drugs.

CONCLUSION

Both Esmolol and Labetalol effectively blunt hemodynamic responses to endotracheal intubation and can be safely used during general anesthesia induction, Labetalol demonstrates superior attenuation of the pressor response to laryngoscopy and intubation. The higher dose of Esmolol (1mg/kg) proves more effective in controlling heart rate responses, likely due to its pharmacological properties.

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