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Original Research Article

A Comparative Study Between Effects of Intravenous Esmolol and Fentanyl for Attenuation of Hemodynamic Responses to Laryngoscopy and Endotracheal Intubation under General Anaesthesia

Nazia Tarannum[1], Subrata Pahari[2], Soma Chakraborty[3]

[1]Junior Resident, Department of Anesthesiology, Bankura Sammilani Medical College and Hospital West Bengal, India

[2]Professor & HOD, Department of Anaesthesiology, Bankura Sammilani Medical College and Hospital West Bengal, India

[3]Assistant Professor, Department of Anaesthesiology, BSMC, India

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Corresponding Author: Soma Chakraborty

Conflict of interest: Nil

Abstract:

Introduction: Haemodynamic stability is a fundamental and crucial objective of any anesthetic management strategy. Laryngoscopy and intubation can induce significant alterations in hemodynamics. The elevation of blood pressure and heart rate mostly results from reflex sympathetic and vagal activation in response to laryngotracheal stimulation, subsequently causing an increase in plasma norepinephrine levels. This study aimed to examine the efficacy of esmolol and fentanyl in mitigating hemodynamic responses associated with laryngoscopy and endotracheal intubation.

Methods: A total of 100 patients of either gender, classified as American Society of Anesthesiologists physical status I and II, aged between 20 and 50 years, scheduled for various elective surgeries necessitating general anesthesia with endotracheal intubation at Bankura Sammilani Medical College and Hospital, Bankura, West Bengal. Hundreds of patients were randomized into two groups: Group E (n = 50) and Group F (n = 50).

Results: The inhibition of maximum heart rate elevation by Esmolol is statistically significant in comparison to Fentanyl (P<0.001). It remains pertinent for five minutes. By the inference of 10 minutes, the levels in the Esmolol and Fentanyl groups diminish to a clinically insignificant threshold.

Conclusion: This clinical comparison investigation shows that both esmolol and fentanyl effectively mitigate the sympathetic hemodynamic response linked to laryngoscopy and endotracheal intubation. Nonetheless, esmolol demonstrated superior efficacy compared to fentanyl in attenuating this reaction.

Keywords: Intubation; Hypertensive patients; Esmolol; Fentanyl; Heart rate; Blood pressure.

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Introduction

Laryngoscopy and endotracheal intubation are essential components of balanced general anaesthesia with controlled ventilation and are employed during resuscitation in intensive care units (ICU) [1]. These procedures represent the gold standard for airway management and facilitating positive pressure ventilation. Intubation has become requisite for the majority of patients undergoing surgery under general anaesthesia. Since its introduction by Rowbotham and Magill in 1921, endotracheal intubation has been a fundamental aspect of anaesthetic management and critical care [2] . The stimulation of the larynx and trachea elicits a reflex sympathoadrenal response, resulting in a significant increase in heart rate and blood pressure, which is frequently observed during laryngoscopy and intubation [3].

Direct laryngoscopy has been employed for many years as a standard procedure to enable this intervention. A variety of laryngoscopes with diverse sizes and shapes have been developed to address viewing challenges and ensure smooth endotracheal intubation [4]. Pharmaceuticals such as Esmolol hydrochloride are commonly employed to mitigate the pressor response during laryngoscopy and intubation, which are linked to temporary yet significant cardiovascular alterations [5]. This is due to sensory afferents from the epipharynx and laryngopharynx being predominantly transmitted via the glossopharyngeal nerve to the vasomotor centre, responsible for the elevation in pulse rate and blood pressure, resulting in tachycardia, hypertension, and dysrhythmias [6]. Fentanyl citrate

is efficient and commonly utilized to mitigate hemodynamic stress reactions during laryngoscopy and intubation, including hypertension, tachycardia, myocardial ischemia, and elevated circulating catecholamines. Elevated dosages of Fentanyl may induce respiratory depression [7].

A singular medicine or technique is inadequate. Various techniques for mitigating the response to laryngoscopy and intubation remain to be investigated, with new pharmacological agents being tested periodically [8]. Among the prescribed methods, intravenous lignocaine, fentanyl, and esmolol are often utilized medications. Esmolol is a compelling choice due to its Beta 1 cardioselectivity and extremely short duration of action (9 to 10 minutes) [9]. Fentanyl induces relaxation of pharyngeal, laryngeal, and jaw musculature, suppresses the cough reflex, and delivers drowsiness and analgesia; however, it is associated with respiratory depression at elevated doses [10].

Materials and Method

An interventional study was designed to evaluate the efficacy of intravenous bolus Esmolol and Fentanyl in mitigating hemodynamic responses, specifically pulse rate, systolic, diastolic, mean blood pressure, and rate pressure product, resulting from direct laryngoscopy and intubation, while also assessing the superiority of one intervention over the other.

Study Area: Preoperative room, Department of Anaesthesiology, elective surgery operating theatre, Bankura Sammilani Medical College and Hospital, Bankura, West Bengal.

Study Population: A total of 100 patients of either gender, classified as American Society of Anesthesiologists physical status I and II, aged between 20 and 50 years, scheduled for various elective surgeries necessitating general anesthesia with endotracheal intubation at Bankura Sammilani Medical College and Hospital, Bankura, West Bengal.

Inclusion Criteria

- ASA physical status I & II
- Age- 20 - 50 years
- Patients scheduled for elective general surgeries under general anaesthesia with endotracheal intubation
- Duration of laryngoscopy <30 seconds

Exclusion criteria

- Emergency Surgeries
- Anticipated difficult intubation
- Patients with cardiovascular diseases (ischaemic heart disease, heart block etc) and severe respiratory diseases, endocrinal disorders like Diabetes Mellitus, Hyperthyroidism etc and Renal failure patients
- Hypertensive patients on beta blockers or Calcium Channel blockers or sympatholytic drugs.
- Patients in whom laryngoscopy and intubation proved to be prolonged >30seconds.
- Haemodynamically unstable patient
- Patients with raised intra-cranial pressure, intracranial aneurysm, recent cerebro vascular accident, intraocular pressure,
- History of known allergies to study drugs.

Study Period: From March 2018 to August 2019 (18 months).

Sample Design: Hundreds of patients were randomized into two groups: Group E (n = 50) and Group F (n = 50), based on a computer-generated random number table. Allocation concealment was accomplished by storing the randomization sequence for each participant in sequentially numbered sealed brown envelopes.

Study Design: Cross-sectional, randomized, institutional, interventional study.

Study Groups:

Group E (n=50): Esmolol administered as a 2 mg/kg IV bolus 3 minutes before induction during pre-oxygenation.

Group F (n=50): Fentanyl citrate administered at a dose of 2 μg/kg by IV bolus 3 minutes before induction during preoxygenation.

Statistical Analysis: Descriptive statistics are presented as Mean ± SD accompanied with a percentage change. Two group comparisons were performed utilizing an unpaired Student's t-test. For all tests, a 'p' value of less than 0.05 and less than 0.001 was considered statistically significant.

Results

Table 1: Mean age, Body weight and Gender Ratio of the Study Group.

Parameter	Group E (Esmolol)	Group F (Fentanyl)	P-Value
Age (mean±SD) in years	40.32±9.25	37.08±8.61	>0.05
Body weight (mean±SD) in kilograms	60.28 ± 4.81	58.26± 6.15	>0.05
Gender ratio (M:F)	23:27	12:38	

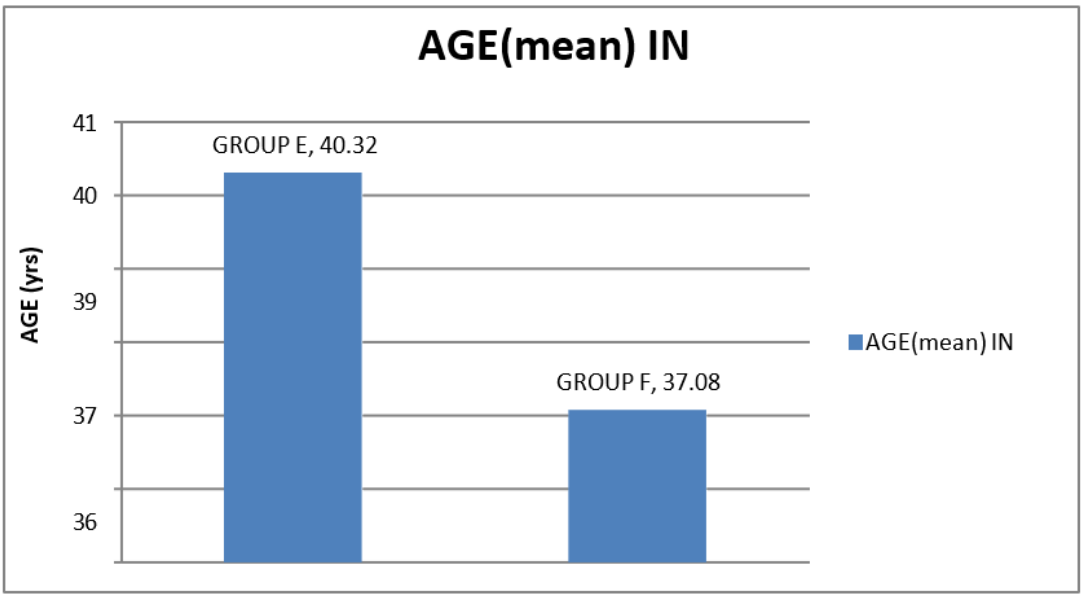

Figure 1: Showing distribution of mean age in study (Group E and Group F)

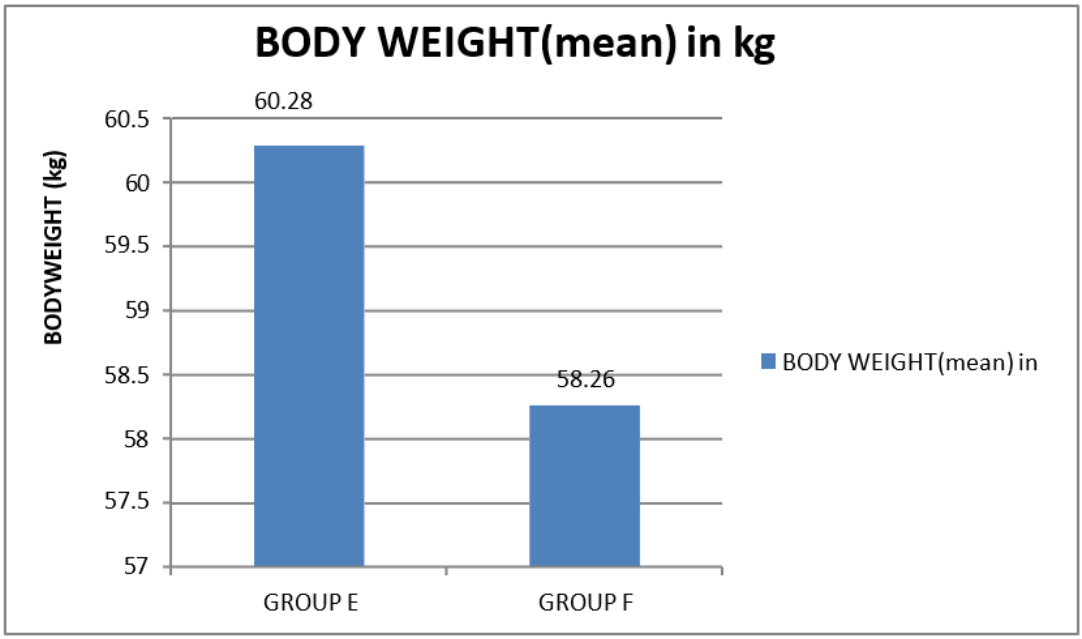

Figure 2: Showing distribution of mean body weight in study (Group E and Group F)

Table 2: Summary of paired 't' test of difference in mean pulse rate between baseline and at different time intervals in study groups.

Parameters	Group E(N=50)		Group F(N=50)		P-value	Significance of difference
	Mean±SD	%Change	Mean±SD	%Change		
BV	82.92±7.79	-	79.3±6.65	-	>0.05	Not significant
AS	80.52±7.85	-2.80%	80.88±6.1	1.99%	>0.05	Not significant
ALI	91.42±8.14	10.20%	98.92±7.21	24.70%	**<0.001**	**Significant**
ETI1	93.52±7.75	12.70%	100.16±6.89	26.30%	**<.001**	**Significant**
ETI2	90.58±6.91	9.20%	98.2±6.81	23.80%	**<.001**	**Significant**
ETI3	87.92±7.03	6%	94.58±5.76	19.20%	**<.001**	**Significant**
ETI4	86.02±6.81	-3.70%	91.6±4.96	15.50%	**<.001**	**Significant**
ETI5	82.26±5.55	-0.80%	87.64±5.14	10.50%	**<.001**	**Significant**
ETI10	79.68±5.97	-3.90%	79.18±7.08	-0.15%	>.05	Not significant

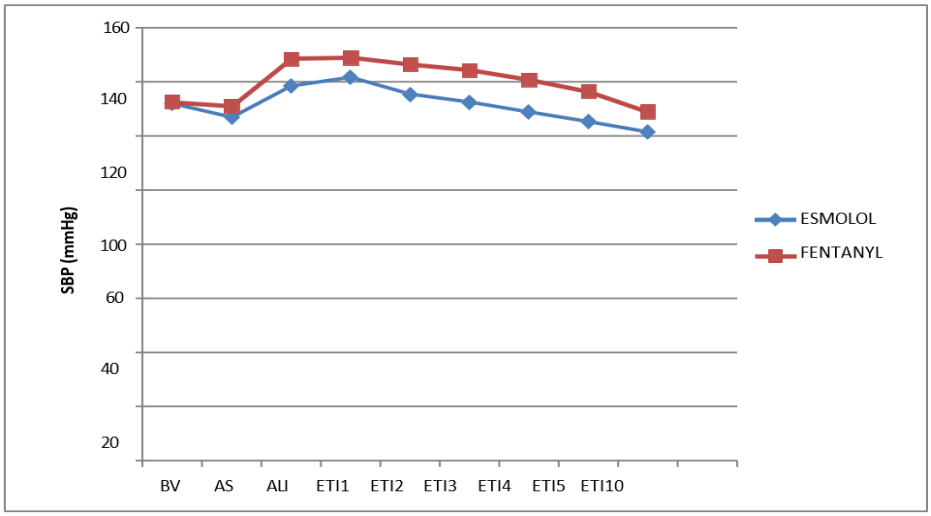

Figure 4: Line diagram showing changes of mean pulse rate at different interval in study groups. (Statistical significance of difference is considered at a confidence interval of 95%)

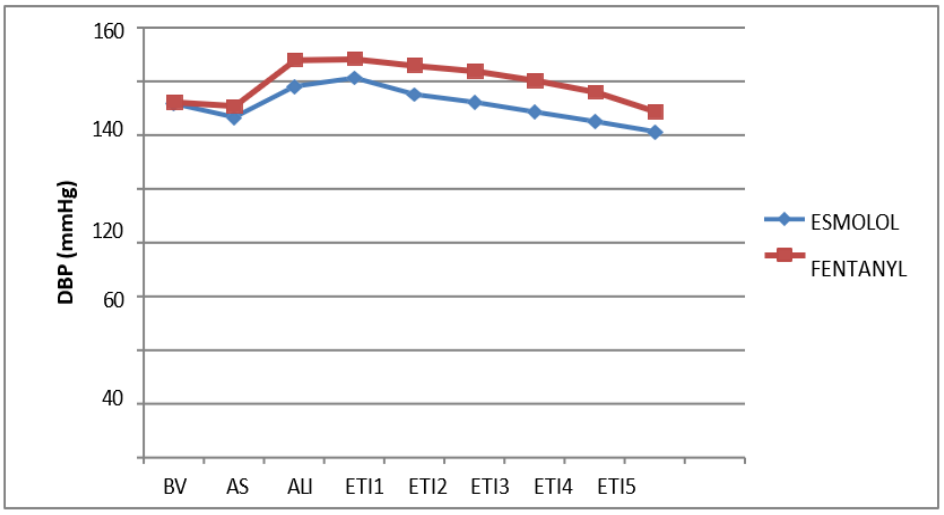

Figure 5: Line diagram showing changes of mean systolic blood pressure rate at different interval in study groups. (Statistical significance of difference is considered at a confidence interval of 95%)

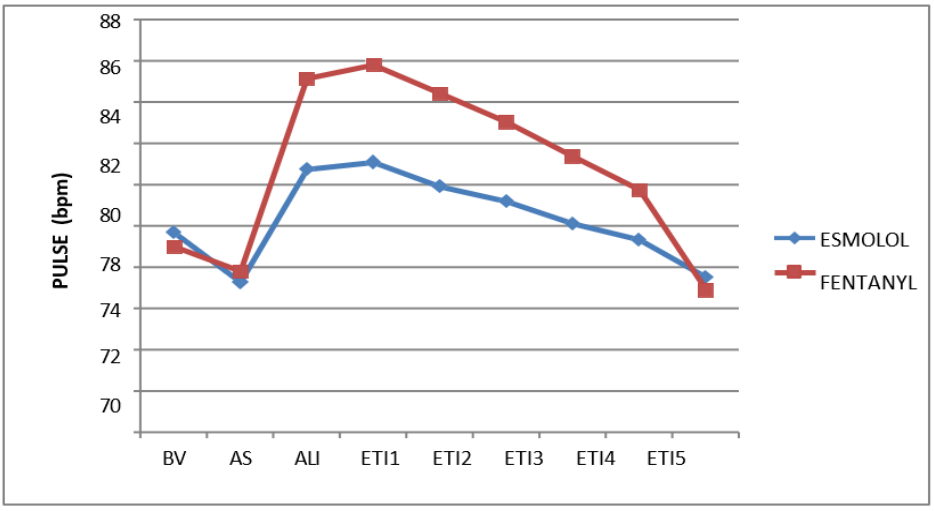

Figure 6: Line diagram showing changes of mean diastolic blood pressure rate at different interval in study groups. (Statistical significance of difference is considered at a confidence interval of 95%)

Table 3: Summary of paired 't' test of difference in mean of the mean arterial pressure between baseline and at different time intervals in study groups

Parameters	Group E(N=50)		Group F(N=50)		P-value	Significance of difference
	Mean±SD (mmHg)	% Change	Mean±SD (mmHg)	% Change		
BV	95.72±6.02	-	95.6±6.55	-	>0.05	Not significant
AS	92.56±5.16	-3.3%	94.24±6.06	-1.42%	>0.05	Not significant
ALI	99.96±4.84	4.42%	106.28±6.33	11.17%	**<0.001**	**Significant**
ETI1	101.14±4.89	5.66%	106.88±6.03	11.7%	**<0.001**	**Significant**
ETI2	98.38±4.68	2.77%	105.1±6.16	9.93%	**<0.001**	**Significant**
ETI3	96.92±4.46	1.25%	103.4±6.21	8.15%	**<0.001**	**Significant**
ETI4	95.02±4.27	-0.73%	101.1±6.3	5.75%	**<0.001**	**Significant**
ETI5	93.26±4.18	-2.56%	98.6±5.55	3.13%	**<0.001**	**Significant**
ETI10	90.76±4.15	-5.18%	93±5.5	-2.71%	**<0.05**	**Significant**

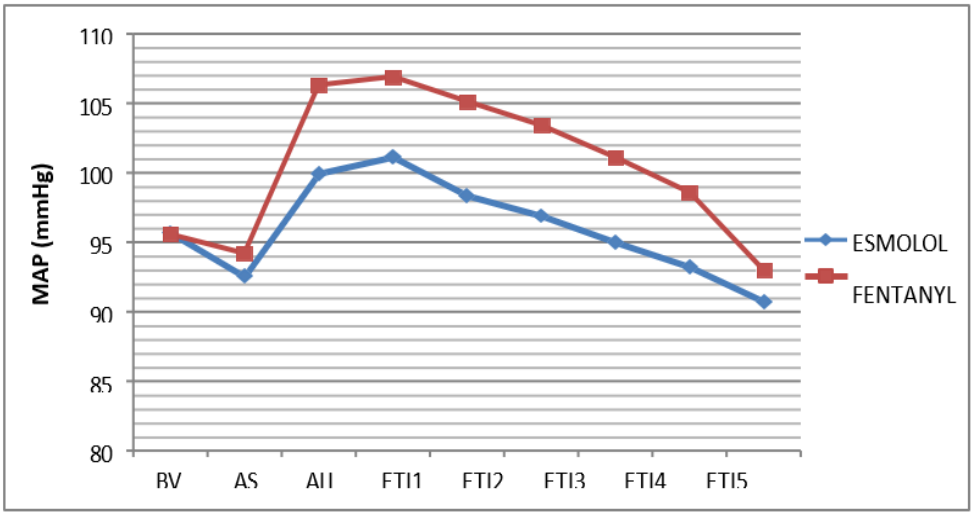

Figure 7: Line diagram showing changes of mean of the mean arterial pressure rate at different interval in study groups. (Statistical significance of difference is considered at a confidence interval of 95%)

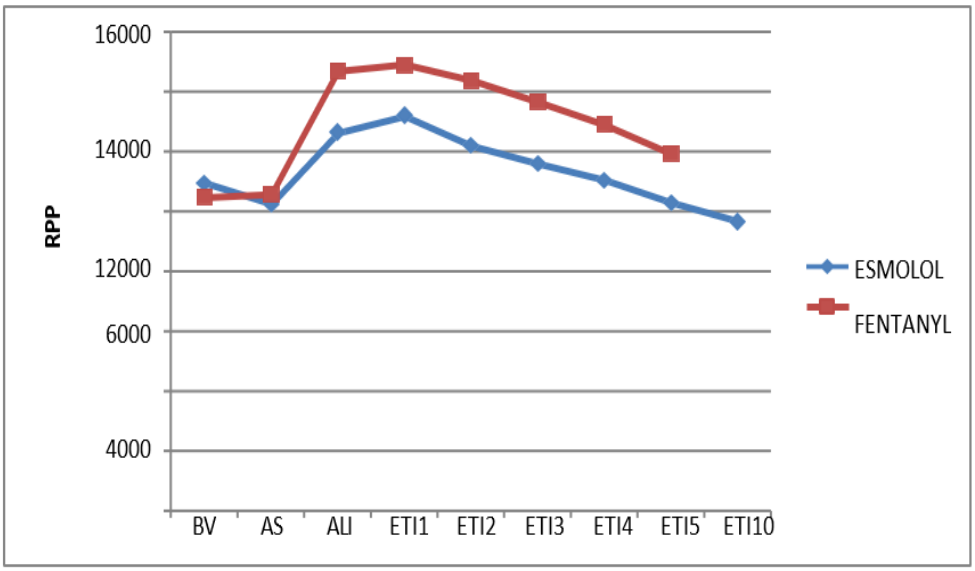

Figure 8: Line diagram showing changes of mean rate pressure product rate at different interval in study groups. (Statistical significance of difference is considered at a confidence interval of 95%)

Discussion

Esmolol is a suitable choice among β-adrenergic blocking agents for mitigating the hemodynamic response to laryngoscopy and tracheal intubation due to its cardioselectivity, fast onset, and brief elimination half-life [11]. Numerous research has examined the impact of Esmolol on pulse rate and arterial blood pressure during laryngoscopy and endotracheal intubation in comparison to a placebo [12].

Fentanyl is recommended to minimize the sympathetic reaction during laryngoscopy and endotracheal intubation. The attenuation of the sympathetic response is dose-dependent [13]. At elevated doses, Fentanyl induces tissue accumulation, resulting in prolonged plasma and cerebral concentrations of the substance [14]. These patients necessitate mechanical ventilation assistance. Fentanyl at 6μg/kg totally eliminates, whereas at 2μg/kg greatly reduces arterial pressure and heart rate elevation during laryngoscopy and intubation. Administering Fentanyl at the right time decreases the required dosage. The ideal administration period for Fentanyl is 5 minutes prior to intubation at a dosage of 2μg/kg [15].

Esmolol is recognized for its substantial impact on both tachycardia and hypertension responses after endotracheal intubation. This investigation revealed no significant change in heart rate at pre- and post-induction levels between the Esmolol and Fentanyl groups. The Esmolol group exhibits a maximum heart rate increase of 12.7%, whereas the Fentanyl group shows an increase of 26.3% [Table 1]. The inhibition of maximum heart rate elevation by Esmolol is statistically significant in comparison to Fentanyl ($P<0.001$). It remains pertinent for five minutes. By the inference of 10 minutes, the levels in the Esmolol and Fentanyl groups diminish to a clinically insignificant threshold.

The current study investigation revealed that Esmolol significantly mitigates the hypertensive response to laryngoscopy and intubation. Fentanyl demonstrates an 11.7% elevation in mean arterial pressure. Esmolol demonstrates a mere 5.66% elevation ($P<0.001$) in mean arterial pressure relative to the baseline value, which is statistically significant [Table 2]. In this investigation, we found that Esmolol was more beneficial in mitigating the hypertensive response than in attenuating the chronotropic reaction to tracheal intubation.

In this study, Mean Arterial Pressure (MAP) rose by 11.7% in the Fentanyl group, whereas in the Esmolol group, it climbed by just 5.66% ($P<.001$). The Fentanyl group attained pre-induction levels in 10 minutes, while the Esmolol group achieved this in 4 minutes. The reduction of Mean Arterial Pressure by Esmolol is markedly significant in comparison to Fentanyl ($P<0.001$).

In the present study, the Rate Pressure Product increased by 42.1% in the Fentanyl group, but it increased by just 20.5% in the Esmolol group. The Fentanyl group attained pre-induction levels in 10 minutes, while the Esmolol group achieved this in 5 minutes. The increase was 50% lower in patients treated with Esmolol compared to those treated with Fentanyl, indicating that Esmolol exerts a significant influence on chronotropy and has a notable effect on mean systolic blood pressure when employed for prophylaxis against sympathetic responses to laryngoscopy. The reduction in rate pressure product by Esmolol is markedly significant in comparison to Fentanyl ($P<.001$).

Conclusion

This clinical comparison investigation shows that both esmolol and fentanyl effectively mitigate the sympathetic hemodynamic response linked to laryngoscopy and endotracheal intubation. Nonetheless, esmolol demonstrated superior efficacy compared to fentanyl in attenuating this reaction. The use of intravenous esmolol at a bolus dose of 2 mg/kg, administered 3 minutes before laryngoscopy and intubation, offers enhanced attenuation of the sympathetic response and is advisable as an effective method for hemodynamic management during airway manipulation.

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