Original Article

A Prospective Randomized Double-Blind Study Comparing Hemodynamic Responses to Laryngoscopy and Endotracheal Intubation Following Induction with Propofol and Etomidate

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Abstract

Background: Laryngoscopy and endotracheal intubation are essential elements of general anesthesia, inducing considerable sympathetic activation, which leads to tachycardia and hypertension. These temporary changes in blood flow may lead to significant heart problems, especially in those whose hearts aren't very strong. The selection of the induction agent is essential in influencing these responses. Propofol and etomidate are frequently utilized intravenous induction medications exhibiting distinct cardiovascular characteristics. The current study was conducted to examine the hemodynamic responses to laryngoscopy and endotracheal intubation following the induction of general anesthesia with propofol and etomidate in patients undergoing elective major abdominal operations. **Material and Methods:** This prospective, randomized, double-blind clinical trial involved 100 adult patients aged 18–60 years, classified as American Society of Anesthesiologists (ASA) physical status I and II, and scheduled for elective major abdominal procedures under general anesthesia. Patients were randomly assigned to two groups: Group P got propofol 2 mg/kg intravenously, and Group E received etomidate 0.3 mg/kg intravenously for induction. At baseline, after induction, during laryngoscopy, and at 1, 3, 5, and 10 minutes after endotracheal intubation, we measured heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO_2). Negative effects were also recorded. **Results:** The baseline demographic features and hemodynamic indicators were similar across the two groups ($p > 0.05$). After laryngoscopy and intubation, both groups saw a big rise in HR, SBP, DBP, and MAP. However, the rise was much bigger in the propofol group at 1 and 3 minutes after intubation ($p < 0.05$). Etomidate exhibited enhanced hemodynamic stability during airway manipulation. Oxygen saturation stayed steady and similar between the two groups for the whole investigation. **Conclusion:** Etomidate offers superior hemodynamic stability relative to propofol during laryngoscopy and endotracheal intubation, and may be favored as an induction drug in individuals for whom cardiovascular stability is critically important.

Keywords: Propofol; etomidate; hemodynamic response; laryngoscopy; endotracheal intubation; general anesthesia.

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Introduction

General anesthesia is a drug-induced state in which a person is asleep, forgetful, pain-free, and unable to protect himself.[1] The initiation of general anesthesia frequently results in substantial modifications in cardiovascular physiology, chiefly attributable to the influence of anesthetic drugs and airway management. Laryngoscopy and endotracheal intubation are significant noxious stimuli that stimulate the sympathetic nervous system, leading to temporary tachycardia, hypertension, and elevated myocardial oxygen demand.[2]

These hemodynamic reactions are typically well tolerated in healthy persons; but, in patients with preexisting cardiovascular disease, hypertension, or diminished cardiac reserve, similar responses may precipitate myocardial ischemia, arrhythmias, cerebrovascular incidents, or heart failure.[3] Consequently, the mitigation of the pressor reaction to laryngoscopy and intubation continues to be a significant concern in anesthetic treatment.

People like intravenous induction medicines a lot because they work quickly, are easy to titrate, and have predictable pharmacokinetics. Propofol, an alkylphenol derivative, is a popular induction agent because it works quickly, smoothly, and has good recovery properties.[4] However, propofol is known to cause hypotension that depends on the dose since it relaxes blood vessels and depresses the heart, which may be worse during induction.[5]

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Etomidate, an imidazole-derived intravenous anesthetic, has very little effect on cardiac contractility and systemic vascular resistance. This makes it a better choice for maintaining hemodynamic stability throughout induction.[6] Due to these characteristics, etomidate is commonly administered to individuals with impaired cardiovascular function. Nonetheless, apprehensions regarding adrenal suppression and other detrimental effects have curtailed its regular application.[7]

Different research have looked at how propofol and etomidate affect blood flow during anesthesia induction, and they have come to different findings about how well they can reduce the stress response to laryngoscopy and endotracheal intubation.[8–10] Additionally, there exists a paucity of data specifically concerning individuals undergoing significant abdominal procedures under standardized anesthetic regimes.

This prospective randomized double-blind study aimed to examine the hemodynamic responses to laryngoscopy and endotracheal intubation following induction with propofol and etomidate in adult patients undergoing elective major abdominal operations under general anesthesia.

Goals and Objectives

Aim

To compare the hemodynamic responses to laryngoscopy and endotracheal intubation after the induction of general anesthesia with propofol versus etomidate.

Primary Objectives

- To compare the heart rates (HR) of the two groups
- To compare systolic blood pressure (SBP)
- To look at diastolic blood pressure (DBP)
- To compare the mean arterial pressure (MAP)
- To compare oxygen saturation (SpO_2)

Secondary Objectives

- To evaluate and contrast the adverse effects linked to propofol and etomidate.
- To assess overall hemodynamic stability during induction and airway management.

Materials and Methods

Study Design and Setting: This investigation was structured as a prospective, randomized, double-blind clinical trial, executed in the primary operating theatres of the Department of Anaesthesiology and Critical Care at Gauhati Medical College and Hospital, Assam, India. The trial lasted for a year, from October 2023 to November 2024.

Before the study started, the Institutional Ethics Committee gave its clearance (clearance No.: MC/190/2007/Pt-11/Oct.2023/30). The research was executed in alignment with the principles delineated in the Declaration of Helsinki and complied with Good Clinical Practice guidelines.[11]

The trial was registered in advance with the Clinical Trial Registry of India (CTRI) under the registration number CTRI/2025/02/080780. This made sure that the trial was open and followed national research guidelines.

Study Population: We first checked to see if 116 individuals who were going to have elective major abdominal surgery under general anesthesia were eligible. After applying the inclusion and exclusion criteria and receiving informed written agreement, 100 patients were included and randomized for final analysis.

Inclusion Criteria

Patients fulfilling all of the following criteria were included in the study:

- Age between 18 and 60 years • Any gender
- The American Society of Anesthesiologists (ASA) says that the person is in physical state I or II.
- Scheduled for major abdominal procedures that are not emergencies and will be done under general anesthesia
- Willingness to take part and giving written informed consent

Exclusion Criteria

Patients were not allowed to take part in the trial if they met any of the following conditions:

- Recognized reactivity or allergy to propofol or etomidate
- A history of serious heart disease, such as ischemic heart disease or high blood pressure that can't be treated
- Having chronic lung problems like bronchial asthma
- Impaired liver or kidney function
- Expected difficult airway, which is when the mouth opening is less than 2 cm
- A modified Mallampati score of III or IV
- Cormack–Lehane grade > III on laryngoscopy • Need more than one try or more than 30 seconds for laryngoscopy or intubation
- Patients who are scheduled for emergency surgery
- Not giving informed consent

Sample Size Calculation

The sample size was determined from a prior study that compared hemodynamic characteristics after induction with propofol and etomidate.[12] Taking into account a mean difference of 5 units in hemodynamic parameters, a standard deviation of 10, a power of 90%, a significance threshold of 5%, and an expected attrition rate of 10%, a sample size of 100 patients was deemed sufficient. The study population was evenly split into two groups of 50 patients each.

Randomization and Allocation Concealment

A computer-generated random sequence was used to randomly allocate patients to two equal groups:

- Group P (Propofol group)
- Group E (the Etomidate group)

The sealed opaque envelope technique, which was only opened when the study began, made sure that allocation was hidden. This strategy reduced selection bias and made sure that the random allocation was done correctly.[13]

Blinding

The study utilized a double-blind methodology:

- The patients did not know what induction agent was utilized.
- The anesthesiology resident who recorded the hemodynamic parameters did not know which group they were in.

A different anesthesiology resident who was not engaged in collecting or analyzing data prepared the research medicines in identical 10-ml syringes with the labels "Drug A" and "Drug B." This kept the study's blinding intact throughout the study period.[14]

Pre-Anesthetic Assessment

On the day before surgery, all patients had a full pre-anesthetic assessment. This included:

- A full medical and surgical history
- Past use of anesthetic
- A physical assessment that focuses on the heart and lungs
- Check the airway, including the modified Mallampati score
- Going over the usual preoperative tests according to institutional rules

Patients were told not to eat or drink anything for at least 8 hours before operation.

Anesthetic Protocol

Getting ready and keeping an eye on things

When the patient got to the operating room, standard monitors were put on them according to ASA recommendations.[15] These included:

- ECG (electrocardiography)
- Non-invasive blood pressure (NIBP)
- SpO_2 pulse oximetry

We recorded the baseline values for heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO_2).

An 18-gauge cannula was used to establish an intravenous line, and Ringer's lactate solution was started.

Premedication

All patients received the following premedication through an IV:

- 4–10 µg/kg of glycopyrrolate via injection
- 1 µg/kg of fentanyl injected for pain relief

Before induction, patients were given 100% oxygen for three minutes to prepare them.

Induction of Anesthesia

Patients were induced based to their group assignment:

- Group P: 2 mg/kg of propofol injected into the vein
- Group E: Intravenous injection of etomidate at 0.3 mg/kg

The absence of verbal response and eyelash reflex served as signs of sufficient induction.

After making sure that the mask breathing was good, an injection of vecuronium bromide 0.1 mg/kg intravenously was used to inhibit the neuromuscular system.

Laryngoscopy and intubation

An expert anesthesiologist used a Macintosh laryngoscope with a blade size of 3 or 4 to do direct laryngoscopy. Endotracheal intubation was successfully performed utilizing a low-pressure, high-volume cuffed endotracheal tube of suitable dimensions.

Bilateral chest auscultation and capnography confirmed that the endotracheal tube was in the right location.

Nitrous oxide, oxygen, and sevoflurane were used to keep the patient asleep at a dial concentration of 1%. More vecuronium doses were given as needed.

Study Parameters

At set times, the following hemodynamic parameters were recorded:

- Before induction, the baseline
- After the induction
- When doing a laryngoscopy or intubation
- One minute after intubation
- Three minutes after intubation
- Five minutes after intubation
- 10 minutes after putting in the tube

The following parameters were recorded:

- Heart rate (HR)
- Systolic blood pressure (SBP)
- Diastolic blood pressure (DBP)
- Average arterial pressure (MAP)
- Oxygen saturation (SpO_2)

Assessment of Adverse Effects

During the research period, patients were monitored for the emergence of side effects, including:

- Low blood pressure
- Hypoxia ($SpO_2 < 95\%$)
- Pain when you get the shot
- Myoclonus
- Nausea and vomiting after surgery (PONV)

Statistical Analysis: We put the data into Microsoft Excel spreadsheets and used SPSS software version 25.0 to look at it. Continuous variables were represented as mean ± standard deviation, whilst categorical variables were represented as frequency and percentage.

The unpaired Student's t-test was used to compare continuous variables between groups, while the Chi-square test was used to look at categorical variables. A p-value of less than 0.05 was seen as statistically significant, and a p-value of less than 0.001 was seen as very significant.[16]

Results

A total of 116 patients scheduled for elective major abdominal surgeries under general anesthesia were initially assessed for eligibility. Sixteen patients were excluded due to failure to meet inclusion criteria or refusal to participate. The remaining 100 patients were randomized equally into two groups: Group P (Propofol, n = 50) and Group E (Etomidate, n = 50). All randomized patients completed the study and were included in the final analysis. There were no protocol deviations, dropouts, or losses to follow-up.

CONSORT Flow of Participants

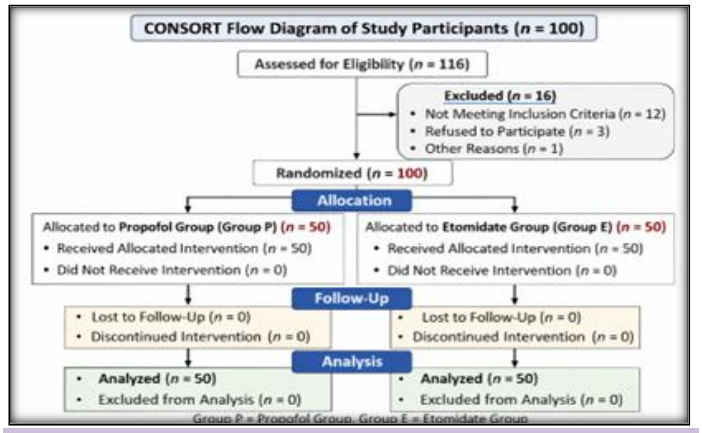

Figure 1: CONSORT flow diagram showing enrolment, randomization, allocation, follow-up, and analysis of study participants.

Demographic Characteristics: The demographic variables including age, gender, height, weight, ASA physical status, and airway characteristics were comparable between the two groups. No statistically significant differences were observed, indicating

appropriate randomization.

Table 1: Age Distribution of Study Participants

Age (years)	Propofol Group n (%)	Etomidate Group n (%)	Total n (%)
18–20	2 (4.0)	3 (6.0)	5 (5.0)
21–30	19 (38.0)	16 (32.0)	35 (35.0)
31–40	16 (32.0)	13 (26.0)	29 (29.0)
41–50	8 (16.0)	11 (22.0)	19 (19.0)
51–60	5 (10.0)	6 (12.0)	11 (11.0)
>60	0 (0.0)	1 (2.0)	1 (1.0)
Total	50 (100)	50 (100)	100 (100)

Chi-square = 2.33, p = 0.80 (Not significant)

Table 2: Mean Age Distribution

Variable	Propofol Group (Mean ± SD)	Etomidate Group (Mean ± SD)	p-value
Age (years)	34.76 ± 10.87	36.96 ± 11.93	0.34

Table 3: Gender Distribution

Gender	Propofol Group n (%)	Etomidate Group n (%)	Total n (%)
Female	39 (78.0)	35 (70.0)	74 (74.0)
Male	11 (22.0)	15 (30.0)	26 (26.0)
Total	50 (100)	50 (100)	100 (100)

Chi-square = 0.83, p = 0.36 (Not significant)

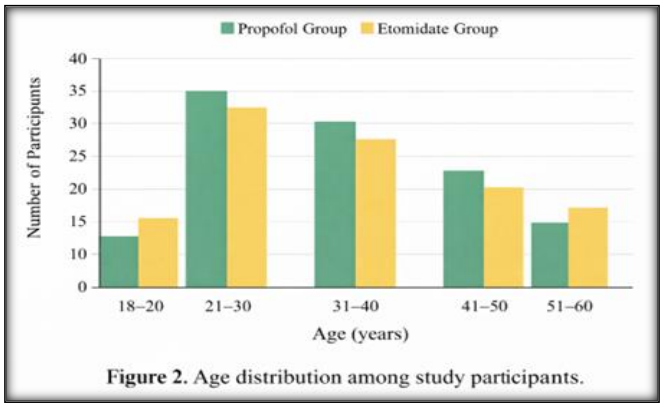

Figure 2. Age distribution among study participants.

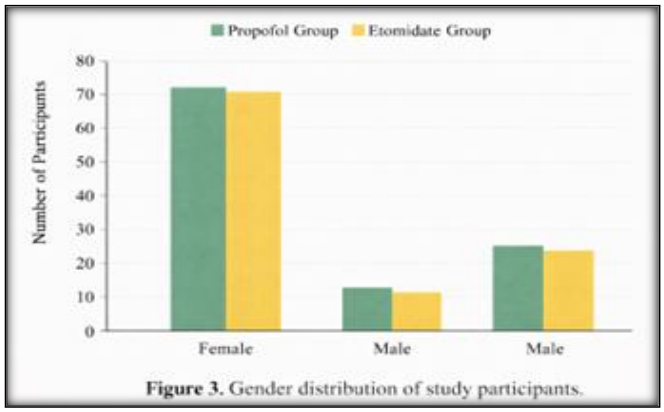

Figure 3. Gender distribution of study participants.

Table 4: Comparison of Anthropometric Parameters

Parameter	Propofol Group (Mean ± SD)	Etomidate Group (Mean ± SD)	p-value
Height (cm)	159.67 ± 5.07	158.23 ± 4.97	0.71
Weight (kg)	55.78 ± 9.74	56.64 ± 11.30	0.68

Table 5: ASA Physical Status Distribution

ASA Grade	Propofol Group n (%)	Etomidate Group n (%)	p-value
I	37 (74.0)	33 (66.0)	
II	13 (26.0)	17 (34.0)	
Total	50 (100)	50 (100)	0.38

Table 6: Mallampati Score Distribution

Mallampati Score	Propofol Group n (%)	Etomidate Group n (%)	p-value
I	22 (44.0)	20 (40.0)	
II	28 (56.0)	30 (60.0)	
Total	50 (100)	50 (100)	0.68

Hemodynamic Parameters

Heart Rate (HR)

Table 7. Comparison of Mean Heart Rate (beats/min)

Time Interval	Propofol Group (Mean ± SD)	Etomidate Group (Mean ± SD)	p-value
Baseline	81.86 ± 11.71	83.20 ± 13.26	0.59
After induction	83.64 ± 12.53	80.32 ± 11.57	0.17
At intubation	86.38 ± 17.14	84.58 ± 15.77	0.59

1 min	101.08 ± 13.47	87.82 ± 12.81	<0.001*
3 min	96.62 ± 14.05	86.28 ± 10.99	<0.001*
5 min	89.40 ± 12.97	83.64 ± 9.91	0.01*
10 min	85.52 ± 13.30	83.02 ± 11.44	0.32

*Statistically significant

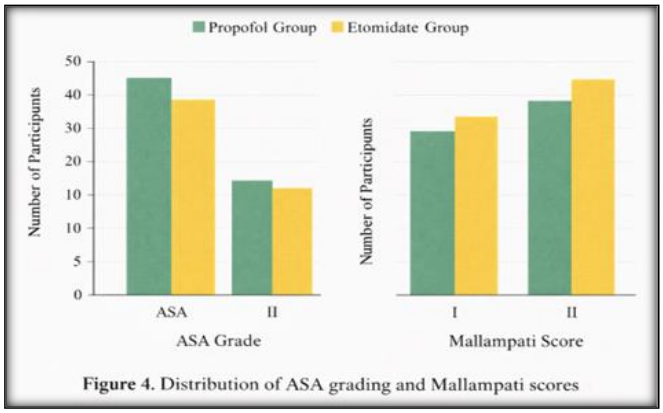

Figure 4. Distribution of ASA grading and Mallampati scores

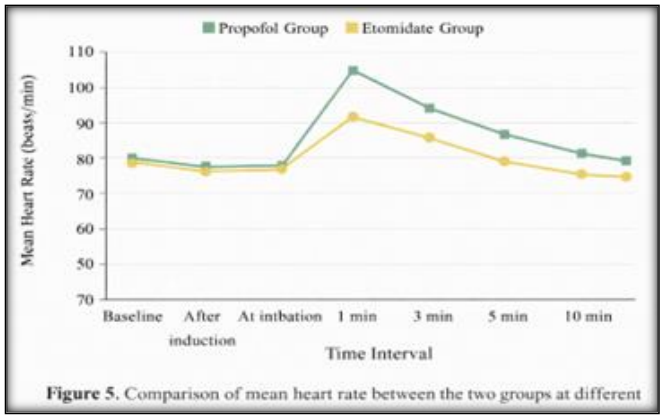

Figure 5. Comparison of mean heart rate between the two groups at different

Systolic Blood Pressure (SBP)

Table 8: Comparison of Mean Systolic Blood Pressure (mmHg)

Time Interval	Propofol Group	Etomidate Group	p-value
Baseline	127.74 ± 12.80	124.84 ± 13.32	0.27
After induction	115.28 ± 14.02	117.26 ± 11.53	0.44
At intubation	125.20 ± 12.97	118.58 ± 15.14	0.02*
1 min	139.80 ± 15.66	133.86 ± 14.23	0.04*
3 min	126.56 ± 13.39	128.64 ± 12.46	0.42
5 min	120.16 ± 13.30	126.62 ± 12.43	0.01*
10 min	122.54 ± 13.63	125.06 ± 10.18	0.30

Diastolic Blood Pressure (DBP)

Table 9: Comparison of Mean Diastolic Blood Pressure (mmHg)

Time Interval	Propofol Group	Etomidate Group	p-value
Baseline	82.18 ± 10.65	79.34 ± 10.26	0.31
After induction	75.72 ± 11.33	75.12 ± 9.33	0.77
At intubation	82.14 ± 11.25	76.88 ± 12.62	0.03*
1 min	92.20 ± 16.19	83.92 ± 11.65	0.004*
3 min	82.94 ± 12.82	80.42 ± 11.37	0.30
5 min	78.22 ± 10.55	80.40 ± 11.45	0.33
10 min	80.26 ± 12.75	79.10 ± 12.00	0.64

Mean Arterial Pressure (MAP)

Table 10: Comparison of Mean Arterial Pressure (mmHg)

Time Interval	Propofol Group	Etomidate Group	p-value
Baseline	98.13 ± 12.23	97.41 ± 11.54	0.32
After induction	89.60 ± 11.93	87.36 ± 9.26	0.30
At intubation	96.26 ± 10.59	90.72 ± 13.29	0.02*
1 min	108.52 ± 15.51	100.02 ± 12.67	0.003*
3 min	97.78 ± 12.42	95.48 ± 11.54	0.34
5 min	92.56 ± 10.46	95.58 ± 11.04	0.16
10 min	95.04 ± 12.61	93.70 ± 10.71	0.57

Oxygen Saturation (SpO_2)

Table 11: Comparison of Mean SpO_2 (%)

Time Interval	Propofol Group	Etomidate Group	p-value
Baseline	99.28 ± 0.70	99.38 ± 0.64	0.46
After induction	99.58 ± 0.58	99.56 ± 0.73	0.88
1 min	99.74 ± 0.49	99.80 ± 0.45	0.52
10 min	99.86 ± 0.35	99.88 ± 0.33	0.77

Adverse Effects: The incidence of hypotension was higher in the propofol group, whereas myoclonus was more frequently observed in the etomidate group. No episodes of hypoxia or serious adverse events were.

Discussion

This prospective randomized double-blind study aimed to examine the hemodynamic responses to laryngoscopy and endotracheal intubation after the induction of general anesthesia with propofol and etomidate in adult patients undergoing elective major abdominal operations. The principal findings of this study indicate that while both induction drugs induce hemodynamic changes during airway manipulation, etomidate offers enhanced cardiovascular stability relative to propofol, especially in the immediate post-intubation phase.

Laryngoscopy and endotracheal intubation are established unpleasant stimuli that elicit a sympathetic stress response through catecholamine release, leading to temporary elevations in heart rate and blood pressure.[17] Although these alterations are often accepted in healthy individuals, pronounced reactions may elevate perioperative morbidity in patients with constrained cardiovascular reserve. Consequently, the mitigation of this pressor response continues to be a significant objective in anesthetic administration.

The current investigation demonstrated that baseline demographic features, including age, gender, height, weight, ASA physical status, and airway parameters, were similar between the two groups, thereby validating the randomization process and reducing potential confounding variables. Baseline hemodynamic measures, such as heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation, were comparable, facilitating dependable intergroup comparisons.

Heart Rate Response: After anesthesia was started, the heart rate went up a little in the propofol group and down a little in the etomidate group. While this difference was not statistically significant right after induction, it became clear that there was a big difference after laryngoscopy and endotracheal intubation. At one minute after intubation, the heart rate went up a lot in both groups. However, the propofol group saw a much bigger increase at one, three, and five minutes.

These results indicate that etomidate is more efficacious in attenuating the sympathetic response linked to airway manipulation. Masoudifar and Beheshtian have made similar discoveries, showing that individuals given etomidate had far lower heart rate responses than those given propofol.[18] Giri et al. also found that propofol caused a bigger rise in heart rate during intubation than etomidate in patients having elective surgery.[19]

On the other hand, several investigations have found no significant differences in heart rate responses between the two agents.[20,21] These differences could be due to differences in opioid dose, depth of anesthesia, patient population, and when the measurements were taken. In this investigation, a comparatively low dose of fentanyl (1 µg/kg) was administered, perhaps influencing the disparities in heart rate responses found between groups.

Blood Pressure Response: After induction, both propofol and etomidate lowered systolic, diastolic, and mean arterial pressures. This shows that induction drugs can cause blood vessels to relax and the heart to slow down. The reduction in blood pressure was similar in both groups, however it was not statistically significant.

After laryngoscopy and intubation, both groups saw a big rise in SBP, DBP, and MAP, which is in line with sympathetic activation. The rise in blood pressure was notably more pronounced in the propofol group, especially one minute after intubation. This pressor reaction slowly went down over time, and by 10 minutes, the levels in both groups were back to where they were before.

These findings align with other research indicating enhanced hemodynamic stability with etomidate during airway manipulation. Devaraj et al. found that etomidate kept blood pressure steady during induction, but it didn't work as well as propofol to lower blood pressure. Propofol, on the other hand, caused stronger pressor responses during intubation.[22] Petrun and Kamenik noted an increased occurrence of hypotension associated with propofol and enhanced blood pressure stability with etomidate in patients undergoing significant abdominal operations.[23]

Conversely, certain publications have indicated elevated post-intubation blood pressure readings with etomidate relative to propofol.[24] These contradictory results may be due to variations in anesthetic methods, BIS-guided induction, or the presence of comorbidities in patients. The systematic protocol employed in this investigation enhances the validity of the observed results.

Mean Arterial Pressure

Mean arterial pressure is a key factor in how well organs get blood. In this study, MAP dropped after induction in both groups, showing no significant difference between the groups. After intubation, nevertheless, MAP went up a lot, and the propofol group had higher values at intubation and one minute after intubation.

Etomidate exhibited superior regulation of MAP variations during the crucial phase of airway manipulation. These results are consistent with those of Kaur et al., who found that etomidate provided better MAP stability than propofol in patients undergoing non-cardiac operations.[25]

Oxygen Saturation: Oxygen saturation stayed the same and was same for both groups over the whole trial period. There were no instances of clinically severe desaturation documented. This indicates that both propofol and etomidate, when administered under regulated conditions with sufficient preoxygenation and neuromuscular inhibition, are safe concerning oxygenation. Similar results have been documented in prior comparative investigations.[18,26]

Adverse Effects: In this study, hypotension occurred more frequently in the propofol group, but myoclonus was more often linked to etomidate. These results align with the established pharmacological characteristics of the two medications. The hypotension caused by propofol is thought to be due to systemic vasodilation and cardiac depression, while the myoclonus caused by etomidate is thought to be due to subcortical disinhibition.[27] There were no major side effects, like persistent hypoxia or arrhythmias, in either group. Even though adrenal suppression is a documented problem with etomidate, this study didn't look at it because it was just for a brief time and used only one induction dose.

Clinical Implications: The results of this investigation have

significant therapeutic ramifications. Etomidate seems to be a better drug to use to start anesthesia in patients whose heart health is very important, like those with inadequate heart reserve or who are at risk of hemodynamic instability. Even if propofol is used a lot, it may need extra measures like larger doses of opioids or beta-blockers to lower pressor responses while manipulating the airway.

Limitations: The current study, while possessing strengths, is not without limitations. The study was conducted at a single tertiary care hospital, perhaps constraining the generalizability of the findings. The study population comprised solely ASA I and II patients; hence, the findings may not be immediately relevant to high-risk cardiac patients. Also, biochemical markers of stress response and adrenal function were not evaluated.

Conclusion

Etomidate offers enhanced hemodynamic stability relative to propofol during laryngoscopy and endotracheal intubation. It is linked to smaller rises in heart rate and blood pressure while manipulating the airway, while still providing enough oxygen. Etomidate may be the best choice for an induction drug in patients whose cardiovascular stability is very important.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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