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TO COMPARE THE EFFECT OF PROPOFOL AND ETOMIDATE AS AN INDUCTION AGENT ON HEMODYNAMIC CHANGES DURING INDUCTION AND ENDOTRACHEAL INTUBATION

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ABSTRACT **Background:** Laryngoscopy and endotracheal intubation are among the most stimulating procedures performed during induction of general anaesthesia. These interventions produce marked sympathetic stimulation resulting in tachycardia, hypertension and increased myocardial oxygen demand. Although these haemodynamic responses are transient in healthy individuals, they may precipitate myocardial ischaemia, cardiac failure, cerebrovascular accidents and arrhythmias in patients with compromised cardiovascular reserve. Therefore, the choice of intravenous induction agent plays a crucial role in minimizing these adverse haemodynamic responses. Propofol is the most commonly used intravenous induction agent because of its rapid onset, smooth induction and favourable recovery profile. However, it is associated with dose-dependent hypotension due to systemic vasodilatation and myocardial depression. Etomidate, an imidazole derivative, is characterised by excellent cardiovascular stability with minimal effects on myocardial contractility and systemic vascular resistance, making it particularly useful in patients at risk of haemodynamic instability. **Aim:** To compare the effects of Propofol and Etomidate on haemodynamic changes during induction of anaesthesia and endotracheal intubation in adult patients undergoing elective surgery under general anaesthesia. **Materials and Methods:** A prospective randomized comparative study was conducted in the Department of Anaesthesiology, Sri Siddhartha Medical College and Research Institute, Tumkur. Seventy-six adult patients aged 18–60 years belonging to ASA physical status I and II scheduled for elective surgery under general anaesthesia were enrolled and randomly allocated into two equal groups (n = 38 each). Group P received intravenous Propofol 2 mg/kg whereas Group E received intravenous Etomidate 0.3 mg/kg for induction of anaesthesia. Heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were recorded at baseline, after induction, immediately after intubation, and at 1, 3, 5 and 10 minutes following intubation. Statistical analysis was performed using SPSS version 26.0. Continuous variables were analysed using the independent Student's ttest, while categorical variables were compared using the Chi-square test. A p value <0.05 was considered statistically significant. **Results:** Baseline demographic characteristics were comparable between both groups. Following induction, the Propofol group demonstrated a significantly greater reduction in systolic blood pressure, diastolic blood pressure and mean arterial pressure compared with the Etomidate group ($p<0.05$). Although both groups exhibited transient tachycardia following laryngoscopy and endotracheal intubation, haemodynamic fluctuations were significantly less pronounced in patients receiving Etomidate. Overall, Etomidate maintained superior cardiovascular stability throughout induction and intubation while Propofol produced greater hypotension despite providing smooth induction. **Conclusion:** Etomidate provides significantly better haemodynamic stability than Propofol during induction of general anaesthesia and endotracheal intubation. It minimizes fluctuations in heart rate and arterial blood pressure while maintaining adequate induction conditions. Etomidate may therefore be considered the induction agent of choice in patients where cardiovascular stability is of paramount importance.

KEYWORDS : General anaesthesia; Propofol; Etomidate; Haemodynamic stability; Endotracheal intubation; Laryngoscopy.

INTRODUCTION

General anaesthesia is an indispensable component of modern surgical practice, providing hypnosis, amnesia, analgesia and muscle relaxation to facilitate surgical procedures safely and effectively. The induction phase of general anaesthesia represents one of the most critical periods during perioperative management because significant cardiovascular alterations may occur secondary to administration of anaesthetic agents and airway manipulation.

Direct laryngoscopy and endotracheal intubation stimulate the sympathetic nervous system through activation of mechanoreceptors located in the pharynx, larynx and trachea. This sympathetic discharge results in increased plasma catecholamine concentrations leading to tachycardia, hypertension and increased myocardial oxygen consumption.

Although these responses are generally transient, they may have serious consequences in patients with coronary artery disease, hypertension, cerebrovascular disease or impaired ventricular function. [1,2]

An ideal intravenous induction agent should produce rapid loss of consciousness, smooth induction, adequate suppression of airway reflexes, minimal respiratory depression, rapid recovery and, most importantly, excellent haemodynamic stability. Propofol remains the most widely used intravenous induction agent because of its rapid onset, antiemetic properties and favourable recovery characteristics. [3] However, Propofol produces dosedependent reductions in systemic vascular resistance, myocardial contractility and arterial blood pressure. These effects may become clinically significant in elderly patients and those with limited cardiovascular reserve. [4,5]

Etomidate is an imidazole-derived intravenous anaesthetic characterised by minimal cardiovascular depression. It preserves myocardial contractility, maintains sympathetic tone and causes negligible changes in heart rate, blood pressure and cardiac output. These properties have made Etomidate particularly valuable in high-risk patients requiring induction of general anaesthesia. [6] Despite widespread clinical use of both agents, controversy remains regarding the optimal induction agent for maintaining haemodynamic stability during laryngoscopy and endotracheal intubation. Therefore, the present study was undertaken to compare the haemodynamic effects of Propofol and Etomidate during induction of general anaesthesia.

MATERIALS AND METHODS

Study design: A prospective, randomized, comparative,interventional study was conducted to evaluate and compare the haemodynamic effects of Propofol and Etomidate during induction of general anaesthesia and endotracheal intubation.

Study setting: The study was conducted in the Department of Anaesthesiology, Sri Siddhartha Medical College and Research Institute, Sri Siddhartha Academy of Higher Education, Tumkur, Karnataka, India.

Study duration: The study was carried out over a period of 18 months, including patient recruitment, data collection and statistical analysis.
Participants

Inclusion Criteria:

- Age between 18 and 60 years.
- Either gender.
- ASA Physical Status I and II.

- Elective surgeries under general anaesthesia.
- Expected duration of surgery less than three hours.
- Patients willing to participate and providing written informed consent.

Exclusion Criteria:
- ASA Physical Status III or IV.
- Emergency surgery.
- Known allergy to Propofol or Etomidate.
- Anticipated difficult airway.
- Pregnancy or lactation.
- Significant hepatic dysfunction.
- Significant renal dysfunction.
- Severe cardiovascular disease.
- Uncontrolled hypertension.
- Cardiac arrhythmias.
- Chronic β-blocker therapy.
- Adrenal insufficiency.
- Neurological disorders affecting autonomic responses.
- Refusal to participate.

Preoperative Assessment: Every patient underwent a detailed pre-anaesthetic evaluation one day before surgery including detailed medical history, general examination, airway assessment, systemic examination, and routine laboratory investigations. Patients were kept nil per oral according to ASA fasting guidelines. Written informed consent was obtained from every participant.

Study sampling: Simple random sampling was performed using computer-generated random numbers. Allocation concealment was achieved using sequentially numbered sealed opaqu

Study sample size: Based on previous published studies evaluating haemodynamic responses following induction with Propofol and Etomidate, and assuming an expected difference of 12% in mean arterial pressure between the groups with 80% statistical power and 95% confidence interval, the minimum calculated sample size was 36 patients per group. Considering possible exclusions and incomplete observations, 76 patients were enrolled and randomly allocated into two equal groups (n = 38 each).

Study groups:
- Group P (Propofol): 38 patients received Injection Propofol 2 mg/kg IV administered slowly over approximately 30 seconds.
- Group E (Etomidate): 38 patients received Injection Etomidate 0.3 mg/kg IV administered over approximately 30 seconds.
- Study parameters:
- Primary Outcome: Haemodynamic responses including Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Arterial Pressure (MAP).
- Secondary Outcomes: Incidence of hypotension, hypertension, bradycardia, tachycardia, myoclonus, pain during injection, arrhythmias, and requirement of rescue medication.

Time Points: Measurements were recorded at:
- T0 — Baseline before induction
- T1 — Immediately after induction
- T2 — Immediately after intubation
- T3 — One minute after intubation
- T4 — Three minutes after intubation
- T5 — Five minutes after intubation
- T6 — Ten minutes after intubation

Study procedure: Inside the operating theatre, standard ASA monitoring was instituted including Electrocardiography (ECG), Non-invasive blood pressure (NIBP), Pulse oximetry (SpO_2), and End-tidal carbon dioxide (EtCO_2). Baseline parameters were recorded before administration of induction agents. All patients received Glycopyrrolate 0.2 mg IV, Ondansetron 4 mg IV, Midazolam 0.03 mg/kg IV, and Fentanyl 2 µg/kg IV.

After adequate preoxygenation with 100% oxygen for three minutes, induction was carried out according to group allocation. Loss of verbal response confirmed induction. Neuromuscular blockade was achieved using Vecuronium 0.1 mg/kg IV. After three minutes of mask ventilation, direct laryngoscopy was performed using a Macintosh blade. Endotracheal intubation was completed by an experienced anaesthesiologist within 20 seconds to minimise variability. Anaesthesia was maintained using Oxygen, Nitrous oxide, Isoflurane, and intermittent Vecuronium. Patients were mechanically ventilated to maintain EtCO_2 between 35–40 mmHg.

Data analysis: Collected data were entered into Microsoft Excel and analysed using SPSS Version 26.0. Continuous variables were expressed as Mean ± Standard Deviation (SD), and categorical variables were presented as frequency and percentage. Comparisons between the two groups were performed using the independent Student's t-test, Chisquare test, and Fisher's exact test whenever appropriate. Repeated haemodynamic measurements were analysed using repeated measures ANOVA. A p-value <0.05 was considered statistically significant.

Ethical considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee of Sri Siddhartha Medical College and Research Institute. Written informed consent was obtained from all participants before enrolment. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

RESULTS

A total of 76 patients scheduled for elective surgeries under general anaesthesia were enrolled in the study. Patients were randomly allocated into two equal groups of 38 patients each. There were no dropouts, and all patients completed the study. The baseline demographic characteristics of both groups were comparable, permitting valid comparison of haemodynamic variables.

Table 1: Baseline Demographic Characteristics of the Study Population

Parameter	Group P (n=38)	Group E (n=38)	p-value
Age (years)	41.8 ± 10.4	42.6 ± 9.8	0.731
Weight (kg)	63.9 ± 8.5	64.8 ± 7.9	0.648
Height (cm)	164.2 ± 7.3	165.1 ± 6.8	0.584
BMI (kg/m²)	23.7 ± 2.8	23.9 ± 2.6	0.812

Interpretation: The mean age, weight, height and body mass index were comparable between both study groups. No statistically significant difference was observed (p >0.05), indicating adequate baseline homogeneity.

Table 2: Gender Distribution

Gender	Propofol	Etomidate	Total	p-value
Male	23	22	45	0.816		Female	15	16	31	

Interpretation: Male patients constituted the majority of the study population (59.2%). Gender distribution was similar in both groups and was not statistically significant.

Table 3: ASA Physical Status

ASA Grade	Propofol	Etomidate	Total	p-value
I	24	23	47	0.792
II	14	15	29	

Interpretation: Most patients belonged to ASA Grade I. Both groups were comparable regarding ASA physical status without any statistically significant difference.

Table 4: Comparison of Heart Rate (beats/min)

Time	Propofol	Etomidate	p-value
Baseline	82.1 ± 9.5	81.8 ± 8.9	0.894
After induction	75.4 ± 8.2	79.9 ± 8.5	0.021*
Immediately after intubation	96.8 ± 10.3	90.2 ± 8.7	0.006*
1 min	93.5 ± 9.7	87.1 ± 8.4	0.004*
3 min	88.7 ± 8.6	84.0 ± 7.9	0.018*
5 min	84.8 ± 7.8	82.6 ± 7.2	0.214
10 min	82.7 ± 7.1	81.6 ± 6.8	0.562

***Statistically significant**

Interpretation: Heart rate increased significantly following laryngoscopy and intubation in both groups. However, the increase was significantly greater in the Propofol group during the early post-intubation period. By 10 minutes, heart rate had returned close to baseline values in both groups.

Table 5: Comparison of Systolic Blood Pressure (mmHg)

Time	Propofol	Etomidate	p-value
Baseline	126.4 ± 11.5	127.1 ± 10.8	0.771
After induction	104.8 ± 10.2	119.6 ± 9.8	<0.001*
Immediately after intubation	136.2 ± 12.4	129.5 ± 10.9	0.014*
1 min	131.5 ± 11.8	126.8 ± 10.1	0.038*
3 min	124.7 ± 10.2	123.4 ± 9.6	0.548
5 min	121.2 ± 8.7	121.8 ± 8.3	0.791
10 min	119.3 ± 7.9	120.4 ± 7.6	0.601

Interpretation: Propofol produced a significantly greater fall in systolic blood pressure immediately after induction. Following intubation, systolic blood pressure increased in both groups, but the Etomidate group maintained superior haemodynamic stability.

Table 6: Comparison of Diastolic Blood Pressure (DBP) Between the Two Groups

Time	Propofol (mmHg)	Etomidate (mmHg)	p-value
Baseline	78.6 ± 8.2	79.2 ± 7.9	0.714
After induction	62.8 ± 6.9	74.6 ± 7.2	<0.001*
Immediately after intubation	84.5 ± 8.6	80.1 ± 7.5	0.023*
1 minute	81.6 ± 8.1	78.4 ± 7.3	0.048*
3 minutes	77.2 ± 7.5	76.1 ± 6.9	0.534
5 minutes	74.8 ± 6.8	75.0 ± 6.7	0.911
10 minutes	73.6 ± 6.2	74.1 ± 6.0	0.748

***Statistically significant (p <0.05)**

Interpretation: Baseline diastolic blood pressure was comparable between the two groups.

Following induction, the Propofol group demonstrated a significantly greater reduction in DBP than the Etomidate group (p<0.001). Although DBP increased transiently after laryngoscopy and intubation in both groups, the rise was less pronounced in the Etomidate group, indicating superior haemodynamic stability.

Table 7: Comparison of Mean Arterial Pressure (MAP)

Time	Propofol (mmHg)	Etomidate (mmHg)	p-value
Baseline	94.5 ± 7.6	95.2 ± 7.2	0.683
After induction	76.7 ± 7.1	89.3 ± 7.6	<0.001*
Immediately after intubation	101.5 ± 8.5	96.4 ± 7.8	0.011*
1 minute	98.2 ± 8.2	94.3 ± 7.4	0.031*
3 minutes	92.7 ± 7.8	91.5 ± 7.2	0.471
5 minutes	90.4 ± 6.9	90.9 ± 6.6	0.772
10 minutes	89.1 ± 6.5	89.7 ± 6.3	0.695

***Statistically significant (p <0.05)**

Interpretation: Mean arterial pressure decreased significantly after induction with Propofol, whereas Etomidate maintained MAP close to baseline values. The difference between the groups was statistically significant immediately after induction and during the early postintubation period. By 10 minutes, MAP values were comparable.

Table 8: Incidence of Adverse Effects

Adverse Effect	Propofol (n=38)	Etomidate (n=38)	p-value
Hypotension	8 (21.1%)	2 (5.3%)	0.041*
Bradycardia	2 (5.3%)	1 (2.6%)	0.554
Pain on Injection	11 (28.9%)	3 (7.9%)	0.018*
Myoclonus	0	5 (13.2%)	0.021*
Nausea/Vomiting	2 (5.3%)	1 (2.6%)	0.554
Arrhythmias	0	0	—

Interpretation: The incidence of hypotension and pain during injection was significantly higher in the Propofol group. Conversely, myoclonus occurred only in patients receiving Etomidate. No serious arrhythmias or major perioperative complications were observed in either group.

DISCUSSION

The induction of general anaesthesia and endotracheal intubation is associated with marked sympathetic stimulation, resulting in transient increases in heart rate and arterial blood pressure. Although these haemodynamic changes are usually well tolerated in healthy individuals, they may precipitate myocardial ischaemia, cardiac dysrhythmias, left ventricular failure, or cerebrovascular events in patients with limited cardiovascular reserve. Therefore, the selection of an induction agent capable of maintaining haemodynamic stability remains an important consideration in anaesthetic practice. The present study compared the haemodynamic effects of Propofol and Etomidate during induction of general anaesthesia and endotracheal intubation in adult patients undergoing elective surgical procedures. The principal finding of this study was that Etomidate provided superior haemodynamic stability compared with Propofol throughout the induction period and during the early post-intubation phase.

Demographic Characteristics: Both study groups were comparable with respect to age, gender distribution, body mass index and ASA. No statistically significant differences were observed in baseline demographic variables (p>0.05). This ensured that the observed haemodynamic differences were attributable to the induction agents rather than patientrelated factors. These findings are consistent with those reported by Möller Petrun and Kamenik, Kaushal et al., and Shah et al., who also demonstrated comparable baseline characteristics between Propofol and Etomidate groups. [7-9]

Heart Rate: In the present study, baseline heart rate was similar in both groups. Following induction, Propofol produced a modest reduction in heart rate, whereas Etomidate maintained heart rate close to baseline values. Immediately after laryngoscopy and endotracheal intubation, heart rate increased significantly in both groups due to sympathetic stimulation. However, the increase was significantly greater in the Propofol group. Heart rate gradually returned toward baseline within ten minutes in both groups. The better preservation of heart rate observed with Etomidate can be explained by its minimal effect on sympathetic nervous system activity and preservation of baroreceptor reflexes.

Propofol, on the other hand, suppresses sympathetic tone and depresses baroreceptor responsiveness, resulting in greater haemodynamic fluctuations during induction. Our observations agree with studies conducted by Möller Petrun et al., Singaravelan et al., Pandey et al., and Shah et al., all of whom demonstrated superior heart rate stability with Etomidate. [7,9,10]

Systolic Blood Pressure: One of the most important findings of the present study was the significant reduction in systolic blood pressure following induction with Propofol. Patients receiving Propofol experienced a marked fall in systolic blood pressure immediately after induction, whereas patients receiving Etomidate maintained blood pressure values much closer to baseline. Following intubation, systolic blood pressure increased transiently in both groups because of the sympathetic response to laryngoscopy, but the increase remained less pronounced in the Etomidate group. The hypotensive effect of Propofol is primarily attributed to peripheral vasodilatation, reduced systemic vascular resistance, direct myocardial depression, and blunting of sympathetic nervous system activity. Etomidate produces minimal myocardial depression and preserves vascular tone, thereby maintaining arterial pressure more effectively. The findings of the present study closely parallel those reported by Kantharia et al., Pandey et al., Möller Petrun et al., and Shah et al., all of whom concluded that Etomidate maintains systolic blood pressure significantly better than Propofol. [7,9,10]

Diastolic Blood Pressure: Diastolic blood pressure followed a pattern similar to systolic blood pressure. Following induction, Propofol produced a significantly greater reduction in DBP compared with Etomidate. Although both groups exhibited transient increases after intubation, recovery towards baseline occurred more rapidly in the Etomidate group. Maintenance of diastolic pressure is clinically important because coronary perfusion predominantly occurs during diastole. Preservation of diastolic blood pressure may therefore reduce the risk of myocardial ischaemia in susceptible patients. The present findings are in agreement with previously published studies comparing Propofol and Etomidate, all of which demonstrated superior maintenance of diastolic pressure with Etomidate.

Mean Arterial Pressure: Mean arterial pressure represents one of the most reliable indicators of overall organ perfusion. The present study demonstrated a significant reduction in MAP immediately after induction with Propofol, whereas MAP remained relatively stable following Etomidate administration. Although both groups exhibited transient haemodynamic responses to laryngoscopy, recovery of MAP occurred more rapidly in the Etomidate group. The preservation of MAP observed with Etomidate is attributable to minimal myocardial

depression, preservation of sympathetic nervous system activity, maintenance of systemic vascular resistance, and preservation of baroreceptor reflexes. These findings are consistent with those reported by Kaushal et al., Pandey et al., Shah et al., and Möller Petrun et al. [7-10]

Adverse Effects: Pain during intravenous injection occurred more frequently in patients receiving Propofol. This finding is well documented and results from irritation of peripheral venous endothelium caused by the lipid emulsion formulation. Conversely, myoclonic movements were observed more frequently in patients receiving Etomidate. Etomidateinduced myoclonus is believed to result from transient subcortical disinhibition before complete cortical depression develops. [11,12] Although myoclonus was observed in a small proportion of patients, it was self-limiting and did not interfere with airway management or patient safety. No serious cardiovascular complications or clinically significant arrhythmias were encountered in either study group.

Clinical Implications: The results of the present study suggest that Etomidate is a preferable induction agent in patients where maintenance of haemodynamic stability is crucial, including elderly patients, those with coronary artery disease, valvular heart disease, cardiomyopathy, heart failure, hypovolaemic patients, polytrauma, septic shock, and patients with limited cardiovascular reserve. Propofol remains an excellent induction agent for routine elective surgeries in healthy individuals because of its rapid onset, smooth induction, antiemetic properties, and favourable recovery profile. However, anaesthesiologists should anticipate and promptly manage the hypotension associated with its use.

CONCLUSION

The present prospective randomized comparative study evaluated the haemodynamic effects of Propofol and Etomidate during induction of general anaesthesia and endotracheal intubation in adult patients undergoing elective surgery. Both induction agents provided satisfactory conditions for induction and facilitated successful endotracheal intubation. However, significant differences were observed in their haemodynamic profiles. Propofol produced a greater reduction in systolic blood pressure, diastolic blood pressure, and mean arterial pressure immediately following induction. Although these changes were transient, they were statistically significant and reflected the well-recognized vasodilatory and myocardial depressant effects of Propofol. The sympathetic response to laryngoscopy and intubation was also more pronounced in the Propofol group.

In contrast, Etomidate maintained heart rate and arterial blood pressure much closer to baseline values throughout the peri-intubation period. The preservation of sympathetic tone and baroreceptor reflexes contributed to its superior cardiovascular stability. While a higher incidence of myoclonus was observed with Etomidate, it was transient, self-limiting, and did not interfere with airway management or the conduct of anaesthesia. Overall, the findings of this study demonstrate that Etomidate provides significantly better haemodynamic stability than Propofol during induction of general anaesthesia and endotracheal intubation. Its favourable cardiovascular profile makes it particularly suitable for patients in whom maintenance of stable haemodynamics is essential.

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