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Comparison Of Haemodynamic Response to Tracheal Intubation with Propofol and Etomidate Under General Anaesthesia in Elective Surgeries: A Randomized Double-Blind Study

Dr. Baldev[1], Dr. Miltan Debbarma[2], Dr. Yasha Tiwari[3], Dr Madhumita G Murthy[4], Dr. Shivam Kaushik[5], Dr. Avinash Kumar Mandavi[6]

[1]PG Resident Chhattisgarh institute of medical sciences
[2]Associate professor Chhattisgarh institute of medical sciences
[3]Assistant professor Chhattisgarh institute of medical sciences
[4]Professor and HOD Chhattisgarh institute of medical sciences
[5]PG Resident Chhattisgarh institute of medical sciences
[6]PG Resident Chhattisgarh institute of medical sciences

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Corresponding Author:

Dr. Baldev
PG Resident Chhattisgarh institute of medical sciences
E-mail - dr.baldev8590@gmail.com

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ABSTRACT

Background Laryngoscopy and endotracheal intubation are associated with significant haemodynamic stress responses that may result in tachycardia, hypertension, and cardiovascular instability. Propofol and Etomidate are commonly used intravenous induction agents with different haemodynamic profiles. The present study was conducted to compare the haemodynamic effects of Propofol and Etomidate during induction of anaesthesia and tracheal intubation.

Materials and Methods This prospective randomized double-blind study was conducted on 80 ASA I and II patients aged 18–60 years undergoing elective surgeries under general anaesthesia. Patients were randomly divided into two groups of 40 each. Group P received intravenous Propofol 2.5 mg/kg, while Group E received intravenous Etomidate 0.3 mg/kg for induction. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO_2) were recorded at baseline, after premedication, during induction, at intubation, and at 1, 3, 5, and 10 minutes post-intubation. Adverse effects such as pain on injection, myoclonus, and postoperative nausea and vomiting (PONV) were also assessed.

Results Baseline demographic variables were comparable between the two groups. At intubation, heart rate was significantly higher in the Propofol group compared to the Etomidate group (89.18 ± 11.65 vs 80.30 ± 4.77 bpm; $p < 0.001$). Similarly, SBP (130.68 ± 13.03 vs 115.50 ± 6.14 mmHg), DBP (73.00 ± 7.59 vs 64.37 ± 4.42 mmHg), and MAP (86.05 ± 7.66 vs 73.45 ± 4.78 mmHg) were significantly higher in the Propofol group during intubation ($p < 0.001$). These haemodynamic differences persisted up to 10 minutes post-intubation. SpO_2 remained comparable in both groups throughout the study. Pain on injection was more common with Propofol (25%), whereas myoclonus (12.5%) and PONV (15%) were more frequent with Etomidate.

Conclusion Etomidate provided superior haemodynamic stability compared to Propofol during induction of anaesthesia and endotracheal intubation. Although Etomidate was associated with higher incidence of myoclonus and PONV, it may be considered a safer induction agent in patients where cardiovascular stability is essential.

Keywords: *Propofol, Etomidate, haemodynamic stability, laryngoscopy, endotracheal intubation, induction agents, general anaesthesia.*

INTRODUCTION

General anaesthesia is an indispensable component of modern surgical practice, providing reversible loss of consciousness, analgesia, amnesia, and muscle relaxation required for a wide range of operative procedures [1]. Among all phases of anaesthesia, induction and endotracheal intubation are considered the most critical because they are frequently associated with significant haemodynamic fluctuations. Laryngoscopy and tracheal intubation provoke intense sympathetic stimulation leading to tachycardia, hypertension, and arrhythmias, which may be transient in healthy individuals but potentially hazardous in patients with limited cardiovascular reserve [2], [3]. Even short-lived haemodynamic instability during this period may precipitate myocardial ischaemia, cerebrovascular accidents, acute heart failure, or renal hypoperfusion in susceptible patients.Several perioperative studies have demonstrated that marked blood pressure variability and episodes of intraoperative hypotension are independently associated with adverse postoperative outcomes, including myocardial injury, acute kidney injury, neurological complications, prolonged hospital stay, and increased perioperative morbidity [4]. Consequently, maintenance of cardiovascular stability during induction of anaesthesia and airway manipulation has become a major objective in contemporary anaesthetic practice. Achieving this stability requires a careful balance between adequate anaesthetic depth and avoidance of excessive cardiovascular depression.The haemodynamic stress response associated with laryngoscopy and intubation primarily results from mechanical stimulation of the oropharyngeal and laryngotracheal structures, which activates sympathetic and sympathoadrenal pathways [5]. This reflex response causes increased catecholamine release leading to elevations in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure. Although these changes generally return to baseline within a few minutes, they may have serious consequences in patients with hypertension, coronary artery disease, cerebrovascular disorders, raised intracranial pressure, or other cardiovascular comorbidities. Conversely, excessive attenuation of sympathetic tone due to anaesthetic agents may result in profound hypotension and bradycardia, thereby compromising coronary and cerebral perfusion.Various strategies have been employed to attenuate the haemodynamic response to laryngoscopy and tracheal intubation. Non-pharmacological measures include use of video-laryngoscopes, fibreoptic bronchoscopes, and supraglottic airway-guided intubation techniques that minimize airway stimulation [6,7]. Adequate preoxygenation, anxiolysis, optimization of intravascular volume status, and minimizing repeated laryngoscopy attempts also contribute to improved cardiovascular stability. Pharmacological methods include administration of opioids, β-blockers, vasodilators, local anaesthetics, calcium channel blockers, magnesium sulphate, and α2-adrenergic agonists such as clonidine and dexmedetomidine. However, no single intervention provides complete suppression of the pressor response without associated adverse effects, and therefore individualized approaches remain necessary.Among intravenous induction agents, Propofol and Etomidate are widely used because of their rapid onset and favourable pharmacokinetic profiles. Propofol, an alkylphenol derivative, is one of the most commonly used induction agents owing to its smooth induction characteristics, rapid recovery profile, antiemetic properties, and ability to suppress airway reflexes effectively [8,9]. Propofol also attenuates the sympathetic response to laryngoscopy and intubation. However, it is associated with dose-dependent cardiovascular depression resulting from systemic vasodilation, reduced systemic vascular resistance, impaired baroreceptor reflexes, and mild myocardial depression [10]. Consequently, hypotension and bradycardia frequently occur following induction with Propofol, particularly in elderly individuals, hypovolemic patients, and those with compromised cardiac function.Etomidate, an imidazole-derived hypnotic agent, differs significantly in its haemodynamic profile. It preserves sympathetic tone and baroreceptor reflexes, producing minimal changes in heart rate, systemic vascular resistance, and myocardial contractility during induction [11]. These properties make Etomidate especially valuable in patients with cardiovascular instability, poor ventricular function, or limited cardiac reserve[12,13]. Nevertheless, Etomidate may not suppress the haemodynamic response to laryngoscopy as effectively as Propofol, leading to transient increases in blood pressure and heart rate during airway manipulation. In addition, Etomidate is associated with adverse effects such as myoclonus, postoperative nausea and vomiting, injection pain, and transient adrenal suppression due to inhibition of 11β-hydroxylase enzyme activity.Although numerous studies have compared Propofol and Etomidate, debate persists regarding their relative efficacy in maintaining haemodynamic stability during induction and intubation [14,15]. Most previous investigations have focused primarily on the immediate response to laryngoscopy rather than evaluating haemodynamic trends throughout the early post-intubation period. Furthermore, data from elective surgical populations in resource-limited settings remain limited. Therefore, the present randomized double-blind comparative study was undertaken to evaluate and compare the haemodynamic effects of Propofol and Etomidate during induction of anaesthesia and the early post-intubation period under standardized clinical conditions. The findings of this study may help guide rational selection of induction agents to improve perioperative cardiovascular stability and patient safety.

MATERIALS AND METHODS

The present study was conducted as a prospective, randomized, double-blind comparative clinical study in the Department of Anaesthesiology at Chhattisgarh Institute of Medical Sciences. The study was carried out in the Major Operation Theatre complex after obtaining approval from the Institutional Scientific Research Review Committee and Institutional Ethics Committee. The study included adult patients aged between 18 and 60 years belonging to American Society of Anaesthesiologists (ASA) physical status I and II who were scheduled for elective surgical procedures under general anaesthesia requiring endotracheal intubation.Patients with ASA grade I and II were selected to reduce the influence of severe systemic illness on haemodynamic parameters and to maintain homogeneity among study participants. Elective surgical procedures were chosen to ensure adequate preoperative optimization and standardized perioperative conditions.

Inclusion Criteria
Patients fulfilling the following criteria were included in the study:

- Age between 18 and 60 years
- ASA physical status I or II
- Mallampati grade I or II
- Patients scheduled for elective surgery under general anaesthesia with endotracheal intubation
- Patients willing to provide written informed consent

Exclusion Criteria
Patients with the following conditions were excluded from the study:

- Known hypersensitivity to Propofol or Etomidate
- Allergy to egg, soy, or soy products
- Anticipated difficult airway
- Primary or secondary adrenal insufficiency
- Patients receiving chronic steroid therapy
- History of seizure disorder
- Pregnant and lactating women
- Patients receiving sedatives or psychoactive medications
- Patients requiring more than one attempt for intubation

Patients with adrenal insufficiency and those on chronic steroid therapy were excluded because Etomidate inhibits 11β-hydroxylase and may suppress adrenal steroidogenesis. Patients requiring repeated laryngoscopy attempts were excluded because multiple intubation attempts can independently exaggerate sympathetic stimulation and alter haemodynamic responses.A total of 80 patients were enrolled in this study.

- Group P (Propofol group): 40 patients
- Group E (Etomidate group): 40 patients

Randomization and Blinding
Randomization was performed using a computer-generated random allocation sequence. Allocation concealment was ensured using sealed opaque envelopes. The study drugs were prepared in identical syringes by an anaesthesia resident who was not involved in data collection or patient monitoring. The anaesthesiologist administering the drug and recording the haemodynamic parameters remained unaware of the group allocation throughout the study period, thereby ensuring double blinding.

Study Procedure
After a thorough pre-anaesthetic evaluation and confirmation of nil per oral (NBM) status, all patients were shifted to the preoperative area. Standard monitoring including electrocardiography (ECG), non-invasive blood pressure (NIBP), and pulse oximetry was instituted, and an 18-gauge intravenous cannula was secured. Baseline haemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO_2) were recorded and considered as T0.

All patients received intravenous Glycopyrrolate 0.2 mg as premedication 10 minutes before entering the operation theatre. In the operation theatre, patients were premedicated with intravenous Ondansetron 0.1 mg/kg, Midazolam 0.02 mg/kg, and Fentanyl 2 µg/kg. Haemodynamic parameters were again recorded and considered as T1. Preoxygenation with 100% oxygen was performed for 3 minutes.

Patients in Group P received intravenous Propofol 2.5 mg/kg for induction, whereas patients in Group E received intravenous Etomidate 0.3 mg/kg administered slowly over 30 seconds. Time from administration of induction agent to loss of eyelash reflex was considered as induction time. Haemodynamic parameters after induction were recorded as T2. Following induction, intravenous Succinylcholine 2 mg/kg was administered to facilitate tracheal intubation. Direct laryngoscopy and endotracheal intubation were performed using appropriately sized endotracheal tubes. Haemodynamic parameters recorded during laryngoscopy and intubation were considered as T3. Correct placement of the endotracheal tube was confirmed by bilateral chest auscultation and capnography.

Patients requiring more than one attempt at intubation were excluded from the study. Haemodynamic parameters were further recorded at 1, 3, 5, and 10 minutes after intubation.

Anaesthesia was maintained with oxygen, nitrous oxide (40:60), and Sevoflurane along with intermittent intravenous Vecuronium 0.1 mg/kg as required. At the end of surgery, neuromuscular blockade was reversed using intravenous Glycopyrrolate 0.008 mg/kg and Neostigmine 0.05 mg/kg. Patients were extubated after fulfilling standard extubation criteria and shifted to the postoperative recovery room for monitoring.

Hypotension defined as MAP <60 mmHg was treated with incremental doses of intravenous Mephentermine, while bradycardia with heart rate <50 beats/minute was managed using incremental doses of intravenous Atropine.

Parameters Observed

The following haemodynamic parameters were recorded during the study:

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

These parameters were recorded at the following intervals:

- T0 – Baseline
- T1 – Pre-induction
- T2 – After induction
- T3 – During laryngoscopy and intubation
- 1, 3, 5, and 10 minutes after intubation

Pain on injection was assessed using a four-point pain scale:

- 0 – No pain
- 1 – Verbal complaint of pain
- 2 – Withdrawal of arm
- 3 – Both verbal complaint and withdrawal of arm

Complications such as nausea, vomiting, and myoclonus were also assessed. Myoclonus was graded as absent, mild, moderate, or severe depending on the intensity of involuntary muscle movements.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software version 22.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequencies and percentages.

Comparison of categorical variables between the two groups was performed using Chi-square test or Fisher's exact test whenever applicable. Continuous variables were compared using unpaired Student's t-test. Trends in haemodynamic parameters over time were illustrated using line diagrams, while categorical data were represented using bar charts and pie charts. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations and Confidentiality

The study was initiated only after approval from the Institutional Ethics Committee. Informed consent was obtained from all participants before enrolment. Confidentiality of patient information was strictly maintained throughout the study. Patient identifiers such as names and contact details were not disclosed in any publication or public presentation.

RESULTS

A total of 80 patients were included in the study and were equally divided into two groups: Group P (Propofol group, n=40) and Group E (Etomidate group, n=40).Baseline demographic characteristics including age, weight, gender distribution, and ASA physical status were comparable between the two groups, indicating adequate randomization and homogeneity of study participants (Table 1, Figure 1). The mean age of patients in the Propofol group was 35.92 ± 10.05 years compared to 34.05 ± 9.25 years in the Etomidate group (p = 0.511). Similarly, mean body weight was 62.52 ± 6.50 kg in Group P and 63.32 ± 7.86 kg in Group E (p = 0.631). Male patients constituted 65% of the Propofol group and 50% of the Etomidate group, while ASA II patients accounted for 65% and 60% of the respective groups. None of these differences were statistically significant (p > 0.05).

Table 1: Baseline Demographic Characteristics of Study Groups

Variable	Group P: Propofol (n=40)	Group E: Etomidate (n=40)	p-value
Age (years), Mean ± SD	35.92 ± 10.05	34.05 ± 9.25	0.511
Weight (kg), Mean ± SD	62.52 ± 6.50	63.32 ± 7.86	0.631
Male	26 (65.0%)	20 (50.0%)	0.258
Female	14 (35.0%)	20 (50.0%)	0.258
ASA I	14 (35.0%)	16 (40.0%)	0.817
ASA II	26 (65.0%)	24 (60.0%)	0.817

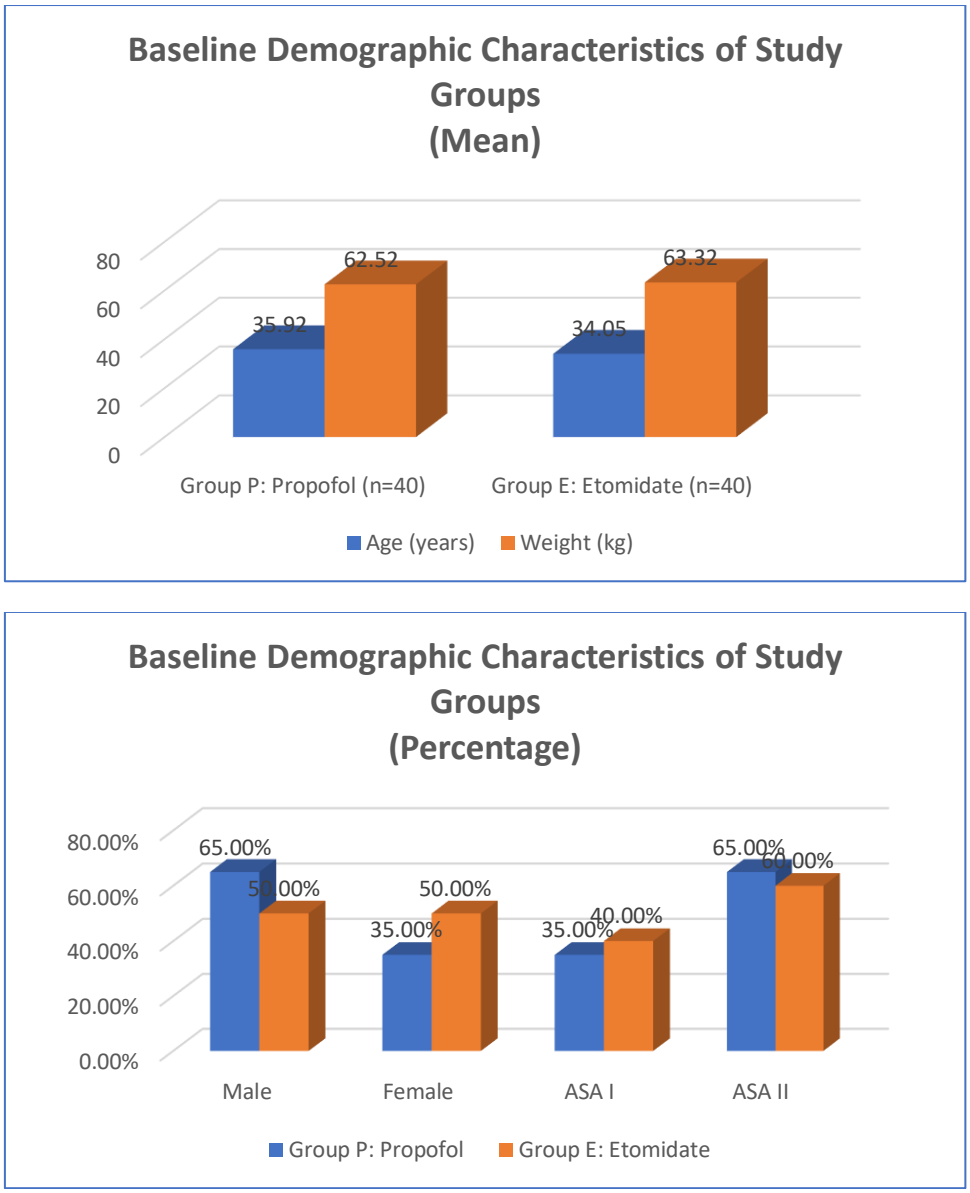

Figure 1 Baseline Demographic Characteristics of Study Groups

Heart rate trends at different peri-intubation intervals are summarized in (Table 2 and Figure 2). Baseline heart rate was comparable between the two groups (84.18 ± 14.80 bpm in Group P vs 79.53 ± 13.95 bpm in Group E; $p = 0.162$). No statistically significant difference was observed after premedication or during induction ($p > 0.05$). However, at the time of intubation, heart rate increased significantly in the Propofol group compared to the Etomidate group (89.18 ± 11.65 bpm vs 80.30 ± 4.77 bpm; $p < 0.001$). This statistically significant difference persisted at 1 minute, 3 minutes, 5 minutes, and 10 minutes after intubation, with consistently higher heart rate values observed in the Propofol group.

Table 2: Comparison of Heart Rate Between Study Groups

Time Interval	Group P: Propofol Mean ± SD	Group E: Etomidate Mean ± SD	p-value
Preoperative	84.18 ± 14.80	79.53 ± 13.95	0.162
Premedication	81.30 ± 11.07	79.39 ± 6.41	0.371
Induction	85.90 ± 15.20	79.65 ± 14.60	0.072
Intubation	89.18 ± 11.65	80.30 ± 4.77	<0.001
1 minute	87.85 ± 11.39	79.93 ± 4.76	<0.001
3 minutes	86.20 ± 11.27	78.93 ± 4.81	<0.001
5 minutes	84.98 ± 11.12	77.93 ± 4.84	0.001
10 minutes	83.45 ± 11.06	76.93 ± 4.86	0.002

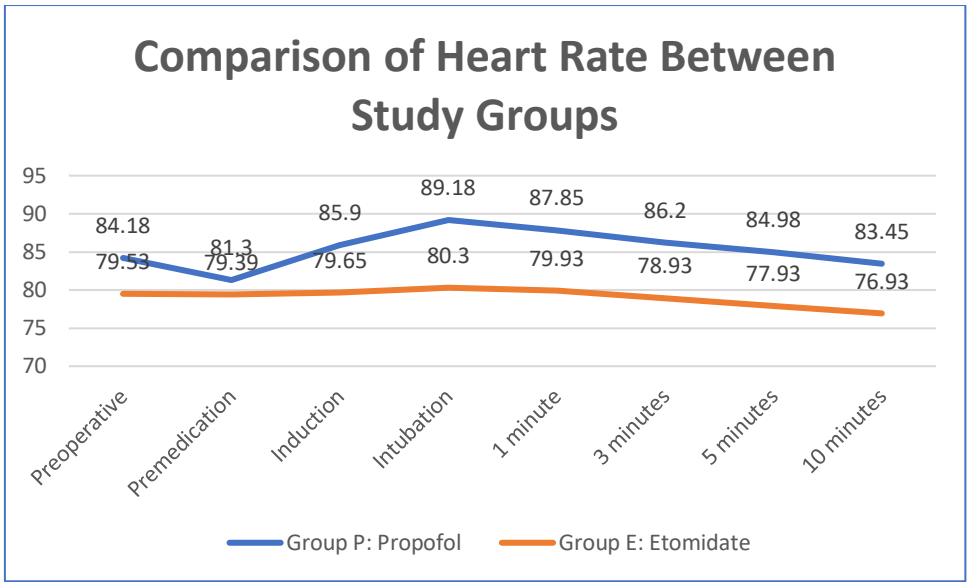

Figure 2 Comparison of Heart Rate Between Study Groups

Comparison of haemodynamic parameters at the time of intubation is shown in (Table 3). Systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were significantly higher in the Propofol group compared to the Etomidate group during intubation. The mean SBP at intubation was 130.68 ± 13.03 mmHg in Group P compared to 115.50 ± 6.14 mmHg in Group E ($p < 0.001$). Similarly, DBP was 73.00 ± 7.59 mmHg in the Propofol group and 64.37 ± 4.42 mmHg in the Etomidate group ($p < 0.001$). Mean arterial pressure was also significantly elevated in Group P (86.05 ± 7.66 mmHg) compared to Group E (73.45 ± 4.78 mmHg) with a highly significant p-value (<0.001). Oxygen saturation remained comparable between both groups throughout the study period and no statistically significant difference was observed ($p = 0.161$).

Table 3: Comparison of Haemodynamic Parameters at Intubation

Parameter at Intubation	Group P: Propofol Mean ± SD	Group E: Etomidate Mean ± SD	p-value
Heart rate (bpm)	89.18 ± 11.65	80.30 ± 4.77	<0.001
SBP (mmHg)	130.68 ± 13.03	115.50 ± 6.14	<0.001
DBP (mmHg)	73.00 ± 7.59	64.37 ± 4.42	<0.001
MAP (mmHg)	86.05 ± 7.66	73.45 ± 4.78	<0.001
SpO_2 (%)	98.88 ± 0.79	99.13 ± 0.79	0.161

Adverse effects observed during the study are summarized in (Table 4). Pain on injection was more frequently observed in the Propofol group (25%) compared to the Etomidate group (7.5%), although the difference was not statistically significant ($p = 0.060$). Myoclonus was observed only in the Etomidate group in 12.5% of patients, while no cases were reported in the Propofol group; however, this difference did not reach statistical significance ($p = 0.060$). Postoperative nausea and vomiting (PONV) occurred exclusively in the Etomidate group in 15% of patients and this difference was statistically significant ($p = 0.026$).

Table 4: Comparison of Adverse Effects Between Study Groups

Adverse Effect	Group P: Propofol (n=40)	Group E: Etomidate (n=40)	p-value
Pain on injection site	10 (25.0%)	3 (7.5%)	0.060
Myoclonus	0 (0.0%)	5 (12.5%)	0.060
Postoperative nausea and vomiting	0 (0.0%)	6 (15.0%)	0.026

DISCUSSION

The present prospective randomized double-blind study compared Propofol (2.5 mg/kg) and Etomidate (0.3 mg/kg) as induction agents in ASA I and II patients undergoing elective surgery under general anaesthesia. Both groups were comparable at baseline with respect to age, gender, weight, and ASA physical status, as the mean age was 35.92 ± 10.05 years in the Propofol group and 34.05 ± 9.25 years in the Etomidate group ($p = 0.511$), with no significant difference in sex distribution, weight, or ASA grade. Similar baseline comparability was reported by Khare et al. [12], Shah and Birajdar [7], Masoudifar and Beheshtian [14], and Raina et al. [16], suggesting that the observed haemodynamic differences were mainly due to the pharmacological effects of the drugs.Heart rate was comparable at baseline and after premedication; however, at intubation it was significantly higher in the Propofol group than in the Etomidate group (89.18 ± 11.65 vs 80.30 ± 4.77 bpm; $p < 0.001$), and this difference persisted up to 10 minutes post-intubation. Similar findings were reported by

Khare et al. [12] and Shah and Birajdar [7], who observed greater heart rate fluctuation with Propofol, while Raina et al. [16] and Roy et al. [17] reported better heart rate stability with Etomidate. This may be explained by the ability of Etomidate to preserve sympathetic tone and baroreceptor reflexes, as described by Forman and Warner [18].

Systolic, diastolic, and mean arterial pressures were comparable at baseline, after premedication, and during induction, but significant differences were observed during intubation. At intubation, SBP was significantly higher in the Propofol group compared with the Etomidate group (130.68 ± 13.03 vs 115.50 ± 6.14 mmHg; $p < 0.001$), DBP was also higher (73.00 ± 7.59 vs 64.37 ± 4.42 mmHg; $p < 0.001$), and MAP showed a similar significant difference (86.05 ± 7.66 vs 73.45 ± 4.78 mmHg; $p < 0.001$). These differences remained significant at 1, 3, 5, and 10 minutes after intubation. Khare et al. [12] and Shah and Birajdar [7] similarly reported greater haemodynamic variability with Propofol and more stable blood pressure with Etomidate. Masoudifar and Beheshtian [14] observed significantly greater SBP and DBP changes with Propofol and reported hypotension in 26.1% of Propofol patients compared with 8% of Etomidate patients. Gholipour Baradari et al. [19], Gupta et al. [15], Raina et al. [16], Prajapati et al. [20], and Roy et al. [17] also supported superior haemodynamic stability with Etomidate. Propofol causes vasodilation, reduced systemic vascular resistance, and myocardial depression, whereas Etomidate has minimal cardiovascular depressive effect . Clinically, this is important because intraoperative blood pressure reductions of ≥20% have been associated with increased postoperative complications .Oxygen saturation remained stable and comparable in both groups throughout the study, with values consistently above 98% and no significant intergroup difference. Similar observations were reported by Khare et al. [12] and Shah and Birajdar [7]. Regarding adverse effects, pain on injection was more common with Propofol than Etomidate (25% vs 7.5%; $p = 0.060$), while myoclonus was observed only with Etomidate (12.5%; $p = 0.060$). Postoperative nausea and vomiting was significantly higher in the Etomidate group (15% vs 0%; $p = 0.026$). Similar adverse effect patterns were reported by Khare et al. [12], Sedighinejad et al. [21], and Roy et al. [17]. Thus, although Etomidate showed better haemodynamic stability during induction and intubation, it was associated with higher myoclonus and PONV, while Propofol was associated with more injection pain.

CONCLUSION

The present study demonstrated that Etomidate provides superior haemodynamic stability compared to Propofol during induction of anaesthesia, laryngoscopy, and endotracheal intubation. Patients receiving Etomidate showed significantly lesser fluctuations in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure during the peri-intubation period. Although Etomidate was associated with a higher incidence of myoclonus and postoperative nausea and vomiting, Propofol produced greater injection site pain and more pronounced haemodynamic variability. Therefore, Etomidate may be considered a safer induction agent in patients where cardiovascular stability is of paramount importance.

LIMITATIONS

The present study was conducted on a relatively small sample size and included only ASA I and II patients undergoing elective surgeries, which may limit generalization of the findings to high-risk patients. Long-term postoperative outcomes and serum cortisol levels were not evaluated, therefore adrenal suppression associated with Etomidate could not be assessed. In addition, invasive haemodynamic monitoring was not used, which may have provided more precise cardiovascular measurements.

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