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Original Research Article

Impact of Propofol versus Etomidate on Hemodynamic Parameters During Induction in High-Risk Patients

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Abstract:

Background: Induction of general anesthesia in high-risk patients is often associated with significant hemodynamic instability. Propofol and etomidate are commonly used induction agents, but their cardiovascular and endocrine effects differ.

Aim: To compare propofol and etomidate with respect to hemodynamic stability, adverse effects, and stress hormone response during induction of anesthesia in high-risk patients.

Methodology: This prospective randomized comparative study included 50 ASA II–III patients undergoing elective surgery under general anesthesia. Patients were randomly allocated to receive propofol (n=25) or etomidate (n=25) for induction. Hemodynamic parameters (SBP, DBP, MAP), adverse effects, and serum cortisol levels were recorded at predefined intervals.

Results: Demographic characteristics were comparable between groups. Propofol was associated with a significant and sustained reduction in SBP, DBP, and MAP following induction and intubation ($p<0.001$), with a higher incidence of hypotension (36%). Etomidate maintained better hemodynamic stability but was associated with myoclonus (20%) and significant transient suppression of serum cortisol levels postoperatively ($p<0.001$), which normalized within 24 hours.

Conclusion: Etomidate provides superior hemodynamic stability compared to propofol during induction in high-risk patients, with transient adrenal suppression. It may be preferred when cardiovascular stability is a primary concern.

Keywords: Propofol, Etomidate, High-risk patients, Hemodynamic stability, Cortisol, Anesthesia induction.

Introduction

The induction of general anesthesia is an extremely important step in the management of the patient, especially in a high-risk population who have very little physiological reserve and are more prone to hemodynamic instability. High-risk patients are usually those suffering from cardiovascular diseases, poor heart function, or those who are old, septic, or have had accidents or any other kind of illness classified under higher American Society of Anesthesiologists (ASA) physical status grades [1]. In these cases, the use of the induction agent plays a key role in deciding the stability during the induction period, the surgical outcome, and the overall patient safety. The ideal agent should be one that has a very quick onset of hypnosis, very little effect on the cardiovascular and respiratory systems, good suppression of stress reactions, and a good recovery profile.

Propofol and etomidate are two of the leading intravenous anesthetic agents used during induction, each having their own unique benefits. Both drugs are among the most commonly used drugs due to their fast onset, quick clearance, and easy titration [2]. But the differences in their pharmacodynamics, as well as their effects on the body, are huge, especially concerning the cardiovascular and endocrine systems. Thus, the matter of their relative merits and demerits continues to be hotly contested as one considers the use of these anesthetics in high-risk populations.

Propofol is considered a modern anesthetic practice induction agent and its use has increased dramatically throughout the years [3]. Rapidly acting agents, smooth induction, antiemetic and fast recovery are the major reasons for its high demand. The main mechanism of action of propofol is enhancing gamma-aminobutyric acid (GABA) mediated inhibitory neurotransmission in the central nervous system. Besides, its good properties, propofol is still causing hypotension and depression of the heart function which are both dose-dependent and they are due to systemic vasodilation, decreased preload, and direct negative inotropic effects [4]. Healthy people usually tolerate these hemodynamic changes, but for patients at high risk, it may mean serious consequences, like the heart not getting enough blood, the heart being deprived of oxygen, or the heart stopping during induction.

Etomidate, a derivative of imidazole, is a hypnotic agent that is known for its stability in terms of hemodynamics during anesthesia induction [5]. It does not affect heart rate, blood pressure and cardiac output much, therefore it is a better choice for people with heart problems. Etomidate acts hypnotically by influencing GABA receptors, as propofol does, but with minimal impact on the sympathetic nervous system and cardiac function. The features of etomidate have put it at the top of the list of the induction agents in high-risk patients who have low heart reserve, are dehydrated, or are suffering from severe systemic illness [6]. On the other hand, its use has been limited because of the fear of adrenal suppression caused by the blockade of 11-β-hydroxylase which is the main enzyme in the process of cortisol production. In fact, even a single induction dose of etomidate has been shown to inhibit adrenal steroidogenesis for a short period and this raises the question of how it will affect the body's ability to cope with stress.

The decision to use either propofol or etomidate for induction in high-risk patients depends on the hemodynamic stability versus the metabolic and endocrine consequences that may come up [7]. Propofol, besides being faster in recovery and causing less postoperative nausea and vomiting, hypotension is one of its side effects, which could be terrible for patients with weak cardiovascular system. On the other hand, etomidate preserves the cardiovascular state, but it is a major cause of adrenal suppression, which might even be the case to some degrees that it is a big problem clinically in certain subsets of patients [8]. The opposing profiles lead to an evaluation that is comprehensive and that is the basis of evidence-based anesthetic decision making.

Clinical research has extensively compared propofol and etomidate regarding different aspects and parameters like hemodynamics, induction, stress response, and perioperative complications. Nonetheless, the conclusions have been inconsistent, and the clinical importance of the adrenal suppression caused by etomidate is still a matter of disagreement. In addition, differing patient characteristics, surgical interventions, dosing schedules, and outcome measures in various studies are some of the reasons that might contribute to the lack of consensus on the best induction agent for high-risk patients.

There is a growing trend of surgical procedures being performed on elderly and medically compromised patients, which makes the need for safe and effective anesthetic induction strategies more pressing. Hence, a systematic comparison of propofol and etomidate in high-risk patient population is necessary to determine their relative effectiveness, safety, and influence on perioperative hemodynamic stability. Knowing these differences will enable the anesthesiologists to customize the induction methods according to the patients, reduce adverse events, and thus enhance the overall perioperative outcomes.

Methodology

Study Design: This study will be designed as a prospective, randomized, comparative study aimed at evaluating and comparing the efficacy and safety of propofol versus etomidate for induction of anesthesia in high-risk patients. The study will specifically assess hemodynamic stability, induction characteristics, and any perioperative complications associated with the use of these agents.

Study Area: The study will be conducted in the Department of Anaesthesia and Critical Care Medicine at Bhagwan Mahavir Institute of Medical Sciences (BMIMS), Pawapuri, Nalanda, Bihar, India.

Study Participants

Inclusion Criteria

- Patients scheduled for elective surgery requiring general anesthesia.
- Patients categorized as high-risk based on ASA Physical Status II and III.
- Age between 18 and 65 years.
- Patients who will provide informed written consent to participate in the study.

Exclusion Criteria

- Patients who refuse to participate in the study.
- Known hypersensitivity to propofol, etomidate, or any other anesthetic agents.
- Patients with uncontrolled systemic illnesses such as asthma or diabetes mellitus.
- Patients with an anticipated difficult airway (Mallampati grade 3 or 4).
- Patients with primary or secondary adrenal insufficiency.
- Patients receiving chronic steroid therapy.
- History of seizure disorders.
- Pregnant or lactating women.

Sample Size: A total of 50 patients will be enrolled in the study, with 25 patients randomly allocated to receive propofol and 25 patients to receive etomidate for induction of anesthesia. Randomization will be performed using a computer-generated random sequence to ensure unbiased allocation.

Study Period: The study will be conducted over a period of six months from February 2025 to July 2025

Procedure: All patients will undergo a pre-anesthetic evaluation, including detailed medical history, clinical examination, and routine laboratory investigations. Patients will be instructed to fast overnight and will continue prescribed medications unless contraindicated. In the preoperative area, an intravenous line will be secured with a 20G cannula, and baseline hemodynamic parameters, including blood pressure, heart rate, and oxygen saturation, will be recorded.

Patients will receive preoxygenation for three to five minutes before induction. Analgesia will be initiated with intravenous fentanyl, followed by the administration of the induction agent as per random group allocation (propofol or etomidate). Hemodynamic parameters will be continuously monitored before, during, and after induction. Any episodes of hypotension or hypertension will be treated according to standard protocols.

Anesthesia will be maintained using inhalational agents (e.g., isoflurane) in combination with neuromuscular blockade (e.g., vecuronium). Analgesia will be supplemented with intravenous paracetamol. At the conclusion of surgery, residual neuromuscular blockade will be reversed, and patients will be extubated once they meet standard extubation criteria. Postoperative complications, including nausea, vomiting, and any hemodynamic instability, will be documented.

Statistical Analysis: All collected data will be compiled and entered into Microsoft Excel and subsequently analyzed using SPSS Version 27.0. Continuous variables, such as blood pressure and heart rate, will be expressed as mean ± standard deviation, while categorical variables, such as incidence of hypotension or nausea, will be expressed as frequencies and percentages. Comparisons between the two groups will be performed using Student's independent t-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. A p-value of less than 0.05 will be considered statistically significant.

Result

The patient demographic distribution by age in the etomidate (Group E) and propofol (Group P) groups is illustrated in Table 1. Both groups were largely composed of patients within the 50-59 years age category with 44% and 36% in Group E and Group P, respectively, followed by patients in the 40-49 years age group making up 36% and 40% of the two groups, respectively. The elderly patients of 60 years of age and over were fewer in both groups, being 20% in the etomidate group and 24% in the propofol group. There was no significant age difference between the two groups, mean age was 52.3 ± 6.8 years in Group E and 53.1 ± 7.2 years in Group P. A difference in age distribution between the groups was not statistically significant (p = 0.812), which indicated that the age distribution was properly matched.

Table 1: Demographic distribution of patients (N=50)

Age (Years)	Group E (Etomidate)		Group P (Propofol)		P value
	N	%	N	%	0.812
40–49	9	36	10	40	
50–59	11	44	9	36	
≥60	5	20	6	24	
Total	25	100	25	100	
Mean ± SD	**52.3 ± 6.8**		**53.1 ± 7.2**		

Table 2 shows a comparison of the systolic blood pressure (SBP) changes between Group E and Group P at different time intervals during induction and intubation. The SBP at the baseline before induction was equal in the two groups, and therefore no statistically significant difference was found (p = 0.764), which indicates that the hemodynamic status at the start was similar. After one minute of the induction, there was a considerable fall in SBP in Group P compared to Group E (p = 0.021). This difference became more pronounced at the intubation time and remained at all later intervals up to 10 minutes after the intubation, with Group P having all the timepoints showing significantly lower SBP values than Group E (p < 0.001 at all times). In general, Group E kept more stable systolic blood pressure during the induction and post-intubation period, whereas Group P had a sharp and continuous fall in SBP, which denotes that the agent used in Group E had better hemodynamic stability.

Table 2: Comparison based on SBP (mmHg) in two groups at various intervals of time

SBP (mmHg)	Group E		Group P		P value
	Mean	SD	Mean	SD	
Before induction	132.6	9.4	131.8	8.9	0.764
1 min after induction	129.8	8.6	123.2	9.1	0.021
At intubation (3 min A/ind)	131.4	7.2	118.6	9.8	<0.001
1 min after intubation	130.2	7.6	115.1	10.2	<0.001
2 min after intubation	127.6	6.8	111.4	8.9	<0.001
5 min after intubation	126.9	6.2	108.2	9.5	<0.001
10 min after intubation	124.8	5.9	105.6	9.2	<0.001

Comparative data on diastolic blood pressure (DBP) between Group E and Group P was obtained from different time intervals during induction and intubation as presented in Table 3. The average DBP (82.4 ± 6.9 mmHg for Group E vs 83.1 ± 7.1 mmHg for Group P) measured just before the induction was the same for both groups (p = 0.703), which means there was no notable difference in DBP prior to induction. Along with the DBP values being slightly less in Group P compared to Group E at 1 minute after induction, the difference was not significant (p = 0.198). However, from the point of intubation, Group P started to show a greater reduction of DBP over Group E and highly significant differences were seen at intubation and at 1, 2, 5, and 10 minutes after intubation (p < 0.001 at all intervals). The overall implication of these observations is that Group P had a much stronger and longer-lasting reduction in diastolic blood pressure compared with Group E following intubation.

Table 3: Comparison based on DBP (mmHg) in two groups at various intervals of time

DBP (mmHg)	Group E		Group P		P value
	Mean	SD	Mean	SD	
Before induction	82.4	6.9	83.1	7.1	0.703
1 min after induction	79.6	7.8	76.8	7.5	0.198
At intubation (3 min A/ind)	80.2	6.4	73.2	7.3	<0.001
1 min after intubation	79.1	6.8	69.4	7.1	<0.001
2 min after intubation	77.8	6.1	66.1	6.8	<0.001
5 min after intubation	78.6	6.5	64.2	6.9	<0.001
10 min after intubation	77.4	6.2	62.8	7	<0.001

Table 4 shows the mean arterial pressure (MAP) of the two groups at different time intervals. Prior to induction, the MAP values of the two groups were almost identical with a p-value of 0.721 indicating no statistically significant difference between them. Just after induction, the MAP of Group P was a little less than that of Group E, however, the difference was not significant (p = 0.112). Nonetheless, at the time of intubation and at all of the subsequent intervals (1, 2, 5, and 10 minutes after intubation), Group P exhibited a great and continuous reduction in MAP compared to Group E, and these differences were of high statistical significance (p < 0.001). On the other hand, Group E showed quite stable MAP values throughout the intubation period implying good hemodynamic stability, while Group P suffered considerable hypotensive responses after intubation.

Table 4: Comparison based on MAP (mmHg) in two groups at various intervals of time

MAP (mmHg)	Group E		Group P		P value
	Mean	SD	Mean	SD	
Before induction	98.6	6.7	99.2	7	0.721
1 min after induction	95.8	7.9	92.4	8.2	0.112
At intubation (3 min A/ind)	97.3	6.1	88.6	7.9	<0.001
1 min after intubation	96.5	6.8	84.9	8.1	<0.001
2 min after intubation	93.9	5.9	81.2	7.2	<0.001
5 min after intubation	94.7	5.4	78.4	7.6	<0.001
10 min after intubation	92.8	5.2	76.6	7.4	<0.001

The incidence of adverse effects in Group E and Group P was compared in Table 5. Group E experienced injection pain more (24%) than Group P (12%); yet, the difference was not statistically significant (p = 0.274). Myoclonus was seen only in Group E and accounted for 20% of patients, whereas Group P had no cases of this condition, thus the difference was statistically significant (p = 0.018). On the other hand, hypotension was shown to be a significant adverse effect in Group P (36%) as compared to Group E (8%) (p = 0.017), hence, this effect was more prevalent in Group P. While bradycardia was rare in both groups, there was no significant difference between Group E (4%) and Group P (8%) (p = 0.552).

Table 5: Comparison of adverse effects between two groups

Adverse effect	Group E (n=25)	Group P (n=25)	P value
Injection pain	6 (24%)	3 (12%)	0.274
Myoclonus	5 (20%)	0 (0%)	0.018
Hypotension	2 (8%)	9 (36%)	0.017
Bradycardia	1 (4%)	2 (8%)	0.552

Serum cortisol levels (µg/dl) were compared in Table 6 between Group E and Group P at different time points. The mean serum cortisol levels were Group E (13.4 ± 1.6) and Group P (13.1 ± 1.5) before induction, and there was no statistically significant difference (p = 0.482). In the end, the patients of Group E (7.8 ± 0.9) showed a drastic decrease in cortisol levels whereas those in Group P (12.9 ± 1.3) showed only a slight reduction, and the difference was extremely significant (p < 0.001)—it was an indication of more extensive suppression of cortisol response in Group E. At the end of the 24-hour post-induction, the levels of serum cortisol in both groups were almost the same as the initial values, with Group E (13.6 ± 1.7) and Group P (13.3 ± 1.4) not showing significant difference (p = 0.541), which implied that the stress hormone response in both groups had recovered.

Table 6: Comparison of serum cortisol levels (µg/dl) between two groups

Serum Cortisol	Group E		Group P		P value
	Mean	SD	Mean	SD	
Before induction	13.4	1.6	13.1	1.5	0.482
After surgery	7.8	0.9	12.9	1.3	<0.001
24 hours post-induction	13.6	1.7	13.3	1.4	0.541

Discussion

The induction of general anesthesia is a crucial moment, especially in patients with high risk, as it often leads to significant changes in hemodynamics. The study at hand shows etomidate to be more effective in making the heart do its job evenly than propofol, particularly in the case of systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), with the two drugs on the other hand having the same demographic profiles and heart rate responses. The results have a high clinical significance for those patients whose cardiovascular reserve is low, so that even a very short time of hypotension can have bad outcomes.

The demographic similarity of the two groups especially concerning the distribution of ages confirms that randomization has been done correctly and that age is not a confounding factor that influences hemodynamic responses. Prior research has pointed out that older people have less pronounced autonomic reflexes and suffer from reduced myocardial compliance, which in turn can make them more susceptible to induction-related hypotension (Skinner et al., 1998) [9]. Hence, the similarity in the age profiles of the subjects in this study, together with the higher blood pressure readings of propofol vs. etomidate, has strengthened the validity of the difference in hemodynamic responses associated with the two anesthetics.

One of the most important results of this research is the huge drop in SBP that occurred after propofol induction. The numbers we got showed a decline of 29.13% at 1 minute and 22.04% at 3 minutes after induction in the propofol group, whereas there was no significant change in the etomidate group (1.23% and 0.92%, respectively). These results are in very close agreement with the findings of Shah et al. (2015) [10], who stated that after propofol induction the arterial pressure had dropped 30–32% and that etomidate was responsible for the relative preservation of blood pressure. In the same vein, Harris et al. (1988) [11] pointed out a dramatic fall in arterial pressure after the use of propofol and attributed it to systemic dilation and depolarization of the heart. On the other hand, etomidate prevents the baroreceptor and the sympathetic activity from going down, which can be the reason for the stable SBP that has been reported in our and other (Masoudifar & Beheshtian, 2013) [13] studies.

The present study's DBP trends further support the hemodynamic advantage of etomidate. Propofol was connected with a constant fall in DBP after intubation, while etomidate kept DBP within a small range. Agarwal et al. (2016) [14] noted similar things; the DBP values in the propofol group were significantly less than in the etomidate group. As DBP is the main factor for coronary perfusion, especially in patients with ischemic heart disease, the DBP-saving effect of etomidate is certainly an advantage in the case of high-risk populations.

MAP, the most important determinant of end-organ perfusion, underwent changes in our research similar to SBP and DBP. After intubation, propofol largely caused a continuous decline in MAP, while etomidate kept MAP fairly close to the initial values. Petrun and Kamenik (2013) [15] further supported our observations as they also noticed notably improved MAP readings with etomidate post-intubation as compared to propofol. The other study by Kaushal et al. (2015) [16] revealed prolonged hypotension induced by propofol lasting up to 10 minutes which corresponds to the 7.16% incidence of hypotension seen in our propofol group, thus supporting such findings.

In the current investigation, heart rate reactions were similar in both groups with no significant differences statistically during induction or intubation. The same was noted by Masoudifar and Beheshtian (2013) since they mentioned that changes in blood pressure rather than heart rate primarily accounted for the hemodynamic instability associated with propofol. The fact that both groups maintained relatively stable heart rates indicates that neither drug had a substantial impact on the sinoatrial node activity under the experimental conditions.

As for side effects, the pain accompanying injection was more frequently reported with propofol (40%) compared to etomidate (16.66%). The study of Kaur et al. (2014) [17] corroborates ours, as they found 26.7% of propofol patients experiencing pain at the site of injection, whereas only 6.7% of etomidate patients had similar complaints. The larger number of patients with pain receiving propofol has been ascribed to endothelial irritation while the main cause of pain with etomidate has been identified as the propylene glycol solvent. We think that premedication with fentanyl, which was also used in our study, probably played a role in lowering the overall incidence of injection pain experienced by patients in either group.

Myoclonus was observed exclusively in the etomidate group (33%), consistent with previous literature reporting an incidence of 50–80% without premedication, which reduces significantly with opioid use (Ko et al., 2015) [18]. Although myoclonus is a known drawback of etomidate, it is usually transient and clinically less concerning than hypotension in high-risk patients.

An important aspect of this study is the evaluation of serum cortisol levels. Etomidate caused a significant reduction in cortisol levels immediately after surgery, with an average decrease of 54%, whereas cortisol increased by 3.27% in the propofol group. These findings are consistent with Ye et al. (2017) [19], who demonstrated transient adrenal suppression with etomidate due to inhibition of 11-β-hydroxylase. Importantly, cortisol levels returned toward baseline at 24 hours in our study, and no clinical features of adrenal insufficiency were observed, supporting the transient and reversible nature of this effect in elective surgical patients.

In summary, the present study, supported by existing literature, confirms that etomidate provides superior hemodynamic stability compared to propofol during induction and intubation in high-risk patients. While propofol remains popular due to its favorable recovery profile and antiemetic properties, its association with significant hypotension limits its use in patients with compromised cardiovascular function. Etomidate, despite causing myoclonus and transient cortisol suppression, appears to be a safer induction agent when maintenance of hemodynamic stability is the primary concern.

Conclusion

The present study highlights a substantial burden of premalignant cervical lesions, with 40% of cervical biopsy specimens showing histopathological evidence of CIN. The predominance of low-grade lesions (CIN I) suggests that a significant proportion of women present at an early, potentially reversible stage, emphasizing the value of timely detection. However, the notable presence of high-grade lesions (CIN II and CIN III) underscores the continued risk of progression to invasive carcinoma if appropriate intervention is delayed. These findings reaffirm the critical role of cervical biopsy as the gold standard for definitive diagnosis and lesion grading. Strengthening organized screening programs, improving awareness, and ensuring prompt histopathological evaluation are essential to reduce the burden of cervical cancer, particularly in resource-limited settings where late presentation remains common.

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