A COMPARATIVE STUDY OF HEMODYNAMIC CHARACTERISTICS AND INTUBATION RESPONSE WITH THREE ANESTHETIC AGENTS – THIOPENTONE, PROPOFOL, ETOMIDATE

Mohamed Abubaker[1], Dr. A.N. Uma[2*], Sowmiya Devi[3], Subasri Elamvazhuti[3], Lavanya B[4]

1 Intern student, Department of Anaesthesia Technology, School of Allied Health Sciences, Sri Balaji Vidyapeeth (Deemed to be University), Puducherry, India

2 Professor of Medical Genetics & Principal, School of Allied Health Sciences, Sri Balaji Vidyapeeth (Deemed to be University), Puducherry, India

3 Tutors, Department of Anaesthesia Technology, School of Allied Health Sciences, Sri Balaji Vidyapeeth (Deemed to be University), Puducherry, India

4 Assistant Professor, Department of Community Medicine, Shri Sathya Sai Medical College and Research Institute, Sri Balaji Vidyapeeth, (Deemed to be University), Chengalpattu District, Tamil Nadu, India.

*Corresponding Author: Dr. A. N. Uma

A COMPARATIVE STUDY OF HEMODYNAMIC CHARACTERISTICS AND INTUBATION RESPONSE WITH THREE ANESTHETIC AGENTS – THIOPENTONE, PROPOFOL, ETOMIDATE

ABSTRACT

Background:
Selecting an optimal intravenous induction agent is crucial to ensure hemodynamic stability during general anaesthesia. Commonly used agents such as Thiopentone, Propofol, and Etomidate differ in their cardiovascular effects, onset, and recovery profiles. This study aimed to compare these agents concerning their influence on hemodynamic parameters during induction and endotracheal intubation.

Methods:
An Observational study was conducted from January to June 2025 in the Department of Anaesthesiology at Mahatma Gandhi Medical College and Research Institute, Puducherry. Sixty patients aged 18–60 years (ASA Grade I–II, Mallampati Class I–II) scheduled for elective surgeries under general anesthesia were enrolled. They were evenly divided into three groups of 20 based on the induction agent—Thiopentone, Propofol, or Etomidate. All participants received standard premedication and monitoring, with hemodynamic parameters and serum cortisol levels recorded at defined intervals. Data were statistically analyzed using descriptive and comparative methods to assess the cardiovascular response and stability of each agent.

Results:
Propofol produced the greatest decline in blood pressure following induction, while Thiopentone caused moderate reductions. Etomidate maintained the most stable cardiovascular profile, with minimal fluctuations in blood pressure and heart rate. Overall, 70% of patients exhibited stable intraoperative hemodynamic status. Minor adverse events included hypotension (20%), bradycardia (7%), and tachycardia (3%). No serious complications were reported.

Conclusion:
Among the three agents studied, Etomidate demonstrated superior hemodynamic stability, making it the preferred choice for patients with cardiovascular compromise. Propofol offers rapid induction and recovery but should be used cautiously in patients susceptible to hypotension. Thiopentone presents intermediate effects and remains suitable for low-risk or cost-sensitive scenarios. Personalized selection of induction agents, based on patient comorbidities and procedural requirements, enhances intraoperative safety and recovery outcomes.

Keywords:
Etomidate, Propofol, Thiopentone, intravenous induction, hemodynamic stability, general anaesthesia, endotracheal intubation, cardiovascular response.

INTRODUCTION

Anesthesiologists have prioritized intravenous anesthetic development for over 70 years, seeking the least side effects from general anesthesia induction. Intravenous induction generally provides a smoother, faster process than inhalational agents. Agents are chosen for their rapid action, effects on hemodynamics, and ability to suppress intubation responses (1). However, no single agent is ideal. Intubation-associated stress can cause hemodynamic changes, cardiac workload, and oxygen consumption. This can lead to ischemia (2) Stimulation of the trachea and larynx releases catecholamines, increasing sympathetic activity and heart rate, and systemic blood pressure (3,4).

In 1872, Pierre Cyprien achieved first intravenous anesthesia using chloral hydrate on patients effectively. The first barbiturate used for anesthesia induction was developed in the early 1930s. Initially discovered in 1932, a more refined form was implemented for medical use in 1934.

Thiopentone is an ultra-short acting barbiturate that induces general anesthesia and decreases systemic vascular resistance in a dose-dependent manner (5).

Propofol, a commonly used intravenous anesthetic, was discovered in 1977. It gained widespread use due to its short acting effect and rapid recovery benefits, making it suitable for daycare anesthetics. It induces unconsciousness within a minute. Possible adverse effects include cardiovascular complications such as low blood pressure(6,7and8).

Etomidate was first utilized for general anesthesia induction purposes in 1973. Notably, its application in patients with pre-existing cardiac disease garnered substantial popularity. However, its efficacy was marred by a significant adverse consequence: adrenal suppression. Despite this, Etomidate's pharmacokinetic profile renders it cardio-stable, thereby facilitating its use in both anesthesia induction and maintenance, as well documented (9). Etomidate modulates steroidogenesis via reversible inhibition of the 11beta-hydroxylase enzyme (10,11). The resultant hemodynamic steadiness enables secure endotracheal intubation (12,13,14). Notably, a single administration results in corticosteroid level decrement, persisting for up to 24 hours (15).

Three anesthetic induction agents were evaluated for hemodynamic reactions - Thiopentone, Propofol, Etomidate - during induction of general anesthesia and endotracheal intubation.

Physiologic Responses Caused by Laryngoscopy and Tracheal Intubation:

Visualizing the vocal folds and glottis through laryngoscopy aids in accessing the trachea during certain procedures or surgeries.

Endotracheal intubation influences respiratory and cardiovascular physiology due to the endotracheal tube's presence and reflex responses, which can cause complications in patients with pre-existing conditions.

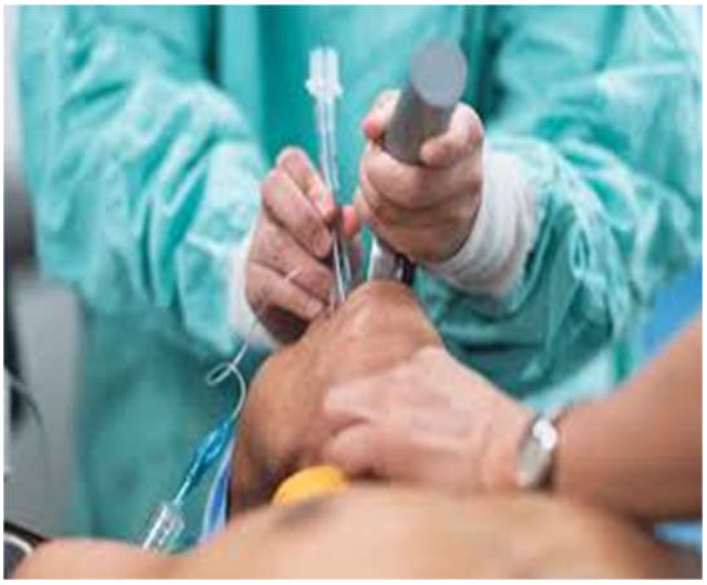

Figure 1: Endotracheal Intubation

Central Nervous System:

Tracheal intubation triggers both autonomic nervous system and CNS activation by elevating cerebral blood flow, raising cerebral oxygen demand, and increasing brain electrical activity.

Cardiovascular Responses:

During laryngoscopy and endotracheal intubation, cardiovascular responses such as tachycardia, bradycardia, and hypertension occur due to sympathetic and parasympathetic nervous system stimulation. In infants and young children, bradycardia is often seen, while in adults it's rare, caused by increased vagal tone in response to airway stimuli. Tachycardia and hypertension are caused by sympathetic efferent responses from cardio accelerator fibers and sympathetic chain ganglia.

The Glossopharyngeal and vagal nerves trigger a complex, wide-ranging response via the brain and spine. This involves the release of several hormones, including epinephrine from the adrenal gland and other stress hormones. Increased blood pressure following intubation is largely due to activation of a hormone-regulating system.

Plasma Catecholamine Response to Laryngoscopy and Tracheal Intubation

In 1981, Russell WJ and colleagues observed changes in dopamine, adrenaline, and noradrenaline levels and arterial pressure in 15 patients who received endotracheal intubation. Following intubation, plasma noradrenaline levels and mean arterial pressure saw a significant increase. This was linked primarily to an increase in noradrenaline, while dopamine and adrenaline levels remained relatively stable. The body's sympathetic response is therefore triggered mainly during intubation, highlighting a need for protection in patients who are at risk.A study found that in 2010, serum catecholamine levels changed after laryngoscopy and intubation. A person measured these levels before and after a certain procedure.

Figure 2: Propofol, Thiopentone, Etomidate

Endotracheal intubation influences both airway mechanics and systemic physiology. It increases upper airway resistance, decreases functional residual capacity, and may impair coughing due to altered reflexes mediated by the glossopharyngeal and vagus nerves. Propofol, a phenol-based IV agent introduced in the 1970s, acts on GABA receptors, offering rapid induction but may cause hypotension and respiratory depression. Thiopentone, an ultra–short-acting barbiturate, induces anesthesia quickly through GABA modulation but can depress breathing and circulation, making it unsuitable for patients with cardiac or respiratory compromise. Etomidate, developed in the 1960s, is favored for its cardiovascular stability and minimal respiratory effects, though it may cause transient adrenal suppression and myoclonic movements. Compared with other agents, etomidate maintains blood pressure and ventilation, making it ideal for patients with cardiac disease. Overall, each induction drug shows distinct systemic and respiratory effects, necessitating individualized anesthetic selection for optimal safety and recovery.

METHODS AND METHODOLOGY

An Observational comparative study was carried out over six months from January to June 2025 in the Department of Anaesthesiology at Lifeline Hospital, Kilpauk, Chennai. The research involved 60 patients aged 18–60 years, categorized as ASA Grade I or II and Mallampati Class I or II, who were scheduled for elective surgeries under general anaesthesia. Patients with anticipated difficult airways, allergies to study drugs, uncontrolled hypertension, severe cardiopulmonary disease, hepatic or renal failure, or those unwilling to participate were excluded. The purpose of the study was to compare hemodynamic responses during induction and intubation using three intravenous anesthetic agents—Thiopentone, Propofol, and Etomidate. Participants were equally divided into three groups of 20 according to the induction drug used. All patients underwent thorough preoperative evaluation and baseline investigations, followed by standard premedication with alprazolam, pantoprazole, and glycopyrrolate. During surgery, continuous monitoring of ECG, non-invasive blood pressure, and pulse oximetry was maintained. Each patient received midazolam and fentanyl prior to induction, after which the designated anesthetic and vecuronium were administered for muscle relaxation. Anaesthesia maintenance was achieved using oxygen, nitrous oxide, and sevoflurane. Hemodynamic parameters and serum cortisol levels were measured at specific

intervals to assess stability and stress response. At the conclusion of the procedure, muscle relaxation was reversed with neostigmine and glycopyrrolate, and extubating was performed once patients regained full consciousness and spontaneous respiration. Postoperative observations included monitoring hemodynamic status and detecting any complications. Data collection was done using a structured proforma through direct observation and patient interviews, and the findings were analysed using descriptive and comparative statistical methods to determine the stability and safety of the anesthetic agents used.

RESULT

This study involved 60 patients scheduled for elective surgeries under general anesthesia at Mahatma Gandhi Medical College and Research Institute, Puducherry. Age analysis revealed that the majority of participants were between 41 and 60 years (45%), followed by those aged 20–40 years (35%), while individuals over 60 years comprised 20% of the sample. This suggests that elective procedures were more frequently performed in middle-aged adults. Regarding gender distribution, males accounted for 55% and females for 45%, indicating an almost balanced representation.

The patients were divided equally into three groups of 20, receiving Thiopentone, Propofol, or Etomidate as induction agents, allowing for a fair comparison. Hemodynamic assessment showed that Propofol caused the largest drop in blood pressure following induction, Thiopentone produced a moderate reduction, and Etomidate resulted in minimal changes, demonstrating its superior cardiovascular stability.

Overall, 70% of patients maintained stable hemodynamic conditions during surgery, while 20% experienced hypotension, 7% had bradycardia, and 3% exhibited tachycardia. Despite some minor variations, most patients tolerated anesthesia without serious complications. Among the three induction agents, Etomidate showed the most consistent hemodynamic stability, suggesting it as a safer and more dependable option for elective surgical anesthesia.

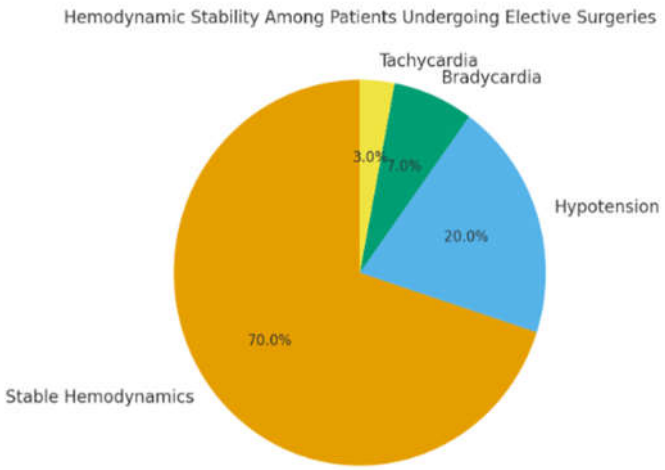

Figure 3: Hemodynamic stability among patients undergoing elective surgeries

DISCUSSION

This study compared the hemodynamic effects of three intravenous induction agents—Thiopentone, Propofol, and Etomidate—during induction and intubation, focusing on heart rate, systolic, diastolic, and mean arterial pressures. Etomidate consistently demonstrated the most stable cardiovascular profile, causing minimal hypotension and heart rate fluctuations, making it particularly suitable for patients with cardiovascular compromise (Raina et al., 2023; Andrabi et al., 2020; Kumar et al., 2023; Nayak et al., 2018). Propofol, although advantageous for rapid induction and recovery, was associated with significant blood pressure reductions, likely due to vasodilation and myocardial depression, which aligns with findings by Sudhir et al. (2022) and Sho Kawasaki et al. (2018). Thiopentone showed moderate hemodynamic effects, with fluctuations higher than Etomidate but less pronounced than Propofol (Sushil Kumar et al., 2020).

Etomidate's cardiovascular stability is attributed to its minimal impact on myocardial contractility, systemic vascular resistance, and sympathetic activity, though it can cause transient adrenal suppression (Wahab et al., 2020; Srivastava et al., 2023). It also effectively blunts the pressor response to laryngoscopy, which is beneficial in elderly and cardiac patients (Vidarshna et al., 2024; Lu et al., 2022). Clinically, these findings suggest individualized anesthetic selection: Etomidate is preferred for patients with cardiovascular risk, Propofol for short-duration procedures in stable individuals, and Thiopentone for low-risk or cost-sensitive cases. Overall, prioritizing agent choice based on patient profile and surgical needs enhances intraoperative safety and postoperative outcomes.

CONCLUSION

In conclusion, the study demonstrates that Etomidate provides the most stable hemodynamic profile among the three induction agents, making it especially suitable for patients with cardiovascular compromise. Propofol, while effective for rapid induction and recovery, is associated with significant hypotension and requires careful monitoring. Thiopentone exhibits intermediate cardiovascular effects, limiting its use in high-risk patients. Etomidate's minimal impact on myocardial contractility, vascular resistance, and sympathetic response explains its superior stability. It also effectively blunts the pressor response during intubation, reducing intraoperative cardiovascular stress. Propofol remains advantageous for short, low-risk procedures due to its fast onset and recovery. Thiopentone may be reserved for cost-sensitive or low-risk cases. Individualized selection of induction agents based on patient comorbidities and surgical requirements is essential. The findings reinforce the importance of cardiovascular stability in improving patient safety. Overall, Etomidate emerges as the preferred induction agent for maintaining hemodynamic balance during elective surgeries.

REFERENCES

1. Thakur S, Sharma A, Kumar R, Pathania J, Thakur G. Comparative evaluation of propofol, thiopentone and etomidate on induction time, intubation response and recovery time during laparoscopic surgery under general Anaesthesia. Indian Journal of Clinical Anaesthesia. 2023 Jun 5;10(2):150-7.
2. Raina P, Gulati S, Chauhan V, Vig A. Comparative study of propofol and etomidate as intravenous induction agents for general anesthesia: hemodynamic effects, adrenal suppression, and blood glucose response in controlled hypertensive patients. International Journal of Research in Medical Sciences. 2023 Oct 30;11(11):4142–6.
3. Bahreini M, Garekani MT, Sotoodehnia M, Rasooli F. Comparison of the efficacy of ketamine–propofol versus sodium thiopental–fentanyl in sedation: a randomised clinical trial. Emergency Medicine Journal. 2021 Mar 1;38(3):211-6.
4. Hu B, Zhou H, Zou X, Tan L, Song T, Zellmer L, Li X. Effect of remimazolam tosilate versus etomidate on hemodynamics in patients undergoing valve replacement surgery: study protocol for a randomized controlled trial. Trials. 2022 Dec 12;23(1):992.
5. Wahab Z, Heisnam I, Nushrat M, Banu R, Nahakpam S, Samjetsabam L, Khuo D, Kumaran TR. A comparative study of the effect of etomidate and propofol induction on haemodynamic response and serum cortisol levels in patients undergoing laparoscopic cholecystectomy. J Evid Based Med Healthc. 2020;7:186-90.
6. Gäßler M, Ruppert M, Lefering R, Bouillon B, Wafaisade A, TraumaRegister DGU. Pre-hospital emergent intubation in trauma patients: the influence of etomidate on mortality, morbidity and healthcare resource utilization. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2019 Jun 7;27(1):61.
7. Kawasaki S, Kiyohara C, Tokunaga S, Hoka S. Prediction of hemodynamic fluctuations after induction of general anesthesia using propofol in non-cardiac surgery: a retrospective cohort study. BMC anesthesiology. 2018 Nov 10;18(1):167.
8. Sudhir N, Satheedevi P, Sunilkumar TS, Joseph E. Tracheal Intubation with Different Doses of Propofol--Haemodynamic Changes. Journal of Evolution of Medical and Dental Sciences. 2022 Jan 1;11(1):21-7.
9. Behzad Nazemroaya, Mousavi SM. Comparison of Premedication with Low-Dose Midazolam Versus Etomidate for Reduction of Etomidate-Induced Myoclonus During General Anesthesia for Electroconvulsive Therapy: A Randomized Clinical Trial. Anesthesiology and Pain Medicine. 2019 Dec 23;In Press(In Press).
10. Nazemroaya B, Mousavi SM. Comparison of premedication with low-dose midazolam versus etomidate for reduction of etomidate-induced myoclonus during general anesthesia for electroconvulsive therapy: A randomized clinical trial. Anesthesiology and Pain Medicine. 2019 Dec 23;9(6):e94388.Veloso H, Wafae B de, da Silva RF. Propofol for sedation for direct current cardioversion. Annals of Cardiac Anaesthesia. 2019;22(2):113.
11. Jiang Z, Xiao J, Wang X, Luo T. The effect-site concentration of remifentanil blunting endotracheal intubation responses during anesthesia induction with etomidate: a dose-finding study. BMC anesthesiology. 2023 Jun 28;23(1):225.

12. Chen L, Liang X, Tan X, Wen H, Jiang J, Li Y. Safety and efficacy of combined use of propofol and etomidate for sedation during gastroscopy: systematic review and meta-analysis. Medicine. 2019 May 1;98(20):e15712.
13. Prakash MS, Gnanasekar R, Sakthirajan P, Adole PS. A comparative study of two infusion doses of etomidate for induction vs standard induction dose of etomidate. European Journal of Clinical Pharmacology. 2019 Jul 1;75(7):889-94.
14. Viburajah V, Selvaraj V. Comparative Evaluation of Effect of Propofol, Etomidate and a Combination of Propofol and Etomidate on the Hemodynamic Response to Induction and Endotracheal Intubation: A Prospective Randomized Double Blinded Study. Journal of Anesthesia/Anestezi Dergisi (JARSS). 2024 Jan 1;32(1).
15. Hossain MM, ul Alam M, Akter S, Hussain MP. Comparison of Haemodynamic Stability of Etomidate versus Propofol for Induction of Anaesthesia in Patients undergoing Coronary Artery Bypass Graft Surgery. Journal of the Bangladesh Society of Anaesthesiologists. 2021 Jan 31;34(1):43-9.