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COMPARISON OF HEMODYNAMIC STABILITY IN PATIENTS RECEIVING TOTAL INTRAVENOUS ANESTHESIA VS INHALATIONAL ANESTHESIA

Omair Ahmad[1], Mujeeb Ahmad[2], Imad Ud Din Khan[*3], Aneeqa Shahzad[4]

[1,*3,4]*Green International University, Lahore*
[2] *North West Institute of Health Sciences*

[*3] imadkhanck@gmail.com

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Imad Ud Din Khan

Abstract

Background:
Maintaining hemodynamic stability during general anesthesia is a crucial aspect of perioperative care. Total Intravenous Anesthesia (TIVA) and inhalational anesthesia are commonly used techniques, each with distinct cardiovascular effects. Understanding their relative impact on hemodynamic parameters can improve patient safety, particularly in those at risk for cardiovascular complications.

Objective:
To compare hemodynamic stability in patients receiving Total Intravenous Anesthesia (TIVA) versus inhalational anesthesia during elective surgical procedures.

Methodology:
This comparative cross-sectional study was conducted at the Department of Anesthesiology, Hayatabad Medical Complex, Peshawar, Pakistan, over six months. A total of 188 patients undergoing elective surgery under general anesthesia were included and equally divided into TIVA (n=94) and inhalational anesthesia (n=94) groups. Patients aged 18–60 years, ASA I–II, and who provided informed consent were included. Intraoperative monitoring included heart rate, systolic and diastolic blood pressure, mean arterial pressure, and vasopressor requirement. Data were analyzed using SPSS, with independent t-tests for quantitative variables and chi-square tests for categorical variables. A p-value ≤ 0.05 was considered statistically significant.

Results:
Age distribution was comparable between groups, with most patients aged 31–45 years. Baseline hemodynamic parameters were similar. Post-intubation heart rate and mean arterial pressure were significantly higher in the inhalational group compared to the TIVA group ($p < 0.05$). The incidence of intraoperative hypotension, hypertension, and tachycardia was lower in the TIVA group. Vasopressor requirement was also significantly reduced in the TIVA group (11.7% vs 24.5%; $p = 0.03$).

Conclusion:
TIVA provides superior intraoperative hemodynamic stability compared to

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inhalational anesthesia, with lower incidence of cardiovascular fluctuations and reduced vasopressor requirement. TIVA may be preferred in patients where cardiovascular stability is critical.

Introduction:

Maintenance of hemodynamic stability during anesthesia is one of the primary goals of perioperative management. Fluctuations in heart rate, blood pressure, and systemic vascular resistance during surgical procedures can significantly influence patient outcomes, particularly in individuals with cardiovascular comorbidities. Anesthetic agents, whether administered intravenously or via inhalation, have direct and indirect effects on myocardial contractility, vascular tone, and autonomic regulation (1). Therefore, the choice of anesthetic technique plays a critical role in maintaining intraoperative hemodynamic stability.

Two commonly employed techniques for maintenance of general anesthesia are Total Intravenous Anesthesia (TIVA) and inhalational (volatile) anesthesia. Total Intravenous Anesthesia involves the administration of anesthetic agents exclusively through the intravenous route, most commonly using agents such as propofol, often combined with short-acting opioids like remifentanil (2). In contrast, inhalational anesthesia utilizes volatile anesthetic agents such as sevoflurane, isoflurane, or desflurane delivered through the respiratory system (3). Both techniques are widely used in modern anesthetic practice and have distinct pharmacological profiles that may influence cardiovascular stability. TIVA, particularly with propofol-based regimens, is known for its rapid onset and recovery characteristics. Propofol produces dose-dependent reductions in systemic vascular resistance and myocardial contractility, leading to hypotension, especially during induction (4). However, when administered using target-controlled infusion systems, TIVA allows for precise titration of plasma drug concentrations, potentially minimizing hemodynamic fluctuations (5). Additionally, the absence of airway irritation and sympathetic stimulation during maintenance may contribute to smoother intraoperative hemodynamic profiles.

Inhalational anesthetics, on the other hand, exert cardiovascular effects through multiple mechanisms, including myocardial depression and vasodilation. Agents such as sevoflurane and desflurane reduce systemic vascular resistance and may cause dose-dependent decreases in blood pressure (6). Some volatile agents also provide cardioprotective effects through ischemic preconditioning mechanisms (7). However, rapid changes in anesthetic concentration, particularly with desflurane, may provoke sympathetic stimulation and transient tachycardia or hypertension (8). These characteristics suggest that inhalational anesthesia may result in different hemodynamic responses compared to TIVA.

Hemodynamic stability is typically assessed using parameters such as mean arterial pressure (MAP), heart rate (HR), systolic and diastolic blood pressure, and the requirement for vasoactive medications. Significant deviations from baseline values may necessitate pharmacological interventions, which themselves carry potential risks and side effects. Maintaining stable hemodynamics is particularly crucial in high-risk populations, including elderly patients and those with ischemic heart disease, hypertension, or reduced cardiac reserve (9). Several comparative studies have evaluated the hemodynamic effects of TIVA and inhalational anesthesia, yet the findings remain variable. Some investigations suggest that TIVA is associated with smoother hemodynamic profiles and reduced incidence of hypertension and tachycardia during intubation and surgical stimulation (10). Conversely, other studies indicate that modern volatile anesthetics provide comparable or even superior stability, particularly when combined with balanced analgesic techniques (11). Differences in patient populations, surgical procedures, anesthetic protocols, and monitoring methods may account for these inconsistencies.

Frontier in Medical & Health Research

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Furthermore, the choice between TIVA and inhalational anesthesia is often influenced by factors beyond hemodynamic stability, including postoperative nausea and vomiting (PONV), recovery time, environmental impact, and institutional resources. However, from a cardiovascular perspective, understanding the relative impact of these techniques on hemodynamic parameters remains clinically relevant. In resource-limited settings, where advanced monitoring systems may not always be available, selecting an anesthetic approach associated with fewer fluctuations could enhance patient safety. Recent advancements in monitoring technologies, such as invasive arterial pressure monitoring and cardiac output measurement, have improved the ability to detect subtle differences in hemodynamic responses between anesthetic techniques. Additionally, enhanced recovery protocols emphasize stable intraoperative physiology as a cornerstone of improved postoperative outcomes (12). Therefore, comparative evaluation of TIVA and inhalational anesthesia in terms of hemodynamic stability is both timely and significant.

Despite the widespread use of both techniques, there is still a need for context-specific research, particularly in regional healthcare settings where patient demographics and perioperative practices may differ. Comparative analysis of intraoperative heart rate variability, mean arterial pressure fluctuations, and vasopressor requirements can provide valuable insights into the relative advantages of each technique. Therefore, the present study aims to compare hemodynamic stability in patients receiving Total Intravenous Anesthesia versus inhalational anesthesia during elective surgical procedures. By analyzing key intraoperative cardiovascular parameters, this study seeks to determine whether one anesthetic technique offers superior hemodynamic control, thereby contributing to evidence-based anesthetic practice.

Methodology:

Study Design

This was a comparative cross-sectional study.

Study Setting

The study was conducted in the Department of Anesthesiology at Hayatabad Medical Complex.

Study Duration

The duration of the study was 6 months.

Sample Size

A total of 188 patients were included and equally divided into two groups:

- **Group A (TIVA): 94 patients**
- **Group B (Inhalational Anesthesia): 94 patients**

Sampling Technique

A non-probability consecutive sampling technique was used.

Inclusion Criteria

1. Patients aged 18–60 years.
2. ASA physical status I–II.
3. Undergoing elective surgery under general anesthesia.
4. Provided informed written consent.

Exclusion Criteria

1. ASA physical status III or above.
2. Known cardiovascular disease.
3. Severe hepatic or renal impairment.
4. Allergy to study anesthetic agents.

Data Collection Procedure

After ethical approval and informed consent, eligible patients were enrolled consecutively. Patients received either Total Intravenous Anesthesia (propofol-based infusion with opioid) or inhalational anesthesia (volatile agent for maintenance) as per anesthesiologist preference. Standard intraoperative monitoring (ECG, NIBP, SpO_2) was applied. Baseline heart rate and blood pressure were recorded before induction, followed by recordings after induction, immediately after intubation, at 5 and 15 minutes post-intubation, and every 15 minutes until the end of surgery. Episodes of hypotension, hypertension, bradycardia, tachycardia, and vasopressor use were documented on a structured proforma.

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Data Analysis

Data were analyzed using SPSS version 27. Quantitative variables were presented as mean ± standard deviation, while qualitative variables were expressed as frequency and percentage. Independent sample t-test was used to compare mean hemodynamic parameters between groups, and Chi-square test was applied for categorical variables. A p-value ≤ 0.05 was considered statistically significant.

Result:

A total of 188 patients were included in the study, with 94 patients in the TIVA group and 94 patients in the inhalational anesthesia group

Table 1: Age-wise Frequency Distribution of Patients

Age Group (Years)	Frequency (n)	Percentage (%)
18–30	54	28.7%
31–45	74	39.4%
46–60	60	31.9%
Total	**188**	**100%**

Figure 1: shows Gender wise distribution

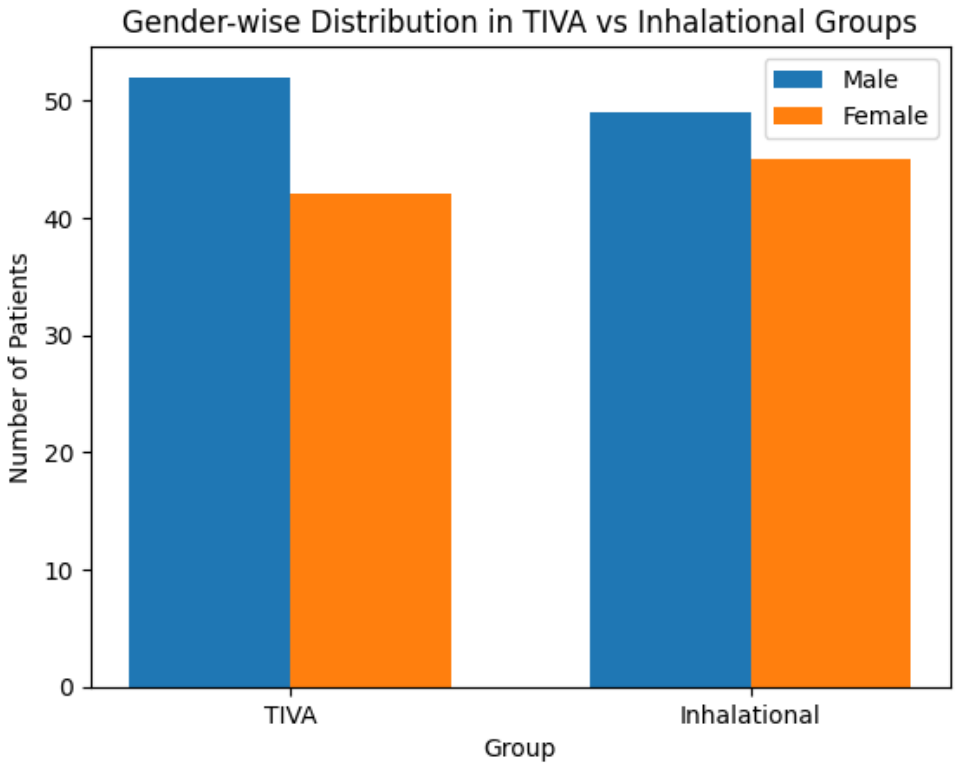


Table 2: Baseline Hemodynamic Parameters

Parameter	TIVA (Mean ± SD)	Inhalational (Mean ± SD)	p-value
Heart Rate (bpm)	78 ± 8	80 ± 9	0.21
Systolic BP (mmHg)	124 ± 10	126 ± 11	0.19
Diastolic BP (mmHg)	78 ± 6	80 ± 7	0.17
MAP (mmHg)	92 ± 7	94 ± 8	0.18

Frontier in Medical & Health Research

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Table 3: Post-Intubation Hemodynamic Response

Parameter	TIVA (Mean ± SD)	Inhalational (Mean ± SD)	p-value
Heart Rate (bpm)	85 ± 10	95 ± 12	0.001
Systolic BP (mmHg)	118 ± 9	132 ± 12	0.002
MAP (mmHg)	88 ± 6	100 ± 9	0.002

Table 4: Incidence of Intraoperative Hemodynamic Events

Event	TIVA (n=94)	Inhalational (n=94)	p-value
Hypotension	9 (9.6%)	18 (19.1%)	0.04
Hypertension	7 (7.4%)	16 (17.0%)	0.03
Bradycardia	5 (5.3%)	6 (6.4%)	0.75
Tachycardia	8 (8.5%)	20 (21.3%)	0.01

DISCUSSION

The present study compared hemodynamic stability between patients receiving Total Intravenous Anesthesia (TIVA) and inhalational anesthesia. Our findings demonstrate that although baseline hemodynamic parameters were comparable between groups, significant differences emerged during post-intubation and intraoperative periods, with TIVA providing superior hemodynamic stability.

In this study, the majority of patients belonged to the 31–45 years age group, with balanced demographic distribution between both groups. Comparable baseline parameters strengthen the internal validity of our findings, ensuring that observed differences were attributable to anesthetic technique rather than preoperative physiological variations. Post-intubation hemodynamic responses were significantly higher in the inhalational anesthesia group. This finding aligns with previous research demonstrating that volatile anesthetics such as sevoflurane and desflurane can produce sympathetic stimulation, particularly during rapid concentration changes (13). Ebert et al. reported transient tachycardia and hypertension during desflurane administration due to sympathetic activation (14). In contrast, propofol-based TIVA is known to blunt airway reflexes and suppress sympathetic responses, thereby attenuating hemodynamic fluctuations (15). Our results also showed a significantly lower incidence of tachycardia and hypertension in the TIVA group. These findings are consistent with Gupta et al., who observed smoother intraoperative cardiovascular profiles with propofol-based TIVA compared to inhalational techniques (16). Propofol reduces systemic vascular resistance and myocardial contractility in a controlled manner, which may contribute to better stability when titrated appropriately (17).

Although hypotension was observed in both groups, it was significantly higher in the inhalational group. Volatile anesthetics are known to cause dose-dependent vasodilation and myocardial depression (18). While propofol is also associated with hypotension, controlled infusion techniques may minimize abrupt hemodynamic drops (19). This could explain the reduced vasopressor requirement observed in the TIVA group in our study. The vasopressor requirement was significantly lower among patients receiving TIVA. Similar findings were reported by De Hert et al., who suggested that volatile anesthetics may require additional pharmacologic support to maintain adequate blood pressure in certain populations (20). Reduced need for vasoactive agents is clinically important, as vasopressors may increase myocardial oxygen demand and potentially affect postoperative recovery. Furthermore, modern anesthetic practice emphasizes enhanced recovery protocols and maintenance of stable intraoperative physiology. Hemodynamic fluctuations have been associated with increased postoperative morbidity and mortality (21).

Frontier in Medical & Health Research

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Therefore, the improved stability observed with TIVA in our study may have implications beyond intraoperative management, potentially influencing overall perioperative outcomes.

However, it is important to recognize that inhalational anesthetics possess certain advantages, including potential cardioprotective effects through ischemic preconditioning mechanisms (22). Thus, the choice of anesthetic technique should be individualized based on patient comorbidities, surgical factors, and institutional protocols. Overall, our findings support the growing body of evidence suggesting that propofol-based TIVA provides better control of heart rate and blood pressure during critical intraoperative periods, particularly intubation. The reduced incidence of hemodynamic disturbances and lower vasopressor requirement indicate superior cardiovascular stability compared to inhalational anesthesia.

CONCLUSION

This study concludes that Total Intravenous Anesthesia (TIVA) provides significantly better intraoperative hemodynamic stability compared to inhalational anesthesia. Patients receiving TIVA exhibited lower post-intubation heart rate and blood pressure fluctuations, reduced incidence of tachycardia and hypertension, and decreased vasopressor requirement. Therefore, TIVA may be considered a preferable anesthetic technique in patients where cardiovascular stability is a primary concern.

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