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Original Research Article

Comparative Study of Post-Operative Nausea and Vomiting (PONV) Between Total Intravenous Anaesthesia and Inhalational Anaesthesia

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Abstract:

Background: Post-operative nausea and vomiting (PONV) remains one of the most distressing complications following general anaesthesia, significantly impacting patient satisfaction and delaying discharge. The choice of anaesthetic maintenance specifically Total Intravenous Anaesthesia (TIVA) versus Inhalational Anaesthesia (IA) plays a pivotal role in influencing PONV incidence.

Objective: The primary objective of this study was to compare the incidence and severity of post-operative nausea and vomiting between patients receiving Propofol-based TIVA and those receiving Sevoflurane/Isoflurane-based inhalational anaesthesia. Secondary objectives included assessing the requirement for rescue antiemetics and hemodynamic stability.

Methods: This prospective cross-sectional comparative study was conducted at the Department of Anaesthesiology, Patna Medical College and Hospital (PMCH), Patna, from January to June. The study included 96 adult patients (ASA I & II) undergoing elective surgeries. Patients were categorized into two groups based on the anaesthetic technique administered: Group A received TIVA (Propofol-based) and Group B received Inhalational Anaesthesia (Sevoflurane/Isoflurane-based). PONV was assessed at 0, 2, 6, and 24 hours post-operatively using a standard 4-point scale.

Results: The demographic profiles including age, gender, and BMI were comparable between the two groups ($p > 0.05$). The overall incidence of PONV in the TIVA group was 12.5% (6/48), significantly lower than the 37.5% (18/48) observed in the Inhalational group ($p < 0.05$). Rescue antiemetic requirements were also significantly reduced in Group A compared to Group B.

Conclusion: Total Intravenous Anaesthesia with Propofol is associated with a significantly reduced incidence of early and late post-operative nausea and vomiting compared to volatile inhalational anaesthesia. TIVA should be considered the technique of choice for patients with a high risk of PONV to enhance recovery quality.

Introduction

Post-operative nausea and vomiting (PONV) is frequently described by patients as "the big little problem" of anaesthesia. Despite significant advances in antiemetic pharmacology and preoperative risk stratification, PONV affects approximately 30% of the general surgical population and up to 80% of high-risk patients [1]. It is clinically associated with adverse outcomes including dehydration, electrolyte imbalance, suture tension, increased intracranial or intraocular pressure, and pulmonary aspiration. Furthermore, PONV is a leading cause of delayed hospital discharge and unplanned readmissions, thereby increasing the overall economic burden on healthcare systems [2].

Pathophysiology of PONV

The pathophysiology of PONV is complex and multifactorial, involving the stimulation of the Chemoreceptor Trigger Zone (CTZ) located in the area postrema on the floor of the fourth ventricle. This area is functionally outside the blood-brain barrier and is rich in dopamine (D_2), serotonin (5-HT_3), histamine (H_1), and muscarinic (M_1) receptors. Anaesthetic agents can trigger this pathway either directly through the bloodstream or by sensitizing the vestibular system [3]. The process involves a complex interplay of inputs from the gastrointestinal tract (via the vagus nerve), the vestibular apparatus (detecting motion and balance), and higher cortical centers (processing anxiety and pain), all converging on the vomiting center in the medulla oblongata [4].

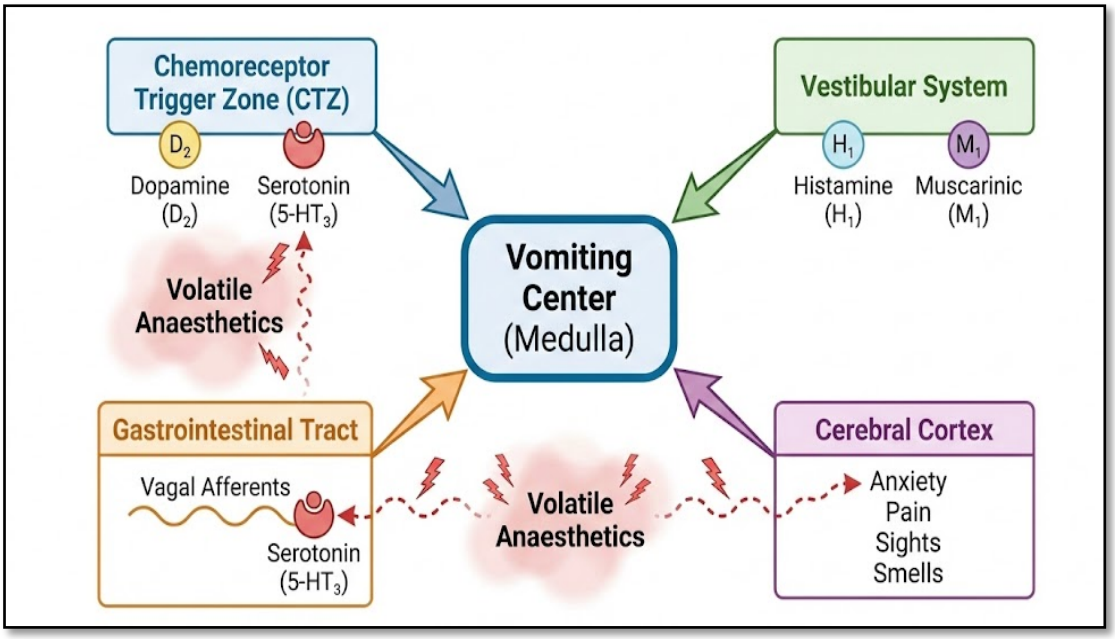

Figure 1 Neurotransmitter pathways triggering the Vomiting Center

Comparison of Anaesthetic Techniques: General anaesthesia is traditionally maintained using inhalational volatile agents such as Isoflurane, Sevoflurane, or Desflurane. While these agents allow for continuous monitoring of end-tidal concentrations and are relatively inexpensive, they are intrinsically emetogenic. They are known to induce early post-operative emesis, a side effect that often necessitates multimodal antiemetic prophylaxis. In contrast, Total Intravenous Anaesthesia (TIVA) relies on the continuous infusion of intravenous agents, predominantly Propofol combined with short-acting opioids like Fentanyl or Remifentanil. Propofol has revolutionized anaesthetic practice not only due to its favorable recovery profile but also because of its distinct antiemetic properties, which persist into the post-operative period [5].

Rationale for the Study: While global literature suggests TIVA offers a superior recovery profile, the adoption of TIVA in developing nations is often limited by the cost of drugs and the requirement for infusion pumps. Consequently, regional data regarding its efficacy in resource-limited settings is valuable for protocol optimization. This study aimed to compare the incidence of PONV between TIVA and Inhalational Anaesthesia in a tertiary care teaching hospital in Eastern India to determine if the clinical benefits justify the procedural choice in this specific demographic.

Methodology

Study Design and Setting: This research was designed as a prospective, cross-sectional comparative study. It was conducted at the Department of Anaesthesiology, Patna Medical College and Hospital (PMCH), Patna, serving as a representative tertiary care center for the region. The data collection and patient observation spanned a period of six months, commencing in January and concluding in June.

Sample Size: The sample size calculation was based on previous literature where the incidence of PONV was reported to be approximately 30% in inhalational groups and 10% in TIVA groups. Using a power analysis with a power of 80% and a significance level of 0.05, it was determined that a minimum of 90 patients would be required to yield statistically significant results. To account for potential dropouts or protocol deviations, a total of 96 patients were recruited and subsequently allocated into two equal study groups consisting of 48 patients each.

Inclusion and Exclusion Criteria: The study population was carefully selected to ensure homogeneity and reduce confounding variables. Inclusion was restricted to adult patients aged between 18 and 60 years with an American Society of Anesthesiologists (ASA) physical status of I or II, scheduled for elective general surgical, gynaecological, or orthopaedic procedures under general anaesthesia. Stringent exclusion criteria were applied to remove factors that independently increase the risk of emesis. Patients with a history of motion sickness or previous PONV were excluded, as were those on chronic antiemetic or steroid therapy. Pregnant women were not included in the study. Furthermore, patients undergoing laparoscopic surgeries were excluded because the creation of pneumoperitoneum acts as a strong independent emetogenic stimulus that could skew the comparison between the anaesthetic techniques.

Anaesthetic Protocol: Patients were assigned to one of two groups to receive specific anaesthetic maintenance. Group A (TIVA) received induction with intravenous Propofol (2 mg/kg), followed by maintenance via a continuous Propofol infusion titrated between 100 and 200 µg/kg/min, delivered in an air-oxygen mixture (FiO_2 0.5). Nitrous oxide was strictly avoided in this group. Group B (Inhalational) was induced with intravenous Propofol (2 mg/kg) but maintained on volatile agents, specifically Sevoflurane (1–2 MAC) or Isoflurane, combined with Nitrous Oxide (N_2O) and Oxygen in a 50:50 ratio.

Standard monitoring protocols were observed for all participants, including continuous Electrocardiogram (ECG), Non-Invasive Blood Pressure (NIBP), Pulse Oximetry (SpO_2), and End-Tidal Carbon Dioxide ($EtCO_2$) monitoring. Premedication was standardized using intravenous Midazolam (0.05 mg/kg) to alleviate anxiety, and intraoperative analgesia was provided with intravenous Fentanyl (2 µg/kg). To ensure the study results reflected the pure emetogenic or antiemetic potential of the maintenance agents, prophylactic antiemetics were withheld during the surgery. Rescue antiemetics were only administered if the patient exhibited symptoms of PONV in the post-operative period.

Data Collection: Post-operative assessment began immediately upon the patient's arrival in the Post-Anaesthesia Care Unit (PACU). A trained observer, blinded to the intraoperative technique used, assessed the patients for nausea and vomiting using a standard 4-point categorical scale. This scale graded symptoms as 0 for no nausea, 1 for mild nausea not requiring treatment, 2 for moderate nausea or a single vomiting episode requiring treatment, and 3 for severe nausea or multiple vomiting episodes. These observations were recorded at specific time intervals: 0–2 hours to capture early PONV and 2–24 hours to assess late PONV.

Statistical Analysis: The collected data were compiled and analyzed using SPSS software version 22.0. Continuous variables such as age, weight, and hemodynamic parameters were presented as mean standard deviation and compared using the student's t-test. Categorical variables, including gender distribution and the incidence of PONV, were analyzed using the Chi-square test or Fisher's exact test where appropriate. A p-value of less than 0.05 was considered statistically significant for all comparisons.

Results

Demographic Characteristics: The study population (n=96) comprised 48 patients in the TIVA group and 48 in the Inhalational group. An analysis of the baseline characteristics revealed no statistically significant differences between the two groups regarding age, gender distribution, Body Mass Index (BMI), or the duration of surgery. This homogeneity ensures that any observed differences in outcomes can be attributed to the anaesthetic technique rather than patient factors.

Table 1: **Demographic Profile of Patients**

Parameter	Group A (TIVA) (n=48)	Group B (Inhalational) (n=48)	p-value
Age (years)	42.5 ± 8.4	44.1 ± 9.2	0.38 (NS)
Gender (M:F)	22 : 26	20 : 28	0.68 (NS)
BMI (kg/m^2)	24.2 ± 3.1	$3.8 ± 2.9	0.52 (NS)
Duration of Surgery (min)	85.4 ± 15.2	88.1 ± 18.5	0.44 (NS)

Data presented as Mean ± SD or Number. NS = Not Significant.

Hemodynamic Stability: Intraoperative hemodynamic parameters were monitored throughout the procedure. While both groups remained within clinically acceptable ranges, Group A (TIVA) demonstrated less variability in Mean Arterial Pressure (MAP) and Heart Rate (HR) compared to Group B. The inhalational group showed a trend toward vasodilation-mediated hypotension, though the overall mean values were comparable.

Table 2: **Intraoperative Hemodynamic Parameters (Mean Values)**

Parameter	Group A (TIVA)	Group B (Inhalational)	p-value
Baseline MAP (mmHg)	92.4 ± 6.5	91.8 ± 7.1	0.67 (NS)
MAP at 30 min (mmHg)	88.2 ± 5.8	84.1 ± 8.2	0.09 (NS)
MAP at 60 min (mmHg)	89.5 ± 6.1	85.3 ± 7.5	0.12 (NS)
Baseline HR (bpm)	78.2 ± 8.4	79.1 ± 9.2	0.61 (NS)
HR at 30 min (bpm)	76.5 ± 7.3	82.4 ± 10.1	0.04 (Sig)

MAP = Mean Arterial Pressure; HR = Heart Rate.; NS= Not Significant, Sig= Significant.

Incidence of PONV: The primary outcome analysis indicated a clear advantage for the TIVA group. In the early post-operative phase (0–2 hours), only 4.1% of patients in Group A experienced nausea compared to 22.9% in Group B. Similarly, in the late phase (2–24 hours), Group A maintained a lower

incidence rate. The cumulative incidence over 24 hours was 12.5% for TIVA versus 37.5% for Inhalational anaesthesia, a difference that was statistically significant.

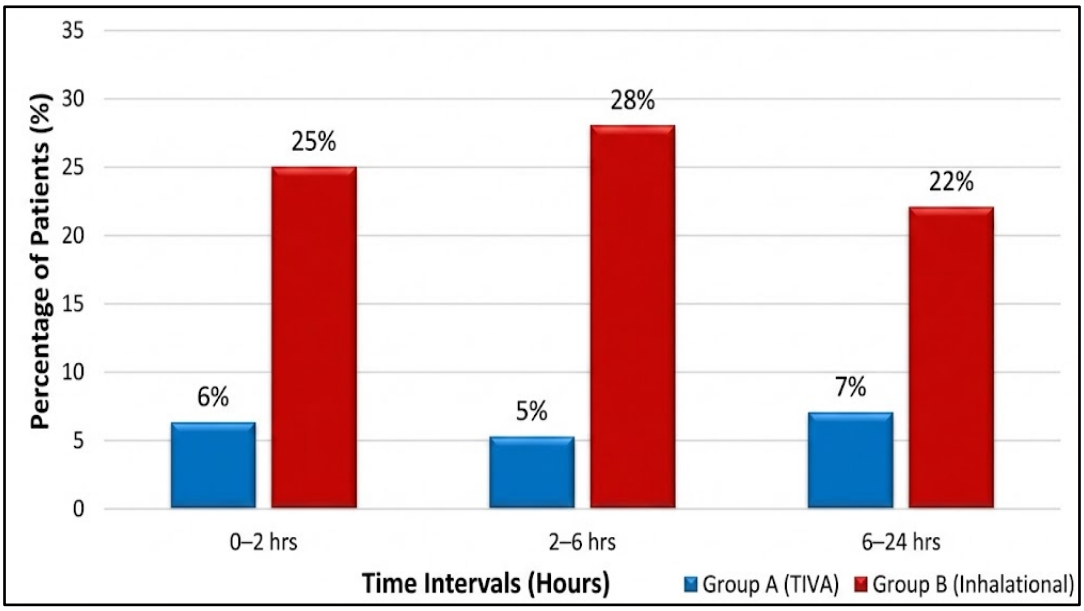

Figure 2: **Incidence of PONV: TIVA vs. Inhalational Group**

Table 3: **Distribution of PONV Severity Scores (0-24 Hours)**

PONV Score	Definition	Group A (TIVA) n(%)	Group B (Inhalational) n(%)
Score 0	No Nausea/Vomiting	42 (87.5%)	30 (62.5%)
Score 1	Mild Nausea	4 (8.3%)	8 (16.7%)
Score 2	Moderate Nausea/Vomiting	2 (4.2%)	6 (12.5%)
Score 3	Severe/Refractory	0 (0.0%)	4 (8.3%)
Total PONV Incidence	**(Score 1+2+3)**	**6 (12.5%)**	**18 (37.5%)**

p-value = 0.004 (Significant)

Rescue Antiemetic Requirement: Reflecting the PONV incidence, the requirement for rescue antiemetics (Inj. Ondansetron 4mg) was markedly higher in the Inhalational group. A total of 14 patients in Group B required pharmacological intervention to control symptoms, whereas only 4 patients in Group A required similar treatment. This reduction in drug consumption further supports the efficacy of TIVA.

Discussion

The findings of this study conducted at PMCH, Patna, strongly corroborate the existing body of evidence suggesting that Total Intravenous Anaesthesia is superior to inhalational anaesthesia in the prevention of post-operative nausea and vomiting. The results highlight a statistically significant reduction in both early and late PONV incidence in the TIVA group (12.5%) compared to the Inhalational group (37.5%).

Comparative Efficacy: The observed reduction in PONV aligns with the comprehensive meta-analyses conducted by Tramèr et al. [6] and the risk stratification models proposed by Apfel et al. [7], which identified the use of volatile anaesthetics as a primary, independent risk factor for PONV. Volatile agents such as Sevoflurane and Isoflurane are known to facilitate the release of 5-hydroxytryptamine (serotonin) in the gut and brainstem, thereby sensitizing the CTZ. Furthermore, the use of Nitrous Oxide (N_2O) in Group B likely acted as a contributory factor. As noted by Divatia et al., N_2O expands air-filled spaces, potentially causing bowel distension and increasing middle ear pressure, which stimulates the vestibular apparatus and triggers emesis [8]. The avoidance of N_2O in the TIVA group is an inherent advantage of the technique.

The "Propofol Effect": The reduced incidence in Group A is not merely a consequence of avoiding volatile agents but is also attributed to the intrinsic antiemetic properties of Propofol. Propofol (2,6-diisopropylphenol) is believed to modulate subcortical pathways, directly antagonizing D_2 receptors in the CTZ and inhibiting serotonin release [9]. Studies by Borgeat et al. have suggested that sub-hypnotic doses of propofol can be as effective as ondansetron in treating chemotherapy-induced

nausea, suggesting a potent pharmacological mechanism beyond simple sedation [10]. This "protective" effect makes TIVA an ideal choice for high-risk demographic groups, such as non-smoking females, as delineated by the Apfel Score [11].

Hemodynamics and Recovery

While both groups maintained hemodynamic stability, the TIVA group exhibited fewer fluctuations in heart rate and blood pressure. This observation is consistent with studies by Visser et al., which suggest that Propofol preserves autonomic regulation better than volatile agents, which often cause vasodilation-induced hypotension [12]. The stability provided by TIVA may also contribute to reduced post-operative dizziness, which can be confounded with nausea. Furthermore, TIVA avoids the "washout" phase required for volatile agents, often leading to a clearer-headed recovery. Schraag et al. emphasized this benefit in ambulatory surgery, noting a quicker return to baseline cognitive function [13]. Similar patterns were observed by Aytan et al. in laparoscopic cholecystectomies, where TIVA facilitated smoother recovery profiles [14].

Limitations

The study is subject to certain limitations that merit consideration. Firstly, it was a single-center study with a relatively small sample size (n=96), which may limit the generalizability of the findings to broader populations with different genetic predispositions to PONV, as suggested by Klenke et al. [15]. Secondly, the use of N_2O in the inhalational group acts as a confounding factor; however, this reflects standard practice in many resource-constrained settings. Additionally, the lack of Bispectral Index (BIS) monitoring to strictly standardize the depth of anaesthesia across all patients is a limitation, although Myles et al. have demonstrated the utility of such monitoring in preventing awareness and refining dosage [16].

Conclusion

This prospective cross-sectional comparative study conclusively demonstrates that Total Intravenous Anaesthesia (TIVA) using Propofol provides a significantly superior antiemetic profile compared to Inhalational Anaesthesia with Sevoflurane/Isoflurane and Nitrous Oxide. Patients in the TIVA group experienced fewer episodes of early and late PONV, reported lower severity scores when symptoms did occur, and required significantly less rescue medication.

The implications of these findings are significant for clinical practice in settings like PMCH. Chatterjee et al. have long argued that effective management of PONV requires a shift towards prophylactic strategies rather than rescue treatments [17]. While TIVA may incur higher immediate drug costs compared to inhalational agents, the reduction in PONV-related complications, nursing workload, and the potential for earlier discharge may offset these costs. This is particularly relevant in day-case surgeries, such as gynaecological laparoscopy, where Paech et al. found anaesthetic technique to be a critical determinant of discharge readiness [18]. Therefore, it is recommended that TIVA be adopted as the standard of care for patients identified as moderate-to-high risk for PONV to optimize patient comfort and hospital efficiency.

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