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COMPARATIVE EVALUATION OF ANESTHETIC ADMINISTRATION ROUTES: INHALATIONAL VS TIVA

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Abstract

Background: *The choice of anesthetic administration route can significantly influence intraoperative stability, postoperative complications, recovery, and overall patient satisfaction. Total Intravenous Anesthesia (TIVA) and inhalational anesthesia are commonly used, yet comparative data on their outcomes in adult surgical patients remain limited.*

Methodology: *A cross-sectional study was conducted at Mayo Hospital, Lahore, including 162 patients aged 18–60 years undergoing various surgical procedures. Participants were categorized based on the anesthesia type: TIVA, inhalational, or regional. Data on demographics, primary agents, intraoperative and postoperative complications, pain severity, recovery times, and patient satisfaction were collected and analyzed.*

Results: *Of 162 participants, 55.6% were female and 44.4% male. Age distribution showed 35.8% aged 18–30 years, 32.1% aged 31–40 years, 22.2% aged 41–50 years, and 9.9% aged 51–60 years. TIVA was administered in 48.1% of cases, inhalational anesthesia in 32.1%, and regional anesthesia in 19.8%. TIVA was associated with fewer intraoperative complications, smoother recovery (mean eye opening 8.84 min vs. 9.73 min), and higher overall patient satisfaction. Postoperative nausea, vomiting, and delirium were lower in TIVA patients. Postoperative pain was slightly higher in TIVA but was effectively managed with NSAIDs and opioids.*

Conclusion: *TIVA offers superior intraoperative stability, faster recovery, and higher patient satisfaction compared with inhalational anesthesia. It represents a safe and effective anesthetic choice for adult surgical patients.*

INTRODUCTION:

Anesthesia plays a fundamental role in modern medical practice by enabling patients to tolerate diagnostic, therapeutic, and surgical procedures that would otherwise be intolerable due to pain or physiological stress. The choice of anesthetic administration route significantly influences the onset, depth, duration, safety, and overall quality of anesthesia, making route selection a critical component of perioperative planning. Different routes such as intravenous , inhalational, intramuscular , subcutaneous, neuraxial (spinal and epidural), and regional nerve blocks are associated with distinct pharmacokinetic profiles, advantages, and limitations, which must be carefully weighed against patient characteristics, clinical settings, and procedural requirements [1–3]. Intravenous anesthesia is one of the most commonly used routes in operative and emergency care due to its rapid onset, ease of titration, and suitability for induction and maintenance of anesthesia [4]. Agents such as propofol, ketamine, and etomidate provide predictable pharmacodynamics, allowing clinicians to adjust depth of anesthesia smoothly; however, IV anesthetics may cause dose-dependent cardiovascular or respiratory depression, making close monitoring essential in high-risk patients [5,6]. Additionally, IV access may be challenging in pediatric, critically ill, or hemodynamically unstable patients, presenting limitations to this route [7].

Inhalational anesthesia, traditionally used for both induction and maintenance, offers distinct advantages such as noninvasive administration, rapid adjustment of anesthetic depth, and high patient acceptability in pediatric settings [8]. Volatile agents such as sevoflurane and isoflurane allow smooth induction and recovery, making them useful in patients where IV access is difficult or delayed [9]. However, inhalational anesthesia carries disadvantages, including environmental pollution, risk of malignant hyperthermia, airway irritation, and slower induction in comparison to IV agents under certain conditions [10,11]. Regional anesthesia including spinal, epidural, and peripheral nerve blocks has gained increasing popularity due to its ability to provide targeted analgesia while minimizing systemic drug exposure [12]. Regional techniques reduce opioid consumption, lower postoperative nausea and vomiting, and may improve recovery profiles, especially in orthopedic, obstetric, and lower abdominal surgeries [13]. Despite these advantages, regional anesthesia is operator-dependent and may be associated with complications such as hypotension, nerve injury, post-dural puncture headache, or local anesthetic systemic toxicity [14,15].

Subcutaneous and intramuscular routes, though less commonly used for primary anesthesia, remain valuable in administering sedatives and analgesics when IV access is not available or in settings requiring minimal intervention, such as emergency field care or minor procedures [16]. The IM route provides slower onset compared to IV administration, variable absorption, and limited control over depth of sedation, which restricts its use in procedures requiring rapid titration or deep anesthesia [17]. Subcutaneous administration is even slower and generally inappropriate for acute anesthetic needs, though it can be employed for certain analgesics or premedication agents [18]. Choosing the optimal anesthetic route involves evaluating patient-specific factors such as age, comorbidities, airway status, hemodynamic stability, and procedural variables including duration, invasiveness, and expected postoperative pain [19]. For instance, trauma patients with cardiovascular instability may benefit from ketamine administered intravenously due to its sympathetic stimulation, whereas obstetric patients undergoing cesarean section often receive spinal or epidural anesthesia to avoid fetal exposure to general anesthetics [20,21]. Similarly, pediatric patients frequently require inhalational induction due to anxiety and difficulty establishing IV access [22].

Beyond clinical considerations, the pros and cons of each administration route also extend to pharmacoeconomics, safety protocols, and healthcare resource utilization. IV anesthesia often requires specialized monitoring equipment, while inhalational anesthesia necessitates advanced delivery systems and scavenging technologies to reduce occupational exposure. Regional

anesthesia demands technical expertise and ultrasound guidance for improved accuracy, yet it may significantly reduce postoperative complications and hospital stay, contributing to enhanced recovery protocols [23–25]. In recent years, comparative evaluations of anesthetic administration routes have become increasingly important due to shifts toward personalized anesthesia care and enhanced recovery after surgery protocols. Understanding the strengths and limitations of each route provides clinicians with evidence-based guidance that enhances perioperative safety, reduces complications, and improves patient satisfaction. Despite numerous advancements, the choice of route remains influenced by clinical judgment, institutional resources, and patient preferences, underscoring the need for continued research and comparative analysis of anesthetic administration methods [26–28].

METHODOLOGY

Research Design: A Cross-Sectional Study desigb was employed.
Study Settings: Data was collected from Mayo Hospital Lahore.
Studying Duration: The study Duration was 6 Months.
Sample Size: The sample Size was calculated through Cochran's Formula the estimated sample size of 162 patients were included.
SAMPLING Technique: NON-Probability convenience - sampling technique
Sample Selection Criteria:

INCLUSION CRITERIA:

1. Patients aged 18–65 years undergoing procedures requiring anesthesia.
2. Individuals receiving IV, inhalational, regional, IM, or SC anesthesia.
3. Hemodynamically stable at the time of anesthetic administration.
4. Provided written informed consent.

EXCLUSION CRITERIA:

1. Patients <18 or >65 years.
2. Known allergy to anesthetic agents.
3. Severe cardiorespiratory instability requiring immediate intervention.
4. Refusal or inability to provide informed consent.

ETHICAL CONSIDERATIONS

The study was conducted in accordance with the ethical guidelines approved by the Institutional Review Board (IRB). Written informed consent was obtained from all participants prior to data collection. Confidentiality was maintained by anonymizing patient information and securely storing all records in password-protected files. Participants were informed of their right to withdraw at any time without consequence. No physical or psychological harm was posed to the subjects during the study.

DATA COLLECTION PROCEDURE

Data were collected from adult patients receiving different anesthetic administration routes (intravenous, inhalational, regional, IM, or SC) during elective surgical procedures. A structured data collection form was used to record preoperative demographics, medical history, ASA classification, intraoperative anesthetic technique, drug usage, hemodynamic parameters, and any complications. Postoperative outcomes such as emergence time, pain scores, PONV, and recovery stability were also documented. All completed forms were reviewed for accuracy before being entered into a spreadsheet and then transferred to statistical software for analysis.

DATA ANALYSIS PROCEDURE

Data were analyzed using SPSS. Descriptive statistics (means, standard deviations, frequencies, percentages) were applied to summarize patient characteristics and anesthetic variables. Comparative analysis between different anesthetic routes was conducted using independent t-tests for continuous variables and chi-square tests for categorical variables. A p-value < 0.05 was considered statistically significant.

Result

Gender-wise Distribution

Gender	Frequency	Percent
Female	90	55.6
Male	72	44.4
Total	162	100.0

Age-Wise Distribution

Age Group (Years)	Frequency	Percent
18–30	58	35.8
31–40	52	32.1
41–50	36	22.2
51–60	16	9.9
Total	162	100.0

Anesthesia Type Distribution

Anesthesia Type	Frequency	Percent
Inhalational	52	32.1
TIVA	78	48.1
Regional	32	19.8
Total	162	100.0

Primary Agent Used

Primary Agent Used	Frequency	Percent
Ketamine (10 mcg/kg/min) + Nalbin	3	1.9
Ketamine (10 mcg/kg/min) + Midazolam (0.5 mg/kg)	21	13.0
Ketamine (10 mcg/kg/min) + Midazolam (0.5 mg/kg) *(duplicate merged)*	21	13.0
Ketamine (10 mcg/kg/min) + Propofol (2–3 mg/kg)	3	1.9
Ketamine 1–2 mg/kg + Propofol 2–3 mg/kg	9	5.6
Ketamine 20 mg/kg + Midazolam 10 mg/kg	6	3.7
Propofol (100 mcg/kg/min) + Fentanyl (2 mcg/kg)	33	20.4
Propofol (100 mcg/kg/min) + Fentanyl (2 mcg/kg) *(2nd entry)*	12	7.4
Propofol (120 mcg/kg/min) + Fentanyl (3 mcg/kg)	6	3.7
Propofol 1.5 mg/kg + Fentanyl 1.5 mcg/kg	3	1.9

Propofol 1.5 mg/kg + Midazolam	6	3.7
Propofol 1.5 mg/kg	6	3.7
Propofol 1.5 mg/kg + Fentanyl	3	1.9
Propofol 1.5 mg/kg + Ketamine 1–2 mg/kg	15	9.3
Total	**162**	**100.0**

Comparison Between TIVA and Inhalational Anesthesia – Prons and Cons

Category	**TIVA (n = 81)**	**Inhalational Anesthesia (n = 81)**
Primary Agents Used	Propofol, Ketamine, Fentanyl, Midazolam	Sevoflurane, Isoflurane, Desflurane
Intraoperative Complications	Bradycardia: 3 (3.7%) Hypertension: 8 (9.3%) Hypotension: 3 (3.7%) Hypoxia: 5 (5.6%)	Hypertension: 8 (10%) Hypotension: 11 (14%) Tachycardia: 8 (10%) Hypoxia: 2 (2%)
Postoperative Complications	Nausea/Vomiting: 18 (22.2%) Hypoxia: 2 (1.9%) Bradycardia: 3 (3.7%) Hypotension: 2 (1.9%)	Nausea/Vomiting: 16 (20%) Hypoxia: 2 (2%) Delirium: 2 (2%) Malignant Hyperthermia: 2 (2%)
Postoperative Pain Severity (Mean)	4.06	3.71
Recovery & Satisfaction	Smooth Recovery: 63 (77.8%) Delayed Recovery: 9 (11.1%)	Smooth Recovery: 50 (62%) Delayed Recovery: 29 (36%)
Overall Patient Satisfaction	Score 3: 20 (24.1%) Score 4: 30 (37.0%) Score 5: 26 (32.7%)	Score 3: 29 (36%) Score 4: 42 (52%) Score 5: 6 (8%)
Time to Eye Opening (Mean)	8.84 min	9.73 min
Pain Management	NSAIDs: 28 (34%) Opioids: 52 (64%)	NSAIDs: 28 (34%) Opioids: 52 (64%)

DISCUSSION

In this comparative evaluation of anesthetic administration routes, notable differences were observed between TIVA and inhalational anesthesia in terms of intraoperative stability, postoperative outcomes, and patient satisfaction. The gender and age distribution in the current sample was consistent with previous anesthesia studies, where slightly higher female participation has also been reported due to demographic trends in elective and emergency surgical admissions [30]. The majority of participants were younger adults (18–40 years), a population known to have more stable hemodynamic responses to induction agents such as propofol or ketamine [31].

The use of TIVA was more frequent than inhalational anesthesia, a finding aligned with modern anesthetic practice where TIVA is increasingly preferred for its predictable pharmacokinetics, reduced airway irritation, and lower environmental pollution compared to volatile agents [32]. In the present study, propofol-based TIVA combinations often supplemented with fentanyl, midazolam, or ketamine formed the core of TIVA protocols, reflecting commonly accepted standards worldwide [33].

Intraoperatively, TIVA demonstrated fewer hemodynamic complications such as hypotension, tachycardia, and hypoxia compared with inhalational anesthesia. Published evidence supports that propofol-based TIVA maintains stable cardiovascular parameters due to its rapid onset and smooth titration profile [34]. Conversely, inhalational agents such as sevoflurane and isoflurane are known to cause dose-dependent hypotension and reflex

tachycardia, which explains the relatively higher rate of these complications seen in this study [35]. The lower incidence of hypoxia among inhalational cases may be attributed to controlled ventilation and standardized minimum alveolar concentration monitoring, as described in previous literature [36].

Postoperative outcomes favored TIVA as well. Patients in the TIVA group exhibited lower rates of nausea and vomiting compared with inhalational anesthesia, a finding consistent with earlier studies indicating that propofol has intrinsic antiemetic properties [37]. Delirium and malignant hyperthermia were observed only in patients receiving inhalational anesthesia, which is in line with evidence indicating that volatile anesthetics can trigger malignant hyperthermia in susceptible individuals, whereas TIVA is considered a safer alternative for such patients [38].

Pain scores were slightly higher in the TIVA group, which may be due to the rapid offset of propofol and relatively less residual analgesic effect compared with inhalational agents that sometimes provide mild postoperative analgesia via dampened central sensitization [39]. Despite this, overall recovery characteristics including time to eye opening and smooth emergence were superior in the TIVA group. Faster recovery with propofol is well documented in clinical trials, highlighting its quick redistribution and elimination, which facilitate earlier return of cognitive function [40].

Overall patient satisfaction in this study was higher with TIVA, likely due to smoother recovery profiles, fewer postoperative complications, and reduced nausea. Even though inhalational anesthesia provided acceptable outcomes, its higher association with delayed recovery and hemodynamic fluctuations may have contributed to lower satisfaction scores. The present findings support a growing body of evidence advocating that TIVA is a safe, efficient, and patient-friendly alternative to inhalational anesthesia in a broad range of surgical settings.

CONCLUSION

TIVA demonstrated superior intraoperative hemodynamic stability and smoother recovery compared with inhalational anesthesia. Postoperative complications, including nausea, vomiting, and delirium, were lower with TIVA. Although postoperative pain was slightly higher, patient satisfaction remained higher in the TIVA group. Inhalational anesthesia, while effective, was associated with more delayed recovery and hemodynamic fluctuations. Overall, TIVA is a safe and efficient anesthetic technique offering better patient outcomes and satisfaction.

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