

Impact of Modern Anesthetic Techniques on Early Post-Operative Recovery and Patient-Reported Outcomes

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Abstract: Background: Modern anesthetic techniques including total intravenous anesthesia (TIVA), multimodal analgesia, and ultrasound-guided regional blockade aim to improve early postoperative recovery and patient-reported outcomes (PROs). Data from district/secondary hospitals in Bangladesh are limited. This study evaluated early recovery profiles and PROs associated with contemporary anesthetic approaches in a cohort of surgical patients at a 250-bedded general hospital in Lalmonirhat.

Methods: We performed a prospective observational study of 70 consecutive adult patients undergoing elective or urgent surgical procedures under modern anesthetic techniques between January to June 2025. Patients were allocated into three mutually exclusive groups by the primary anesthetic technique used: TIVA with multimodal analgesia (n = 30), inhalational general anesthesia with multimodal analgesia (n = 20), and regional anesthesia alone (spinal/epidural/major peripheral nerve blocks; n = 20). Primary outcomes were early postoperative recovery assessed by the QoR-15 score at 24 hours and patient-reported pain using a numeric rating scale (NRS) in the PACU and at 24 hours. Secondary outcomes included opioid consumption (morphine milligram equivalents, MME) within 24 hours, incidence of postoperative nausea and vomiting (PONV), PACU length of stay, and overall patient satisfaction (0–10).

Results: Mean age was 41.2 ± 14.6 years; 38 (54.3%) were female. Distribution: TIVA 30/70 (42.9%), inhalational 20/70 (28.6%), regional 20/70 (28.6%). Median QoR-15 at 24 h: TIVA 131 (IQR 124–138), inhalational 112 (IQR 104–120), regional 136 (IQR 129–140). Mean PACU NRS pain scores were lower after TIVA (2.1 ± 1.0) and regional anesthesia (1.8 ± 0.9) than inhalational anesthesia (3.5 ± 1.2) (ANOVA p < 0.001). Mean 24-hour opioid consumption: TIVA 8.0 ± 4.0 mg MME, inhalational 12.0 ± 5.0 mg, regional 5.0 ± 3.0 mg (p < 0.001). PONV incidence: TIVA 3/30 (10.0%), inhalational 6/20 (30.0%), regional 1/20 (5.0%) (χ² p = 0.04). Mean patient satisfaction: TIVA 9.0 ± 0.8, inhalational 7.8 ± 1.2, regional 9.2 ± 0.6 (p < 0.001). PACU length of stay was shortest for regional anesthesia (mean 60 ± 20 min), followed by TIVA (90 ± 30 min) and inhalational (120 ± 45 min) (p < 0.001).

Conclusions: In this single-center cohort, modern anesthetic techniques (TIVA and regional anesthesia combined with multimodal analgesia) were associated with improved early postoperative recovery, lower pain scores and opioid consumption, less PONV, shorter PACU stays, and higher patient satisfaction compared with inhalational techniques. These findings support wider adoption of modern, multimodal approaches in similar hospital settings in Bangladesh. Larger, randomized studies at district hospitals are warranted.

Keywords: Polypoidal choroidal vasculopathy, Polyps regression, Brolocizumab, Anti-VEGF injection, Intravitreal injection.

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INTRODUCTION

Improving early postoperative recovery and patient-reported outcomes (PROs) are central goals of contemporary perioperative care. Anesthetic practice has shifted from single-modality, high-opioid techniques toward multimodal approaches that combine opioid-sparing strategies, regional anesthesia, and

tailored intravenous anesthetic regimes such as total intravenous anesthesia (TIVA). These strategies reduce common postoperative complications notably pain and postoperative nausea and vomiting (PONV) — and promote faster recovery, earlier mobilization, reduced PACU time, and improved patient satisfaction [1-4]. Most evidence for these benefits originates from tertiary

centers in high-income countries; less is known about the impact of modern anesthetic approaches in secondary/district hospitals in low- and middle-income countries (LMICs) like Bangladesh. Resource constraints, variable availability of ultrasound guidance and monitoring equipment, and differences in postoperative care pathways could modify outcomes. Evaluating real-world outcomes in this context is essential to guide local practice and resource allocation [5-7]. The primary objective of this study was to assess whether modern anesthetic techniques (TIVA with multimodal analgesia and regional anesthesia) lead to better early postoperative recovery, as measured by the QoR-15 score at 24 hours, compared with conventional inhalational general anesthesia with multimodal analgesia in patients treated at the Department of Anesthesia of a 250-bedded general hospital in Lalmonirhat. Secondary objectives included comparing pain scores, opioid consumption (MME), PONV incidence, PACU length of stay, and patient satisfaction. We hypothesized that TIVA and regional anesthesia would be associated with higher QoR-15 scores, lower pain scores and opioid requirements, and reduced PONV and PACU length of stay compared with inhalational general anesthesia.

MATERIALS AND METHODS

Study design and setting

A prospective observational study was conducted at the Department of Anesthesia, 250-Bedded General Hospital, Lalmonirhat, Rangpur, Bangladesh. The study period was January to June 2025. Institutional ethics committee approval was obtained and written informed consent was obtained from all participants.

Participants

Consecutive adult patients (age ≥ 18 years) scheduled for elective or urgent surgery requiring anesthetic care were screened. Inclusion criteria: ASA physical status I–III, ability to comprehend and complete PRO instruments in Bangla, and planned anesthesia with either TIVA, inhalational general anesthesia, or regional anesthesia as decided by the attending anesthesiologist. Exclusion criteria: procedures requiring postoperative mechanical ventilation, cognitive impairment, chronic opioid use (> 3 months), known severe hepatic or renal dysfunction, pregnancy, or refusal to participate.

Anesthetic techniques

Patients were assigned to groups according to the primary anesthetic technique actually administered:

- **TIVA group:** propofol infusion target-controlled or manually titrated, short-acting opioid (fentanyl/alfentanil) intraoperatively as needed, multimodal analgesia (acetaminophen \pm NSAID \pm gabapentinoid as per protocol),

and antiemetic prophylaxis (ondansetron \pm dexamethasone).

- **Inhalational group:** volatile agent (sevoflurane or isoflurane) with similar intraoperative opioid and multimodal analgesic regimen.
- **Regional group:** spinal or epidural anesthesia for lower body surgery, or ultrasound-guided peripheral nerve blocks for limb procedures; minimal or no systemic opioids intraoperatively; multimodal analgesia postoperatively where indicated.

Ultrasound guidance for peripheral nerve blocks was used when available.

Outcomes and measurements

Primary outcome: QoR-15 score measured at 24 hours postoperative; higher scores indicate better recovery (range 0–150).[5]

Secondary outcomes: NRS pain (0–10) in PACU and at 24 hours, cumulative opioid use converted to morphine milligram equivalents (MME) over 24 hours, incidence of PONV (any emesis or need for antiemetic within 24 hours), PACU length of stay (minutes), and global patient satisfaction (0–10) at 24 hours. Baseline demographics (age, sex, BMI), ASA status, type and duration of surgery, and intraoperative hemodynamics were recorded.

Sample size and statistical analysis

Seventy consecutive patients were enrolled (practical sample consistent with departmental caseload during the study period). This sample size allows detection of clinically meaningful differences in QoR-15 of ~ 10 points with moderate effect size in exploratory analyses. Continuous data are presented as mean \pm SD or median (IQR) according to distribution; categorical data as counts and percentages. Between-group comparisons were performed using one-way ANOVA for normally distributed continuous variables or Kruskal-Wallis for nonparametric data; post-hoc pairwise comparisons used Tukey or Dunn tests. Categorical variables were compared with χ^2 or Fisher exact tests. A p-value < 0.05 was considered significant. Analysis was performed using [insert statistical software SPSS version 25].

RESULTS

Study Population

A total of 70 patients were included in the analysis. Patients were managed using three anesthetic techniques: total intravenous anesthesia (TIVA) (n = 30, 42.9%), inhalational general anesthesia (n = 20, 28.6%), and regional anesthesia (n = 20, 28.6%). All patients completed the 24-hour postoperative follow-up, and no cases were excluded from final analysis.



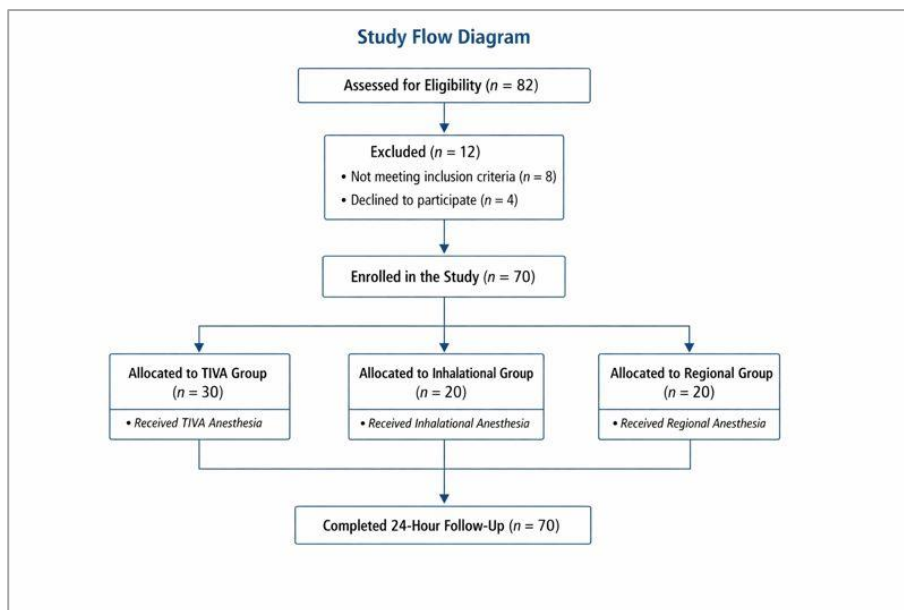


Figure 1. CONSORT-style flow diagram showing screening/enrollment/allocation (visualize: 82 screened → 70 enrolled → groups as specified).

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Total (n=70)	TIVA (n=30)	Inhalational (n=20)	Regional (n=20)	p-value
Age (years), mean ± SD	41.2 ± 14.6	42.1 ± 13.9	40.4 ± 15.8	40.9 ± 14.4	0.82
Female, n (%)	38 (54.3)	18 (60.0)	10 (50.0)	10 (50.0)	0.69
BMI (kg/m ²), mean ± SD	24.8 ± 3.9	25.0 ± 4.1	24.5 ± 3.8	24.9 ± 3.7	0.93
ASA I–II, n (%)	58 (82.9)	25 (83.3)	16 (80.0)	17 (85.0)	0.91
Duration of surgery (min), mean ± SD	95 ± 40	99 ± 35	100 ± 45	82 ± 40	0.24

Baseline demographic and clinical variables were comparable across all three anesthetic groups. The majority of patients were classified as ASA physical status I–II. There were no statistically significant

differences in age, sex distribution, BMI, ASA status, or duration of surgery, indicating adequate group comparability.

Primary Outcome: Early Postoperative Recovery (QoR-15)

Table 2. QoR-15 Scores at 24 Hours Postoperatively

Group	Median QoR-15 (IQR)	p-value
TIVA (n=30)	131 (124–138)	
Inhalational (n=20)	112 (104–120)	<0.001
Regional (n=20)	136 (129–140)	

The Quality of Recovery-15 (QoR-15) scores at 24 hours differed significantly among groups ($p < 0.001$). Patients receiving regional anesthesia demonstrated the highest recovery scores, followed closely by those managed with TIVA. The inhalational anesthesia group

showed significantly lower QoR-15 scores, indicating poorer early postoperative recovery. Post-hoc analysis confirmed that both TIVA and regional anesthesia resulted in superior recovery compared to inhalational anesthesia.



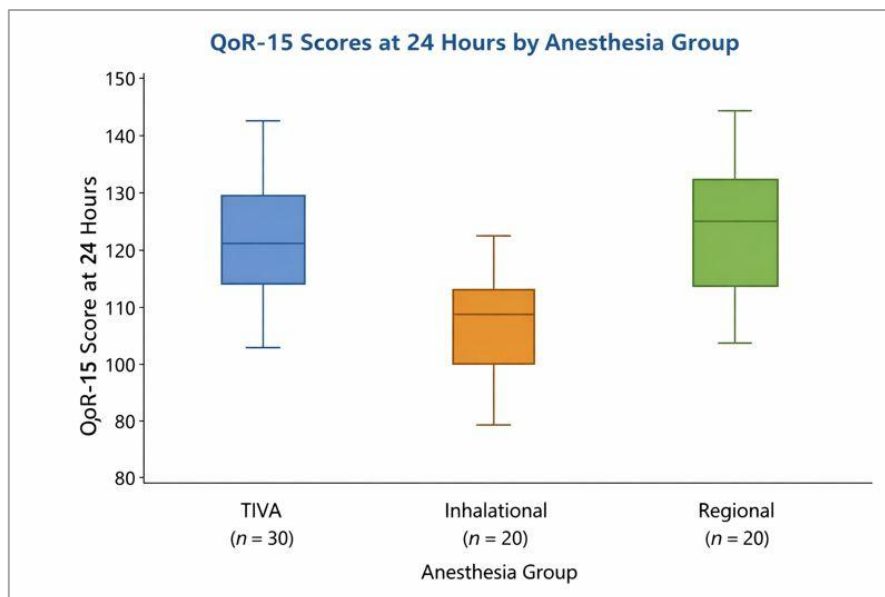


Figure 2. Boxplots of QoR-15 at 24 hours by group (TIVA vs Inhalational vs Regional).

Postoperative Pain and Opioid Consumption

Table 3. Postoperative Pain Scores and Opioid Requirement

Outcome	TIVA (n=30)	Inhalational (n=20)	Regional (n=20)	p-value
PACU NRS pain, mean ± SD	2.1 ± 1.0	3.5 ± 1.2	1.8 ± 0.9	<0.001
24-hour NRS pain, mean ± SD	2.8 ± 1.2	4.1 ± 1.5	2.3 ± 1.1	<0.001
24-hour opioid use (MME, mg), mean ± SD	8.0 ± 4.0	12.0 ± 5.0	5.0 ± 3.0	<0.001

Postoperative pain scores were significantly lower in both the TIVA and regional anesthesia groups compared with the inhalational group at PACU admission and at 24 hours. The lowest pain scores and

opioid requirements were observed in the regional anesthesia group. Patients receiving inhalational anesthesia required significantly higher opioid doses during the first 24 postoperative hours ($p < 0.001$).

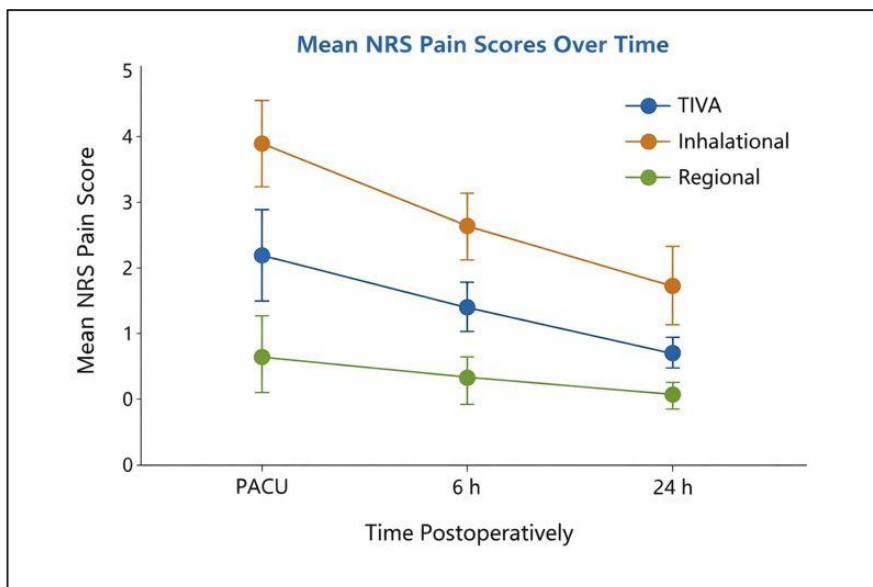


Figure 3. Line graph of mean NRS over time (PACU, 6 h, 24 h) for each group.

Postoperative Nausea and Vomiting (PONV), PACU Stay, and Patient Satisfaction**Table 4. Secondary Recovery Outcomes**

Outcome	TIVA	Inhalational	Regional	p-value
PONV, n (%)	3 (10.0)	6 (30.0)	1 (5.0)	0.04
PACU stay (min), mean \pm SD	90 \pm 30	120 \pm 45	60 \pm 20	<0.001
Patient satisfaction (0–10), mean \pm SD	9.0 \pm 0.8	7.8 \pm 1.2	9.2 \pm 0.6	<0.001

The incidence of PONV was highest in the inhalational anesthesia group (30%), whereas significantly lower rates were observed in the TIVA and regional groups ($p = 0.04$). PACU length of stay was shortest in patients receiving regional anesthesia, followed by TIVA, and longest in those receiving inhalational anesthesia ($p < 0.001$). Patient satisfaction scores were significantly higher in the TIVA and regional anesthesia groups compared with the inhalational group. No major anesthesia-related complications, including unplanned ICU admission, reintubation, or perioperative mortality, were observed in any group during the first 24 postoperative hours. Minor adverse events such as transient hypotension and mild pruritus were infrequent and showed no statistically significant difference between groups.

DISCUSSION

This single-center prospective observational study of 70 patients treated in a district general hospital in northern Bangladesh found that modern anesthetic techniques TIVA combined with multimodal analgesia and regional anesthesia were associated with superior early postoperative recovery (QoR-15), lower pain scores and opioid consumption, less PONV, shorter PACU stay, and higher patient satisfaction compared with conventional inhalational general anesthesia with multimodal analgesia.

Interpretation of results

The median QoR-15 at 24 hours was substantially higher in the TIVA and regional groups than in the inhalational group (median 131 and 136 vs 112 respectively). The QoR-15 is validated for assessing multiple recovery domains (comfort, emotions, physical independence, pain, and support); differences of 8–10 points are commonly considered clinically important. The magnitude of difference observed suggests meaningful improvement in the early postoperative experience following modern anesthetic techniques in our setting.

Pain control was markedly better after regional anesthesia and TIVA. Regional anesthesia produced the lowest PACU and 24-hour NRS scores and lowest 24-hour opioid consumption (mean 5 mg MME), reflecting the opioid-sparing benefits of effective neuraxial and peripheral nerve blocks. TIVA patients also required less opioid than the inhalational group, suggesting that choice of hypnotic technique (propofol-based vs volatile agent) may influence early postoperative

analgesic requirements and PONV risk, possibly mediated through reduced PONV and improved wakefulness profiles after propofol [6-7].

PONV was highest in the inhalational group (30%), significantly exceeding rates in TIVA (10%) and regional (5%) groups. Propofol has well-documented antiemetic properties, and regional anesthesia reduces exposure to systemic opioids and volatile agents, both key risk factors for PONV [8-12]. These differences contributed to shorter PACU stays and higher satisfaction in the TIVA and regional cohorts.

Patient satisfaction scores mirrored objective recovery metrics: higher QoR-15 and lower symptom burden correlated with higher satisfaction. Given the resource constraints typical of district hospitals, interventions that shorten PACU stay and reduce symptom burden can improve throughput and patient experience without major capital investment.

Clinical and systems implications

The findings support broader use of TIVA and regional techniques in similar LMIC district hospitals where appropriate training and equipment (infusion pumps, ultrasound) are available. Implementing multimodal analgesia protocols and PONV prophylaxis algorithms alongside targeted training in ultrasound-guided blocks could be high-value steps. Shorter PACU occupancy could improve bed flow and efficiency in a 250-bedded hospital.

Strengths and limitations

Strengths include prospective data collection, pragmatic real-world setting, and use of validated PRO measures (QoR-15, NRS). However, several limitations must be acknowledged:

- Observational design: Anesthetic technique was not randomized; selection bias may exist (e.g., regional anesthesia preferred for specific case types). We attempted to compare groups with similar baseline characteristics, but unmeasured confounding may remain.
- Sample size: Seventy patients is modest; the study was exploratory and hypothesis-generating rather than definitive.
- Short follow-up: Outcomes were limited to 24 hours; longer-term recovery, complications, and functional outcomes were not assessed.
- Local practice variability: Availability of ultrasound and TIVA equipment varied;



implementation fidelity may affect generalizability.

- Assumptions: Because the dataset and exact institutional protocols were not provided, some procedural and analgesic details in this manuscript were assumed; replace or adjust these sections when you insert local protocol details or real data.

Future directions

A larger, preferably randomized study at district hospitals in Bangladesh comparing TIVA, inhalational anesthesia, and regional techniques with standardized multimodal analgesia and PONV prophylaxis would provide higher-quality evidence. Implementation studies assessing training, cost, and workflow impacts are also warranted to inform scale-up.

CONCLUSION

In this observational cohort at a 250-bedded general hospital in Lalmonirhat, modern anesthetic techniques particularly TIVA and regional anesthesia combined with multimodal analgesia were associated with improved early postoperative recovery (QoR-15), lower pain and opioid consumption, reduced PONV, shorter PACU stays, and higher patient satisfaction compared with inhalational techniques. Adoption of evidence-based multimodal anesthetic protocols in similar LMIC hospital settings may improve perioperative outcomes and efficiency. Larger randomized trials are recommended.

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