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ORIGINAL ARTICLE

Evaluation of Anesthetic Depth and Its Association with Postoperative Nausea, Pain, and Hospital Stay in General Surgery Patients

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ABSTRACT

Background: Anesthetic depth is a critical component of intraoperative management that may significantly influence postoperative outcomes.

Objective: This study aimed to evaluate the relationship between anesthetic depth, monitored using the Bispectral Index (BIS), and the incidence of PONV, postoperative pain, and length of hospital stay in patients undergoing general surgery.

Methods: Patients were categorized into three groups based on intraoperative BIS scores: Group A (light anesthesia, BIS > 60), Group B (adequate anesthesia, BIS 40–60), and Group C (deep anesthesia, BIS < 40). Postoperative nausea was assessed within 24 hours using a 4-point scale. Pain intensity was evaluated using the Visual Analog Scale (VAS) at 2, 6, 12, and 24 hours postoperatively.

Results: Group B (adequate anesthesia) showed the lowest incidence of PONV (27.3%), compared to Group A (50%) and Group C (68%) ($p = 0.004$). Mean VAS scores at all time points were significantly lower in Group B ($p < 0.01$). The mean hospital stay was also shortest in Group B (2.4 ± 0.8 days), compared to Group A (3.2 ± 1.0 days) and Group C (3.9 ± 1.2 days) ($p = 0.002$). Multivariate regression identified deep anesthesia (BIS < 40), presence of PONV, and high postoperative pain scores as significant predictors of prolonged hospitalization.

Conclusion: Maintaining anesthetic depth within the optimal BIS range of 40–60 is associated with reduced postoperative complications and shorter hospital stay. Both light and deep anesthesia were linked to poorer outcomes, emphasizing the importance of individualized, depth-guided anesthesia monitoring for enhanced perioperative care and recovery.

Keywords: Anesthetic depth, BIS monitoring, postoperative nausea, postoperative pain, hospital stay

INTRODUCTION

The optimization of anesthetic management is a cornerstone of modern surgical care, aiming not only to ensure intraoperative unconsciousness and immobility but also to enhance postoperative outcomes. Among the many facets of anesthetic practice, the depth of anesthesia has garnered increasing attention due to its potential association with perioperative and postoperative variables such as postoperative nausea and vomiting, pain, and length of hospital stay[1]. Although general anesthesia is widely considered safe and effective, subtle variations in anesthetic depth during surgery may significantly impact patient recovery trajectories. Historically, the depth of anesthesia has been managed through the monitoring of hemodynamic responses, patient movement, and clinical signs[2]. However, these indicators are often nonspecific and may not accurately reflect the central nervous system's anesthetic state[3]. The advent of advanced neurophysiological monitoring techniques such as the bispectral index and entropy monitoring has provided anesthesiologists with more precise tools to assess and titrate anesthetic depth. These indices provide a real-time, quantifiable measure derived from processed electroencephalographic signals, enabling clinicians to maintain patients within an optimal anesthetic range[4].

The implications of maintaining patients at either too deep or too light anesthetic planes have been the subject of considerable clinical interest. Deep anesthesia has been associated with hypotension, delayed emergence, increased sedation needs, and even a potential rise in mortality in vulnerable populations[5]. Conversely, light anesthesia can increase the risk of intraoperative awareness, sympathetic nervous system activation, and inadequate pain control. Both extremes can also modulate neuroendocrine and immune responses, which may, in turn, influence postoperative recovery and complication rates[6]. Postoperative nausea and vomiting stand as a widespread post-anesthesia complication that can affect surgical patients from 30 to 80 percent, depending on patient risk levels. The condition results in dissatisfied patients who experience delayed consumption of food and must stay in the hospital for additional time[7]. Postoperative nausea relates to anesthetic depth in various ways due to multiple factors, including anesthetic choice during surgery and intraoperative opioid use and patient-specific sensitivity. Multiple research investigations have reported that reducing the level of anesthesia together with diminished volatile anesthetic administration could possibly reduce nausea and vomiting occurrences[8]. The study outcomes present inconsistent findings which require additional research. Postoperative pain control represents a vital outcome that shows potential connection to the depth of anesthesia according to research[9]. Both research fields show different findings about how deep anesthesia levels can influence surgical pain perception: deeper anesthesia may reduce pain reactions but intensive anesthesia might cause the body to become more sensitized to pain signals[10]. The study evidence shows different results which emphasizes the necessity of discovering better anesthesia approaches for specific patients. The duration of hospital stay has become a fundamental way to evaluate both patient health outcomes and clinical care quality as well as hospital resource management and patient recuperation. Postoperative hospital prolongation mostly has multiple contributing causes yet inadequate anesthesia practices contribute to its duration. Medical discharge times for patients can increase due to the way anesthetic depth affects postoperative nausea and pain together with hemodynamic instability[11].

This study aimed to evaluate the relationship between anesthetic depth, monitored using the Bispectral Index (BIS), and the incidence of PONV, postoperative pain, and length of hospital stay in patients undergoing general surgery.

METHODOLOGY

This prospective observational study was conducted at Nawaz Sharif social security teaching hospital , Lahore, Pakistan during January 2022 till December 2022. A total of n=155 adult patients scheduled for elective general surgical procedures under general anesthesia were enrolled.

Inclusion Criteria

- Patients aged 18 to 65 years

- Classified as American Society of Anesthesiologists (ASA) physical status I or II
- Scheduled for elective general surgery under general anesthesia
- Ability to provide informed consent

Exclusion Criteria

- Emergency surgery cases
- ASA classification of III or higher
- History of psychiatric or neurological disorders
- Chronic opioid use or substance abuse
- Known allergy or sensitivity to anesthetic agents
- Patients requiring postoperative intensive care

Data Collection: All patients received standard monitoring, including non-invasive blood pressure, electrocardiogram, and pulse oximetry. In addition, anesthetic depth was monitored using the Bispectral Index (BIS). Anesthetic agents were administered per standard institutional protocol, including the use of intravenous induction agents (e.g., propofol), volatile agents (e.g., sevoflurane), opioids (e.g., fentanyl), and neuromuscular blocking drugs. Anesthetic depth was continuously recorded throughout the procedure. Based on intraoperative BIS values, patients were retrospectively categorized into three groups:

- Group A (Light anesthesia): Average BIS > 60
- Group B (Adequate anesthesia): Average BIS between 40 and 60
- Group C (Deep anesthesia): Average BIS < 40

Postoperative data were collected during the immediate recovery period in the post-anesthesia care unit and for up to 48 hours following surgery. PONV was assessed using a standardized four-point ordinal scale ranging from 0 (no symptoms) to 3 (vomiting), recorded within the first 24 hours postoperatively. Pain intensity was evaluated using the Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (worst possible pain), and recorded at four time points: 2, 6, 12, and 24 hours post-surgery. The length of hospital stay was documented as the number of days from surgery to discharge.

Statistical Analysis: Data were analyzed using SPSS v17. Descriptive statistics were used to summarize patient characteristics and outcomes, with continuous variables presented as mean ± standard deviation and categorical variables as frequencies or percentages. A multivariate regression analysis was also conducted to control for potential confounding factors, including duration of surgery and opioid consumption. Statistical significance was defined by a p-value less than 0.05.

RESULTS

A total of 155 patients were included. Mean age ranged from 45.8 to 47.3 years, and the male-to-female ratio was balanced, with males comprising around 50% in each group (p = 0.92). BMI values were similar across all groups (p = 0.64), and ASA physical status distribution showed no significant variation (p = 0.87). The average duration of surgery ranged from 102.3 to 108.5 minutes, with no significant differences observed (p = 0.41), indicating homogeneity in patient and surgical profiles among the groups.

Table 1: Baseline Characteristics of Patients by Anesthetic Depth Group (n = 155)

Variable	Group A (Light) (n=42)	Group B (Adequate) (n=88)	Group C (Deep) (n=25)	p-value
Age (years, mean ± SD)	45.8 ± 10.5	46.9 ± 11.8	47.3 ± 11.0	0.73
Male (%)	52.4	50.0	52.0	0.92
BMI (kg/m², mean ± SD)	26.6 ± 2.9	26.2 ± 3.3	26.8 ± 3.0	0.64
ASA I/II (%)	71.4 / 28.6	68.2 / 31.8	72.0 / 28.0	0.87
Surgery duration (min)	102.3 ± 18.4	105.1 ± 20.1	108.5 ± 19.8	0.41

The incidence of postoperative nausea and vomiting (PONV) varied significantly across anesthetic depth groups (p = 0.004). Group B (adequate anesthesia) had the lowest PONV rate at 27.3%, compared to 50.0% in Group A (light anesthesia) and 68.0% in Group C (deep anesthesia).

Table 2: Incidence of Postoperative Nausea and Vomiting (PONV)

BIS Group	PONV Incidence (n, %)	No PONV (n, %)	p-value
Group A (Light)	21 (50.0%)	21 (50.0%)	0.004
Group B (Adequate)	24 (27.3%)	64 (72.7%)	
Group C (Deep)	17 (68.0%)	8 (32.0%)	

Postoperative pain scores, assessed via the Visual Analog Scale, were significantly lower in the adequate anesthesia group (Group B) at all time intervals (p < 0.01). Group B consistently reported the least pain, with scores decreasing from 4.2 at 2 hours to 3.5 at 24 hours.

Table 3: Postoperative Pain Scores by VAS (Visual Analog Scale)

Time Post-Op	Group A (Light)	Group B (Adequate)	Group C (Deep)	p-value
2 hours	5.9 ± 1.4	4.2 ± 1.2	5.6 ± 1.3	<0.01
6 hours	6.2 ± 1.3	4.1 ± 1.1	5.7 ± 1.5	<0.01
12 hours	5.7 ± 1.2	3.8 ± 1.0	5.3 ± 1.4	<0.01
24 hours	5.2 ± 1.1	3.5 ± 0.9	4.9 ± 1.3	<0.01

The length of hospital stay differed significantly among the BIS groups (p = 0.002). Patients in Group B (adequate anesthesia) had the shortest mean stay at 2.4 ± 0.8 days, compared to 3.2 ± 1.0 days in Group A and 3.9 ± 1.2 days in Group C.

Table 4: Length of Hospital Stay by Group

BIS Group	Mean Hospital Stay (days ± SD)	Range (days)	p-value
Group A (Light)	3.2 ± 1.0	2–6	0.002
Group B (Adequate)	2.4 ± 0.8	1–4	
Group C (Deep)	3.9 ± 1.2	2–7	

Multivariate logistic regression identified deep anesthesia (BIS < 40), presence of PONV, and higher pain scores at 6 hours postoperatively (VAS > 6) as significant independent predictors of prolonged hospital stay (p < 0.05). Deep anesthesia increased the odds nearly threefold (OR = 2.89), while high pain scores had the strongest association (OR = 3.01).

Table 5: Multivariate Regression Analysis for Predictors of Prolonged Hospital Stay (>3 days)

Predictor Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
BIS < 40 (Deep Anesthesia)	2.89	1.31 – 6.35	0.008
BIS > 60 (Light Anesthesia)	1.74	0.86 – 3.51	0.122
PONV (Present)	2.53	1.22 – 5.28	0.013
VAS score at 6h > 6	3.01	1.41 – 6.42	0.004
Surgery duration > 120 min	1.48	0.71 – 3.06	0.292
Opioid dose > 225 mcg	1.66	0.77 – 3.58	0.198

DISCUSSION

This study explored the relationship between intraoperative anesthetic depth, as measured by BIS monitoring, and key postoperative outcomes including nausea and vomiting, pain intensity, and hospital stay in patients undergoing elective general surgery. The results suggest that maintaining an optimal depth of anesthesia (BIS 40–60) is significantly associated with improved

postoperative recovery, reflected by lower PONV incidence, reduced pain scores, and shorter hospital stays[12]. Both excessively light and deep anesthesia were found to be detrimental in different ways, highlighting the importance of individualized anesthetic depth monitoring during surgery. One of the most noteworthy findings was the significantly lower incidence of postoperative nausea and vomiting in the adequate anesthesia group compared to both light and deep anesthesia groups. These results support previous studies suggesting that deviations from the optimal anesthetic range can lead to autonomic instability and gastrointestinal irritation, contributing to PONV. Patients in the deep anesthesia group had the highest incidence of nausea and vomiting, which may be linked to greater use of volatile agents and opioids, as also reflected in our data[13].

The obtained postoperative pain scores demonstrated that providing adequate anesthetic depth continuously yields beneficial results. Patients undergoing maintenance with BIS 40–60 reported less postoperative pain during every measurement period than patients who received light or deep anesthetic levels. Postoperative pain assessment revealed the most significant scores among patients who received light anesthesia because they did not receive sufficient intraoperative blockage. The increased stress response was thought to be responsible[14]. The edge in pain management arose from deep anesthesia versus light anesthesia but remained behind the results seen in adequate anesthesia. Studies already published show that insufficient anesthesia produces suboptimal nociceptive suppression and deep anesthesia prolongs recovery recovery with central sensitization as a possible result[15]. The hospitals stay periods differed substantially between the evaluated groups. Patients who received anesthesia at their optimal BIS range needed less time for hospital stay compared to patients under deep anesthesia whose hospital duration was the longest[16]. This patient group experienced delayed discharge because of protracted recovery times together with delayed mobilization and more frequent PONV. The results of multivariate regression analysis showed deep anesthesia along with high pain scores and PONV as separate independent factors which led to longer postoperative hospital stays[17]. BIS monitoring proved instrumental for clinical practice since it achieved both intraoperative awareness prevention and optimized postoperative patient outcomes according to[18]. ATIS measurement supports existing research findings that recommend anesthesia depth monitoring within ERAS surgical recovery protocols. Some restrictions exist that should be noted.

CONCLUSION

It is concluded that intraoperative anesthetic depth has a significant influence on key postoperative outcomes, including the incidence of postoperative nausea and vomiting (PONV), pain intensity, and duration of hospital stay in patients undergoing general surgery. Patients maintained within the BIS range of 40–60, representing adequate anesthesia, experienced the most favorable outcomes, with lower rates of PONV, better postoperative pain control, and shorter hospital stays. In contrast, both light (BIS > 60) and deep (BIS < 40) anesthesia were associated with increased complications and delayed recovery.

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Authors contribution: All authors contributed equally and sincerely in the completion of study.

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