



The Effect of Bispectral Index Monitoring on Emergence Delirium in Pediatric Patients: A Retrospective Observational Study

Bahar Uslu Bayhan^{1*} , Tuğçe Gazioğlu Kişi¹ , Şevki Sarı¹ , Bekir Suat Kürkcüoğlu¹ 

¹ Department of Anesthesiology and Reanimation, Gaziantep City Hospital, Gaziantep, Türkiye.
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*Corresponding author:
dr.b.uslu@gmail.com

ABSTRACT

Aim: Emergence delirium (ED) is a common behavioral disturbance during recovery from general anesthesia in pediatric patients. This retrospective observational study aimed to evaluate the effect of intraoperative bispectral index (BIS) monitoring on the incidence and severity of ED in children undergoing elective surgery.

Material and Methods: Medical records of 160 pediatric patients aged 2-7 years who underwent elective surgery under general anesthesia were retrospectively reviewed. Patients were divided into two groups according to anesthetic depth monitoring: BIS-guided (n=80) and control (n=80). ED was assessed using the pediatric anesthesia emergence delirium (PAED) scale, and postoperative pain was evaluated using the face, legs, activity, cry, consolability (FLACC) scale.

Results: The rate of ED was significantly lower in the BIS group compared with the control group (4 patients [5.0%] vs. 54 patients [67.5%], p=0.001). PAED (4.00±2.1 vs. 7.17±2.9) and FLACC (2.11±1.5 vs. 3.00±1.7) scores were also significantly reduced in the BIS-monitored group (p=0.001 for both). Recovery time (8.52±2.9 vs. 10.04±3.2 minutes, p=0.001) and PACU stay duration (44.68±11.2 vs. 59.76±14.5 minutes, p=0.001) were significantly shorter in the BIS group. In multivariate logistic regression analysis, BIS monitoring remained an independent protective factor against ED (OR=0.020, 95% CI: 0.010-0.080, p=0.001).

Conclusion: Intraoperative BIS monitoring significantly reduces ED and improves recovery quality in pediatric patients. Objective monitoring of anesthetic depth may improve postoperative behavioral stability.

Keywords: Bispectral index, emergence delirium, pediatric anesthesia, postoperative recovery.

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INTRODUCTION

Emergence delirium (ED) is a common behavioral disturbance in pediatric patients during recovery from general anesthesia, characterized by agitation, disorientation, inconsolable crying, and restlessness. Its reported incidence ranges from 20% to 60%, particularly in children aged 2-10 years following inhalational anesthesia (1,2). Clinically, ED may result in self-injury, disruption of surgical sites, and increased stress for caregivers and post-anesthesia care unit (PACU) staff, making its prevention an important quality indicator in pediatric anesthesia (3-5).

The etiology of ED is multifactorial, with contributing factors including rapid emergence, use of low blood/gas solubility volatile anesthetics such as sevoflurane and desflurane, preoperative anxiety, postoperative pain, and surgical type (6-9). Among these, anesthetic depth represents a potentially modifiable factor. Inadequate titration of anesthetic depth may contribute to unstable emergence and increased ED risk.

Bispectral index (BIS) monitoring provides an objective, EEG-based assessment of anesthetic depth, allowing more precise titration of anesthetic agents. Previous studies have suggested that maintaining BIS values within the 40-60 range may reduce the incidence of ED; however, findings remain inconsistent across different study designs and patient populations (10-14).

Therefore, the role of BIS monitoring in reducing ED in

pediatric patients undergoing general anesthesia remains an important area of investigation. The present retrospective observational study aimed to evaluate the effect of BIS-guided anesthesia on ED, postoperative pain, assessed by the face, legs, activity, cry, consolability (FLACC) scale, recovery time, and postoperative outcomes in children aged 2-7 years.

MATERIAL AND METHODS

This research was conducted as a retrospective observational study in the Department of Anesthesiology and Reanimation at Gaziantep City Hospital. After obtaining approval from the Institutional Non-Invasive Clinical Research Ethics Committee (Approval No: 247/2025, Date: June 18, 2025), the medical records of pediatric patients who underwent elective procedures under general anesthesia between January 2022 and December 2024 were examined. All procedures adhered to the ethical principles of the Declaration of Helsinki, and patient confidentiality was strictly maintained throughout the study.

The study included children aged 2-7 years, an age group frequently reported in the literature as having the highest susceptibility to ED (9). Only patients classified as American Society of Anesthesiologists (ASA) physical status I or II were selected to avoid the confounding influence of significant systemic illnesses that might alter

anesthetic responses or postoperative recovery. All surgical interventions were elective and performed under general anesthesia.

The surgical procedures consisted of adenoidectomy, tonsillectomy, inguinal hernia repair, and circumcision—routine pediatric operations characterized by low blood loss and relatively short operative times (approximately 20-90 minutes). Selecting these procedures helped maintain a homogeneous cohort and minimized variability related to surgical stress, procedure duration, or extended anesthetic exposure, all of which could potentially influence the development of ED.

Only patients who received sevoflurane for maintenance of inhalational anesthesia were included. Sevoflurane is widely used in pediatric anesthesia and has been associated with an increased risk of ED, making its standardized use essential for accurately evaluating the relationship between BIS monitoring and ED occurrence.

Children with neurological disorders, developmental delay, or cognitive impairment were excluded due to the potential of these conditions to independently alter emergence behaviors and postoperative assessments. Furthermore, patients without complete intraoperative BIS recordings or missing postoperative pediatric anesthesia emergence delirium (PAED) and FLACC scores were not considered eligible. These criteria ensured consistent and reliable evaluation of intraoperative anesthetic depth and postoperative emergence characteristics across all participants. The following patients were excluded from the study:

- Children with neurological disorders, developmental delay, epilepsy, neuromuscular disease, or cognitive impairment
- Patients undergoing emergency surgery
- Patients who received premedication
- Patients with significant systemic disease, such as cardiopulmonary instability or advanced hepatic or renal failure
- Patients receiving total intravenous anesthesia (TIVA) or combined anesthesia techniques
- Patients with missing or unreliable BIS recordings
- Patients with incomplete or non-standardized PAED or FLACC assessments
- Cases with incomplete or inaccurate medical records

All data in this retrospective study were obtained from the hospital's anesthesia information management system, intraoperative anesthesia records, and PACU charts. These systems routinely record intraoperative and postoperative variables automatically, ensuring reliable and standardized data collection. No additional procedures were performed on patients beyond routine clinical practice.

The included patients were divided into two groups according to the use of BIS monitoring during anesthesia. The BIS group consisted of patients whose anesthetic depth was continuously monitored via EEG-based BIS monitoring. The control group included patients whose anesthetic depth was managed solely based on clinical parameters such as hemodynamic responses and surgical stimulation. This classification allowed the evaluation of the impact of BIS monitoring on the incidence of ED and postoperative recovery parameters.

For both groups, the same dataset was collected using a

standardized data collection form. Demographic variables included age, sex, body weight, ASA class, type and duration of surgery, which were used to assess clinical comparability between the two groups.

Anesthetic variables were retrieved retrospectively from anesthesia records, including induction agents (e.g., propofol), maintenance volatile agents (e.g., sevoflurane), and intraoperative administration of opioids, analgesics, and neuromuscular blockers. These parameters were analyzed to evaluate standardization of anesthetic management and the potential influence of pharmacologic variations.

Intraoperative hemodynamic parameters (non-invasive arterial blood pressure—systolic and diastolic, heart rate, oxygen saturation [SpO₂], respiratory rate, and end-tidal carbon dioxide [EtCO₂]) were obtained from anesthesia monitor recordings at regular intervals to assess hemodynamic stability throughout the procedure.

In patients with BIS monitoring, minimum, maximum, and mean intraoperative BIS values were retrieved from the device memory. These data served as key variables for statistical analyses of anesthetic depth and intergroup comparisons.

Postoperative assessments included the PAED score, the FLACC pain score, recovery time, length of stay in the PACU, the need for supplemental analgesics, and postoperative complications such as nausea, vomiting, agitation, or respiratory depression. These data were collected from standardized postoperative monitoring forms and were used to evaluate how BIS monitoring influenced recovery quality and emergence characteristics. All patients received maintenance anesthesia with sevoflurane delivered in a mixture of 50% oxygen and 50% air. In the BIS-monitored group, the concentration of sevoflurane was adjusted to maintain BIS values within the recommended range of 40-60. For patients in the control group, anesthetic depth was regulated based on clinical judgment, hemodynamic fluctuations, and surgical stimuli. Detailed end-tidal sevoflurane concentration or MAC values were not consistently available in the retrospective dataset. Rocuronium (0.6 mg/kg) was administered when muscle relaxation was necessary; however, for shorter procedures, neuromuscular blockade was avoided whenever feasible. Intraoperative analgesia was provided with either fentanyl or paracetamol, with dosing tailored to surgical duration and clinical requirements.

BIS monitoring was performed using single-use electrodes placed on the forehead. The device analyzed EEG signals and generated numerical BIS values ranging from 0 to 100, recorded automatically every 15 seconds in the device memory. Intraoperative minimum, maximum, and mean BIS values were routinely documented in anesthesia records. These values were retrospectively analyzed as primary variables representing anesthetic depth and used to investigate the relationship between anesthesia depth and ED.

All data were derived from routine anesthetic protocols applied in pediatric surgical practice at our institution. No additional interventions were performed, and the study was entirely based on existing medical records.

Following surgery, all patients were transferred to the PACU once spontaneous breathing and hemodynamic stability were achieved. PACU charts confirmed that vital signs and neurological status were monitored in

accordance with the institutional postoperative observation protocol. All assessments were performed by experienced anesthesia nurses and anesthesiologists using standardized forms. PAED and FLACC assessments were performed by trained anesthesia personnel according to standardized institutional protocols. However, due to the retrospective nature of the study, assessor blinding to BIS monitoring status could not be ensured, which may have introduced potential observer bias.

ED, disorientation, and behavioral changes were evaluated using the PAED scale at 5, 10, 15, and 30 minutes postoperatively. The PAED scoring system includes five parameters—eye contact, purposeful actions, awareness of surroundings, restlessness, and consolability—each rated

on a 0-4 scale, with a total score ranging from 0 to 20. A PAED score ≥ 10 was considered indicative of ED. The clinical interpretation and scoring ranges of the BIS, PAED, and FLACC scales used in this study are summarized in Table 1.

Postoperative pain was evaluated using the FLACC scale at the same time points as the PAED assessments—5, 10, 15, and 30 minutes after arrival in the recovery area. The FLACC tool scores five behavioral components (face, legs, activity, cry, and consolability) on a scale of 0 to 2, producing a total score ranging from 0 to 10. The total score was interpreted as follows: 0 indicating no pain, 1-3 mild discomfort, 4-6 moderate pain, and 7-10 severe pain.

Table 1. Scales used in the study and their clinical interpretation (4,10,11).

Scale	Full Name	Assessed Parameter	Score Range	Interpretation / Clinical Meaning
BIS	Bispectral Index	Depth of anesthesia based on EEG wave patterns	0-100	100: awake; 40-60: surgical anesthesia level; <40: deep anesthesia level
PAED	Pediatric Anesthesia Emergence Delirium	Agitation, orientation, and behavioral disturbances during emergence	0-20	≥ 10 : presence of emergence delirium
FLACC	Face, Legs, Activity, Cry, Consolability	Postoperative pain intensity (behavioral assessment)	0-10	0: no pain; 1-3: mild pain; 4-6: moderate pain; 7-10: severe pain

Recovery time was defined as the period between discontinuation of anesthetic agents and the child's first spontaneous eye opening, as recorded in the anesthesia documentation. The duration of stay in the PACU was measured from the moment the patient arrived in the unit until the time of discharge. Discharge readiness required the patient to be awake, hemodynamically stable, breathing effectively without assistance, and adequately relieved of pain. Additional analgesic use was assessed retrospectively. As recorded, paracetamol (15 mg/kg), ibuprofen (10 mg/kg), or low-dose fentanyl were administered as required, and the need for additional analgesics was used as an indicator of postoperative pain control quality.

Postoperative complications, including nausea, vomiting, agitation, desaturation, respiratory depression, bradycardia, and tachycardia, were reviewed from PACU records. Notes regarding the potential for agitation-related self-injury or interference with surgical or IV sites were also evaluated. These data were analyzed to assess the effect of BIS monitoring on recovery safety and quality. Finally, BIS-related technical issues, signal loss, or skin irritation were reviewed, and no complications related to electrode application or device use were reported in this study.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was evaluated using the Kolmogorov-Smirnov test. Continuous variables with normal distribution were presented as mean $\pm$ standard deviation (SD), whereas non-normally distributed variables were summarized as median (25th-75th percentiles) [minimum-maximum]. Categorical variables were expressed as numbers and percentages (n,

%). Between-group comparisons were performed using the independent samples t-test for normally distributed continuous variables and the Mann-Whitney U test for non-normally distributed variables. Categorical variables were analyzed using the chi-square test or Fisher's exact test, as appropriate, based on expected cell counts. A multivariate logistic regression model was constructed to identify independent predictors of ED. Variables included in the initial model were selected based on clinical relevance and previously reported associations with ED. These variables comprised age, body weight, duration of surgery, FLACC pain score, and BIS monitoring status. A backward stepwise elimination method based on the likelihood ratio test was applied to obtain the final model. Model fit was evaluated using the Hosmer-Lemeshow goodness-of-fit test, and the statistical significance of the regression model was assessed using the Wald test. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 160 children met the inclusion criteria for this study. Eighty patients were managed with BIS monitoring (BIS group), while the remaining eighty received standard anesthetic care without BIS (control group). The two groups were comparable with respect to age, sex distribution, body weight, ASA physical status, and surgical duration, with no significant differences observed (Table 2).

The findings presented in Table 3 demonstrate the influence of BIS monitoring on postoperative recovery profiles and behavioral outcomes. Marked distinctions were evident between the two groups regarding the

occurrence of ED, agitation, recovery time, and length of stay in the PACU.

PAED scores were significantly lower among children in the BIS group (4.00 ± 2.1) compared with those in the control group (7.17 ± 2.9 ; $p=0.001$). Consistent with this, the rate of ED was dramatically reduced in BIS-monitored patients 4 (5.0%) versus 54 (67.5%), a difference that reached high statistical significance ($p=0.001$). These results strongly suggest that adjusting anesthetic depth using BIS guidance plays a decisive role in minimizing ED following general anesthesia (Table 3). Agitation followed a similar pattern; its incidence was restricted to 4 (5.0%) in the BIS group, compared with 54 (67.5%) in the control group ($p=0.001$). Although postoperative pain scores measured by the FLACC scale were lower in the BIS group, this improvement did not correspond to a significant reduction in the need for additional analgesic medication

(24 (30.0%) vs. 34 (42.5%); $p=0.139$). Recovery profiles also favored BIS monitoring. Both the time to spontaneous awakening (8.52 ± 2.9 min vs. 10.04 ± 3.2 min; $p=0.001$) and the duration of PACU stay (44.68 ± 11.2 min vs. 59.76 ± 14.5 min; $p=0.001$) were significantly shorter in the BIS group, suggesting faster and smoother emergence when anesthetic depth is titrated using BIS values. Postoperative nausea and vomiting were infrequent in both groups, and the difference between them was not statistically significant (5 (6.2%) vs. 8 (10.0%); $p=0.563$).

Multivariate logistic regression analysis identified BIS monitoring as the only variable independently associated with a lower likelihood of ED. BIS use was associated with a significantly reduced risk of ED (OR=0.020, 95% CI: 0.010-0.080, $p=0.001$). Other variables, including age, body weight, duration of surgery, and FLACC score, were not significantly associated with ED (Table 4).

Table 2. Demographic characteristics.

Parameter	BIS (n=80)	Control (n=80)	p
Age (years), mean $\pm$ SD	5.08 $\pm$ 1.34	5.10 $\pm$ 1.51	0.871
Weight (kg), mean $\pm$ SD	20.64 $\pm$ 4.06	20.80 $\pm$ 4.18	0.835
Duration of surgery (min), mean $\pm$ SD	41.99 $\pm$ 17.44	43.96 $\pm$ 16.18	0.282
Sex, n (%)			
Male	49 (61.3)	59 (73.8)	0.091
Female	31 (38.7)	21 (26.2)	
ASA class, n (%)			
ASA I	56 (70.0)	55 (68.8)	0.864
ASA II	24 (30.0)	25 (31.2)	

BIS: Bispectral index, ASA: American Society of Anesthesiologists, SD: standard deviation

Table 3. Postoperative findings and clinical outcomes.

Parameter	BIS (n=80)	Control (n=80)	p
PAED score, mean $\pm$ SD	4.00 $\pm$ 2.1	7.17 $\pm$ 2.9	0.001
FLACC score, mean $\pm$ SD	2.11 $\pm$ 1.5	3.00 $\pm$ 1.7	0.001
Recovery time (min), mean $\pm$ SD	8.52 $\pm$ 2.9	10.04 $\pm$ 3.2	0.001
PACU stay duration (min), mean $\pm$ SD	44.68 $\pm$ 11.2	59.76 $\pm$ 14.5	0.001
ED, n (%)	4 (5.0)	54 (67.5)	0.001
Agitation, n (%)	4 (5.0)	54 (67.5)	0.001
Additional analgesic requirement, n (%)	24 (30.0)	34 (42.5)	0.139
Respiratory complications, n (%)	0 (0.0)	2 (2.5)	0.154
PONV, n (%)	5 (6.2)	8 (10.0)	0.563

BIS: Bispectral index, PAED: pediatric anesthesia emergence delirium, FLACC: face, legs, activity, cry, consolability, PACU: post-anesthesia care unit, ED: emergence delirium, PONV: postoperative nausea and vomiting, SD: standard deviation

Table 4. Independent factors affecting the development of ED.

Variable	OR	95% CI	p
BIS group (present)	0.020	0.010-0.080	0.001
Age (years)	0.700	0.370-1.350	0.291
Weight (kg)	1.140	0.910-1.430	0.264
Duration of surgery (min)	1.010	0.980-1.040	0.430
FLACC score (10 th min)	0.980	0.740-1.300	0.910

ED: emergence delirium, BIS: bispectral index, FLACC: face, legs, activity, cry, consolability, OR: odds ratio, CI: confidence interval

DISCUSSION

ED remains a frequent and challenging phenomenon in pediatric anesthesia, characterized by agitation, disorientation, and inconsolable behavior during early recovery from general anesthesia. Although ED is typically self-limiting, it may result in self-injury, disruption of surgical sites, increased caregiver distress, and prolonged PACU stay (4,5). Consequently, identifying modifiable perioperative factors that may reduce ED is of considerable clinical importance.

In this retrospective observational study, the use of BIS monitoring during general anesthesia was associated with a substantially lower incidence of ED, lower PAED scores, and shorter recovery and PACU durations in children undergoing elective surgery. These findings suggest that objective monitoring of anesthetic depth may contribute to improved emergence profiles in the pediatric population.

Previous studies have consistently demonstrated that ED is most prevalent among children aged 2-8 years, a period marked by heightened sensory sensitivity and limited cognitive coping mechanisms (12). At this developmental stage, limited cognitive maturity and heightened sensory reactivity have been identified as contributors to ED risk (13). For this reason, restricting our sample to this age range was appropriate.

Failure to objectively assess anesthetic depth may result in unnecessarily high concentrations of volatile anesthetics such as sevoflurane or desflurane, both associated with postoperative agitation and ED (15-17). BIS, by quantifying EEG activity, can help prevent excessive dosing (10). The lower PAED scores and reduced ED incidence observed in our BIS group align with these physiologic principles.

Recent evidence further supports the association between volatile agents—particularly sevoflurane—and elevated ED risk. Pediatric ENT studies have demonstrated higher ED incidence with sevoflurane than desflurane, and these findings have been corroborated by recent systematic reviews and meta-analyses (16,17). Additionally, both randomized controlled trials and contemporary meta-analyses report fewer ED episodes and shorter recovery durations with BIS-guided anesthesia. Frelich et al. (12) demonstrated significantly reduced ED with BIS guidance, and other investigations confirmed shorter recovery and PACU times (18,19). These findings parallel our results.

Postoperative pain often coexists with agitation, complicating differentiation from ED. However, several studies have reported that ED may occur independently of pain, driven instead by rapid emergence and the neurostimulatory properties of sevoflurane (20-22). In our study, although FLACC scores were lower in the BIS group, supplemental analgesic requirements did not differ significantly, suggesting that reduced ED incidence was likely attributable to optimized anesthetic depth rather than improved analgesia. In our institution, intraoperative anesthetic management follows standardized clinical protocols, including uniform use of sevoflurane for maintenance anesthesia and routine administration of intraoperative analgesics such as fentanyl or paracetamol according to procedural duration. Although minor variations in drug dosing may occur according to individual patient characteristics, the overall anesthetic strategy remained consistent across both groups. This

relative standardization likely reduced intergroup variability and supported the reliability of the comparative analysis.

Another important finding was the significantly shorter PACU stay in the BIS group. This aligns with previous work demonstrating that BIS guidance enhances emergence quality and accelerates discharge readiness (18,19). These advantages likely stem from the avoidance of excessively deep anesthesia, enabling more controlled emergence. Multicenter meta-analyses similarly confirm reduced PACU durations with BIS use.

In the present study, multivariate logistic regression analysis identified BIS monitoring as the only variable independently associated with a lower likelihood of ED. The observed OR indicates a strong inverse association between BIS use and the development of ED. However, this finding should be interpreted with caution. Given the retrospective design of the study, BIS monitoring may reflect not only the use of an EEG-based depth-of-anesthesia tool but also a broader pattern of optimized anesthetic management, increased clinician vigilance, and institutional practice preferences that were not fully captured in the available data. Therefore, BIS monitoring should be interpreted as a marker of optimized anesthetic depth management rather than a direct causal intervention for preventing ED. The relatively high incidence of ED observed in the control group deserves careful interpretation. Although the reported ED incidence in the literature generally ranges between 20% and 60%, higher rates have been documented in young children receiving sevoflurane anesthesia, particularly in ENT-related procedures and short-duration surgeries characterized by rapid emergence. In our study, the exclusive use of sevoflurane for maintenance anesthesia and the inclusion of procedures associated with rapid awakening may have contributed to the increased ED incidence observed in the control group. Additionally, the absence of objective anesthetic depth monitoring in the control group may have resulted in variability in anesthetic titration, potentially increasing the likelihood of unstable emergence patterns.

Another important methodological consideration relates to the distribution of surgical procedures between groups. The procedures included in this study—adenoidectomy, tonsillectomy, inguinal hernia repair, and circumcision—were selected because of their relatively short duration and standardized anesthetic requirements. These procedures are commonly associated with rapid emergence, which represents a known risk factor for ED. Although baseline surgical duration did not differ significantly between groups, subtle procedural differences may still have influenced emergence characteristics and should be considered when interpreting the results.

Limitations

This study has several limitations that should be acknowledged. First, the retrospective observational design inherently limits the ability to establish causal relationships and may introduce selection bias or unmeasured confounding factors. Although strict inclusion and exclusion criteria were applied to enhance group homogeneity, residual confounding cannot be completely excluded. Second, anesthetic management decisions, including the use of BIS monitoring, were based on clinician preference and institutional practice rather than

randomized allocation, which may have introduced practice-related variability. However, standardized anesthetic protocols, uniform use of sevoflurane for maintenance, and consistent postoperative assessment using validated PAED and FLACC scales helped minimize intergroup variability and strengthened the internal consistency of the dataset. Third, as this was a single-center study, the generalizability of the findings to other institutions with different clinical practices may be limited. Finally, although multivariate regression analysis was performed to adjust for clinically relevant variables, unrecognized confounders may still exist. Therefore, the findings of this study should be interpreted as associative rather than causal, and future large-scale, multicenter, prospective randomized studies are warranted to confirm and generalize these results.

Additionally, the magnitude of the observed difference in ED incidence between groups should be interpreted with caution. BIS monitoring in our institution was applied according to clinician preference rather than randomized allocation, which may have introduced selection bias. It is also possible that anesthesiologists using BIS monitoring were more attentive to anesthetic depth titration, reflecting differences in clinical vigilance rather than solely the effect of the monitoring device itself. Institutional practice patterns and provider-related variability may therefore have contributed to the observed effect size. Future prospective studies with standardized allocation strategies are needed to clarify these effects.

Moreover, detailed end-tidal sevoflurane concentration and MAC data were not consistently available in the retrospective dataset. Therefore, potential differences in anesthetic exposure between groups cannot be completely excluded and may have influenced the observed outcomes.

CONCLUSION

This study demonstrates that BIS monitoring significantly reduces the incidence of ED and improves postoperative recovery quality in pediatric patients. BIS-guided anesthesia allows for precise titration of anesthetic agents, minimizing the risks of both excessive and insufficient anesthesia depth. As a result, behavioral stability during emergence is enhanced, and the duration of post-anesthesia care is shortened. Integrating BIS monitoring into routine pediatric anesthesia practice may enhance patient safety, improve comfort, and contribute to the prevention of postoperative complications. Nevertheless, multicenter, large-scale, prospective randomized controlled studies are needed to confirm and generalize these findings.

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