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RESEARCH ARTICLE

Bispectral index monitoring: Optimizing anesthesia in rigid bronchoscopy

Özal ADIYEKE[1] (ID)
Onur SARBAN[1] (ID)
Ergün MENDEŞ[1] (ID)
Hilal AKÇA[1] (ID)
Engin İhsan TURAN[3] (ID)
Barış DEMİRKOL[2] (ID)
Mehmet Akif ÖZGÜL[2] (ID)
Funda GÜMÜŞ ÖZCAN[1] (ID)

[1] Clinic of Anesthesiology and Reanimation, Başakşehir Çam and Sakura City Hospital, İstanbul, Türkiye
[2] Clinic of Pulmonology, Başakşehir Çam and Sakura City Hospital, İstanbul, Türkiye
[3] Clinic of Anesthesiology and Reanimation, Kanuni Sultan Süleyman Training and Research Hospital, İstanbul, Türkiye

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Address for Correspondence
Dr. Özal ADIYEKE
Clinic of Anesthesiology and Reanimation, Başakşehir Çam and Sakura City Hospital
İSTANBUL-TÜRKİYE
e-mail: ozaladiyeke@gmail.com

ABSTRACT

Bispectral index monitoring: Optimizing anesthesia in rigid bronchoscopy

Introduction: *This study investigates the application of bispectral index (BIS) monitoring in rigid bronchoscopy to enhance anesthetic delivery and patient outcomes, a topic that remains underexplored.*

Materials and Methods: *A retrospective analysis of 155 patients undergoing elective rigid bronchoscopy under general anesthesia was conducted. Patients were divided into BIS-monitored and conventional anesthesia groups. Inclusion criteria were adults aged over 18 years with American Society of Anesthesiologists (ASA) physical status I-IV.*

Results: *No significant demographic differences were found between the groups. The BIS group showed significant reductions in propofol usage (231.40 ± 74.63 mg vs. 190.19 ± 91.83 mg, p= 0.003) and prednol dosage (94.27 ± 42.56 mg vs. 79.71 ± 18.97 mg, p= 0.020). Remifentanil administration approached statistical significance (56.99 ± 34.69 mcg vs. 45.36 ± 36.75 mcg, p= 0.055).*

Conclusion: *BIS monitoring effectively reduces anesthetic dosage in rigid bronchoscopy, representing a significant advancement in anesthetic management.*

Key words: *Rigid bronchoscopy; outpatient anesthesia; bispectral index monitoring; interventional pulmonology*

ÖZ

Rijit bronkoskopi anestezisini iyileştirmede bispektral indeks monitorü

Giriş: *Bu çalışma, rijit bronkoskopide anestezi uygulamasını ve hasta sonuçlarını iyileştirmek için bispektral indeks (BİS) monitörizasyonunun uygulanmasını araştırmaktadır.*

Materyal ve Metod: *Genel anestezi altında elektif rijit bronkoskopi planlanan toplam 155 hasta çalışmaya dahil edildi. Dahil edilme kriterleri Amerikan Anestezistler Derneği (ASA) fiziksel durumu I-IV olan 18 yaş üstü yetişkinlerdir.*

Bulgular: *Gruplar arasında anlamlı demografik farklılıklar bulunmamıştır. BİS grubu propofol kullanımında (231,40 ± 74,63 mg'a karşı 190,19 ± 91,83 mg, p= 0,003) ve prednol dozajında (94,27 ± 42,56 mg'a karşı 79,71 ± 18,97 mg, p= 0,020) anlamlı azalma gösterdi. Remifentanil uygulaması istatistiksel anlamlılığa yaklaşmıştır (56,99 ± 34,69 mcg vs. 45,36 ± 36,75 mcg, p= 0,055).*

Sonuç: *BİS monitörizasyonu, rijit bronkoskopide anestezik ilaç kullanımını etkili bir şekilde azaltarak anestezi yönetiminde önemli ileri bir adımı temsil etmektedir.*

Anahtar kelimeler: *Rijit bronkoskopi; günübirlik anestezi; bispektral indeks monitorü; girişimsel pulmonoloji*

INTRODUCTION

Rigid bronchoscopy is a critical procedure utilized in diagnosing and treating tracheobronchial disorders. Despite its benefits, it poses significant anesthetic challenges due to the need for precise management to ensure patient safety and comfort. Recent advancements like bispectral index (BIS) monitoring have emerged as pivotal tools in optimizing anesthesia delivery, particularly by tailoring anesthetic doses and potentially reducing hospital stays. BIS monitoring, introduced in the early 1990s, analyzes brain electrical activity to estimate the depth of anesthesia, thereby enhancing the safety and efficacy of perioperative care (1). However, its integration into rigid bronchoscopy is not well-documented, presenting a gap in research, especially concerning its impact on anesthetic dosage and patient outcomes.

The management of anesthesia during rigid bronchoscopy poses unique challenges, not only due to the invasiveness of the procedure but also because of the critical need to maintain optimal patient safety and comfort. BIS monitoring, a tool for assessing the depth of anesthesia, has garnered significant attention for its potential to enhance anesthetic delivery and patient outcomes during such intricate procedures. Nevertheless, the application of BIS in the context of rigid bronchoscopy remains underexplored.

Furthermore, the utilization of BIS monitoring could potentially reduce the incidence of anesthesia-related complications, such as underdosing and overdosing of anesthetic agents, which are pivotal concerns in rigid bronchoscopy. Moreover, optimizing the dosage of anesthetic drugs with the guidance of BIS might not only decrease the risk of immediate perioperative complications but also influence the duration of hospitalization post-procedure (2). This retrospective study aimed to fill the gap in existing literature by examining the effects of BIS monitoring on the administration of anesthetic drugs and the subsequent length of hospital stay for patients undergoing rigid bronchoscopy.

MATERIALS and METHODS

Study Design

This retrospective research was designed to evaluate the effectiveness of BIS monitoring in reducing anesthetic dosage and hospitalization time while improving patient outcomes during rigid bronchoscopy procedures. As a retrospective study, it relies on previously collected data, which may introduce biases such as selection bias, recall bias, and information bias. Efforts were made to minimize these biases through stringent inclusion criteria and standardized data collection protocols.

Participants

A total of 155 patients scheduled for elective rigid bronchoscopy under general anesthesia were enrolled between 06.2020-06.2022. Inclusion criteria included adults aged over 18 years old with American Society of Anesthesiologists (ASA) physical status I-IV.

Anesthesia Management

All patients underwent standard preoperative fasting and received midazolam 0.03 mg/kg as premedication. Anesthesia was induced with propofol and fentanyl to both groups and maintained with remifentanil infusion and intravenous propofol boluses. In both groups, the patients took 3 L/dk O_2 from the nasal cannula. In group B, anesthesia was adjusted to maintain a BIS score between 40 and 60.

BIS Monitoring

In the BIS group, a bispectral index™ (BIS™) sensor was applied to the forehead before induction, and BIS values were recorded every five minutes until the end of the procedure. The BIS monitoring system was used to continuously display the BIS scores.

Data Collection

Data on total anesthetic dosage, corticosteroid dosage, and demographic data such as age, sex, ASA score, intraoperative hemodynamic parameters, and length of stay in the post-anesthesia care unit (PACU) and hospital were collected.

Statistical Analysis

Data were analyzed using SPSS version 26.0. continuous variables were compared using the independent sample t-test, and categorical variables with the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In this study, demographic comparisons between the conventional model and BIS groups revealed no significant differences in age (56.23 ± 14.13 vs. 55.25 ± 15.94, p= 0.69) or body mass index (BMI) (27.13 ± 4.20 vs. 26.41 ± 4.03, p= 0.31). However, significant reductions were observed in the BIS group for propofol usage (231.40 ± 74.63 mg vs. 190.19 ± 91.83 mg, p= 0.003) and prednol dosage (94.27 ± 42.56 mg vs. 79.71 ± 18.97 mg, p= 0.020). Remifentanyl administration approached statistical significance (56.99 ± 34.69 mcg vs. 45.36 ± 36.75 mcg, p= 0.055) (Table 1).

No significant differences were found in anesthesia time (43.08 ± 19.27 minutes vs. 47.26 ± 19.33 minutes, p= 0.20) or bronchoscopy time (32.89 ± 17.80 minutes vs. 35.75 ± 17.25 minutes, p= 0.34). Importantly, hospitalization duration was significantly shorter in the BIS group (7.44 ± 9.06 days vs. 3.90 ± 4.88 days, p= 0.01) (Table 1).

Our analysis explored various outcomes between patients managed under conventional anesthesia and those monitored with BIS. The distribution of sex across both groups did not show significant differences (Males: Conventional 73 vs. BIS 43, Females: Conventional 30 vs. BIS 9; p= 0.10). Mortality rates were comparable between the two groups (Conventional 5% vs. BIS 2%; p= 0.95) (Table 2).

ASA scores, representing preoperative health status, were similar across groups (p= 0.49), indicating a balanced risk profile in both cohorts. Postoperative intubation needs were equivalent (Conventional 3% vs. BIS 3%; p= 0.40), and follow-up in intensive care showed no significant difference (Conventional 7% vs. BIS 3%; p= 1.00) (Table 2).

DISCUSSION

This study investigated the effectiveness of BIS monitoring in optimizing anesthetic dosages and reducing hospitalization duration in patients undergoing rigid bronchoscopy. Consistent with the findings from the study conducted by Parikh and Mehta, we observed a significant reduction in total propofol consumption when BIS monitoring was utilized, paralleling the decreased anesthetic requirements reported in their research (3).

Similarly, our results align with those reported by Casal et al., who found that BIS monitoring could enhance patient safety by reducing the incidence of over-sedation and related adverse events during procedures requiring sedation (4). This is particularly relevant in the context of rigid bronchoscopy, where maintaining patient stability and quick recovery are paramount.

Moreover, our findings contribute to the discussion on the impact of BIS monitoring on hospitalization duration. While the study by Casal et al. did not find a significant reduction in the length of hospital stay, our data suggest that optimizing anesthetic dosage

Table 1. Impact of BIS monitoring on dosage of anesthetic drugs and recovery metrics in rigid bronchoscopy

	Conventional model	BIS	
	Mean ± standard deviation	Mean ± standard deviation	p[b]
Age[a]	56.23 ± 14.13	55.25 ± 15.94	0.69
Body mass index[a]	27.13 ± 4.20	26.41 ± 4.03	0.31
Propofol[a]	231.40 ± 74.63	190.19 ± 91.83	0.003
Remifentanil[a]	56.99 ± 34.69	45.36 ± 36.75	0.055
Prednol/mg[a]	94.27 ± 42.56	79.71 ± 18.97	0.20
Anesthesia time[a]	43.08 ± 19.27	47.26 ± 19.33	0.20
Bronchoscopy time[a]	32.89 ± 17.80	35.75 ± 17.25	0.34
Hospitalization[a]	7.44 ± 9.06	3.90 ± 4.88	0.01

[a]Independent sample t-test applied,
[b]p≤ 0.05 is accepted as a statistically significant difference.

Table 2. Demographic characteristics and postoperative outcomes: Conventional vs. BIS monitoring in rigid bronchoscopy

	Conventional	BIS	p
Sex[a]	73/30	43/9	0.10
Mortality[b]	98/5	50/2	0.95
ASA score[c]	2/38/55/4	1/21/29/1	0.49
Intubation need[d]	3/100	3/49	0.40
Intensive care follow-up[e]	7/96	3/49	1

[a]Male/female,
[b]Healthy/ex,
[c]ASA scores I-IV,
[d]Postoperative intubation/O_2 supply,
[e]Intensive care follow-up/Service follow-up.
There were no significant differences between both preoperative and postoperative SpO_2, heart rate, systolic blood pressure, and diastolic blood pressure in the two groups.

through BIS can indeed shorten hospitalization, perhaps due to fewer complications and quicker patient recovery (4).

This study also corroborates the results of a larger analysis at an academic medical center, which demonstrated variable impacts of BIS on recovery times and postoperative outcomes (5). In our research, similar variability was observed, suggesting that while BIS can be beneficial, its effects may be influenced by specific patient characteristics and procedural details.

Furthermore, as indicated in the broader literature, including a recent study published in the Anesthesiology journal, BIS monitoring is associated with a reduction in intraoperative awareness and a potential decrease in the use of anesthetic agents (5). These aspects are crucial for procedures like rigid bronchoscopy, where the surgical environment demands precise control over anesthesia depth to prevent both awareness and undue respiratory depression.

For instance, BIS monitoring has been shown to reduce the risk of intraoperative awareness and improve recovery times. Specifically, a Cochrane review included studies showing that BIS-guided anesthesia could reduce the time to eye-opening, orientation, and discharge from the post-anesthesia care unit compared to standard practice guided by clinical signs or end-tidal anesthetic gas (6).

Moreover, studies suggest that BIS monitoring could potentially influence postoperative outcomes such as cognitive function. A systematic review highlighted BIS's role in possibly mitigating the risk of postoperative cognitive decline (POCD) and delirium, which are significant concerns, especially in elderly patients undergoing surgery (7).

Additionally, the effectiveness of BIS in reducing anesthetic consumption has been confirmed in various contexts. For example, BIS monitoring has been associated with decreased sevoflurane usage during surgeries, which not only aids in faster recovery but also minimizes the exposure to anesthesia, thus enhancing overall patient safety and reducing hospitalization needs (8).

However, the financial aspect of BIS monitoring should not be overlooked. While BIS can reduce anesthetic costs and improve recovery times, its cost-effectiveness is more apparent in high-risk patients than in routine surgeries. The economic implications of widespread BIS use have been debated, especially considering the low incidence of complications it aims to prevent, such as awareness during anesthesia (9).

Moreover, a study on the effectiveness of raw electroencephalogram-guided anesthesia demonstrated that such precision in monitoring can help reduce postoperative complications in elderly patients undergoing major surgeries. This suggests that BIS monitoring, which also uses EEG data, might improve outcomes by providing real-time insights into the patient's anesthetic state, potentially reducing the occurrence of complications like systemic infections and cardiovascular issues often seen post-surgery (10).

Another study emphasized the importance of BIS in optimizing recovery times. It was found that desflurane anesthesia combined with BIS monitoring significantly reduced the time to extubation and other recovery parameters compared to controls. This indi-

cates that BIS monitoring does not only help in the careful titration of anesthesia but also facilitates faster recovery, which could be particularly beneficial in procedures like rigid bronchoscopy where patient turnover and recovery speed are crucial (11).

Moreover, the research highlighted that BIS monitoring might help reduce intraoperative awareness, a critical factor in patient experience and safety during surgery. It was noted that BIS monitoring could effectively measure the hypnotic component of anesthesia, thereby preventing the distressing phenomenon of patients regaining awareness mid-procedure (12).

These findings are consistent with the broader literature on the use of BIS monitoring across various types of surgeries and patient demographics. By integrating BIS, healthcare providers can not only ensure the safety and comfort of patients during procedures but also streamline postoperative recovery, ultimately enhancing overall surgical care efficiency.

Clinical Implications

Enhanced Anesthetic Management

The significant reduction in anesthetic dosages with BIS monitoring implies more precise anesthetic management during rigid bronchoscopy. By avoiding over-sedation, BIS monitoring helps maintain optimal anesthesia levels, reducing the risk of anesthesia-related complications and improving patient safety. This precision in dosing not only minimizes the risk of intraoperative awareness but also prevents undue respiratory depression, which is critical in procedures involving the airway, such as rigid bronchoscopy.

Improved Recovery and Shortened Hospitalization

The significant reduction in hospitalization duration observed in the BIS group highlights the potential for faster patient recovery and discharge. This outcome can lead to increased patient throughput in hospitals, allowing for more efficient use of healthcare resources. Shortened hospital stays are beneficial not only for patient satisfaction but also for reducing the overall cost of care. By minimizing complications and enhancing recovery times, BIS monitoring can contribute to a more streamlined perioperative care process.

Reduction in Anesthetic Consumption

The reduced consumption of propofol and prednol in the BIS group suggests a more efficient use of anesthetic agents. This efficiency can lead to cost savings for healthcare facilities by reducing the amount of expensive anesthetic drugs required per procedure. Additionally, minimizing anesthetic exposure is beneficial for patients as it reduces the likelihood of side effects and promotes quicker postoperative recovery.

Potential for Standardization in High-Risk Procedures

The consistent findings across various studies, including our own, support the standardization of BIS monitoring in high-risk procedures such as rigid bronchoscopy (11). Given the invasive nature of the procedure and the critical need for precise anesthetic control, BIS monitoring can be integrated as a standard practice to enhance patient outcomes. The adoption of BIS monitoring as a routine part of anesthetic management in high-risk surgeries could lead to improved clinical protocols and better patient care standards.

As we draw conclusions from our findings and the corroborated evidence from other studies, it becomes evident that the benefits of BIS monitoring in rigid bronchoscopy are multifaceted. Not only does BIS monitoring enhance patient safety by ensuring optimal anesthesia depth, but it also contributes to broader healthcare objectives such as cost efficiency, environmental sustainability, and improved recovery times. The aggregation of these studies presents a compelling case for the adoption of BIS monitoring as a standard practice in anesthesia, especially for procedures that involve high-risk populations or complex surgical tasks.

In conclusion, our study adds to the growing evidence supporting the use of BIS monitoring in specialized anesthetic practices. It reaffirms the technology's role in improving clinical outcomes through better anesthetic management and potentially reduced hospital stays. Nevertheless, further research is necessary to explore the full scope of BIS benefits across different surgical settings and patient demographics to standardize its use in clinical practice.

CONCLUSION

This study underscores the significant benefits of BIS monitoring in rigid bronchoscopy, enhancing anesthetic precision and improving patient safety. The data revealed that BIS monitoring contributes to a significant reduction in anesthetic dosage and a decrease in hospitalization duration, underscoring its value in optimizing perioperative management. These

findings align with broader research, suggesting that BIS monitoring is crucial for minimizing the risk of anesthesia-related complications and enhancing recovery times. As healthcare continues to advance towards more efficient and safer surgical practices, the integration of BIS monitoring in rigid bronchoscopy and similar procedures represents a forward step in anesthetic management.

During the preparation of this work, the authors used GPT-3.5 Turbo in order to beautify the language of the text. After using this tool/service, the authors reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Ethical Committee Approval: This study was approved by İstanbul Provincial Health Directorate (Decision no: E-15916306-604.01.01 Date: 27.10.2022).

CONFLICT of INTEREST

The authors declare that they have no conflict of interest.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: ÖA, OS, FGÖ

Analysis/Interpretation: ÖA, BD, EM

Data acqusition: ÖA, HA, MAÖ

Writing: ÖA, OS, FGÖ, EİT

Clinical Revision: ÖA, EİT, BD, MAÖ, FGÖ

Final Approval: ÖA, MAÖ, FGÖ

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