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Research Article

# Comparison of Bispectral Index versus. End-Tidal Anaesthetic Gas Concentration Guided Protocols for Time to Tracheal Extubation in Paediatric Patients Undergoing Surgical Procedures under General Anaesthesia: A Prospective Randomized Controlled Study

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**ABSTRACT**

**Background:** An optimal anaesthesia protocol is critical for paediatric patients undergoing surgery to ensure smooth recovery and minimize complications. This study compares the impact of Bispectral Index (BIS) and End-Tidal Anaesthetic Gas (ETAG) concentration-guided protocols on tracheal extubation time in paediatric patients.

**Methods:** A prospective randomized controlled study was conducted on 60 paediatric patients (4-12 years) undergoing general anaesthesia. Patients were divided into BIS-guided (Group B) and ETAG-guided (Group E) protocols. Various parameters, including age, gender, duration of surgery, duration of anaesthesia, and time to extubation, were analyzed using statistical methods such as Chi-Square Test, Analysis of Variance (ANOVA), and Logistic Regression.

**Results:** No significant differences were found in demographic characteristics, surgery duration, anaesthesia duration, or time for extubation between the two groups. Both monitoring techniques demonstrated comparable efficacy in maintaining appropriate anaesthesia levels and ensuring a smooth recovery process.

**Conclusion:** The study concludes that BIS and ETAG-guided protocols are equally effective in maintaining optimal anaesthesia levels and facilitating a seamless recovery for paediatric patients. While the monitoring techniques are not interchangeable in all clinical scenarios, this research provides valuable insights for anaesthesia management.

## Introduction

Ensuring optimal anaesthetic regimens [1] is crucial to facilitate complete recovery, minimize postoperative complications, and enhance the overall well-being of paediatric patients undergoing surgical procedures. Monitoring the depth of anaesthesia [2] is essential to maintain an optimal anaesthetic state and prevent complications associated with both excessively shallow and excessively deep anaesthesia. In this study, two monitored modalities, namely Bispectral Index (BIS) and End-Tidal Anaesthetic Gas (ETAG) concentration, are compared to assess their impact on the time to tracheal extubation in paediatric patients.

To assess and compare the impact of Bispectral Index (BIS) and End-Tidal Anaesthetic Gas Concentration guided protocols on the time to tracheal extubation in paediatric patients undergoing surgical procedures under general anaesthesia.

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**Objectives:**

**Primary Objective:**

To compare the time to tracheal extubation between paediatric patients monitored with Bispectral Index (BIS) and those monitored with End-Tidal Anaesthetic Gas Concentration protocols.

**Secondary Objectives:**

To evaluate the hemodynamic parameters (e.g., heart rate, blood pressure) in paediatric patients monitored with BIS and End-Tidal Anaesthetic Gas Concentration protocols.

## Methods

This prospective randomized controlled study (CTRI/2023/05/052267), conducted at ESIC SSH (ESIC Super Speciality Hospital) after obtaining approval from the ethical committee (ESICMC/SNR/IEC-F423/02-2022), aimed to investigate the impact of different depth of anaesthesia monitoring techniques on anaesthesia management in paediatric patients aged between 4-12 years undergoing surgical procedures.

**Ethical Approval:**

The study adhered to ethical guidelines and received approval from the institutional ethical committee, ensuring the rights, safety, and well-being of the participating paediatric patients. Informed consent(assent) was obtained from the parents or legal guardians of the children involved in the study.

**Patient Selection:**

Paediatric patients between the ages of 4-12 years scheduled for surgical procedures under general anaesthesia were included in the study. Exclusion criteria, were clearly defined to ensure the homogeneity of the study population.

The sample size was calculated assuming a difference of 3 min in time to tracheal extubation in BIS and ETAG group in a recent study [3], with $\alpha$ error of 0.05, and a $\beta$ error of 0.05 (power of 0.95). Thirty patients per group would be needed to show a significant difference between BIS and ETAG groups

**Randomization and Group Allocation:**

Upon meeting the inclusion criteria, patients were randomly assigned to two groups: Group B-30 Paediatric patients (BIS guided) and Group E-30 Paediatric patients (ETAG guided). Randomization procedures were employed to ensure an unbiased allocation of patients into the two groups, minimizing selection bias.

**Anaesthesia Management:**

Patients in Group B were monitored using Bispectral Index (BIS), which measures the depth of anaesthesia, while patients in Group E were monitored using End-Tidal Anaesthetic Gas (ETAG) concentration. Standard anaesthesia procedures, including pre-anaesthetic checkup, necessary premedication, and application of standard anaesthesia monitoring (ECG, blood pressure, SPO2), were carried out for all patients.

**Monitoring Protocols:**

In Group B (30), BIS electrodes were placed to monitor and maintain BIS values between 40 and 60, ensuring an optimal anaesthetic state. In Group E (30), ETAG concentration was measured using an adult multigas sidestream analyzer module. Anaesthetic agents were titrated in both groups to maintain appropriate anaesthesia levels based on the respective monitoring techniques.

**Data Collection:**

Baseline data, including demographic information, surgical details, anaesthesia duration, and time to tracheal extubation, were recorded for each patient. Intraoperative and immediate postoperative complications were also documented. Data collection was meticulous and followed standardized protocols to ensure accuracy and reliability.

**Statistical Analysis:**

Chi-Square Test was used to compare proportions or categorical variables between the two groups (e.g., gender distribution, proportions of specific types of surgeries).

Analysis of Variance (ANOVA) was used to compare means among multiple groups.

Logistic Regression was used analyse the relationship between predictor variables (like BIS or ETAG guidance) and binary outcomes.

Repeated Measures ANOVA was used to compare hemodynamic parameters at baseline and every 5-minute intervals, to analyse changes over time within groups.

The analysis aimed to identify any significant differences in anaesthesia duration, time to tracheal extubation, and other relevant factors.

Time to tracheal extubation was recorded as the primary outcome, along with intra-operative and immediate postoperative complications.

## Results

The key findings of our investigation revealed that there were no statistically significant differences in demographic characteristics, including age, gender distribution, and weight, between patients monitored with BIS and those monitored with ETAG (Table 1). This

uniformity in baseline characteristics is crucial as it ensures that any observed differences in subsequent parameters are more likely attributed to the monitoring techniques rather than patient-specific factors.

**Table 1- Distribution of cases in Group E and Group B by age, gender & weight**

| Age (in years) | Group E | Group B |
|---|---|---|
| Mean | 6.37 | 7.53 |
| S.D | 2.87 | 3.04 |
| F=0.588, P=0.132 | | |
| Gender | Group E | Group B |
| Males | 26 (86.7%) | 25 (83.3%) |
| Females | 4 (13.3%) | 5 (16.7%) |
| Total | 30 (100%) | 30 (100%) |
| Chi-square =0.718, P=1.000 | | |
| Weight (kgs) | Group E | Group B |
| Mean | 19.88 | 21.65 |
| S.D | 8.41 | 8.67 |
| F=0.051, P=0.430 | | |

For the uration of surgery, the mean time was 63.93 minutes in Group E and 76.40 minutes in Group B, with no significant difference F=0.152, P=0.287 (Table 2).

For the duration of anaesthesia, the mean time was 88.83 minutes in Group E and 105.70 minutes in Group B, with no significant difference (F=0.016, P=0.216) (Table 2).

**Table 2- Distribution of cases in Group E and Group B by duration of surgery & duration of Anaesthesia**

| Duration of surgery (in minutes) | Group E | Group B |
|---|---|---|
| Mean | 63.93 | 76.40 |
| S.D | 46.31 | 43.46 |
| Median | 44.50 | 60.50 |
| IQR | 32.25 – 79.25 | 43.50 – 99.50 |
| F=0.152, P=0.287 | | |
| Duration of Anaesthesia (in minutes) | Group E | Group B |
| Mean | 88.83 | 105.70 |
| S.D | 54.07 | 50.28 |
| Median | 67.0 | 82.50 |
| IQR | 52.0 – 104.25 | 69.25 – 135.50 |
| F=0.016, P=0.216 | | |

For the Time for extubation in Group E and Group B was 7.77 minutes and 8.73 minutes, respectively, showing no significant difference (F=1.548, P=0.370) (Table 3).

The intra-operative heart rate change was monitored in both groups. No significant differences were observed in heart rate changes between Group E and Group B (Figure 1).

**Table 3- Distribution of cases in Group E and Group B by Time for extubation**

| Time for extubation (in minutes) | Group E | Group B |
|---|---|---|
| Mean | 7.77 | 8.73 |
| S.D | 3.45 | 4.73 |
| Median | 7.0 | 7.0 |
| IQR | 5.0 – 9.25 | 6.0 – 11.0 |
| F = 1.548, P= 0.370 | | |

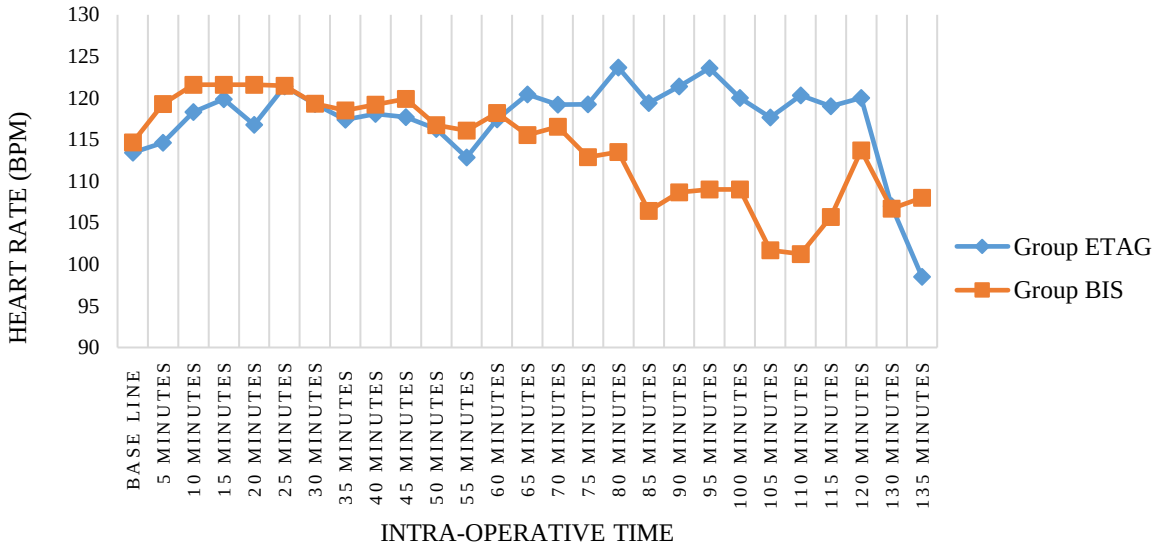


**Figure 1- Showing distribution of cases in Group E and Group B by Intra-operative Heart Rate Change (BIS = Bispectral, ETAG = End-tidal anaesthetic gas).**

Intra-operative Systolic Blood Pressure (SBP) changes were compared between Group E and Group B. The monitoring showed similar patterns of SBP changes in both groups, indicating comparable hemodynamic stability under both protocols (Figure 2).

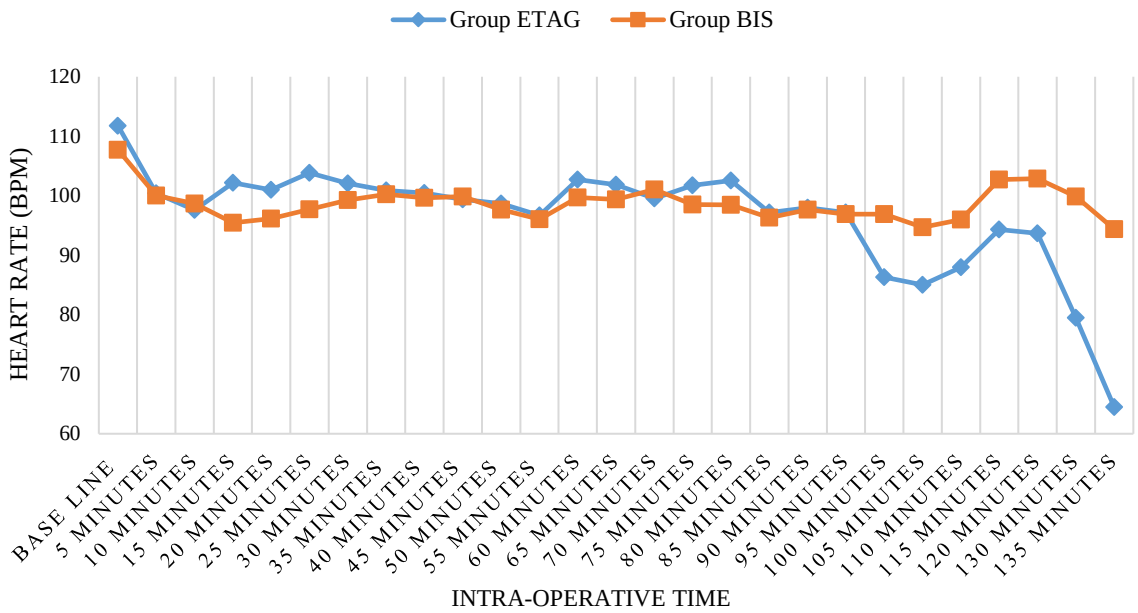


**Figure 2- Showing distribution of cases in Group E and Group B by intra-operative SBP change (BIS = Bispectral, ETAG = End-tidal anaesthetic gas, SBP = Systolic Blood Pressure).**

## Discussion

In this study, we systematically compared the efficacy of two distinct anaesthetic monitoring techniques, namely Bispectral Index (BIS) and End-Tidal Anaesthetic Gas (ETAG) concentration, in paediatric patients undergoing surgical procedures. The key findings of our investigation revealed that there were no statistically significant differences in demographic characteristics, including age, gender distribution, and weight, between patients monitored with BIS and those monitored with ETAG. This uniformity in baseline characteristics is crucial as it ensures that any observed differences in subsequent parameters are more likely attributed to the monitoring techniques rather than patient-specific factors, enhancing the internal validity of our study.

Our analysis of the duration of surgery showed that there was no significant difference between the BIS and ETAG groups, indicating that the choice of anaesthetic monitoring technique did not impact the duration of surgical procedures. Similarly, the duration of anaesthesia exhibited no significant variance between the two groups, reinforcing the equivalence of BIS and ETAG in maintaining appropriate anaesthesia levels throughout the surgical interventions. These results align with prior studies such as Wang,Fang et al [4]. and Hirshman et al. [5], emphasizing the effectiveness of BIS in anaesthesia management, particularly in paediatric populations.

A critical endpoint in our study was the time required for extubation, which signifies the patient's ability to regain consciousness and resume normal breathing independently. Notably, our analysis revealed no significant difference in extubation time between the BIS and ETAG groups. This finding underscores the comparable effectiveness of these monitoring methods in facilitating the patients' smooth recovery process. These results are consistent with the systematic review conducted by Punjasawadwong et al. [6] Stewart, Robyn et al. [7], which emphasized the benefits of using BIS to enhance anaesthesia delivery and postoperative recovery. In contrast, Shukla et al [3]. discovered a shorter tracheal extubation time in the BIS group compared to the ETAG group among adult patients.

In our study comparing intra-operative hemodynamic parameters in Group ETAG and Group BIS, similar systolic blood pressure (SBP) patterns were observed, indicating comparable hemodynamic stability under both protocols. These findings comparable with the previous studies [8] and are suggest the effectiveness and equivalence of both monitoring methods, offering flexibility in choosing appropriate monitoring techniques for surgical procedures

The study's focus on paediatric patients is noteworthy due to the unique challenges associated with this demographic. The stability and efficiency demonstrated

by both BIS and ETAG monitoring techniques in our study suggest that anesthesiologists can choose either method based on institutional preferences, availability, and cost-effectiveness, without compromising patient outcomes during the perioperative period.

However, it is essential to acknowledge the study's limitations. While our research provides valuable insights into the comparability of BIS and ETAG monitoring in paediatric patients, the results may not be universally applicable to all surgical procedures and patient populations. Additionally, advancements in monitoring technologies and anaesthesia practices, as explored in studies like Bouvet et al [9-10], could offer new perspectives that might influence the choice of monitoring techniques in future clinical practice

## Conclusion

It can be concluded that there were no substantial differences in the duration of surgery, duration of anaesthesia, or time for extubation between patients monitored with ETAG and those monitored with BIS. This suggests that both monitoring techniques were equally effective in maintaining appropriate levels of anaesthesia and ensuring a smooth recovery process for the patients.

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