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A comparative randomized study on effect of bispectral index versus end-tidal anesthetic gas concentration-guided protocol on time to tracheal extubation for isoflurane based general anesthesia

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Abstract
Introduction: To facilitate early emergence from general anaesthesia, monitored titration of inhalation anaesthetic is a necessity intra operatively. These monitored modalities may be Bispectral index (BIS) and end-tidal anaesthetic gas (ETAG) concentration Early tracheal extubation after general anaesthesia is a desirable goal as it is associated with decreased Intensive Care Unit (ICU), length of stay (LOS), hospital LOS, and thus, the potential for improved recovery and adequate or titrated resource utilisation. While intra operative anaesthetic techniques have made progress to accentuate fast track recovery, the role of brain monitoring in extubation has not been well studied. Bispectral index (BIS) monitoring has been used to monitor the depth of anaesthesia.
Objectives: To study duration of recovery time from the depth of anaesthesia between both the groups and the haemodynamic response during tracheal extubation, in both groups.
Methodology: A Comparative, Randomised, double blinded study was conducted on 60 adult patients undergoing elective surgeries under Isoflurane based general anaesthesia in Basaveshwara Medical College and Hospital, Chitradurga. Sampling is done by Simple Random Sampling using computer generated table with the duration of study was 18 months i.e. from August 2022, to February 2024,Therefore a sample size of 30 in each group is considered.
Results: The duration of surgery, and anaesthesia are not significant, where as time of extubation is significant in BIS group with 5.16±0.65 (Mean and SD) with p value is < 0.005.
Conclusion: In our study, comparing BIS with ETAG with isoflurane, the BIS group had early recovery and post extubation, BIS group 5.16±0.65 and ETAG 7.3±1.26 with p-value -0.0001, with haemodynamic stability in both group.

Keywords: Bispectral index, end-tidal anaesthetic gas (ETAG), extubation, minimum alveolar concentration (MAC)

Introduction

To facilitate early emergence from general anaesthesia, monitored titration of inhalation anaesthetic is a necessity intra operatively. These monitored modalities may be Bispectral index (BIS) and end-tidal anaesthetic gas (ETAG) concentration [1]. Early tracheal extubation after general anaesthesia is a desirable goal as it is associated with decreased Intensive Care Unit (ICU), length of stay (LOS), hospital LOS, and thus, the potential for improved recovery and adequate or titrated resource utilisation. While intra operative anaesthetic techniques have made progress to accentuate fast track recovery, [2] the role of brain monitoring in extubation has not been well studied. Bispectral index (BIS) monitoring has been used to monitor the depth of anaesthesia [3] and might authorise better precision regarding titration of anaesthetic doses to individual patient requirement; therefore, may have relevance regarding reducing recovery time. The widely accepted concept of minimum alveolar concentration (MAC) has led to the use of end- tidal anaesthetic gas (ETAG) concentration as a way to monitor the level of un-consciousness induced by inhaled anaesthetics. Unlike BIS which provides EEG-based measures of brain activity, the ETAG criteria are related to brain activity through concentration of anaesthetic expired in lungs, taking an assumption of its equilibrium with brain concentration [4]. Yet, the efficacy of these two monitoring modalities for achieving earlier tracheal extubation has not been unequivocally established [5]. Very few studies have compared the effect of BIS versus ETAG monitoring on tracheal extubation time after anaesthesia in patients under Isoflurane.

The present study investigates the effect of BIS versus ETAG monitoring on time to tracheal extubation for Isoflurane based general anaesthesia. Mean Alveolar Concentration (MAC) describes the potency of the inhalational anaesthetic, and also is one of the commonly used modality to titrate volatile anaesthetics. EEG-derived BIS is more specific to get the centration-response curves for the hypnotic effects of various inhalation anaesthetics [6].

Methodology

A Comparative, Randomised, double blinded study was conducted on 60 adult patients undergoing elective surgeries under Isoflurane based general anaesthesia in Basaveshwara Medical College and Hospital, Chitradurga. Sampling is done by Simple Random Sampling using computer generated table with the duration of study was 18 months i.e. from August 2022, to February 2024 Sample size is Calculated using open EPI software with significance level of 95%, power of 80% Allocation ratio of 1, Therefore a sample size of 30 in each group is considered. And inclusion criteria is Patient's consent willing to participate in the study, age between 18 to 50 years of either sex, ASA I-II scheduled for elective surgical procedures under general anaesthesia, Mallampati Grade I-II. And subjects not willing to participate in the study, patients with anticipated difficult intubation, pregnant and lactating mother, patients on psychoactive medication, psychiatric patients, known or suspected, EEG abnormalities (e.g. epilepsy and previous brain surgery). Patients with abnormal kidney function, history of alcohol and drug abuse, Deranged liver function were execluded from the study. After the approval by the Institutional Ethical Committee IEC/79/2022-2023, written informed consent will be obtained from all the patients before being included in the study. The study population was subdivided randomly into 2 groups each consisting 30 patients: Group 1(BIS): Consisting of 30 patients, BIS electrodes will be applied before starting the procedure to note the baseline awake BIS value Group 2 (ETAG) consisting of 30 patients, End tidal anaesthetic gas concentration will be measured before the start of surgery, MAC values of Isoflurane will be considered and will be taken as the measure of ETAG concentration. Both the groups baseline parameters will be noted 10 minutes prior tracheal intubation. Pre anaesthetic evaluation will be done a day prior to surgery. The following investigations will be done in patients as required as CBC (complete blood count), Blood sugars (FBS, PPBS). Blood urea, serum creatinine and electrolytes, Liver function test, Standard 12 lead ECG, screening chest x ray. The procedure of general anaesthesia was explained to the patient and written informed consent will be taken. Preparation will include overnight fast according to ASA nil per oral status before the surgery. Anaesthetic machine and all the equipments was checked and kept ready along with the crash cart. TECHNIQUE :- Patient shifted on the OT table, intravenous line is secured using 20G IV cannula connected to standard monitoring using BPL ExcelSign E12 monitor comprising, heart rate, non-invasive measurements blood pressure (NIBP), mean arterial pressure (MAC), oxygen saturation (SpO_2), end tidal carbon dioxide, temperature probe, and continuous ECG monitoring. Baseline readings were recorded by an anaesthesiologist who will be blinded for the study. BIS monitoring will be started using the "Quatro" BIS sensor to record the patient's awake BIS. The 2011 Covidien, 10071702 Rev C module acquires real time electroencephalography data and processes it into a BIS number. Total MAC value of the inhalation agent was taken as a measure of ETAG concentration. BPL ExcelSign E12 monitor will be used to measure ETAG also displaying the ETAG of the inhalation agent. The vaporizer used is Datex-Ohmeda, Inc.isofluranevaporizer. The anaesthesiologist caring for patients in ETAG group will be using a monitor configuration that will omit BIS number, while in the BIS group will be using a monitor with no MAC values displayed. Thus, the anaesthesiologist will be blinded to MAC value in BIS group and to BIS value in ETAG group. All the study vital parameters required were recorded at an interval of 1 minute up to 10 minutes before intubation followed by every 5 minutes up to 30 minutes after intubation and every 30 minutes till the end of the surgery. All the patients were premeditated with InjGlycopyrrolate (0.005mg/kg) IV; Inj Midazolam (0.05mg/kg); Inj Fentanyl (2mcg/kg) IV and pre oxygenated with 100% oxygen for 3 minutes. Induction was achieved with InjPropofol (2mg/kg) IV and abolishment of eyelash reflex were recorded, followed by Inj Succinylcholine (2mg/kg) IV was administered to facilitate intubation and produce muscle relaxation. Intubation was carried out with an appropriate sized disposable high volume low pressure cuffed PVC endotracheal tube. After confirmation of the tracheal intubation with auscultation of the chest for bilateral air entry and using ETCO2 the tube was secured and connected to a closed circuit and anaesthesia was maintained with 66% nitrous oxide, 34% oxygen and Isoflurane 0.8%, maintenance dose of vecuronium with a tidal volume of 8-10ml/kg and respiratory rate of 12-14 breaths per minute. Isoflurane was titrated to maintain a BIS value of 40-60 in BIS group 1 and 0.3-0.7 MAC in ETAG group2. After the last skin suture, N2O will be cut off and Isoflurane will be titrated to maintain a MAC value between 0.3-0.7. After achieving the train of four ratio (TOF) of > 0.9 with the BIS value between 40-60% and ETAG concentration between 0.3-0.7, residual neuromuscular blockade was reversed with Inj Neostigmine (0.05mg/kg) and InjGlycopyrrolate (0.01mg/kg). Extubation was done when a) patient will follow verbal commands, b) has a sustained head lift for 5sec, c) maintain adequate saturation. Variables such as type and duration of surgery and duration of anaesthesia (time from induction to skin closure) were documented. The time between anaesthetic discontinuation and tracheal extubation were taken as tracheal extubation time. Anyintra operative or immediate postoperative complications were recorded and managed appropriately with the necessary drugs.

Results

Table 1: Demographic profile of patient

	BIS Group (N=30)	ETAG Group (N=30)
Gender		
Female	11	18
Male	19	12
Asa Physical Status		
Asa 1	17	16
Asa 2	13	14
Age in Years (Mean ± SD)	47.21±9.06	47.73±8.19
Weight in Kg (Mean ± SD)	65.4±10.92	65.4±10.92

Table 2: Mean duration of surgery, anaesthesia and time to tracheal extubation in BIS & ETAG Group

	BIS Group	ETAG Group	P-Value
Duration of Surgery (H)	2.93±0.359	2.429±0.663	0.0005
Duration of Anesthesia (H)	3.599±4.81	2.773±0.658	0.3535
Time to Tracheal Extubation (Min)	5.16±0.65	7.353±1.26	0.0001

The duration F-surgery, and anaesthesia are not significant whereas time of extubation is significant in BIS group with 5.16 ± 0.65 (Mean and SD) with p-value is < 0.005.

Discussion

Mean Alveolar Concentration (MAC) describes the potency of the inhalational anaesthetic, and also is one of the commonly used modality to titrate volatile. Anaesthetics. EEG-derived BIS is more specific to get the concentration-response curves for the hypnotic effects of various inhalation anaesthetics [6]. Gupta *et al.* found that at equi-MAC Sevoflurane produces lower BIS values as compared to Isoflurane, pointing at an agent specific effect and deficiency in BIS algorithm for certain inhalational agents [7] and The BIS values produced by Isoflurane and halothane at equal end-tidal MAC concentration and found that at equi-MAC end-tidal concentrations Isoflurane produces lower BIS values than halothane. The BIS values were 54.2±3.7 and 42.4±5.8 at 1 MAC in halothane and Isoflurane groups, respectively [8]. Murrell, *et al.* studied the effects of halothane, Isoflurane, Sevoflurane, and Desflurane on the electroencephalogram of the rat. They concluded that halothane causes significantly less depression of cortical activity than the newer inhalant agents at equivalent multiples of MAC and that halothane has fundamentally different mechanism of action than the other inhalant agents. These studies explain the prolongation of extubation time in BIS-guided group in our study when compared to ETAG group [9]. Where as in our study, comparing BIS with ETAG with isoflurane, the BIS group had early recovery and post extubation, BIS group 5.16±0.65 and ETAG 7.3±1.26 with p-value -0.0001. In previous study conducted by Krishna Murthy *et al.* Found the effectiveness of Bispectral index monitoring in reducing the awakening time, extubation time in morbidly obese patients posted for elective laparoscopic sleeve gastrostomy for Desflurane based general anaesthesia without compromising the heamodynamics [10]. Which correlates with the results of our study with isoflurane agent. As p value is 0.0001. Schwab *et al.* Studied the effect of Sevoflurane and Halothane on BIS values, they concluded that Sevoflurane causes greater decrease in BIS values as compared to Halothane at equal MAC multiples. They found that mean BIS value was 54±7 with halothane as compared with sevoflurane at 1 MAC [11] with other study of Sudhakaran *et al.* studied recovery characteristics including time to tracheal extubation in BIS monitoring, ETAG monitoring and standard monitoring in Desflurane Based anaesthesia. They found that extubation time in ETAG and BIS guided was significantly lower than standard group (p<0.001) but ETAG-guided anaesthesia comparable to BIS-guided anaesthesia [12]. Which is contrary with our study which shows BIS group with early recovery and haemodynamic stability in both group.

Conclusion

In our study, comparing BIS with ETAG with isoflurane, the BIS group had early recovery and post extubation, BIS group 5.16±0.65 and ETAG 7.3± 1.26 with p value -0.0001, with haemodynamic stability in both group.

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