Section: Anesthesia

Original Research Article

EFFECT OF BISPECTRAL INDEX MONITORING ON SEVOFLURANE CONSUMPTION IN PATIENTS UNDERGOING CORTICAL MASTOIDECTOMY UNDER GENERAL ANESTHESIA

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Abstract

Background: Using bispectral index (BIS) guided anesthesia may affect the quality of recovery and consumption of inhalational anesthetic agents. The aim is to study the effect of BIS monitoring on sevoflurane consumption in patients undergoing cortical mastoidectomy under general anesthesia. **Materials and Methods:** In the present study, 44 patients of either sex, in ASA class 1 and 2, aged from 20 to 60 years, going for cortical mastoidectomy under general anesthesia, were selected for the study. All the patients were randomly divided into two equal groups: the BIS group (Group B) and the non-BIS group (Group NB). All patients were evaluated for eye-opening, response to follow the motor command, time of extubation and modified Aldrete score. **Result:** Female predominance is reported in both groups. The maximum number of patients (50%) were reported in the age group of 40 to 49 years in the BIS group. In the Non-BIS group, maximum patients were observed in the age group of 30 to 39 years, with (40.9%) of patients. The mean age, weight, baseline PR, Intra-OP PR, MAP, Intra-OP MAP, and duration of surgery were reported to be comparable in both groups. The mean amount of sevoflurane used, time for eye-opening, motor response and extubation parameters were significantly ($p<0.05$) higher in Non-BIS. The patients of the Non-BIS group showed ($p<0.05$) higher modified Aldrete scores significantly. **Conclusion:** Sevoflurane anesthesia guided by BIS decreased recovery time and decreased sevoflurane concentration without affecting recovery quality in patients undergoing cortical mastoidectomy under general anesthesia.

INTRODUCTION

Consciousness and memory are among the most fascinating and complex subjects in science, which is clinically most relevant for anesthesiologists. The introduction of general anesthetics into clinical practice stands as one of the seminal innovations of medicine that facilitated modern surgery's development and spawned the speciality of anesthesiology.[1-2] General anesthesia can be broadly defined as a drug-induced reversible depression of the central nervous system resulting in loss of response to and perception of all external stimuli. Lundy introduced balanced anesthesia in 1926, defined as a triad of amnesia, analgesia and muscle relaxation. Anesthesia with a single agent can require doses that produce excessive hemodynamic depression. Lundy suggested that a balance of agents and techniques be used to produce the different components of anesthesia.[3]

Awareness under anesthesia, also referred to as intraoperative awareness, is a complication of general anesthesia (1 to 2 cases per 1000). It is possible to regain consciousness during surgery without any memory of it. There are instances where patients can remember the events related to their surgery, an entity called awareness with explicit recall, which is clinically more relevant. It is an infrequent but frightening event that has potentially devastating psychological consequences and is associated with a high incidence of posttraumatic stress disorder.[4] Patients have recalled various experiences ranging from vague, dreamlike states to being fully awake, sensations of paralysis, pain, anxiety, helplessness and powerlessness. Feeling the endotracheal tube's placement in the trachea and

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being unable to signal distress to the anesthesiologist can create anxiety and panic. This is usually caused by the delivery of inadequate anesthetics relative to the patient's requirements.[5]

In clinical practice, conventional methods are used to monitor the depth of anesthesia. Clinical signs like perspiration, shedding of tears, limb movements, and cardiovascular and pulmonary measures like the heart rate, blood pressure, and respiratory rate are unreliable for evaluating anesthetised patients' brain status. These measures do not indicate the adequacy of anesthesia reliably because they can be influenced by factors unrelated to the depth of anesthesia.[5-6]

To objectively quantify the level of sedation and anesthesia, the intuitive solution is to monitor the brain's activity directly. Researchers have suggested that cerebral monitoring can be used to assess the depth of anesthesia, prevent awareness and facilitate early recovery after general anesthesia by optimizing drug delivery to each patient.[7] Recent advances have led to the manufacture of monitors of awareness, which monitor the electroencephalogram (EEG) that represents the electrical activity of the cerebral cortex.

The Bispectral index monitor (BIS) is the first quantitative EEG index introduced into clinical practice as a monitor to assess the depth of anesthesia. Other newer technologies include EEG entropy monitoring, auditory evoked potentials, the Narcotrend monitor and the SNAP monitor.[8] The American Society of anesthesiologists have set some minimum standard monitors for routine anesthesia practice like non-invasive blood monitoring (NIBP), pulse oximeter, end-tidal CO2 monitoring (ETCO2), temperature, and Electrocardiogram (ECG). BIS is not a minimum standard monitor but a desirable monitoring technique. There is much evidence regarding the importance of BIS monitoring as it helps to monitor the adequacy of the depth of anesthesia, reduces the inhalation agent consumption, and improves the patient recovery profile hence reducing the cost of anesthesia as well as theatre pollution. [9-10]

This study aimed to evaluate the impact of BIS monitoring on sevoflurane (inhalational anesthetic) consumption and recovery profile in patients undergoing cortical mastoidectomy under general anesthesia.

MATERIALS AND METHODS

Patients undergoing cortical mastoidectomy under general anesthesia at Govt Kilpauk Medical College and Govt Royapettah hospital, Chennai, between June 2020 to August 2020 were assessed for inclusion and exclusion criteria and included in the study.

After obtaining written informed consent and institutional ethical committee approval, the study was conducted on 44 patients. All were ASA I and II patients undergoing elective surgical procedures under general anesthesia lasting for less than 3 hours but more than 1- hour duration. After getting consent, the anesthetic technique was performed.

Inclusion criteria: Standard ASA 1 and 2 category patients of age group 20 to 60 yrs posted for Mastoidectomy (Cortical and Modified Radical Mastoidectomy) surgeries in Govt Kilpauk Medical College Hospital and Govt Royapettah hospital.

Exclusion criteria: Patients with ASA class 3 or more, allergy to any drugs used for the surgery, neurological dysfunction, altered mental function, Alzheimer's disease, Cerebral Palsy and psychiatric illness. Patients who refused to participate in the study were excluded from the study. A total of 44 patients were included in the study and were divided into two groups of 22 each.

Group B (BIS group): Patients undergoing cortical mastoidectomy under general anesthesia with Bispectral index monitoring. In addition to the standard ASA monitors, 22 patients who underwent cortical mastoidectomy received BIS monitoring. Their sevoflurane consumption and recovery profile were noted.

Group NB (Non-Bis Group): Patients undergoing cortical mastoidectomy under general anesthesia without Bispectral index monitoring, including 22 patients who also satisfy the inclusion criteria. In the control group, titration of sevoflurane concentration was based on intraoperative clinical parameters and the MAC value of the inhalation agent. The obtained data from the study group was compared against the control group.

Premedication was given to all patients with Ranitidine 50 mg and Alprazolam 0.5mg orally on the previous night and the morning of the surgery. In the operation theatre, all standard monitors such as ECG, pulse oximeter, non-invasive BP monitor (NIBP), and end-tidal carbon di oxide concentration (ETCO2) were used to monitor all patients. After securing IV access, the patients were premedicated with Inj. Midazolam 1mg, Inj. Glycopyrrolate 0.2mg and Fentanyl 2mics/kg dose. Patients in the study group had continuous BIS monitoring by applying BIS sensors to the forehead and temporal regions before induction.

All patients were pre-oxygenated for 3 minutes, followed by induction with Inj. Propofol 2mg/kg. Hemodynamic stress response attenuation was done using Inj. Lignocaine 1.5mg/kg. Muscle relaxation was achieved using Inj. Vecuronium 0.1mg/kg after ensuring the adequacy of mask ventilation. Airway secured with adequate size oral endotracheal tube. All patients were then mechanically ventilated to keep their ETCO2 between 35 to 40.

Maintenance of anesthesia was done using Nitrous Oxide: Oxygen mixture and sevoflurane with a fresh gas flow of 3l/min. Sevoflurane concentration was then adjusted using routine clinical parameters like heart rate (HR), blood pressure (BP) and minimum alveolar concentration (MAC) values in the control group. While in the study group, sevoflurane was

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titrated by keeping the BIS value between 40 to 60 with a mean of 50.

Intraoperatively adequate analgesia was provided with fentanyl and supplementation of muscle relaxation with vecuronium for all the patients. Patients in both groups were extubated when they fulfilled the subjective and objective criteria for extubation. Neuromuscular blockade was reversed with Glycopyrrolate 0.4mg and Neostigmine 0.05 mg/kg. Patients were followed up in the post anesthesia care unit, and the time to achieve a modified Aldrete score of 9 was evaluated subsequently at 10-min intervals until 3 hours after surgery.

The recovery profile of the patient was noted as follows, time of eye-opening - defined as the time from discontinuation of the anesthetic agent to the eye-opening on verbal command. The time of response to follow motor command is from discontinuing the anesthetic agent to hand squeezing. Time of extubation is defined as the time from discontinuing the anesthetic agent to extubation of the endotracheal tube and modified Aldrete scoring at PACU (Time to achieve a modified Aldrete score of 9).

Data were entered into Microsoft Excel, and statistical analysis was carried out in SPSS software version 17.0. Qualitative variables were presented as frequency and percentages. Quantitative variables were presented as mean (standard deviation) or median (range) depending upon the data distribution. Differences in gender between the study and control groups were assessed using the chi-square test. Haemodynamic parameters and other continuous variables (duration, time to motor response, etc.) were compared between the two groups using an independent t-test. A p-value of less than 0.05 was considered statistically significant. Bar diagrams and pie charts were used for the graphical representation of data.

RESULTS

The study was performed on 44 patients of either sex, aged 20 to 60 years, within ASA grading 1, 2. All 44 patients of both sexes were randomly allotted to the Bispectral index group (BIS-Group) and Control group (non-BIS group), with 22 patients in each group. Female predominance is reported in both groups. The maximum number of patients, 11 (50%), were reported in the age group of 40 to 49 years in the BIS group, whereas in the Non-BIS group, maximum patients were observed in the age group of 30 to 39 years with 9 (40.9%) patients. The mean age, weight, baseline PR, Intra-OP PR, MAP, Intra-OP MAP, and duration of surgery were reported to be comparable in both groups [Table 1].

Table 1: Observation of various evaluating parameters of both group patients

Variables	BIS Group (Group BIS)	Non-BIS Group (Group NB)	p-value by 't-test
Gender			
Female	14 (63.6%)	12 (59.1%)	
Male	8 (36.4%)	10 (40.9%)	
Mean Age years ± SD	44.1 ±9.4	40.6 ±8.2	0.202
Weight (Kg± SD)	66.7±9.5	64.7 ±8.7	0.460
Base Line PR	79.2± 10.6	76.7 ±7.9	0.39
Baseline MAP	64.9 ±3	65.5 ±2.8	0.535
Intra-OP PR	74.9 ±10.4	77.5± 9.3	0.381
Intra-OP MAP	63.8 ±2.7	66.7 ±2.8	<0.001
Duration of surgery (min)	90.9 ±9.1	91.8 ±8	0.726
Amount of sevoflurane used	20.4 ±1.7	27.1 ±2.4	<0.001
Time for eye-opening (min)	4.8 ±1	8.3± 0.9	<0.001
Time for motor response (min)	7 ±1	10.8 ±0.8	<0.001
Time for extubation (mins)	8.4 ±1.2	13.3± 0.7	<0.001
Modified Aldrete score	14.5 ±1.2	19.6 ±2.2	<0.001

The observation of the mean amount of sevoflurane used, time for eye-opening, time for motor response and time for extubation parameters were found to be significantly ($p<0.05$) higher in non-BIS groups than BIS group [Table 1].

In our study, both groups were evaluated for Modified Aldrete score, and it was found that patients of the non-BIS group showed ($p<0.05$) more time to reach modified Aldrete score significantly as compared to BIS-group patients [Table 1, Figure 1].

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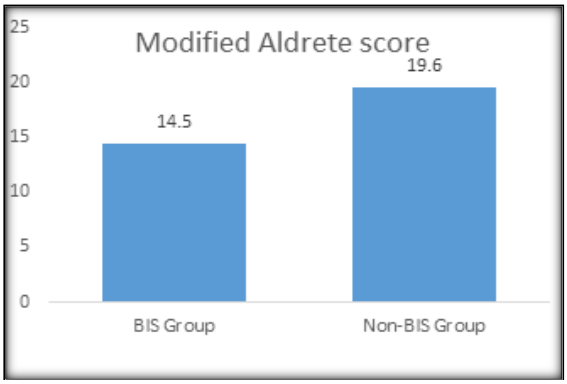

Figure 1: Observation of Modified Aldrete Score of both group patients

DISCUSSION

Bispectral index monitoring has been used in many studies comparing the emergence and recovery profiles of inhalational anesthetics like desflurane and sevoflurane. These studies demonstrate that the time to recovery from anesthesia is shortened compared with previous non-BIS-guided studies where desflurane or sevoflurane adjustments were based on MAC and hemodynamic response.[3-4] Rapid emergence from anesthesia with minimal respiratory and cardiovascular adverse effects is important for all patients undergoing surgery. Tang et al. found that AEP and bispectral index monitoring can decrease the end-tidal desflurane concentration during the maintenance of anesthesia. It has been shown that high costs can be minimized without compromising clinical outcomes and patient satisfaction.[11]

The hypothesis adopted in this study was that sevoflurane titration guided by BIS monitoring could reduce the agent consumption and ensure a faster recovery. We demonstrated that adding BIS to standard monitoring was associated with a significant decrease in sevoflurane consumption. Also, there was a significant difference in recovery times when comparing BIS-guided and standard monitoring anesthesia. These results are comparable to those reported in other studies that assessed the titration of propofol, desflurane or sevoflurane by using BIS monitoring.[10-11]

Bispectral index monitoring allows a reduction in the total amount of anesthetic that patients are exposed to and appears to decrease the time for emergence and recovery. Yli-Hankala et al. found that sevoflurane reduction was 40% in gynaecological surgery patients who also received opioids.[12] Other authors using isoflurane found similar findings. In that study, there was a 12% reduction in isoflurane consumption when using BIS.[13]

The time to eye opening, motor response and extubation were shorter in the study group where titration of the anesthetics was done with BIS monitoring. Post anesthesia recovery score of greater than ten was achieved earlier in the study group. Leslie et al. also reported similar findings in their investigations.[14]

In our study, the mean sevoflurane consumption was 20.4±1.7ml/h in the BIS group, whereas it was higher in the non-Bis group as the average usage was 27.1±2.4ml/h. The time to eye-opening was just 4.8 minutes in the BIS group, and it was around 8.3 minutes in the Non-Bis group. In the BIS group, the patient moved their limbs in a mean time of 7 minutes after the discontinuation of the anesthetics. At the same time, it took a mean of 10.8 minutes in the control group. Basar et al., in their study, reported 44.13±5.79 ml/h consumption of sevoflurane in the BIS group and 46.32±7.72 ml/h sevoflurane consumption in the Non-BIS group with insignificant effect.[15]

The patients in the BIS group were extubated earlier (8.4±1.2minutes) than those in the non-Bis group (13.3±0.7minutes). The post-anesthesia recovery score of greater than 10 (PARS>10) was achieved in a mean of 14.5 minutes in the BIS group, which was earlier than the Non-Bis group (19.6 minutes). Bispectral index monitoring during anesthesia for surgical patients significantly reduces recovery times. It has the added advantage of decreasing sevoflurane consumption. These findings in the present study follow earlier reported studies.[16-17]

CONCLUSION

In conclusion, the recovery variables were shorter with Bispectral index (BIS) monitoring, which in turn made significant savings in sevoflurane consumption, influencing the speed of recovery and early discharge.

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