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Original Research Article

Effect of BIS (Bispectral Index) Monitoring on Recovery Profile of Patients using Sevoflurane as a Maintenance Inhalational Anaesthetic Agent

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Abstract

Background: One of the objectives of modern anaesthesia is to ensure adequate depth of anaesthesia to prevent awareness without inadvertently overloading the patient with potent drugs. An important achievement of modern anaesthesia is the ability to monitor depth of anesthesia. Bispectral index uses a combination of EEG sub parameter that were selected after analysis of large database of EEG. This parameter were combined to form optimum configuration to monitor the hypnotic state. This is then described as a dimensionless number ranging from o to 100 with lower number corresponding to deeper level of hypnosis.

Aim of the Study: To evaluate efficacy of Bispectral index monitoring on recovery profile of patients maintained with sevoflurane under general Anaesthesia.

Methods: This clinical study was conducted in the Department of Anaesthesiology & Critical care of Osmania General Hospital, Hyderabad, from June 2020 to November 2021.

Results: The recovery profile is better in patient who were administered BIS guided anaesthesia.

Conclusion: BIS monitoring results in higher modified aldrete score on arrival to PACU, there by leading to early discharge from PACU.

Keywords: Bispectral Index (BIS); Post anaesthesia care unit (PACU); Modified Aldrete score.

Introduction

One of the objectives of modern anaesthesia is to ensure adequate depth of anaesthesia to prevent awareness without inadvertently overloading the patient with potent drugs. An important achievement of modern anaesthesia is the ability to monitor depth of anaesthesia. The overall incidence of intra-operative awareness with recall is about 0.2-3% [1] but it may be >40% in certain high risk patients, like, those with multiple trauma, caesarean section, and hemodynamically unstable patients [2] intra-operative awareness is a major medico-legal liability to anaesthesiologist and can lead to postoperative psychosomatic dysfunction in the patients, and therefore should be avoided at all costs [3]. Ability to judge the depth of anaesthesia has been a continuous quest ever since snow first described five stages of narcotisim of ether anaesthesia in 1847 [4]. These were later refined by Guedel into four stages on the basis of somatic muscle tone,

respiratory parameters and ocular signs [5]. In 1954, Joseph F Artusio [6] further divided the Guedel's stage I into three planes. With the advent of neuromuscular blocking agents and other adjunctive agents, many of the clinical signs and stages of anaesthesia described by snow and Guedel were obliterated. In 1957, Woodbridge [7] defined anaesthesia as having four components, sensory blockade, motor blockade, blockade of autonomic reflexes, and loss of consciousness. What began as the continuous clinical monitoring of patient's physiological parameters, evolved to include the measurement of real-time airway gas volatile agent concentration and more recently of neurophysiological parameters.

Aim of the Study

1. To evaluate the effect of bispectral index monitoring on recovery profile of patients maintained with sevoflurane under general anaesthesia.
2. To assess the effect of bispectral index monitoring on
   i) Recovery parameters (time of eye opening, extubation time, time of shifting to PACU after extubation).
   ii) Modified Aldrete score.

Material & Methods

This clinical study of 60 cases was conducted in the Department of Anaesthesiology and critical care of Osmania General Hospital, Hyderabad from June 2020 to November 2021.

Inclusion criteria

The following patients were included in the study

1. Patients of age between 18 and 50 years of both sexes.
2. Patients with American Society of Anaesthesiologists grade 1 and 2 physical status.
3. Patients posted for various general surgical abdominal and urological surgeries.

Exclusion criteria

1. Patients who are unwilling to give consent.
2. ASA Grade III, IV, V or E.
3. Obese patients.
4. Patients with psychiatric illness, altered mental health, alcohol and drug abusers.
5. Patients requiring head and neck surgeries.
6. Surgical procedures with anticipated major blood loss or fluid shift.
7. Patients with coronary artery disease and heart blocks.

Standard practice group (SP group): Thirty patients were allocated in this group. The depth of anaesthesia in these patients was monitored with routine clinical parameters like heart rate (<80), blood pressure (SBP<130 & DBP<80).

Bispectral index group (BIS group): Thirty patients were allocated in this group. The depth of anaesthesia in these patients were monitored with bispectral index. To achieve adequate depth BIS is kept between 45-60. The consultant anaesthetic supervised all the cases. Routine standard monitoring in the form of pulse oximetry, electrocardiogram, end tidal carbon dioxideand non invasive blood pressure was instituted in both the groups. Patients in the BIS group had continuous assessment of BIS monitoring by applying BIS sensors to the forehead and temple region before the induction of anaesthesia. After preoxygenation with 100% oxygen, general anaesthesia was induced in both the groups with propofol 1.5-2.0 mg/kg, fentanyl 2 mcg/kg and atracurium 0.5-1.0mg/kg of body weight. Endotracheal intubation was performed after three minutes of giving muscle relaxant. All patients were mechanically ventilated to keep end tidal carbon dioxide of 32-35mmHg.

Results

Table 1: Gender Distribution in two groups

Group	Standard Practice	BIS	Test	P value
Male	14 (46.66%)	15 (50%)	Fischer's Exact Test	0.79
Female	16 (53.33%)	15 (50%)		

Table 2: Comparison of mean duration of surgery (in mins) between two groups

Group	Mean duration (in mins)	± SD	Test	P value
Standard Practice	130.83	9.10	Unpaired t test	0.687
BIS	129.93	10.16		

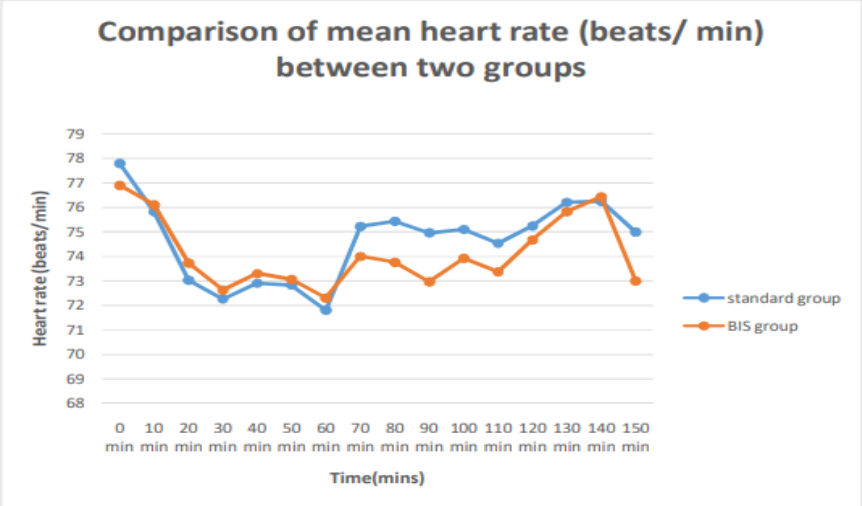

Figure 1: Comparison of heart rate (beats/ min) expressed as mean ±SD between two groups

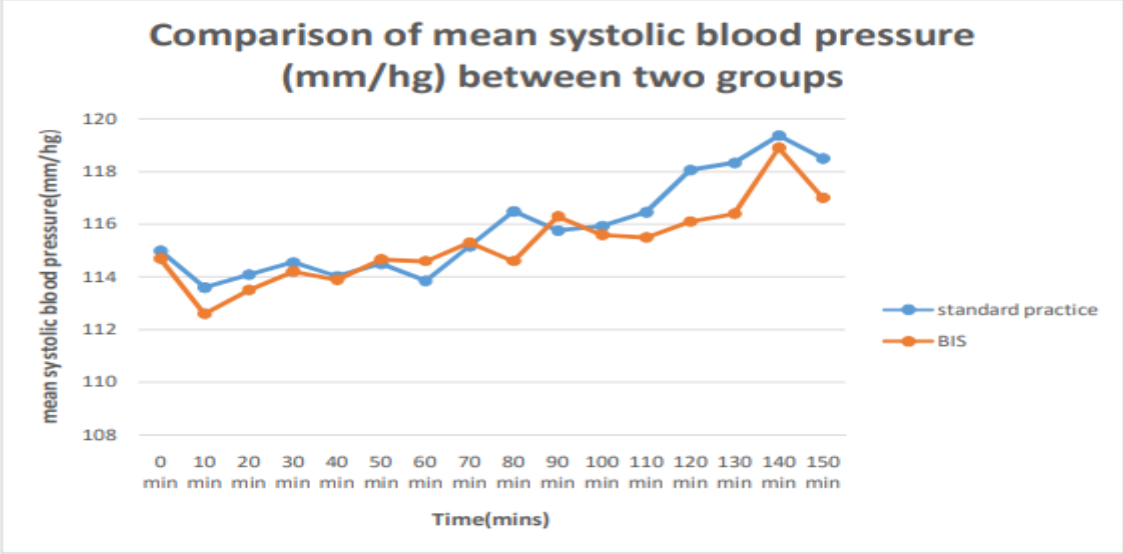

Figure 2: Comparison of mean systolic blood pressure (mm/hg) in two groups at various time intra operatively

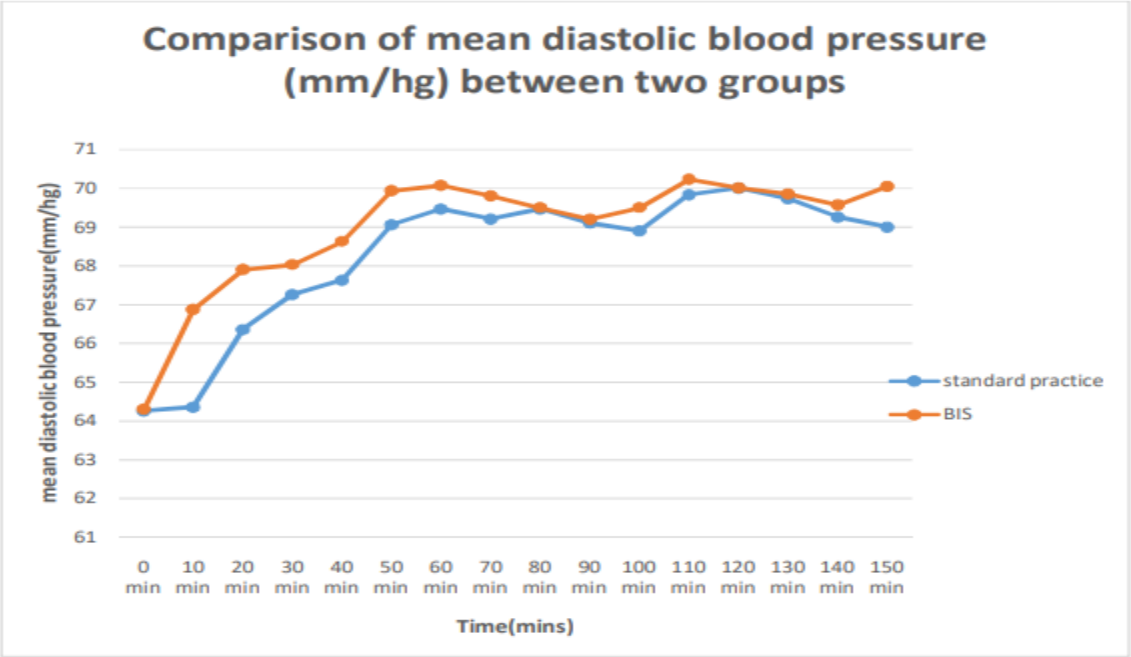

Figure 3: Comparison of mean diastolic blood pressure (mm/hg) in two groups at various time intra operatively

Table 3: Mean BIS value(mean ±SD) in BIS group at different times intra operatively

Time	BIS value	
	Mean	± SD
10 min	51.07	1.41
20 min	46.76	1.71
30 min	45.97	1.49
40 min	46.33	1.72
50 min	46.30	1.61
50 min	46.30	1.68
60 min	46.70	1.78
70 min	46.43	1.88
80 min	46.77	1.56
90 min	45.97	1.40
100 min	47.00	1.57
110 min	46.07	1.95
120 min	46.90	2.19
130 min	47.75	2.17
140 min	47.86	2.46
150 min	49.00	1.41

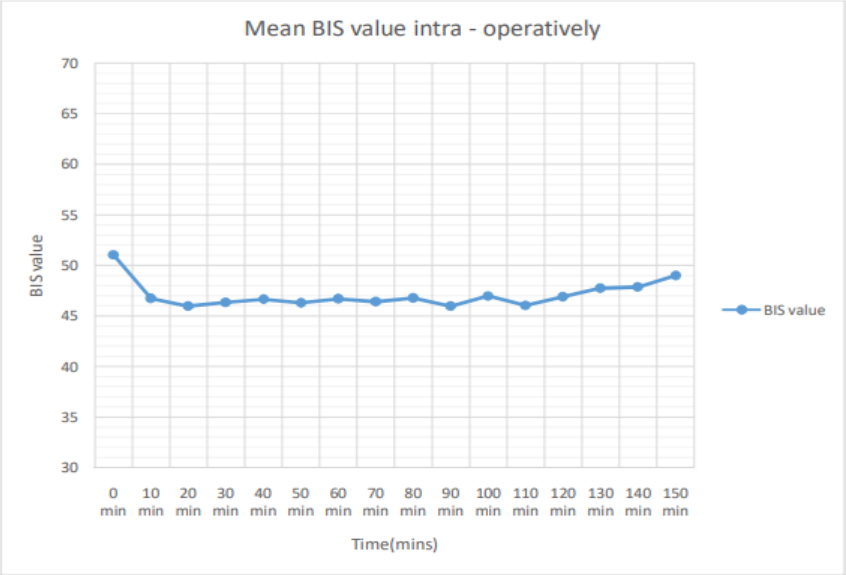

Figure 4: Comparison of time of eye opening (in mins) expressed as mean ± SD in two groups

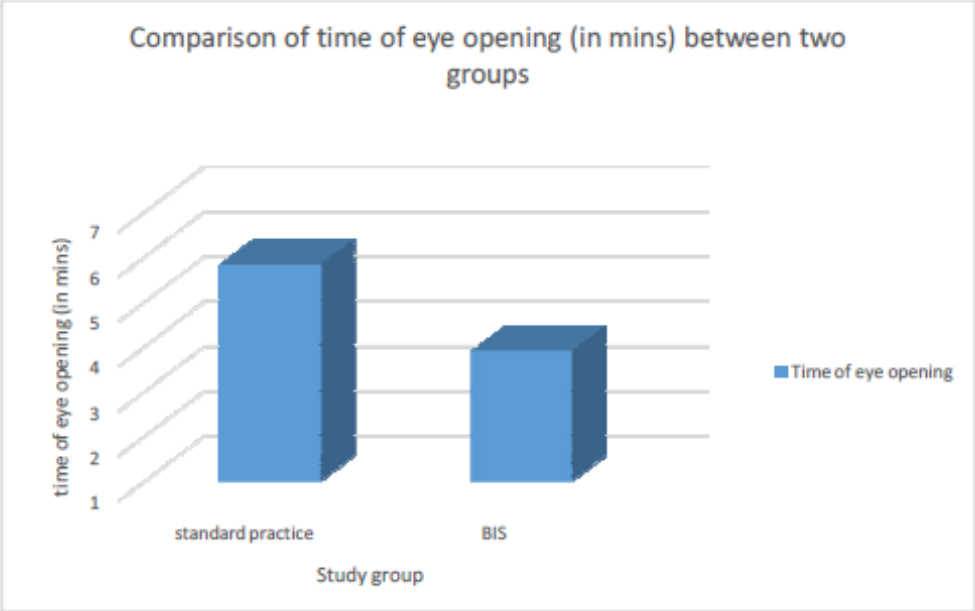

Figure 5: Comparison of time of eye-opening (in mins) between two groups

Table 4: Comparison of time to shift to PACU (in mins) expressed as mean + SD in two groups

Group	Time to shift to PACU (in mins)	Test	p value
Standard practice	11.31 ± 0.72		
BIS	7.31 ± 0.40	Unpaired t test	0.0001

Table 5: Comparison of time to extubation (in mins) expressed as mean±SD in two groups

Group	Time to extubation (in mins)	Test	p value
Standard practice	8.95±0.42		
BIS	5.76±0.50	Unpaired t test	0.0001

Table 6: Comparison of Modified Aldrete Score expressed as mean ± SD in two groups

Group	Time to shift to PACU (in mins)	Test	p value
Standard practice	6.50 ± 0.50	Unpaired t test	0.0001
BIS	8.40 ± 0.49		

Discussion

An individual patients response to sedation and hypnosis is difficult to predict based on complex interplay of factors including co-administration of multiple synergestic medications and significant individual pharmacokinectic and pharmacodynamic variability. Most anaesthesiologist were trained to administer hypnotic anaesthetics until both hemodynamic and movement responses were suppressed routinely overmedicating their patients leading to prolonged ventilation and post operative sedation of patients. On other hand, it has been reported that "deep" anaesthesia is associated with increased 1 year mortality, conceivably due to impairment of immune system [8].

Depth of anaesthesia is usually assessed by monitoring clinical parameter during anaesthesia. These clinical parameter became unreliable in terms of exact titration of anesthetic agents. The BIS index is numerically processed, clinically validated EEG parameter that measures the effect of anaesthesia and sedation on brain. According to the manufacturer of BIS, this monitoring may act as an additional vital sign that allow the clinicians to deliver anaesthesia according to the patient need, and to assess and respond appropriately to a patient clinical condition during surgery.

Our randomized observational study was conducted to evaluate the effect of bispectral index monitoring on recovery profile of patients with sevoflurane as an inhalational maintenance agent undergoing abdominal and urological procedures surgery under general anaesthesia of less than 3 hours duration.

We randomised sixty patients in two groups with 30 patients in each group.

Group 1 (Standard practice group): To maintain adequate depth of anaesthesia, anaesthetic agents were titrated based on routine clinical parameters(heart rate < 80, blood pressure < 130/80).

Group 2 (Bispectral index group): Anaesthetic agent titration was done in this group using bispectral index monitoring. To achieve adequate depth of anaesthesia BIS is kept between 45-60

Our results correlate with study conducted by Ibrahim *et al* [9] who evaluated the effect of bispectral index monitoring on desflurane consumption and recovery time in morbidly obese patients undergoing laproscopic sleeve gastrectomy. The hemodynamic parameters were comparable in both groups in their study.

Our results are similar to study of Persec *et al* [10]. who observed no statistically significant difference in hemodynamic parameters in SP and BIS group of patients undergoing abdominal surgery.

BIS value intraoperatively

The mean ± SD BIS value in our study was 47.34± 0.73.

Recovery profile

There was statistically significant difference in time to eye opening (mins) between two groups. In SP group it was 5.83±0.44 whereas in BIS group it was 3.90±0.42. The difference was statistically significant (p=0.0001).

The patient in BIS group were extubated earlier as compared to SP group. The mean time to extubation in SP group was 8.95±0.42

whereas in BIS group it was 5.76±0.50.The difference was statistically significant (p=0.0001). There was also a significant reduction in time of shifting patient to PACU in BIS group as compared to SP group. The mean time to shift to PACU was 11.31±0.72 in SP group whereas in BIS group it was 7.31±0.40.The difference was statistically significant (p=0.0001).

Our results are in concordance with the study conducted by johansen *et al* [11] who observed a 37% reduction time to extubation after emergence from anaesthesia in BIS group, while the theatre exit time was reduced by 24%. Our study results also correlate with the study of Gan *et al* [12] who observed a significant reduction in extubation time in BIS group as compared to SP group.

Our results also correlate with the study of Yli-Hankla *et al* [13] who observed a significant improvement in recovery profiles with BIS monitoring in patients undergoing gynecological surgery.

Our study results are also in concordance with the study of Anez et al [14] Paventi et al [15] Wong et al [16] Morimoto et al [17] White et al [18] Mostafa et al [19] Persec et al [10] Ibrahim et al [9]

The study conducted by Zohar *et al* [20]. contradicts our study. They observed no significant improvement in recovery profile of patients using BIS monitoring. The contraindication was in part due to elderly patients in their study and recovery process appears to be dependent on age. Also they used laryngeal mask airway with spontaneous ventilation. The electromyographic activity during spontaneous ventilation will effect BIS monitoring and thus may influence titration of anesthetic agents. In our study we used general anaesthesia with muscle relaxation.

Our study results are also in contraindication with the study of Pavlin *et al* [21] who observed no significant difference on the recovery profiles after anaesthesia in BIS group. The major difference in the study conducted by Pavlin *et al* [21] and our study is non standardization of anaesthetic technique in Pavlin's [21] study.

Our study results are also in contraindication with the study of Ahmad *et al* who observed no improvement in recovery profiles in patients undergoing laparoscopic gynecological surgery using BIS monitoring. The contradiction was in part due to patient selection. The patients in their study were carefully chosen middle aged females. In order to avoid gender bias in our study, we sought a balanced male female ratio.

Our study results in contraindication with the study of Bruhn *et al* [22] who observed no significant improvement in recovery profiles in patients undergoing minor orthopedic surgery using desflurane – remifentanil anaesthesia in BIS monitored patients. This contraindication was in part due to use of remifentanil along with desflurane.

Post anaesthesia recovery score

The Modified Aldrete score was used for monitoring and discharging the patients from PACU in our study. The time to achieve Modified Aldrete score of greater than 9 at the time of arrival in PACU was faster and statistically significant in BIS group. The mean Modified Aldrete score on arrival to PACU in SP group was 6.50±0.50 whereas in BIS group it was 8.40±0.49. The difference was statistically significant (p-value =0.0001).

Our study results are in concordance with the study of Wong *et al* [16] who observed Aldrete score >9 in patients with BIS monitoring on arrival to PACU. Our results are also similar with the study of Nelskyla *et al* [13] who observed a significant difference in post anaesthesia recovery score in BIS monitored patients. They also found a significant reduction PACU stay in these patients. Our study results are also in

concordance with the study of Mostafa *et al* [19] and Paventi *et al* [15] They observed a significant reduction in PACU stay in patients with BIS monitoring.

The study results of Ahmad *et al* [23] contradicts are study results. This contradiction was in part due to the patient selection and gender bias. They conducted their study on middle aged females undergoing laparoscopic gynecological surgery. In our study we selected a balanced male female ratio.

Our study results are also in contradiction with the study of Zohar *et al* [20] who found no difference in post anaesthesia recovery score in BIS monitored patients. This contradiction was in part due to different technique of anaesthesia used. Also they conducted their study in elderly patients.

Conclusion

1. Maintaining the depth of anesthesia is a vital component of modern anaesthesia, inadequate depth may lead to haemodynamic variations and intra-op awareness leading to post traumatic stress disorder and excess depth leads to delayed recovery and prolongs PACU stay.
2. The Bispectral index monitor is to date most effective and only US FDA approved monitor to measure the anaesthesia state of central nervous system.
3. Titration of anaesthetic agent with BIS monitoring intraoperatively can result in decreased post operative recovery time and early discharge from PACU unit.
4. BIS guided anaesthesia in our study lead to optimal use of inhalational agent thereby leading to decreased recovery time from anaesthesia and quicker discharge from PACU unit.
5. We would further like to conclude that making BIS monitoring part of standard ASA monitoring would help in maintaining proper depth and early recovery from anaesthesia.

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