Scholars Journal of Applied Medical Sciences (SJAMS)
Abbreviated Key Title: Sch. J. App. Med. Sci.
ISSN 2320-6691 (Online)
ISSN 2347-954X (Print)

A Unit of Scholars Academic and Scientific Society, India
www.saspublishers.com

Anaesthesiolog

Assessment of Depth of Anaesthesia during General Anaesthesia Using PRST (Pressure, Rate, Sweating, Tears) Score and Bispectral Index Monitoring

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Original Research Article

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Article History
Received: 13.06.2018
Accepted: 20.06.2018
Published: 30.06.2018

DOI:
10.36347/sjams.2018.v06i06.016

Abstract: Since the advent of anaesthesia in 1846, ensuring adequate depth has been a major concern of anaesthesiologists to prevent awareness without inadvertently overloading the patients with potent drugs. The aim of this prospective comparative study was to evaluate and correlate the efficacy of Bispectral index monitoring along with PRST score in assessment of depth of anaesthesia. A total of 100 patients were included in this study undergoing surgery under general anaesthesia. Patients were included randomly in group 1(Depth of anaesthesia assessed by PRST score) and group 2 (Depth of anaesthesia was assessed by PRST score along with BIS index monitoring). The distribution of mean PRST score at T1, T2, T3, T4 and T5 was significantly higher in group 1 (Depth of anaesthesia was assessed by PRST score) as compared to group 2. Intraoperative BIS values were maintained between 40 – 60 and no post-operative awareness was detected in either of the groups. When BIS values are maintained between 40 – 60, patients are more hemodynamically stable. Bispectral index monitoring allows anaesthesiologist to directly and accurately monitor the hypnotic effect of anaesthesia.

Keywords: Awareness, Bispectral index monitoring, Depth of anaesthesia, Evan's score (PRST score).

INTRODUCTION

One of the objectives of modern anaesthesia is to ensure adequate depth of anaesthesia is to prevent awareness [1]. Awareness is defined as post-operative recall of events occurring during general anaesthesia [2]. Awareness with recall after general anaesthesia is an infrequent but well described phenomenon that may result in post- traumatic stress disorder [3], therefore should be avoided at all costs.

The use of clinical signs may not be reliable in measuring the hypnotic component of anaesthesia [4]. The BIS Index offers anaesthesiologist a direct and accurate method for continuous brain status monitoring, the hypnotic effect of anaesthesia [5]. Hence we have conducted a study on assessment of depth of anaesthesia with two different monitoring techniques in our institution, the PRST score and the BIS index.

PRST SCORE

Evans and Davies in 1984 introduced a scoring system for clinical assessment of depth of anaesthesia, the PRST score (systolic blood pressure, heart rate, sweating, tears)[6,7]. This subjective method of assessing depth of anaesthesia is based on autonomic changes in response to surgical stimulus which is scored from 0-8.

BISPECTRAL INDEX

BIS has been proven to accurate and reliable in nearly all patients and clinical settings, in the presence of most commonly used anaesthetic and sedative agents [5]. BIS is dimensionless number scaled from 100-0, with 100 representing an awake EEG and zero representing complete elevtrical silence (cortical suppression)[8,9].

The primary objective of this study was to correlate the efficacy of BIS monitoring along with PRST score in assessment of the depth of anaesthesia. The secondary objective of this study was to evaluate the incidence of awareness during general anaesthesia.

MATERIALS AND METHODS

A prospective comparative clinical study was conducted in 100 ASA 1 and 2 patients between the ages of 18-60years with either gender, posted for surgeries lasting 1-3 hours duration under general anaesthesia. These patients were divided into two groups of 50 patients each using simple random sampling method by consecutive selection.

All neurosurgery patients, patients with injury or scar on forehead and ear surgery patients were excluded from the study. After approval by the institutional ethical committee, written informed consent was taken from patients after explaining the procedure in their own language. Specific precautions were taken for maintaining the operation theatre environment free of auditory stimulus.

Group 1: Depth of anaesthesia was assessed by PRST score.

Group 2: Depth of anaesthesia was assessed by BIS index monitoring and PRST score.

Before induction, all patients were premedicated with intravenous Midazolam 0.02-0.04mg/kg and intravenous Fentanyl 1-2 microgram for analgesia. For induction of anaesthesia, intravenous Propofol was used with a dose of 1.5-2.5mg/kg, for muscle relaxation appropriate dose of intravenous Vecuronium was given and plane of anaesthesia was maintained with oxygen and Nitrous oxide (40:60) and Sevoflurane.

Various timings when PRST score and BIS Index values were assessed:

T0	Baseline reading before General anaesthesia
T1	At intubation
T2	At first skin incision
T3	30min after skin incision
T4	60min after skin incision
T5	Immediately after placing the last suture in the skin

In group 1 patients, the depth of anaesthesia was assessed by PRST score at various time intervals mentioned above. The components of PRST score are systolic blood pressure, heart rate, sweating and tears. Each parameter is scored from 0-2. The depth of anaesthesia was estimated by summing up all the points obtained by the PRST score. Any total score >3 was considered inadequate anaesthetic depth.

Index	Condition	Score
Increase in Systolic blood Pressure	< 15mmHg from baseline 15-30mmHg from baseline > 30mmHg from baseline	0 1 2
Increase in Heart rate	< 15bpm from baseline 15-30 bpm > 30 bpm from baseline	0 1 2
Sweating	Nil Skin moist Visible beads of sweat	0 1 2
Tears	No excess tears Excess tears in open eyes Tears over flowing	0 1 2

In group 2 subjects, to estimate the depth of anaesthesia, a BIS index monitor was used. Before the induction, BIS sensor that records the frontal EEG waves, was secured on clean and dried forehead. The BIS index values were maintained in the range of 40-60, which is considered adequate depth of anaesthesia. BIS index values and the PRST score was also noted. While BIS index values were monitored continuously, BIS values were recorded at the same time interval as in group 1.

May respond to loud commands or mild prodding and shaking	80
Moderate sedation	60
General anaesthesia low probability of explicit recall unresponsive to verbal stimulus	40
Deep hypnotic state Burst suppression	20
Flat line EEG	0

In both the group of respondents, an interview was conducted 24 hours after surgery, according to the questionnaire (Modified Brice Questionnaire) to know about the awareness.

STAISTICAL ANALYSIS

Data analysis was performed using statistical package for social science (SPSS ver 16.0, IBM corporation: NY USA) for MS Windows. The data on categorical variables was shown as 'n' (% of cases) and data on continuous variables was presented as mean and standard deviation across two intervention groups. The inter-group comparison of categorical variables was performed using chi-square test/ Fisher's exact probability test. The statistical significance of inter-group difference of mean of continuous variables was tested using independent sample't' test or unpaired't' test. The p-values less than 0.05 were considered to be statistically significant.

RESULTS

Table-1: The age distribution of the patients studied between two study groups

Age Group (years)	Group 1 [PRST] (n=50)		Group 2 [BIS + PRST] (n=50)		P-value [Inter-Group]
	N	%	N	%	
20.0 – 39.0	30	60.0	34	68.0	0.405^{NS}
40.0 – 60.0	20	40.0	16	32.0	
Total	50	100.0	50	100.0	

Table-2: The gender distribution of the patients studied between two study groups

Gender	Group 1 [PRST] (n=50)		Group 2 [BIS + PRST] (n=50)		P-value [Inter-Group]
	No.	%	No.	%	
Male	26	52.0	19	38.0	0.159^{NS}
Female	24	48.0	31	62.0	
Total	50	100.0	50	100.0	

There was no significant difference in the demographic profile among the two groups (Table 1 and 2).

The distribution of mean absolute difference in systolic BP from baseline at T1, T2, T3, T4 and T5 is significantly higher in Group 1 compared to Group 2 (P-value<0.001 for all) (Table 3).

Table-3: The inter-group comparison of mean absolute difference in systolic BP (in mm of hg) from baseline at different time intervals studied

	Group 1 [PRST] (n=50)		Group 2 [BIS + PRST] (n=50)		P-value
Time	Mean	SD	Mean	SD	(Group 1 v Group 2)
T1	18.60	4.56	9.40	4.20	0.001^{***}
T2	12.30	3.20	4.40	2.30	0.001^{***}
T3	10.60	4.54	2.40	1.34	0.001^{***}
T4	10.80	5.46	2.70	1.24	0.001^{***}
T5	16.00	7.40	5.20	3.20	0.001^{***}

Table-4: The inter-group comparison of mean absolute difference in pulse rate (in beats per minute) from baseline at different time intervals studied

	Group 1 [PRST] (n=50)		Group 2 [BIS + PRST] (n=50)		P-value
Time	Mean	SD	Mean	SD	(Group 1 v Group 2)
T1	16.87	3.56	11.74	5.20	0.038^{*}
T2	13.52	2.60	5.79	2.54	0.029^{*}
T3	9.40	3.54	2.30	1.54	0.001^{***}
T4	8.80	4.46	2.10	1.44	0.001^{***}
T5	11.10	6.20	4.20	2.40	0.001^{***}

The distribution of mean absolute difference in pulse rate from baseline at T1, T2, T3, T4 and T5 is significantly higher in Group 1 compared to Group 2 (P-value<0.05 for all).

Table-5: The distribution of mean PRST scores in group 1 and 2

	Group 1 [PRST] (n=50)		Group 2 [BIS + PRST] (n=50)		P-value
Time	Mean	SD	Mean	SD	(Group 1 v Group 2)
T0	0.00	0.00	0.00	0.00	0.999^{NS}
T1	1.50	0.71	1.00	0.00	0.008^{**}
T2	0.80	0.65	0.40	0.00	0.006^{**}
T3	0.60	0.54	0.10	0.37	0.002^{**}
T4	0.60	0.45	0.08	0.42	0.004^{**}
T5	1.00	0.49	0.20	0.57	0.001^{***}

The distribution of mean PRST score at T1, T2, T3, T4 and T5 is significantly higher in Group 1 compared to Group 2 (P-value<0.01 for all) (Table-5).

Baseline BIS value (T0) in an awake patient was 93.06 ± 7.21. Intraoperatively (T1-T4) BIS values were between 40-60 i.e. within the range necessary for maintaining adequate depth of anaesthesia. Near the end of surgery (T5) before extubation as the plane of anaesthesia was becoming lighter, BIS value was increased to 67.90 ± 3.64 (Table-6).

Table-6: BIS scores at different time intervals in Group 2

Time	BIS Score (Group 2, n=50)	
	Mean	SD
T0	93.06	7.21
T1	41.10	1.63
T2	43.20	1.72
T3	45.60	3.78
T4	46.70	4.53
T5	67.90	3.64

DISCUSSION

Depth of anaesthesia is assessed based on clinical signs which present as a response of the autonomic nervous system. The use of pharmacological agents like opioids, cholinergic drugs, beta blockers and antihypertensives mask the autonomic response and hinders the assessment of depth of anaesthesia [10]. Although various clinical techniques have been utilized to prevent awareness [11], BIS has been proved one of the most promising techniques.

In our study at induction with Inj. Propofol 2mg/kg, mean BIS value was decreased from a basal value of (T0) 93.06(± 7.21) to 41.10 (± 1.63) (Table 6). At intubation in group 1, mean increase in systolic blood pressure and pulse rate was 18.60(± 4.56) mm of Hg and 16.87 (±3.56) bpm respectively, which was significantly higher as compared to group 2 which was 9.40(± 4.20)mm of Hg and 11.74 (±5.20) bpm respectively.

In our study, a transient increase in BIS value was observed following tracheal intubation at T1, from post induction value of 41.10 ± 1.63 to 43.40 ± 3.2 within 1 minute. The BIS value further increased to 44.10 ± 6.4 in next 2 minutes.

After incision at T2, the BIS score increased to 43.2 ± 1.72 from T1 value of 41.10 ± 1.63(Table 6). This minimal increase in BIS could be because of the good depth of anaesthesia provided by the residual effects of Propofol, analgesia by Fentanyl and also because of the titration of Sevoflurane.

In this study we found that mean PRST values in group 2 were significantly lower at all the time intervals as compared to group 1. This indicates better hemodynamic stability in patients in whom depth of anaesthesia is maintained with BIS monitoring. No postoperative awareness was seen in either of the groups.

In 2014, Y. Punjasawadwong, A. Phongchiewboon *et al.* included 36 randomized controlled trials comparing BIS with standard practise criteria for titration of anaesthetic agents. They concluded that BIS – guided anaesthesia can reduce the risk of intraoperative awareness among surgical patients at high risk of awareness in comparison to using clinical signs as a guide of anaesthetic depth[12].

In 2015 Rahul R, Sawmya M *et al*. conducted a prospective clinical study on 160 patients undergoing surgery in various specialities. They measure depth of anaesthesia using PRST score in one group and with both PRST and BIS index monitoring in other group. They concluded that BIS monitoring is better for precise decision making and balancing the dose of anaesthetics and cardio-active agents for better hemodynamic stability [13]. Thus our findings are similar to above study.

Myles and colleagues conducted a study on two groups. In one group of subjects the depth of anaesthesia was assessed by BIS index and in second group by clinical parameters. The result showed that the use of BIS index in assessing depth of anaesthesia reduced the risk of intraoperative awareness by 82% (P<0.022)[14].

P. S. Sebel A. Bowdle, *et al*. conducted the first stage prospective study examining the incidence of awareness during anaesthesia in the United States. Out of nearly 20,000 patients 25 patients (0.13%) experienced awareness [3].

R. H. Sandin, G. Enlund *et al*. in their study on 11,785 patients, observed that awareness occurred in 0.15% or 1 in 655[15].

In our study we had a standard interview questionnaire in the postoperative period to study the incidence of awareness. We found that none of the participants had conscious recall of events during surgery (from the period of induction until the waking period). In our study the incidence of awareness was nil and this may be attributed to our sample size which was relatively smaller (n=100).

CONCLUSION

Patients are hemodynamically more stable when depth of anaesthesia is monitored by maintaining BIS index values between 40-60 along with PRST score as compared to relying solely on PRST score. BIS index allows anaesthesiologists to directly and accurately monitor the hypnotic effect of anaesthesia. Along with the assessment of clinical parameters BIS monitoring guides in the decision making and facilitates titration of anaesthetic drugs.

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