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ORIGINAL ARTICLE

MONITORING DEPTH OF ANAESTHESIA USING PRST SCORE AND BISPECTRAL INDEX

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ABSTRACT: BACKGROUND: Intraoperative awareness is a frightening experience for any patient for it has long term psychological consequences. Among the various tools available for monitoring depth of anaesthesia, Bispectral index monitoring (BIS) is one of the recent and widely accepted techniques. **AIMS AND OBJECTIVES:** The present study was carried out to evaluate and correlate the efficacy of BIS monitoring along with PRST score in assessment of depth of anaesthesia. **MATERIALS AND METHODS:** A prospective clinical study was conducted on 160 patients undergoing surgery in various specialties, in the department of Anaesthesiology at Rajarajeswari Medical College and Hospital which included adult patients between the ages of 18 and 65 years and of ASA I/II posted for elective surgeries under general anaesthesia. Conditions and drugs likely to interfere with BIS values were excluded. Anaesthesia protocol was kept uniform. These patients were divided into two groups of 80 patients each by consecutive selection. In Group 1- depth of anaesthesia was assessed by PRST score, in Group 2-by BIS monitoring and PRST score. Statistical analysis was performed by descriptive statistics to calculate the mean and standard deviation, the t-test, χ^2 tests for calculating the materiality for establishing the results. **RESULTS:** We saw that the Bispectral index varied with various stages of anaesthesia, almost simultaneous changes in systolic, diastolic and mean arterial blood pressures occurred in both groups in T1 and T2. On intubation, both blood pressure and heart rate increased but BIS showed a very minimal increase, which was because of adequate depth of anaesthesia and analgesia. There was a statistically significant difference in PRST scores between the two groups. There was no incidence of awareness among our study population. **CONCLUSION:** Evaluation of intraoperative depth of anaesthesia is one of the major tasks of anaesthesiologist. In patients with higher operative risk, using clinical parameters along with BIS monitor allows us to make precise decision and balance the dose of anaesthetics and cardioactive agents.

KEYWORDS: Depth of anaesthesia, BIS monitoring, PRST score.

INTRODUCTION: Awareness is defined as post-operative recall of events occurring during General anaesthesia.[1] A spectrum of cognitive activity including awareness, unconscious memory formation and dreaming has been reported during surgery under general anaesthesia. One of the objectives of modern anaesthesia is to ensure adequate depth of anaesthesia to prevent awareness without inadvertently overloading the patients with potent drugs. Intraoperative awareness is a major medico-legal liability to the anaesthesiologists and can lead to postoperative psychosomatic dysfunction in the patient, and therefore should be avoided at all costs.[2] Despite the remarkable improvements in assessment of the cardiovascular system during anaesthesia, direct determination of the effect of the anaesthetic agents on the central nervous system has remained a challenge.[3] Hence we conducted a study on assessment of depth of anaesthesia with two different monitoring techniques in our institution, the PRST score and the BIS index.

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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).[4,5] This subjective method of assessing depth of anaesthesia is based on autonomic changes in response to surgical stimulus which is scored from 0-8. This method is simple for it does not require sophisticated equipments but it has been proven that hemodynamic responsiveness to noxious stimuli does not necessarily signify awareness, nor does the lack of it guarantee unconsciousness. In most of the cases of ASA closed claim for recall during anaesthesia, there was no concomitant autonomic sign.[6] Sudden hypertension and/or tachycardia, sweating, tearing or mydriasis may indicate lightening of anaesthesia. However, a wide range of other events like, hypotension, dehydration, hypoxia, hypo or hyperthermia, sudden massive blood loss may also lead to such hemodynamic changes.

THE BISPECTRAL INDEX: The Bispectral Index (BIS Index) offers the anaesthesiologist a direct and accurate method for continuous brain status monitoring, the hypnotic effect of anaesthesia. It has been proven to be accurate and reliable in nearly all patients and clinical settings, in the presence of most commonly used anaesthetic and sedative agents.[7] Bispectral analysis (BIS) of the EEG is a non-invasive signal processing technique that quantifies the level of synchronization in the signal along with the traditional amplitude and frequency variables, thereby providing a more complete description of complex EEG patterns. The BIS algorithm uses various derivatives from conventional EEG power spectral analysis as well as elements of Bispectral analysis. BIS scores are displayed continuously and objectively in the monitor which indicate the level of consciousness. BIS is a dimensionless number scaled from 100–0, with 100 representing an awake EEG and zero representing complete electrical silence (cortical supression).[8]

AIMS AND OBJECTIVES:

- To evaluate the incidence of awareness during general anaesthesia and any adverse effects perceived in our hospital surgical population.
- To evaluate efficacy of PRST score in the assessment of depth of anaesthesia.
- To correlate the efficacy of BIS monitoring along with PRST score in assessment of depth of anaesthesia.

MATERIALS AND METHODS: A prospective comparative clinical study was conducted on 160 patients undergoing surgery in various specialties under general anaesthesia at Rajarajeswari Medical College & Hospital Bengaluru. These patients were divided into two groups of 80 patients each using simple random sampling method by consecutive selection.

Subjects of both sexes aged 18-65 years and American Society of Anesthesiologists (ASA) grade I and II were included. All patients less than 18 years and over 65 years and patients with ASA grade III and grade lV were excluded from the study.

After approval by the institutional ethical committee, informed written consent was taken from patients after explaining the procedure in their own language.

Group 1 - Depth of anaesthesia was assessed by PRST score.
Group 2 - Depth of anesthesia was assessed by BIS index monitoring and PRST score.

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Before induction, all patients were premedicated using intravenous Midazolam-0.05 mg/ kg and intravenous Fentanyl 2 mcg/kg for analgesia. For induction of anaesthesia, intravenous Propofol was used with a dose of 1.5 to 2.5 mg/kg, for muscle relaxation appropriate dose of intravenous Vecuronium was given while the anaesthesia was maintained with oxygen with nitrous oxide (40:60) and Sevoflurane.

Various timings when PRST score and BIS Index were assessed:

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

In group 1 patients, the depth of anaesthesia was assessed by PRST score at T0, T1, T2, T3, T4, T5 intervals.

The components of PRST SCORE are Systolic Blood Pressure, Heart Rate, Sweating, Tears. Each parameter was scored from 0 to 2. The depth of anaesthesia was estimated by summing up all the points obtained by the PRST score. Any score more than 3 was considered inadequate anaesthetic depth.

PRST SCORE:

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

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

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NORMAL BISPECTRAL INDEX CORRELATION:

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

With both groups of respondents, an interview was conducted 24 hours after surgery, in order to obtain information about whether something was heard, seen or felt during the general anaesthesia according to the questionnaire (Modified Brice Questionnaire) to know about the awareness.

STATISTICAL ANALYSIS: Descriptive and inferential statistical analysis were used in our study. Results on continuous measurements were presented on Mean± SD (Min-Max) and results on categorical measurements were presented in Number (%). Student t test (two tailed, dependent) was used to find the significance of study parameters on continuous scale within each group. Chi-square/ Fisher Exact test was used to find the significance of study parameters on categorical scale between two or more groups. Significance was assessed at 5 % level of significance. ($P<0.05$) and $P<0.001$ highly significant.

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, Med Calc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel was used to generate graphs, tables etc**.**

RESULTS:

Age in years	**Group 1**		**Group 2**	
	No	**%**	**No**	**%**
<20	1	1.3	0	0.0
21-30	32	40.0	34	42.5
31-40	19	23.8	23	28.8
41-50	11	13.8	20	25.0
51-60	13	16.3	1	1.3
>60	4	5.0	2	2.5
Total	**80**	**100.0**	**80**	**100.0**
Mean ± SD	37.66±13.51		36.16±9.80	

Table 1: Age distribution of patients studied

Samples are age matched with P=0.423.

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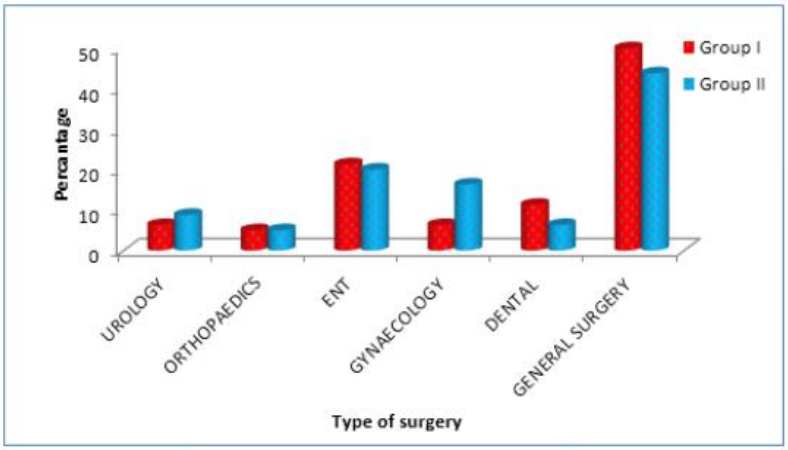
Gender	Group 1		Group 2	
	No	%	No	%
Female	31	38.8	38	47.5
Male	49	61.3	42	52.5
Total	**80**	**100.0**	**80**	**100.0**

Table 2: Gender distribution of patients studied

Samples are gender matched with P=0.264.

Type of surgery	Group 1 (n=80)		Group 2 (n=80)	
	No	%	No	%
Urology	5	6.3	7	8.8
Orthopaedics	4	5.0	4	5.0
Ent	17	21.3	16	20.0
Gynaecology	5	6.3	13	16.3
Dental	9	11.3	5	6.3
General surgery	40	50.0	35	43.8

Table 3: Type of surgery



Graph 1: Types of Surgery

	Group	N	Mean	Standard deviation
PRST Score T1	1	80	1.5875	0.566886902
PRST Score T2	1	80	0.85	0.764728793
PRST Score T3	1	80	0.59493671	0.610148938
PRST Score T4	1	80	0.6875	0.772858413
PRST Score T5	1	80	0.95	0.855362829

Table 4: PRST score in group 1 respondents

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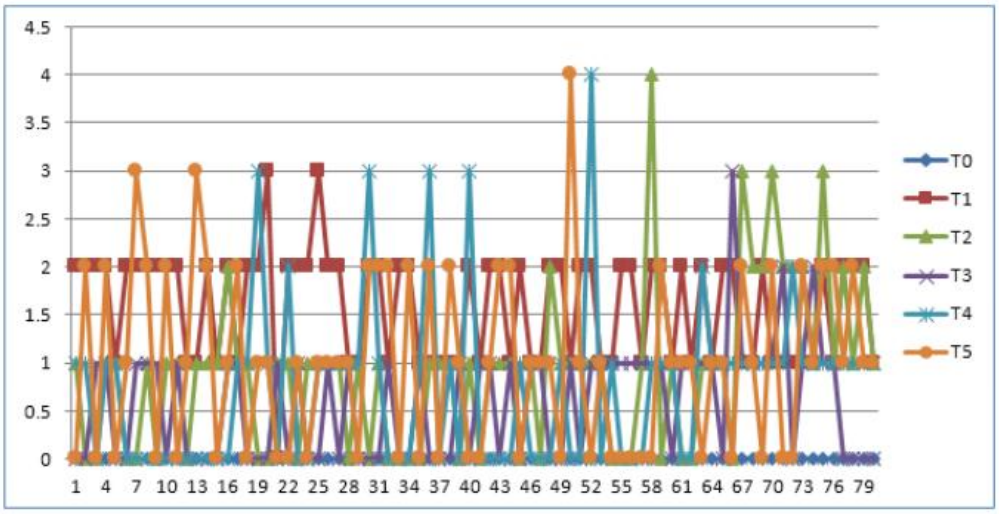
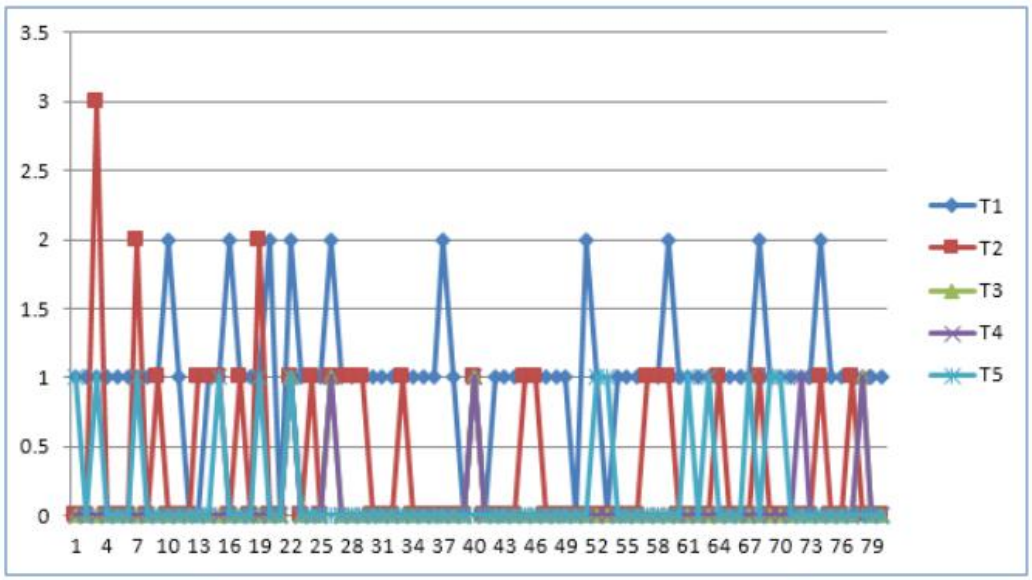


Graph 2: PRST Score in Group 1 of Respondents

	Group	N	Mean	Standard deviation
PRST Score T1	2	80	1.0375	0.4623
PRST Score T2	2	80	0.3625	0.6005
PRST Score T3	2	80	0.05	0.2193
PRST Score T4	2	80	0.0625	0.2435
PRST Score T5	2	80	0.1625	0.3712

Table 5: PRST score in the second group of respondents



Graph 3: PRST in Group 2 respondents

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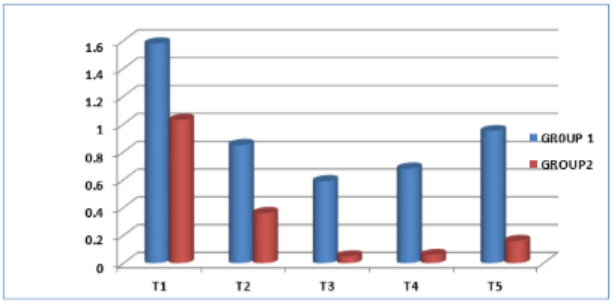
PRST score	Group 1	Group 2	P value
T0	0±0	0.0±0.0	--
T1	1.58±0.56	1.03±0.46	<0.001**
T2	0.85±0.76	0.36±0.60	<0.001**
T3	0.59±0.61	0.05±0.22	<0.001**
T4	0.68±0.77	0.06±0.24	<0.001**
T5	0.95±0.85	0.16±0.37	<0.001**

Table 6: PRST score-An evaluation between the two groups at different time points studied

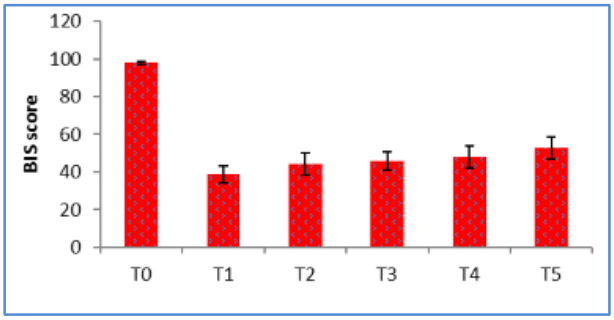
Mann Whitney U test.



Graph 4: PRST score in both groups

BIS score	Min-Max	Mean ± SD	Difference from T0	t value from T0	P value
T0	94.00-99.00	98.14±0.82	-	-	-
T1	30.00-56.00	38.63±4.29	59.513	79.000	<0.001**
T2	32.00-63.00	44.01±5.88	54.125	79.000	<0.001**
T3	38.00-59.00	45.66±4.75	52.475	79.000	<0.001**
T4	36.00-64.00	47.96±5.74	50.175	79.000	<0.001**
T5	39.00-70.00	52.91±5.75	45.225	79.000	<0.001**

Table 7: BIS score- An evaluation at different time points



Graph 5: BIS scores

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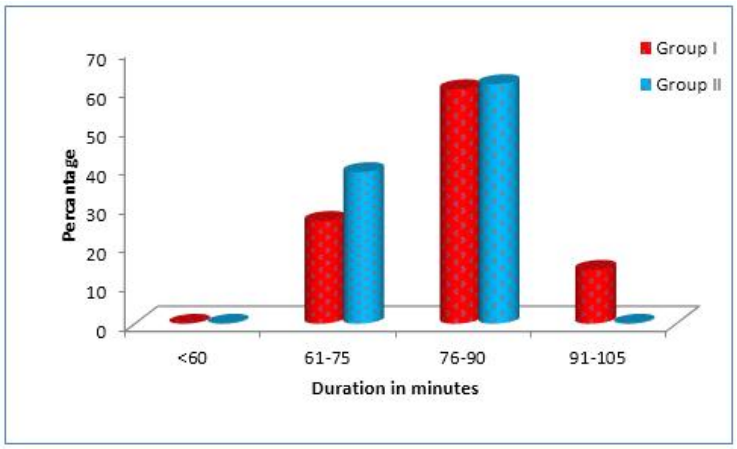
Duration in minutes	Group 1		Group 2	
	No	%	No	%
<60	0	0.0	0	0.0
61-75	21	26.3	31	38.8
76-90	48	60.0	49	61.3
91-105	11	13.8	0	0.0
Total	**80**	**100.0**	**80**	**100.0**
Mean ± SD	82.68±9.67		75.22±7.23	

Table 8: Duration of Anaesthesia - A comparison in two groups studied

P<0.001**, Significant, Student t test.



Graph 6: Duration of Anaesthesia

DISCUSSION: Depth of anaesthesia is assessed based on clinical signs which represent a response of the autonomic nervous system. The use of pharmacological agents like opioids, cholinergic drugs, beta-blockers, vasodilators and antihypertensives mask the autonomic response and hinders the assessment of depth of anaesthesia.

In our study, depth of anaesthesia in the first group of subjects was assessed only on the basis of PRST score. In the second group we used BIS monitoring along with PRST score.

At induction with Inj. Propofol 2mg/kg, mean BIS decreased from a basal value of (T0) 98.14±0.82 to 38.63±4.29. In group 1 respondents, there was a decrease of both heart rate 10±6 beats/min and systolic blood pressure 20-25mmHg from the basal values. In group 2 respondents, the BIS values decreased to 38.63±4.29 with concurrent decrease in heart rate by 8-10 beats and blood pressure by 10-12 mmHg from the basal values (Table-7). The study showed that in group 2 respondents, the induction was smooth and better titration of induction agents was possible.

In our study, a transient increase in BIS value (ΔBIS) was observed following tracheal intubation at T1, from a post induction value of 38.63±4.29 to 42.14+3 within 30 seconds (Table-7). The BIS value further increased to 46.4±10.53 in the next 2 minutes. In 65 respondents BIS during

induction was between 42-48 with minimal or no change in BIS values and in heart rate or blood pressure whereas in 15 patients whose BIS levels were between 50-52 showed increase in heart rate by 18 beats/min and blood pressure by 20 mmHg. Targeting the induction to a BIS value of 50 was shown to produce the most stable induction/intubation characteristics.

After incision,-T 2 the BIS score increased to 44.01±5.88 from T1 values (Table-7). 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.

During the maintenance phase in our study T3, T4 BIS values were maintained between 44-52 until 15 min before closure where the BIS scores increased to 72-77 in the last 15 min to facilitate recovery from anaesthesia (Table-7). This was brought about by stopping administration of Sevoflurane at skin closure. Davidson A.J. et al[9] in their study showed that immediate post extubation, the BIS values were 87.48 ± 5.27 and it increased to 93.24 ± 2.82 within 15 min, which was similar in our study.

We observed that the Bispectral index varies with various stages of anaesthesia and simultaneous changes in systolic, diastolic and mean arterial blood pressures occurred in both groups at T1 and T2. When there was a fall in blood pressure on induction, there was a decrease in BIS scores as well. On intubation, both the blood pressure and heart rate increased but BIS showed a very minimal increase likely because of the use of adequate analgesia and depth of anaesthesia. During maintenance phase, adequate depth of anesthesia was maintained, reflected by heart rate, blood pressure and BIS values (40-60). At extubation, there was again a rise in the BIS scores along with the heart rate and blood pressure. Reduced Sevoflurane dosing associated with more rapid emergence was seen in group -2 respondents. BIS monitoring provided a direct measure of the anaesthetic effect of the agent and allowed dosage titration. Gan T J et al[10] in their study observed that patients in the BIS monitored group emerged from anaesthesia faster than the standard practice group. In the BIS-monitored group, 43% of patients were fully oriented on arrival in the post anaesthesia care unit compared with 23% in the standard practice group.

In our study, depth of anaesthesia in the first group of subjects was assessed only on the basis of PRST score. The highest mean of PRST score we had at T1 was 1.58. According to the mean value at this time we had an adequate depth of anaesthesia, but analysis of individual values showed a score of 3 in 12 patients score indicating a shallower anaesthesia. Of these 12 patients, PRST score at T2 was 3 in three patients, at T3 it was 3 in one patient and at T4 was 3 in four patients. Overall 3 patients had a score of 4 at varying times which also indicated inadequate depth. After placing the last suture (T5), PRST score in 2 subjects was three. So in five periods of assessment of depth of anaesthesia by PRST score, we could conclude that in some respondents we had not achieved an adequate depth of anaesthesia. When we conducted the postoperative interview after 24 hours with the subjects, all of them gave a negative answer to questions about recall of events during surgery.

In the group 2, the PRST scores were significantly lower than PRST scores of group 1 respondents in all time variants ($P<0.001$) (Table-6). In any period of analysis we had no PRST score higher than three. In this group of subjects we titrated the anaesthetic by the BIS index value, neither did the PRST score nor did BIS score indicate inadequate anaesthesia.

In our study we had a standard interview questionnaire in the post-operative period to study the incidence of awareness. We found that none of the patients had conscious recall of the events during surgery (from a period of induction until the waking period) in both group of respondents.

There was no significant difference in that what was the last thing they remembered before the surgery (P=0.1724). Sebel PS et al[11] conducted the first large 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. Sandin RH et al[12] in their study on 11,785 patients, observed that awareness occurred in 0.15% or (1 in 655). In our study the incidence of awareness was nil maybe because the sample size was relatively smaller. (n=160)

Myles and colleagues[13] conducted a study on two groups. In one group of subjects the depth of anaesthesia was assessed by bispectral index, and in second group by clinical parameters. The results showed that the use of bispectral index in assessing depth of anaesthesia reduced the risk of intraoperative awareness by 82% ($p<0.022$).

In our study only 2% patients had the incidence of dreams, but the dreams were not unpleasant. O. Nordstorm et al[14] in 1997 reported an incidence of dreaming as 2.7% which is similar to our study.

In our study, the average duration of general anaesthesia in the first group of subjects was 70+3.5 min while in the second Group 1 was 62±2.14 min (significant $p< 0.001$) (Table-8). By this we can infer that our respondents in the group 2 had a faster recovery compared to group 1 respondants.

In a similar study conducted by Gan and colleagues[10], the rate of recovery from general anaesthesia in two groups was analysed. The results showed that the respondents in the BIS group opened their eyes, carried out the orders before they were extubated.

CONCLUSION: Bispectral index allows anaesthesiologists to directly and accurately monitor the hypnotic effect of anaesthesia. BIS monitoring alone is not a substitute for clinical assessment of depth of anaesthesia. Along with the assessment of clinical parameters, BIS monitoring guides in the decision making, facilitates titration of anaesthetics and achieve the best possible outcome for each patient.

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