

## EFFECT OF DESFLURANE ANAESTHESIA ON BISPECTRAL INDEX AND POST-OPERATIVE RECALL

JAISWAL RAJMALA, AHLAWAT MANGAL\*

Department of Anaesthesiology, Pt. B.D. Sharma PGIMS, Rohtak, Haryana, India. Email: drmangalahlawat@gmail.com

Received: 08 Oct 2013, Revised and Accepted: 29 Oct 2013

### ABSTRACT

**Objective:** The aim of this study was to evaluate the effect of MAC 1.0 desflurane with 50% nitrous oxide on Bispectral Index, post-operative recall and to find out any correlation between the above two values.

**Methods:** Hundred patients of either sex, between the age group of 30-60 years, scheduled to undergo surgery under general anaesthesia were included in the study. General anaesthesia was administered with standard anaesthesia technique. The inhaled desflurane concentration was adjusted to maintain the value of MAC stable at 1.0. BIS recording was done every 5 minutes from monitor and each patient received auditory stimulus in form of familiar musical songs via an i-pod using earphones. Different songs of 15 min each were played during entire surgery upto skin closure.

In the post-operative period, patient was interviewed as per the Modified Brice Questionnaire and data recording was done.

**Results:** Our results showed there was no case of awareness in our study patients and BIS was maintained at average  $49.1 \pm 6.20$  when desflurane was adjusted to attain MAC 1.0.

**Conclusion:** In our study of small group of patients we found no incidence of awareness, which implies that desflurane MAC 1.0 in balanced anaesthesia technique is sufficient to prevent intra-operative awareness and that value of BIS  $49.1 \pm 6.20$  is good enough to prevent post-operative recall.

**Keywords:** Desflurane, awareness, postoperative recall, Bispectral index, anaesthesia.

### INTRODUCTION

Historically, awareness under general anaesthesia has been a concern of the anaesthesia provider. Since the first published administration of surgical anaesthesia at Massachusetts general hospital in 1846 by T.G. Morton, attempts have been made to limit recall of events taking place during the operative period. The American Society of Anesthesiologists (ASA) in year 2000 define awareness as "the un-intended postoperative explicit recall of sensory perceptions during general anaesthesia". Recall may occur immediately postoperatively or may be delayed. It does not include the phenomenon of intra-operative dreaming which is more commonly reported than awareness and is not an early interpretation of delayed awareness. The definition also does not include intra-operative consciousness/ responsiveness without recall. [1-3]

Anesthetic technique is important in the occurrence of awareness during anaesthesia. Several case reports and small clinical studies have suggested that intraoperative awareness is more likely to occur during anaesthetics based on nitrous oxide and intravenous agents, and is less likely to occur when potent volatile anaesthetics are used. Isoflurane in concentrations of  $\geq 0.6$  MAC prevented conscious recall and unconscious learning in anesthetized patients. [3-5]

The ability to objectively determine whether the patient is unconscious or not, and preferably also to define optimal anaesthetic drug effect on the brain has for a long time been desired. General anaesthetics cause changes in the brain electrical activity seen in the registration of brain waves, the electroencephalogram (EEG). Devices utilizing anaesthesia induced changes in the EEG for quantification of anaesthetic depth have become commercially available and have been used for more than ten years.

Monitors measuring depth of anaesthesia using processed electroencephalogram (EEG) have been utilized during the last decade. The most commonly used is called Bispectral Index Scale™ (BIS, Aspect Medical Inc., Norwood, MA, USA), and it uses a scale of hypnotic depth from 1-100. The recommended BIS ranges are 65-85 for sedation, 40-65 for general anaesthesia. Values below 40 reflect burst suppression, a pattern associated with deep anaesthesia. [7,8]

Desflurane has been recently introduced in our country. We proposed to study the effect of desflurane anaesthesia on BIS (monitored intraoperatively) and to find out postoperatively any recall of intra-operative events by questionnaire method, and to correlate the two observations.

### METHOD

After obtaining approval from scientific committee of Pt.BDS PGIMS Rohtak, written informed consent was obtained from patients scheduled to undergo surgery under general anaesthesia. A total of hundred patients of either sex, between the age group of 30-60 years belonging to physical status class I or II according American Society of Anaesthesiologists (ASA), having body mass index (BMI)  $< 30$  were enrolled in the study. Patients with history of neurological disorders, hearing abnormalities, drug abuse or body weight  $< 30$ kg or  $> 90$ kg were excluded from the study.

Data was then collected and following observations were recorded- Pre-induction BIS value, desflurane concentration, time required to achieve MAC 1, Then BIS values at 5 minutes interval, BIS at extubation, duration of surgery. In the post operative period patients were interviewed as per the modified Brice Questionnaire and data recording was done when the patient was conscious and appeared to be rational. Three interviews were conducted in the first few minutes after extubation, 6 hours after surgery, and one week post-operatively by the candidate.

Induction of anaesthesia was achieved with standard intravenous technique comprising of injection glycopyrrolate 0.2mg, fentanyl ( $3 \mu\text{g kg}^{-1}$ ), thiopentone ( $4-6 \text{ mg kg}^{-1}$ ), and vecuronium bromide ( $0.1 \text{ mgkg}^{-1}$ ) was given to facilitate endotracheal intubation. Following ventilation with 6% desflurane in 100%  $\text{O}_2$  via face mask, oro-endotracheal intubation was done. Anaesthesia was maintained with mixture of nitrous oxide (50%) in oxygen (50%) via closed circuit system and infusion of vecuronium at a rate of  $1-2 \mu\text{g kg}^{-1} \text{ min}^{-1}$ . The inhaled desflurane concentration was adjusted to maintain the value of MAC stable at 1.0. Measurement of BIS was started after attaining stable MAC 1.0. BIS recording was done every 5 minutes from monitor and each patient received auditory stimulus in form of familiar musical songs via an i-pod using earphones. Different songs

of 15 min each will be played during entire surgery upto skin closure.

In the post-operative period, patient will be interviewed as per the Modified Brice Questionnaire and data recording will be done when the patient is conscious and appeared to be rational. The first interview was conducted within first few minutes after extubation, second interview was conducted 6 hours after surgery, third interview after one week post-operatively by the candidate. All the data were compiled and statistically analysed using arithmetic mean.

#### Questionnaire for post-operative recall:

1. What was the last thing you remember before you went to sleep?
2. What was the first thing you remember after your operation?
3. Can you remember anything in between?
4. Did you dream during your operation?
5. What was the worst thing about your operation?
6. Did you hear any musical songs during surgery?

Based on the data obtained from these interviews, any reports suggestive of awareness will be reported and classified as:

1. No awareness
2. Possible awareness: when patient is unable to recall any event definitively indicative of awareness.
3. Definite awareness: when events are confirmed or have a high likelihood of occurring in the intraoperative period.

Any patients with possible or definite awareness are followed up by the anesthesiologist and will be provided expert psychiatric care.

#### Statistical analysis

1. For every 15 minutes, the BIS range will be calculated for each patient.
2. Awareness will be determined for each 15 min interval period.
3. We will correlate BIS value with type of awareness for each time interval.
4. Percentage of patient with definite awareness = (No of patients with definite awareness /100) x 100, will be calculated.

#### RESULTS

Demographic profile

Table I: Demographic profile of the patients

	N	Minimum	Maximum	Mean	Std. Deviation
Age	100	30	60	40.27	8.938
Weight	100	40	86	64.64	8.762
Height	100	1.5	1.9	1.671	.0804
BMI	100	20.0	28.2	23.079	1.4692

Mean =  $\sum$  sum of N values / N, B.M.I = weight in kilo gram / (height in meters)<sup>2</sup>

\* The mean age (in years) was 40.27 ± 8.93, mean weight was 64.64 ± 8.72 kilograms, mean height in meters was 1.67 ± 0.08 and mean BMI in kilograms meters<sup>-2</sup> was 23.079 ± 1.46. Average duration of surgery in our study was 80 minutes.

Table II: Pulse rate and Respiratory rate

	N	Minimum	Maximum	Mean	Std. Deviation
PR	100	65	100	78.75	6.150
RR	100	10	15	12.18	.999

PR – pulse rate

RR –respiratory rate

\*Pulse rate (beats per minute) and respiratory rate (breaths per minute) recorded during pre anaesthetic check up is shown in table II

\*\* The mean pulse rate is 78.75 ± 6.15 and mean respiratory rate is 12.18 ± 6.15.

The study includes 64 females and 34 males with mean age in years of 39.92 and 41.31 respectively.

#### Postoperative recall ( an indicator of intraoperative awareness)

##### Q. 1 What is the last thing you remember before going to sleep?

Burning or stinging in the I.V. line is the most frequently remembered thing before going to sleep (n=42, 31.58%), followed by feeling mask on face (n=26, 19.5%), seeing the operating room ( n=15, 11.28 %).

##### Q. 2 What is the first thing you remember after waking up?

The most frequently recalled first response after waking up is Seeing the operating room (n=27, 26.21%), followed by Feeling pain (n=20, 19.42% ), Being in the recovery room(n=19, 18.45%), Feeling mask on face(n=11, 10.68%).

##### Q. 3 Do you remember anything between going to sleep and waking up?

None of the 100 patients recalled anything between going to sleep and waking up.

##### Q. 4 Did you dream during your procedure?

Four patients (4/100) reported dream in recovery room and after 6 hours and 7 patients (7/100) after one week. Out of these, 3 female patients reported dreams in recovery room and after 6 hours and 4 patients after one week. One male patient reported dreams in recovery room and after 6 hours and 3 patients after one week. Remaining patients had no dreams.

##### Q. 5 Were your dreams disturbing to you?

No, the dreams were not disturbing to anyone of the hundred patients.

##### Q. 6 Did you hear any musical songs during surgery?

None of the hundred patients heard any musical songs during intraoperative period.

Q. 7 Extracts from the musical songs played during intraoperative period plus some extra songs will be played and the patient will be asked whether he/she associates either of them with the operation.

None of the hundred patients associate musical songs during intra-operative period.

**Bispectral index values during intropereative period****Table III: showing bispectral index values at interval of 5 minutes during intraoperative period**

	N	Minimum	Maximum	Mean	Std. Deviation
Pre induc	100	97	100	98.39	1.109
Des Conc	100	6	6	6.00	.000
MAC 1(min)	100	8	11	9.38	1.080
BIS 5	100	45	72	62.06	4.422
BIS 10	100	41	69	55.04	5.499
BIS 15	100	40	69	51.71	5.897
BIS 20	100	38	65	51.00	5.937
BIS 25	100	38	63	48.96	5.917
BIS 30	100	36	62	48.36	5.686
BIS 35	97	38	62	47.77	5.835
BIS 40	97	36	59	45.68	5.121
BIS 45	95	36	64	48.81	6.845
BIS 50	89	38	64	46.74	5.563
BIS 55	86	37	78	49.53	7.429
BIS 60	82	38	68	49.05	7.457
BIS 65	74	35	62	45.19	6.339
BIS 70	71	38	64	45.39	5.628
BIS 75	69	33	67	47.78	6.651
BIS 80	60	44	66	56.73	5.336
BIS 85	58	34	62	46.83	6.564
BIS 90	54	38	67	50.07	8.454
BIS 95	32	38	59	47.34	6.073
BIS 100	28	40	60	47.11	4.848
BIS 105	27	40	62	49.78	7.459
BIS 110	16	39	76	46.69	9.652
BIS 115	13	40	59	47.54	6.450
BIS 120	13	39	67	52.46	8.819
Total dura ( min)	100	30	120	82.90	24.774
BIS at extubation	100	71	80	76.29	2.350
REMARKS	0				

1. The baseline BIS values recorded in our group of the patients ranged between 96- 100.
2. After intra-venous induction and maintenance of anaesthesia with desflurane (6%), MAC 1.0 were achieved in a duration of  $9.38 \pm 1.08$  minutes.
3. The BIS values decreased after induction of anaesthesia and were maintained between 40-60 at MAC1.0
4. After the close observation of BIS value, highest BIS reading of  $62 \pm 4.42$ , was recorded after 5 minutes of achieving MAC 1.0.
5. The averaged BIS reading throughout the procedure was  $49.1 \pm 6.20$ .
6. The lowest BIS value was traced after 40 minutes of surgery i.e  $44.9 \pm 4.84$ .
7. The BIS value at extubation was  $76.29 \pm 2.35$ .

**DISCUSSION**

Awareness with recall during general anaesthesia is a known anaesthesia related problem. For patients, the possibility of being awake during operation is a primary cause of worry and that they score this event as a cause of dissatisfaction.

Awareness results from an imbalance between anaesthetic need and delivery. During any surgical procedure, the intensity of surgical stimulation, and thus anaesthetic need, varies greatly. Some patients might have unpredictably high anaesthetic requirement and others might have a low anaesthetic requirement. On other hand, anaesthetic may be constraint by haemodynamic side-effects of the anaesthetic drugs. Alternatively, insufficient anaesthesia can be delivered as a result of technical errors or equipment failure. [9]

During inhalation anaesthesia before introduction of muscle relaxant (paralyzing agents), the monitoring of depth of anaesthesia was an automatic and continuous process. If the patient became too light he moved, if too deep then respiration became impaired. The anaesthesiologist exercised his craft in maintaining the optimum equilibrium between these two boundaries. The detection of the two

boundaries depended on observation of muscular activities. If this was blocked then new ways of defining the safe boundaries of anaesthetic state were needed. It became necessary to know the concentration of agent required to ensure anaesthesia, i.e., depth of anaesthesia monitoring with the help of MAC concept or some equivalent measure of anaesthetic potency. The concentration of inhalational agent directly effects brain activity (fed concentration leads to decreased brain activity) which may be measured by electro encephalography derived cerebral monitors and more commonly in use is BIS monitor. [10]

We conducted a study to record the BIS value and post-op recall in patients undergoing elective surgical procedure belonging to ASA group I & II in the age group 30 – 60 years of either sex.

**Demographic profile**

Our study included 100 patients in the age group of 30 to 60 years, ASA class I and II. The study covers 64 females and 36 males with mean age in years of 39.92 and 41.31 respectively and overall mean age is  $40.27 \pm 8.93$ . Mean weight in kilograms is  $64.64 \pm 8.762$ , mean height in meters is  $1.671 \pm 0.0804$  and mean BMI (kilograms meter-square<sup>-1</sup>) is  $23.079 \pm 1.4692$ . The mean duration of anaesthesia in our patients was 1 hr & 22 minutes.

A similar study was conducted by Myles et al in the B-aware randomized control trial on 2463 patients: out of 1225 patients in BIS group 752 were males and 473 were females. In the BIS group mean age and mean weight, was  $58.1 \pm 16.5$  years,  $72.7 \pm 17.6$  kilograms respectively. The duration of anaesthesia in hours in BIS group was 3.2 hr. The mean age in the study of Myle et al is higher as compared to our study. This variation can be due to larger number of patients included in their study. Mean weight is less in our study which can be possibly due to nature of Indian population. [11]

**Bispectral Index (BIS)**

The baseline BIS values recorded in our patients ranged between 96- 100. After intra-venous induction and maintenance of anaesthesia with desflurane (6%), MAC 1.0 was achieved in a

duration of  $9.38 \pm 1.08$  minutes. The BIS values decreased after induction of anaesthesia and were maintained between 45.19-62.06 at MAC 1.0. After the close observation of BIS value, highest BIS reading of  $62 \pm 4.42$ , was recorded after 5 minutes of achieving MAC 1.0. This could be due to intubation response, inadequate depth of anaesthesia at beginning of anaesthesia and response to surgical incision. The averaged BIS reading throughout the procedure was  $49.1 \pm 6.20$ . The lowest BIS value of  $44.9 \pm 4.84$  was traced after 40 minutes of anaesthesia. This could be due to the fact that as the duration of anaesthesia progresses, the depth of anaesthesia becomes more intense. The BIS value at extubation was  $76.29 \pm 2.35$ .

In the similar study conducted by Myles et al averaged BIS value recorded through out the procedure was  $44.5 \pm 6.8$ . This value was slightly lower as compared to what was achieved in our study. However there is no standardization of the anaesthetic agents in study of Myles et al which was in contrast to our study in which we used varied concentration of desflurane to achieve MAC 1.0. [9]

Results of the study conducted by Yoo et al is in concordance to our study. In their study, women with prior labor pain (atleast 4 hours) undergoing cesarean delivery, as compared to those women without prior labor, were associated with intraoperative BIS values ( BIS <60) during sevoflurane / N<sub>2</sub>O general anaesthesia. In their group of patients the BIS values decreased after anaesthetic induction and then increased to  $47 \pm 14$  after tracheal intubation and further to the maximum value of  $55 \pm 12$  at skin incision. [12]

#### Post operative recall

In our study we conducted postoperative interviews to detect cases of awareness. The interviews were conducted on three occasions, i.e immediate postoperative period, after 6hr, and one week after surgery. There was no incidence of postoperative recall in any patient in either of the three interviews. Absence of postoperative recall in our group of patients can be attributed to the fact that the sub group of patients who are known to have high incidence of awareness (for example, cardio-pulmonary bypass surgeries, cesarean section, ejection fraction less than 30 %, anticipated difficult airway), were not included in our study. Use of inhalational agents also supports the decreased incidence of awareness in patients in our study in which MAC 1.0 was maintained, as in Myles study in which end-tidal volatile concentration was 0.57 in BIS group and MAC was 0.43-0.72. High risk surgery is also one of the compounding factors for awareness, which was absent in our study, as general anaesthesia was administered to ASA I & II patients scheduled for elective surgery. However in contrast study by Myles et al included major surgeries in 905 (74%) patients.

In Avidans et al B-unaware clinical trial, involving 2000 high risk patients divided into two groups did not reproduced results of lower incidence of awareness with BIS monitoring. There were 2 cases of awareness in both BIS and end tidal anaesthetic gas-guided anaesthesia group (ETAG). The BIS value was greater than 60 in one case of definite anaesthesia awareness, and the ETAG concentration were less than 0.7 MAC in three cases. [13]

#### Dream

Four patients (4%) reported dream in postoperative interview in recovery room and 6 hours after surgery, seven patients (7%) reported dream after one week. Remaining patients had no dreams. The dreams were of short duration and were pleasant. The patients could not tell about exact time of dreams. The incidence in our study was different from Myles study possibly due to large study population.

In Myles study dreaming was not uncommon, and similar rates have been reported previously. There were 62 reports (5.2%) of intraoperative dreaming in the BIS group. There were 20 reports of possible awareness that were not confirmed by the study endpoint committee in BIS group, most of which involved vivid dreaming about subject matter unrelated to surgery. The endpoint committee judged that some events could have occurred during the time spent in the intensive care unit. It is unclear whether this represents a light level of anaesthesia analogous to near-awareness. [9]

In Leslie study dreaming was reported by 22% of patients on emergence. There was no difference between dreamers and non-dreamers in median Bispectral index values during maintenance 37 (23-55) vs 38 (20-59). Most dreams were similar to dreams of sleep and were pleasant, and the content was unrelated to surgery. They concluded dreaming during anaesthesia is unrelated to the depth of anaesthesia in almost all cases. Similarities with dreams of sleep suggest that anaesthetic dreaming occurs during recovery, when patients are sedated or in a physiologic sleep state. [14]

#### Pre-recorded tapes

In our study each patient received auditory stimulus in form of familiar musical songs, via an i-pod using earphones. Different songs of 15 min each were played during entire surgery and were stopped at skin closure. None of the hundred patients could recall any musical songs in post-operative interviews. According to our protocol we could delineate exact timing (particular song played during specific time interval) of recall if any patient recalled the songs.

#### CONCLUSION

1. Desflurane when used to maintain MAC 1.0 almost abolishes the post-operative recall, which can be correlated with level of brain activity and is sufficient for maintaining a average BIS value of  $49.1 \pm 6.20$ .

2. The MAC 1.0 is enough to prevent recall of anaesthetic and surgical events.

#### REFERENCES

1. Bigelow HJ. Insensibility during surgical operations produced by inhalation. *Boston Med Surg J* 1846; 35: 309-17.
2. Brown EN, Lydic R, Schiff ND. General anaesthesia, sleep, and coma. *N Engl J Med* 2010; 363: 2638-50.
3. Ghoneim MM, Veiskopf RB. Awareness during anaesthesia. *Anesthesiology* 2000;92(2): 597-03.
4. Moerman N, Bonke B, Oosting J. Awareness and recall during general anaesthesia. Facts and feelings. *Anesthesiology* 1993; 79: 454-64.
5. Domino KB, Posner KL, Caplan RA, Cheney FW. Awareness during anaesthesia: a closed claims analysis. *Anesthesiology* 1999; 90: 1053-61.
6. Gonsowski CT, Chortkoff BS, Eger EI 2nd, Bennett HL, Weiskopf RB. Subanaesthetic concentrations of desflurane and isoflurane suppress explicit and implicit learning. *Anesth Analg* 1995; 80: 568-72.
7. Johansen JW, Sebel PS. Development and clinical application of encephalographic bispectrum monitoring. *Anesthesiology* 2000; 93: 1336-44.
8. Leslie K, Sessler DI, Schroeder M, Walters K. Propofol blood concentration and bispectral index predict suppression of learning during propofol /epidural anaesthesia in volunteers. *Anesth Analg* 1995; 81: 1296-74.
9. Myles PS, Leslie K, McNeil J, Forbes A, Chan MTV. Bispectral index monitoring to prevent awareness during anaesthesia: the B-aware randomised controlled trial. *Lancet* 2004; 363: 1757-63.
10. Myles PS, Leslie K, McNeil J, Forbes A, Chan MTV. Bispectral index monitoring to prevent awareness during anaesthesia: the B-aware randomised controlled trial. *Lancet* 2004; 363: 1757-63.
11. Johansen JW. Update on Bispectral Index monitoring. *Best Practice & Research Clinical Anesthesiology* 2006; 20( 1): 81-99.
12. Yoo KY, Jeong CW, Kang MW, Kim SJ, Chung ST, Shin MH et al. Bispectral index values during sevoflurane-nitrous oxide general anaesthesia in women undergoing cesarean delivery: a comparison between women with and without prior labor. *Anesth Analg* 2008; 106: 1827-32.
13. Avidan MS et al. Anaesthesia awareness and the bispectral index. *N Engl J Med* 2008; 358: 1097-1108.
14. Leslie k, Skrzypek H, Paech M J, Kurowski I, Whybrow T. Dreaming during anaesthesia and anaesthetic depth in elective surgery patients. *Anesthesiology* 2007; 106: 33-42.