



## Bi Spectral Index Targeted General Anaesthesia Technique to Reduce Awareness in Patients Undergoing Caesarian Section

**Dr Josemine Davis**

Associate Prof, Dept of Anaesthesiology and Critical Care, Command Hospital, Pune -411040

**Dr Amit Rai**

Associate Prof, Dept of Anaesthesiology and Critical Care, Command Hospital, Pune -411040

### ABSTRACT

*The incidence of awareness under anaesthesia for caesarian section is reported to be more than that for other patients undergoing general anaesthesia. The aim of our study was to evaluate whether maintaining a BIS value < 70 during general anaesthesia with inhalational agents in lower segment caesarian section will provide adequate anaesthesia to prevent explicit recall. The study design allowed us to alter the anaesthetic technique to achieve pre-determined BIS values- that is BIS value of 70 till delivery of baby and BIS of 60 thereafter – so as to minimise the probability of recall without adverse effects on mother and neonate. 100 patients in ASA I or II were included in the study. Induction of anaesthesia was carried out using a standard protocol and anaesthetic depth was titrated with isoflurane in 50% N2O to a BIS value of 70 till delivery of baby. After delivery opioids were given, N2O increased to 66% and isoflurane titrated to a target BIS value of 60. Explicit awareness was assessed using a structured post-operative interview. Uterine tone and bleeding was documented and neonatal apgar score noted at 1 minute and 5 minutes.*

*No patient had awareness or dreaming during surgery, as seen from the results of post-operative structured interview. The uterus remained responsive to oxytocin even in the presence of volatile agents and there was no incidence of severe uterine bleeding. There were no adverse effects on new born babies as seen from acceptable Apgar scores in all neonates. We concluded that Bispectral index is useful in monitoring the brain state during general anaesthesia for caesarian section and helps to titrate drug delivery and to time intra operative manipulations so as to minimise the risk of intra operative awareness.*

**KEYWORDS :** Bi Spectral index, awareness under anaesthesia, caesarian section, targeted anaesthesia

### Introduction

General anaesthesia for Caesarian Section is always challenging for the young anaesthesiologist. The conflicting goals of anaesthesia – ie keeping the mother deep enough to ensure adequate analgesia and hypnosis and at the same time preventing the depressant effects of anaesthetic drugs on the foetus- coupled with the often emergent nature of the situation calls for presence of mind and vigilance. Thiopentone- nitrous oxide-muscle relaxant technique of anaesthesia for caesarian section has been practiced for decades now (1), but has been found to be associated with an incidence of awareness as high as 4%(2). Some studies reported that volatile anaesthetic agent use reduced the incidence of awareness to 1.3-0.4% (3) where as more recent studies continue to report high incidences of awareness from 7 to 28% (4, 5).

Bi Spectral Index (BIS) is an EEG based monitor which quantifies depth of anaesthesia as a number from 0 to 100 and has been validated as a tool for monitoring depth of anaesthesia. An attempt was made by investigators to quantify the depth of anaesthesia during caesarian sections using the prevailing standard technique of anaesthesia (4,6). A median Bi Spectral Index value of 70 was obtained in most cases without any incidence of awareness.

The aim of our study was to evaluate whether maintaining a BIS value < 70 during general anaesthesia with inhalational agents in lower segment caesarian section will provide adequate anaesthesia to prevent explicit recall. The study design allowed us to alter the anaesthetic technique to achieve pre-determined BIS values- that is BIS value of 70 till delivery of baby and BIS of 60 thereafter – so as to minimise the probability of recall without adverse effects on mother and neonate.

### METHODOLOGY

100 patients in ASA I or II undergoing lower segment caesarian section who opted for general anaesthesia were selected for this study, after clearance from hospital ethical committee. Patients with severe pre eclampsia, previous history of awareness under

anaesthesia, ASA status III and above were excluded from the study.

All patients were pre medicated with Inj Metoclopramide 10 mg IV and Inj Ranitidine 50 mg IV, 30 minutes prior to induction. In addition to routine monitoring (Heart rate, non-invasive blood pressure, ECG, Pulse Oximetry), the EEG signal was acquired using four electrodes using BIS electrode (Aspect Medical Systems, Natick, MA, USA) after skin preparation. The BIS value was displayed using a BIS monitor (model A-2000, Aspect Medical systems, Natick, MA, USA)

After obtaining baseline values for BIS and hemodynamic variables, anaesthesia was induced with Inj Thiopentone 4-5mg/kg iv. Rapid sequence intubation was carried out after Inj Succinylcholine 1.5 mg/kg iv. Anaesthesia was maintained using Oxygen- 50%, Nitrous oxide-50%, Isoflurane <1% titrated to maintain a BIS Index value of 70. Immediately after delivery of baby, concentrations were changed to 66% N2O in O2 and volatiles adjusted to maintain a BIS value of 60. Muscle relaxation was achieved by Inj Vecuronium -100 mcg/kg IV initially and 25mcg/kg IV as and when required. All patients were mechanically ventilated to maintain an end – tidal carbon dioxide concentration of 32 to 36 mmHg. Immediately after delivery of baby Inj Morphine 0.1 mg/kg and Inj Methyl Ergometrine 0.2 mg iv was administered. Uterine tone and bleeding was assessed by the gynaecologist and was recorded. Inj Oxytocin 10 IU was given as slow bolus if asked for by gynaecologist.

Apgar scoring of the newborns was done in the operation theatre by the pediatrician, at one minute and five minutes. BIS values were recorded continuously; MAP and HR values at 1 minute intervals during the induction of anaesthesia and at 3-minute intervals during maintenance. The volatile agent usage was monitored using end tidal anaesthetic gas monitoring and changes made to volatile agent concentrations to maintain pre-determined BIS values as described earlier. Volatiles were turned off at last skin suture and reversal of myoneural blockade achieved using Inj Glycopyrrolate 0.1 mg/kg iv and Inj Neostigmine 50 mcg/kg iv.

A structured interview for assessing awareness was carried out in the PACU one hour after surgery and in the ward 24 hours after surgery (7).

Questions in the protocol

- a) What was the last thing you remember before you went to sleep for your operation?
- b) What was the first thing you remember after your operation?
- c) Can you remember anything in between these two periods?
- d) Did you dream during operation?
- e) What was the worst thing about your operation?

**Results**

Hundred patients were included in the study. The mean age of patients was 24.7 (+/- 4.2) and the mean weight of the patients was 64.3 (+/- 5.2). Table 1 shows the changes in haemodynamic variables (mean) at various time points from beginning to end of case for the study population.

**TABLE 1: Changes in haemodynamic variables**

TIME	Heart Rate	Systolic BP	Diastolic BP
BASAL	82.32	117.32	85.16
INDUCTION	95.12	121.28	88.20
INTUBATION	104.15	138.40	94.62
5 MIN	99.3	123.62	90.56
10 MIN	92.36	122.48	87.76
20 MIN	88.40	123.42	83.36
30 MIN	90.78	120.88	82.60
40 MIN	88.80	120.75	84.20
END OF PROCEDURE	95.84	122.12	85.56

A structured post-operative interview was carried out one hour after extubation in the PACU and after 24 hours in the ward. None of the patients exhibited any evidence suggestive of explicit recall of intra operative events. The results are as given below.

- a) What was the last thing you remember before you went to sleep for your operation- 67 patients remembered a mask being held over their face and 33 patients remembered a drug being injected to their IV lines
- b) What was the first thing you remember after your operation-56 patients remembered being asked to open their eyes and 46 patients remembered being lifted from the operation table.
- c) Can you remember anything in between these two periods- None of the patients remembered anything in between.
- d) Did you dream during operation- None of the patients dreamt during the operation.
- e) What was the worst thing about your operation-81 patients expressed fear of not getting up from sleep after anaesthesia. 19 patients did not feel anything unpleasant regarding the experience.

Apgar scoring of the newborns were done in the operation theatre by the pediatrician, at one minute and five minutes. Median Apgar scores were 8 (range 7-9) and 9 (range 8-10) respectively at one minute and five minutes. Uterine atony if any due to the effects of volatiles was assessed by determining the total blood loss during surgery, jointly by the anaesthesiologist and the gynaecologist. The data is shown in Table 2 and Table 3. There was no case of severe uterine bleeding due to uterine atony resulting from use of volatile anaesthetic agents.

**TABLE 2: Severity of Uterine Bleeding and Atony**

UTERINE BLEEDING	
MILD (500-750ml)	41
MODERATE (750-1000)	59
SEVERE (>1000)	0

**TABLE 3: Drugs used to control Uterine Bleeding**

DRUGS USED TO CONTROL BLEEDING	
METHYL ERGOMETRINE	62
METHYL ERGOMETRINE + OXYTOCIN	38

**Discussion**

Administration of general anaesthesia for caesarian section has always been a tight ropewalk. Too much of volatiles and a prolonged induction-delivery interval would cause foetal depression, uterine atony and excessive intra operative bleeding. On the other hand using too little volatiles would lead to awareness. Maintaining general anaesthesia for caesarian section with only Nitrous oxide and Oxygen produces an unacceptable incidence of patient awareness and recall(3). The addition of a volatile anaesthetic agent led to decrease in incidence of awareness; but reported incidence remains higher than that for other surgeries.

Our study examined the possibility of using BIS monitor to titrate volatile use to pre-determined end points – i.e BIS value of 70 till delivery of baby and BIS value of 60 thereafter, till the end of surgery and measured awareness during anaesthesia as the primary outcome. Isoflurane was used as the volatile anaesthetic agent for the study and intraoperative haemorrhage and uterine atony were measured as secondary outcomes.

Out of the total 100 patients who underwent the study, none had any recall of any intra operative events. The last thing, which patients remembered before going to sleep, was either a drug being injected to the IV line or a mask being held to their face. The first thing which patients remembered after surgery was either being asked to open their eyes or being lifted up from operation table. None of the patients recollected dreaming during the surgery.

There are very few studies in literature evaluating use of BIS in general anaesthesia for caesarian section. Yeo et al (6) studied the adequacy of the prevailing technique of general anaesthesia to prevent awareness, using BIS monitoring. They measured BIS values in patients undergoing caesarian section using a standard anaesthetic technique. A median BIS value of 70 was obtained and none of the patients experienced awareness. In contrast to the study by Yeo et al, our study was aimed at measuring incidence of awareness using a technique of BIS targeted anaesthesia- ie target BIS of 70 till delivery of baby and 60 thereafter. The BIS value of 70 till delivery was chosen based on data from previous studies. Yeo et al demonstrated that median BIS value was 70 when a standard technique was used for general anaesthesia for caesarian section. Current literature on BIS also shows that there is a very low probability of recall at BIS values of 70 or less (8,9).

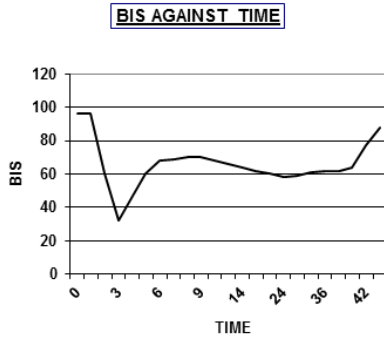
The absence of awareness in this study can at best be accepted as an observational analysis since the sample size was small (only 100). Sample size calculation for this study showed that the sample size required would be too large (approx 1500 each in control and study groups) to conclusively prove that BIS monitoring can reduce the incidence of awareness. However an analysis of the causes of increased awareness during GA for caesarian section was carried out which is outlined in the following paragraphs.

A review of literature revealed (5) two “time slots” where the probability of causing awareness was high.

- a) At the time of incision— when patients were presumably in a light plane of anaesthesia – inadequate to tolerate the pain of incision.

In our study, surgical skin preparation, cleaning and draping was done for all patients before induction of anaesthesia. The sequences of events were correlated to the corresponding BIS values against time (Fig. 1). There was a delay of 1.5 min from injection of Thiopentone to a visible fall in BIS values from awake values (mean 96), followed by a precipitous fall in BIS value, over next one-minute to a mean lowest value of 32. The mean time to achieve BIS nadir was

2.5 minutes. The volatiles were turned on at this point –i.e just when the BIS values started rising from the lowest value, with an aim to prevent rise of BIS value above 70. There was a slow rise of BIS value to 60 over next 3.5 min. That is, there is a period of 4.5 min when BIS values remained below 60—the recommended surgical plain of anaesthesia. If the surgical incision is timed in this period of deep hypnosis provided by Thiopentone—there is a low probability of recall. Cleaning and draping the patient helps in this regard and valuable time is saved when the patient is in a deep plane of anaesthesia which would prevent awareness.



**Fig 1: CORRELATION OF BIS VALUES WITH TIME**

However there was a period of time from incision till delivery of baby (<6 min) when BIS values were at 70. This short period of relatively higher BIS value is associated with very low probability of recall.

a) The second time slot when probability of recall was high is after delivery of the baby till end of the surgery—when the volatiles were switched off and anaesthesia maintained with 70% N<sub>2</sub>O in O<sub>2</sub> and a large dose of opioid was given, as was the earlier practice. This problem has been addressed adequately - after a much publicized incident in UK (3) - and volatiles are now recommended to be used. In our study Inj Morphine (0.1 mg/kg) was given immediately after delivery of baby; N<sub>2</sub>O was increased to 66% (from 50%) and volatiles increased and titrated to obtain a BIS value of 60. Several articles have reviewed the most appropriate technique for general anaesthesia for caesarian section and use of newer volatiles (except halothane) has become standard practice. Several articles have also explored the use of Total Intravenous Anaesthesia (TIVA) or supplementation of anaesthesia with iv agents like propofol to prevent uterine atony and maintain adequate plane of anaesthesia. Use of opioids after delivery of baby also contributes to the anaesthetic and analgesic requirements. Several short acting and ultra- short acting opioids are in use today. Overall a multitude of drugs and techniques are available today and the anaesthetic technique can be modified to eliminate awareness in this second time slot with relative ease.

**Conclusion**

This study was carried out to evaluate the use of Bispectral index as a means of preventing explicit recall during general anaesthesia for obstetric surgery. No patient had awareness or dreaming during surgery using a BIS targeted technique of general anaesthesia- ie maintaining a BIS of 70 till delivery of baby and BIS of 60 after delivery till end of surgery. The uterus remained responsive to oxytocin even in the presence of volatile agents and there was no incidence of severe uterine bleeding. There were no adverse effects on new born babies as seen from acceptable Apgar scores in all neonates. We concluded that Bispectral index is useful in monitoring the brain state during general anaesthesia for caesarian section and helps to titrate drug delivery and to time intra operative manipulations so as to minimise the risk of intra operative awareness.

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