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# Evaluation of Effect of Bispectral Index Monitoring as Compared to Haemodynamic Monitoring in Patients Undergoing One Lung Ventilation During Thoracic Surgery

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**Abstract:** ***Aim: In this study we will evaluate the effect of Bispectral index monitoring as compared to haemodynamic monitoring in patients undergoing one lung ventilation during thoracic surgery. Study Design: Prospective single blinded study. Methods: 30 adult patients of age group 20-65 years scheduled for thoracotomy were divided into two groups of 15 each. Patients in group 1(Haemodynamic group): anaesthesia was maintained with 100% oxygen and isoflurane based upon haemodynamic variables. The anaesthesiologist was blinded to BIS values in group 1. Patients in group 2 (BIS group): anaesthesia was maintained with 100% oxygen and isoflurane and a BIS of 40-60 was maintained. In group 2 BIS monitoring was continuously available to the anaesthesiologist. Bispectral index values between the groups and within the group compared.Haemodynamic variability, MAC values, end-tidal isoflurane concentration, Eye opening time and extubation time and amount of isoflurane were compared between both groups. Results: BIS values are high during one lung ventilation with 100% oxygen in haemodynamic as compared to BIS group. Haemodynamic variability ,eye opening time ,tracheal extubation time, MAC values, End-tidal isoflurane concentration, and amount of isoflurane was less in BIS group as compared to haemodynamic group.***

**Keywords:** Awareness, BIS, haemodynamic, thoracotomy

## 1. Introduction

Awareness during general anaesthesia can be defined as the undesired unanticipated patient wakefulness during surgery or recall afterwards. Intraoperative awareness can be a horrifying experience resulting in psychological trauma. Patient may present with anxiety, irritability, nightmares, sleep disturbances, panic, depression and post traumatic stress syndrome.

Adequate depth of anaesthesia occurs when the concentration of the agents in the brain are sufficient to produce the effects needed for the comfort of patient and the conduct of surgery. Clinical signs of somatic or autonomic responsiveness have been the mainstay of anaesthetic depth monitoring, but the lack proven utility in detecting awareness.

Many attempts have been made to produce a simplified interpretation of EEG that predicts anaesthetic depth but in most cases these were unsatisfactory. One such monitor is Bispectral index. Monitoring of the brain state using a combination of currently monitored parameters and clinical signs may allow better balancing of hypnotic and analgesic administration. Potential benefits include reduced risk of awareness, better management of responses to surgical stimulation, more rational selection of cardiovascular intervention. Advantages of BIS monitoring includes faster wake up and recovery, more cost effective use of drugs, fewer unwanted intraoperative responses.

BIS provides a continuous and observer independent digital value representing cerebral activity. BIS values of 40-60 are typical during maintenance of general anaesthesia. During one lung ventilation in thoracic surgery 100% oxygen (FiO2=1) is used for adequate oxygenation. This may lead to awareness during anaesthesia.

## 2. Aim of the Study

1) To evaluate BIS during one lung ventilation with 100% oxygen (FiO2=1).
2) To evaluate the effect of BIS controlled titration on haemodynamic parameters and recovery characteristics.

## 3. Materials and Methods

Study design: prospective single blinded study. Approval from the institutional ethical committee, a written informed consent was obtained from patients.

30 adult patients of age group 20-65 years scheduled for thoracotomy were studied. They were divided into two groups of 15 each. In both groups during the period of one lung ventilation, FiO2=100% and isoflurane was given for maintenance of anaesthesia. Patients in group 1(Haemodynamic group): anaesthesia was maintained with 100% oxygen and isoflurane based upon haemodynamic variables. The anaesthesiologist was blinded to BIS values in group 1. Patients in group 2 (BIS group): anaesthesia was maintained with 100% oxygen and isoflurane and A BI of 40-60 was maintained. In group 2 BIS monitoring was continuously available to the anaesthesiologist.

**Exclusion Criteria**:
Patients with any neurological impairment like head injury, stroke, psychiatric disease, epilepsy, Hepatic failure patients, patients receiving long term opioids, use of Drugs affecting CNS, alcohol abuse, Opioid abuse, and difficult intubation patients.

**Preanaesthetic Work Up**
Preanaesthetic work up is to be done along with routine investigations, ECG, CXR. Patients will be explained about awareness.

**Anaesthesia Technique**

Premedication with oral diazepam 0.1mg/kg night before surgery and IV midazolam 0.05mg/kg half hour prior to surgery, routine monitoring of ECG, pulse oximetry, NIBP, IBP, temperature .Peripheral IV access secured .BIS monitor electrodes will be placed above the bridge of nose, over the temple area, and between the corner of eye and hairline .Anaesthesia induced with propofol 2.5mg/kg and muscle paralysis will be achieved with vecuronium0.1mg/kg. Trachea will be intubated with appropriately sized double lumen tube. Correct position of DLT confirmed.Anaesthesia is to be maintained with $O_2$, $N_2O$, isoflurane and vecuronium. Intraoperative analgesia was titrated with increments of IV fentanyl.The isoflurane concentration in group 1 was adjusted to maintain a MAP and HR within 20% of preoperative baseline. Other signs of inadequate anaesthesia were noted and isoflurane concentration adjusted accordingly.The isoflurane concentration in group 2 was adjusted to maintain a BIS value of 40-60.Volume replacement was done with crystalloids and colloids adequately throughout the surgery after appropriate calculation of requirements.

**Statistical Analysis**

The statistical analysis was done between the groups using the SPSS 20.0 version for windows. Demographic variables (age, weight) and duration of surgery were compared between both groups using t-test. To compare the difference in sex distribution the Chi square/Fischers exact test were used. For comparing the Bispectral index values between the groups and within the group the generalised estimating equation (GEE) test was used. Haemodynamic variability, MAC values, end-tidal isoflurane concentration and amount of isoflurane were compared between both groups using Fischer's exact test. Eye opening time and extubation time were compared between the groups using unpaired t-test.

## 4. Results

Demographic variables like age, sex, weight in kgs and duration of one lung ventilation in minutes were shown in table 1. There was no significant difference between the groups.

**Table 1:** Demographic characteristics

| *Demographic variable* | *BIS group* | *Haemodynamic group* | *P value* |
|---|---|---|---|
| Age | 40.7±14.51 | 39.3±14.15 | 0.391 |
| Sex M:F | 11:4 | 9:6 | 0.698 |
| Weight in kgs | 57.9±9.10 | 60.1±8.21 | 0.243 |
| Duration of one lung ventilation in minutes | 107±28.27 | 104±23.79 | 0.368 |

p value >0.05, statistically not significant

The mean BIS values were comparable between the two groups. The maximum BIS values were high during one lung ventilation period in the haemodynamic group. BIS values during one lung ventilation are shown in table 2 and 3.In the BIS group the values were kept within 40-60 except at two points

**Table 2:** BIS values during one lung ventilation (BIS group)

| BIS | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| Baseline | 94.4 | 1.88 | 92 | 98 |
| After induction | 49.26 | 1.98 | 45 | 52 |
| 15min | 51.4 | 2.22 | 48 | 56 |
| 30min | 52 | 2.81 | 48 | 57 |
| 45min | 52.86 | 2.41 | 50 | 57 |
| 60min | 52.46 | 2.55 | 49 | 58 |
| 75min | 52.44 | 2.9 | 47 | 58 |
| 90min | 55.15 | 7.64 | 48 | 78 |
| 105min | 52 | 3.17 | 47 | 57 |
| 120min | 55.77 | 5.91 | 50 | 70 |
| 135min | 53.42 | 3.1 | 50 | 59 |
| 150min | 55.75 | 4.34 | 50 | 60 |
| 160min | 53 | 1.41 | 52 | 54 |

**Table 3:** BIS values during one lung ventilation (Haemodynamic group)

| *BIS* | *Mean* | *Std Dev* | *Minimum* | *Maximum* |
|---|---|---|---|---|
| Baseline | 94.4 | 1.88 | 92 | 98 |
| After induction | 55 | 5.19 | 43 | 62 |
| 15min | 53.66 | 4.01 | 45 | 60 |
| 30min | 55 | 5.80 | 46 | 72 |
| 45min | 55.2 | 3.70 | 50 | 64 |
| 60min | 56 | 5.85 | 40 | 68 |
| 75min | 55.66 | 4.57 | 44 | 64 |
| 90min | 55.92 | 5.96 | 43 | 69 |
| 105min | 55.25 | 3.74 | 50 | 61 |
| 120min | 55.87 | 5.86 | 50 | 68 |
| 135min | 54.42 | 5.65 | 45 | 60 |
| 150min | 51.5 | 5.74 | 48 | 60 |
| 160min | 48 | 0 | 48 | 48 |

The mean BIS values were comparable between the two groups .the maximum BIS values were high during one lung ventilation period in the haemodynamic group

**Table 4:** Maximum (above 60) BIS values

| BIS group | Haemodynamic group | P value |
|---|---|---|
| (8) 0.153±0.37 | (2) 0.6153±0.506 | 0.00365 |

Awareness: interview was done on 1st and 3rdpost operative day andnone of the patients developed awareness in both groups as shown in table 4.

**Table 5:** Awareness

| *Group* | *First post operative day* | *Third post operative day* |
|---|---|---|
| BIS | 0 | 0 |
| Haemodynamic | 0 | 0 |

Heart rate and BP: in haemodynamic group four patients developed hypotension and bradycardia but none in the BIS group. This is both clinically and statistically significant

**Table 6:** Hypotension

| *Group* | *Number of patients* | *Mean* | *Std. dev* | *P value* |
|---|---|---|---|---|
| BIS | 0/15 | 0 | 0 | 0.0160 |
| Haemodynamic | 4/15 | 0.26 | 0.457 | |

**Table 7:** Hypertension

| *Group* | *Number of patients* | *Mean* | *Std. dev* | *P value* |
|---|---|---|---|---|
| BIS | 2/15 | 0.133 | 0.351 | 0.104 |
| Haemodynamic | 5/15 | 0.33 | 0.487 | |

**Table 8:** *Bradycardia*

| *Group* | *Number of patients* | *Mean* | *Std. dev* | *P value* |
|---|---|---|---|---|
| BIS | 0/15 | 0 | 0 | 0.0160 |
| Haemodynamic | 4/15 | 0.26 | 0.457 | |

**Table 9:** *Tachycardia*

| *Group* | *Number of patients* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|---|
| BIS | 2/15 | 0.133 | 0.351 | 0.104 |
| Haemodynamic | 5/15 | 0.33 | 0.487 | |

Eye opening and: shown in table 10. There was significant difference in the time to tracheal extubation between two groups.

**Table 10:** Eye Opening Time

| *Group* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|
| BIS | 13.7 | 2.98 | 0.002 |
| Haemodynamic | 18.2 | 2.75 | |

Eye opening time was 13.7±2.98 and18.2±2.75 minutes in BIS and haemodynamic group respectively.

**Table 11:** Extubation Time

| *Group* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|
| BIS | 16.06 | 3.127 | 0.0004 |
| Haemodynamic | 20.46 | 3.35 | |

There was significant difference in the time to reach the defined recovery end point or the time to tracheal extubation between the two groups. Time to tracheal extubation was 16.06±3.127 and 20.46±3.35 minutes in BIS and haemodynamic group respectively.

MAC value, End-tidal isoflurane concentration and amount of isoflurane used were high in the haemodynamic group. This was statistically significant. This is shown in table 11, 12, 13.

**Table 12:** MAC Values

| *Group* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|
| BIS | 0.688 | 0.21 | 0.000 |
| Haemodynamic | 0.788 | 0.21 | |

**Table 13:** End tidal isoflurane

| *Group* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|
| BIS | 0.619 | 0.17 | 0.000 |
| Haemodynamic | 0.77 | 0.16 | |

**Table 14:** Amount of isoflurane

| *Group* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|
| BIS | 0.625 | 0.17 | 0.000 |
| Haemodynamic | 0.984 | 0.19 | |

SpO2: shown in table 15. In the BIS group 5 patients and 4 patients in haemodynamic group developed transient desaturation. At the time of desaturation BIS values were within normal limits.

**Table 15:** SpO2

| *Group* | *Mean* | *Std dev* | *P value* |
|---|---|---|---|
| BIS | 97 | 2.5 | 0.819 |
| Haemodynamic | 96 | 5.8 | |

Total IV fentanyl requirements were similar in BIS as well as haemodynamic groups. Neuromuscular monitoring was done until extubation. None of these patients had any delayed neuromuscular recovery. Temperature was monitored with nasal temperature probe and no significant differences were found between the two groups.

## 5. Discussion

The main aim of anaesthetic depth monitoring is to tailor the amounts of anaesthetic to the needs of the individual patient, thus avoiding either unnecessarily deep anaesthesia or awareness. Awareness is the postoperative subsequent explicit recollection of events occurring during general anaesthesia[1] .The incidence of awareness is said to be 0.1-0.2 % of general surgical population[1] .but it may be as high as 40% in certain high risk patients like those with multiple trauma, caesarean section , cardiac surgery and haemodynamically unstable patients[2] sleigh et al found that heart rate variability is less reliable indicator than EEG as indicator of consciousness .Interpretation of approximate entropy (ApEn) is not easy and does not offer advantage over BIS as a measure of awareness[3] . Clinical signs of somatic or autonomic responsiveness have always been the mainstay of anaesthetic depth monitoring, but they lack proven utility in detecting awareness.

A monitor of anaesthetic depth like the BIS monitor may improve anaesthesia. The BISPECTRAL Index (BIS) monitor processes a modified electroencephalogram (EEG) to assess the hypnotic effects of sedative and anaesthetics, replacing the reliance on physiological variables for determining the depth of anaesthesia the advantages are faster wake up and recovery, more cost effective use of drugs, fewer unwanted intraoperative responses.

In the BIS group, BIS values were within acceptable (40-60) range except two values were high (78, 70) because anaesthesia was titrated to maintain the normal BIS values for surgery. Whereas in Haemodynamic group BIS values were high during the one lung ventilation, here anaesthesia was maintained with hemodynamic parameter without considering the BIS values.

Awareness was assessed by the use of Brice structured questionnaire [4] in the first and third postoperative day. Interviews were scheduled on two occasions after surgery because postoperative recollections can be transient. Liu et al [5] demonstrated in surgical patients that BIS index accurately tracked the degree of clinical sedation with midazolam given during regional anaesthesia. Glass et al [6] studied the relationship between BIS index, clinical sedation and measured drug concentration of propofol, isoflurane, midazolam and alfentanyl. They concluded the BIS index correlated well with the measured drug concentration and clinical measures of sedation.

In contrast to our study PS Myles et al[7] in a randomized multicentre study in 2463 general surgical patients found BIS guided anaesthesia reduced the risk of awareness by 82% (n= 1227, 2 patients) in comparison to the control group (n=1238, 11 patients).

In SAFE II study the use of BIS monitoring associated with significantly reduced incidence of awareness (78% reduction) when compared with historical controls from the same hospital and investigators. Recruitment of fewer patients may also be the reason for the differences being insignificant. Following up patients for longer periods after operation is more desirable to determine the true incidence of recall.

However Pavlin[8] and colleagues also reported that BIS monitoring did not influence the duration of recovery. In relation to BIS patients had less haemodynamic variability and BIS values were within acceptable range in BIS group this could be a possible reason for early awaking. Frenzel et al [9] studied surgical patients in the ICU and found that BIS did not correlate well with clinical sedation scores especially at deep levels of sedation.

Time to tracheal extubation was higher in haemodynamic group (16.06±3.127 and 20.46±3.35 minutes in BIS and Haemodynamic groups respectively). Consciousness cannot be the sole predictor of successful tracheal extubation as it includes many other factors such as adequate respiratory parameter, haemodynamics, body temperature, adequate neuromuscular blockade recovery. In our study, we have monitored neuromuscular monitoring in all patients. Patients were monitored until the recovery of all four switches following the train-of-four stimuli and all patients recovered before extubation. Anaesthesia was maintained at a deeper level in the haemodynamic group, that results in delay in recovery. De Deyne et al[10] concluded from their study that measuring the BIS might be an accurate method to avoid the risk of over sedation. Myles [7] found BIS group patients recovered from anaesthesia earlier than conventional group.

In the BIS group five patients developed transient desaturation in which one patient required manual ventilation. Four patients developed transient desaturation in the Haemodynamic group. But this was not statistically significant.

The MAC values, the End tidal isoflurane concentration and amount of isoflurane used were high in the Haemodynamic group. Basar et al [11] studied the effect of BIS monitoring on sevofluorane consumption.

Intravenous fentanyl requirement was not significantly different between two groups. Lowenstein et al [12] found that large doses of opoids does not always produce complete unresponsiveness.

Barr and colleagues assessed BIS as a monitor of the depth of anaesthesia during fentanyl and midazolam anaesthesia in CABG SURGERY [13]

Puri et al [14] studied that BIS monitoring in patients undergoing cardiac surgery and CPB and found that the incidence of tachycardia and hypotension in the BIS controlled group may be decreased due to titration of drug in the study group.

## 6. Conclusion

We evaluated the BIS values during one lung ventilation period with 100% oxygen and recovery characteristics in 30 patients. We concluded that:

BIS values are high during one lung ventilation with 100% oxygen in haemodynamic as compared to BIS group. None of the patients had intra operative awareness in both groups.Haemodynamic variability was less in BIS group as compared to haemodynamic group.The eye opening time and tracheal extubation time was significantly less in the BIS group as compared to haemodynamic group.The MAC values, End-tidal isoflurane concentration, and amount of isoflurane were less in BIS group as compared to haemodynamic group.Intraoperative analgesic requirements were similar in BIS and haemodynamic groups.

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