MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2024.2.289.292

OPEN ACCESS

Key Words
Bispectral index, cardiopulmonary bypass, open-heart surgeries, anaesthesia, hypothermia, rewarming

Corresponding Author
Prasandan Thayyil,
Department of Anaesthesiology and Critical care, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamil Nadu, India
prasandant@yahoo.com

Author Designation
[1,5]Assistant Professor
[2]Associate Professor
[3]Senior Resident
[4]Professor and Head
[6]Senior Consultant

Received: 9 December 2023
Accepted: 24 January 2024
Published: 10 February 2024

Citation: Prasandan Thayyil, Rommy Geever, Sahil, Thavamani, P. Jayakumar and Madhu Shankar, 2024. Evaluation of Bispectral Index and Incidence of Awareness in Anaesthesia for Open Heart Surgeries Done Under Cardiopulmonary Bypass. Res. J. Med. Sci., 18: 289-292, doi: 10.59218/makrjms.2024.2.289.292

Evaluation of Bispectral Index and Incidence of Awareness in Anaesthesia for Open Heart Surgeries Done Under Cardiopulmonary Bypass

[1]Prasandan Thayyil, [2]Rommy Geever, [3]Sahil, [4]Thavamani, [5]P. Jayakumar and [6]Madhu Shankar

[1-4,6]Department of Anaesthesiology and Critical Care, Sree Mookambika Institute of Medical Sciences(SMIMS), Kulasekharam, Tamil Nadu, India
[5]Department of General Surgery, Sree Mookambika Institute of Medical Sciences(SMIMS), Kulasekharam, Tamil Nadu, India

ABSTRACT
To evaluate bispectral index and incidence of awareness in anaesthesia for open heart surgeries done under cardiopulmonary bypass. A total of 61 adult patients undergoing elective open-heart surgeries under CPB were selected and assessed for bispectral index (BIS). The study showed that the BIS values were within acceptable limits throughout surgery. A mean BIS value of 52.03±0.51 was recorded at 37°C core body temperature of rewarming and it was the highest BIS value during the CPB period. It was observed that the BIS value changed by 1.48 units with every 1°C change in temperature. None of the patients had any incidence of recall of intraoperative events when assessed with modified BRICE questionnaire. The highest chance of awareness during CPB was during the rewarming time and least chance of awareness was during the hypothermic phase based on the BIS. The BIS value decreased with decrease in temperature and increased with increase in temperature.

INTRODUCTION

It is challenging to modify the degree of anaesthesia during open cardiac surgery for a variety of reasons. Some cases of awareness might occur as a result of inadequate anesthetic dosing[1] and therefore constitute potentially preventable medical errors[2]. Additionally, the pharmacokinetics of anesthetic medications may alter when using the heart-lung machine.3 Because of this, a drug's same dose administered to two patients may be more or lower in effect. A Cochrane meta-analysis of 36 trials found that BIS-guided anesthesia was highly effective in reducing the risk of intraoperative awareness in 7761 high-risk patients when compared with guiding the dose based on clinical signs[4].

While there are many sophisticated techniques for monitoring respiratory and hemodynamic functions during heart surgery, there aren't many options for monitoring brain activity[5]. BIS monitoring is a modality that was created in response to research that sought to evaluate electroencephalography (EEG), which digitizes the electrical activity of the brain. The bispectral index (BIS), a variable derived from the frontal EEG is a very useful adjunct for monitoring depth of anaesthesia[6]. BIS is most promising as a monitor of unconsciousness[7]. It is a dimensionless number from 0-100, when the value is decreased it indicates more unconsciousness or sedation. The optimum value during General Anaesthesia is to keep between 40-60. The value less than 60 is said to predict the absence of consciousness correctly but it may vary from patient to patient[8]. Thus, BIS appears to be a useful tool to measure the level of consciousness and thereby measure the effect of the anaesthetic drugs used and hence is useful in reducing the incidence of awareness during surgery[9,10]. In this study, by using BIS, we have assessed the adequacy of anaesthesia during different steps in the cardiac surgeries done under CPB and thereby analysed whether the protocol we are following in our institution for anaesthetizing a patient is adequate for preventing awareness and also assessed the explicit memory postoperatively, using the modified BRICE questionnaire.

MATERIALS and METHODS

After considering the utility of the study and obtaining approval from the ethical review committee, we selected a total of 61 adult patients undergoing elective open-heart surgeries under CPB. Inclusion criteria were age group between 20-70 years of both male and female gender. Patients undergoing elective open-heart surgeries ASA grade 4-Coronary artery bypass grafting and valve replacements. Exclusion criteria were previous cardiac surgery, preoperative neurological disease, ejection fraction of less than 35%, known allergy to any one of the drugs used, severe renal and hepatic impairment, patient who has not given consent for study, patient with heart rate less than 45/min, patient with known psychiatric illness and on psychiatric medications. Scientific basis of sample size was used in the study 19:4 pq/d2 where p = prevalence q = 100-P, d = 20% of p, where p = 62 q = 38 d = 20× 62/100, by substituting these values n = 61.

Data such as name, age, etc. were recorded. Tab. Lorazepam 2 mg and Tab. Ranitidine 150 mg were given orally on the previous night and two hours before surgery. Inj. Morphine 5mg and Inj Promethazine 12.5 mg were given IM in the pre-medication room 30 minutes before induction of anesthesia. Anesthesia was induced with intravenous injections of 0.05 mg/kg (body weight) of Midazolam, 4-6 µg/Kg of Fentanyl, 0.5-1mg/Kg of Propofol and 0.1 mg/Kg of Pancuronium Bromide as muscle relaxant. Anaesthesia was maintained mainly using intermittent bolus doses of Midazolam, Fentanyl and Propofol. Pancuronium was supplemented 1 mg IV every hour. Nitrous oxide was used with oxygen with 50% FIO2 till Inj. Heparin was administered. Isoflurane 0.5-2% was used intermittently if BP was increased. The BIS value, heart rate, MAP, SpO2, temperature at baseline, post-induction, skin incision, sternotomy, aortic cannulation, nadir temperature, every 30 mins in CPB, rewarming, immediate post-CPB, sternal wiring, skin closure and recovery of spontaneous movement were recorded. The variation of BIS with temperature was studied. Any recall of intraoperative events was assessed using a modified BRICE questionnaire. The results were compiled and subjected to statistical analysis using the Mann-Whitney U-test. $p>0.05$ was regarded as significant.

RESULTS AND DISCUSSIONS

The gender distribution had 54.09% of males and 45.91% of females (Table 1). Out of the 61 cases who underwent open heart surgery under CPB, 40 were CABG surgeries and 21 were single valve (Aortic and Mitral) replacement surgeries (Table 2). The mean age of the patients was 54.2 years, height was 167.4 cms, weight was 76.8 kgs, ejection fraction was 60.2%, operation time was 230.4 min, anesthesia time was 269.2 min, cross-clamping time was 79.6 min and the number of anastomoses was 2.8 Table 3).

Parameters such as BIS (%) recorded at preoperatively, during skin incision, after sternotomy, after pericardiotomy, before bypass, cross-clamp time, after cross-clamp time, after pump, after aortic cannula removal, during thorax closure and end of surgery were 96.4, 54.6, 52.8, 50.4, 50.2, 48.4, 48.2, 46.0, 44.8, 44.4 and 42.2 respectively. Heart rate found

Table 1: Distribution of patients

Total- 61		
Gender	Male	Female
Percentage	54.09%	45.91%

Table 2: Type of procedure

Type	Number
CABG surgeries	40
Single valve (aortic and mitral) replacement	21

Table III Patient characteristics (mean values)

Parameters	Mean	SD
Age (years)	54.2	3.5
Height (cm)	167.4	21.6
Weight (kgs)	76.8	11.5
Ejection fraction (%)	60.2	5.8
Operation time (min)	230.4	29.4
Anesthesia time (min)	269.2	27.2
Cross-clamping time (min)	79.6	8.4
Number of anastomoses(in CABG)	2.8	1.2

Table 4: Assessment of perioperative hemodynamics

Parameters	BIS (%)	Heart rate	MAP (mmHg)	SpO2 (%)
Preoperative	96.4	64.2	72.2	97.6
Skin incision	54.6	70.2	78.4	98.0
After sternotomy	52.8	68.4	72.6	98.2
After pericardiotomy	50.4	64.2	68.7	98.6
Before bypass	50.2	60.8	65.2	99.0
Cross-clamp time	48.4	62.4	62.8	98.2
After Cross-clamp time	48.2	68.4	60.1	98.8
After pump	46.0	70.2	64.2	98.6
After Aorta cannula removal	44.8	76.4	68.4	99.0
Thorax closed	44.4	78.4	70.2	99.2
End of surgery	42.2	80.2	72.0	99.4

to be 64.2, 70.2, 68.4, 64.2, 60.8, 62.4, 68.4, 70.2, 76.4, 78.4 and 80.2. MAP (mmHg) was 72.2, 78.4, 72.6, 68.7, 65.2, 62.8, 60.1, 64.2, 68.4, 70.2 and 72.0 respectively.

Awareness during anaesthesia has become a major concern for the anaesthesiologists. One of the major risk factors for awareness was cardiac surgery itself[11,12]. In our study, the maximum patients were in the age group 40-60 years and minimum in the age group above 60. The gender distribution had 54.09% of males and 45.91% of females. Out of the 61 cases who underwent open heart surgery under CPB, 40 were CABG surgeries and 21 were single valve (Aortic and Mitral) replacement surgeries. During cardiac surgery, there were incidences of heart rate variability. As in other surgeries the heart rate increased during the intubation time and it was mainly attributed to the stress response due to intubation. The heart rate also increased during the aortic cannulation, this finding was also attributed to the stress response during aortic cannulation. The increase in heart rate with standard deviation was from 64.2 before intubation to 80.2 after intubation (Table 4). It was supported by the study done by Ledowski, Thomas *et al*.[13], in which endocrine changes and heart rate variability during total intravenous anaesthesia and balanced anaesthesia were compared. There was a significant increase in heart rate and this was probably due to the increased catecholamine release in relation to the stress response. It was supported by the study done by Reves, Karp *et al*.[14] in which they studied 28 patients undergoing surgery under CPB and found that there was an increase in heart rate and MAP due to the consequent increase in epinephrine and norepinephrine due to stress response from the time of aortic clamping and at different events of CPB.

There was also an increase in MAP during the time of intubation when compared to that before intubation (Table 4). This increase was again attributed to the stress response during intubation. During aortic cannulation, there was a decrease in the MAP. This was due to the effect of increased administration of anaesthetic drugs during this time. It was found that there was no significant increase in BIS in relation to the haemodynamic reaction to the stress responses. It was supported by the previous study done by Kussman *et al*.[15] in which 19 patients who were undergoing cardiac surgeries were monitored for BIS, Blood pressure (BP), heart rate (HR) and plasma epinephrine, norepinephrine, cortisol, ACTH, glucose, lactate and fentanyl were analysed 15 min post-induction, 15 min post-sternotomy, 15 min on CPB, during cooling and during skin closure. No significant differences were observed in changes in BIS over time. A significant correlation was found 15 min post-induction between BIS and BP but not between BIS and HR. BIS did not correlate with BP or HR at any other time point. Hence, they were unable to demonstrate a relationship between the BIS and haemodynamic, metabolic or hormonal indices of anaesthetic depth.

It was found that temperature had a major influence in the variation of BIS values. The BIS value becomes lower as the temperature is decreased and is increased as the temperature is increased during rewarming. There was a change of BIS of about 1.48 units with 1 degree C change in temperature. The hypothermia reduces the energy required for the maintenance of the intrinsic activities of the brain and also reduces the electrical activities. The low BIS values during hypothermia is attributed towards the depressant effect of increasing hypothermia on the cerebral metabolism, which is represented by the EEG as an isoelectric or burst suppression pattern dominated by isoelectric periods. It was supported by the study done by Joseph Mathew *et al*.[16], who found that hypothermia decreases BIS by 1.12 units for every degree Celsius decrease in temperature, which is not dependent on predicted drug concentration, patient age and surgical time at any point of time. Further the propofol biotransformation was reduced by hypothermia which increased the effective propofol concentration. This was supported by the study done by Schmidlin *et al*.[17] who showed that the same BIS level was achieved by higher dose of propofol during normothermia and lower dose during hypothermia.

CONCLUSION

It was concluded from the study that, the predominantly intravenous anaesthetic technique used to anaesthetize the patients for cardiac surgery in our institution was adequate in terms of depth of anaesthesia. The highest chance of awareness during CPB was during the rewarming time and least chance of awareness was during the hypothermic phase. The BIS value decreased with a decrease in temperature and increased with an increase in temperature.

REFERENCES

1. Ghoneim, M.M., R.I. Block, M. Haffarnan and M.J. Mathews, 2009. Awareness during anesthesia: Risk factors, causes and sequelae: A review of reported cases in the literature. Anesth. Analg., 108: 527-535.
2. Avidan, M.S., E. Jacobsohn, D. Glick, B.A. Burnside and L. Zhang et al., 2011. Prevention of intraoperative awareness in a high-risk surgical population. N. Engl. J. Med., 365: 591-600.
3. Sarkar, M. and V. Prabhu, 2017. Basics of cardiopulmonary bypass. Indian J. Anaesth., 61: 760-767.
4. Shander, A., G.P. Lobel and D.M. Mathews, 2018. Brain monitoring and the depth of anesthesia: Another goldilocks dilemma. Anesth. Analg., 126: 705-709.
5. Sebel, P.,S., 1997. Awareness during general anesthesia.
6. Goddard, N. and D. Smith, 2013. Unintended awareness and monitoring of depth of anaesthesia. Contin. Educ. Anaesth. Crit. Care. Pain., 13: 213-217.
7. Kissin, I., 2000. Depth of anesthesia and bispectral index monitoring. Anesth. Analg., 90: 1114-1117.
8. Schwender, D., H. Kunze-Kronawitter, P. Dietrich, S. Klasing, H. Forst and C. Madler, 1998. Conscious awareness during general anaesthesia: Patients' perceptions, emotions, cognition and reactions. Br. J. Anaesth., 80: 133-139.
9. Ranta, V.,S.O., P. Herranen and M. Hynynen, 2002. Patients' conscious recollections from cardiac anesthesia. J. Cardio. Vasc. Anesth., 16: 426-430.
10. Ranta, S., J. Jussila and M. Hynynen, 1996. Recall of awareness during cardiac anaesthesia: Influence of feedback information to the anaesthesiologist. Acta. Anaesth. Scand., 40: 554-560.
11. Ekman, A., M. Lindholm, C. Lennmarken and R. Sandin, 2003. Reduction in the incidence of awareness using bis monitoring. Acta. Anaesth. Scand., 48: 20-26.
12. Myles, P., K. Leslie, J. McNeil, A. Forbes and M. Chan, 2004. Bispectral index monitoring to prevent awareness during anaesthesia: The b-aware randomised controlled trial. Lancet., 363: 1757-1763.
13. Ledowski, T., B. Bein, R. Hanss, A. Paris, W. Fudickar, J. Scholz and P.H. Tonner, 2005. Neuroendocrine stress response and heart rate variability: A comparison of total intravenous versus balanced anesthesia. Anesth. Analg., 101: 1700-1705.
14. Reves, J.G., R.B. Karp, E.E. Buttner, S. Tosone and L.R. Smith et al., 1982. Neuronal and adrenomedullary catecholamine release in response to cardiopulmonary bypass in man. Circul., 66: 49-55.
15. Kussman, B.D., E.M. Gruber, D. Zurakowski, D.D. Hansen, L.J. Sullivan and P.C. Laussen, 2001. Bispectral index monitoring during infant cardiac surgery: Relationship of bis to the stress response and plasma fentanyl levels. Pediatr. Anesth., 11: 663-669.
16. Abdel Rahman, S.E.M.K., 2007. Comparison of Sudanese standard parameters for intrauterine growth with other population. Sudan J. Paed., 8: 66-79.
17. Schmidlin, D., P. Hager and E.R. Schmid, 2001. Monitoring level of sedation with bispectral eeg analysis: Comparison between hypothermic and normothermic cardiopulmonary bypass. Br. J. Anaesth., 86: 769-776.