ORIGINAL ARTICLE

CORRELATION OF BIS INDEX WITH SEVOFLURANE CONCENTRATION IN PAEDIATRIC ANAESTHESIA

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ABSTRACT

Objectives: To correlate BIS value with anaesthetic concentration of sevoflurane during various phases of conventional anaesthesia in children and to compare end-tidal with alveolar concentration of Sevoflurane on Gasman.

Methods and Material: It is a prospective single blind study conducted in 25 ASA-I and II paediatric patients of either sex between 2 to 12 years of age posted for general surgical procedures. Anaesthesia was conducted in conventional manner by consultant who was blinded for BIS value and Sevoflurane concentration. Same cases were compared on Gasman simulator programme.

Results: BIS value decreased to 71.65±13.5 at the induction and it further reduced to 40 at intubation, it was ranged between 40 and 60 during maintenance phase of anaesthesia. Extubation was done at BIS value of 75. At induction, end-tidal Sevoflurane concentration was 6.41±0.67 which was 7.08±0.69 at intubation. During maintenance, end-tidal concentration was in range of 1.5±0.64 -3.19±0.39 and decreased to 0.14 ±0.27 at extubation. At induction, MAC of Sevoflurane was 3.37±0.34, which was 3.58±0.3 at intubation. During maintenance, MAC was in range of 1.07±0.56 to 1.71±0.28 which decreased to 0.07±0.16 at extubation. End-tidal concentration of conventional method was comparable with alveolar concentration of Gasman simulator.

Conclusions: Correlating BIS value with end tidal Sevoflurane concentration, inverse linear relationship was established and our clinical finding correlates well with Gasman simulator programme.

Key-words: General Anaesthesia; Sevoflurane, Paediatric patients, BIS monitor; Gasman simulator software

INTRODUCTION

Awareness is defined as the postoperative recall of event occurring during general anaesthesia. Awareness is often associated with adverse psychological sequel, including symptoms associated with post traumatic stress disorder and aversion to anaesthesiologist. [1] Emerging evidence is indicating that intra operative maintenance of adequate depth of anaesthesia with hypnotic component of anaesthetic can significantly decrease the risk of awareness. Clinical parameters such as hemodynamic, somatic and autonomic parameters are routinely used by anaesthetists to monitor anaesthetic depth, but such methods are unreliable to monitor hypnosis. Bispectral Index (BIS) provides a measurement of the hypnotic effect of anaesthesia [1]. In today's era of safe anaesthesia practice, Sevoflurane become inhalation agent of choice for induction and maintenance of general anaesthesia in paediatric patients [2]. Thus, we designed our study with the goal of anaesthesia practice in children to correlate BIS value with anaesthetic concentration (end tidal) of Sevoflurane during various phases of conventional anaesthesia in children.

With the advent of technology, a computer software-Gasman is available at present, and we decided to compare end-tidal Sevoflurane concentration during conventional clinical method of anaesthesia with alveolar concentration observed on Gasman simulator programme.

SUBJECTS AND METHODS

This prospective single blind study was conducted in 25 ASA I & II patients with either sex, between 2-12 years of age posted for short general surgical procedures from period of September 2010 to March 2012 after taking permission from departmental ethical committee. Children less than 2 years, delayed development, psychological disorders, neurological disorders, recent URTI (upper respiratory tract infection) were excluded from study. After thorough pre anaesthetic check up, written and informed consent was taken from parents.

Patients were kept nil by mouth 4 to 6 hours according age. Midazolam (0.5mg/kg) and glycopyrolate (20µg/kg) was given orally as premedication, 30 minutes

before surgery in the recovery room. Standard monitoring was done with NIBP, pulse oximetry and capnography (which were measured from anaesthesia delivery system- **DatexOhmeda - Aestiva 5**). End -tidal N_2O concentration, MAC (Minimum alveolar concentration) value and end tidal concentration of Sevoflurane through Gas module were also measured from **Aestiva machine**. Baseline hemodynamic parameters were recorded.

BIS sensor strip was applied over patient's forehead after cleaning forehead with alcohol. Baseline BIS value was recorded by an observer from **Aspect Medical Science-BIS Monitor.**

Anaesthesia was conducted in conventional manner by a consultant who was blinded for BIS value as well as Sevoflurane concentration (end-tidal concentration and MAC value). Observer recorded findings of BIS value, end-tidal Sevoflurane concentration, MAC value and other parameters every 2 minutes for initial 15 minutes and then at 5 minutes interval during maintenance of anaesthesia.

Pre oxygenation was carried out for 5 minutes and then patients were induced with O_2+N_2O (50:50) + 8% Sevoflurane. After adequate jaw relaxation, patients were intubated with appropriate size endotracheal tube. No muscle relaxant was used for intubation or maintenance of anaesthesia.

Anaesthesia was maintained with O_2+N_2O+Sevoflurane. The concentration of Sevoflurane was adjusted as per clinical judgment of a blinded consultant anaesthesiologist who conducted the entire case. No other sedative and hypnotic drugs were used during maintenance. Inj. Tramadol 1 mg/kg IV was given around 15 minutes before the end of surgery for postoperative analgesia. Patients were extubated once criteria for extubation were fulfilled. Post operative parameters as well as complications if any were recorded.

Later on, we ran Gasman-computer simulator programme in the same cases. Gasman computer simulator software was opened, patient weight was entered. The whole simulator was run with semi closed circuit with 2 agents (N_2O and Sevoflurane) for all cases with 5x speed of simulator. Fresh gas flow was set at 6litres/min throughout the course. The simulator was started with $O_2+ N_2O$ (50:50) and 8% dialled Sevoflurane concentration. On Gasman programme, Sevoflurane concentration was changed for maintenance in correlation to the concentration on anaesthesia delivery system (as per the record of the observer).

Data of alveolar concentration of Sevoflurane at various phases of anaesthesia, dynamic pictures and graphs of uptake and distribution of Sevoflurane on Gasman simulator were also documented.

Statistical Analysis: Using mean ± standard deviation for BIS and end-tidal Sevoflurane concentration from our study, using ∞ error of 0.25 and ß error of 0.25, we derived sample size of 16 per group using MedCalc software. To decrease error and further authenticate the study sample size of 25 was selected. Power of analysis of our study was 80%. All the data were compiled and tabulated. End tidal Sevoflurane concentration during conventional anaesthesia was compared with alveolar concentration (Gasman) using paired student's 't' test. Other values were analyzed using statistical inference using Mean ± standard deviation. P-value less than 0.05 were considered significant.

RESULTS

In this study, total of 25 ASA I paediatric patients were enrolled. Demographic data are as shown in Table 1.

Table 1: Demographic data

Variables	Values
Age(Years) (Mean ± SD)	6.05 ± 2.85
Gender	
Male	96%
Female	4%
Weight(Kg)	16.12 ± 6.40
Duration Of Surgery (minutes)	62.45 ± 22.41

The age range was 2 to 12 years with mean age of 6.05 ± 2.85 years in our study. Davidson et al [3] showed that correlation of BIS value with Sevoflurane concentration was not found in children less than 1 year of age and therefore we did not include infants in our study.

Male preponderance was seen due to types of surgery (congenital hernia, circumcision, etc.) selected for the study. Baseline parameters were recorded. They were within normal limits.

Table 2: Correlations of BIS Value with End-Tidal Concentration and MAC Value of Sevoflurane

Various Phases of Anaesthesia	BIS Value (Mean ± SD)	Dialled Sevoflurane Concentration (%)	End-Tidal Sevoflurane Concentration (%)	MAC
Baseline (Sedation)	85.25 ± 6.69	-	-	-
Induction	71.65 ±13.58	8 ± 0	6.41± 0.67	3.37 ± 0.34
Intubation	40.4 ± 10.75	8 ± 0	7.08 ± 0.69	3.58 ± 0.3
Maintenance phase	48.22 ± 5.26	3.83 ± 0.59	3.19 ± 0.39	1.71 ± 0.28
Last 15 min.	58.10 ± 8.73	1.67 ± 1.04	1.50 ± 0.64	1.07 ± 0.56
End of surgery	58.31 ± 8.69	0.3 ± 0.7	1.22 ± 0.48	0.75 ± 0.4
1st Movement	68.23 ±19.06	-	0.41 ± 0.36	0.18 ± 0.23
Extubation	75.41 ± 5.97	-	0.14 ± 0.27	0.07 ± 0.16

We used oral Midazolam as a premedication in all the children. Sedation was satisfactory in all the cases with baseline BIS value was 85.25±6.96.

Table 2 shows Correlations of BIS value with end-tidal concentration and MAC value of sevoflurane.

Baseline mean BIS value was 85.25±6.96. BIS index decreased to 71.65 at the time of induction and further decreased to 40 at the time of intubation. During maintenance phase, BIS values ranged between 40 and 60. After completion of surgery, Sevoflurane and N2O were discontinued. We found that BIS value was increased up to 75.41± 5.9, at that level extubation was performed.

Sevoflurane concentration (in terms of end-tidal concentration) and MAC value at the time of intubation was 7.08±0.69 and 3.58±0.3 respectively. During maintenance, these values reduced further till extubation. Thus, it is derived that BIS value increased while Sevoflurane concentration (end-tidal and MAC) decreased depicting inverse relationship.

As seen from table -3, Recovery after surgery and anaesthesia was faster and even readiness for discharge from PACU was also fast.

None of our patients had hypoxia, nausea/vomiting, coughing and any other complications during postoperative period.

Table 3: Postoperative Recovery Parameters

Recovery Criteria	Mean±SD (min)
Time from end of surgery to 1st movement	4.25 ± 2.03
Time from end of surgery to extubation	5.75 ± 1.07
Time from end of surgery to PACU discharge readiness	18.05 ±5.04

Figure 1 show (Bar diagram). Comparison of end-tidal Sevoflurane concentration of conventional clinical method of anaesthesia with alveolar Sevoflurane concentration of Gasman simulator was done at various phases of anaesthesia (baseline, induction, intubation, maintenance phase, last 15 minutes, end of surgery, 1st movement, and extubation). No statistical significance is observed between these two parameters. Thus, end tidal Sevoflurane concentration is comparable with alveolar Sevoflurane concentration. (Clinical method vs. Gasman simulation)
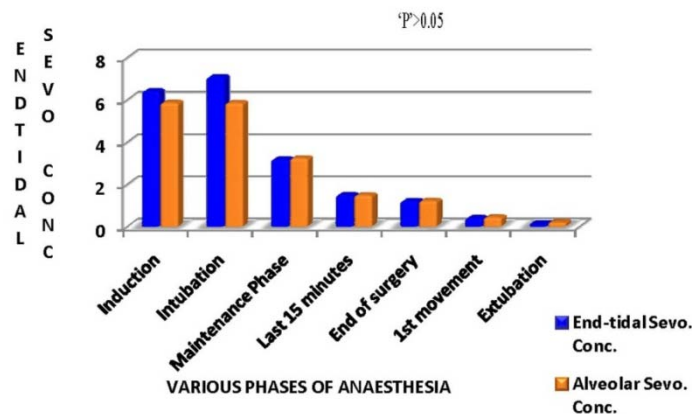

Figure: 1 Comparison of End-Tidal Sevoflurane Concentration of Conventional Clinical Method with Alveolar Sevoflurane Concentration of Gasman- A Computer Simulator.
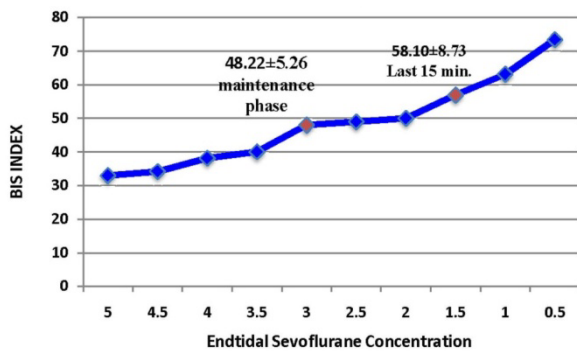

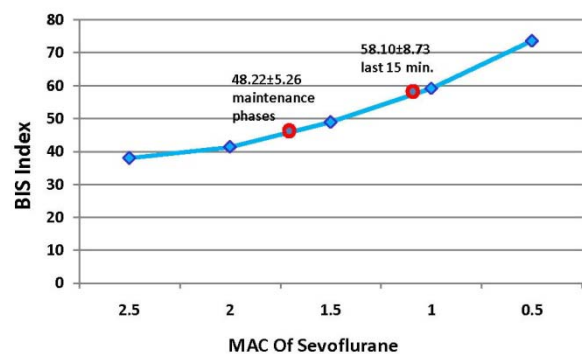**Figure: 2 Correlation of end-tidal sevoflurane concentration with BIS index**

Figure 3: Correlation of BIS index with MAC of sevoflurane

DISCUSSION

Sevoflurane is an inhalation agent of choice in paediatric patients due to low blood gas partition co-efficient (0.6-0.7) and absence of pungency with rapid induction as well as rapid recovery from anaesthesia. Bispectral Index and gas analyzer were newly introduced monitors for the depth of anaesthesia [4]. BIS index ranges from 0 to 100. Value of 100 represents awakened CNS. After administration of hypnotic agents, BIS index decreases and loss of consciousness happens between70 and 80. At value of 60, probability of consciousness is low. And BIS value of 40 suggests deep hypnosis [1].

This was a prospective single blind study conducted in 25 paediatric patients. Sample size was calculated using Medcalc software. Data collection and data analysis was carried out using Medcalc software. We could not found any limitation in the study.

This study may be an addition to the available evidence and may be helpful for teaching and training of anaesthesiologists for Sevoflurane anaesthesia in paediatric patients.

In our study, Midazolam was used as oral pre-medication with satisfactory sedation effect in all cases. Baseline BIS value also suggests good sedation (BIS 85.25 ± 6.96). Premedication was given for smooth and fast induction, as well as smooth recovery [5]. However Denman et al [1] and Kim H.S. et al [6] had not used any premedication fearing the effect of it on BIS value. Respiratory rate was not altered by premedication in our study.

In our study, induction was done with conventional method using O_2+N_2O (50:50) and 8% Sevoflurane and no muscle relaxant was used during intubation. Denman et al [1] also did not use muscle relaxant in their second arm study. However, some workers [7] used muscle relaxant to facilitate endotracheal intubation. We found smooth induction and intubation period without any complication like coughing, bucking and laryngospasm. Mean BIS value at the time of intubation was (40.4 ± 10.75) with end tidal sevoflurane concentration (7.08±0.69) and MAC (3.58±0.3) were found and correlated with adequate depth of anaesthesia.

In this study, Sevoflurane was used as a sole anaesthetic agent with $O_2 + N_2O$ (50:50) during maintenance; no muscle relaxant was used throughout the surgical procedure. No additional sedative and hypnotics were used in maintenance phase. Denman WT et al [1] and. Bannister CF et al [7] used Sevoflurane with 60% N_2O in Oxygen during maintenance phase. Both of them did not use any sedative and hypnotic drugs throughout the procedure. In study of Denman et al [1] BIS for maintenance was 42.39 ± 14.18 while in study by Bannister et al [7] in standard practice group BIS was 39.6 ± 11.5 while in our study BIS value was 48.22±5.26. Thus the values of BIS are in higher range in our study.

End-tidal concentration was 2.4±0.6 in study by Bannister et al [7] which was similar to our study (1.5±0.64 - 3.19±0.39).

BIS value of 48.22 ± 5.26 with MAC of 1.71 ± 0.28 during maintenance in our study resembles that with Katoh et al [8]. However, Tsuruta S et al [9] showed higher values (2.83% MAC for BIS < 50).

Correlation of BIS value with end-tidal Sevoflurane concentration is shown in Fig: 2, while correlation of BIS value with MAC is shown in Fig: 3.

Both the graphs show inverse linear relationship between BIS value and Sevoflurane concentration. Our findings are similar to Denman WT et al [1] and Bannister CF et al [7].

In our study, all patients had rapid recovery as shown in Table: 3 and our findings are in consonance with Bannister et al [7].

Capcava et al [10] has shown that Sevoflurane correlate closer with BIS than with mean arterial pressure and did not correlate with heart rate. We have not correlated hemodynamic parameters with Sevoflurane concentration.

We compared end tidal Sevoflurane concentration with alveolar Sevoflurane concentration from Gasman- a software programme by Philips J [11]. The comparison was done at various phase of anaesthesia i.e. during induction, intubation, maintenance phase, last 15 minutes, at the end of surgery, 1st movement and during extubation. The comparison showed statistical insignificance with P value of more than 0.05. (Fig: 1)

CONCLUSION

Correlating BIS value with end tidal Sevoflurane concentration, inverse linear relationship was established and our clinical finding correlates well with Gasman simulator programme.

Intubation was smoothly accomplished at BIS value of 40. During maintenance of anaesthesia, BIS value ranged between 40 and 60 with end tidal Sevoflurane concentration between 1.5±0.64 -3.19±0.39 and MAC 1.07±0.28 to 1.7±0.28.Thus desired level of BIS values were achieved during clinical anaesthesia.

We can conclude that depth of anaesthesia in term of concentration of Sevoflurane correlates well with BIS index (during clinical conventional anaesthesia technique). It can also be compared satisfactory on simulation exercise programme (Gasman).

REFERENCES

1. Denman WT, Swanson EL, Rosow D, Ezbicki K, Connors PD, Rosow CE. Pediatric evaluation of the bispectral index (BIS) monitor and correlation of BIS with end-tidal sevoflurane concentration in infants and children. Anesthesia Analgesia 2000; 90: 872–7.

2. Lerman J, Sikich N, Kleinman S, Yentis S. The pharmacology of sevoflurane in infants and children. Anesthesiology 1994; 80: 814–24.

3. Davidson AJ, McCann ME, Devavaram P, Auble SA, Sullivan LJ, Gillis JM et al. The differences in the bispectral index be-

tween infants and children during emergence from anesthesia after circumcision surgery. Anesthesia Analgesia 2001; 93:326–30.

4. Bergman I. J. Awareness during general anaesthesia. Anaesthesia, 2002, 57, 549 – 556.

5. Swadia V.N., Patel Mamta. Comparison of induction and intubation characteristics of Sevoflurane and halothane in pediatric patients. Indian journal of Anesthesia 2001; 45(4): 294-297.

6. Kim H.S., A.Y.Oh, C.S.Kim, S.D.Kim, K.S.Seo. Correlation of Bispectal index with end-tidal sevoflurane concentration and age in infants and children. British Journal of Anesthesia, 2005: volume 95, no: 3,362-366.

7. Bannister CF, Brosius KK, Meyer BJ, Sebel PS, Sigl JC. The effect of bispectral index monitoring on anesthetic use and recovery in children anesthetized with sevoflurane in nitrous oxide. Anesthesia Analgesia.2001; 92:877-881.

8. Katoh T, Suzuki A, Ikeda K. Electroencephalographic derivatives as a tool for predicting the depth of sedation and anesthesia induced by sevoflurane. Anesthesiology 1998; 88: 642–50.

9. Tsuruta S, Satsumae T, Mizutani T, Inomata S, Shimizu T. Minimum alveolar concentration of sevoflurane for maintaining bispectral index below 50 in children. Paediatr Anaesth.2011 Nov;21(11):1124-7

10. Capkova J; Komanova B; Spodnik K; Firment J .The benefits of BIS monitoring during sevoflurane anaesthesia in children. Anestheziol.med; 18/2(65-72)/2007

11. Philip James H. Gas Man – An example of goal oriented computer –assisted teaching which results in learning. International Journal of Clinical Monitoring and Computing 1986; 3: 165 – 173.