Original Article

Comparison between patient state index, bispectral index, and clinical parameters for propofol induction in Indian patients: A prospective study

Mohammed Shafiq Shajahan, Sanjay Agrawal, Deepak Singla

Department of Anaesthesia, AIIMS, Rishikesh, Uttarakhand, India

Abstract

Background and Aims: Patient state index (PSI) and bispectral index (BIS) are depth of anesthesia monitors utilized for the dosage of propofol usage for induction. We compare PSI, BIS, and Observer's Assessment of Alertness/Sedation Scale (OAA/S) for propofol dose usage for induction.

Material and Methods: Seventy-four ASA I and II patients, aged 18–65 years scheduled for laparoscopic cholecystectomy were included and divided into groups to titrate the drug dosage of propofol needed for induction of anesthesia, monitored by PSI (Group A), BIS (Group B), or clinical OAA/S (Group C). The drug dosage needed for induction was based on a PSI value of 25 ± 2, BIS value of 48 ± 2, and OAA/S value of ≤2 as the endpoint of induction in respective groups. Intraoperative hemodynamic variables and any complications were compared.

Results: The mean doses of propofol needed for induction were 2.23 mg/kg (Group A), 2.05 mg/kg (Group B), and 2.11 mg/kg (Group C). A significantly decreased dose was needed to achieve the desired end in Group B compared to Group A ($P = 0.01$). The hemodynamic variables such as heart rate, systolic blood pressure, and diastolic blood pressure among the three groups were comparable.

Conclusion: The clinical method of titrating the dose of propofol for induction and anesthetic depth by the loss of verbal response is comparable to both BIS and PSI monitoring.

Keywords: Bispectral Index monitor, consciousness monitor, laparoscopic cholecystectomy, Observer's Assessment of Alertness/Sedation Scale, Patient State Index

Introduction

Anesthesia is a state of controlled and temporary loss of awareness needing to be thoroughly monitored and adequately maintained to achieve the desired outcome, that is, a pain-free surgical experience with no recall. Inadequate doses of anesthetic agents lead to perioperative awareness, whereas increased dosages lead to hemodynamic instability, delayed recovery, and increases the incidence of drug-related complications.[1] Reliable and noninvasive monitoring of depth of anesthesia, therefore, becomes very important.[2]

Modalities such as clinical endpoints, electroencephalogram, or its derivatives are routinely used for assessing the depth of anesthesia. Advances in electrophysiological studies lead to the use of electroencephalogram (EEG) as a potential indicator of anesthetic depth.[3,4] The bispectral index (BIS) is one such monitor, with values of 40–60 indicating the adequate

Address for correspondence: Dr. Mohammed Shafiq Shajahan, Department of Anaesthesia, AIIMS, Rishikesh - 249 203, Uttarakhand, India.
E-mail: shafinmbb@gmail.com

Access this article online

Quick Response Code:

Website: https://journals.lww.com/joacp

DOI: 10.4103/joacp.joacp_10_22

How to cite this article: Shajahan MS, Agrawal S, Singla D. Comparison between patient state index, bispectral index, and clinical parameters for propofol induction in Indian patients: A prospective study. J Anaesthesiol Clin Pharmacol 2023;39:544-9.

Submitted: 11-Jan-2022 **Revised:** 23-Mar-2022
Accepted: 24-Mar-2022 **Published:** 05-May-2023

depth of anesthesia, whereas values below 40 indicate a deep hypnotic state.[5]

The patient state index (PSI) is a quantitative EEG index assessing the level of consciousness during sedation and general anesthesia.[6] PSI-derived measure of the effect is calculated through a proprietary algorithm by a high-resolution 4-channel EEG monitor after advanced artifact rejection. Values in the range of 25–50 are adequate. The BIS algorithm is also a proprietary, complex algorithm that was derived empirically and iteratively using an EEG database and behavioral scales among subjects exposed to different anesthetic protocols.

Observer's Assessment of Awareness/Sedation (OAA/S) is a common clinical scoring to assess the level of patient sedation. It utilizes four parameters—responsiveness, speech, facial expression, and eyes.

Traditionally clinical endpoints are utilized to assess adequate dosage of propofol for induction of anesthesia. There are times when this leads to an inappropriate dosage being administered. BIS and PSI have been studied as endpoints of sedation with midazolam or fentanyl. As the data in our Indian subjects are sparse, this study was formulated to evaluate and compare BIS and PSI with OAA/S in predicting the loss of consciousness from a standardized general anesthetic technique in Indian patients undergoing laparoscopic cholecystectomy. There has been no study that compares BIS, PSI, and clinical parameters for propofol induction in the Indian population. We hypothesize that the dosage used will be the same if PSI/BIS or clinical parameters are utilized for end of propofol induction. The primary aim was to evaluate the dosage of propofol needed for induction of anesthesia as evaluated by PSI, BIS, or OAA/S, whereas hemodynamic effects at different stages of surgery, the time needed to reach endpoints for extubation as well as any adverse effects noted were the secondary objectives of the study.

Material and Methods

The study was conducted after approval of the Institutional Ethics Committee and registration at the Clinical Trials Registry of India [CTRI/2020/01/022634] and completed in 9 months. We were able to assess seventy-four patients randomized to three groups as shown in the consort diagram [Figure 1]. Seventy-four patients, of either sex, aged 18–65 years, American Society of Anesthesiologists (ASA) grade of I-II scheduled for elective laparoscopic cholecystectomy under general anesthesia were included in the study. Refusal to participate, hemodynamic instability, cardio-respiratory compromise, hepatic, renal, or metabolic diseases, and in whom laparoscopy surgery was converted to open cholecystectomy were excluded from the study.

The patients fasted for 6 h for solid food and 2 h for clear fluid before surgery. Tablet alprazolam 0.25 mg orally was administered the night before and in the morning 2 h before surgery with a sip of water. The patients were randomly allocated into three groups utilizing the table of random numbers by entering values online. Groups were based on the type of monitor utilized for the depth of anesthesia. Group A consisted of patients monitored by PSI (SedLine). Group B with patients monitored by BIS (Medtronic), and Group C with patients monitored by OAA/S.

On shifting to OR and attaching the standard monitoring, that is, electrocardiogram, pulse oximeter, and noninvasive blood pressure measurement were applied. The skin over the forehead was cleaned with isopropanol and PSI (Group A), BIS (Group B), or nothing (Group C) was attached to the forehead as per the group allocation of the patient. The baseline values were recorded. Anesthesia induction in all patients was standardized; preoxygenation was started 3 min before the administration of intravenous injection (inj.) of propofol infusion at the rate of 30 mg/kg/h to achieve the desired endpoint of induction as per group allotment. Preoxygenation was done for 3 min before propofol infusion. For Group A, the infusion was stopped once a PSI value of 25 ± 2 was achieved. Similarly, for Group B, a BIS value of 48 ± 2, and in Group C OAA/S value of ≤2 was used as the endpoint of induction. All values were observed by the resident who is an investigator for this study.

The total dose of propofol utilized to achieve induction endpoints was noted. Inj. fentanyl 2 μg/kg followed by inj. vecuronium 0.1 mg/kg to facilitate endotracheal intubation with an appropriate sized cuffed endotracheal tube were administered. Anesthesia was maintained with 50% nitrous oxide in oxygen, sevoflurane (0.8–1.2 MAC), and intermittent boluses of fentanyl and vecuronium. Inhalational agent administration was stopped after withdrawal of the laparoscope by the surgeon and inj. paracetamol 15 mg/kg intravenously was administered. Neuromuscular blockade was reversed with inj. neostigmine (0.05 mg/kg) and inj. glycopyrrolate (0.01 mg/kg) and the patient was extubated. Extubation was started once adequate reversal of neuromuscular block was achieved and a PSI value of more than 50 (Group A), BIS value of more than 60 (Group B), and an OAA/S score of >4 was achieved. Time for achieving adequate extubation was noted. Patients were transferred to the post anesthesia care unit (PACU) and later shifted to the ward on achieving an Aldrete score ≥9. The values of BIS and PSI were recorded at preinduction, at induction, intubation, at the creation of pneumo-peritoneum, and at deflation of pneumo-peritoneum and after extubation.

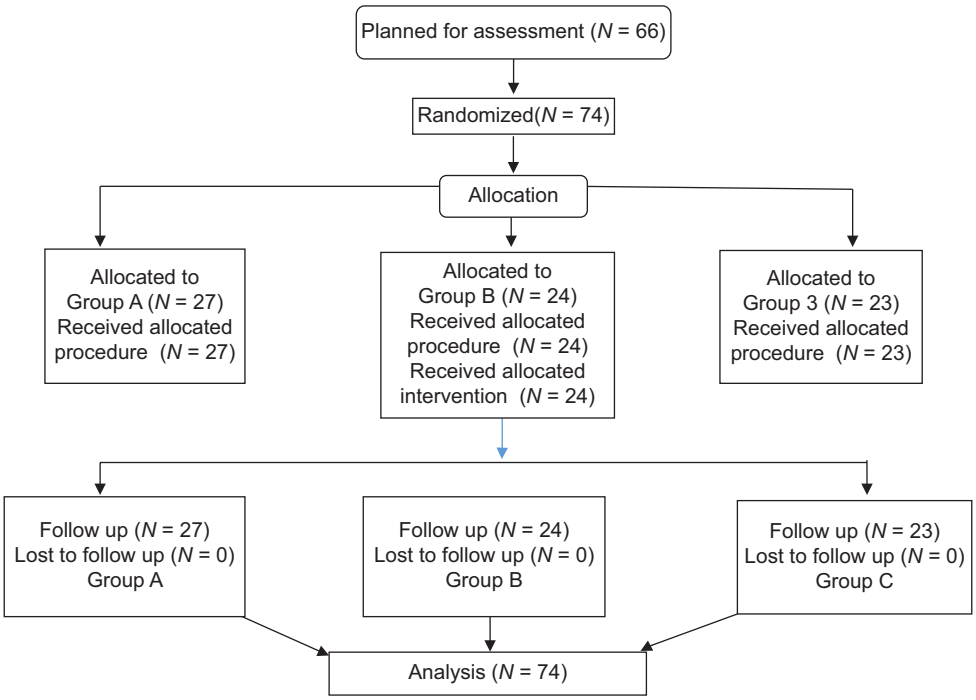

Figure 1: Consort diagram

Results

To determine a sufficient sample size, power analysis for one-way analysis of variance (ANOVA) was conducted in G-POWER. The difference between the three groups using an alpha of 0.05, a power of 0.80 (80%), an effect size of 0.4 (medium effect size for one-way ANOVA using Cohen's convention), and two tails were taken. There was an equal allocation of participants into each group. Based on the aforementioned assumptions, 66 patients, 22 in each arm were required for the study. Seventy-four patients were included in the study even though the sample size was 66 as the power of the study was adjusted during the end of the study with the COVID-19 pandemic making it difficult for the team to complete the initial larger sample size. However, the corrected power has not affected the significance of the study.

Data were analyzed using the statistics package SPSS 26.0 version for Windows. Descriptive data are represented as mean ± standard error (SD), median (interquartile range [IQR]) for numerical variables, and percentages and proportions for categorical variables. Appropriate tests of significance were used depending on the nature and distribution of variables such as repeated measures ANOVA, one-way ANOVA followed by *post hoc* test Bonferroni. For continuous variables, the mean difference between two independent groups was tested using the independent *t*-test. $P < 0.05$ was considered statistically significant.

The patients in the groups were identical with respect to demographic profiles as shown in Table 1. The mean (SD) dose of propofol utilized for induction of anesthesia was 136.1 (16.95) mg (Group A), 125.7 (15.45) mg (Group B), and 130.96 (±15.07) mg (Group C), respectively. The difference in the dosage of propofol needed for induction was statistically significant ($P = 0.04$). Intergroup comparison of propofol dosage utilization difference between Groups A and B were 136.1 ± 16.95 mg vs. 125.7 ± 15.45 mg ($P = 0.01$), Groups B and C were 125.7 ± 15.45 vs. 130.96 ± 15.07 mg ($P = 0.24$), and Groups A and C were 136.1 ± 16.95 vs. 130.96 ± 15.07 mg ($P = 0.26$). Also, 70.37% of patients in Group A, 74% of the patients in Group B, and 65.2% of the patients in Group C reported no pain on injection. The incidence was comparable between the groups ($P = 0.25$). Involuntary movements were seen in eight patients. Four patients belonged to Group A, three in Group B, and one in Group C.

Hemodynamic variables such as heart rate, systolic, and diastolic blood pressure were comparable at different time intervals [Tables 2–4 respectively]. Comparable values of BIS and PSI at different times are shown in Table 5.

Discussion

Depth of anesthesia is influenced by the type of anesthetic agents used, the age and physiology of the patient, and the use of concomitant medication.[7] Algorithms are derived from

specific parameters of the EEG to accurately predict the depth of anesthesia and expressed as a simple, easy-to-read number. Two such monitors are BIS and PSI. BIS is among the most popular EEG monitor worldwide utilized for monitoring the intraoperative depth of anesthesia. The BIS is determined by parameters, which are Sync Fast Slow, a sub-parameter derived from the analysis of the bispectrum, relative β ratio, and burst suppression ratio.[8] In contrast, the PSI assesses purely quantitative EEG changes in alpha and beta between electrodes, and total spectral power in the frontopolar region. Both PSI and BIS are calibrated between 0 and 100 with lower numbers depicting the greater depth of anesthesia. The recommended electroencephalographic indices during general anesthesia are lower for PSI (25–50) when compared to BIS (40–60). This range is required so that it may allow for accurate dosing of the anesthetic agent and reduce the risk of intraoperative awareness. In our study, we have taken the values as 25 ± 2 for PSI and 48 ± 2 for BIS.[9,10] The PSI monitor has the added advantage of advanced artifact rejection such as electocautery.[11]

Table 1: Demographic profile of the study population

Parameter	Group A (*n*=27)	Group B (*n*=24)	Group C (*n*=23)	*P*
Age				
Mean (± SD)	42.92 (± 11.72)	45.73 (± 11.40)	46.26 (11.40)	0.54
Range	22-64	25-65	28-64	
Male: female	4:23	3:20	1:22	0.46
ASA (I: II)	18:09	14:09	15:08	0.9
Weight (Kgs)				
Mean (± SD)	61.22 (± 8.23)	61.19 (± 7.1)	61.34 (± 7.27)	0.99
Range	47–72	48-78	48-78	
Height (cm)				
Mean (± SD)	155.48 (± 5.58)	156.65 (± 6.16)	157.69 (± 6.08)	0.42
Range	147–166	144-167	149-172	
BMI (Kg/m^2)				
Mean (± SD)	25.22 (± 2.43)	24.85 (± 2.42)	24.77 (± 2.85)	0.8
Range	20.7-28.69	20.2-32	20.3-32.09	

The plasma concentration of propofol depends on factors such as the age of the patient, dose, body weight, gender, infusion rate, and cardiac output.[12] Studies have shown that the plasma effect-site concentration is influenced by a complex interaction of rate, dosage, and duration of anesthetic exposure and physiologic factors for intravenous anesthetic.[13] Various infusion rates of propofol have been used. Gürses *et al*.[7] administered propofol at 2 mg/kg and at the infusion rate of 20 mg/kg/h by an infusion pump in their three groups of patients

Table 2: Heart rate changes between the groups

Time	Normal Distribution	Group A (*n*=27)	Group B (*n*=24)	Group C (*n*=23)	*P*
Pre induction	Mean±SD	84.40±12.50	80.34±8.47	80.73±11.9	0.36
Intubation	Mean±SD	91.11±6.39	90.78±10.24	93.39±8.94	0.5
Post intubation at 2 min	Mean±SD	89.19±7.94	92.86±6.84	94.78±7.39	0.29
Post insufflation at 2 min	Mean±SD	82.81±6.71	85.82±4.32	85.34±5.17	0.15
Post deflation at 2 min	Mean±SD	85.7±5.55	88.21±4.18	88.47±4.90	0.11
Extubation	Mean±SD	98.88±7.17	96.95±6.19	98.65±5.88	0.53

Table 3: Changes in systolic blood pressure (mmHg) (Mean±SD) among the groups

Time	Normal distribution	Group A (*n*=27)	Group B (*n*=24)	Group C (*n*=23)	*P*
Pre induction	Mean±SD	132.2±16.70	128.2±12.88	121.1±11.52	0.03
Intubation	Mean±SD	128.1±14.90	129.6±11.81	125±9.18	0.4
Post intubation at 2 min	Mean±SD	132.5±14.53	134.5±8.47	126.6±6.9	0.1
Post insufflation at 2 min	Mean±SD	127.2±11.43	124.2±10.45	122.31±6.64	0.2
Post deflation at 2 min	Mean±SD	131.2±6.69	131.7±5.67	128.3±10.05	0.26
Extubation	Mean±SD	144.7±11.42	147.3±10.99	143.0±8.95	0.19

Table 4: Changes in diastolic blood pressure (mmHg) (Mean±SD) among the groups

Time	Normal distribution	Group A (*n*=27)	Group B (*n*=24)	Group C (*n*=23)	*P*
Pre induction	Mean±SD	78.37±7.47	75.39±6.32	77.65±6.66	0.29
Intubation	Mean±SD	82.48±8.85)	84.47±3.16	87.65±3.84	0.13
Post intubation at 2 min	Mean±SD	86.11±7.45	83.91±5.29	89.43±8.02	0.08
Post insufflation at 2 min	Mean±SD	79.07±5.58	77.56±7.94	82.73±5.60	0.51
Post deflation at 2 min	Mean±SD	82.85±6.47	79.8±6.70	84.95±7.81	0.59
Extubation	Mean±SD	97.33±3.21	93.26±9.16	93.56±6.07	0.05

Table 5: Comparison of PSI and BIS values at specific end points

Time	Group A	Group B
Pre induction	100	99.3
Induction	25.2	44.26
Intubation	26.8	46.2
Post intubation at 2 min	30.9	50.6
Post insufflation at 2 min	31.59	45.35
Post deflation at 2 min	30.26	48.83
Extubation	72.2	80.7

in determining the propofol requirement and hemodynamic effects as guided by BIS during the induction of anesthesia. Induction doses of propofol are variable at administration rates of <20 mg/kg/h. Wei–Dong *et al*.[14] used a rate of 30 mg/kg/h of propofol infusion until the BIS value reached 45 ± 5 for induction in assessing the hemodynamic and EEG responses to intubation during propofol or propofol/fentanyl induction. Singh *et al*.[15] used propofol infusion at 1 mg/kg/min and followed it with 200 μg/kg/min until skin incision. Target controlled infusion provides a better correlation; however, because it was not available, in lieu of the study of Wei–Dong *et al*. and Arya *et al*. we have used the propofol infusion of 30 mg/kg/h in all groups.

The use of BIS, when compared to PSI, was associated with a reduction in the dosage of propofol for induction in our study, which was found to be statistically significant (125.7 ± 15.45 mg compared to 136.1 ± 16.95mg) ($P = 0.01$) in our study. We found that the use of BIS was associated with a reduction in the dosage of propofol for induction when compared with the clinical method OAA/S of evaluation. This was, however, not found to be statistically significant (125.7 ± 15.45 mg compared to 130.96 ± 15.07 mg) ($P > 0.05$). This reduction in induction dosage of propofol was supported by previous studies. Luginbühl *et al*.[16] had concluded from their study that BIS monitoring reduced propofol usage and hastened recovery after propofol anesthesia. Soehle *et al*.[10] had concluded that both the PSI and the BIS monitors predict the depth of propofol anesthesia with a similar and sufficiently high probability. We observed an overall decrease of 5% though studies have described an overall decrease of 10–40%. This could be explained by the lower cut-off value taken for BIS (48 ± 2). The use of the clinical method OAA/S was associated with a reduction in dosage of propofol for induction in our study when compared with PSI for evaluation. This was, however, not found to be statistically significant (130.96 ± 15.07 mg compared to 136.1 ± 16.95 mg) ($P > 0.05$). Lee *et al*.[11] had concluded that the PSI index is well correlated with the MOAA/S scale and effectively distinguishes the level of sedation during propofol infusion.

Hemodynamic variables such as systolic blood pressure, diastolic blood pressure, heart rate, and corresponding changes in BIS/PSI were compared at different times. No significant changes were observed in blood pressure and heart rate. Arya *et al*.[17] in their study had concluded that the hemodynamic variables including heart rate, systolic/diastolic blood pressure, and BIS were comparable within the group at induction, post-induction, and intubation. Hemodynamic variations among the three groups and their corresponding changes in BIS/PSI values were evaluated at different times of the study. A comparison of PSI and BIS changes at different times showed insignificant changes in BIS after induction; however, we could observe a significant increase in the values for both groups after intubation. Chen *et al*.[18] in their study has also shown the increase in BIS and PSI values following intubation. A significant increase in values could be seen in both groups after extubation.

There was no significant difference between the three groups with respect to the time of resumption of spontaneous respiration after administration of the reversal agent, time of regaining spontaneous respiration, time for eye-opening/protrusion of tongue, and time for extubation. Schneider *et al*.[19] in their study had measured the ability of PSI and BIS to distinguish consciousness from unconsciousness during induction and emergence from anesthesia and a period of awareness in surgical patients and estimated that the BIS and PSI as comparable but insufficient to detect awareness. Sang–Hwan *et al*.[20] in their study, had demonstrated that BIS and PSI can both be used to monitor the maintenance state and recovery state.

On administration of propofol, involuntary movements were seen in eight patients in our study. Four of the patients belonged to the PSI group, three to the BIS group, and one to the OAA/S group. There were no changes observed in the PSI and BIS monitors during involuntary movements. Unlike BIS and PSI, OAA/S does not allow a continuous method of evaluating consciousness. Involuntary movements unrelated to the light plane of anesthesia were seen in propofol induction as shown in their study by Boey *et al*.[21] This is attributed to the fact that the excitatory effects caused by propofol are not associated with EEG activity and are subcortical in origin. Around 30% of the patients reported pain while being injected with propofol mixed with lignocaine. This is in line with the studies already conducted on propofol administration with lignocaine.[22,23]

Our study had certain limitations. A small number of patients undergoing only one type of surgical procedure were studied. The majority of the recruited patients were from the female population. This may have influenced the result. The effect

of the sex of the patient on the effects on BIS and PSI with induction dosage of propofol can be studied further. Even though BIS monitoring has shown certain statistically significant values, this does not, however, translate to be of clinical significance. As only healthy patients were considered for this study, how effective these monitors are in patients with comorbidities or among elderly patients remains to be seen.

Conclusion

In conclusion, we state that BIS, PSI, and OAA/S have all shown good measures of assessment for induction dose requirement with propofol. We could say that the clinical method of titrating the dose of propofol for induction and anesthetic depth by the loss of verbal response is comparable to both BIS and PSI monitoring.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Bruhn J, Myles PS, Sneyd R, Struys MMRF. Depth of anaesthesia monitoring: What's available, what's validated and what's next? Br J Anaesth 2006;97:85-94.
2. Ranta SO, Laurila R, Saario J, Ali-Melkkila T, Hynynen M. Awareness with recall during general anesthesia: Incidence and risk factors. Anesth Analg 1998;86:1084-9.
3. Dutton RC, Smith WD, Smith NT. EEG predicts movement response to surgical stimuli during general anesthesia with combinations of isoflurane, 70% N2O, and fentanyl. J Clin Monit 1996;12:127-39.
4. RampilIJ, Matteo RS. Changes in EEG spectral edge frequency correlate with the haemodynamic response to laryngoscopy and intubation. Anesthesiology 1987;67:139-42.
5. Liu J, Singh H, White PF. Electroencephalogram bispectral analysis predicts the depth of midazolam-induced sedation. Anesthesiology 1996;84:64-9.
6. Drover D, Ortega HR. Patient state index. Best Pract Res Clin Anaesthesiol 2006;20:121-8.
7. Gürses E, Sungurtekin H, Tomatir E, Dogan H. Assessing propofol induction of anesthesia dose using bispectral index analysis. Anesth Analg 2004;98:128-31.
8. Loskota WJ. Intraoperative EEG monitoring. Semin Anesth Perioperat Med 2005;24:176-85.
9. Drover DR, LemmensHJ, Pierce ET, Plourde G, Loyd G, Ornstein E, *et al*. Patient state index titration of delivery and recovery from propofol, alfentanil, and nitrous oxide anesthesia. Anesthesiology 2002;97:82-9.
10. Soehle M, Kuech M, Grube M, Wirz S, Kreuer S, Hoeft A, *et al*. Patient state index vs bispectral index as measures of the electroencephalographic effects of propofol. Br J Anaesth 2010;105:172-8.
11. Lee KH, Kim YH, Sung YJ, Oh MK. The Patient State Index is well balanced for propofol sedation. Hippokratia 2015;19:235-8.
12. Adachi YU, Watanabe K, Higuchi H, Satoh T. The determinants of propofol induction of anesthesia dose. Anesth Analg 2001;92:656-61.
13. Ludbrook GL, Visco E, Lam AM. Propofol: Relation between brain concentrations, electroencephalogram, middle cerebral artery blood flow velocity, and cerebral oxygen extraction during induction of anesthesia. Anesthesiology 2002;97:1363-70.
14. Mi W-D, Sakai T, Takahashi S, Matsuki A. Haemodynamic and electroencephalograph responses to intubation during induction with propofol or propofol/fentanyl. Can J Anaesth 1998;45:19-22.
15. Singh H, Sakai T, Matsuki A. Movement response to skin incision: Analgesia vs. bispectral index and 95% spectral edge frequency. Eur J Anaesthesiol 1999;16:610-4.
16. Luginbühl M, Wüthrich S, Petersen-Felix S, Zbinden AM, Schnider TW. Different benefit of bispectal index (BIS™) in desflurane and propofol anesthesia. Acta Anaesthesiol Scand 2003;47:165-73.
17. Arya S, Asthana V, Sharma JP. Clinical vs. bispectral index-guided propofol induction of anesthesia: A comparative study. Saudi J Anaesth 2013;7:75-9.
18. Chen X, Tang J, White PF, Wender RH, Ma H, Sloninsky A, *et al*. Acomparison of patient state index and bispectral index values during the perioperative period. Anesth Analg 2002;95:1669-74.
19. Schneider G, Gelb AW, Schmeller B, Tschakert R, Kochs E. Detection of awareness in surgical patients with EEG-based indices: Bispectral index and patient state index. Br J Anaesth 2003;91:329-35.
20. Ji SH, Jang YE, Kim EH, Lee JH, Kim JT, Kim HS, *et al*. Comparison of bispectral index and patient state index during sevoflurane anesthesia in children: a prospective observational study. 2020. doi:10.21203/rs.3.rs-53378/v1.
21. BoeyWK, Kumar A. Comparison of propofol and thiopentone as induction agents for laparoscopy. Singapore Med J 1991;32:150-3.
22. Gehan G, Karoubi P, Quinet F, Leroy A, Rathat C, Pourriat JL. Optimal dose of lignocaine for preventing pain on injection of propofol. Br J Anaesth 1991;66:324-6.
23. King SY, Davis MF, Wells EJ, Murchison DJ, Pryor PJ. Lidocaine for the prevention of pain due to injection of propofol. Anesth Analg 1992;74:246-9.