Original

Anesthesia Depth Measurement with Bispectral Index Monitoring during Minor Surgery among Children With and Without Cerebral Palsy

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Abstract

Introduction: Unfortunately, few studies have been performed on the pharmacodynamic effects of anesthesia in children suffering cerebral palsy(CP).Patients were candidates for surgery for various reasons. Due to the lower need for anesthesia in these children, side effects of various anesthetic agents, adverse drug reactions, delayed awareness and higher costs can be prevented in these children. The present study aims to evaluate and compare the depth of anesthesia in minor surgeries using Bispectral Index (BSI) in children suffering CP.

Materials and Methods: This cross sectional study was performed on 64 children aged two to ten years in two groups with and without cerebral palsy in Mofid Hospital, Tehran, Iran in 2020. BIS index, mean arterial blood pressure and heart rate were measured before and after anesthesia induction, every ten minutes during operation, after extubation and

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when being able to respond to verbal stimulation.

Results: This study examined 64 patients equally divided into two study groups "with and without cerebral palsy". The mean BIS level in children suffering CP was lower than children without cerebral palsy. The dosage of isoflurane gas used for anesthesia in CP patients was meaningfully lower than its dosage in children without cerebral palsy.

Conclusion: Monitoring of anesthesia in this study, showed that use of BIS could reduce the use of anesthetic agents and related side effects to provide the appropriate depth of anesthesia.

Keywords

- Anesthesia depth
- Cerebral palsy
- BIS index

Introduction

Awareness during surgery is unwanted and can have long-term behavioral and psychological consequences. This condition can lead to post-traumatic stress disorder (PTSD) in the form of behavioral disorders, sleep disorders and unwanted phobias.[1] Awareness during anesthesia has been reported to be four to eight times higher in children than in adults.[2] Bispectral Index (BIS) is a parameter that calculates the index using EEG processing over the last 15-20 seconds and is updated every second.[3] The range of this index varies from zero "complete suppression of brain activity" to 100 "awareness". In general, a number between 40 and 60 is appropriate for surgical anesthesia, which prevents awareness and avoids the administration of additional doses of drugs.[4] Accordingly, this range of BIS is used for more effective drug use, faster recovery from anesthesia, shorter extubation time, and better recovery after surgery.[5]

The prevalence of cerebral palsy (CP) has been reported in about two cases per 1000 live births in various studies, and these children have different sensitivity to anesthetic agents compared to healthy ones.[6, 7] Unfortunately, few studies have been conducted on the pharmacodynamic effects of anesthesia in children suffering CP, who are candidates for surgery for a variety of reasons. The most common surgeries in these children include tooth restoration and extraction, gastroesophageal reflux correction, spinal fusion correction and other neurosurgical procedures to control spasticity and orthopedic and soft tissue procedures of the upper and lower limbs.[8] Studies have shown that using the same agents to induce and maintain anesthesia in patients with CP results in greater depth of anesthesia and more delayed awareness.[9] In addition, the use of anticonvulsants in these children reduces the need for anesthetics.[10] Due to the lower need for anesthesia in these children, side effects of multiple anesthetic drugs, adverse drug reactions, delayed awareness and higher costs can be prevented in these children.[11]Regarding aforementioned, the present study aims to evaluate and compare the depth of anesthesia in minor

surgeries using the BIS index in pediatric patients with and without CP.

Materials and Methods

The present cross sectional study was performed on 64 children admitted in Mofid Hospital, Tehran, Iran in 2020. Patients were 2 to 10 years old .Class I or II of ASA indexare included in the study for minor dental or orthopedic surgeries with duration of less than two hours. Among the participants, those who had syndromes, uncontrolled seizures, renal or hepatic failure, anemia, hemorrhage, intraoperative transfusion and surgery lasting more than two hours were excluded from the study. The research has been approved by the Research Institute of Children Health - Shahid Beheshti University of Medical Sciences (IR.SBMU.RICH.REC.1399.036), and all parents expressed their consent for their children to participate in the study. Finally, 32 patients suffering CP and 32 children without CP were included in the two study groups. Routine monitoring in these patients, such as pulse oximetry, 3-lead electrocardiography, non-invasive arm blood pressure monitoring, capnography and BIS index monitoring were performed for all patients and the baseline data were recorded. BIS index was obtained by monitoring four points on the forehead of children with gelatinous leads (Covidien IIC, VISTA, USA). The device actually split the EEG signals into qualitative numbers between zero (full brain suppression) and 100 (full awareness).

After three minutes of pre-oxygenation, induction was performed with 8% sevoflurane and 8 l/min of oxygen via mask. After lowering the level of awareness, IV Line was established and three minutes after injection of 0.5 mg/kg atracurium and 2 μ/kg fentanyl, intubation was performed with an endotracheal tube suitable for age and weight and patients were connected to ventilator with a pressure control ventilation mode while maintaining 30-35 ETCO2 (End Tidal CO2). Maintenance of anesthesia was performed with approximately 1MAC (Minimum Alveolar Concentration)of isoflurane. During surgery, the BIS number was recorded every 10 minutes, and in the case of a BIS above 60, the MAC of isoflurane increased to 1.5,and if it was not enough, infusion of propofol was started and was documented in the check list. If the BIS number was less than 40, the MAC of isoflurane was reduced and recorded in the checklist. Monitoring subjects included heart rate, MAP, baseline BIS, BIS scale of post-induction and post-intubation, BIS number at the beginning of surgery, then every 10 minutes during surgery, in the end of surgery, after extubation, and when being able to respond to verbal stimulation. The control group used in this study were patients without CP who were selected by simple random sampling.

Statistical analysis

After collection, data were entered into SPSS. Frequency and percentage were used to explain qualitative variables, while mean and standard deviation were used to describe indices of quantity. T-test, ANOVA and Chi Square tests were used to assess the relationship. Then, regression modeling was used to control confounding variables. All P-values below 0.05 were considered of significance.

Results

Sixty four patients (36 boys) are equally divided into two study groups, including those suffering CP and those without it. Three patients in without CP group were excluded because they needed propofol infusion in order to maintain appropriate depth of anesthesia. The mean age and weight of study participants were 4.771.86 ± years and 16.70 3.71± kg. The most commonly-observed underlying disease among the participants in the study is ADHD (Attention deficit hyperactivity disorders), and others suffered arthrogryposis, autism and seizures, respectively. The mean duration of surgery in the participants was76.6418.98± minutes. In this study, the age of children with CP is significantly higher than the age of non-CP children (5.661.66± vs. 3.881.62± years; P <0.001). The mean weight of children in the CP group was significantly lower than children without CP (14.972.34± vs. 16.84 3.98± kg; P = 0.02) **Table 1**.

Table 1: comparing demographic variables between two study groups

GroupsVariables	CP group	Non-CP group	P-value
Age (years)	5.66±1.66	3.88±1.62	< 0.001
Gender (male)	18	18	0.99
Weight (kg)	14.97±2.34	16.84 ±3.98	0.02

In this study, the mean duration of surgery was not significantly different between the two groups of children (76.72 19.16± minutes vs. 76.56 19.11± minutes; P = 0.97). Furthermore, there was a significant relationship between the type of surgery performed between the two groups of children (P = 0.012). Minor orthopedic operations were more common in CP group and the dental surgeries were common in both groups. The mean heart rate and mean arterial pressure among children undergoing surgery were similar between two groups.

As presented in **Figure 1**, although all of BIS scores within the operation time were in safe range (40-60),mean of BIS scores at the baseline (95.94±2.31 vs. 99.13±0.83; P<0.001) and awareness time (90.30±3.33 vs. 93.03±5.71; P=0.03) in the CP group were significantly lower than patients without CP.

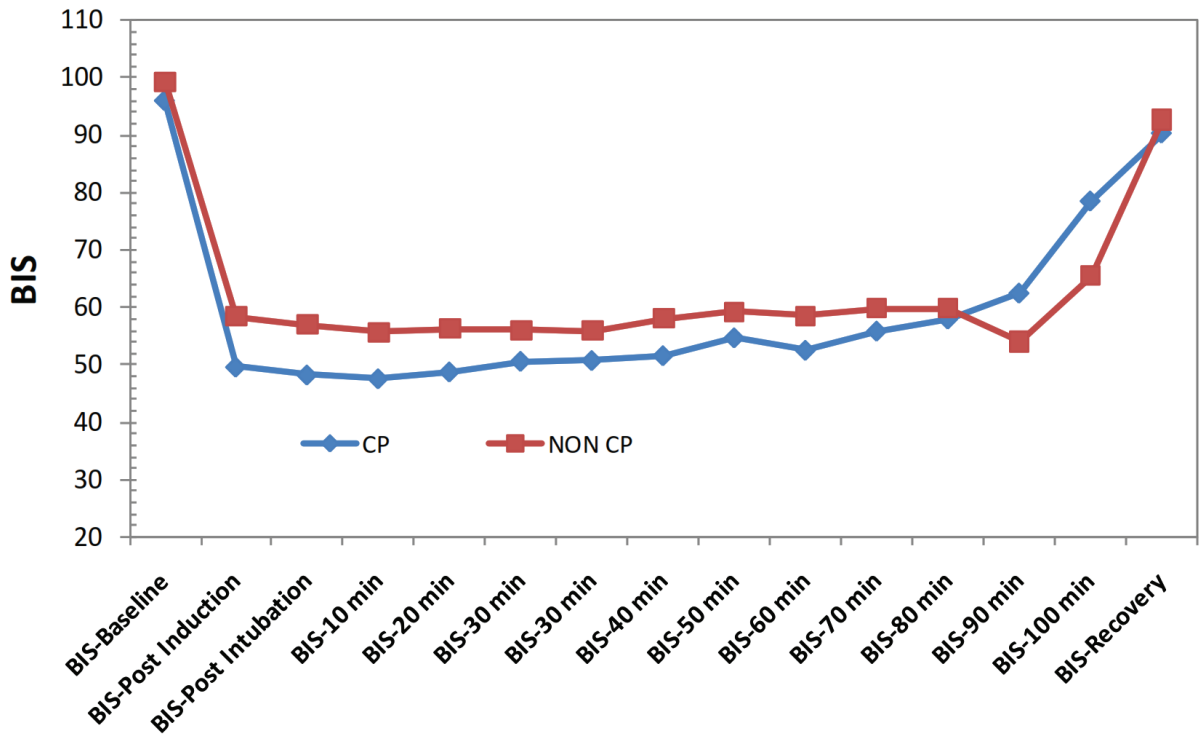

Figure 1: Comparing BIS score at the awareness time and during of anesthesia between children of two study groups.

In this study, although the mean BIS score in CP patients with history of seizure and treatment with anticonvulsant drugs was lower than other patients suffering CP, this difference was not meaningful. In this study, the rate of isoflurane gas used in anesthesia of CP group was significantly lower than the rate of isoflurane used in patientswithout CP, as was presented in **Figure 2**. On the other hand we used less Isoflurane gas for patients suffering CP **Table 2**. Also in this study, the intake of isoflurane gas in patients under three years of age was higher than its intake in children older than three years old, but this difference was not significant.

Table 2: frequency distribution of Isoflurane gas consumption among study participants in different measurement time

Study variable	CP patients	Non-CP patients	P-value
ISO1	0.93±0.13	1.15±0.11	<0.001
ISO2	0.93±0.17	1.30±1.87	<0.001
ISO3	0.93±0.21	1.28±0.18	<0.001
ISO4	0.95±0.20	1.22±0.18	<0.001
ISO5	0.90±0.19	1.20±0.21	<0.001
ISO6	0.93±0.16	1.17±0.19	<0.001
ISO7	0.86±0.19	1.09±0.25	<0.001
ISO8	0.77±0.20	1.05±0.39	0.004
ISO9	0.76±0.19	1.03±0.35	0.02
ISO10	0.71±0.23	1.04±0.33	0.02
ISO11	0.6±0.18	1.06±0.38	0.03
ISO12	0.40±0.01	1.45±0.07	0.002

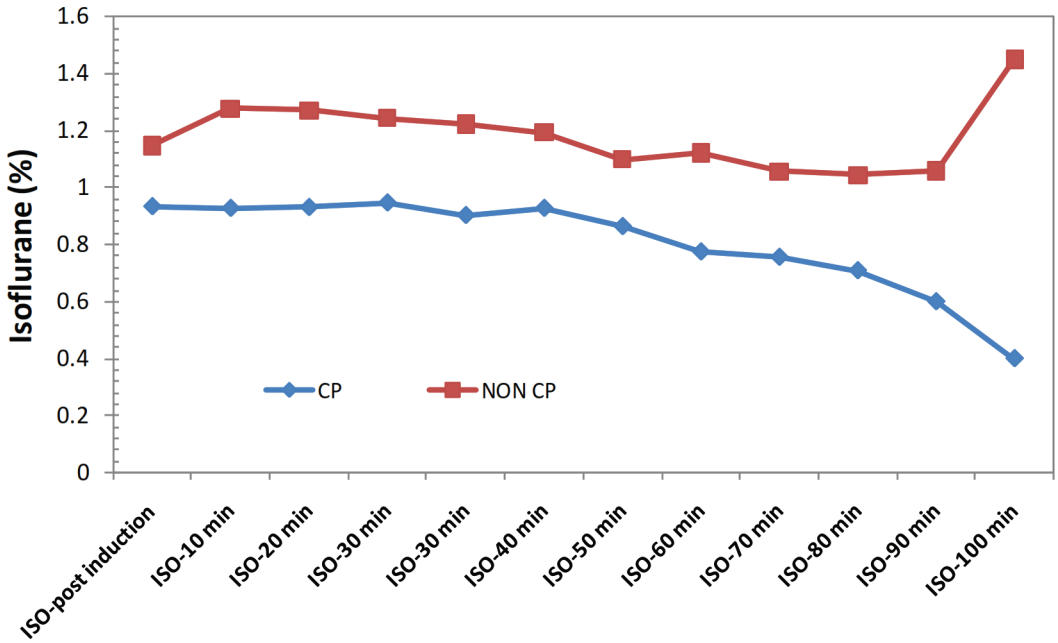

Figure 2: Comparing Isoflurane gas used during anesthesia between children of two study groups

Discussion

The present research has been performed to evaluate the strength of the BIS index in assessing the depth of anesthesia in patients suffering CP and compare it with other children. The mean weight and duration of surgery in patients with and without CP were not significantly different. In this study, BIS index was used to monitor the depth of anesthesia in patients undergoing surgery. Similar studies have used the BIS index to estimate the anesthesia depth in surgeries, especially in children. In their study in 2018, Silva et al, reported that in induction of anesthesia for children with various types of mental disabilities such as Lennox_Gastant, west syndrome, CP and seizures, BIS provided researchers with more relevant data on the anesthesia depth compared to the other two indices of anesthesia depth monitoring including SEP 95 and TP.[4]

The mean BIS level among patients with CP was significantly lower than children without it. This result was observed in various other studies. For example, Kim et al., in their study in 2019 showed that the BIS number in the group of children suffering CP was lower than the BIS number in normal children.[6] Another study by Saricaoglu et al., compared the monitoring power of the BIS in controlling anesthesia and the content of propofol needed to reach the anesthesia depth in children with cerebral palsy and normal children undergoing orthopedic operations. The study also found that patients suffering CP needed less propofol than children without CP to reach a BIS level. The induction dose of propofol was also significantly lower in patients suffering CP. In this study, no significant difference was observed in the required dosage between patients undergoing anticonvulsant treatment and other children with CP.[8]

In the present study, the dosage of isoflurane gas used in anesthesia of patients suffering CP was meaningfully lower than the dosage of isoflurane gas used in children without CP. Another study was performed in 2015 on children with developmental delay and the BIS index was used to control the anesthesia depth in this study. Patients were grouped in two and in the first group, anesthesia was maintained with 1 to 2 MAC of sevoflurane with oxygen and in the second group, the content of sevoflurane was adjusted using BIS. The outcome of this research demonstrated that the recovery time of spontaneous ventilation and the time of extubation and ICU admission time were significantly lower in the second group.[5] In other words, the results observed in this study, like our study, proved that the use of BIS to estimate the depth of anesthesia, can regulate the souflurane content in patients under anesthesia.

In this study, the consumption of isoflurane gas in children under three years of age was more than that of children over three years and the difference was significant. In a study in 2015 on patients with neurological disorders including CP, autism, mental retardation with and without seizures, who undergone general anesthesia for dental surgery, researchers found that the use of an anticonvulsant agent to control seizures resulted in significant reduction of the amount of propofol required for infusion compared to circumstances, in which it was not used.[11]

Conclusion

The outcomes of our study demonstrated that the use of BIS index in monitoring patients suffering CP can reduce the amount of anesthetic agents necessary to provide the appropriate depth of anesthesia for surgery. Therefore, utilizing the BIS index to control the depth of anesthesia not only to manage the anesthesia more efficiently but also to reduce the side effects of anesthetic agents in patients suffering CP is recommended.

Ethical Consideration

This study was approved by Research Institute of Children Health - Shahid Beheshti University of Medical Sciences with code number IR.SBMU.RICH.REC.1399.036

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Conflict of interests

There is no conflict of interest.

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