THE EFFECTS OF LISTENING TO THE MOTHER’S HEARTBEAT ON THE DEPTH OF ANAESTHESIA IN CHILDREN

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Abstract

**Background:** The present study aimed to evaluate the effects of listening to the mother’s heartbeat and womb sounds on the depth of anaesthesia in children.

**Methods:** The present study included 40 children scheduled for minor surgery under general anaesthesia, with an American Society of Anaesthesiologists (ASA) status of 1 to 2. Anaesthesia was induced with sevoflurane, and maintained with sevoflurane and oxygen in nitrous oxide. Patients were randomly divided into two groups. The children in Group I were made to listen to recordings of their mothers’ heartbeat and womb sounds via earphones during anaesthesia induction, while those in Group II were made to listen to ambient noise via earphones. The music was turned off when the inhalational anaesthetics were discontinued. Intraoperative monitoring included electrocardiogram (ECG) recordings, heart rate (HR), oxygen saturation, non-invasive systolic blood pressure (SBP) and diastolic blood pressure (DBP), bispectral index system (BIS), end-tidal (ET) sevoflurane, ET N₂O, ET CO₂, and SaO₂.

**Results:** In Group I, there was a significant decrease in bispectral index (BIS) values over time (p < 0.05). Although blood pressure and heart rate were lower in Group I, no significant differences between the groups were detected. While the duration of extubation was shorter in Group I, overall, there was no significant difference between the groups.

**Conclusion:** We found that children exposed to recordings of their mothers’ heartbeat and womb sounds in addition to music had lower BIS values under anaesthesia, which indicates deeper anaesthesia levels.

**Keywords:** child, age, audit, depth of anaesthesia.
Introduction

Music is an essential part of human life, and its multifaceted aspects have revived interest in its use in the medical field. Although not curative alone, music has been shown to help in relieving pain, in allowing individuals to express themselves, and in alleviating stress\(^1-3\). The use of music during the anaesthesia phase of surgery could potentially serve as an adjunctive therapy across patient populations, including children.

When treating children, induction of anaesthesia should be carefully monitored, both medically and psychologically. Anaesthesia should prevent the child from experiencing the trauma of the surgical procedure, and not lead to additional trauma. To that end, we considered whether it would be beneficial for patients to listen to music he/she chose during the perioperative period, as a simple, cheap, and non-invasive method in addition to pharmacological methods. (Listening to white noise, which masks ambient noise, has also been found to decrease anxiety and worry, although to a lesser extent than music). Porcaro et al demonstrated that a foetus can respond to a mother’s heart beat and external auditory stimuli\(^4\). Further, in a study evaluating the effects of music on the bispectral index system (BIS) and the sedation levels during the preoperative period, Ganidagli et al found that listening to music during midazolam premedication increased the level of sedation and decreased the BIS values during the preoperative period\(^5\).

The aim of our study was to evaluate the effects of listening to music along with the sound of their mother’s heartbeat and womb sounds on the depth of anaesthesia in children.

Methods

After approval was obtained from the hospital ethics committee, 40 children, aged 0 to 18 months, scheduled for minor surgery and having an American Society of Anaesthesiologists (ASA) status of 1 to 2, were included in the study. Children with hearing problems were excluded. Written informed consent was obtained from the children’s parents, and each child was evaluated preoperatively. Children older than 6 months were premedicated with 0.8 mg/kg intranasal midazolam 20 minutes before the surgery. The BIS monitoring was initiated with the induction of anaesthesia. After anaesthesia was induced with oxygen and sevoflurane, intravenous catheterization was performed. Normal saline (1/3) at a dose of 5-10 ml/h was started, and after muscle relaxation had been achieved with 0.6 mg/kg of rocuronium, anaesthesia was maintained with sevoflurane and 50% \(\text{O}_2\) in 50% \(\text{N}_2\text{O}\). After induction, patients were given 20 mg/kg of rectal or intravenous paracetamol for postoperative pain relief. During the procedures, the minimal alveolar concentration (MAC) of sevoflurane was maintained at 1.5. After the surgery, atropine (0.01 mg/kg) and neostigmine (0.05 mg/kg) were administered to all children to reverse the action of the muscle relaxant. Patients were randomly assigned to two groups: the children in the first group (Group I) listened to their mothers’ heart beat and womb sounds in addition to music, and the children in the second group (Group II) listened to recorded ambient noise via earphones. During anaesthesia induction, the children in Group I listened to a CD recording of their mothers’ heart beat and womb sounds via earphones; the music was turned off when the inhalational anaesthetics were discontinued.

Patients’ age, gender, ASA status, and type of surgery were recorded. The time from the beginning to the end of anaesthesia was defined as “duration of anaesthesia”, and the time from the beginning to the end of surgery was recorded as “duration of surgery”. Extubation time was recorded, and the time interval between the discontinuation of anaesthetic gases and extubation was recorded as “duration of extubation”. In addition, BIS, systolic blood pressure (SBP) and diastolic blood pressure (DBP), end-tidal (ET) sevoflurane, ET \(\text{N}_2\text{O}\), ET \(\text{CO}_2\), and \(\text{SaO}_2\) values were recorded before anaesthesia induction (baseline), at 10-minute intervals during anaesthesia, and immediately after the inhalational anaesthetics were discontinued (recorded as “end of procedure”).

Statistical Analysis

Data were analysed with the statistical package for the social sciences (SPSS Inc., Chicago, IL) version 15.0 software. Repeated measures analysis of variance (ANOVA) was used for the analysis of data.
Least significant difference (LSD) test was used in evaluating the differences. The statistical significance level was set at $p \leq 0.05$.

**Results**

The groups were similar in terms of age, gender, ASA group, duration of anaesthesia, duration of surgery, and duration of extubation ($p > 0.05$; Table 1).

**Table 1**

Demographic data

<table>
<thead>
<tr>
<th></th>
<th>Group I (n = 20)</th>
<th>Group II (n = 20)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>10.6 ± 4.9</td>
<td>12.9 ± 4.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>13/7</td>
<td>17/3</td>
<td>0.13</td>
</tr>
<tr>
<td>ASA status 1 or 2</td>
<td>18/2</td>
<td>19/1</td>
<td>0.69</td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>42 ± 16</td>
<td>40 ± 19</td>
<td>0.44</td>
</tr>
<tr>
<td>Duration of anaesthesia (min)</td>
<td>50 ± 16</td>
<td>49 ± 17</td>
<td>0.74</td>
</tr>
<tr>
<td>Duration of extubation (min)</td>
<td>2.9 ± 2.8</td>
<td>5.2 ± 3.6</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD or n/n, where appropriate.

ASA: American Society of Anaesthesiologists; min: minute.

When the effects of midazolam premedication (performed in children younger than 6 months before anaesthesia) on BIS values were evaluated, no significant difference was found between the groups ($p > 0.05$).

In Group I, SBP, DBP, and heart rate (HR) values showed a significant decrease over time; however, inter-group analysis revealed no significant difference between the groups ($p > 0.05$). In Group I, ET sevoflurane concentrations at 10 and 20 minutes were significantly different from the concentrations at baseline; however, there was no difference between the groups in terms of ET sevoflurane concentrations ($p > 0.05$). Inter-group and intra-group comparisons revealed no difference regarding peripheral oxygen saturation, ET N$_2$O concentrations, and ET CO$_2$ (mmHg) concentrations ($p > 0.05$). However, for Group I, listening to their mothers’ heartbeat and womb sounds in addition to music had a significant effect on BIS values. The BIS value measured at baseline and at the 30-minute interval in Group I was significantly lower than that of Group II ($p < 0.05$).

**Table 2**

The changes in systolic blood pressure (mm Hg), diastolic blood pressure (mm Hg), heart rate, and bispectral index system values over time

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>10 min</th>
<th>20 min</th>
<th>30 min</th>
<th>End of procedure</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I (n = 20)</td>
<td>90 ± 7</td>
<td>83 ± 10</td>
<td>85 ± 8</td>
<td>86 ± 9</td>
<td>94 ± 11</td>
<td>0.275</td>
</tr>
<tr>
<td>Group II (n = 20)</td>
<td>94 ± 12</td>
<td>94 ± 12</td>
<td>95 ± 10</td>
<td>96 ± 10</td>
<td>102 ± 15</td>
<td></td>
</tr>
<tr>
<td>DBP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I (n = 20)</td>
<td>49 ± 6</td>
<td>45 ± 7</td>
<td>47 ± 6</td>
<td>48 ± 8</td>
<td>56 ± 12</td>
<td>0.206</td>
</tr>
<tr>
<td>Group II (n = 20)</td>
<td>49 ± 11</td>
<td>51 ± 9</td>
<td>52 ± 6</td>
<td>52 ± 8</td>
<td>57 ± 17</td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I (n = 20)</td>
<td>143 ± 14</td>
<td>131 ± 12</td>
<td>129 ± 15</td>
<td>122 ± 15</td>
<td>135 ± 18</td>
<td>0.089</td>
</tr>
<tr>
<td>Group II (n = 20)</td>
<td>127 ± 15</td>
<td>121 ± 15</td>
<td>120 ± 14</td>
<td>119 ± 17</td>
<td>128 ± 18</td>
<td></td>
</tr>
<tr>
<td>BIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I (n = 20)</td>
<td>80 ± 8</td>
<td>48 ± 9</td>
<td>49 ± 10</td>
<td>51 ± 10</td>
<td>72 ± 9</td>
<td>0.014</td>
</tr>
<tr>
<td>Group II (n = 20)</td>
<td>73 ± 20</td>
<td>54 ± 13</td>
<td>56 ± 12</td>
<td>58 ± 10</td>
<td>71 ± 10</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD.

SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; BIS: bispectral index system.
Intra-group analysis revealed that the change in BIS values over time was significant at all time points in Group I, while there was a significant difference between the BIS values measured at 10, 20, and 30 minutes in Group II (Table 2).

**Discussion**

At present, the use of pharmacological agents in outpatient practice is limited because of their prolonged effects, and thus researchers continue their efforts to find alternative non-pharmacological methods to prevent patient anxiety. In anaesthesia practice, listening to music during the preoperative period has been found to have an anxiolytic effect.6-8 Individuals are mostly affected by music of their own culture, as that can often better express their emotions, although the choice of music varies according to the social and cultural structure of the population they live in and their education level. Therefore, in our study, infants between the age of 0 and 18 months were made to listen to their mother’s heartbeat and womb sounds (as the most known, familiar, and best-recognized noise) along with music, and its effect on the depth of anaesthesia levels was evaluated using BIS monitoring. Our study demonstrated that listening to the mother’s heartbeat and womb sounds during surgical intervention increased the depth of anaesthesia, as could be seen from the BIS values of the groups (<50 in Group I and >50 in Group II). This finding is consistent with those of Ovayolu et al,9 who reported that listening to Turkish classical music decreased anxiety, pain, and dissatisfaction in patients and reduced the dose of sedative drugs used during colonoscopy.

We found that induction of anaesthesia while maintaining the BIS between 45 and 60 decreased propofol use and allowed rapid awakening. Bannister et al also found that the use of sevoflurane, desflurane, and isoflurane led to rapid awakening and a decrease in the use of anaesthetic drugs.10 Another study revealed that BIS monitoring decreased the dose of anaesthetic drugs, shortened the duration of extubation, and eased awakening.11 Bannister et al10 carried out a study on children between the ages of 0 and 3 years and the ages of 3 and 18 years, who received sevoflurane and 60% N₂O/O₂ as anaesthetics. They created a BIS-controlled group and compared the data of this group with that of a control group given a standard anaesthesia protocol. They found that when the BIS values of children between the ages of 0 and 6 months, who were given combined general/regional anaesthesia, were maintained between 45 and 60, the use of anaesthetic drugs decreased with no effect on awakening and recovery period. These same researchers found that in children aged 6 months to 3 years, who were anaesthetized with BIS-controlled combined general/ regional anaesthesia, the requirement for anaesthetic drugs did not decrease and the recovery time was not affected. BIS-controlled anaesthesia decreased anaesthetic use, and provided early awakening and rapid recovery in older children. Zhang et al12 evaluated the effects of music on the requirement for target-controlled infusion of propofol and demonstrated the beneficial sedative effects of music during combined spinal-epidural anaesthesia. Further, a study evaluating the efficacy of music in providing preoperative sedation by observer’s assessment of alertness/sedation (OAA/SS) and BIS measurements showed that the level of sedation was significantly decreased in the group that listened to music.5

In our study, we found that the duration of extubation was shorter in children who listened to their mothers’ womb sounds (2.9 minutes vs 5.2 minutes for the control group). In addition, they experienced early awakening and rapid recovery; however, there was no significant difference between the two groups.

Besides being used to measure the depth of general anaesthesia, the BIS index is also used to monitor the level of sedation.13 The fact that awareness incidence can be as high as 0.8% clearly shows the importance of monitoring the depth of anaesthesia in paediatric patients.14 As the use of BIS monitoring in children is still being debated, we used traditional monitoring methods along with BIS in this study. In our study, intra-group analysis performed in both groups showed a significant decrease in HR, SBP, and DBP compared to baseline values. However, although the decrease in Group I was higher than that of Group II, there was no significant difference between the groups.

Denman et al15 found that BIS measurements of awake and anaesthetized children between the ages of 1
month and 12 years correlated with the data from adults used as the control group; in other words, BIS values do provide correct clinical information for children. It has also been demonstrated that BIS could be used in controlling the depth of anaesthesia in children other than infants, as well as decreasing medication consumption and speeding awakening in children older than 3 years\textsuperscript{16,17}. Rodriguez et al\textsuperscript{18} evaluated the relationship between BIS measurements and simple clinical findings in children between the ages of 4 months and 14 years, and found that BIS values during inhalation induction correlated with several levels of hypnosis. On the other hand, Davidson et al\textsuperscript{16} found a relationship between BIS values and ET sevoflurane in children undergoing circumcision, but this relationship was not present in infants. They pointed out that, similar to adults, BIS values in children increased with the decrease in ET sevoflurane concentrations during arousal; however, they stressed that BIS values should be carefully interpreted in infants. They stated that BIS values in infants vary across a broad spectrum; in their study, BIS values were low immediately before arousal, and again during arousal, indicating no correlation between ET sevoflurane and BIS values.

In our study, while ET sevoflurane, ET N\textsubscript{2}O, and ET CO\textsubscript{2} concentrations were similar in both groups, BIS values in the children who listened to music were lower. Although there were no significant differences between the groups, ET sevoflurane and ET N\textsubscript{2}O concentrations were higher in Group II. The fact that there was no difference between the groups indicates that we maintained MAC at the same level in all patients.

In the children who were premedicated with midazolam (0.08 mg/kg IM), perioperative music was associated with higher sedation levels and decreased BIS values\textsuperscript{5}. We also found that premedication with midazolam before anaesthesia had similar effects on the BIS values of both groups. While children younger than 6 months had lower BIS values than those older than 6 months, the mean BIS values of the groups were similar. In Group I, there was a significant decrease in the BIS values of over time ($p <0.05$). While there was no significant difference between the groups in terms of mean SBP, DBP, and HR, these parameters were lower in Group I versus Group II. Duration of extubation was shorter in Group I than in Group II; however, the difference between the groups did not reach statistical significance. Our findings do indicate that listening to their mother’s heartbeat and womb sounds along with music decreased the BIS values and increased the depth of anaesthesia in children undergoing minor surgery.
References

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¹ Train-of-four  
² Post-tetanic counts  
³ Second twitch

**REFERENCES**
1. BRIDION Summary of Product Characteristics (SPC)  

Please see summary of product characteristics for full prescribing information.

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References: