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# Is music the food of the anesthesia in children?

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## ABSTRACT

**Background** The noise in an operating room may have a detrimental effect on human cognitive functions, and it may cause perioperative anxiety with prolonged exposure. The aim of this study was to investigate the effects of music therapy and use of earplugs and normal noise level in the operating room under general anesthesia of pediatric patients on hemodynamic parameters and postoperative emergence delirium.

**Methods** One hundred and five pediatric patients were involved in this study. The patients were randomly divided into three groups. Group N was exposed to the ambient operating room noise, group S received earplugs from an independent anesthesiologist, and group M used a CD player. The preoperative anxiety levels of children were evaluated with the Modified Yale Preoperative Anxiety Scale (M-YPAS). Mean arterial pressure (MAP) and heart rate were recorded at 30-minute periods until the completion of surgery, end of surgery and postoperatively. During each measurement, noise level recordings were performed using sonometer. Pediatric Anesthesia Emergency Delirium (PAED) score was evaluated after postoperative extubation.

**Results** M-YPAS was similar between groups. The MAP at 30 and 60 min intraoperatively, at end of surgery, and at 5, 10, and 15 min postoperatively was significantly lower in group S than in group N. There were no differences in heart rate among the groups. Postoperative PAED score was not significantly different among the groups.

**Conclusions** The music therapy was not more effective than silence and operating noise room in reducing PAED score postoperatively in pediatric patients.

**Trial registration number** ClinicalTrials.gov Registry (NCT03544502).

## Key messages

### What is already known about this subject?

- Noise is usually defined as undesirable sound. Operating room noise had been measured at 70–80 decibels (dB) with frequent sound peaks exceeding 80 dB.
- The noise in an operating room may have a detrimental effect on human mental functions.
- There is no clear information about musical medicine's use in the anesthetic application process, although it has been found to have protective sedative effects.
- Emergence delirium (ED) is defined as cognitive functions disturbance during the recovery from anesthesia.

### What are the new findings?

- This is the first study conducted on the use of earplugs and normal noise level to compare with perioperatively applied music therapy.
- Listening to music during perioperative period did not affect Pediatric Anesthesia Emergency Delirium (PAED) in pediatric patients.
- There was no significant difference in pediatric patients for PAED between silence group, noise group and music group.

### How might it impact on clinical practice in the foreseeable future?

- Music therapy may not be effective in the treatment of PAED because children's experiences of music related to their lives were not as developed as adults.
- Patients under general anesthesia may continue to have hearing sensations even though they are unconscious. Therefore, the exposure to noise can have a detrimental effect on body systems at surgical procedures in children.

## INTRODUCTION

The exposure to noise can have a detrimental effect on multiple human body systems. Noise may be associated with increases in blood pressure and heart rate (HR), and an increased prevalence of various forms of cardiovascular diseases and peripheral vascular resistance, including angina pectoris and myocardial infarction. Many studies have shown that exposure to noise may have a detrimental effect on cognitive functions, therefore it may result in anxiety with prolonged exposure. Noise is usually defined as undesirable sound.[1–3] Operating room noise has been determined at 70–80 decibels (dB) with frequent sound peaks exceeding 80 dB. For example, if your speaking voice is above conversational level, the ambient noise is about 80 dB. Noise levels in the operating theaters are determined according to the time-weighted average for which the Occupational Safety and Health Administration requires hearing protection. Operating room noise may cause peripheral vasoconstriction, dilatation of the pupil, physiological effects, and agitation.[3 4]

Performing non-pharmacological methods can be easier and more effective to cope with stress anxiety and pain in surgical procedures in children.[5] Music is one of these methods. Because music has an important place in our daily life, the effect of anesthesia for surgical operation has been the subject of studies. Intraoperative or perioperative music applications are among the promising non-pharmacological methods with a low cost. Musical medicine has been found to have protective sedative effects and has also been shown to reduce stress hormones. There is no clear information about its use in the anesthetic application process, although the benefits of using therapeutic-purpose music have a long history.[6–9]

Although operating room noise above 70–80 dB is known to be harmful, there are few studies investigating the effect of ear-plugged applications to prevent noise on recovery from anesthesia in patients under anesthesia. Gonano *et al*[10] showed that the incidence of awareness and potential harmful intraoperative noise were reduced when intraoperative earplugs were used during spinal anesthesia in adults. They recommend using single-use paraffin wax earplugs. However, application of earplugs during general anesthesia has so far not been studied in children.

Emergence delirium (ED) is defined as cognitive functions disturbance during the recovery from anesthesia. Involuntary physical activity, restlessness, delusions, hallucinations, thrashing about in bed and confusion manifested by moaning are described as delirium. ED has been accepted as a post-anesthetic problem in children. The prevalence of ED is between 25% and 80% in children. ED has been characterized as self-limiting but of changeable duration, and it usually occurs within the first 30 min after anesthesia. Children are at risk of injuring their surgical repair and themselves during an ED.[8 9 11] Pharmacological or non-pharmacological treatment of ED is very important.

This study aims to evaluate the effects of music therapy or quiet environment or normal noise level in pediatric patients under general anesthesia on postoperative ED and hemodynamic parameters.

## MATERIALS AND METHODS

One hundred and five American Society of Anaesthesiology (ASA) physical status I–II children, 5–6 years old and scheduled for elective abdominal surgery with an expected operation time of 60–120 min were registered in this study. Patient characteristics were recorded before surgery. Children with cognitive disorders, chronic illness, with clinically evident hearing impairment, unstable medical conditions requiring intensive care unit admission, and undergoing emergency surgery were excluded from the study.

Patients were randomized and divided to three groups according to a computer-generated table of random numbers. The silence group (group S, n=35) patients received the independent anesthesiologist-placed earplugs during anesthesia induction and the earplugs were removed immediately before tracheal tube extubation by the independent anesthetist. The music group (group M, n=35) patients used a CD player. One CD was prepared with five children's songs (classic music) for this study. The CD player was opened during anesthesia induction and continued until postoperative 15 min. The noise group (group N, n=35) patients were exposed to the ambient operating theater noise.

Anxiety was assessed with Modified Yale Preoperative Anxiety Scale (M-YPAS), an observational instrument of anxiety having 22 questions in five sections indicating anxiety in children (emotional expressivity, state of arousal, activity, vocalization, and use of parents). Results range from 22 to 100, and higher scores indicate a higher degree of anxiety.[12] M-YPAS was used to evaluate the anxiety levels of children before surgery in the operating room.

ED was evaluated as a Pediatric Anesthesia Emergence Delirium (PAED) score >12 at the postoperative period. PAED score was assessed after extubation and postoperatively at the 5th, 10th and 15th minutes.[11] PAED and M-YPAS were evaluated by an anesthesiologist blinded to the groups.

Children were premedicated with intravenous midazolam (0.03 mg/kg) 30 min before the surgical procedure. Routine monitoring such as ECG, body temperature, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide (Cato PM; Drager, Lübeck, Germany) at the operating room was performed. After preoxygenation, anesthesia was induced with intravenous administration 2–3 mg/kg propofol, 1 µg/kg fentanyl and rocuronium 0.6 mg/kg, and tracheal intubation. For intraoperative analgesia, fentanyl 1 µg/kg was given. Maintenance of anesthesia was provided with 2.0%–2.5% of sevoflurane and air in oxygen in all three groups. Isotonic normal saline 5–6 mL/kg/hour was given. HR and mean arterial pressure (MAP) were recorded at 30-minute intervals until the end of surgery and postoperatively at the 5th, 10th and 15th minutes. During each hemodynamic measurement, noise level recordings were implemented using CEL-480 sound level meter. The accepted normal operating room noise is at 70–80 dB. Extubation was performed after decurarization with 0.015 mg/kg atropine and 0.05 mg/kg neostigmine. The children were transported to the recovery room. After recovery, the patients were transferred to their clinical wards.

### Statistical analysis

Normality distribution of numeric variables was tested by using the Shapiro-Wilk test. Numeric variables were compared by using the Kruskal-Wallis test among groups (silence, noise, and music) due to non-normal distribution. Dunn test with Bonferroni correction was used for multiple comparisons of the groups when the significant difference was obtained. The power of this study was calculated as 0.967 by using a post-hoc power analysis

**Table 1** Demographic and surgery data

| | Group S (n=35) | Group N (n=35) | Group M (n=35) | P value |
|---|---|---|---|---|
| Age (y) | 6.9±1.4 | 6.6±1.5 | 6.7±1.6 | 0.681 |
| Weight (kg) | 23.5±4.9 | 23.1±5.7 | 23.6±5.4 | 0.914 |
| Height (cm) | 122.8±7.9 | 120.5±12.5 | 118.5±12.4 | 0.270 |
| Gender (F/M) | 18/17 | 19/16 | 19/16 | 0.962 |
| Duration of anesthesia (min) | 75±10.8 | 72.4±11.1 | 72.3±12.1 | 0.571 |
| Total intraoperative fentanyl consumption (µg) | 22.1±7.1 | 22.6±6.6 | 22.7±6.6 | 0.934 |
| M-YPAS preoperative | 28.3±6.5 | 26.5±6.2 | 26.1±3.4 | 0.360 |
| Operation type, n | | | | |
| Orchiopexy | 10 | 9 | 10 | 0.942 |
| Hypospadias | 7 | 5 | 5 | |
| Inguinal hernia | 18 | 21 | 20 | |

No significant differences were noted among the groups.
Data are shown in mean±standard deviation (SD) if not indicated.
F, female; Group M, music; M, male; M-YPAS, Modified Yale Preoperative Anxiety Scale; N, noise; S, silence.

with an alpha level of 5% and with an effect size of 0.502 in changes from baseline to the end of MAP scores. Categorical variables were compared by using the $X^2$ test.

## RESULTS

Among the 105 patients included and randomized in this study, the groups were similar with respect to age, gender, weight, height, operation type and duration of anesthesia (table 1). M-YPAS scores of children were not significantly different preoperatively among the groups (table 1).

There were no differences in HR among the groups (table 2). All patients had a normal body temperature, and $SpO_2$ values remained higher than 97% during the perioperative period. Operating room noise level was within normal limits.

MAPs at 30 and 60 min intraoperatively, at end of surgery, and at 5, 10, 15 min postoperatively were significantly different among the groups (p=0.026, p=0.008, p=0.019, p=0.030, p=0.018, p=0.004, respectively, table 2). The MAPs at 30 and 60 min intraoperatively, at end of surgery, and at 5, 10, 15 min postoperatively were significantly lower in group S than in group N (p=0.021, p=0.009, p=0.016, p=0.025, p=0.016, p=0.003, respectively, table 2). However, there were no statistically significant

**Table 2** Hemodynamic data of groups

| | | Group S (n=35) | Group N (n=35) | Group M (n=35) | P value | P* |
|---|---|---|---|---|---|---|
| Baseline value | HR (beats/min) | 113.0±13.2 | 114.4±12.6 | 114.4±11.4 | 0.874 | |
| | MAP (mm Hg) | 72.5±7.8 | 71.8±7.5 | 72.7±8.4 | 0.745 | |
| Intraoperative 30 min | HR (beats/min) | 108.6±13.1 | 107.4±14.2 | 112.3±12.5 | 0.227 | |
| | MAP (mm Hg) | 69.6±9.7 | 75.1±7.3 | 72.7±5.5 | 0.026 | N-S=0.021 |
| Intraoperative 60 min | HR (beats/min) | 107.9±12 | 106.4±10.4 | 108.4±11.9 | 0.758 | |
| | MAP (mm Hg) | 68.6±9.7 | 73.7±6.6 | 73.3±4.3 | 0.008 | N-S=0.009 |
| End of surgery | HR (beats/min) | 106.4±11 | 108.4±9.4 | 107.7±10.7 | 0.710 | |
| | MAP (mm Hg) | 68.9±9.9 | 74.1±6.5 | 72.5±5.3 | 0.019 | N-S=0.016 |
| Postoperative 5 min | HR (beats/min) | 108.3±8.4 | 106.2±10.8 | 108.9±12.1 | 0.426 | |
| | MAP (mm Hg) | 69.2±9.5 | 74.1±6.2 | 72.5±5.4 | 0.030 | N-S=0.025 |
| Postoperative 10 min | HR (beats/min) | 107.2±7.3 | 106.2±8.5 | 108.7±8 | 0.468 | |
| | MAP (mm Hg) | 69.1±8.5 | 73.6±6 | 72.1±5.4 | 0.018 | N-S=0.016 |
| Postoperative 15 min | HR (beats/min) | 106.4±6.7 | 108.1±9.9 | 107.5±8.3 | 0.685 | |
| | MAP (mm Hg) | 69.2±8.7 | 74.5±5.8 | 71.9±5.1 | 0.004 | N-S=0.003 |
| Change from baseline to postoperative 15 min | HR (beats/min) | −6.6±13.2 | −6.2±11.6 | −6.9±12.4 | 0.940 | |
| | MAP (mm Hg) | 2.7±9.6 | −3.3±6.4 | −0.8±9.7 | 0.003 | N-S=0.003<br>S-M=0.045 |

Data are shown in mean±standard deviation (SD) if not indicated.
*Pairwise comparison of groups when the significant difference was obtained.
HR, heart rate; M, music; MAP, mean arterial pressure; N, noise; S, silence.

Table 3 Pediatric Anesthesia Emergence Delirium (PAED) score values between the groups

| | | Group S (n=35) | Group N (n=35) | Group M (n=35) | P value |
|---|---|---|---|---|---|
| PAED | After extubation | 10.7±3.4 | 10.0±3.9 | 9.1±3.7 | 0.179 |
| | Postoperative 5 min | 10.4±3.4 | 8.7±2.6 | 9.6±3.7 | 0.123 |
| | Postoperative 10 min | 9.7±3.0 | 8.6±2.0 | 8.9±3.1 | 0.385 |
| | Postoperative 15 min | 8.4±2.9 | 8.2±2.7 | 7.1±2.7 | 0.462 |
| | Change from after extubation to postoperative 15 min | 2.3±2.8 | 1.8±4.9 | 2.0±4.2 | 0.968 |

No significant differences were noted between the groups.
Data are shown in mean±standard deviation (SD) if not indicated.
M, music; N, noise; S, silence.

differences regarding MAPs, among the group S, group N and group M at the baseline (p=0.745, table 2). There was no significant difference in opioid consumption between groups. There were no significant differences among the groups in HR change from baseline to postoperative 15 min (p=0.940, table 3). However, there were significant differences among the groups in MAP change from baseline to postoperative 15 min (p=0.003, table 2). In addition, MAPs at change from baseline to postoperative 15 min were significantly lower in group N than in group S, and MAPs at change from baseline to postoperative 15 min were significantly lower in group M than in group S (p=0.003, p=0.045, respectively, table 2).

PAED scores after extubation, and at 5, 10, and 15 min postoperatively were not significantly different among the groups (p=0.179, p=0.123, p=0.385, p=0.462, respectively, table 3). There were no significant differences among the groups in PAED scores from after extubation to postoperative 15 min (p=0.968, table 3).

## DISCUSSION

The most important finding of this study is that listening to music during perioperative period did not affect PAED in pediatric patients. In addition, there was no significant difference in pediatric patients for PAED between group S, group N and group M where the operating room sound level was within normal limits. Moreover, MAPs at change from baseline to postoperative 15 min were significantly lower in group M than in group S.

Patients with paralysis under general anesthesia may continue to have hearing sensations even though they are unconscious. This potential advantage has led to the use of music to support anesthesia.[13] Until today, many studies have been published showing the effect of music therapy on the prevention of perioperative anxiety and postoperative pain. Although music is one of many potential adjuvants for traditional pharmacological analgesia, there are many studies also showing that music therapy is ineffective in surgical patients. Studies conducted in the postoperative period showed that the patients who were given music therapy required less rescue analgesics, and they can be mobilized earlier after the surgery.[14 15] Nilsson *et al*[15] reported that the effect of music therapy was short term and pain relieving, but the beneficial effects were not different when the patient was exposed to music intraoperatively or postoperatively. However, there are no studies in which children received intraoperative music therapy and were evaluated with PAED.

ED, impairment of awareness generally occurring after the first 15 min postoperatively, psychomotor agitation and perceptual changes are manifested by indifference to the environment. ED mostly occurs in preschool children and is understood as distress by pediatric anesthetists. Although ED is usually short period, it increases the risk of self-injury and delays discharge from the hospital, thus it requires extra health personnel and it may increase medical costs.[16] The type of surgeon, physiological and pharmacological factors, painful stimuli, various patient factors and used anesthetics may affect ED. Fortunately, the three groups in this study presented the same results relative to gender, age, M-YPAS before surgery, associated medical disorders, operation time, and use of opioids intraoperatively. The diagnosis of delirium is based not only on crying and inconsolability but also on the use of scales with specific cut-offs.[17] Sikich and Lerman[11] developed the PAED score for assessing consciousness and cognitive disorders, psychomotor behaviors and emotions. The PAED score had been approved for reliability and validity and is recently used in pediatric ED studies.[11]

Hospitalization and surgical procedures are serious and unforgettable events for children and their parents. The music is a soul food when it suits the acquired experience of the person. This factor is why every person likes different music genres. We also planned to study children as patients because the music experience gained in children was less. However, we used postoperative PAED to not ignore the children's experience, if at all. There are many studies investigating the effects of music on postoperative behavior and anxiety in children undergoing anesthesia surgery. However, this is the first study that alternatives have been performed with the use of earplugs and normal noise level when perioperatively applied music therapy is unsuitable to the children's acquired musical experience. In addition, this is the first study to evaluate PAED for music therapy in children's surgery.

The following mostly comparative studies showed the effect of music therapy as anxiolytic and analgesic with excellent properties in postoperative pain.[18–20] Binns-Turner *et al*[19] showed that perioperative music may reduce pain, anxiety and MAP among women who have mastectomy for breast

cancer. In our study, we found that MAP at change from baseline to postoperative 15 min in the music group was lower compared with the silence group. Conversely, a systematic review showed that the music therapy did not appear to be effective for dealing with preoperative anxiety though relatively few studies examined this.[21] In this study, we have a similar finding that listening to music during perioperative period did not affect PAED in pediatric patients.

Buehler *et al*[22] reported that intraoperative music application in minor urogenital surgery in children reduced maladaptive behavior in the first week postoperatively but music did not affect postoperative patient pain, comfort or vomiting and nausea rates. In the study, postoperative behaviors of children receiving intraoperative music therapy were documented by their families at 7, 14 and 28 days postsurgery, using a questionnaire adapted from the 'Post Hospitalization Behavior Questionnaire'. Music therapy decreased the distress and the requirement of morphine after minor surgery but did not otherwise influence postoperative care.[23] Therefore, we evaluated the effect of music in surgical procedures with PAED.

The study was limited by several factors. First, sevofluran consumption was not calculated. However, the duration of the operation was not statistically different between the groups. Second, the use of other opioid anesthetic drugs may affect the study results.

In conclusion, the music therapy was not more effective than silence or operating room noise in reducing PAED score postoperatively in pediatric patients undergoing surgery in our study. We believe that music therapy may not be effective in the treatment of PAED because children's experiences of music related to their lives were not as developed as adults.

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