

## ORIGINAL RESEARCH

## PERIOPERATIVE MEDICINE

# The effect of preoperative music therapy on perioperative anxiety and cognitive functions in adult patients in Erzincan, Turkey: a cohort study

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## ABSTRACT

**Background & objective:** Perioperative anxiety affects 25-80% of all surgical patients. It has a negative impact on postoperative recovery, potentially increasing morbidity and mortality. The anxiolytic effects of music therapy are well recognized, but its cognitive implications are unknown. We examined the effects of 440 Hz and 432 Hz music therapy on pre-operative anxiety and cognitive functions in patients scheduled for surgery.

**Methodology:** The study took place in the operating room of our hospital. Following ethical committee approval, the study was launched. It was a prospective observational study comprising 66 ASA I, II, and III patients, between the ages of 18 and 65, scheduled to undergo surgery. They were divided into three groups: Control Group (CG), music therapy at 440 Hz (MG440), and music therapy at 432 Hz (MG432). Music therapy was administered to MG440 and MG432, but not to CG. Patients took the Montreal Cognitive Assessment (MoCA) and the Beck Anxiety Scale (BAS). MoCA and BAS were assessed before surgery, one hour and at 24 hours following surgery.

**Results:** In both groups, preoperative music therapy significantly reduced anxiety ( $P < 0.001$ ). Anxiety levels following surgery were comparable in all groups. Postoperative one-hour cognitive performance in music therapy groups was lower than in controls ( $P < 0.001$ ), but increased and became significantly higher than in the control group at 24 h ( $P < 0.001$ ). There was no substantial difference between the 440 Hz and 432 Hz groups.

**Conclusions:** Preoperative music therapy reduced anxiety; it initially lowered postoperative cognitive performance; nevertheless, within 24 hours, therapy groups had enhanced cognitive skills when compared to controls.

**Ethical committee approval:** (Protocol No. 2023-01/2, Date: May 1, 2023).

**Abbreviations:** BAS - Beck Anxiety Scale; MoCA - Montreal Cognitive Assessment;

**Keywords:** Music; Therapeutics; Anxiety; Cognition; Anesthesia, General

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## 1. INTRODUCTION

More than 200 million surgical operations have been performed every year all over the world, especially since the early 2000s.<sup>1</sup> Due to the nature of the imminent intervention, anxiety among hospitalized patients might range from 25% to 80% in the context of surgical procedures.<sup>2-4</sup> It has been determined that anxiety can have a negative impact on postoperative recovery and even increase morbidity and mortality rates.<sup>5-7</sup> Postoperative pain is negatively impacted by preoperative anxiety.<sup>8</sup>

Even in ancient literature, cognitive dysfunction brought on by anesthesia has historically been referred to as "delirium" or "chronic feeble-mindedness".<sup>9</sup> It has been hypothesized that anesthesia has a negative impact on cognitive functions, particularly when general anesthesia is performed.<sup>9,10</sup>

Studies have demonstrated the favorable effects of music therapy on perioperative anxiety.<sup>11</sup> Some studies indicated a range of effects of music therapy on anxiety at various frequencies,<sup>12</sup> whereas some studies revealed no discernible effects.<sup>13</sup> Regardless of frequency, these studies collectively indicate a reduction in anxiety levels with music therapy. However, there is no known study investigating the impact of music therapy on cognitive functions.

The International Organization for Standardization (ISO) has set the standard pitch for the note "A" at 440 Hz.<sup>14</sup> On the other hand, 432 Hz music is thought to be more mellow, serene, and harmonic.<sup>15</sup>

We aimed to find out how preoperative music therapy administered at 440 Hz and 432 Hz frequencies affects perioperative anxiety and cognitive functions.

## 2. METHODOLOGY

This observational prospective study was conducted at operating rooms of the Erzincan Mengücek Gazi Education and Research Hospital. The study was launched after receiving the One day before surgery, each patient received comprehensive information about the study's protocol and procedures, and their written consent was obtained. The study comprised 66 patients who had surgeries that lasted more than an hour and were ASA classes I, II, and III, aged 18 to 65 (according to G-Power analysis). The study excluded participants who had a history of drug allergies, pregnancy, electrolyte imbalance, organ failure, mental health disorders, cognitive dysfunction, or who were unwilling or unable to cooperate.

Control Group (CG), Group with Music Therapy at 440 Hz (MG440), and Group with Music Therapy at 432 Hz

(MG432) were the three groups that the patients brought to the operation room were split into. According to Aravena et al.'s study<sup>13</sup>, patients in the CG group were kept under observation for 15 min in the preoperative waiting room without any assistance, while patients in the MG440 group and MG432 group listened to Giorgio Costantini's song "Life" at 432 Hz frequency and 440 Hz frequency, respectively, for the same period of time. All patients then performed the Montreal Cognitive Assessment (MoCA) and the 21-item Beck Anxiety Scale for documentation purposes.

Patients had a venous access set up in the left antecubital area when they entered the operating room. Non-invasive blood pressure monitoring, a 3-channel electrocardiogram, and peripheral oxygen saturation (SpO<sub>2</sub>) were also carried out. The induction of intravenous general anesthesia was performed in accordance with standard general anesthesia procedure, volatile anesthetics were used to maintain anesthesia. The use of anesthetics was stopped after the procedure, and patients proceeded to the extubation phase with 100% oxygen. Patients were moved to the postoperative recovery room after being extubated. Patients were administered the Beck Anxiety Scale and the MoCA scale after the first hour following extubation. Patients were sent to the ward if their Aldrete scores at 5, 10, and 30 min were greater than 9. At 24 hours after surgery, the Beck Anxiety Scale and the MoCA scale were once more administered on the ward. The Beck anxiety level assessment scale assigned 0-8 points to no anxiety, 8-15 points to mild anxiety, 16-25 points to moderate anxiety, and 26-63 points to severe anxiety.

### 2.1. Statistical Analysis

The data was analyzed using the IBM SPSS 25.0 package program (SPSS Inc., Chicago, IL, USA). For quantitative variables, descriptive statistics are reported as Mean  $\pm$  SD and for nominal variables, as frequency (%).

The One-Way ANOVA analysis of variance test was performed to determine the significance of the difference between groups in terms of quantitative variable means, and the Tukey's test was employed for pairwise comparisons. Pearson Chi-Square was used to assess nominal variables.

Beck and MoCA scores were compared using two-way mixed ANOVA by group and time. Because the sphericity assumption is violated, the findings are presented using the Greenhouse Geisser correction. The LSD multiple comparison test was used to make pairwise comparisons for this test. Results were considered statistically significant if  $P < 0.05$ .

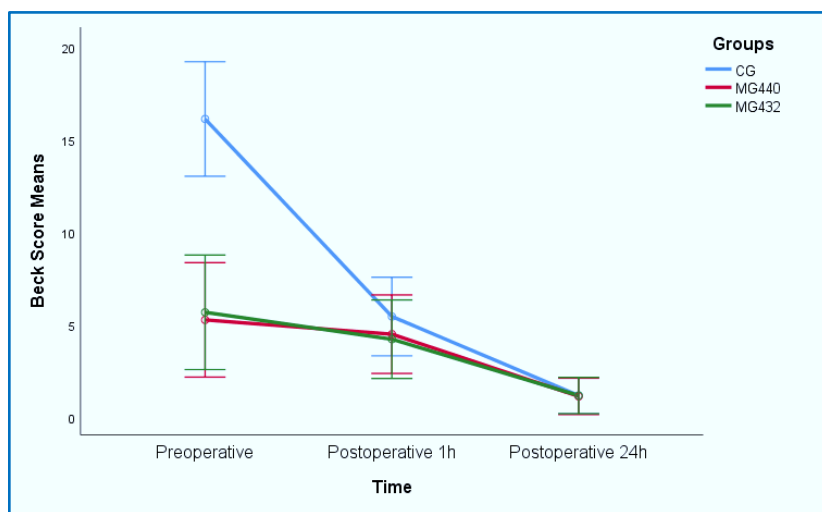
According to the two-way mixed ANOVA test, the number of persons to be included in the study was

**Table 1: Age and sex according to study group**

Parameter	Control Group (n = 22)	MG440 Group (n = 22)	MG432 Group (n = 22)	P value
Age (y)	38.27 ± 14.01	29.91 ± 12.57	33.45 ± 11.41	0.099 <sup>a</sup>
<b>Gender: Male</b>	7 (28)	9 (36)	9 (36)	0.773 <sup>b</sup>
Female	15 (72)	13 (64)	13 (64)	

CG, Control Group; Data presented as mean ± SD or n (%); <sup>a</sup> One-way ANOVA (P < 0.05); <sup>b</sup> Chi-Square Test (P < 0.05)

groups: the Control Group (CG) (n = 22), the 440 Hz Music Therapy Group (MG440) (n = 22), and the 432 Hz Music Therapy Group (MG432) (n = 22). The study did not have any exclusions. The participants' average age was 33.88 ± 12.98



**Figure 1: Preoperative and postoperative variation of Beck Score between groups. Error bars: 95% CI. CG, Control Group; MG440, 440 Hz Music Therapy Group; MG432, 432 Hz Music Therapy Group**

years. Sixty-two percent of the participants were female. The gender and age distributions were comparable between groups. (Table 1).

The Beck anxiety level assessment scale assigned 0-8 points to no anxiety, 8-15 points to mild anxiety, 16-25 points to moderate anxiety, and 26-63 points to severe anxiety. Preoperatively, mild to moderate stress symptoms were present in 72% of CG group patients, 31% of MG440 group patients, and 27% of MG432 group patients. These levels were 31%, 22%, and 27%, respectively, at one hour postoperative. At the postoperative 24 h, this rate fell to 4% in both the MG440 and MG432 groups, while no patients in the control group had mild or moderate anxiety symptoms.

determined as 66, when Type 1 Error ( $\alpha$ ) = 0.05, power (1- $\beta$ ) = 0.95, correlation value between measures (r) = 0.5, and effect size (cohen-f) = 0.25. The number of persons in each group was kept consistent, with 22 people in each group.

### 3. RESULTS

The study comprised 66 participants ranging in age from 18 to 65 y. Participants were placed into one of the three

While analyzing Beck anxiety level, variance analysis was applied in two-way repeated measurements. According to the results of the simple main effect analysis, the group effect on Beck anxiety scores was found to be statistically significant ( $F(2,63) = 5.80$ ;  $P = 0.005$ ). In addition, according to the results of the simple main effect analysis, the effect of time on Beck anxiety score was found to be statistically significant ( $F(1.39,126) = 83.41$ ;  $P < 0.001$ ). The group x time

**Table 2. Intergroup comparison of Beck anxiety levels at preoperative, 1st hour postoperative, and 24th hour postoperative time points.**

Score time	Groups			Pairwise Comparisons P values		
	CG (1)	MG440 (2)	MG432 (3)	1 vs 2	1 vs 3	2 vs 3
<b>Preop Beck Score</b>	16,14 ± 10,16	5,27 ± 5,13	5,68 ± 5,36	< 0.001	< 0.001	0.853
<b>Postop Beck Score (1h)</b>	5,45 ± 5,35	4,50 ± 4,44	4,23 ± 5,11	0.528	0.417	0.857
<b>Postop Beck Score (24h)</b>	1,18 ± 1,91	1,14 ± 2,35	1,18 ± 2,57	0.948	1.000	0.948

CG, Control Group; MG440, 440 Hz Music Therapy Group; MG432, 432 Hz Music Therapy Group

**Table 3. Comparison of Beck anxiety scores in the CG, MG440 and MG432 groups at the preoperative, postoperative 1st hour and postoperative 24th hour.**

Groups	Beck Scores			Pairwise P values		
	Preoperative (1)	Postop 1 h (2)	Postop 24 h (3)	1 vs 2	1 vs 3	2 vs 3
<b>CG Group</b>	16,14 ± 10,16	5,45 ± 5,35	1,18 ± 1,91	< 0.001	< 0.001	< 0.001
<b>MG440 Group</b>	5,27 ± 5,13	4,50 ± 4,44	1,14 ± 2,35	0.431	< 0.001	< 0.001
<b>MG432 Group</b>	5,68 ± 5,36	4,23 ± 5,11	1,18 ± 2,57	0.141	< 0.001	< 0.001

CG, Control Group; MG440, 440 Hz Music Therapy Group; MG432, 432 Hz Music Therapy Group

**Table 4. Intergroup comparison of MoCA levels at preoperative, 1 h postoperative, and 24 h postoperative time points.**

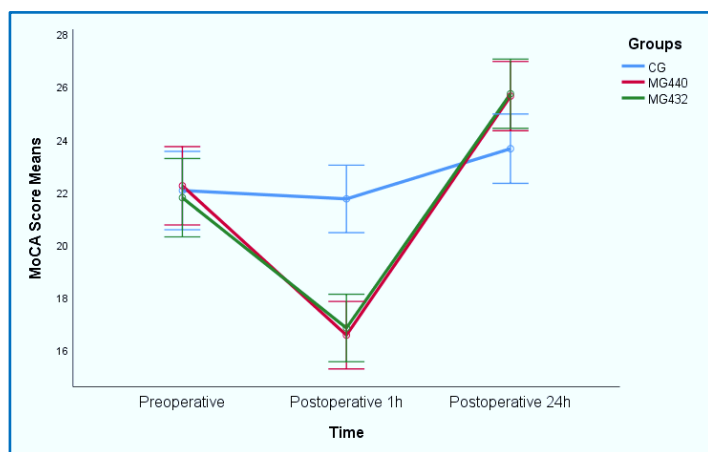
Time	MoCA Score			Pairwise P values		
	CG Group (1)	MG440 Group (2)	MG432 Group (3)	1 vs 2	1 vs 3	2 vs 3
<b>Preoperative</b>	22.05 ± 3.81	22.23 ± 3.14	21.77 ± 3.50	0.864	0.797	0.668
<b>Postoperative (1 h)</b>	21.73 ± 3.10	16.55 ± 3.21	16.82 ± 2.68	< 0.001	< 0.001	0.765
<b>Postoperative (24 h)</b>	23.64 ± 3.56	25.64 ± 2.59	25.73 ± 3.04	< 0.001	< 0.001	0.923

CG, Control Group; MG440, 440 Hz Music Therapy Group; MG432, 432 Hz Music Therapy Group

interaction effect for Beck scores was also statistically significant ( $F(2,79,126) = 20.55$ ;  $P < 0.001$ ).

There was insignificant difference between the Beck scores in MG440 and MG432 groups ( $P = 0.853$ ), despite the preoperative Beck score in the CG group being statistically greater than that in the MG440 and MG432 groups ( $P < 0.001$ ). Between the CG, MG440, and MG432 groups, there was insignificant difference in the Beck scores evaluated at the first and 24 h postoperatively. Beck anxiety levels at preoperative, first hour postoperative, and 24th hour postoperative time points are given in Table 2 and Figure 1.

In the CG group, the preoperative Beck score was statistically substantially higher than the postoperative Beck scores at the first and 24th hours ( $P < 0.001$ ). The difference between the Beck score at the postoperative first hour and the score at the postoperative 24th hour was statistically significant ( $P < 0.001$ ). Although the MG440 group's preoperative Beck score was greater than the postoperative first hour Beck score, this difference was not statistically significant ( $P = 0.431$ ). In the MG440 group, the preoperative and postoperative Beck scores in the 1st hour were statistically greater than those at the 24th hour ( $P < 0.001$ ). Although the preoperative Beck score was greater in the MG432 group than the postoperative Beck score after an hour, this difference was not statistically significant ( $P = 0.141$ ). In the MG440 group, the preoperative and postoperative Beck scores in the 1st hour were statistically greater than those at the 24th hour ( $P < 0.001$ ). Table 3 provides an overview of comparison of Beck anxiety scores in the groups preoperatively, at postoperative one hour and postoperative 24 hours (Figure 1).

**Figure 2: Preoperative and postoperative variation of MoCA Score between groups. Error bars: 95% CI.**

While analyzing the MoCA level, variance analysis was applied in two-way repeated measurements. According to the results of the simple main effect analysis, the group effect on MoCA scores was not found statistically significant ( $F(2,63) = 1.18$ ;  $P = 0.313$ ). In addition, according to the results of the simple main effect analysis, the effect of time on MoCA scores was found to be statistically

**Table 5: Comparison of MoCA scores in the CG, MG440 and MG432 groups at the preoperative, postoperative 1st hour and postoperative 24th hour.**

Groups	MoCA Scores			Pairwise Comparisons P values		
	Preop Score (1)	1 h Postop Score (2)	24 h Postop Score (3)	1 vs 2	1 vs 3	2 vs 3
<b>CG Group</b>	22.05 ± 3.81	21.73 ± 3.10	23.64 ± 3.56	0.704	< 0.001	< 0.001
<b>MG440 Group</b>	22.23 ± 3.14	16.55 ± 3.21	25.64 ± 2.59	< 0.001	< 0.001	< 0.001
<b>MG432 Group</b>	21.77 ± 3.50	16.82 ± 2.68	25.73 ± 3.04	< 0.001	< 0.001	< 0.001

*CG, Control Group; MG440, 440 Hz Music Therapy Group; MG432, 432 Hz Music Therapy Group*

significant ( $F(1.77,126) = 124.74$ ;  $P < 0.001$ ). The group x time interaction effect for MoCA scores was also statistically significant ( $F(3.54,126) = 16.79$ ;  $P < 0.001$ ).

Preoperative MoCA scores for the CG, MG440, and MG432 groups did not reveal any statistically significant differences. The CG group was shown to have a statistically substantially higher postoperative 1st hour MoCA score than the MG440 and MG432 groups ( $P < 0.001$ ). The postoperative MoCA score at the first hour was comparable between the MG440 and MG432 groups ( $P = 0.765$ ). Both the MG440 group and the MG432 group's postoperative 24th hour MoCA scores were discovered to be statistically substantially higher than those of the CG group ( $P < 0.001$ ) in both of these groups. The MG440 and MG432 groups had identical postoperative 24 h MoCA scores ( $P = 0.923$ ). Table 4 provides an overview of group comparisons (Figure 2).

When compared to the preoperative period, the MoCA score in the CG group exhibited a modest decline in the first postoperative hour, although this decline was not statistically significant. It was discovered that the MoCA score obtained at the postoperative 24th hour was greater than the MoCA scores obtained at the preoperative and postoperative 1st hours ( $P < 0.001$ ). At the postoperative first hour, it was discovered that the MoCA scores in the MG440 and MG432 groups were lower than the preoperative values ( $P < 0.001$ ). In comparison to preoperative measurements and the postoperative first hour, the postoperative 24th hour MoCA score was greater in the MG440 and MG432 groups ( $P < 0.001$ ). Table 5 provides an overview of group comparisons (Figure 2).

## 4. DISCUSSION

In this study, we examined how preoperative music therapy at two different frequencies, 440 Hz and 432 Hz, affects surgical patients' anxiety levels and cognitive functions in the first and twenty-four hours after surgery.

We discovered that 15 min of preoperative music therapy considerably decreased preoperative anxiety ( $P < 0.001$ ), and this drop was similar in both frequencies. Anxiety levels in the first and 24 h following surgery were comparable in all three groups. The postoperative cognitive function level of the music therapy groups was considerably lower than the control group ( $P < 0.001$ ), even though the cognitive functions were at the same level in all three groups during the preoperative period. The situation was reversed, nevertheless, and the cognitive functions of the music treatment groups increased to a considerably higher level than the control group when the postoperative 24th hour levels were investigated ( $P < 0.001$ ). At all measurement times, there was no statistically significant difference between the 440 Hz and 432 Hz music therapy groups regarding levels of cognitive function.

In a very large study by Britteon et al. on 176827 orthopedic surgery patients, it was found that patients with moderate or higher levels of anxiety or depression had wound site-related problems that were considerably higher than in healthy persons.<sup>5</sup> Examining the research reveals that preoperative anxiety increases the risk of postoperative depression.<sup>6</sup> According to another study, postoperative mortality and morbidity are negatively impacted by preoperative anxiety levels.<sup>7</sup> A study by Chieng et al. demonstrated a direct correlation between high preoperative anxiety and high postoperative pain levels.<sup>8</sup> Preoperative anxiety is a condition that should be avoided as much as possible, since in light of research, it is evident that it has a detrimental impact on postoperative complications.

In a study by Ruis et al., 25% of patients who underwent surgery displayed anxiety symptoms; it was shown that women and young individuals are more likely than older persons to experience these symptoms.<sup>2</sup> In a study by Hellstadius et al., it was discovered that 34% of 106 patients scheduled for surgery for esophageal cancer experienced preoperative anxiety.<sup>3</sup> In a study by Tosun et al., 58% of the 99 patients, who were scheduled for surgery, had moderate preoperative anxiety symptoms.<sup>4</sup>

In a study by Rubalcava et al., it was discovered that music therapy decreased the level of cortisol in saliva and decreased the level of anxiety in 34 patients who underwent elective dental surgery.<sup>11</sup> The impact of preoperative music therapy at 440 Hz and 432 Hz on anxiety and salivary cortisol levels was investigated. It was found that the anxiety levels of the music therapy groups were significantly lower than the control groups, and the salivary cortisol level was significantly lower in the group that received 432 Hz music therapy.<sup>13</sup> In our study, 72% of the patients in the control group, who did not receive music therapy, had mild to moderate anxiety, but this rate was found to be 31% in the MG440 group, who received 440 Hz music therapy, and 27% in the MG432 group, who received 432 Hz music therapy. There was no statistically significant difference between the MG440 and MG432 groups ( $P = 0.853$ ), despite the fact that the preoperative Beck score was determined to be statistically greater in the CG group compared to the MG440 and MG432 groups ( $P < 0.001$ ).

Postoperative cognitive dysfunction is assumed to be caused by anesthesia, surgery, the patient themselves, or a mixture of all of these. However, the actual cause is unknown. The decline in postoperative cognitive abilities may occur without any connection to hypoxia, hypotension, or even the use of anesthetics with a central effect.<sup>9</sup> A study by Plas et al. of 307 individuals revealed that 53% of patients experienced postoperative improvement in their cognitive functions while 12% experienced regression.<sup>16</sup>

In addition to altering autonomic and neurochemical responses, musical stimuli also enhance synaptic plasticity, which has a positive impact on cognitive processes.<sup>17</sup> Individuals with musical interests had increased gray matter mass in the hippocampal region of the brain, networks had formed in the frontal cortex, and their overall cognitive abilities had improved in comparison to the control group.<sup>18</sup> In our study, preoperative cognitive functions were comparable between the CG group and the two music therapy groups. A value similar to the preoperative period was seen in cognitive functioning in the CG group at the first postoperative hour. This group had a high preoperative anxiety level. The cognitive function level during the first hour following surgery was significantly lower in the MG440 and MG432 groups than in the CG group, whose preoperative anxiety level was significantly lower. This shows that anxiety during the preoperative period has a beneficial impact on the restoration of cognitive skills following surgery. In contrast to the postoperative first hour results, the MG440 and MG432 groups exhibit higher cognitive function values than the CG group when the postoperative 24th hour cognitive functions are investigated. At the first and 24th postoperative hours, there was no significant difference

between the cognitive abilities of the MG440 and MG432 groups. When all variables were included, both music therapy groups scored higher on cognitive function tests than the CG group at the postoperative 24th hour, despite the fact that preoperative music therapy appeared to have a negative impact on cognitive functions at the postoperative first hour.

Adrenergic activation caused by anxiety has some hemodynamic and psychological repercussions. Beta-adrenergic blockers, which belong to the class of medications known as "anxiolytics," are used to alleviate anxiety.<sup>19</sup> By lowering the autonomic reaction, beta adrenergic blockers can also lessen anxiety.<sup>20</sup> In this sense, it is possible to think of anxiety and the adrenergic system as two interrelated systems.

The Locus Coeruleus, a region of the brain with a high density of noradrenergic neurons, plays a significant role in cognitive processes like memory, learning, and attention. Advanced Alzheimer's patients have been discovered to have atrophic changes in this area.<sup>21</sup> In addition, it has been discovered that activating adrenergic receptors in animal models can reverse memory loss.<sup>22</sup> Based on these findings, cognitive abilities are positively impacted by the adrenergic system. In our study, we hypothesize that the music therapy's reduction of preoperative anxiety decreased adrenergic discharge, and that as a result, cognitive skills declined since there was no longer an adrenergic stimulating effect in the first postoperative hour. The favorable effects of music therapy become more noticeable in the postoperative 24th hour and cognitive functions reach substantially higher levels compared to the control group, despite the fact that cognitive functions decline in the early postoperative period.

## 5. LIMITATIONS

Larger trials including more patients will yield more reliable findings. Preoperatively, immediately after surgery, and 24 h later, we assessed cognitive performance. Long-term comparisons of the groups will be more accurate following a final assessment of cognitive function at three to six months.

## 6. CONCLUSION

We discovered that preoperative music therapy for 15 min decreased anxiety and that postoperative music therapy groups had lower cognitive functions in the first hour after surgery. We discovered that the music therapy groups significantly outperformed the control group in terms of cognitive skills at the 24-hour period following surgery. We believe that the groups who received music therapy had better cognitive functions because the positive effects of music therapy became apparent at the

postoperative 24th hour, even though the cognitive functions of the control group were better at the first postoperative hour as a result of preoperative anxiety increasing adrenergic activity.

### 7. Data availability

The numerical data generated during this research is available with the authors.

### 8. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

### 9. Authors' contribution

HGT: Conduction of the study and writing the manuscript

FS: Data analyze, supervision and writing the manuscript

SH: Supervision, Statistical analyze and revising

MA: Writing the draft, revising

UK: Supervision, Revising and writing the manuscript

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