Effect of Listening to Music on Postoperative Cognitive Function in Older Adults After Hip or Knee Surgery: A Randomized Controlled Trial

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Purpose: *This study aimed to assess the effect of listening to music on postoperative cognitive function in older adults after hip or knee surgery.*
Design: *This work was a randomized controlled study that involved an intervention group and control group.*
Methods: *Study data were recollected by using a patient information form, Mini-Mental State Examination (MMSE), and NEECHAM Confusion Scale. Music was played three times a day to the participants in the intervention group for 3 days postoperatively.*
Findings: *The mean MMSE and NEECHAM scores of the intervention and control groups were compared. No statistically significant difference was found in the mean MMSE ($P > .05$) between the two groups. A statistically significant difference in the mean NEECHAM Confusion Scale score was observed between the groups ($P < .001$).*
Conclusions: *This study demonstrated that listening to music was important in preventing postoperative cognitive dysfunction in patients who underwent hip or knee arthroplasty.*

Keywords: *cognitive function, listening to music, older adults.*

THE GOALS OF KNEE and hip arthroplasty application are to relieve the patients' pain and discomfort, improve joint function and increase the level of movement and the ability to perform daily activities.[1] Total knee arthroplasty and total hip arthroplasty are common procedures in Turkey and globally.[2] Total joint replacement is frequently observed in surgical interventions, especially among older adults aged 75 years or above.[3-5]

One of the most common problems encountered by older adults after surgery is delirium.[6] Approximately 30% to 50% of older adults experience acute confusion or delirium after hip and knee surgery, and this rate increases with age.[7] Acute confusion or delirium is characterized by a sudden change in mental status. Confusion is clouding of consciousness characterized by an impaired capacity to think, understand, and respond to and remember stimuli.[8] Delirium is a condition characterized by irregular thoughts without neurological symptoms, with an altered level of consciousness deteriorating for a certain period. Postoperative cognitive dysfunction is a subtle neurocognitive disorder characterized by a decline in cognitive performance after surgery and anesthesia.[9] The most common causes of postoperative cognitive dysfunction include age, surgical stress, mental state of the patient in the preoperative period,

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anesthesia application, postoperative pain, electrolyte imbalance, and postoperative sensory deprivation.[10-12]

The consequence of cognitive dysfunction in older adults after surgery is difficulty coping with postoperative stress, delay in healing, and occurrence of various complications.[13,14] The literature states that cognitive impairment in older adults who undergo hip surgery is a major concern during the first 2 to 12 months after the operation, and the quality of life of these individuals can be adversely affected in this process.[15] Gruber-Baldini et al[16] reported that acute confusion in older adults after hip and knee surgery negatively impacts postoperative functional outcomes. Given that early diagnosis of cognitive dysfunction in patients after hip and knee surgery has a positive effect on healing of postoperative patients,[16] the cognitive functions of the patient must be evaluated, and acute confusion prevented or reduced with appropriate nursing interventions.[6]

Nonpharmacologic methods such as music,[17,18] simple calculation, and reading aloud[12] are generally applied to increase cognitive function and prevent acute confusion after surgery. Music therapy is a natural intervention for physical, psychological, social, emotional, and spiritual recovery. It is a cost-effective technique that is easy to apply and use, and it has no adverse effects.[19] Music plays an important role in people's life. Carefully selected music can reduce stress, improve comfort, and provide relaxation.[20] Classical Turkish music is slow and relaxing instrumental music that has a relaxing effect on patients' psychological states.[21]

Music is a nonpharmacologic method frequently used to reduce anxiety[22] and pain levels.[23] Studies have found that listening to music reduces the cortisol level, anxiety, and pain;[24] decreases systolic blood pressure and heart rate at preoperative and postoperative periods;[25] improves cognitive function among patients with Alzheimer's disease[26] and surgical patients;[17,18] and decreases sedative drug dose during invasive procedures.[27] No study in the literature has examined the effect of classical Turkish music on cognitive function in older adults after hip or knee surgery.

This study aimed to examine the effect of the Acemasiran style of classical Turkish music on postoperative cognitive function in older adults after hip or knee surgery.

Methods

Design and Setting

A randomized controlled experimental study was conducted to determine the effect of listening to music on postoperative cognitive function in older adults after hip or knee surgery. The study was conducted at the orthopedics clinic in an educational research hospital, Aksaray, Turkey, between February and June 2018.

Sample

The target population consisted of 87 patients with hip or knee prosthesis on the date of the study. Sixty patients (30 in the intervention group and 30 in the control group) were included in the study sample (Figure 1). The study power analysis in G* Power, version 3.1 (Heinrich-Heine University of Dusseldorf, Germany) computer program was deployed to determine the sample size. For repeated measures analysis of variance, the effect size was calculated as f = 0.55. For the 95% confidence interval (α = 0.05) and 0.90 power (1-β), the total number of samples reached was calculated as 24 individuals. The inclusion criteria for the study were 65 years of age or older, no complications during the 3 days of the postoperative period, and willingness to participate in the study. The exclusion criteria were mental retardation that hinders communication, dementia (defined as a Mini-Mental State Examination [MMSE] score of $<$23), age $<$ 65 years, hearing problem, development of postoperative complications, and unable to speak Turkish.

Measurement Instruments

The "Patient Information Form" developed by the researcher, the "MMSE," and the "NEECHAM Confusion Scale" were used for data collection.

PATIENT INFORMATION FORM. The questionnaire created by the researcher comprised a total of 10 close-ended questions. This questionnaire

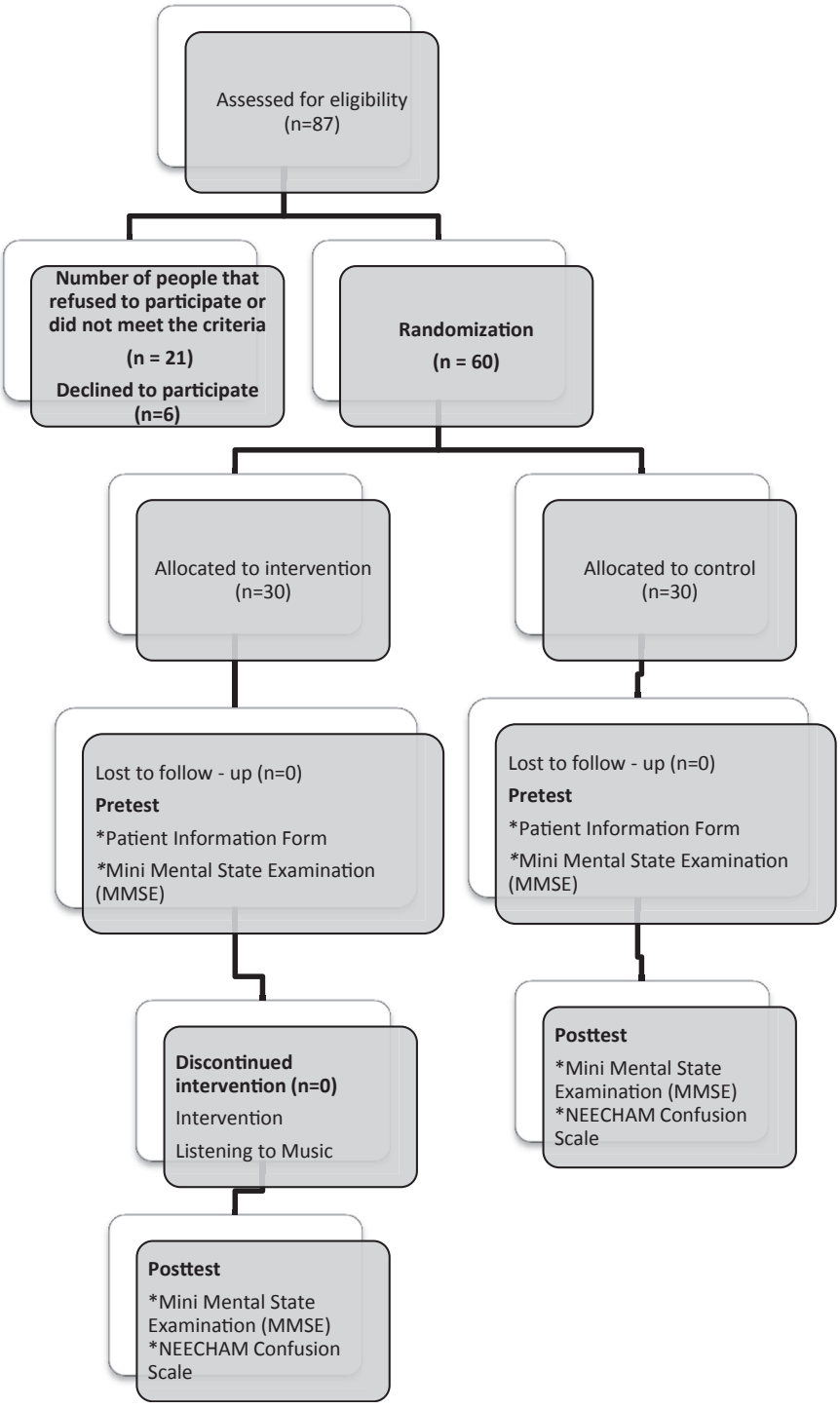

Figure 1. Flow chart of patient selection.

contained items about demographic characteristics (age, gender, marital status, education status, and occupation), medical characteristics (chronic illnesses, medications used, surgical history, and surgical type), and their style of music.

MMSE. The MMSE was first published by Folstein et al.[28] The reliability and validity study for Turkey was conducted by Güngen et al.[29] Domains assessed include orientation, registration and short-term recall, attention and concentration, language (naming, sentence writing, and comprehension), and visuospatial abilities. Scores ranged from 0 to 30. Individual items are summed to generate the total score. If individuals decline or are unable to attempt a task, the value on that particular item would be missing. Güngen et al[29] reported that the threshold value is 23–24. Instrument sensitivity is 0.91 and specificity is 0.95 with high reliability between practitioners (Pearson coefficient: 0.99, Kappa: 0.92). The MMSE appropriate for the educational status of the subjects in the study was administered by the investigator to both the intervention and control groups both in the preliminary and final tests of our study.[29]

THE NEECHAM CONFUSION SCALE. This scale was developed by Neelon et al[30] and consists of three subgroups. The scale measures attention, command, orientation, appearance, motor behavior, and verbal status. Physiological parameters are also included. Scores are between 0 and 30. A score of 0–19 indicates moderate to severe confusion, a score of 20–24 suggests moderate or early confusion, a score of 25–26 implies high risk for confusion, and a score of 27–30 refers to normal function. Sensitivity of the scale was calculated as 95%, whereas specificity was 78%. The Turkish validity and reliability study was conducted by Elibol[31], at a Cronbach's $\alpha = 0.96$.

Intervention

After the baseline measurement, patients were exposed to music for 3 postoperative days after hip or knee surgery. The patients listening to music were supplied with an Mp3 player in their room, in bed. A separate headset was used for each patient. The patients listened to Acemasiran-type classical Turkish music. Acemasiran-type music affects the human brain and provides a sense of creativity to people. In addition, it keeps the person engaged by activating stagnant thoughts.[21] The patient was awake while listening to music through a headset connected to the Mp3 player (covering his/her ear completely so as not to get disturbed). Each patient in the intervention group listened to the music for 20-min sessions three times a day for 3 postoperative days.

Procedure

A total of 87 patients underwent hip or knee surgery. Sixty patients (21 patients did not meet the research criteria, and 6 patients did not agree to participate in the study) were included in the study. After explaining the purpose of the research and baseline assessment, participants were randomly allocated into two groups by drawing lots using closed envelopes with numbers from 0 to 9. Those who selected single numbers were allocated to the control group, and those with double numbers formed the intervention group. All the patients in this study had similar operation times. In addition, the protocol for postoperative pain medication and ambulation for patients who underwent hip and knee surgery included standard treatments for pain and ambulation. The rooms were all equipped with the same clock, calendar, and television.

Patients in the intervention group were visited by the researcher and asked to complete the Patient Information Form and MMSE scale before the operation. Approximately 20 min was needed to complete the forms for each patient. After the surgery, besides routine nursing care, Acemasiran-type classical Turkish music listening (20 min) was performed for three times a day for three postoperative days. When the music-listening activity was completed, the MMSE and NEECHAM confusion scale were filled during 3 days postoperatively. Data collection for the patients in the control group was performed in the same content and at the same period, with exception of music listening. In this study, nurses and the statistician were blinded to assignment of patients into the groups.

Ethical Considerations

This study was carried out in accordance with the principles of the Declaration of Helsinki.

Before the study, written permission was obtained from the Aksaray University Human Research Ethics Committee (number: 2018/17) and institution's directorate (number: 66472688-799). All participants were informed about the purpose and design of the research. Anonymity and confidentiality were guaranteed. The decision of the patients to not participate in the study did not affect the routine nursing interventions. Also, the patients were allowed to withdraw from the study at any time.

Data Analysis

Data were analyzed in IBM SPSS, version 22, and RStudio software. Descriptive characteristics are shown as the mean, standard deviation, and percentage. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to evaluate the suitability of normal distribution of research data. The χ^2 test was used to compare the demographic characteristics of the individuals involved in the study. The MMSE scale was assessed with nonparametric tests because normal distribution in groups did not show suitability. The post hoc Dunn test was used for MMSE intragroup comparisons. The intragroup, time-time, and group-time interactions of the NEECHAM confusion scale test score medians were evaluated by a nonparametric test (Brunner Langer) for repeated measures of factorial design. For comparisons, $P < .05$ was considered statistically significant.

Results

Participant Characteristics

Descriptive characteristics are described in Table 1. Approximately 73.3% of the individuals in the intervention group in the study were in the 65- to 74-year age group; 66.7% were women, 80.0% were married, and 53.3% were literate. About 76.7% of the individuals had at least one chronic illness, 56.3% used regular medication, and 73.3% of the patients had knee replacement surgery. Of the individuals in the control group, 86.7% were in the 65- to 74-year age group, 83.3% were women, 76.7% were married, 60% were illiterate, 53.3% had at least one chronic illness, 60% regularly used medication, and 80% of them underwent knee replacement surgery. There were no significant differences between groups, suggesting that the groups are similar in terms of demographic variables that may affect postoperative cognitive function.

Effects of Listening to Music on MMSE

The results of the comparison of the mean of intragroup and intergroup MMSE are given in Table 2. No difference was found between groups ($P = .069$), but changes in group-time and group-time interaction were statistically significant ($P = .000$).

Result of in-group binary comparisons revealed significant differences in the means between preoperative and postoperative day 1 ($P = .000$), preoperative and postoperative day 2 ($P = .001$), preoperative and postoperative day 3 ($P = .004$), and postoperative day 1 and postoperative day 2 ($P = .016$) of the control group. These results indicated that the preoperative MMSE measurement mean significantly increased. By contrast, the intervention group evaluated binary comparisons; a significant difference was observed between the means of preoperative and postoperative day 1 ($P = .002$), postoperative day 1 and postoperative day 2 ($P = .007$), and postoperative day 1 and postoperative day 3 ($P = .001$; Table 2).

Effects of Listening to Music on the NEECHAM Confusion Scale

A comparison of the mean of the NEECHAM Confusion Scale between groups and within groups is given in Table 3.

A statistically significant difference between the groups in the NEECHAM confusion scale mean was found ($P = .000$). A significant difference in the mean change of the groups according to time was noted within the groups ($P = .000$). Given that the group-time interaction was not significant, intragroup and intergroup differences were evaluated separately. The NEECHAM Confusion Scale means were compared for the control and intervention groups, and there was no significant difference between days 1 ($P = .051$), but a statistically significant difference was observed between days 2 ($P = .006$) and 3 ($P < .001$).

Table 1. Characteristics of the Study Participants (n = 60)

	Control (n = 30)	Intervention (n = 30)	Total		
	n (%)	n (%)	n (%)	χ^2	*P*
Age (mean, SD) 69.86 ± 7.59					
65-74	26 (86.7)	22 (73.3)	48 (80.0)	1.833	.400
75-84	3 (10.0)	5 (16.7)	8 (13.3)		
≥85	1 (3.3)	3 (10.0)	4 (6.7)		
Gender					
Female	25 (83.3)	20 (66.7)	45 (75.0)	2.222	.136
Male	5 (16.7)	10 (33.3)	15 (25.0)		
Marital status					
Married	23 (76.7)	24 (80.0)	47 (78.3)	2.118	.347
Single	7 (23.3)	6 (20.0)	13 (21.7)		
Education status					
Literate	18 (60.0)	16 (53.3)	34 (56.7)	2.118	.347
Primary school	12 (40.0)	12 (40.0)	24 (40.0)		
High school	0 (0)	2 (6.7)	2 (3.3)		
Chronic diseases					
Yes	16 (53.3)	23 (76.7)	39 (65.0)	3.590	.058
No	14 (46.7)	7 (23.3)	21 (350)		
Regular use of medication					
Yes	18 (60.0)	17 (56.3)	35 (58.3)	0.069	.793
No	12 (40.0)	13 (43.3)	25 (41.7)		
Previous surgery					
Yes	18 (60.0)	20 (66.7)	38 (63.3)	0.287	.592
No	12 (40.0)	10 (33.3)	22 (36.7)		
Operation type					
Hip prosthesis	6 (20.0)	8 (26.7)	14 (23.3)	0.373	.542
Knee prosthesis	24 (80.0)	22 (73.3)	46 (76.7)		

SD, standard deviation.

When the groups were evaluated, a significant difference was found between the means of postoperative days 1 and 3 of the control group ($P = .003$). The mean of NEECHAM Confusion Scale was significantly higher on postoperative day 3 than on the postoperative day 1.

In the intervention group, a significant difference was found between the mean of postoperative day 1 and postoperative day 2 ($P = .006$) and postoperative day 1 and postoperative day 3 ($P = .000$; Table 3).

Discussion

This study was conducted to determine the effect of classical Turkish music on postoperative cognitive function in older adults after hip or knee surgery. Postoperative cognitive dysfunction, which usually develops in older adults in the postoperative period, is a problem that disrupts almost all functions of the patient and increases the patient's hospital stay, mortality, and morbidity.[6,11] An individual's cognitive function is affected by a variety of personal and environmental factors including age, mental state, preoperative period, and operation times.[32] In this study, no statistically significant difference is shown between participants in terms of age, gender, educational status, previous surgery, and operations times. These findings suggest that the groups are similar in terms of demographic variables. Although there was no difference between the two groups in this study, there were more females in both groups. Parameters such as gender and its influence were not clearly established by the relevant literature[32] or this study.

There was no statistically significant difference between the mean postoperative MMSE of the

Table 2. Comparison of MMSE Intragroup, Intergroup and Group-Time Interaction

MMSE	Control (n = 30) Mean ± SD	$\tilde{X}$[Min-Max]	Test Statistic	Binary Comparisons	Intervention (n = 30) *Mean* ± *SD*	$\tilde{X}$[Min-Max]	Test Statistic	Binary Comparisons	Test Statistic; *P*
Preoperative (Pre-O)	27.77 ± 2.4	29 [21-30]	χ^2 = 44.719	Pre-O–Post-O1: *P* = .000	27 ± 2.49	27.5 [21-30]	χ^2 = 22.665	Pre-O–Post-O1: *P* = .002	Group: WTS = 3.314; *P* = .069
Postoperative day 1 (Post-O1)	23.37 ± 3.26	24.5 [14-27]		Pre-O–Post-O2: *P* = .001	24.97 ± 3.26	26 [14-29]		Post-O1–Post-O2: *P* = .007	Time: WTS = 88.08; *P* = .000
Postoperative day 2 (Post-O2)	25.77 ± 2.7	26.5 [18-29]		Pre-O–Post-O3: *P* = .004	26.8 ± 2.81	28 [9-30]		Post-O1–Post-O3: *P* = .001	Group*Time: WTS = 24.41; *P* = .000
Postoperative day 3 (Post-O3)	25.33 ± 2.71	26 [19-29]		Post-O1–Post-O2: *P* = .016	27.23 ± 2.21	28 [21-30]			

MMSE, Mini-Mental State Examination; SD, standard deviation.
χ^2: Friedman test statistic; WTS: Wald Test Statistics, nonparametric test statistic for repeated measures of factorial design.
$P < .05$ significance level.

individuals in the intervention and control groups. However, postoperative NEECHAM Confusion Scale mean showed that there was a statistically significant difference between the groups.

This study determined that the patients with preoperative control and intervention had a normal mean of MMSE scores, but a decrease in cognitive functions was observed in both groups on the first day after surgery. Although the increase in the mean MMSE of the patients in the intervention group was greater than that in the control group after listening to music, the differences were not statistically significant among the postoperative days 1, 2, and 3 ($P > .05$). In the literature, it is emphasized that with the progression of age, decline in cognitive function and postoperative cognitive impairment constitute a great risk.[10,33] Contrary to the results of this study, McCaffrey[18] found that MMSE mean is significantly higher in the intervention group than that in the control group. McCaffrey and Locsin[17] found that listening to music significantly increased the MMSE mean in the intervention group.

NEECHAM Confusion Scale mean scores showed statistically significant differences between the groups ($P < .05$). Similar to the present study, McCaffrey[18] found that the mean score of the NEECHAM Confusion Scale after listening to music is significantly higher in the intervention group than in the control group. Vasionyte and Madison,[34] Van de Winckel et al,[35] Han et al,[36] and Fischer-Terworth[37] found a significant increase in the levels of cognitive function in studies conducted to determine the effect of music on improving cognitive function among patients with dementia. Emery et al[38] reported that listening to music improves cognitive performance among participants in a cardiac rehabilitation program.

All the patients in this study listened to the same style of classical Turkish music. Rogers and Gibson reported that classical music listening increases posttest scores in late learners.[39] Hicks-Moore,[40] showed that music reduces agitation, a frequent symptom of acute confusion. Listening to music plays an important role in emotional stimulation and self-regulation by reminding individuals about their own life experiences and musical memories.[41,42] In addition, the emotions stimulated by music offer important findings to improve cognitive function.

Table 3. Comparison of Intragroup, Intergroup, and Group-Time Interaction of Mean NEECHAM Confusion Scale

NEECHAM Confusion Scale	Control (n = 30)				Intervention (n = 30)				
	Mean ± SD	X̃[Min-Max]	Test Statistic	Binary Comparisons	Mean ± SD	X̃[Min-Max]	Test Statistic	Binary Comparisons	Test Statistic; *P*
NEECHAM postoperative day 1	24.1 ± 2.43	24.0 [18-29]	χ^2 = 12.865 *P* = .002	1-3: *P* = .003	25.57 ± 2.73	24.5 [22.0-30.0]	χ^2 = 25.846 *P* = .000	1-2: *P* = .006	U = 320.000; *P* = .051
NEECHAM postoperative day 2	26 ± 2.75	26.0 [20.0-30.0]			27.87 ± 2.19	28.0 [22.0-30.0]		1-3: *P* = .000	U = 266.500; *P* = .006
NEECHAM postoperative day 3	26.63 ± 2.51	27 [19.0-30.0]			28.97 ± 1.43	30.0 [25.0-30.0]			U = 181.000; *P* = .000

SD, standard deviation.
χ^2: Friedman test statistic; U: Mann Whitney U test statistic.
$P < .05$ is considered statistically significant.

The interaction between cognition and musical emotions is due to the colocation of memories and the emotional function of the local hippocampus.[43] The results of this study were similar to the findings in the literature.

In contrast, Chien-Hsun et al,[44] Chang et al,[45] Narme et al,[46] and Ueda et al[47] in a patient with dementia and Li et al[48] in the elderly patients reported that listening to music had no significant effect on development of cognitive function.

This study had some limitations. The research was conducted in one center only, and patients were not allowed to choose the music they listened to, which may have affected the results.

Conclusions

This study evaluated the effect of listening to music on the cognitive function of older adults after hip or knee surgery. Results showed no statistically significant difference in MMSE averages between the individuals in the intervention group and those in the control group, but a significant difference was found for the mean scores of NEECHAM Confusion Scale. The cognitive function of the group listening to music was higher than that of the nonlistening group. Listening to music is an easy, safe, and inexpensive intervention that nurses can implement to help older adults after hip or knee surgery. The results of this study showed that this technique could be used safely in older adults undergoing hip and knee prosthesis surgery to improve postural cognitive function and reduce acute confusion.

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