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Does Music during Image-Guided Procedures Reduce Patient Anxiety Levels?

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Abstract

Purpose The aim of the study was to evaluate the role of music in alleviating anxiety in patients undergoing image guided procedures.

Materials and Methods A total of 129 patients were included in this prospective study after obtaining clearance from the Institutional Ethics Committee. Patients were randomized into control ($n = 59$, median age 46, 30 males) and music ($n = 70$, median age 46.5, 33 males) groups. Procedures included thoracocentesis, paracentesis, fine needle aspiration cytology and biopsies of the breast, liver, thyroid and lymph nodes. It was performed over a period of 4 months, between September 2020 and December 2020. Pre- and intra procedure recordings of systolic blood pressure, diastolic blood pressure and heart rate were recorded. Circumstantial anxiety was evaluated using the Spielberg State-Trait Anxiety Inventory before and after the procedure.

Results There was a statistically significant reduction ($p = 0.001$) in the rise of systolic blood pressure, diastolic blood pressure and heart rate in the music group as compared to the control group. There was also a statistically significant reduction ($p = 0.001$) in the State-Trait Anxiety Inventory scale values in the music group as compared to the control group during the procedure.

Conclusion Patients undergoing image-guided procedures may be offered a choice to listen to music of their preference to reduce situational anxiety.

Keywords
- music
- anxiety
- intervention

Introduction

Anxiety is a psychological condition that affects almost everyone at some point of time and like any other state of mind, it can manifest at any given moment. Invasive procedures, including image-guided ones, carry a high chance of inducing anxiety in patients owing to its inherent complication risk, apprehension of potential pain, discomfort and unfavorable outcome. Provision of pleasing auditory stimuli such as music has been shown to reduce anxiety in a wide gamut of interventional procedures like hysteroscopies and biopsies.[1–3] Multiple studies have shown that music can be efficacious in reducing circumstantial anxiety in preoperative and in-patients.[4,5] However, in the context of image-guided interventions, studies have shown mixed results. Few studies have shown music to effectively reduce patient anxiety levels,[6,7] while some other studies failed to show the same.[8,9] This study aims to investigate if listening to music during image-guided procedures helps reduce patient anxiety levels.

Materials and Methods

Study Participants

This study was approved by the Institutional Ethics Committee of Father Muller Medical College Hospital, Mangalore, Karnataka, India. Patients referred to the Department of Radiology for the purpose of image-guided interventions,

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aged 18 years and above were included in the study. Procedures included fine-needle aspiration cytology (FNAC) and biopsies of the breast, liver, thyroid or lymph nodes, thoracocentesis, and paracentesis. The study was performed over a period of 4 months, between September 2020 and December 2020. Uncooperative patients, unconscious patients, patients diagnosed with psychiatric illnesses, and those with comorbidities like hypertension and cardiovascular disorders were excluded. Patients with hearing difficulties and those who did not understand written English were also excluded, as the inventory to assess anxiety was only available in the English language. Patients who did not consent to participate in the study were excluded as well.

Study Design

This was a cohort type of a study, cross-sectional in nature. The total sample size was 132, calculated using the formula $n = 2(za + zb)^2\sigma^2/d^2$ at 95% confidence interval using the article by Akin[10] as the reference. Subsequent to obtaining written informed consent, pre procedure systolic (SBP) and diastolic blood pressure (DBP) and heart rates (HRs) were obtained using noninvasive blood pressure and pulse oximeter, respectively. Participants completed a written preprocedure questionnaire in printed format utilizing the Spielberg State-Trait Anxiety Inventory[11] (STAI) Y-1 short-form which assesses the circumstantial or "state" anxiety of the patient. This form was not translated into other languages to maintain the accuracy of the inventory. The score was calculated using the provided scoring key for each patient and the results were tabulated. STAI is a validated, self-assessment inventory to evaluate the circumstantial (state) and general (trait) anxiety of the patient, and has been used extensively in research.[11] The assessment of each part consists of 10 questions with 4 answers each, out of which one answer has to be selected for each question. The total score ranges from 10 to 40, with a higher score depicting a higher level of anxiety.

Before the start of the procedure, patients were randomized into the "control" and "music" groups using a technique of simple random sampling. A coin was tossed prior to the procedure, and the patients were put sorted into the "music" group if the outcome was heads and into the "control" group if the outcome was tails. During the procedure, music was played for the patients in the "music" group, on Spotify using boAt Rockerz 255 Pro+ headphones which was in accordance with the patient's choice. Patients were given only one headphone to allow communication between the interventionist and the patient throughout the procedure. Volume was adjusted according to the patient's preference.

Patients under the "control" group were not provided with music. Blood pressure and HR values were recorded and documented during the procedure as well. Postprocedure questionnaire was provided to the patient to assess their "state" anxiety for the second time and the score was calculated. Postprocedure state anxiety scores were taken and these were considered as a part of the intraprocedure values as patients would not be able to record their experiences during the procedure. The interventional procedure was performed as given under the "Intervention" section.

Intervention

Patients were taken up for the procedure with the usual standard of care regardless of the group assigned. Procedures such as FNAC and biopsies, thoracocentesis, and paracentesis were performed under ultrasound guidance by an interventional radiologist or by a radiology resident under supervision by the interventional radiologist. Local anesthesia was achieved with 1% lignocaine injection without adrenaline.

Statistical Analysis

The data was analyzed using SPSS for windows (SPSS version 22, IBM Corp, Armonk, New York, United States). The data was analyzed for normality using Shapiro–Wilk test. Within-group comparison was done using Wilcoxon rank sum test and between-group comparison was done using Mann–Whitney *U* test. Graphs and tables were used to describe the data. The level of significance was set at $p < 0.05$.

Results

Study Participants

A total of 132 patients who fulfilled the inclusion criteria were enrolled in the study. Out of these 3 patients had to be excluded, because they developed a vasovagal episode during the procedure. A total of 129 patients who gave written informed consent prior to the procedure were thus included in the study, who were then randomized into control (59 patients) and music (70 patients) groups. The control group was composed of 30 males (50.8%) and 29 females (49.2%) while the music group was made up of 33 males (47.1) and 37 females (52.9%). The ages of the control group participants ranged from 22 to 78 years and that of the music group ranged from 25 to 64 years. The demographics of the enrolled patients are summarized in ►**Table 1**.

Table 1 Distribution of study participants according to gender and age in both the groups

Control group ($N = 59$)			Music group ($N = 70$)		
Gender	Male Female	30 (50.8) 29 (49.2)	Gender	Male Female	33 (47.1) 37 (52.9)
Age range (in years)		22 to 78	Age range (in years)		25 to 64
Age [Median (IQR)]		46 (45–54)	Age [Median (IQR)]		46.5 (42–52.25)

Abbreviation: IQR, interquartile range.

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Table 2 Between-group comparison of control and tests before the procedure

Variables	Group	Mean (IQR)	Mean rank	*p*-Value
Systolic blood pressure	Control Test	119 (114–123) 122.5 (117–125)	56.2 72.41	0.014[a]
Diastolic blood pressure	Control Test	84 (81.75–88) 84 (82–91)	66.02 64.14	0.7 NS
Heart rate	Control Test	74 (72–78) 74 (72–78)	62.69 66.95	0.51 NS
STAI	Control Test	30 (27–32) 31 (28–32)	66.37 63.84	0.7 NS

Abbreviations: IQR, interquartile range; NS, not significant; STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$.
[a]Statistically significant using Mann–Whitney *U* test.

Baseline Measurements

Prior to the procedure, it was found that the mean SBP of the control (mean = 119, range = 114–123) group was higher than that of the music (mean = 122.5, range = 117–125) group, which was statistically significant ($p = 0.014$). There was no statistically significant difference in DBP, HR, and preprocedure state anxiety score between the controls and tests ($p > 0.05$) (►**Fig. 3** and **4**). The preprocedure baseline measurements of SBP, DBP, HR, and STAI values in the control and music groups are summarized in ►**Table 2**. In our experience, females were more apprehensive in general before the procedure, but there was no statistically significant difference in the preprocedure values of BP, HR, and STAI values between the two genders, in both the groups (►**Tables 3** and **4**) ($p > 0.05$).

Anxiety Outcome Measurements

The results obtained showed that in both the control and music groups, the SBP, DBP, and HR were elevated during the procedure than before (►**Figs. 1** and **2**) that was found to be

Table 3 Comparison of mean values of SBP, DBP, HR, and STAI between gender in control group before procedure

		N	Mean	SD	*p*-Value
Systolic blood pressure	Males Females	18 41	118.6 118.83	6.09 4.8	0.88 NS
Diastolic blood pressure	Males Females	18 41	84.17 85.37	6.428 6.576	0.51 NS
Heart rate	Males Females	18 41	75.39 74.83	3.55 4.159	0.62 NS
STAI	Males Females	18 41	31.06 29.83	2.859 3.09	0.15 NS

Abbreviations: DBP, diastolic blood pressure; HR, heart rate; *N*, frequency; NS, not significant using unpaired *t*-test; SBP, systolic blood pressure; SD, standard deviation; STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$.

Table 4 Comparison of mean values of SBP, DBP, HR, and STAI between gender in test group before procedure

		N	Mean	SD	*p*-Value
Systolic blood pressure	Males Females	18 41	121.45 120.32	4.691 5.297	*p* 0.35 NS
Diastolic blood pressure	Males Females	18 41	84.33 84.22	5.661 6.545	*p* 0.93 NS
Heart rate	Males Females	18 41	75.88 75.81	6.035 5.768	*p* 0.96 NS
STAI	Males Females	18 41	29.76 30.19	3.509 4.088	*p* 0.63 NS

Abbreviations: DBP, diastolic blood pressure; HR, heart rate; *N*, frequency; NS, not significant using unpaired *t*-test; SBP, systolic blood pressure; SD, standard deviation; STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$.

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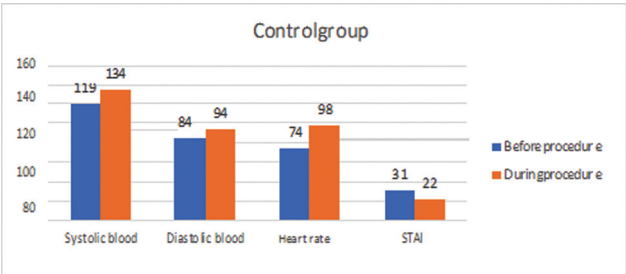

Fig. 1 Median values of variables before and during the procedure in control group.

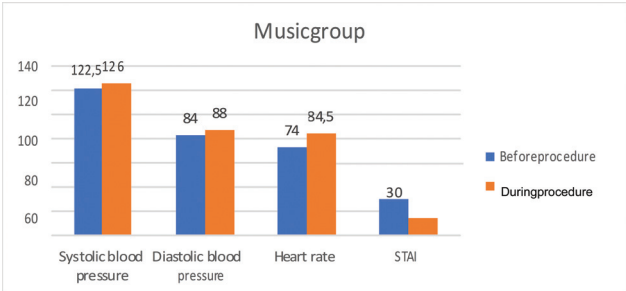

Fig. 2 Median values of variables before and during the procedure in music group.

Table 5 Within-group comparison of variables before and during the procedure in the control group

Control	Negative ranks			Positive ranks			Test statistic		
During–Before	*n*	Mean rank	Sum of ranks	*n*	Mean rank	Sum of ranks	Ties	*Z*	*p*-Value
Systolic blood pressure	0	0	0	58	29.50		1	−6.6	0.001[a]
Diastolic blood pressure	4	4.75	19	53	30.83	1,634	2	−6.7	0.001[a]
Heart rate	0	0	0	59	30	1,770	0	−6.6	0.001[a]
STAI	59	30	1,770	0	0	1,770	0	−6.8	0.001[a]

Abbreviation: STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$; *n*, frequency.
[a]Statistically significant using Wilcoxon rank sum test.

Table 6 Within-group comparison of variables before and during the procedure in the music group

Music	Negative ranks			Positive ranks			Test statistic		
During–Before	*n*	Mean rank	Sum of ranks	*n*	Mean rank	Sum of ranks	Ties	*Z*	*p*-Value
Systolic blood pressure	5	34.5	172.5	63	34.5	2,173.5	2	−6.12	0.001[a]
Diastolic blood pressure	0	0	0	68	34.5	2,346	2	−7.1	0.001[a]
Heart rate	0	0	0	70	35.5	2,485	0	−7.2	0.001[a]
STAI	70	35.5	2,485	0	0	0	0	−7.27	0.001[a]

Abbreviation: STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$; *n*, frequency.
[a]Statistically significant using Wilcoxon rank sum test.

statistically significant ($p = 0.001$), respectively. It was also found that STAI scores were significantly ($p = 0.001$) less after the procedure than before the procedure. This points toward the fact that patients in both the groups had significantly elevated anxiety levels during the procedure, and were more relaxed after the procedure was done, as evidenced by the reduction in the postprocedure state anxiety score values. ►**Tables 5** and **6** summarize these values. It was found that there was no statistically significant difference in mean SBP, DBP, and STAI between males and females in the control group before the procedure ($p > 0.05$). However, the HR of females was more than males during the procedure which was statistically significant ($p = 0.04$) (►**Table 7**). In the music group as well, males and females had no statistically significant difference in the intraprocedure values ($p > 0.05$) (►**Table 8**). The mean values obtained in the control group before and during the procedure are depicted in ►**Figs. 5** and **6**. The mean values obtained in the test group before and during the procedure are shown in ►**Figs. 7** and **8**.

It was found that there was a substantial reduction in the rise of SBP ($p = 0.001$), DBP ($p = 0.001$), and HR ($p = 0.001$) and reduction in the STAI ($p = 0.001$) values in the music group as compared with the control group during the procedure which was also statistically significant. These values signify that the extent of reduction of anxiety was substantially more in the group provided with music, as compared with the control group. The intraprocedure measurements of SBP, DBP, and HR and the postprocedure STAI values are summarized in ►**Table 9**.

Discussion

Patient anxiety is extremely common in the hospital setup, more so in the patients undergoing invasive

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Table 7 Comparison of mean values of SBP, DBP, HR, and STAI between gender in control group during procedure

		N	Mean	SD	*p*-Value
Systolic blood pressure	Males Females	18 41	131.56 133.17	2.955 4.353	0.15 NS
Diastolic blood pressure	Males Females	18 41	94.5 94.41	2.333 2.636	0.9 NS
Heart rate	Males Females	18 41	97.22 103.02	4.223 11.731	0.04
STAI	Males Females	18 41	21.83 21.63	1.79 2.643	0.77 NS

Abbreviations: DBP, diastolic blood pressure; HR, heart rate; *N*, frequency; NS, not significant using unpaired *t*-test; SBP, systolic blood pressure; SD, standard deviation; STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$.

Table 8 Comparison of mean values of SBP, DBP, HR, and STAI between genders in control group during procedure

		N	Mean	SD	*p*-Value
Systolic blood pressure	Males Females	18 41	125.15 126.03	4.177 4.113	0.38 NS
Diastolic blood pressure	Males Females	18 41	87.94 89.03	4.789 5.48	0.38 NS
Heart rate	Males Females	18 41	86 83.92	8.562 7.143	0.27 NS
STAI	Males Females	18 41	14.76 14.84	1.542 1.385	0.81 NS

Abbreviations: DBP, diastolic blood pressure; HR, heart rate; *N*, frequency; NS, not significant using unpaired *t*-test; SBP, systolic blood pressure; SD, standard deviation; STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$.

Table 9 Between-group comparison of control and tests during the procedure

	Group	Mean (IQR)	Mean rank	*p*-Value
Systolic blood pressure	Control Test	134 (131.7–135) 126 (124–129)	93.13 41.29	0.001[a]
Diastolic blood pressure	Control Test	94 (93–97) 88 (84–92.25)	87.9 45.7	0.001[a]
Heart rate	Control Test	85 (83–87.25) 79 (77.75–81.25)	94.42 40.21	0.001[a]
STAI	Control Test	21 (20–23) 15 (14–16)	99.24 36.14	0.001[a]

Abbreviations: IQR, interquartile range; STAI, State-Trait Anxiety Inventory.
Note: Level of significance at $p < 0.05$.
[a]Statistically significant using Mann–Whitney *U* test.

procedures. It can lead to apprehension which may in turn lead to a negative patient outcome. Any tool which can reduce anxiety in this subset of patient population will be of utmost importance. From the results obtained in this study, we have found that providing music to the patients while performing an image-guided procedure, can lead to significant reduction in the anxiety levels of the patients. These results are comparable to the studies done by Bradt et al,[4] Soo et al,[5] and Bennett et al.[12] A study has shown that patients prefer the choice of being offered music though it did not change the final outcome of anxiety.[13] Another study has shown music to be effective in improving patient satisfaction in a scenario of bone marrow biopsy.[14]

Music can be an exceptional tool in patient anxiety reduction as it is widely available, economical, and easy to dispense. It can be provided by using the patient's own phone, headphones, or with the help of a music system installed in the intervention room. Due to its noninvasive nature and lack of ramifications, it can be a powerful appliance in reduction of patient anxiety levels. Also, since music is nonpharmacological, it lacks the adverse effects commonly associated with anxiolytic medications.[12] There are several theories as to why music may reduce anxiety. A study has

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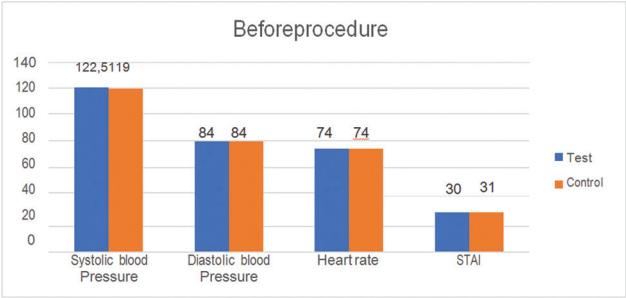

Fig. 3 Median values of variables between control and test before the procedure.

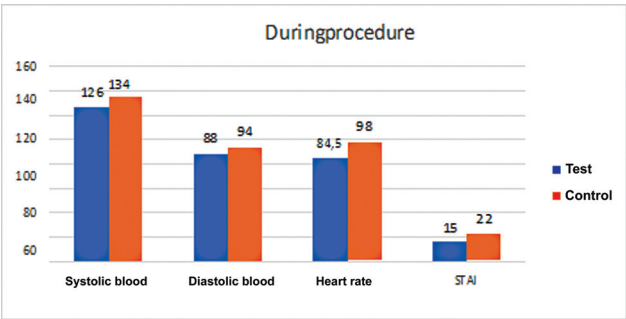

Fig. 4 Median values of variables between control and test during the procedure.

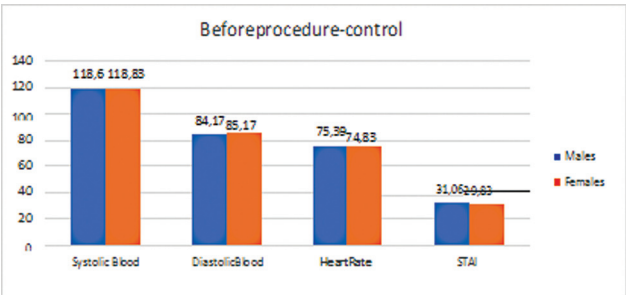

Fig. 5 Mean values of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and State-Trait Anxiety Inventory (STAI) between genders in control group before procedure.

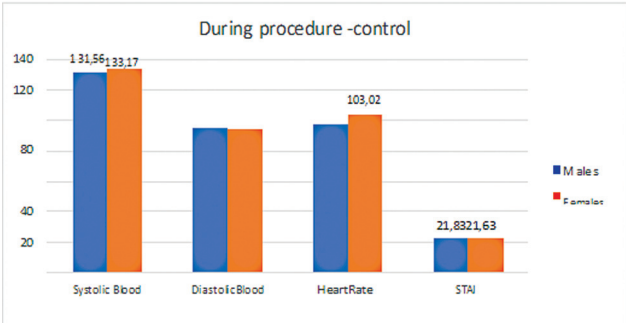

Fig. 6 Mean values of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) and State-Trait Anxiety Inventory (STAI) between genders in control group during procedure.

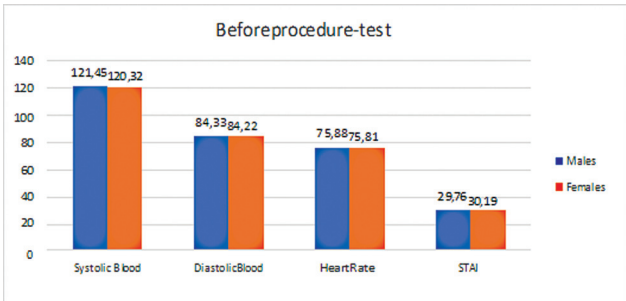

Fig. 7 Mean values of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) and State-Trait Anxiety Inventory (STAI) between genders in test group before procedure.

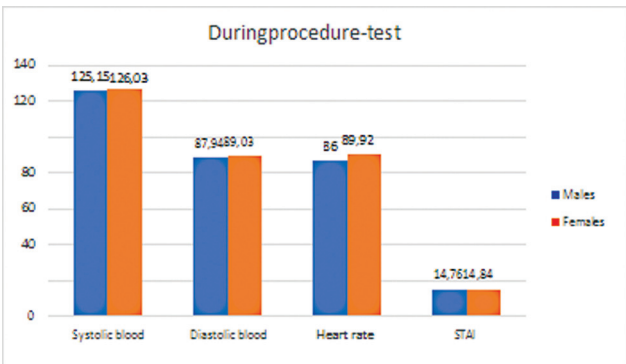

Fig. 8 Mean values of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) and State-Trait Anxiety Inventory (STAI) between genders in test group during procedure.

suggested that music may reduce pain by modulating connectivity between various pain centers in the brain.[15] Listening to music may also mask unpleasant noises in the hospital and may also cause time to be perceived in a faster manner.[12] The study by Bennett et al[12] has further hypothesized that providing the patient with a choice in the music type and the concept of familiarity might have something to do with alleviation of anxious thoughts.

In our study, we found elevated levels of preprocedure anxiety in both the groups as evidenced by the state inventory scores. This is self-validating as apprehensive states can lead to heightened anxiety levels. Both the groups showed a significant reduction in the state inventory scores postprocedure, signifying the relatively relaxed state of mind of the patients after the end of the procedure. However, the music group experienced a greater reduction in anxiety which was statistically significant, as compared with the control group ($p = 0.001$). Also, the anxiety was reduced right after the procedure was completed, highlighting the fact that preprocedure anxiety is time limited.

Furthermore, though the blood pressure and HR values were elevated during the procedure as compared with the preprocedure levels in both the groups, the rise was significantly less in the music group as compared with the control group ($p = 0.001$). This gives an objective angle to the study, signifying the relatively relaxed state of mind provided by the presence of music.

In our experience, anxiety levels of females were more than that of males, but there was no statistically significant difference between the values obtained between the two

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genders. An exception to this was the preprocedure recording of HR values which was more in females ($p = 0.04$).

There were a few limitations in this study. First, this was a single-center study done for the South Indian population. Generalizing this data might give inconsistent results. Also, different procedures—irrespective of location of biopsy/FNAC/aspiration—were taken into consideration with equal weightage. Further studies might be required to analyze the effect of music in individual procedures, with a larger sample size.

There are various ways in which research can be extended in this topic using the results of this study. Preprocedure anxiety values may be compared with normative state anxiety levels of the population which provides another variable for comparison. Subsequent research may also focus on comparing the efficacy of headphones as compared with speakers to reduce anxiety. Every patient might have a different threshold for the triggering of anxiety and tailor-made questionnaires may be developed for various personality types of the patients which may help us assess different states of mind in a more effective manner.

In conclusion, patients who listened to music of their choice were less anxious as compared with the patients who did not. Based on this data, patients undergoing image-guided procedures should be offered a choice to listen to music of their preference to reduce situational anxiety levels.

Ethical approval

This prospective study was approved by the Institutional ethics committee and informed consent was taken.

Conflict of Interest

None declared.

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