Comparative Evaluation Of Anxiety Levels In Patients Undergoing Root Canal Treatment With Frequencies Of Music Therapy Of 432Hz And 440Hz: A Randomized Clinical Study

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Abstract

***Objectives**: To compare and evaluate the anxiety levels in patients undergoing root canal treatment with frequencies of music therapy of 432Hz and 440Hz.*

***Methods:** 150 patients were enrolled; before endodontic therapy was initiated, they were provided with a visual analog scale (VAS) score to evaluate the baseline anxiety level. The participants were randomly divided into three groups: the control group (no music), 432 Hz music group and 440 Hz music group. The vital signs (SBP, DBP and HR) were recorded at three intervals (before, during and after the treatment). They were statistically analyzed ($p \leq 0.05$).*

***Results:** One sample t-test and one-way ANOVA revealed statistically significant differences in the SBP and HR between patients who received music therapy and those who did not. Tukey post hoc test revealed a significant difference between 432 Hz music and no music in terms of SBP (**p=0.032**). There was a considerable difference in HR between the 432 Hz music and the no music groups (**p=0.009**) and between the 440 Hz music and the no music groups (**p=0.007**).*

***Conclusion:** Music therapy plays an important role in reducing the anxiety levels of patients undergoing root canal treatment, with the Pythagorean turning at 432 Hz having more favorable results.*

Keywords: Anxiety, Music therapy, Endodontics

1. INTRODUCTION

Root canal therapy is a well-accepted treatment for diseases of the dental pulp and its sequela in periapical tissues (Ray & Trope 1995) [1]. However patient management is an important and sometimes challenging component of endodontic therapy and can be perceived by some patients as painful and therefore feared.

Patients generally perceive dental care as invasive. ‘‘Dental anxiety’’ covers a wide range of emotions, from mild apprehension to extreme anxiety or dental phobia. Patients who undergo endodontic therapy often have severe preoperative and intraoperative anxiety, which may lead to increased perceptions of pain and vital sign instability throughout treatment [2].

During endodontic treatments, patients are exposed to various sounds, such as the metallic sounds of instruments and drill noise. Annoying rubber dams and sharp instruments. Fear from injections (anesthesia). The professional conversations of staff members are all perceptions that are further emphasized, especially if the patient(s) had previous negative experiences at the dental clinic.

Methods practiced to reduce dental anxiety include meditation and Hypnosis [3], Inhaled anesthetics (nitrous oxide) [4], aroma therapy (the use of essential oils, scented, volatile liquid substances for therapeutic purposes) [5], different behavioral techniques (yoga or meditation practices) [6], verbal relaxation therapy [7], virtual reality distraction [8], etc

One of the therapies documented for reducing pain and anxiety is music therapy. The relationship between music and medicine has been studied extensively, especially with respect to the use of music in clinical practice.[2] Music has been proposed to have a psychophysiological effect that aids in the reduction of sympathetic activity, thereby reducing blood pressure, heart rate, and respiratory rate and inducing relaxation [9].

In the field of music, songs are tuned at two different frequencies., i.e., "The 432 Hz vs. 440 Hz" is known for its merits and demerits. The modern standard is 440 Hz (A=440 Hz), where Hz is a unit per second, and "440 Hz" refers to 440 vibrations per second. The peak at 432 Hz has presumed to promote healing and soothing properties and is believed to be tuned to the vibrations of nature it self, whereas the 440 Hz tuning was introduced by Joseph Goebbels, the *Nazi minister of propaganda,* to bring standardize in the field of music [10]. However according to few studies, inharmonious vibrations of 440 Hz can be a source of illness [11] .

The visual analogue scale (VAS) used in this study is an effective scale for assessing the impact of anxiety.

Hence the purpose of this study was to compare music at frequencies of 432 Hz and 440 Hz as a nonpharmacologic adjuvant, and evaluate its effect in terms of systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) during endodontic treatment.

2. MATERIALS AND METHODS

The current research is a parallel design randomized controlled clinical trial. Ethical approval from the institutional ethics committee was obtained (Ref no.: SVIEC/ON/Dent/SRP/18101) before intervention. The study was carried out following the Declaration of Helsinki and the methodology was performed within the parameters of the CONSORT statement guidelines (Figure. 1).

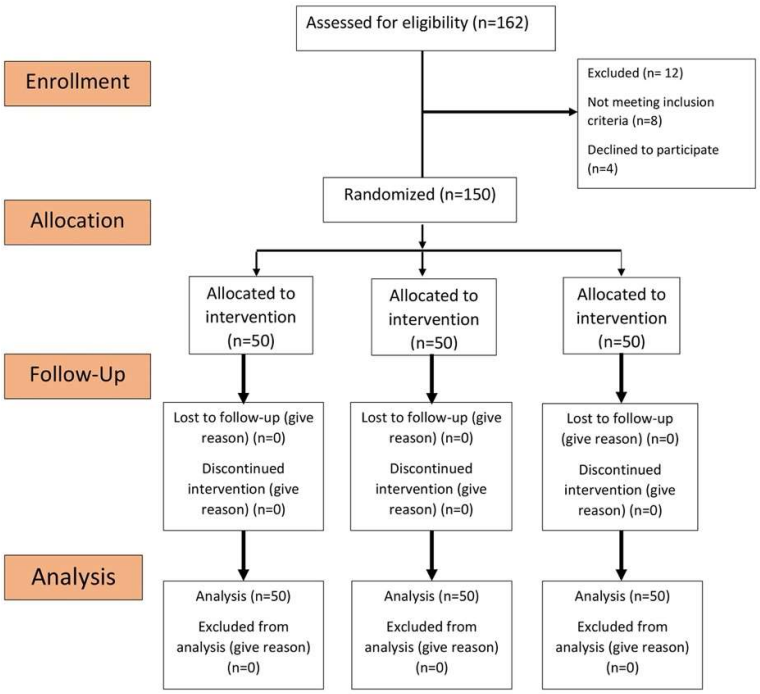

Fig 1: CONSORT Flowchart

2.1. Sample size determination:

A total of 150 patients (50 patients per arm) were evaluated to reject the null hypothesis of equality in all 3 groups in terms of SBP, DBP, and HR. The group sample size is 50 per group achieving a 92% confidence interval.

- Sample size = 2*(Zalfa/2 +Z1-beta)^2/ (m1-m2/sigma)^2
  where zalfa/2= 1.96, Z1-beta= 0.84

As there was no follow-up of the patients, no dropouts were considered.

2.2. Selection criteria:

All participants were informed about the aim of the study. Both male and female patients who were older than 18 years of age and in need of root canal therapy for teeth with irreversible pulpitis were selected for the study. Patients who did not use any medication, and had no systemic, chronic or mental disease were included in the study.

Patients who were suffering from hearing loss, had any physical disability, or who were pregnant or lactating were excluded from the study.

2.3. Clinical procedure:

A total of 150 patients were recruited from the OPD of the Department of Conservative Dentistry and Endodontics, and patients were selected on the basis of the inclusion and exclusion criteria. The patients were informed about the study, and informed consent was obtained. In cases of patients under the age of 18, their parents gave their informed consent. All participants were informed of the aim of the present study.

The patients were randomized via computerized randomization (randomizor.org).

The investigators involved and the roles assigned to each were as follows:

A. Principal investigator: he/she performed the root canal treatment and was blinded to the rest of the procedure
B. Coinvestigator-1: he/she allocated specified frequency music to the patient and was blinded to the rest of the procedure.
C. Coinvestigator-2: he/she recorded the vital measurements before, during and after the root canal treatment and was blinded to the rest of the procedure.
D. Coinvestigator-3: he/she carried out a randomization process, and the tracks were randomly divided by successive numbers (1, 2, 3)

The Principal Investigator, the Coinvestigator-1 and the Coinvestigator-2 were blinded, making it a triple-blinded study.

After the randomization process, the Coinvestigator-1 allocated headphones along with a specific frequency music track to the patients.

Before endodontic treatment began, patients were sensitized to the VAS scale, and the measurements were recorded by the Coinvestigator-3. The patients were subsequently classified into 4 anxiety levels on the basis of the VAS scale.

No anxiety (score <0), mild anxiety (score 1-2), moderate anxiety (score 3-4, 5-6) and severe anxiety (score 7-8, 9-10).

All the steps of root canal treatment were performed by the principal investigator under local anesthesia (1:200000 Lignocaine with Adrenaline) in a standardized manner. The teeth were isolated via a rubber dam, and the treatment did not exceed one hour.

The patients were divided into three groups.

•Group A: control group (patients undergoing root canal treatment with no music therapy);
•Group B: patients who underwent root canal treatment with music therapy at a frequency of 432 Hz
•Group C: patients who underwent root canal treatment with 440 Hz frequency music therapy

Before initiating the root canal treatment, the patients were seated comfortably, and vital signs were recorded via a digital sphygmomanometer (OMRON) by Co-Investigator-2.

After the vital signs were recorded, the patients were instructed to wear headphones and adjust the volume according to their comfort. The volume was within the normal range.

The vital signs (SBP, DBP, heart rate) were recorded (A) at baseline (before initiation of treatment), (B) 30 minutes after the commencement of treatment and (C) at the end of the treatment (1 hr) by

coinvestigator 2. After the completion of the treatment, the VAS score was recorded again to assess anxiety levels in all 3 groups.

Selection Of Music:

The music selected for this study consisted of two tracks:

Artist: Mozart; Song: Andantino

Artist: Michael; Song: Relax Daily

Both tracks were tuned to frequencies of 432 Hz and 440 Hz by coinvestigator 1.

2.4. Statistical Analysis

The results obtained were tabulated and sent for statistical analysis, where the p value and chi-square value were calculated with SPSS software version 22.0. All the statistical tests were applied keeping confidence at 90% and ($p < 0.05$) was considered to be statistically significant.

3. RESULTS

Among the 150 patients treated (fifty in each group), 81 were male, whereas 69 were female. The ages of 30 patients were between 40 and 60 years, the ages of 80 patients were between 30 and 40 years, and the ages if the remaining 40 patients were between 18 and 29 years. There was no significant difference in mean age, education status, height and weight between the tested groups. (Table 1)

Table 1: Demographic Data of the study participants:

	432 Hz (n=50)	**440 Hz (n=50)**	**No Music (n=50)**
Male n (%)	28 (56%)	23 (46%)	30 (60%)
Female n (%)	22 (44)	27 (54)	20 (40)
Age (years), mean SD	36.67 (14.87)	34.12 (15.98)	38.80 (16.23)
High School n (%)	16 (32%)	12 (24%)	10 (20%)
University n (%)	34 (68%)	38 (76%)	40 (80%)
Height (cm), mean (SD)	153.80 (5.80)	156.74 (8.91)	154.68 (7.81)
Weight (kg)	59.62 (11.46)	59.45 (12.94)	60.66 (12.36)

The value for the systolic blood pressure of patients undergoing root canal treatment receiving music therapy was <0.05, i.e., significant posttreatment; thus, we considered the Tukey post hoc test. The diastolic blood pressure of patients undergoing root canal treatment; receiving music therapy was not <0.05, i.e., insignificant at any time of treatment; thus, we did not consider the Tukey post hoc test. The heart rate of patients undergoing root canal treatment receiving music therapy was $p<0.05$, i.e., significant posttreatment; thus, we considered the Tukey Post Hoc Test (Table 2 and Table 3).

Table 2: Comparison of the Mean Values ±Std. deviation of vitals before, during and after the treatment of all three groups according to one-sample t test (N=50)

GROUP	432 Hz			440 Hz			NO MUSIC		
Mean±Std.	Before (N=50)	During (N=50)	After (N=50)	Before (N=50)	During (N=50)	After (N=50)	Before (N=50)	During (N=50)	After (N=50)
SBP (std=120)	122.70± 16.89	121.20± 12.69	121.12± 8.528	127.40± 13.31	125.44± 9.34	122.94± 6.98	124.62±2 0.20	126.20± 21.11	128.16± 21.24
DBP (std=80)	80.58±1 4.69	79.10±8 .00	80.94±4 .88	84.84±1 2.21	83.50±8 .95	81.54±7 .14	80.78±14. 33	82.38±1 3.78	85.12±1 3.64

HR (std=72)	82.38±13.18	78.60±7.64	75.30±5.69	80.16±11.33	77.18±8.36	75.14±6.09	80.36±15.56	78.62±12.83	80.50±12.59

Table 3: Comparison of the sum of squares of vital signs before, during and after the treatment in all the three groups (p-value) (one-way ANOVA)

BETWEEN GROUPS	SUM OF SQUARES	F	p VALUE
Before treatment SBP	558.413	.962	.385
During treatment SBP	725.920	1.569	.212
After treatment SBP	1335.373	3.497	.033*
Before treatment DBP	577.853	1.519	.222
During treatment DBP	522.880	2.347	.099
After treatment DBP	510.813	2.935	.056
Before treatment HR	150.813	.415	.661
During treatment HR	68.173	.349	.706
After treatment HR	929.920	6.115	.003*

***statistically significant**

The Tukey post hoc test showed that there is a significant difference (p=0.032) between 432Hz and no music and no significant difference between 432 Hz and 440 Hz in terms of SBP. Also, there is a significant difference between 432Hz and no music (p=0.009), and also between 440hz and no music(p=0.007) in terms of heart rate. Thus these results depict that music frequencies of both 432 Hz and 440 Hz can improve the anxiety levels in terms of SBP and HR (See Table 4).

Table 4: Comparison of The Mean difference in SBP and HR after the treatment of all the three groups

Dependent variable	(I) group	(J) group	Mean difference (I-J)	p Value
After treatment SBP	432Hz	440 Hz	-1.820	.788
		No Music	-7.040	.032*
	440 Hz	432Hz	1.820	.788
		No Music	-5.220	.145
		440 Hz	.160	.995

After treatment HR	432Hz	No Music	-5.200	.009*
	440Hz	432Hz	-.160	.995
		No Music	-5.360	.007*

4.DISCUSSION

Dental treatment, which is invasive, is considered a source of anxiety for patients. The present study aimed to evaluate whether the presence of 432 Hz or 440 Hz music could help improve patient cooperation during endodontic treatment by reducing anxiety levels. Music was the only significant variable for cardiovascular changes in the present study. The anxiety level and time of recording did not significantly influence cardiovascular percentage changes.

We specifically selected music since it has been shown to have a favorable effect on the body and mind by promoting motivation, reviving memories, calming stress, and arousing emotions. It also has relaxing and anxiolytic effects and is a noninvasive, painless technique. Music therapy is more affordable than pharmaceutical and other therapies since it does not require significant equipment or training expenditures. Additionally, because sound transcends time and location, music may readily enter the neural system and alter brain waves, therefore altering a person's physiological and psychological state[12]. Since background music therapy is a readily available, practical, and affordable approach in dental clinics, it may be chosen to establish a calm environment. Furthermore, it has been suggested that Mozart's music, in particular, improves the learning of tasks involving spatiotemporal rotation by stimulating relevant brain regions [13].
The effects of music on patients during various medical procedures have been investigated from various perspectives (Lai & Good 2002) [14]. According to many musicians and musicologists, 432 Hz is the frequency closest to natural human frequencies. This frequency is characterized by slow rhythms and melodies that can produce physical and emotional relaxation in listeners. The 432 Hz frequency originally was derived from Pythagoras (a Greek philosopher, mathematician, and scientist) and is known as Pythagorean tuning, a mathematical formula.

The brain perceives a quiet rhythm and gentle sound as a sign of relaxation. Reduced sympathetic nerve activity in the autonomic nervous system causes a relaxed person to secrete less epinephrine (adrenaline). Blood pressure and pulse are two clinical symptoms of anxiety that are influenced by adrenaline. A lower blood pressure and pulse result from less adrenaline being released [15].
The value of 440 Hz is considered to be forced tuning, not natural, defined by some Nazi tuning. When the two frequencies are examined in Cymatics experiments, the patterns show that 432 Hz creates distinct shapes that indicate that they resonate with nature. The 440 Hz tuning creates indistinct patterns, revealing a lack of coherence. The human body is approximately 70% water, so these harmonious ripples can affect our cells. Likewise, the inharmonious vibrations of 440 Hz can be a source of illness [16].

There are different scales available for the measurement of dental anxiety/fear, such as Corah's dental anxiety scale and Kleinknecht's survey. However, owing to their unavailability in multilinguistic language, a 10-point unidirectional VAS was taken into consideration.

The statistical analysis of the results of the present study revealed a statistically significant difference in the clinical performance of patients undergoing root canal treatment among the 3 groups in terms of systolic blood pressure and heart rate. In addition, 432 Hz music therapy helped increase the SBP to a normal value. Both 432 Hz and 440 Hz music therapy helped increase the heart rate to a normal value, which suggests that music plays a vital role in controlling anxiety by increasing the heart rate to a normal value. These results are in accordance with those of Di Nasso L et al. [2]. Additionally, studies by Stegemann T et al [17], and Bradt J et al. [18] demonstrated the pharmacological aid of music therapy in medicine.

Limitations

The different results of the present study could be due to the effect of lack of preferential music; listening to music that one generally likes could have a positive effect as opposed to music that is disliked or unfamiliar. This could be one of the limitations of the study. Other shortcomings include the need for a larger sample size and the inclusion of additional physiological measures to gauge anxiety.

5. CONCLUSION

Within the limitations of the study, it can be concluded that 432 Hz and 440 Hz music therapy helped increase the heart rate and diastolic blood pressure to normal values, with Pythagorean tuning of 432 Hz being at an edge.

Clinical Significance

Music therapy is a nonpharmacological, and noninvasive method to reduce the anxiety of patients during dental endodontic procedures, thus making the visit pleasant visit for the patients in a dental setting.

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Ethical Policy and Institutional Review Board statement: The study was conducted in accordance with the ethical standards of the Declaration of Helsinki (1964), and the protocol was approved by the Ethics Committee of the Institute (Ref no.: SVIEC/ON/Dent/SRP/18101).

Patient Consent: Written consent was obtained from all the subjects included in the study.

Data Availability Statement: The data used to support the findings of this study are included within the article.

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