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Evaluation of the effect of Mozart's music on stress, anxiety, and dexterity levels of dental students in preclinical endodontic training using a haptic virtual reality simulator

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Purpose: To assess the stress and anxiety levels of 3rd-year students in preclinical training along with their success rates under the background of Mozart's music using a haptic virtual reality simulator (HVRS).

Methods: Sixty 3rd-year dentistry students enrolled in preclinical endodontic training were selected based on the inclusion criteria. Participating students were randomly divided into two groups according to whether Mozart's music was used during the access cavity preparation using HVRS. Stress and anxiety levels were evaluated with the Stress-VAS 1 and 2 scales and STAI S and T questionnaires, respectively. Manual dexterity was measured based on the target progress, accuracy, target volume, and outside volume. Data were analyzed with Fisher's exact and Mann-Whitney U tests and the square of the Spearman linear coefficient.

Results: There was no statistically significant difference between genders regarding stress and anxiety levels ($p > 0.05$). Music significantly reduced stress and anxiety levels and enhanced manual dexterity ($p < 0.05$). A significant negative association was observed between the target progress and Stress-VAS 2 ($p < 0.05$), whereas the correlation did not differ between accuracy and Stress-VAS 2 ($p > 0.05$).

Conclusion: Mozart's music positively affected stress and anxiety levels along with the manual dexterity of students in preclinical endodontic training using HVRS.

Keywords: Anxiety; endodontics; music; stress; virtual reality.

Introduction

Preclinical training, which usually occurs during the 2nd and 3rd year of study, is an essential component of dental education. Students can learn basic dentistry applications and gain experience by developing the foundational knowledge and skills required for clinical practice (1). Consequently, this phase mainly focuses on providing a combination of theoretical (classroom-based) learning, hands-on laboratory exercises, and simulated clinical experiences (2). As well as in other dentistry fields, it is also aimed at training versatile and self-confident students by teaching various treatments within the scope of preclinical endodontic training (3).

The essential goal of endodontic preclinical training is to enable students to practice basic endodontic applications such as access cavity preparation, root canal instrumenta-

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tion, obturation, and restoration of endodontically treated teeth (4). Moreover, this training could help detect and prevent possible complications, test suitable working conditions, and shorten the time required for clinical treatments (5,6). Extracted human teeth have been used for many years in preclinical training to achieve present goals (7). However, over the years, some concerns regarding extracted teeth, such as being difficult to obtain, the risk of cross-infection, anatomical variability, and ethical issues, have popularized the use of artificial tooth models (8,9). Although artificial models can overcome the present limitations of extracted teeth, they cannot replace the requirement to learn with natural teeth as part of endodontic training curriculum since they cannot stimulate clinical conditions (9). Additionally, nowadays, advances in technology have enabled the constitution of new educational models in addition to traditional preclinical training (10).

One of the contemporary preclinical educational approaches, virtual reality, refers to a human-computer interface that provides three-dimensional visualization and control of applications by evoking a sensory experience similar to a real clinic setting (11). The haptic virtual reality simulators (HVRS) facilitate students to perform applications realistically and interactively as many times as possible without the need for any material (12). In order to increase realism, haptic devices that ensure tactile sensations to the users have been developed. The HVRS provides feedback by forces, vibrations, or motions (11,13), and therefore these simulators are used in preclinical endodontic training (14). Students can open the access cavities in teeth with different root canal anatomy by feeling the enamel and dentine tissues, and they also can obtain the errors and deficiencies as a result of the applications (15).

Although preclinical training is aimed to be facilitated with new technological education models, the transition period from theoretical education to the preclinical stage still poses challenges (16). Especially the lack of theoretical knowledge or the inability to adequately reflect the learned information in preclinical training can cause high stress and anxiety levels in dentistry students (17,18). Consequently, this stressful and anxious psychological state may impact students' learning and practice skills (19). In order to create a relaxed atmosphere, background music therapy can be preferred since it is an easily accessible, applicable, and inexpensive method in preclinical training (20,21). It was reported that music helps individuals focus on tasks requiring concentration (22). Moreover, it was also indicated that Mozart's music, in particular, enhances the learning of spatiotemporal rotation tasks by activating related brain areas (23).

The impact of background music on stress reduction and practical performance in preclinical training has been investigated previously (18,24). However, to our knowledge, there is no study that evaluates the stress and anxiety levels of students along with manual dexterity using HVRS under background music in preclinical endodontic training. Since HVRSs could be experienced by students as relatively new and unusual, the possible stress levels and learning abilities need to be assessed. Thus, this study aimed to assess the stress and anxiety levels of 3rd-year students in preclinical training along with their success rates under the background of Mozart's music using an HVRS. The null hypothesis was that the background of Mozart's music would not affect stress and anxiety levels and manual dexterity.

Materials and Methods

This study was approved by the University's ethical board (No.: 2023-37). The sample size estimation was done based on a similar study in the literature, with the level of significance at 5% and the power of the study at 90% by G*Power 3.1.9.2 software program. Consequently, the minimum required total number of students was found to be 60 (25).

All 3rd-year dentistry students enrolled in preclinical endodontic training scheduled by the Department of Endodontics were informed regarding the scope of the study. Afterwards, seventy voluntary students were tested in terms of inclusion criteria. The inclusion criteria for the participating students are as follows: being a 3rd-year dentistry student aged 20-21, having experience of access cavity preparation using extracted human teeth, not taking any medication for anxiety, depression, or systemic illness, having at least a moderate ability to utilize a computer, and not having intolerance against music. The stress level was evaluated using a 10 cm stress visual analog scale (Stress-VAS 1) (26). The level of stress was determined from 0 (no stress) to 10 (worst possible stress). A threshold of 6 was assigned for the description of the student as stressful (27), and the students who had 6 or more were excluded. Moreover, computer usage skills were assessed with an adapted computer literacy self-assessment (14). Based on the primary evaluation, sixty students were included, and signed written consents were obtained. Demographic data of each participant (age and gender) were recorded.

All interventions were conducted in the simulation laboratory of the University. In the first session, trained endodontists (SNU and ED) gave a brief lecture regarding the use of HVRSs (VirTeaSy Dental©, France), and a practical demonstration was conducted by the same endodontist (ED) for selected students in divided groups of six stu-

dents each. In this sense, an access cavity preparation of the mandibular canine was performed. Thereafter, students exercised the same preparation on the HVRS three times within a week in the same conditions. No time restriction was applied to allow the students to feel relaxed and learn the basic properties of the simulator adequately.

Students were divided into two groups randomly (https://www.randomizer.org/) to evaluate the effect of background Mozart music on anxiety and practical dexterity levels. Students in Group 1 performed cavity preparation without any musical effect. On the other hand, students in Group 2 listened to the Mozart Sonata for Two Pianos in D major, K. 448 with headphones while performing the same training since Mozart's music can be easily implemented for reducing anxiety and improving learning ability (23,28). Due to the fact that there are two simulators in the laboratory, one student from Groups 1 and 2 carried out the applications with simulators concurrently in routine preclinical endodontic training sessions. In Group 1, the tempo of the original version of the song (138 beats/min) was converted to 68 beats/min, and the volume was set to 50 dB (29).

The VirTeaSy dental simulator consists of a touchscreen and three-dimensional (3D) screen that allow the visualization of high-resolution views of teeth, endodontic instruments, and dental tools (30). Below the 3D screen, there are haptic and mirror tools and a 3D mouse. Students in the groups performed the access cavity preparation of the mandibular canine within ten minutes using a simulator (Fig. 1). The output data included the following parameters: surgery time (the total time of performance (second)), drilling time (the time of using the handpiece (second)), target progress (the percentage (%) of the area that should be removed), accuracy (% of the area that should not be removed), target volume (the area (mm^3) that should be removed), and outside volume (the area (mm^3) that should not be removed) (Fig. 2). All results of the performance process of each student were recorded and evaluated regarding manual dexterity. The assessments were only done

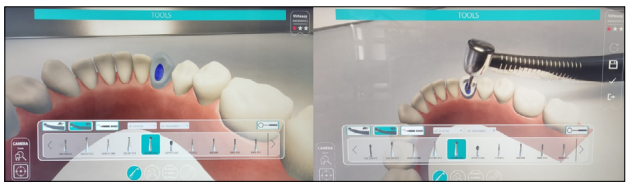

Fig. 1. Demonstration of the preparation of access cavity of mandibular canine tooth.

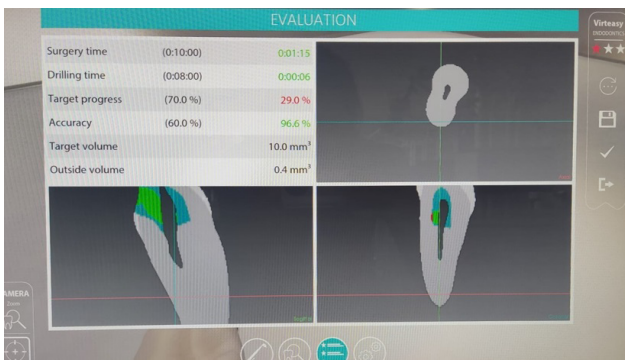

Fig. 2. Parameters obtained from haptic virtual reality simulator.

according to the output data received from the software to ensure standardization and avoid any bias.

Steady-State Anxiety Inventory (STAI (S and T)), which was developed by Spielberg et al. (31), was used to measure the anxiety levels of students. Whereas STAI-S indicates the anxiety level at a particular moment, STAI-T demonstrates the general perspective of a person's emotional state. STAI-S and T contain 20 items rated one to four. The higher scores indicate higher anxiety. The Turkish adaptation, validity, and reliability of STAI were created by Öner et al. (32). Accordingly, STAI-S was asked to be replied to just after performing the access cavity preparation along with Stress-VAS (Stress-VAS 2) to measure the post-training stress level. STAI-T was utilized before training to evaluate the general condition of the students to detect any possible extraordinary anxiety level that may impact the study's outcome.

Table 1. Stress-VAS 1 and 2 values regarding gender and groups

	Stress-VAS 1	Stress-VAS 2	p Value
Female	$3.53 \pm 0.97^{a,1}$	$2.93 \pm 1.55^{a,1}$	0.43
Male	$3.43 \pm 1.07^{a,1}$	$3.2 \pm 1.9^{a,1}$	0.83
Inter-gender p value	0.88	0.84	
Group 1	$3.6 \pm 1.06^{a,1}$	$3.83 \pm 1.85^{a,1}$	0.76
Group 2	$3.36 \pm 0.96^{a,1}$	$2.3 \pm 1.17^{b,2}$	0.006
Inter-group p value	0.78	0.015	

Different superscript lowercase letters in the same row indicate a statistically significant difference ($p < 0.05$). Different superscript numbers in the same column indicate a statistically significant difference ($p < 0.05$).

Statistical Analysis

All statistical analyses were done using IBM SPSS (SPSS Inc., Chicago, IL, USA) version 26. Normality of variables was determined by the Kolmogorov-Smirnov test since the number of samples per group was 30. Stress-VAS 1 and 2 values were compared by Pearson chi-square/Fisher's exact tests. Parameters such as surgery time, target progress, target volume, and outside volume were analyzed using Mann-Whitney U test between Group 1 and 2. Among two groups, drilling time, accuracy, STAI-S, and STAI-T values were compared by independent t-test. The correlation between accuracy, target progress, and Stress-VAS 2 was evaluated using the square of the Spearman linear coefficient. The significance level was 5%.

Results

Thirty (50%) of the 60 selected students in this study were female, and 30 (50%) were male. The mean age was 20.38. Stress-VAS 1 and Stress-VAS 2 values did not differ regarding gender ($p > 0.05$), indicating a random distribution as shown in Table 1. Moreover, while Stress-VAS 1 values were similar between groups ($p < 0.05$), Group 1 had significantly higher Stress-VAS 2 values compared to Group 2 ($p < 0.05$) (Table 1).

There was no significant difference between Group 1 and Group 2 in terms of drilling time, surgery time, target volume, and outside volume ($p > 0.05$) (Table 2). On the other hand, accuracy and target process values were significantly higher in Group 2 compared to Group 1 ($p < 0.05$) (Table 2).

Table 2. Output data obtained from VR simulator in terms of manual dexterity

	Group 1	Group 2
Surgery time (sec)	247.83[a]	243.13[a]
Drilling time (sec)	82.9[a]	79.96[a]
Target progress (%)	67.12[a]	82.57[b]
Accuracy (%)	76.36[a]	85.54[b]
Target volume (mm^3)	23.01[a]	26.74[a]
Outside volume (mm^3)	8.35[a]	13.37[a]

Different superscript lowercase letters in the same row indicate a statistically significant difference ($p < 0.05$).

Table 3. STAI-S and STAI-T values regarding gender and groups

	STAI-S	STAI-T
Female	37.06 ± 10.35[a]	44.2 ± 7.44[a]
Male	37.2 ± 9.47[a]	42.6 ± 9.11[a]
Inter-gender p value	0.93	0.47
Group 1	41.27 ± 10.78[a]	42.60 ± 7.91[a]
Group 2	33.07 ± 6.77[b]	44.27 ± 8.71[a]
Inter-group p value	0.001	0.44

Different superscript lowercase letters in the same column indicate a statistically significant difference ($p < 0.05$).

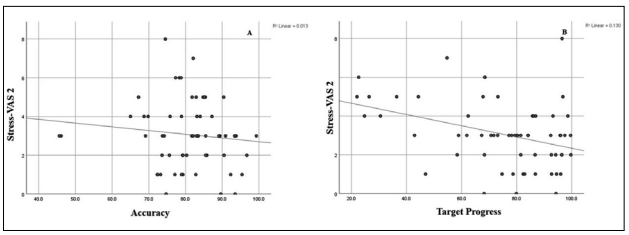

Fig. 3. Association between accuracy and Stress-VAS 2 **(a)**, association between the target progress and Stress-VAS 2 **(b)**.

STAI-S and STAI-T values did not differ regarding gender ($p > 0.05$) (Table 3). Furthermore, although Group 1 had significantly higher STAI-S values compared to Group 2, STAI-T values were identical between groups as presented in Table 3.

A significant negative association was observed between the target progress and Stress-VAS 2 (correlation coefficient = -0.313, $p < 0.05$). However, the correlation between accuracy and Stress-VAS 2 was not statistically significant (correlation coefficient = -0.117, $p > 0.05$). Associations are shown in Figure 3.

Discussion

Preclinical endodontic training is a core process where dental students can develop their manual dexterity and have the opportunity to practice in different clinical scenarios along with theoretical education within the scope of endodontic treatments (33). Students may experience high levels of anxiety and stress during this challenging and stressful period (34). In this sense, background Mozart's music could be beneficial for reducing undesirable stress parameters and increasing the success rate in applications by creating a comfortable and relaxing working environment (35). Thus, this study aimed to evaluate the possible effects of Mozart's music in preclinical endodontic training using HVRS. Based on the findings, the null hypothesis was rejected since the background music was associated with low levels of stress and anxiety and high accuracy values.

In this study, the HVRS was used since these simulators are relatively new preclinical educational tools that can simulate the clinical condition more accurately. In addition, the environment, used materials, and selected tooth for access cavity preparation were the same for each student; therefore, standardization was ensured completely, and possible external factors that may affect the results were eliminated. Moreover, all selected students had previously performed access cavity preparation with extracted human

teeth and had experience using an HVRS in preclinical restorative training. Hence, the stress and anxiety levels that can be caused by using a new tool or performing a new application were minimized. Furthermore, a mandibular canine was used for access cavity preparation since it has less complex anatomy compared to the premolars and/or molars (36).

It has been shown that music therapy has a positive effect on patients' emotional states during dental treatments and also reduces the stress levels of clinicians during demanding procedures or busy schedules as well as undergraduate dental students who perform preclinical training (18,37,38). Similar to the present findings of this study, Felszeghy et al. (24) also showed that music reduced stress and increased the motivation of dental students to learn and practice in preclinical cariology training. Moreover, Varma et al. (18) indicated a strong positive relation between stress and background music in the preclinical laboratory. In these two studies, various types of music were used. However, different types may cause variable feelings, behaviors, and cognitive skills in students. Thus, the particular Mozart sonata was listened to by students since it impacts concentration and efficiency in tasks as well as reduces stress and anxiety levels as previously shown (25).

It is essential for the maintenance of the mental and physical health of the students who enroll in preclinical endodontic training, which includes various compelling tasks. In this sense, educational models are continuously evolving through the development of technology and enhanced experience of dental educators to ensure relaxed and comfortable working conditions (39). This is the first study that evaluates the stress and anxiety levels of students along with manual dexterity using HVRSs as a relatively recent educational tool under background music in preclinical endodontic training. Accordingly, Stress-VAS 2 and STAI-S values were significantly lower among students who listened to Mozart's music. Reduced stress and anxiety levels could have been observed due to the release of dopamine, which is the body's natural happy chemical that improves a person's mood and also blocks the release of stress (40).

According to the results, the higher target process and accuracy values were observed in the group where the background music was applied. Listening to calming and soothing music might have led to better focus and concentration, which could potentially benefit the student's performance during preclinical endodontic training (22). Furthermore, music may have acted as a distraction, positively affecting the student's motivation while performing challenging practices. Accordingly, the negative correlation between Stress-VAS 2 and dexterity levels in preclinical training also highlights the potential benefits of background music.

Although the Mozart effect theory has been shown to increase the success rate in applications (41), it is considered that the improving effect in preclinical education is indirect. It should be noted that the variable demographic characteristics and predispositions of the students may pose a risk of bias in the study results. Future studies are needed to comprehensively evaluate the effect of Mozart's music in preclinical endodontic training with different ethnic groups and larger numbers of participants.

Conclusion

Background Mozart's music had a positive effect on dexterity as well as students' stress and anxiety levels in preclinical endodontic training using an HVRS.

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Conflict of Interest: The authors declare that they have no competing interests.

Ethical Approval: This study was performed in line with the principles of the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of the University where the study was conducted (No: 2023-37).

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