



Research Article

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## ***Review of the Impact of Music on the Rate of Salivary Cortisol of Patients during Dental Treatment***

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### **ABSTRACT**

**Introduction:** dentistry environment is a very stressful environment for patients and some factors can be mentioned for it including fear of anesthetic injection and a record of painful treatments. The purpose of this study is to review the impact of music on the anxiety of the patient through measuring salivary Cortisol. **Materials and methods:** in this clinical experiment, 60 patients visiting the dentist for repairing their teeth were reviewed who were randomly divided into two groups of 30. In the experimental group, an instrumental music of the patient's choosing was used at the time of treatment and in the control group, the treatment was done without music. Salivary of all of those in the control and experimental group before, during and after the tooth is repaired was collected and sent to the laboratory in order to determine the concentration of its Cortisol. The rate of salivary Cortisol was measured through a kit specific for Cortisol with the ELISA method. In this study, the rate of changes of Cortisol in the groups is changed through the ANOVA test. The significance level in this study has been considered to be 0.05. **Findings:** the rate of concentration of Cortisol in the two groups did not have a significant difference in the beginning ( $P=0.65$ ), but as the treatment went on and at the end of it the concentration of Cortisol in the experimental group significantly reduced (respectively ( $P=0.018$ ) and ( $P=0.001$ )). There was no significant relationship between gender and age and concentration of Cortisol. **Conclusion:** this study showed that the rate of salivary Cortisol of those being studied listening to the music of their liking during the treatment to the end of it significantly reduced which was indicative of the reduction of anxiety in the studied people.

**Keywords:** Anxiety, Music, Cortisol

### **INTRODUCTION**

Today, dental treatments are moving towards preventing and preserving teeth more and more with the repairing method and it has been attempted to reduce teeth extraction and loss of teeth. One of the problems that exist in the society and causes people not to visit the dentist on time, is the fear and anxiety regarding dentistry (1). Factors such as the fear of anesthetic injection, the record of previous painful treatments, smell of the dentistry environment and materials increase the anxiety of the patients (2). Presence of this anxiety leads to the reduction of patients' effort to eliminate dental problems. Anxious patients usually have a worse oral health status than normal people. When these patients go to dentist, dentists face special treatment problems. Anxious patients are often less satisfied with treatment measures and they might make their families give up any kind of diagnostic and treatment measures (3). If the problem regarding anxiety of dentistry continues and is not solved, the simple dental problems of the patient turn into complex ones because they do not visit the dentist on time for periodical checking, and the problems won't be solved with simple treatment and advanced complex treatments will be needed (1).

Stress is defined as a physiological and psychological reaction to the external pressures and improper conditions and arises the defense of the host against internal and external risks and anxiety is one of its common side effects (4). Anxiety is an inclusive, undesirable and ambiguous concern and stress which often comes along with some signs such as headache, sweating, palpitations, restlessness and shortness of breath (5). Stress and anxiety is a biological – hormonal response to the social – mental environment which is influenced by the activity of the Hypothalamic-pituitary-adrenal axis and leads to the increase of Catecholamines such as epinephrine, norepinephrine and Cortisol in response to fear and anxiety (6).

Treatment methods of reduction of anxiety include two groups of pharmacological and non-pharmacological treatments which can include breaks during dental operations, using sedative drugs controlling pain and anxiety, using music in order to preserve mental health and cohesion, also creation of therapeutic touch (a kind of energy treatment in which the dentists improves the condition of the patient with his/her hand gestures on the energy field of the patient), visualization (intellectual focus on something or mental imagination) and aroma therapy (therapy with a nice aroma) and using music and its impact is a kind of non-pharmacological treatment.

What existed in nature for the early humans, like the sound of a waterfall, pouring rain, wind blowing, sound of birds, sea waves and horse's galloping, led to the advancement of music which was discusses and analyzed by Plato to the new psychiatrics. Plato have also mentioned that the mind of man learns proportion and coordination through music and education through music is so influential that regulation and coordination easily finds its way to the depth of the mind and it brings delicacy and elegance in its movement and creates a delicate sanctity. Music softens people and it is therefore effective in society and politics (8). Music has always been used as a tool for bringing joy and motivation and also as a therapeutic tool. Egyptians used music for treating women's infertility. And also what has been left of those ages show that Iranians used the sound of lute (a kind of music) to treat many patients (9). In the age of Zoroastrians, doctors treated their patients with Iranian music just as music was used as a tool for a doctor when women delivered babies in the Sasanian court. In terms of perceiving music, Avicenna says: music therapy has a history as a healing factor (10). Reich believes that music awakens subconscious images and emotions. Ego is strengthened by the symbolic dominance and ultimately super ego is fascinated by surrendering to aesthetic criteria and regulations. Some classic pieces can arise some emotions in people some examples of which are as follows:

Many works of Mozart create the feeling of physical and mental peace and relaxation. One of Bartok's works cause the mode of rage, anger and nervous anxiety. Brahms' works are influential in reinforcing and intensifying inner feelings. Bach transfers the feeling of being realistic and following logical reason and wisdom to the listeners. Beethoven's last quartet provokes the effort for an inner unity and compromise (11).

Cortisol is a 21-carbon Glucocorticoid which is created by the adrenal cortex and it has important influences on the metabolism of sugar, protein and fat of body and in case of anxiety, it leads to the decomposition of these substances (12).

Secretion of Cortisol is because of a cycle of diurnal variations that depend on Hypothalamus signals and secretion of Adrenocorticotrop hormone (ACTH) from Hypothalamus. Stress activates the hypothalamic-pituitary-adrenal path along with release of Cortisol. Diurnal variations and its maximum secretion is 20-30 minutes after waking up and the maximum secretion of Cortisol in the morning and the minimum secretion of it is at night. Diurnal variations are not related to gender and age and maturity status (13). The control factors of this cycle are completed in early infancy and its regulation might be disturbed under the influence of some physical and mental factors such as stress (14). Cortisol, which is also called stress hormone, can be a determinative index for measuring anxiety and increasing the level of stress and anxiety increases of the level of blood Cortisol (15). Salivary Cortisol is an indicator of the concentration of unbounded Cortisol in the serum. In the condition of stimulation and repression, variations of plasma Cortisol are reflected accurately and quickly in salivary Cortisol. Measuring salivary Cortisol is a proper parameter for dynamic endocrine tests and evaluation of anxiety. Also salivary Cortisol does not depend on the rate of salivary stream and variables such as not smoking. Blood sampling is stressful and annoying for measuring released plasma Cortisol and at the same time, it can change the activity of the hypothalamic-pituitary-adrenal path. Therefore, among fear and anxiety evaluation methods, measuring salivary Cortisol is a simple and non-invasive method because of easy sampling (16 and 17).

It has been shown that all of the operations of dentists, even treatment and prophylaxis, increase the level of salivary Cortisol. The natural rate of salivary Cortisol is considered to be at least 1.21-2.25 nmol/l to 11.42-14.29 nmol/l at most which can be increased to 20 times more in case of stress (18). Given that the rate of Cortisol secretion can be measured in a complete quantitative way through various methods including ELISA in comparison with the criteria of determining stress and its accurate rates can be reported. Thus, the study was done with the purpose of reviewing the impact of music therapy on the rate of anxiety of patients through measuring salivary Cortisol. In case of seeing its impact on the reduction of patients' anxiety and stress, in line with other studies, this method was used for bringing peace in patients before doing the dental operations.

In the study of Vedhara, et al., in 2003 for reviewing the relationship between stress and anxiety and level of salivary Cortisol, the results showed that there is a relationship between anxiety and level of Cortisol and as anxiety increases salivary Cortisol also increases (19). In the study of Marjan Farshadi (2004), who reviewed the impact of music on sleeping disorders in 50 students, the results showed that nightmares were significantly reduced and listening to light music before sleep can increase the person's efficiency in the next day and it affects the improvement of people's mood (20). In the study of Roohi, et al., in 2005 which was done for reviewing the effect of music on the level of anxiety and physiological responses of 124 patients who were candidates for abdominal surgery, the results showed that the average rate of blood pressure and anxiety were reduced in a group who listened to music, but the difference between the rate of breathing and pulse was not significant in the two groups (21). In the study of Labeh, et al., in 2007, which was done for reviewing the impact of classical and metal music in stressful situations for reducing anxiety, the results showed that the group who listened to the classical music of their own liking experienced reduction of incitement of the sympathetic system, anxiety and rage than those who weren't listening to any music or those who listened to metal music. Anxiety with the incitement of the sympathetic system leads to the increase of heartbeat, increase of blood pressure, reduction of blood supply to the wound, arterial vasoconstriction and reduction of partial pressure of tissues (22). In the study of Berbel, et al., in 2007 which was done for reviewing the impact of midazolam and music in patients under surgery treatment, the results showed that no clear difference was seen between the level of blood pressure, heartbeat and anxiety of the patients of the two groups. These results have been indicative of the impact of music in the reduction of the level of these factors (23). In the study of Herikumar, et al., in 2007 for reviewing the reduction of the need for sedatives during colonoscopy through listening to music in 78 patients, the results showed that the period of consumption of midazolam was longer in the group the member of which did not listen to music. Listening to music during colonoscopy helps reduction of the dosage of sedatives and the rate of dissatisfaction of the patient is reduced during the process. nonetheless music is non-invasive and easily accessible and does not have any side effects and can be of help for a sedative in patients (24). In a randomized clinical trial in 2008, Nilson, et al. reviewed the anti-anxiety and analgesic impacts of music on the occurrence of type of systemic symptoms of 42 patients. Their results showed that music leads to the significant reduction of heartbeat in 27% of the items, reduction of pain in 59% of the items and reduction of anxiety in 50% of the items (25). In a randomized controlled trial in 2008, Lay, et al. reviewed the impact of music on anxiety and the physiological signs of 44 patients under the root treatment and their results showed that the group under music therapy experienced a significant reduction of anxiety but there was no significant difference in the biologic factors including systolic and diastolic blood pressure and heartbeat (26). In a study in 2010, Sha'banlooyi, et al. reviewed the impact of music therapy on the pain and anxiety of patients bone marrow biopsy treatment and the results showed that the rate of pain and concern of patients about their treatment in a group who listened to music was reduced (27). In a study in 2010, Maleki, et al. reviewed the impact of music on the reduction of anxiety of the dental endodontic treatment and their results showed that the rate of mental anxiety in the control group has been reduced but there was no significant difference in the systolic and diastolic blood pressure (28). In a study in 2010, Akhavan, et al. reviewed the impact of watching cartoons on the variations of salivary Cortisol of children during the dental treatments and showed that watching cartoons during the treatment does not have a significant impact on the rate of salivary Cortisol (29). In a study in 2011, Kim, et al. reviewed the anti-anxiety impact of music on the patients under impacted wisdom teeth surgery. Their results showed that the heart rate in the group under treatment with music has increased in comparison with the control group but no significant difference was seen in the systolic and diastolic blood pressure (30).

### Materials and methods

In this study, which has been a clinical trial, 60 patients visiting a private clinic in the district 2 of Tehran in 2015 participated. These individuals were randomly divided into two groups of 30: an experimental group and a control group. These individuals were between 15 and 65 years old and went through an operative treatment with localized anesthesia and individuals who went through a treatment with sedatives in the past 72 hours or had hearing problems and diagnosed psychological disorders and also pregnant patients, individuals with suppressed immune system, heart diseases and other systemic diseases were eliminated from the study. In this study, an instrumental music (Mozart, Rain of Love and Iranian classical music) was played during the treatment for the people being studied 10 minutes before the treatment began. However, no music was played for the control group. The treatment was done by an experienced person in a 45-minute period. Before, during and after the treatment, the saliva of the patients was collected by using the non-stimulation spitting in the Falcon conical tubes (Ideal-e Pars bridge, Tehran, Iran) for 2ml. in order to prepare the saliva during the treatment, the patient washed his/her mouth with water after the cavity preparation and after three minutes, the sample was collected. Samples were kept in a -20°C temperature until the day of experiment and they were put in the centrifuge with the speed of 10000rpm for separating debris and food (Labtron, Tehran, Iran) and the samples, controls and standards were put in the kit wells of salivary Cortisol (Zellbio, Wuttemberg, Germany). In the next stage, a type of antibody labeled with enzyme named conjugated was added (Zellbio, Wuttemberg, Germany) and they were incubated for 45 minutes on the shaker in the room temperature. After incubation, free antibodies or antigens were washed by using a washer buffer (Zellbio, Wuttemberg, Germany). Then the substrate was added and the incubation was done again in a 15-minute time interval. Then, an interrupter solution (Zellbio, Wuttemberg, Germany) was used for stopping the enzyme – substrate reaction and more variations in the intensity of the created color were prevented.

At the end of the light absorption was read by the ELISA Reader device (Anthnos, Landan, England) at the wavelength of 450nm. the collected data was analyzed by the SPSS version 18.0 software and the level of salivary Cortisol was compared in the two groups.

### Findings

60 patients participated in this clinical trial but three data were eliminated due to error in the experiment and ultimately, 57 patients were reviewed 27 of whom were female (47.36%) and 30 of whom were male (52.64%). In the group receiving music (27 persons), there were 12 females (44.44%) and 15 males (55.55%) and in the group with no music (30 persons), we had 15 males and 15 females (both 50%). Distribution of the frequency of gender was not statistically significant in the two groups ( $P=0.422$ ). Mean and standard deviation of age in the control group was  $33.53\pm 6.42$  years and  $37.47\pm 8.38$  years in the experimental group. The mean of age in the two groups was not statistically significant ( $P=0.253$ ). The study showed that before the treatment, mean and standard deviation of the rate of concentration of salivary Cortisol was  $144.45\pm 72.58$  ng/ml in the group with music and  $136.77\pm 95.35$  ng/ml in the group with no music and this difference of the mean of Cortisol was not statistically significant ( $P=0.65$ ). The mean and standard deviation of the rate of concentration of salivary Cortisol during the treatment was  $128.39\pm 82.42$  ng/ml in the group with music and  $176.41\pm 94.81$  ng/ml in the group with no music and this difference of the mean of Cortisol was statistically significant ( $P=0.018$ ). Also, it was specified in the study that at the end of the treatment, mean and standard deviation of the rate of concentration of salivary Cortisol during the treatment was  $95.23\pm 77.25$  ng/ml in the group with music and  $174.31\pm 97.19$  ng/ml in the group with no music and this difference of the mean of Cortisol was statistically significant ( $P=0.001$ ).

**Table 1** – comparing demographic variables in the reviewed groups

<b>Drug variable</b>	<b>With music (n=27)</b>	<b>Without music (n=30)</b>	<b>P-value</b>	<b>Result</b>
<b>Age (year)</b>	33.53±8.38	33.53±6.42	0.253	The mean difference is not statistically significant
<b>gender</b>			0.422	
<b>male</b>	12	15		The frequency difference is not statistically significant
<b>female</b>	15	15		

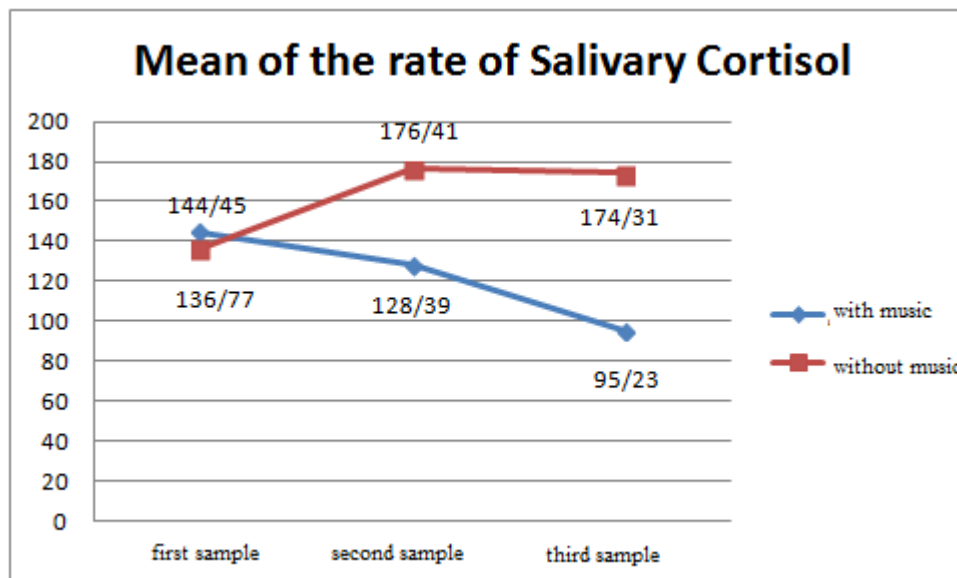
As it seen in table 1, the one-way ANOVA showed that the age average in the two reviewed groups do not have a significant difference with each other ( $P>0.05$ ). also, the Chi-Square test showed that the distribution of the frequency of gender is similar in the two reviewed groups ( $P>0.05$ ).

**Table 2** – comparing the rate of Cortisol in the reviewed groups based on the time of evaluation

<b>Group The time of evaluation</b>	<b>With music (n=27)</b>	<b>Without music (n=30)</b>	<b>P-value</b>	<b>Result</b>
<b>Before treatment</b>	145.45±81.58	136.77±95.35	0.65	The mean difference is not statistically significant
<b>During treatment</b>	128.39±82.42	176.41±94.81	0.018	The mean difference is statistically significant
<b>After treatment</b>	95.23±77.25	174.31±97.19	0.001	The mean difference is statistically significant

Data of the table has been reported as "standard deviation ± mean".

As it seen in table 2, the one-way ANOVA showed that the mean of the rate of Cortisol before treatment in the two reviewed groups did not show a statistically significant difference ( $P=0.65$ ). Also, the mean of the rate of Cortisol during the treatment and at the end of it showed a statistically significant difference in the two reviewed groups ( $P<0.05$ ).



**Figure 1** – comparing the mean of the rate of salivary Cortisol in the two reviewed groups during the treatment

### Discussion and conclusion

Dentistry environment is a very stressful environment for patients. In the most prevalent dentistry emergencies such as Hyperventilation and syncope, anxiety is present as a main etiologic factor (31). Therefore, finding any helpful way of treatment for reducing this anxiety and calming the patient in the respect of executing the anxiety reduction protocol is always valuable. Treatment methods of anxiety reduction include two pharmacological and non-pharmacological treatments groups and using music and its impact is a kind of non-pharmacological treatment (7). Music is the mutual language of the people of the world and its impact exceed any geographical, cultural and racial borders. Although the usage of music in treatment is developing, its physiological and emotional dimensions on the human body have not been well specified (32). Music increases concentration but it has different neurophysiologic dimensions the effectiveness of each of them depends on the personal preference of the patients (33). Nilson believes that in order for the music to be more influential it's better to play an instrumental music of the patient's choosing with about 60 dB sound and with 60-80 bits in a minute (25). In this study, it has been attempted to observe these. Absence of sufficient dentistry researches on the biologic factors, Iranian patients in particular, indicates that more researches on this field are needed; therefore, the purpose of the present research is to determine the effect of music on the rate of anxiety of the patients by measuring salivary Cortisol. The results of this study showed that music leads to the reduction of the rate of secretion of salivary Cortisol as a criterion for measuring anxiety in the experimental group. The strength of this study in comparison with most studies which were done in the field of the impact of the music on the reduction of the rate of stress, is similar to the study of Seyed Akhavan, et al. who reviewed the level of salivary Cortisol as a way more accurate criterion of heart rate, VAS scale, variations of blood pressure or variation of psychological criteria (28, 29 and 34).

However, unlike the present research, Seyed Akhavan, et al. in a study reviewed the impact of watching cartoons on the variations of salivary Cortisol of children during the dental treatments and showed that watching cartoons during the treatment does not have a significant impact on the rate of salivary Cortisol in the control and experimental group. Perhaps this difference is due to the focus which is more on the external factors and also more intellectual cohesion in the adults in comparison with children (29). But the study of Maleki, et al., like the present research, the purpose has been reviewing the impact of music on the reduction of anxiety of the dental endodontic treatment and their results were indicative of the reduction of mental anxiety in the music group in comparison with the control group but there was no significant difference in the systolic and diastolic blood pressure although the method of

determining anxiety has been different in these two studies (28). Although the way music affects anxiety has not been completely identified yet, in 2008 Lim did a study and showed that listening to music leads to the reduction of arousal caused by nervous tension (35). Music may shift the focus and increase the threshold of malady such as anxiety and pain (36). People close their eyes while listening to music to focus on it and therefore it is like they are not in the dentistry environment (37). Also, music reduces the undesirable sound of the dentistry tools (38). In 2009, Farokh Gissor, et al. reviewed the impact of two types of music (upbeat and light) on the threshold of pain reaction and the rate of fear of a child in a cross-sectional study. In their research, although the determiner of the heart rate was used for determining anxiety, but like our study, their results were also indicative of the reduction of anxiety in patients without a connection with the type of music (39). Although the study of Labeh, et al. in 2007 specified that listening to classical and calming music of the person's own choosing, after encountering the stressful factors leads to a considerable reduction of anxiety, rage and arousal of the sympathetic nervous system. Relaxation was seen more in individuals who listened to this kind of music than those who selected Heavy Metal or those who chose silence (22). In 2008, Lay, et al. showed that listening to music reduces anxiety through ear and increases the temperature of the fingers but does not have a significant impact on the heart rate and blood pressure (26). In contrary, Berbel, et al., in 2007, observed that music has been influential on the reduction of anxiety, heart rate, blood pressure and level of Cortisol just as much as Diazepam in people waiting for surgery (23). Miskja and Lindbik also showed that music affects central physiological variables including blood pressure, heart rate, Respiration rate, EEG variables, body temperature and galvanic skin response (40). In other studies, the significant impacts of music on physiological variables have been shown (41). Musical stimulus activates special paths in various areas of brain which are related to the emotional behaviors. These areas include hypothalamus, hippocampus, amygdala and insular cortexes, cingulate and prefrontal and numerous biochemical mediums such as endorphins, endocannabinoids, dopamine and nitric oxide are active in them (42). It seems that music affects vital variables with the effect of hypothalamus that regulates various processes of the homeostatic processes of body, or its effects on the hypothalamic - pituitary-adrenal axis. But this impact might have different effects on various factors. Hypothalamus functions are affected by the presence of brain-derived neurotrophic factor (BDNF) and nerve growth factor (NGF). These two are proteins that are involved in the growth, survival and function of the neurons in the central nerve system (CNS). In 2007, Angelosi, et al. showed that after the mice encountered light music for 21 days, the level of BDNF in hypothalamus increased. These hormones (Estradiol and progesterone) have important role in regulating anxiety. In the study of Chikahisa, et al. in 2007, it was showed that music reduces the level of anxiety and gonadal steroid (especially progesterone) in the mouse (43).

Anyway, it is necessary to mention that the present study was done in an office which provides services at an average level based on spatial situation and dentistry tariffs about the dentistry offices and it seems that these patients to some extent introduce the overall community of the dentistry patients. However, given that the patients seeking repair treatment were the only ones who were reviewed, the statistics of the obtained information cannot be extended to other patients. The results of this study showed that the rate of salivary Cortisol of the studied people was significantly reduced by listening to the music of their own liking during the treatment till the end of it which itself is indicative of the reduction of anxiety in the studied individuals. Music is an easy, non-invasive method which costs little and it does not have a specific intervention with various dental treatments. Nonetheless, music shall be used along with other methods of the anxiety reduction protocols. In selecting the music, the interest of individuals shall be considered as well as cultural differences. Each research paves the way of another. It is recommended for the next researches to review the impact of other factors such as decoration of the environment and educational videos and etc. on the anxiety of the individuals and since using music is an easy method of treatment without risk, its usage at the time of treatment can be recommended. It is recommended to use the cross-sectional method by counting more samples and other age groups in the next reviews.

## REFERENCES