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ORIGINAL RESEARCH

The Use of Photoacoustic Stimulation for reducing Dental Fear in Patients living with Down Syndrome

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ABSTRACT

Aim: Although people living with Down syndrome have high demand for dental care treatment, dissolving dental fear makes the choice of proper methods extremely difficult. The aim of the study was finding a new method for solving this problem.

Materials and methods: In the present study, a 10-minute-long photo-acoustic stimulation with rhythmic sounds or relaxation music was used for tranquilizing the patients before a dental examination. Thirty volunteers living with Down syndrome participated in the study. They were divided into three groups (rhythmic sound, relaxation music, and control groups). A piece of Johan Sebastian Bach (Bach Cello Suite No. 1 in G major BWvi007) was applied as a relaxing music. Spielberger State-Trait Anxiety Inventory (STAI) Child version, Dental Anxiety Scale (DAS), and Dental Anxiety Question (DAQ) were used for measuring the anxiety level of the participants.

Results: The results confirm the first hypothesis, namely that photo-acoustic stimulation with rhythmic sounds or relaxation music is suitable for decreasing the level of fear of dental patients living with Down syndrome. The other hypothesis that the anxiety-suppressing effect of light stimulation with classical music would be larger than that of light stimulation with rhythmic sounds was not proven statistically.

Conclusion: The results suggest that application of photo-acoustic method by using either relaxing music or rhythmic sounds is able to reduce dental fear of patients although some contraindications should be respected (e.g., the presence of epilepsy).

Clinical significance: The importance of photo-acoustic stimulation in dental fear reduction is underestimated and deserves higher attention, especially in case of people living with Down syndrome.

Keywords: Dental anxiety, Dental fear, Down syndrome, Photo-acoustic.

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INTRODUCTION

In case of people living with disabilities, it is particularly important to ensure proper dental care. On the one hand, medicines they take often damage the teeth indirectly and, on the other hand, many of them are unable to signal if they had any problems with their teeth. Down syndrome is one of the disabilities where there is an increasing demand for dental care treatment. The choice of treatment technique, however, should take into account any systemic disease present (e.g., congenital heart and neurological diseases), and that conscious or deep sedation and general anesthesia should only be properly adopted in a hospital environment and require the presence of an anesthesiologist. That makes the dental care of people living with Down syndrome extremely difficult. Fears associated with this are especially peculiar to Down syndrome patients who are closely dependent on their parents or their caregiver.[1] Therefore, before the dental intervention, foreign environments, auditive and visual stimuli have a particularly disturbing effect. It is a special problem that dental disorders are more common among Down syndrome.[2-4] These facts justify the extension of the palette of anxiety-suppressing methods related to the dental treatments applied among patients living with Down syndrome.

The goal of the study was to investigate if photo-acoustic stimulation can be used for reducing dental fear in patients living with Down syndrome. According to the hypothesis, photo-acoustic stimulation with rhythmic sounds or relaxation music is suitable for decreasing the anxiety level of patients. It is also assumed that the anxiety-suppressing effect of light stimulation with classical music will be larger than that of light stimulation with rhythmic sounds.

MATERIALS AND METHODS

The experiments were performed between 2015 and 2017 in accordance with the ethics standards of the WHO

Helsinki Declaration (1994). The number of the Ethical Permission is SE TUKEB: 171/2015.

The criteria for being a subject in the experiment were having Down syndrome, being capable of understanding the questions of the questionnaires, and having the capability for giving answers to the questions. Epilepsy was also an excluding criterion because of the possible danger of visually induced seizure. Several Down syndrome patient care organizations were contacted and offered a free dental survey for volunteer patients living with Down syndrome. The volunteers, their caregivers, and the patients' parents were informed properly in written form about the aim and process of the experiment. If they decided to participate in the experiment, they signed a consent statement. Forty volunteers applied for the examination. Two volunteers were filtered out because of extreme STAI-T-C and background scale values and eight volunteers were not able to fill the tests out because they did not understand the questions. Finally, 30 Down syndrome patients participated in the study. They were divided into three groups (10 participants per group). Two experimental groups were applied, and one group served as a control. In the first experimental group, rhythmic "bleep" sounds were used with the photo stimulation. In the second experimental group, the first three parts of a Bach cello suite (Bach Cello Suite No. 1 in G major BWvi007, length: 10 minutes) were chosen, since the relaxation effect of Bach's music is already experimentally proven[5] and the length of the work presumably did not burden the attention of the patients too much. The audiovisual stimulation (Avs) eyeglasses (Goggle, Ganzframe, etc.) are usually closed, so they do not support using them with open eye. Transparent glasses are recommended when working with small children or anxious people. In present study, transparent glasses were used providing the opportunity for reducing the brightness ensuring a more secured feeling for the user. Proteus advanced light sound stimulation system was used that is commercially available (Fig. 1). It was possible to edit the target frequency and the period of the photo-acoustic sessions. Instead of the built-in sessions, slow ones were used to provide a pleasant experience for those who have not used the Avs device before. When music was used instead of rhythmic sounds, the participants were listening to the music of Bach through an iPod. The visual stimulation in both groups (visual stimulation with rhythmic sounds and visual stimulation with music) had the same frequency, namely 10 Hz. The total length of the sessions was 10 minutes in each of the groups. During an Avs session, the rhythm of stimulating light and sound impulses were changing. In case of a relaxation program, it started from a wakeful, beta range and then slowed down. Depending on the slowdown intensity and session length, after a few minutes, it reached the target frequency in the alpha range and it stayed there. Approaching the end of the session, leaving the target frequency it was accelerating to an awake state and reached an awake state in beta range.

Fig. 1: Proteus advanced light sound stimulation system. Manufacturer: the MindPlace Company (PO Box 833, 50 Timber Lane, Eastsound, WA 98245)

Measurement Methods

- State and trait anxiety of the patents were measured by Spielberger STAI child version (STAI-S-C and STAI-T-C)[6] suitable for the study of larger children or persons whose mental performance is less than adequate for responding to the questions of the adult test. Based on the results of STAI-T-C, patients of abnormally high anxiety level were supposed to be excluded (finally, there were no such participants, so nobody had to be excluded from the research).
- Dental Anxiety Scale[7]: The scale measures the level of dental fear despite the "anxiety" word in its name.
- Dental Anxiety Question[8]: It consists of only one question: "Are you afraid of going to the dentist?"
- Background Scale: Fábián et al[9,10] revised and altered some questions that appeared in the early version of the DAS and created a new scale. The subject's ideas were measured on a 5-point scale as to what people think about the strength of the dental fears of their mother, father, sister, and friend.

Experimental Arrangement

In group I (pulsating sine experimental group—PSEG) after 10 minutes of 10 Hz target-focused light-tone stimulation session with flashing lights and pulsating sine sound, the clients underwent a dental examination. In group II (Bach experimental group—BEG), the clients were listening a 10-minute-long 10 Hz target-focused light-tone stimulation session in which the pulsating

sounds was substituted by the selected Bach Cello Suite (No. 1 in G major BWvi007). It was followed by a dental examination. In group III (control group—CG), the experimental subjects underwent a dental examination without photo-acoustic treatment. The STAI-S-C, STAI-T-C, DAS, DAQ, and Background Scale questionnaires were taken before and STAI-S-C, DAS, and DAQ questionnaires were taken again after the dental examination in all groups.

Total scores of the different questionnaires were used in the statistical analysis. Because of the small sample size, interval scaled and not normally distributed variables, Fisher–Pitman exact permutation tests for paired replicates were performed to compare the scores of scales before and after the dental examination. Stata (Stata/IC 15.0, StataCorp LLC, Texas, USA; permtest1 command)[11] was used for the analysis. Multiplicity correction was not applied for not reducing the statistical power at the cost of increasing the probability of first-type error.

RESULTS

The number of answers processed strongly depended on the mental level of the participants. Some answers were not processable since some people living with Down syndrome could not understand the meaning of words. Thus, the sample size was different regarding each scale as it can be seen in Table 1.

The changes in results of STAI-S-C, DAQ, and DAS scales were analyzed. In the PSEG group, the results of STAI-S-C, DAQ, and DAS questionnaires showed reduction after examination, and these changes were statistically significant. Descriptive statistical values, confidence intervals of mean, and Fisher-Pitman p-values for differences before and after examination are shown in Table 1, while the changes in STAI-C, DAQ, and DAS are shown in Graphs 1 to 3 respectively.

In BEG, a remarkable change could only be observed on the STAI-C scale, but there was no statistical evidence regarding anxiety change because of the small sample size. The changes in DAQ and DAS values were small and not significant.

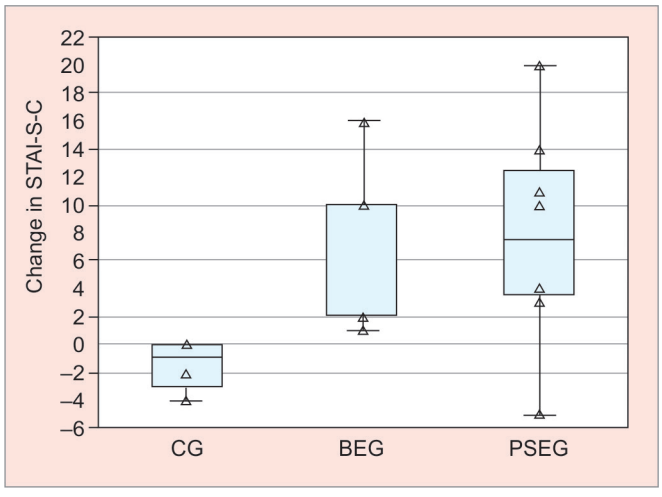
Table 1: Changes in DAS, DAQ, and STAI-S-C in CG, BEG, and PSEG

		CG	*BEG*	*PSEG*
Change in DAS	Sample size	5	11	10
	Mean	1.6	1.8	4.5
	Median	2	0	3.5
	SD	3.5	4.3	5.3
	95% CI of mean	−2.8 to 6.0	−1.1 to 4.7	0.7 to 8.3
	p	0.3750	0.2266	0.0273
Change in DAQ	Sample size	5	10	8
	Mean	2.6	0.9	2.5
	Median	2	0	1.5
	SD	2.3	2.6	3.1
	95% CI of mean	−0.3 to 5.5	−1.0 to 2.8	−0.1 to 5.1
	p	0.1250	0.4063	0.0313
Change in STAI-S-C	Sample size	4	5	8
	Mean	−1.5	7.8	7.75
	Median	−1	10	7.5
	SD	1.9	6.3	7.7
	95% CI of mean	−4.5 to 1.5	0 to 15.6	1.3 to 14.2
	p	1.0000	0.0625	0.0391

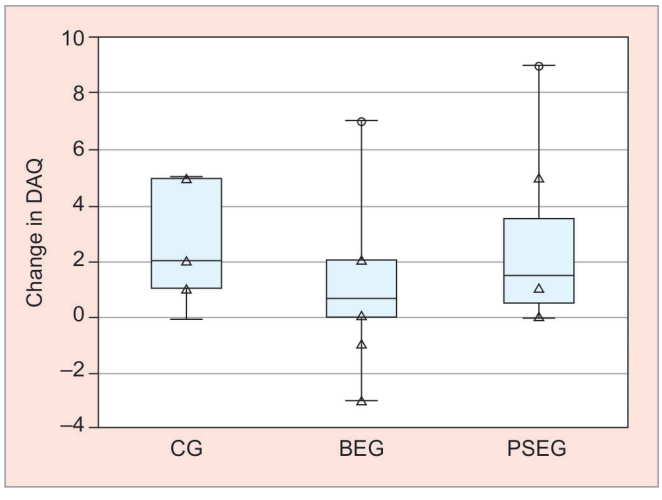
SD: Standard deviation; CI: Confidence interval

DISCUSSION

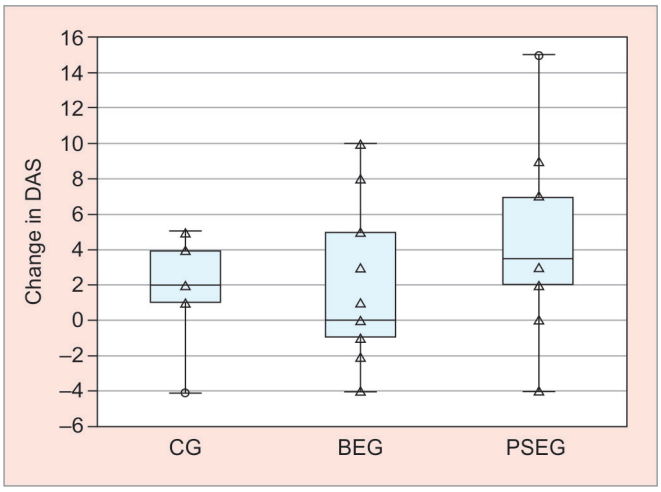
Several attempts were made for reducing the level of fear against dentists. Melamed et al[12] used video films and experienced that children who viewed a videotape demonstration of a peer model coping with dental procedures showed significantly fewer fear-related disruptive behaviors during restoration of lesions. Bernstein and Kleinknecht[13] used multiple approaches including



Graph 1: Change in STAI-C in CG, BEG, and PSEG. The boxplots show median values with quartiles, minimum, and maximum



Graph 2: Change in DAQ in CG, BEG, and PSEG. The boxplots show median values with quartiles, minimum, and maximum



Graph 3: In the control group, DAQ and DAS values showed small decrease, while STAI-S-C increased after the examination. The changes were not relevant, and there was no statistical evidence (at 5% significance level) for the changes in this group

systematic desensitization, symbolic modeling by applying a videotape recording and participant modeling; nevertheless, they could not find statistically significant outcome differences among treatment groups, although all of them reported significant reduction in state anxiety and expected pain. Lundgren et al[14] applied both relaxation and cognitive therapies for fear reduction and they ascertained that patients with different fear etiologies or response styles benefit differentially from such two types of treatments. Schwamburger et al[15] call the attention to the adverse effects (infiltration) of conscious sedation and suggested to use moderate sedation provided by general dentists and periodontists. Isik et al[16] evaluated the effectiveness of binaural beats, namely an auditory illusion perceived when two different pure-tone sine waves were presented one to each ear at a steady intensity and frequency, and found such treatment useful in reducing preoperative anxiety in dentistry. Since people living with Down syndrome need special care and attention, the methods mentioned above can be used only in very special cases when the clients both physically and mentally are capable of participating in a fear reduction treatment. Providing a program that can be generally applied for them, a very special intervention needed to be worked out taking into consideration the mental capacity of the patients.

Fábián and Fábián[17] discovered that photo-acoustic stimulation is useful to eliminate simple anxiety, and to reduce salivary secretion in the oral cavity. It can relax the body by providing a powerful stimulation of the central nervous system. They successfully combined photo-acoustic stimulation with hypnotic techniques for treating orofacial psychogenic symptoms and denture intolerance. Balint et al[18] used modified photo-acoustic stimulation technique in the explorative part of the psychotherapy of atypical orofacial pain patients. The conclusion was that modified technique advantageously speeded up the therapeutic process; nevertheless, they did not test their method on people living with disabilities.

The advantageous effect of audiovisual stimulation in fear reduction has already been proven by some studies.[17,19,20] Such favorable effects can be evoked by using rhythmic sounds or relaxation music with light stimulation. According to studies,[21] no acoustic stimulation without visual effects has significant anxiolytic effects, so it was worth adding visual stimuli. The editing capability of commercially available light-sound stimulation devices is of particular importance to people with disabilities, as this allows flexible adaptation to individual, atypical needs. The favorable effect of classical music on fear and anxiety reduction has also been proven several times.[22-25] The relaxation effect of light stimulation used with classical music offers remarkable opportunities.[26-28] The present research was expected to expand the range of such studies. Summarizing the above findings, photo-acoustic stimulation applying sound effects or classical music was a reasonable solution for testing the method on people living with Down syndrome.

Based on the results of STAI-C data, the first hypothesis was confirmed, namely that photo-acoustic stimulation with rhythmic sounds or relaxation music is suitable for decreasing the level of fear of patients living with Down syndrome. The other hypothesis regarding that anxiety-suppressing effect of light stimulation with classical music would be larger than that of light stimulation with rhythmic sounds was not proven statistically. Probably, another study should be implemented involving more participants for gaining more exact data.

CONCLUSION

The most important finding of the present study was that photo-acoustic stimulation accompanied by relaxing music of rhythmic sounds is suitable for dental fear reduction in people living with Down syndrome. Based on the results of the study, the application of photo-acoustic method by using either relaxing music or rhythmic sounds is to be considered for reducing dental fear of people living with Down syndrome, although some contraindications should be respected (e.g., the presence of epilepsy). The study did not compare its results with conscious or deep sedation and general anesthesia study groups and underwent dental examination alone. This is a limitation of the study. It should be also emphasized that it was just a pilot study and the sample was too small and thus the data of this study are preliminary ones and further clinical studies are needed for the proper evaluation of the method.

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