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Original Article

Dentistry Section

Evaluating the Use of Audiovisual Distraction in Reducing Stress during Dental Treatment in Children using Salivary Chromogranin A: A Quasi-experimental Study

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ABSTRACT

Introduction: Audiovisual Distraction (AVD), as a behaviour management technique, has gained significant importance in aiding patient cooperation during routine dental procedures. However, the scale at which it makes a difference needs to be evaluated. Objective approaches like measuring heart rate and pulse rates are unreliable methods. The quantification can be done using salivary Chromogranin A (CgA), a stress marker.

Aim: To evaluate the use of AVD for reducing stress in children aged 4-7 years during dental treatment using salivary CgA.

Materials and Methods: The present quasi-experimental study was conducted within the Department of Paediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Pune, Maharashtra, India, from January 2022 to March 2022 after obtaining ethical clearance from the Institute and consent from parents. Six uncooperative children who required two Class-I restorative treatments for occlusal caries involving enamel and dentin were included in the study. The sample size was estimated using G*Power software v3.1.9.2 and calculated using t-tests. The treatment plan was divided into two appointments. In the first appointment, the cavity was prepared without the use of AVD. In the second appointment, AVD was incorporated during the dental procedure using the patient's favourite cartoon. Unstimulated salivary samples were collected during both appointments, before and immediately after the procedure, which were sent to the laboratory for evaluation of CgA levels to gauge the stress levels during each appointment and the effect AVD has on the same.

Results: Within the group without AV aids used, the mean salivary CgA levels showed a significant increase from 0.23 pmol/mg pretreatment to 1.26 pmol/mg protein after treatment. Within the group with AV aids, salivary CgA levels showed a significant reduction ($p \leq 0.05$) from 1.08 pmol/mg before treatment to 0.43 pmol/mg protein after treatment. There was also a significant difference in the change in salivary CgA levels from pre- to post-treatment between the two study groups.

Conclusion: The study shows quantitatively that AVD reduced stress levels during dental treatment and therefore can be used as an adjunct for behaviour management. It can also be seen that Salivary CgA is a reliable short-term stress marker and can be used objectively to evaluate and quantify stress levels in children.

Keywords: Behaviour management, Distraction technique, Salivary cortisol, Uncooperative children

INTRODUCTION

Dental fear is one of the major reasons for distress and anxiety in children, leading to significant challenges for dentists during patient treatment. Fearful or uncooperative behaviour in children could impede the effective administration of dental treatment and potentially compromise the quality of care delivered [1,2]. Over time, a range of strategies has been developed to aid in behaviour management during dental procedures. These encompass pharmacological options, such as benzodiazepines, nitrous oxide, and general anaesthesia, as well as non pharmacological approaches like virtual reality, AVD, tell-show-do, musical techniques, etc. [3]. McCaul KD and Mallot's JM theory suggest that diverting a patient's attention from discomfort can decrease their perception of pain [4]. Distractive behaviour guidance involves techniques aimed at redirecting attention away from potentially unpleasant procedures [5].

Distraction, as a psycho-behavioural approach within behaviour management techniques, aims to divert patients from anxiety-inducing stimuli, thereby reducing their distress during treatment. Its primary objective is to induce relaxation and alleviate anxiety [6]. An optimal distractor engages multiple sensory modalities (visual, auditory, and kinaesthetic) and encourages patient participation to effectively counteract signals from potentially discomforting stimuli [7]. AVD engages all the senses of the child, thereby helping in calming the patient down and also allowing the dentist to continue the treatment with ease [8]. The distraction techniques can be either passive or active. Passive methods entail the child listening to music on headphones or watching videos, while active approaches involve the child participating in activities such as playing with electronic devices or telling the dentist a story [9].

Saliva has emerged as a significant diagnostic tool for assessing health and disease due to its non invasive collection method, ease of access, and painless procedure, eliminating the need for specialised personnel. Over the past few years, salivary biomarkers like salivary Alpha-Amylase (sAA), salivary cortisol, and CgA have been used as valuable indicators for evaluating anxiety-inducing events such as dental treatments in paediatric patients [10].

The CgA is an acidic protein belonging to the granin family and is expressed by various normal or malignant cells in the diffuse endocrine and neuroendocrine systems, as well as by certain cancer cells capable of neuroendocrine differentiation [11]. It is co-stored and released alongside catecholamines from storage granules in the adrenal medulla [12]. Previous research has shown that CgA is secreted into saliva from human submandibular glands [13], establishing salivary CgA levels as a dependable, non invasive marker for gauging psychological stress, particularly in instances of anxiety-inducing circumstances and depressive episodes. Previous studies have confirmed the role of salivary CgA as a short-term stress marker [14].

Although previous research has shown that AVD aids in managing behaviour in uncooperative children, there is a lack of knowledge about its effectiveness in reducing stress and anxiety [15]. The present study aimed to address this gap by employing a unique method using salivary CgA as a stress biomarker. This method, unprecedented in previous research, allows for quantification of the effects of AVD on children's stress levels during treatment. Thus, the purpose of the present study was to assess the stress levels experienced by children during dental treatment and the effect of AVD on stress in children.

MATERIALS AND METHODS

The present study employed a quasi-experimental design and took place within the outpatient department of the Department of Paediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Pune, Maharashtra, India, from January 2022 to March 2022. The Institutional Research Committee cleared the study protocol, and ethical clearance was obtained from the Institutional Ethical Committee (EC/NEW/INST/2019/329). The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975 that was revised in 2013. Written informed consent was taken from the parents of the patients who were to be included in the study, as well as from the patients participating. The consent forms were reviewed and approved by the ethical committee.

Sample size: Six patients were selected for the study, from whom four samples were taken each, resulting in a total of 24 samples. The sample size was determined using G*Power software v3.1.9.2, employing a two-tailed t-test for assessing the difference between two dependent means (matched pairs). The effect size was determined using the data obtained from a previous study conducted by Jani J et al., [16]. Keeping the level of significance at 5%, the power of the study at 90%, and the effect size of 1.73, the estimated sample size was six per group.

Inclusion and Exclusion criteria: The inclusion criteria for the study included children aged 4-7 years, those with a rating of 1 and 2 on Frankel's behaviour rating scale, along with the requirement of two Class-I restorative treatments for occlusal caries involving enamel and dentin of primary second molars of the mandibular arch. Only children visiting a dental clinic for the first time were involved in the present study. At the same time, children with a history of pain and those under any systemic medication were excluded from the study.

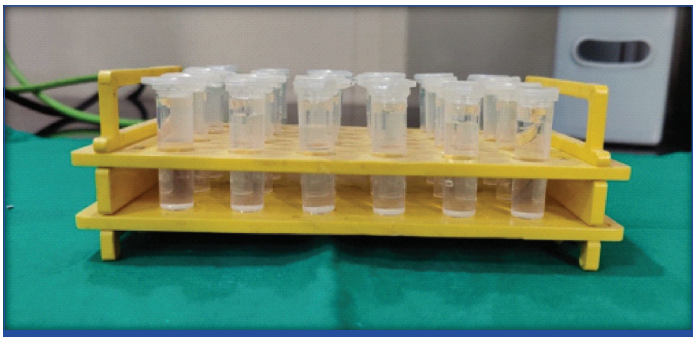
Study Procedure

Patients visiting the outpatient department underwent initial screening involving drying their teeth and examining them using dental mirrors and probes. The carious lesions were differentiated by visual examination. Patients were asked not to eat or drink 1-2 hours before the scheduled appointment.

In the first appointment, restorative treatment was undertaken. Unstimulated salivary samples measuring approximately 1 mL were collected by asking the child to expectorate into a saliva collecting tube before commencing the treatment. Following this, caries excavation was done using a high-speed bur, and a Class-1 cavity was prepared on the primary mandibular second molar of the 3rd quadrant. Finally, the cavity was restored with glass ionomer cement (GC-Type II). The treatment was carried out without using AVD. An unstimulated salivary sample was collected again immediately after the completion of the procedure. The second appointments were scheduled after one week. During the second appointment, the same procedure was carried out on the primary mandibular second molar of the 4th quadrant but with the aid of AVD using a mobile phone displaying the patient's favourite cartoon [Table/Fig-1]. Similarly, unstimulated salivary samples were also collected before and after the procedure [Table/Fig-2].

[Table/Fig-1]: Treatment using AVD.

[Table/Fig-2]: Collection of salivary sample. **[Table/Fig-3]:** ELISA kit. (Images from left to right)



[Table/Fig-4]: Supernatant of salivary samples.

The collected salivary samples were centrifuged within two hours of collection. Centrifugation was done at 2000 rpm for 20 minutes at 4°C. After aspiration of the supernatant [Table/Fig-3,4], the samples were stored at -80°C in the freezer until they were assayed. The stored samples were then assessed for the concentration of salivary CgA using Enzyme-linked Immunosorbent Assay (ELISA) with the commercially available FineTestTM Kit, wherein the chemicals provided in the kit [Table/Fig-3] were added to the samples and incubated at 37°C. Following a colour change, the wells were immediately placed in an optical density meter, and the results were read. These readings were noted, tabulated, and statistically analysed.

STATISTICAL ANALYSIS

The data was analysed using Statistical Package for the Social Sciences (SPSS) v23 software, with a predetermined significance level of 5% and a study power of 90%. To compare salivary CgA levels between two groups, an independent t-test was employed. Additionally, to evaluate changes in salivary CgA levels within each group, a paired t-test was utilised. These statistical analyses were chosen to accurately assess differences between groups and changes within groups throughout the study.

RESULTS

In the present quasi-experimental study, six children were included as study participants. Among them, four were boys and two were girls, ranging in age from 4 to 7 years, with a median age of 5 years. Within the group of boys, two were assessed with Frankel's rating of 1, while the other two received Frankel's rating of 2 on the Frankel's Behaviour rating scale. Both girls were rated as Frankel's rating 2.

The results of the paired t-test demonstrate that within the group without AV aids used, salivary CgA levels showed a significant increase after the treatment (p=0.022). Whereas within the group with AV aids used, salivary CgA levels showed a significant reduction after the treatment (p=0.036) [Table/Fig-5]. Independent t-test also shows that there was a significant difference in salivary CgA levels between the two study groups before treatment and a non significant difference in salivary CgA levels between the two study groups after the treatment. There was a significant difference in the change in salivary CgA levels from pre to post-treatment between the two study groups (p=0.001) [Table/Fig-6].

Group	Pretreatment		Post-treatment		Difference	p-value
	Mean	SD	Mean	SD		
W/o Audiovisual Distraction (AVD)	0.23	0.44	1.26	0.93	-1.03	0.022*
With Audiovisual Distraction (AVD)	1.08	0.49	0.43	0.57	0.65	0.036*

[Table/Fig-5]: Shows the evaluation of change in salivary chromogranin A (CgA) levels within each group.
Paired t-test; * indicates significant difference at p≤0.05

Group	W/o Audiovisual Distraction (AVD)		With Audiovisual Distraction (AVD)		Difference	p-value
	Mean	SD	Mean	SD		
Pre-treatment	0.23	0.44	1.08	0.49	-0.84	0.001*
Post-treatment	1.26	0.93	0.43	0.57	0.83	0.091 (NS)
Change	-1.03	0.77	0.65	0.56	-1.68	0.001*

[Table/Fig-6]: Shows the comparison of salivary chromogranin A (CgA) levels between two groups.
Independent t-test; * indicates significant difference at p≤0.05

DISCUSSION

The study demonstrates that employing AVD effectively reduces stress levels in children during dental procedures. By utilising salivary CgA as a stress biomarker, the research indicates a significant decrease in CgA levels among children treated with AVD compared to those without AVD. This suggests that AVD is successful in alleviating stress and promoting relaxation during dental treatment in paediatric patients. Additionally, the study highlights the potential of salivary CgA as a reliable marker for quantifying stress levels in children undergoing dental procedures.

One of the most important goals of a paediatric dentist is to provide a comfortable clinical environment and prevent children from developing dental anxiety and odontophobia. Dental anxiety is a common phenomenon, the prevalence of which varies from 7.4% to 22.6% among children aged three to 14 years in New Delhi [17]. It is defined as a cognitive emotional response to a stimulus or an experience associated with dental treatment [3].

Dental anxiety not only hampers the quality of the treatment but also affects the patients and their oral health, leading to dental neglect [18]. The American Academy of Paediatric Dentistry has introduced several approaches and guidelines for behaviour guidance, which could be pharmacological and non pharmacological [5]. Distraction guidance is one such non pharmacological intervention that involves redirecting the patient's focus away from potentially discomforting procedures [19].

The effectiveness of audio-visual aids in reducing anxiety during dental procedures can be attributed to the immersive nature of storytelling, music, and cartoons. These stimuli capture children's attention, diverting them away from the anxiety-inducing aspects of dental treatment. As children become engrossed in these activities, the sights and sounds of the dental procedure are consequently screened out, further diminishing anxiety levels [9].

Similar to the present study, Delgado A et al. conducted a study wherein they evaluated the effects of AVD on children's behaviour and pain expression and concluded that AVD can be used as a beneficial technique for diverting the attention of young children during dental procedures, irrespective of their expressions of pain [19]. Similarly, in a study conducted by Zakhary S et al., the AV eyewear group showed a significant decrease in heart rate during the entire procedure of local anaesthesia administration and pulp therapy as compared to the control group, proving that AVD has a considerable effect on reducing dental anxiety in children [20].

The available literature suggests the use of AVD as a behaviour management technique based on objective and behavioural observations. However, quantifying stress in children has posed challenges due to their limited ability to describe it. While behavioural cues like facial or limb movements have been utilised, along with some self-assessment tools, objective methods such as monitoring heart rates, breathing rates, and blood pressure have been emphasised [14]. However, subjective techniques have been insufficient, and objective biochemical measures are often impractical in terms of time and resources [14]. In the present study, we have quantified how much of a difference AVD makes in reducing stress levels in children by the use of a short-term stress marker, that is, salivary CgA.

Catecholamines are often employed as a sensitive biochemical indicator of stress, yet their measurement in saliva poses challenges due to low concentrations and rapid degradation [21]. In contrast, CgA is more stable in the circulatory system, offering a potentially more accurate reflection of sympathetic activity during stress [21]. CgA, an acidic glycoprotein, is co-released with catecholamines from the sympathetic nerve endings and adrenal medulla, serving as a reliable indicator of sympatho-adrenal activity [21]. Studies have demonstrated that CgA is stored in the granular convoluted tubules and released into saliva upon stimulation with norepinephrine and acetylcholine in isolated rat submandibular glands [22,23].

Hence, the submandibular gland itself is considered to secrete salivary CgA when the sympatho-adrenal system is stimulated as a result of stress. Salivary CgA exhibits more rapid changes and greater sensitivity to psychological stressors compared to other biological stress markers like salivary cortisol, which may remain elevated even after stress has subsided. Nakane H et al., have corroborated this phenomenon, noting prompt CgA level responses and delayed salivary cortisol increases during induced psychosomatic stress, followed by immediate decline upon stress

relief suggesting CgA's potential as a biomarker for short-term mental workload [24].

Similarly, Lee T et al., investigated the efficacy of salivary CgA and cortisol as stress indicators, along with the impact of using a kaleidoscope for distraction in alleviating stress among children. They discovered that salivary CgA showed significant changes in its levels before and after venipuncture and non significant changes with the distraction, therefore, concluding that salivary CgA level can be used as a valuable stress marker and gauge the effectiveness of distraction techniques in children [14].

Stress levels in children participating in the study were checked before the commencement and after the completion of the treatment for each visit. Children showing a rating of 1 and 2 on Frankel's behaviour rating scale were considered for the study to effectively evaluate the influence of dental treatment on stress and anxiety.

There was a statistically significant increase in stress levels after the treatment was over compared to before the initiation in the first appointment, suggesting that the process of dental treatment has a considerable influence on a child's stress levels. This could be due to the fear of the unknown [25], which could play an important role in elevating stress.

During the second appointment, there was a statistically significant increase in the stress levels before the treatment started, which suggests that the child was already stressed before coming to the department, probably due to the anxiety experienced during their last visit. This can be attributed to the use of the airotor, which has been thought to be a stress-provoking stimulus. The high-frequency sound and vibrations often tend to make patients feel uncomfortable. There was also a statistically significant decrease in stress levels after the completion of the treatment, indicating that AVD helped calm the patient and reduce their anxiety. These results are similar to the studies conducted by Al-Khotani A et al., wherein dental anxiety was evaluated using Modified Venham's clinical ratings of Anxiety and cooperative behaviour Scale (MVARS) and the Facial Image Scale (FIS) [8]. Frere CL et al., where they used the dental fear survey and the Fear of Pain Questionnaire-III for evaluation in contrast to a biomarker used for the present study [26].

In the AVD-absent group, post-treatment salivary CgA levels indicated a mean stress level of 1.08 pmol/mg protein, whereas the AVD-present group demonstrated a greater reduction in stress to a mean of 0.43 pmol/mg protein post-treatment. This suggests that AVD effectively decreased stress levels during dental treatment.

Limitation(s)

Firstly, the sample size of the study was relatively small, and expanding it in future studies could enhance result precision, offering a more robust foundation for conclusions. Additionally, the use of multiple biomarkers and other subjective measures can be undertaken to get a more accurate look at stress assessment. Addressing these limitations in future research could provide a more comprehensive understanding of the role of AVD in managing stress during dental procedures in children.

CONCLUSION(S)

Based on the findings of the study, it can be concluded that the use of AVD significantly reduces stress levels in children during dental treatment, as indicated by the change in salivary CgA levels. Therefore, AVD can be used as an aid to reduce dental anxiety, which, in turn, will allow clinicians to deliver dental treatment effectively and efficiently, instilling a positive attitude in children towards the same. It can also be concluded that salivary CgA can be used to quantify stress levels in children as it is a non invasive and reliable short-term stress marker.

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