

# Behavioral management using sequenced treatment paradigm and audiovisual distraction during dental treatment in children with attention deficit/hyperactivity disorder

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## ABSTRACT

**Objective:** The present study aimed to assess behavioral management using sequenced treatment approach and audiovisual distraction (AVD) with/without video eyewear during dental procedure in children with attention deficit/hyperactivity disorder (ADHD). **Materials and Methods:** This clinical trial included 31 children ( $n = 21$  boys;  $n = 10$  girls), aged between 6.5 and 8.1 years, distributed into Group A ( $n = 17$ , children not on ADHD medication) and Group B ( $n = 14$ , children taking medication for ADHD symptoms). The study involved four sessions, 1 week apart. Sessions I and II included behavioral management assessment and dental screening, respectively, while participants watched cartoon movie using an AV distracter with/without a video eyewear. During Sessions III and IV, dental prophylaxis and sealants were placed on first permanent molars, respectively, for both upper and lower jaws in both the groups. During the procedure, children were distracted with AV distracter with/without a video eyewear, and the mean changes in blood oxygen saturation ( $\text{SaO}_2$ ) and pulse rate were recorded every 5 min. Independent samples t-test was used, assessing for significant changes in pulse rate and  $\text{SaO}_2$  during each visit in both groups. **Results:** Almost 95% ( $n = 113$ ) of the first permanent molars showed signs of pit and fissure demineralization of varying severities, classified as the International Caries Detection and Assessment System-codes 1–3. During Session IV, there were significant differences ( $P \leq 0.03$  and  $P \leq 0.05$ ) in mean pulse rate in both groups of children, respectively, during fissure sealants or preventive resin restoration application on their permanent molars while being distracted using AVD with video eyewear. **Conclusion:** Our study recommends splitting of dental visits into multiple short sessions and video eyewear distraction for optimum behavioral management during dental procedures of children with ADHD.

**Key words:** Audiovisual distraction eyewear, attention deficit/hyperactivity disorder, dental anxiety

## INTRODUCTION

Attention deficit/hyperactivity disorder (ADHD) is a common neurodevelopmental disorder, and children diagnosed with ADHD have symptoms such as trouble paying attention, impulsivity, and hyperactivity.<sup>[1]</sup> Several studies<sup>[2-5]</sup> reported that pharmacotherapy used to manage symptoms of ADHD

alters the salivary composition and reduces salivary flow, thus increasing the risk of developing dental caries. Moreover, routine oral care is less common among these children. An often parent-child conflict

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also influences oral health behavior. Furthermore, exposure to high carbohydrate foods as a dietary habit also contributes to the development of dental caries.<sup>[6]</sup> Depending on the severity of such symptoms, treating children with ADHD in the traditional dental setting is often quite challenging.<sup>[7]</sup>

Although medications such as stimulants, noradrenergic uptake inhibitors, and tricyclic antidepressants are standard in the management of ADHD,<sup>[8]</sup> it is crucial for the clinician to be familiar with the signs and symptoms of the disorder and employ adjunctive behavioral strategies for case management. Audiovisual distraction (AVD) is one of the methods used to lessen dental anxiety and phobias in children during dental procedures.<sup>[9]</sup> Music, video display, and recently three-dimensional eyeglass goggle display were proved to be useful distraction tools during dental treatment in children.<sup>[10]</sup>

Anxiety among children during dental visits can be measured using Frankl and psychometric scales which rate behavior during dental procedure.<sup>[11]</sup> In addition, pulse rate (PR) and muscle tension readings are indicative of anxiety and phobias.<sup>[12]</sup> The present study aimed to evaluate the effectiveness of AVD with/without video eyewear during dental caries assessment and preventive sealant placement in children with ADHD. The blood oxygen saturation (SaO<sub>2</sub>) and PR will be used as indicators of children's anxiety during different dental sessions, with the null hypothesis that AV distractor does not affect the level of dental anxiety of children with ADHD.

## METHODOLOGY

For the present clinical trial, a local facility for ADHD patients' rehabilitation was contacted. The study details with consent form and questionnaires were sent to parents of 31 ( $n = 21$  boys;  $n = 10$  girls) enrolled children aged between 6.5 and 8.1 years. Except for two included child participants ( $n = 2$ ; 6.5%), who had a history of dental extractions under general anesthesia, the rest of all the participants had no previous dental experience. Children with ADHD, having at least two first permanent molars with caries code 0–3, according to the International Caries Detection and Assessment System (ICDAS) caries classification, were selected for preventive sealant placement. However, children with more than two permanent molars with caries severity of ICDAS codes 4–6 were excluded from the study.

Of the 31 participants, 17 children (54.8%) were grouped as Group A, for they were not on any medication for ADHD, and another 14 children (45.2%) were arranged in a separate group (Group B), who were on methylphenidate, a psychostimulant medication (CONCERTA<sup>®</sup>, Janssen Pharmaceuticals Inc., Belgium or Ritalin, Novartis Pharmaceuticals Co., NJ, USA). Research approval was obtained from the Research Ethics Committee, University of Sharjah, United Arab Emirates. Children accompanied by their parents/caregivers visited the dental facility at Special-Needs-Teaching Clinic, University Dental Hospital, Sharjah.

The study comprised four sessions as follows: Session I – behavioral assessment; Session II – dental screening and charting; Session III – dental prophylaxis; and Session IV – sealants' placement [Figure 1]. From behavioral assessment to fissure sealant placement, a pediatric dentist (KSF) was involved during all sessions. A dental assistant (JA) recorded PR and blood SaO<sub>2</sub> during all the four sessions.

### Session I

During Session I, baseline assessment of all the study participants was carried out by a pediatric dentist. In this course, parents/caregivers handed the filled-out questionnaire to the resident doctors for records in the Patient Health Information system (AxiUm, Exan Co., Canada). Health information includes patient's age, general medical conditions, any comorbid factor (seizure), current medications (if any), dietary habits, past dental visits, communication skills, and preferences. Under traditional dental setting, children's ability to cooperate was assessed and categorized as extraordinarily impulsive/aggressive/restless by a pediatric dentist. Treatment was planned accordingly as three appointments/sessions 1 week apart.

Employing TELL-SHOW-DO methods of behavior management, a resident doctor demonstrated how dental drill and suction feels and works by using dental model and play dough. Playfully, children were introduced to an air–water syringe. In addition, on iPad, Apple Inc., CA, graphic animations of dental caries were shown to these children. This serves as an educational tool to help reduce their anxiety and prepare them for future scheduled treatment. Children were then given the option to select their choice of age-appropriate cartoon movie from the collection of "Treehousetv.com" website. They were introduced to a video eyewear (Vuzix Wrap 310XL; Vuzix Corporation, Rochester, NY, USA) which was attached to the iPad and they were made to watch two

cartoon movies, each 20-min long. At first, participants watched a cartoon movie projected on the ceiling without wearing the video eyewear. Following this, they watched another cartoon movie with video eyewear on.

For systematic desensitization with vibrations from dental drills, they were given powered toothbrushes (oscillating, rotating type). Parents/caregivers were advised to use these toothbrushes at least twice every day. At the end of Session I, for positive reinforcement, children were being rewarded with a stuffed toy for following instructions, by sitting calmly in the dental chair while watching cartoon movies.

### Session II – dental screening and charting

For children on ADHD medication, prior to Session II, medication scheme was discussed and followed as per the advice of the prescribing doctor. This helps optimize the effect of this drug at the time of the dental procedure, demonstrating improved behavioral outcome, mostly noticeable within an hour after taking this medication.

A detailed oral examination was recorded using ICDAS index for caries classification.<sup>[13]</sup> Furthermore, for precise diagnosis, intra oral radiographs were taken, if needed, for participants in either group. During the dental examination of the upper jaw, children in both groups watched cartoon movie

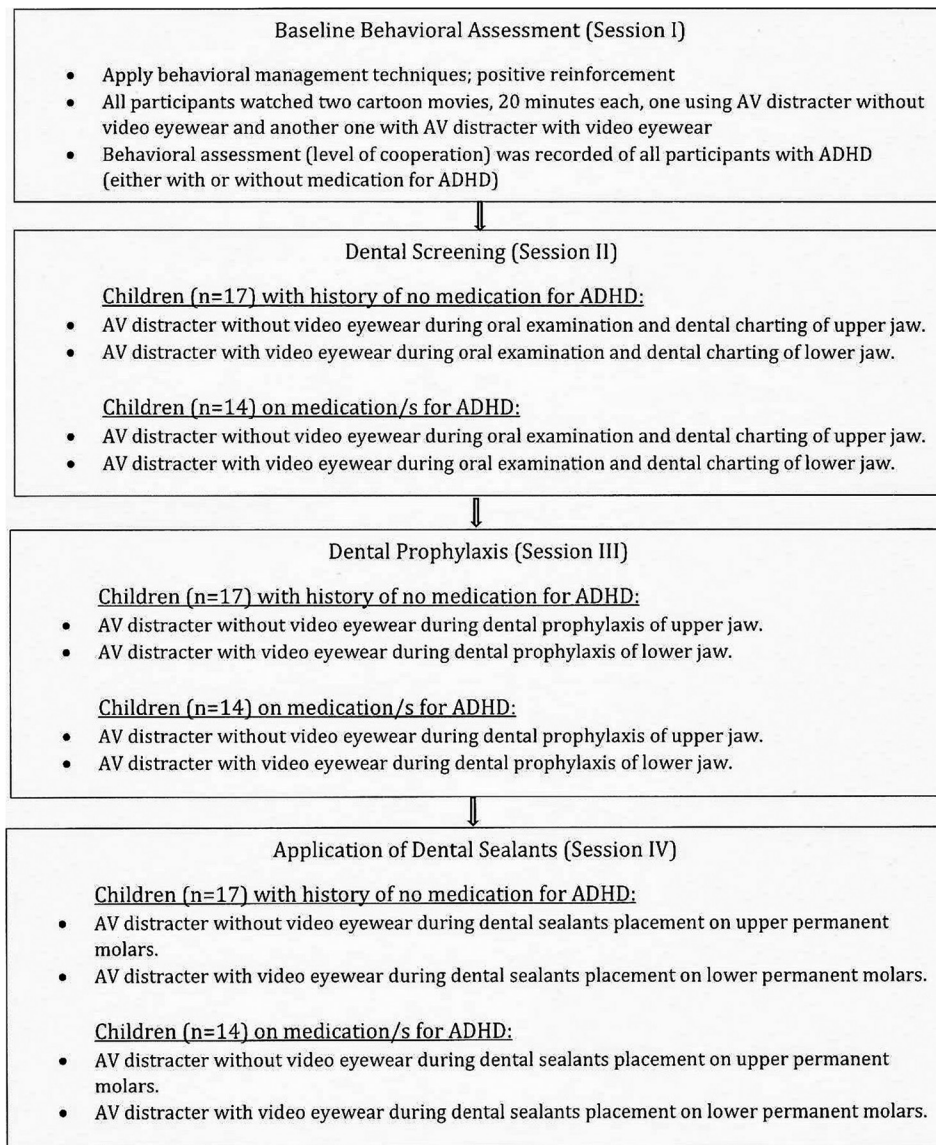


Figure 1: Patient flow through Sessions I-IV in the research study

without wearing video eyewear. Though during the lower-jaw dental examination, they observed a movie using the video eyewear.

**Sessions III and IV**

The same AVD protocol was followed during dental prophylaxis and sealant application procedures during Sessions III and IV. Children in either group watched a movie without video eyewear on while undergoing treatment for their upper teeth. Conversely, during treatment for lower teeth, both groups were distracted with video eyewear AV distracter while watching cartoon movie.

Prophylactic cleaning using Prophy paste (Pumice) and low-speed handpiece was done in Session III. In Session IV, sealants were placed on permanent molars after a

professional cleaning. During placement of sealant, a mouth prop was used to help keep their mouth open. Where moisture control seemed impossible due to the active tongue, GC-Fuji Triage sealants were placed after conditioning the tooth. Under ideal moisture control, resin-based sealants were placed.

During all the sessions (I through IV), blood SaO<sub>2</sub> and PR were monitored and recorded every 5 min using fingertip pulse oximeter (PO 80, Beurer GmbH, Ulm, Germany). The changes in the recorded measurements above the baseline readings were recorded.

To assess the significance of changes in PR and SaO<sub>2</sub> during each visit, an independent sample *t*-test was used to evaluate significance of change during each appointment visit. Statistical significance was set at *P* ≤ 0.05.

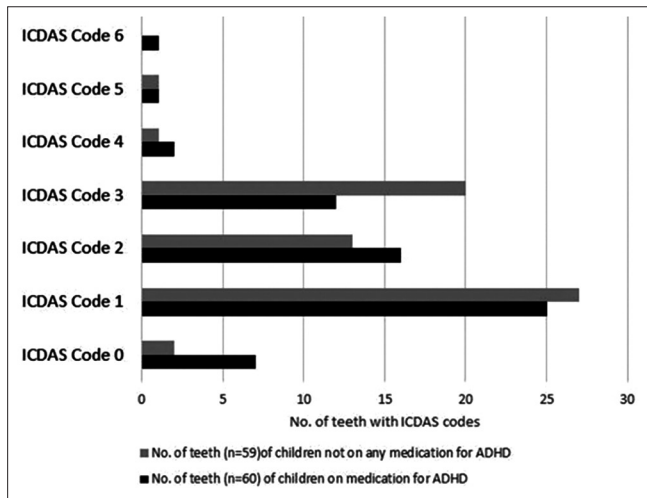


Figure 2: The prevalence percentage of each International Caries Detection and Assessment System code per tooth (*n* = 119)

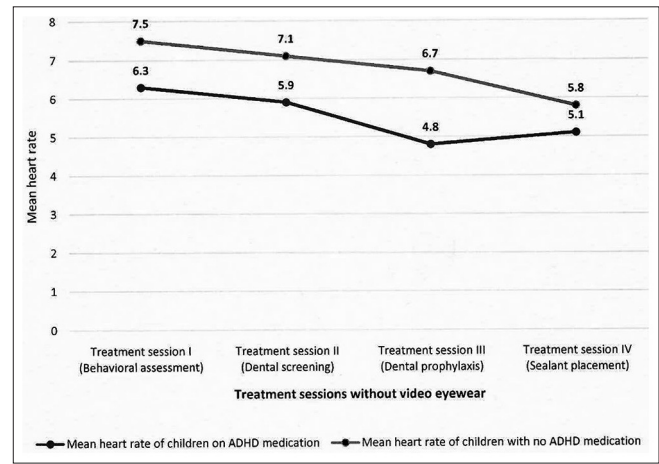
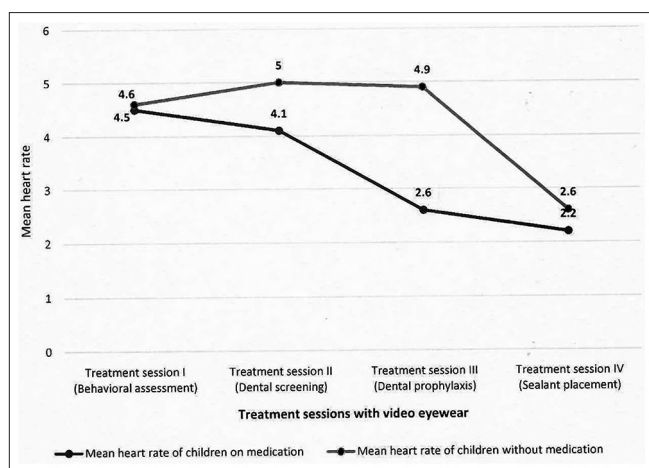


Figure 3: Mean pulse rate during Sessions I-IV with audiovisual distraction without video eyewear

**Table 1: Mean changes in blood oxygen saturation and pulse rate among 31 children (Group A: children not taking medication and Group B: children taking medication)**

Treatment session	Mean (SD)				<i>P</i>
	AV distracter without video eyewear		AV distracter with video eyewear		
	SaO <sub>2</sub>	PR	SaO <sub>2</sub>	PR	
I (Behavioral assessment)					
Group A	5.3 (0.05)	7.5 (1.32)	4.2 (2.13)	4.6 (0.11)	0.07 (NS)
Group B	3.6 (0.32)	6.3 (0.16)	3.0 (1.35)	4.5 (0.26)	0.09 (NS)
II (Dental screening)					
Group A	5.2 (0.72)	7.1 (0.06)	4.4 (0.19)	5.0 (1.05)	0.10 (NS)
Group B	4.3 (0.66)	5.9 (0.02)	3.2 (0.01)	4.1 (0.14)	0.08 (NS)
III (Dental prophylaxis)					
Group A	4.7 (0.13)	6.7 (0.94)	3.9 (0.02)	4.9 (1.03)	0.11 (NS)
Group B	2.3 (0.13)	4.8 (0.26)	2.8 (0.11)	2.6 (0.15)	0.07 (NS)
IV (Sealant placement)					
Group A	3.6 (1.13)	5.8 (0.04)	3.4 (0.14)	2.6 (0.06)	0.05*
Group B	3.6 (0.31)	5.1 (0.12)	3.1 (1.01)	2.2 (0.10)	0.03*

Obtained using *t*-test; \**P*≤0.05. NS: Not significant, SD: Standard deviation, PR: Pulse rate, AV: Audiovisual, SaO<sub>2</sub>: Oxygen saturation



**Figure 4:** Mean pulse rate during Sessions I-IV with audiovisual distraction using video eyewear

## RESULTS

In the present clinical study, mean age of participants with ADHD was 7.5 years (range: 6.5–8.1 years). Based on those taking medication for ADHD ( $n = 14$ ) and without ( $n = 17$ ), the participants were divided into two groups. According to ICDAS criteria codes, the severity of pit and fissure demineralization of permanent first molars was assessed and recorded. Of the 31 participants, first permanent molars ( $n = 119$ ) were evaluated.

Dental evaluation using ICDAS caries assessment tool demonstrated that only (6%) 7 teeth of children on ADHD medication had caries code 0 (caries free), while (2%) 2 children had code 0 in the nonmedication group. Almost 95% ( $n = 113$ ) of the first permanent molars showed signs of pit and fissure demineralization of varying severities classified as ICDAS codes 1–3. ICDAS caries code 1 was the most prevalent on the first permanent molars ( $n = 52$ ; 44%) found on occlusal surfaces and buccal pits of lower permanent molars. This was followed by ICDAS code 2 ( $n = 29$ ; 24%), predominantly observed on occlusal surfaces and palatal pits and fissures of permanent upper molars. ICDAS code 3 was detected in 27% ( $n = 32$ ) of the first permanent molars, as shown in Figure 2. In addition, 5% ( $n = 6$ ) of the first permanent molars demonstrated caries severity of ICDAS codes 4–6.

There was no significant difference in  $\text{SaO}_2$  levels or heart rate during the initial three sessions among children using AV distracter with/without a video eyewear in both groups [Table 1]. During baseline assessment, we recorded a noticeable decrease in mean PR among children in both groups while

they were distracted watching a movie using a video eyewear. Moreover, we observed a gradual reduction of mean changes in PR from initial to final sessions among children wearing video eyewear in groups (with/without medication) [Figures 3 and 4]. This demonstrated a reduction in anxiety level during successive treatment sessions among children distracted using AV distracter with video eyewear.

During treatment Session IV, statistically significant differences in mean PR ( $P \leq 0.03$  and  $P \leq 0.05$ , respectively) were observed among children in both groups who received fissure sealants on their first permanent molars with caries codes 0, 1, and 2. In our study, glass ionomer sealants (Fuji VII) were the most commonly used sealant, placed on lower permanent molars with caries codes 0, 1, and 2. This was followed by resin-based fissure sealant applied to permanent upper molars. Among Group B children, six of the lower permanent molars with caries code 3 received preventive resin restoration (PRR-type B). Conversely, for children in the nonmedication group, PRR-type B was only possible on one of the four teeth with caries code 3, due to difficulty in moisture control. These teeth were managed using temporary glass ionomer cement restoration.

## DISCUSSION

ADHD is a neurobehavioral condition that often becomes apparent in early childhood.<sup>[14]</sup> The condition interferes with an individual's ability to attend to tasks and affects their behavior. Behavioral expressions of the disorder frequently impair the patient's ability to perform oral care adequately and make dental appointments stressful and tiring.<sup>[15]</sup>

The current study targeted a child population that is agreed by most studies to be a risk group for dental caries and its sequel. In our study, we demonstrated a protocol which can facilitate caries management at the prepathogenic level (true prevention) for a highly susceptible group of children aiming to save time and effort which may be wasted during extensive caries management for exposed and poorly decayed teeth if the risk in this group of children was overlooked. Corroborating Rosenberg *et al.*'s. (2014) results,<sup>[16]</sup> our study also demonstrated higher caries scores expressed in ICDAS caries codes, where almost 95% of the first permanent molars showed signs of pit and fissure demineralization of varying severities.

Almost half the children in our study ( $n = 14$ ; 45.2%) were on long-acting stimulant (CONCERTA®/Ritalin) medication. Information related to dosing schedule was obtained from the child's physician. An early morning dental appointment was set for all participants. Especially for children on ADHD medication, morning appointments are ideal, as therapeutic drug concentration in plasma are optimal, resulting, these children are more attentive during morning hours.

The physiological measures employed in this study were PR and blood-SaO<sub>2</sub>. Several studies reported that stress and anxiety cause changes in heart rate and alter respiration, leading to changes in SaO<sub>2</sub> of the blood.<sup>[17,18]</sup> A study by Poiset *et al.* also reported that measuring SaO<sub>2</sub> in the blood is a reliable method for monitoring dental anxiety.<sup>[19]</sup> In the current study, to measure anxiety level during procedure, a small fingertip device was used to avoid apprehension among these children.

Employing "tell-show-do, modeling, and AVD" approaches during the initial treatment session assists overcome communication barrier, as observed in this study. Children with ADHD perform best when they know what to expect.<sup>[15]</sup> Using animated cartoons displayed on tablets, we informed the child about what we want to accomplish during the appointment. To introduce and desensitize children's visual, auditory, and tactile sensations, we demonstrated using tooth model on how hand-piece, air-water syringe and suction sounds and works. Due to the short attention span of these children, we demonstrated the procedure in a simple, quick, and fun way. In addition, the treatment was split into short and positive sessions. These behavioral modification approaches encourage cooperative behavior among these children, as evident from the fact that they watch cartoon movie projected on the ceiling above the chair without any apprehension.

Considering that behaviors which are rewarded lead to improvement toward positive behavior, a powered toothbrush was given at the end of the first session. This also helped in systematic desensitization to vibrating stimuli of the dental drills. In addition, this is useful for obtaining compliance from an ADHD child.

Children with ADHD often become frustrated because inattentive children are easily distracted.<sup>[1]</sup> These distracting stimuli may result in unusual responses which might cause interruption during treatment.

To direct their attention away from these distracting stimuli, thoughts, and feel, we use AVD with video eyewear, similar to our finding from the previous study which demonstrated that the use of video eyewear might be a better distraction than watching video projected on the screen.<sup>[20]</sup> In this study, AVD also served as a useful distraction tool showing statistically significant results with changes in heart rate during dental examination with and without visual eyewear. As breaks is a critical component in working with ADHD children, after we finish procedure on upper teeth, children in both groups were given the choice to select a cartoon movie they prefer before we start the procedure on lower jaw teeth.

Performance bias was avoided in the current trial by involving a dental assistant (JA), from whom children's treatment group information was concealed and was assigned the task of recording levels of SaO<sub>2</sub> and PR of all participants during each session. Moreover, to avoid detection and reporting bias in the study, a dentist (HE) who was not involved at any stage of treatment sessions did data analysis and reported write-up.

A limitation in the current study might be the use of different types of sealants where difficulty in moisture control for lower teeth favored the use of glass ionomer sealant on those teeth. Another comparative study on the long-term protective effect of different materials for this highly susceptible group of children is recommended.

## CONCLUSION

Children with ADHD may show higher caries risk than healthy children. For better behavioral management, our study recommends splitting the dental visits into multiple short visits that could lead to better treatment results. In most cases, video eyewear distraction showed better behavioral management outcome compared to distraction by screen projection.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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