

Comparison of Virtual Reality Glasses vs On-screen Distraction Technique in Reduction of Pediatric Dental Anxiety: An *In Vivo* Study

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ABSTRACT

Aims and objectives: To evaluate and compare virtual reality (VR) glasses vs on-screen audiovisual distraction techniques in managing anxious pediatric patients during dental procedures at sequential dental visits.

Materials and methods: This study was conducted in the age group of 4–8 years anxious children who reported to the department. The informed written consent from the parents was taken. The 40 children were divided into two groups: group I—on-screen distraction aid and group II—audiovisual distraction aid (VR glasses) with 20 patients in each group. Each child in all the subgroups had gone through three dental visits. Child anxiety level at each visit was assessed by using a combination of anxiety measuring parameters.

Results: Chi-square and Student's *t*-test (two-tailed, independent) analyses were used to find the significance of study parameters on a categorical scale and continuous scale between two groups (intergroup analysis) on metric parameters. It revealed that VR glasses audiovisual aid group showed a statistically highly significant difference from the on-screen method.

Conclusion: Audiovisual distraction aid was found to be a more effective mode of distraction in the management of anxious children when compared to the on-screen distraction method.

Keywords: Audiovisual distraction, Behavior, Behavior management of children, Dental anxiety, Virtual reality glasses.

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INTRODUCTION

Oral health care for children has a profound impact on their health; however, dental anxiety can be a major obstacle to children undergoing dental treatment. Children have limited communication abilities and are therefore unable to communicate their anxieties to their family and the dental team. It is the most common emotion associated with children and the reciprocation of emotion due to anxiety varies at a different age.¹ As, pediatric dentist managing anxious children is the most challenging task. Behavioral management of such anxious children can be done by instilling a positive dental attitude before and during the dental procedure. There are various behavior management practices used worldwide, either they are pharmacological or non-pharmacological depending on the behavior recorded according to Frankel's rating scale.²

Nowadays, the patients discredit the methods advocating the use of sedation with general anesthetics, as they are undesirable due to perceived medical risks and the invasiveness of the procedure. The nonpharmacological methods of behavioral management include parental presence and reassurance, tell-show-do, tell-play-do, distraction, relaxation, systematic audio analgesia, desensitization, modeling, hypnosis, tranquilizing verbal approaches, physical contact by light touching or stroking, and music.³

Distraction technique has been documented for more than a decade as one of the new nonpharmacological behavior management techniques that involve watching movies, listening to music,⁴ counting items in the room, watching cartoons, music, books, or stories.⁵ Audiovisual distraction is an effective tool as it takes control of hearing and visual stimuli in an exciting way.⁶

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Audiovisual distraction technique's potential has led many dental practitioners to set up television screens in the dental environment.³ Recently developed audiovisual (A/V) distraction techniques have advancement which includes virtual reality (VR). Virtual reality is a human-computer interface that enables the user to communicate with the computer-generated atmosphere with dynamism.⁷

Virtual reality uses head-mounted, wide field-of-view, 3D displays, and motion sensing which is less complex as compared to A/V distraction. This helps users to connect to the virtual environment (VE). To date, however, there have been very few studies that have tested the effectiveness of the virtual reality headset vs on-screen technique using a tablet, on anxious pediatric

patients during the dental treatment when searched in EBSCO and PUBMED dated till December 15, 2020, using MESH words. Therefore, the study aimed to assess the effectiveness of the virtual reality headset vs on-screen technique using a tablet, on anxious pediatric patients during dental treatment.

MATERIALS AND METHODS

Study Design

The research was *in vivo* comparative study. It was conducted on a total sample of 40 children aged between 4 years and 8 years. It was initiated after ethical approval was obtained from the institutional ethical committee (SVIEC/ON/DENT/SRP/16144). Parents gave comprehensive medical and dental history along with informed consent. The study period was 6 months and the sample collection was carried out during the OPD timings of the Department by random sampling method.

Sample Determination

The sample size of 40 children was determined by considering the difference in group means to be 20%, research power to be 80%, 95% confidence interval, sample size ratio (group I/group II) to 1 and with the significance level to be 5%.

Inclusion and Exclusion Criteria

The children who had at least two carious teeth out of which one undergoing cavity preparation without administration of local anesthesia and one requiring endodontic treatment with the administration of local anesthesia were included in this study. The children who had any systemic condition like cerebral palsy, bleeding disorders, etc., mental and physical disabilities, those who were uncooperative, had allergies to local anesthesia, had past dental visit history, or required emergency treatment were excluded from the study.

Methods

Forty children were randomly divided by chit method into two different groups with 20 children in each group by co-investigator. The two groups were as follows:

Group I (Experimental Group I): Audiovisual distraction from on-screen technique using tablet (HCL, India).

Group II (Experimental Group II): Audiovisual distraction with VIRTUAL REALITY headset (Lenovo, Beijing).

Participants of both groups were allowed to listen and view their own choice-based audiovisual clips. It can either be English or Hindi or Gujarati short dramatic clips, video songs, and cartoons. Children of both groups had undergone three dental visits in an interval of 2 days. These visits were divided as follows:

- First visit: Screening or diagnosis (R1) (Fig. 1).
- Second visit: Cavity preparation without the need for administration of local anesthesia (R2) (Fig. 2).
- Third visit: Administration of local anesthesia for invasive procedures like extraction or endodontic procedure (R3) (Fig. 3).

Evaluation Method

Dental procedures were carried out by the principal investigator and the level of anxiety was measured by the co-investigator during each visit. During the procedure, anxiety levels were measured by both physiological and anxiety assessment parameters:

Physiological parameter: heart rate, pulse rate, and oxygen saturation were recorded using a fingertip pulse oximeter (BPL



Fig. 1: First visit: Screening or diagnosis carried out in patient

Company) during the treatment procedure in all three dental visits in both groups.

Behavioral Measures

- Venham's clinical anxiety rating scale⁸—It is a six-pointer scale used to measure the situational anxiety of the child by the clinician. It is an interval rating scale in which the rating procedure is reliable, valid, and can be easily integrated into clinical or research activities. The scale points anchored in an objective, specific, and readily-observable behavior.
- Venham's picture test⁸—This scale consists of series of eight paired drawings of a child. Each pair consists of a child in a fearful and a non-fearful pose. It is a projective, psychometric, self-measure test that is used to measure the state anxiety of the young child. It permits the child to respond non-verbally minimizing the distortion produced by the subject's attempt to give socially desirable responses.

STATISTICAL ANALYSIS

The data were tabulated and it was subjected to statistical analysis using Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA). Descriptive and inferential statistical analyses were carried out in the present study. The values were represented in number (%) and mean \pm SD. The level of significance was fixed at $p = 0.05$ and any value ≤ 0.05 was considered to be statistically significant. Student *t*-tests (two-tailed, unpaired) were used to find the significance of study parameters on a continuous scale between two groups, and analysis of variance (ANOVA) was used to find the significance of study parameters between the groups (intergroup analysis). Further *post hoc* analysis was carried out if the values of the ANOVA test were significant.

RESULTS

This study was conducted as a double-blinded *in vivo* experimental study, where the Principal investigator and Statistician were blinded. A total of 40 children were selected as per the inclusion criteria and were randomly divided into two groups by co-investigator with chit method with 20 patients in each group. The following result was seen as described below.



Fig. 2: Second visit: Cavity preparation without the need for administration of local anesthesia in both the groups



Fig. 3: Third visit: Administration of local anesthesia for invasive procedures like extraction or endodontic procedure in both the groups

Table 1: Comparison of pulse rate in terms of {Mean (SD)} at different visits in group I and group II using unpaired test

	Group	N	Mean	Std. deviation	t value	p value
Pulse rate R1	Tab group	20	91.25	8.771	0.503	0.618
	VIRTUAL REALITY headset group	20	92.55	7.522		
Pulse rate R2	Tab group	20	96.25	7.691	4.633	<0.001**
	VIRTUAL REALITY headset group	20	86.85	4.815		
Pulse rate R3	Tab group	20	106.10	7.587	9.833	<0.001**
	VIRTUAL REALITY headset group	20	86.00	5.099		

* $p < 0.05$ = significant; ** $p < 0.001$ highly significant

Table 2: Comparison of oxygen saturation in terms of {Mean (SD)} at different visits in group I and group II using unpaired test

	Group	N	Mean	Std. deviation	t value	p value
Oxygen saturation R1	Tab group	20	95.70	2.029	2.086	0.044*
	VIRTUAL REALITY headset group	20	97.05	2.064		
Oxygen saturation R2	Tab group	20	96.40	2.113	1.840	0.074
	VIRTUAL REALITY headset group	20	97.45	1.432		
Oxygen saturation R3	Tab group	20	96.65	1.899	0.627	0.535
	VIRTUAL REALITY headset group	20	97.00	1.622		

* $p < 0.05$ = significant; ** $p < 0.001$ = highly significant

Table 3: Comparison of VCARS in terms of {Mean (SD)} at different visits in group I and group II using unpaired test

	Group	N	Mean	Std. deviation	t value	p value
VCARS R1	Tab group	20	1.95	1.356	3.147	0.003*
	VIRTUAL REALITY headset group	20	3.10	0.912		
VCARS R2	Tab group	20	2.45	1.050	2.694	0.010*
	VIRTUAL REALITY headset group	20	1.65	0.813		
VCARS R3	Tab group	20	3.25	0.671	12.192	<0.001**
	VIRTUAL REALITY headset group	20	1.2	0.826		

* $p < 0.05$ = significant; ** $p < 0.001$ = highly significant

Table 1 shows a comparison of pulse rate at different visits in both groups. In the second dental visit, the tab group showed a mean value of pulse rate was 96.25 and the VIRTUAL REALITY Headset group showed 86.85 which showed a highly significant reduction in pulse rate with VIRTUAL REALITY Headset ($p < 0.001$). In the third dental visit, the tab group showed a mean value of pulse rate was 106.10 but in VIRTUAL REALITY Headset group showed 86.00 which showed a highly significant reduction in pulse rate ($p < 0.001$).

Table 2 shows a comparison of oxygen saturation in terms of {Mean (SD)} at different visits in group I and group II using unpaired test showed there was not ant correlation of the oxygen saturation

with the dental anxiety. From the above values, a statistically significant difference was seen in oxygen saturation for R1, R2, and R3 in both groups.

Table 3 shows a comparison of VCARS in terms of {Mean (SD)} at different visits in group I and group II using an unpaired test. It showed that the mean value in the tab group for the first dental visit was 1.95 and for VIRTUAL REALITY Headset was 3.10 with a significant p value of 0.003. In the second dental visit, the mean value for the tab group was 2.45 and for the VIRTUAL REALITY Headset group was 1.65, which was showing a significant reduction in clinical anxiety with VIRTUAL REALITY Headset ($p = 0.010$). At the third dental visit, in the tab group, the mean value was 3.25 but with

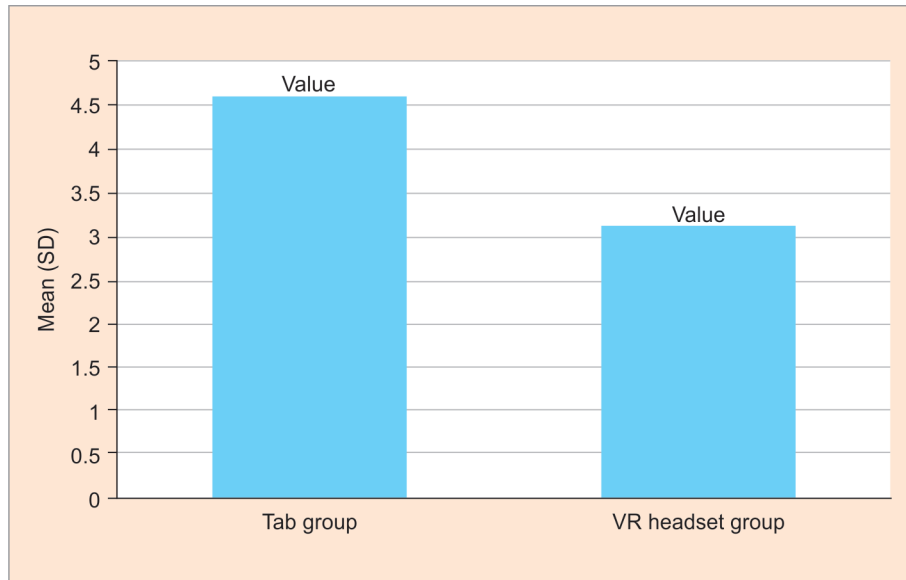


Fig. 4: Comparison of picture test score in terms of mean (SD) at different visits in group I and group II using unpaired test

the VIRTUAL REALITY Headset group was 1.2 which is showing a highly significant reduction in anxiety with the VIRTUAL REALITY Headset ($p < 0.001$).

Figure 4 shows a comparison of picture test score in terms of {Mean (SD)} at different visits in group I and group II using unpaired test showed the mean value of picture test in tab group was 4.65 and in VIRTUAL REALITY Headset group was 3.15 which showed the significant value in VIRTUAL REALITY Headset group ($p = 0.020$).

DISCUSSION

Dental anxiety can be defined as a feeling of apprehension about the dental treatment that is not necessarily connected to a specific external stimulus.⁹ There are multiple reasons for the development of anxiety, such as a learned reaction to a previous traumatic or unpleasant dental experience or can result from negative dental state beliefs and expectations that make patients especially vulnerable to the reception and contact, they receive from dental staff and to the outcome of dental treatment.¹⁰ Behavior management is a valuable skill and should be mastered by all the dental team members who serve children.

Any pediatric dentist involved in the virtuous handling of anxious children is a daunting yet rewarding experience. In the present research, the age range of 4 to 8 years was chosen because in this age group children are difficult to handle as they show more destructive behavior and dental anxiety. Hence, this age group is most difficult to manage.¹¹ In newer practices, visual stimuli or combination of visual stimuli with audio stimulation helps in diverting the patient by exposing him or her to two-dimensional (2-D) or three-dimensional (3D) videos.¹²

These methods include VR audiovisual systems, A/V eyeglass systems, or A/V distraction. In our study, we have used video eyewear, which may act as a powerful distraction than watching video exhibited on the screen as the occlusive eyewear projects images in front of the eyes of the user and also blocks out the surrounding visual and auditory stimuli. To be effective, it should be age-appropriate and it must be appealing to the recipient.¹³

In comparison to the findings obtained from the current research, the VIRTUAL REALITY headset group in children was

substantially successful relative to the tablet group. As, it is hypothesized that an optimum amount of concentration involving multiple sensory modalities (visual, auditory, and kinesthetic) will be required for the ideal distractor, active emotional involvement,¹⁴ and the patient's involvement to cope with the noxious stimulus signals.

In the presented study, with three different dental procedures, researchers selected three dental visits to compare anxiety between the first and third dental visits. The three-visit assessment of anxiety helped to assess the success of intervention groups at each visit. Yamini et al.¹⁵ reported that three visits could assist in estimating the children's anxious nature.

The result revealed that there was an increase in mean of the anxiety rating scale and cooperative behavior rating scale scores from first to second and minimized in the third visit in both the groups. It might be because the children were able to distinguish between stressful and nonstressful situations in the operatory as at the first visit, the only diagnosis was performed. In the second visit, complex dental treatment procedures were performed by using airoter, local anesthesia, and dental instruments.

The results are in accordance with the research carried out by Venham et al. wherein, children were more anxious during treatment which decreased the cooperation level of children despite the use of different distraction aids.⁸ Mccarthy¹⁶ stated that heart rate is a reliable indicator of stress and anxiety. Venham et al. stated that the anxiety rating scale and cooperative behavioral rating scale are valid and dependable rating scales and are beneficial in evaluating dental stress by responses obtained by children.¹⁷ Here, in this study, we used a pulse oximeter to check heart rate as it assesses physiological change. This is considered as one of the most standard methods stated by Corah et al.¹⁸ Venham's anxiety rating scale is also a reliable and resource for measuring anxiety in children.

One of the accurate indicators of self-reported anxiety in children is the Venham picture test. However, it gave statistically indecisive results, because the children's choice of the picture was consistent across all four visits, this finding was also observed by Prabhakar et al.¹⁹ Despite the inconclusive results, the picture test

was an efficient measure of the child's emotional condition at that specific instance.¹⁷ So, in this study, both the tests were used to get more reliable results for anxiety.

The overall results revealed by all the parameters indicated that children were most relaxed in the VIRTUAL REALITY Headset group than the tab group during three dental visits. Similar results were found in the research conducted by Prabhakar et al.¹⁹ and Florella et al.³ They stated that there was a statistically significant difference between the control group and audiovisual group. Pande et al.²⁰ also stated that AVD (VR) was found to be the most effective in reducing dental fear/anxiety in uncooperative pediatric dental patients. Al-Halabi et al.²¹ observed that children aged between 8 and 10 years preferred "VR Box" to younger patients. Fakhruddin and Hisham El Batawi²² evaluated anxiety in Down syndrome children by using CDS-IS system, video eyewear and Tell-Show-Do CDS-IS system was an effective behavior management technique. Results from present and previous studies states that audiovisual distraction with VR glasses is one of the most effective way of non-pharmacological behavioral management.

LIMITATIONS

As with any other method, the clinician often faces some restrictions when using the audio distraction technique. The sound of video may interfere with the communication and interaction of the patient with the dentist. This can prevent the clinician and the patient from establishing proper relationships. This can, however, be avoided by allowing the child to listen at an appropriate degree of volume so that proper masking of the sound of the dental operating instruments occurs and the patient is thus able to interpret the dentist's instructions properly. Thus, along with other well-established behavior modification strategies, audio distraction can be used as an adjunct. Also, there is a need to carry out randomized clinical trials for a greater level of evidence. Further studies are required with a larger sample size.

CONCLUSION

Considering the limitations of the study, different conclusions were drawn:

Virtual reality Headset group was significantly more effective when compared with the tablet group in reducing dental anxiety in children. Also, there was a significant reduction in anxiety at the second and third dental visit of a child in the VR Headset group when compared with the tablet group. Therefore, it is suggested that audiovisual aids are an effective alternative in the management of anxious child patients in the dental office.

FUTURE DIRECTIONS

The findings of this study will enable clinicians with minimal resources to treat anxious children. This approach is also cost-efficient and readily accessible in the market. Nowadays, children have grown so dependent on their cell phones that they would prefer an option of watching videos rather than any other type of behavior modification.

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