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Evaluation of the success of distraction through virtual reality using the Child Drawing Hospital Scale

Ayça Hande Sari[1], Elif Deniz[2], Esra Ceren Tuğutlu[3]

Highlights

- The success of distraction with VR on anxiety and pain perception during dental restorative procedures in children was evaluated in comparison with tell-show-do technique.
- There was no superiority of distraction with VR glasses over tell-show-do technique in reducing anxiety.
- There was no statistically significant difference between the groups in terms of pain perception after local anesthesia applications and dental procedures.

[1] Research Assistant, Department of Pedodontics, Faculty of Dentistry, Yıldırım Beyazıt University, Ankara, Türkiye
[2] Pyschological Counselor, Prof.Dr. Fuat Sezgin Secondary School, Adana, Türkiye
[3] Assistant Professor, Department of Pedodontics, Faculty of Dentistry, Yıldırım Beyazıt University, Ankara, Türkiye

Abstract

Aim: The aim of this study was to compare the effect of three-dimensional audio-visual distraction on reducing dental anxiety and pain perception in children with tell-show-do technique. **Methods:** 52 children aged 6-11 years were randomly divided into two groups (n=26). During restorative dental treatment, distraction was given to the study group by letting them watch cartoons with 3D virtual reality (VR) glasses, while tell-show-do technique was used in the control group. The anxiety levels of the children in both groups after dental treatment were measured with the Child Drawing: Hospital Scale (CD:H) and the Children`s Fear Survey Schedule-Dental Subscale (CFSS-DS). Pulse rate measurements were made with pulse oximetry before, during and after the dental procedures. In addition, perception of pain was evaluated with the Wong-Baker FACES Pain Rating Scale. **Results:** There was no statistically significant difference between the study and control groups in terms of anxiety levels, CFSS-DS scores, CD:H scores and pulse rate (P>0.05). Also, there was no statistically significant difference between the groups in terms of Wong Baker scores (P>0.05). **Conclusions:** Watching cartoons with 3D VR glasses did not show any superiority over tell-show-do technique in reducing anxiety and pain levels in children during dental restorative procedures.

Keywords: Anxiety; Child Behavior; Drawing; Pain Perception; Virtual Reality

Correspondence:
Department of Pedodontics, Faculty of Dentistry, Yıldırım Beyazıt University, Ankara, Türkiye
E-mail address:
cerentatli88@gmail.com

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INRODUCTION

Dental anxiety is defined as a cognitive and emotional reaction to a stimulus or experience related to dental treatment.[1] Although dental anxiety affects both adults and children, its prevalence in children and adolescents has been reported to be as high as 13.3%-29.3%.[2] Behaviors such as avoiding treatment, crying, refusing to open their mouths, and covering their faces have been observed in anxious pediatric patients during dental treatment.[3] Therefore, for anxious children, dental procedure requires the use of behavioral management techniques.

Pediatric dentists frequently use a variety of non-pharmacological behavioral management techniques, such as direct observation, "ask-tell-ask", memory reconstruction and positive reinforcement, to help manage an anxious child.[4] One of the most widely known and used behavioral management technique is "tell-show-do". This technique is based on keeping the child well informed and demonstrating exactly what will happen before any dental procedure is performed.[5] Another technique that can, like tell-show-do, be used in any child patient is distraction. Stories, the clinical setting, music and/or visual effects can all be used as distracters during dental procedures.[4] Audio-visual distraction provides a pleasant stimulus to two types of sensation, auditory and visual, while partially isolating the patient from potentially disturbing sounds and images in the clinical enviroment.[6]

There are three main types of measurement in the assessment of dental anxiety in children: psychometric scales, physiological measurements and projective techniques.[7] The Children`s Fear Survey Schedule-Dental Subscale (CFSS-DS) questionnaire is one of the most commonly used psychometric scales to assess dental anxiety in children aged 4-14 years.[8] Various physiological measurements, such as pulse rate, nerve activity and muscle activity, can enable the assessment of dental anxiety through real-time and continuous measurement at different stages of treatment.[9] In addition, drawings can be used to assess the emotional reactions of children. In 1999, Clatworthy et al.[10] developed Child Drawing: Hospital (CD:H) as a useful assessment method for subjectively measuring the anxiety of hospitalized children. In recent years, this method has been used in the evaluation of dental anxiety in the field of dentistry and has been validated in Turkish.[11] The advantages of the technique are that it is easy to apply and allows children to express their feelings subjectively and show the anxiety that they experience during dental treatment as it occurs.[10,12]

One of the most important causes of dental anxiety in children is the painful stimuli they experience during treatment.[13] Various measurement methods are used in the evaluation of dental pain. Among these, the Wong-Baker Facial Pain rating scale is one of the most frequently used in school-age children because it can be easily and quickly understood by them.[14]

Despite the fact that research has been conducted to assess the effectiveness of virtual reality (VR) glasses for behavioral management, none of these studies have examined anxiety with the CD:H.[15,16] The aim of this study was to evaluate and compare the anxiety and pain levels in pediatric patients who underwent dental restorative procedures using two different behavioral management techniques. The null hypotheses of the present study were as follows:

1. There would be no difference between the anxiety levels of children who were given tell-show-do and distraction with VR glasses as behavioral management techniques during restorative dental treatments.

2. These two behavioral management techniques would have no effect on pain perception levels after local anesthesia applications and restorative procedures.

METHODS

Ethical approval

Ethics committee approval was obtained from the Clinical Research Ethics Committee of Ankara Yıldırım Beyazıt University Yenimahalle Training and Research Hospital (No: E-2021-57). All clinical procedures were performed in accordance with the Declaration of Helsinki and Good Clinical Practice. After informing the patient and their parents about the study protocol, informed consent was obtained from the parents. The patients were included in the present prospective, randomized, open label study in accordance with the CONSORT (Consolidated Standards of Reporting Trials) statement.[17]

Patient selection

After doing a power analysis with 80% power and a 5% error level, it was decided that 52 patients (n=26) should be included in the study. The study included children aged 6 to 11 years who came to xxx Faculty of Dentistry Hospital Pediatric Dentistry clinic for routine examination and dental treatment. The inclusion criteria for children were as follows: 1) without any systemic/chronic disease or mental disorders 2) with no previous dental experience 3) with categories of III or IV according to the Frankl behaviour rating scale 4) who agreed to draw and 5) who required of LA administration in the mandibular arch (inferior alveolar block) for restorative treatments in primary second molars.

All patients with systemic/chronic disease or mental disorders, acute toothache, and refusing to draw were excluded. The enlisting, randomisation, allocation and completion of patients in groups are represented in the CONSORT flow diagram (Figure 1).

Study protocol

At the first visit, a topical fluoride application was applied to both groups in order to understand the Frankl behavioral scale scores. The children included in the study were divided into two groups using a simple randomization method (n=26).

Two different behavioral management techniques were applied to the two groups. While the study group watched cartoons with 3D VR glasses during the treatment, behavioral guidance was given to the control group before the treatment using tell-show-do technique. Ultracare benzocaine topical anesthetic spray (Ultradent Products Inc., USA) was applied for one minute to all children included in the study. Following this, Nervus Alveolaris inferior block anesthesia was performed with Ultracain D-S (articaine HCL: 40mg/ml + epinephrine HCL:0.006 mg/ml). Then, restorative treatments were performed on the lower primary second molars of the children (Imicryl Nova Compomer, Türkiye).

The children in the study group were shown cartoons through 3D VR glasses (Zore G06A VR Shinecon 3D virtual reality glasses, China). The children were told that they could choose whatever they wanted from three cartoon options “Spider Man”, “Sponge Bob” and “Frozen Cars” suitable for their age. For the children in the control group, the dental procedure and all the dental materials to be used were explained in detail with tell-show-do technique using statements suitable for their age, and the treatment procedure was begun after the explanation.

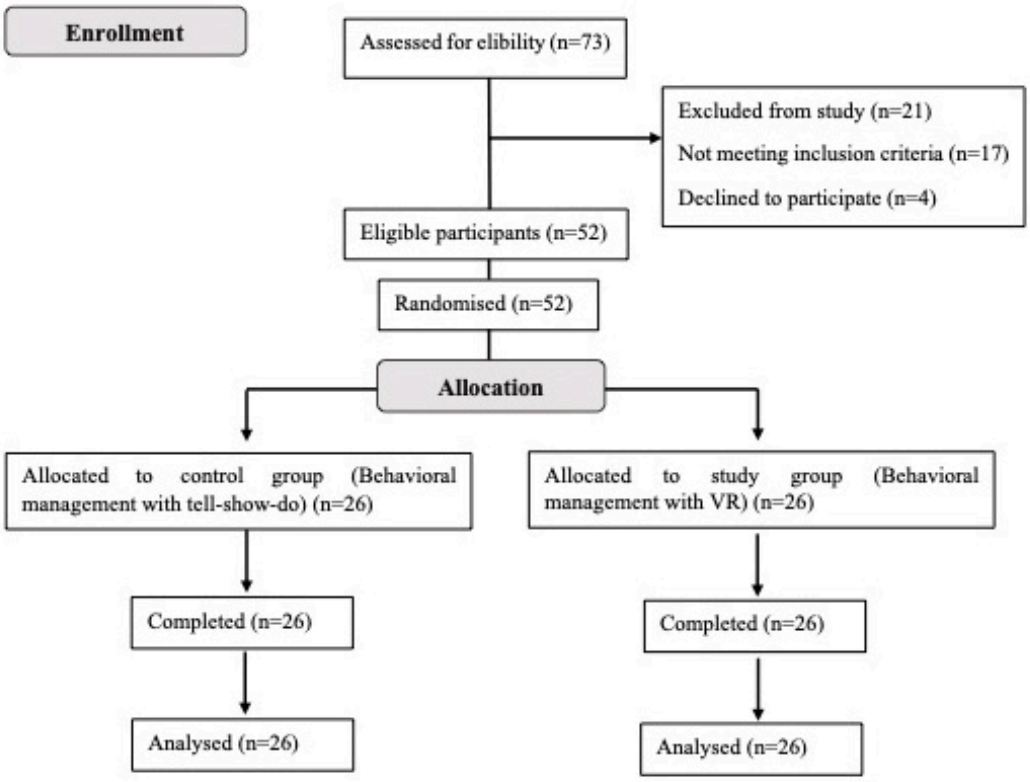

Figure 1. Flow diagram of the study

Assessment of anxiety level

The anxiety levels of the children in both groups were determined with CD:H and CFSS-DS after dental procedures; and pulse rate measurements before/during/after dental procedures.

1. For the CD:H application, after the completion of the dental treatments, the children were taken to a separate room and each child was given white paper and eight colored crayons and told "I want you to draw a picture of me and you, considering the time you spent here today and your dental treatment." If the children asked any questions, the command was repeated. The children' drawing sessions had no time limitations. All drawings were carried out under the supervision of the dentist who performed the study. After the completion of all the drawings in the study and control groups, the pictures were subsequently evaluated by an expert psychologist according to CD:H (E.D) (Figure 2,3).[11] This scale consisted of 3 subsections. After determining the individual scores of these sections, the anxiety levels of the children were determined with the total score obtained. The anxiety scores are divided into five categories: very low anxiety (≤43),low anxiety (44–83), average anxiety (84–129), above average anxiety (130-167),very high anxiety (≥168).

2. The CFSS-DS comprises fifteen questions about dental treatment and equipment. Each response is given a score between 1 ("I'm not afraid") and 5 ("I'm afraid"). The anxiety scores range from 15 to 75 and are divided into three categories: a low level of anxiety (15–31); a moderate level (32–38); and a high level (39). The Turkish version of the CFSS-DS has been established to be valid and reliable.[18] After the dental procedures, each child was asked to mark the appropriate option and the scales were filled.

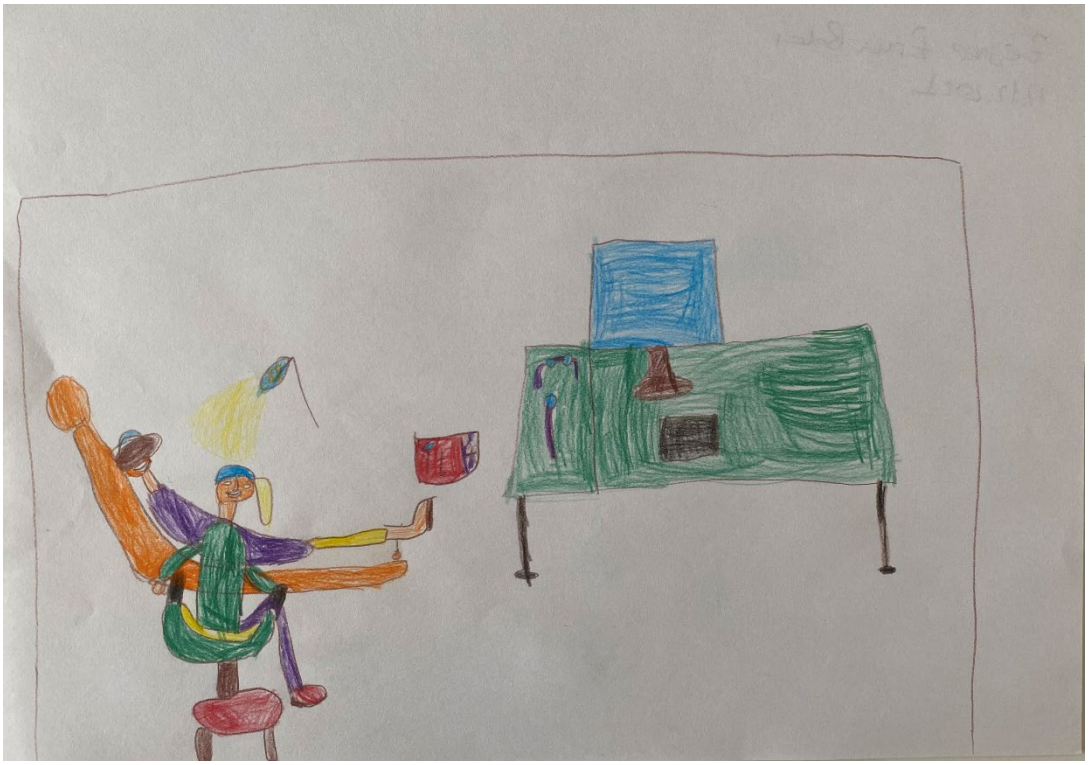

Figure 2. A representative picture drawn by a patient drawn in the study group after the dental restorative treatment

Figure 3. A representative picture drawn by a patient in the control group after the dental restorative treatment

3. Pulse rate measurements were recorded before, during and after the dental procedure by placing a pulse oximeter on the right index fingers of the patients.

Assessment of pain level

The Wong Baker FACES Pain Rating scale, which consists of six facial expressions evaluated from 0 to 10 according to the severity of the pain, was applied to children after local anesthesia applications and dental procedures. The child was asked to point out the face to which he/she could most relate in terms of the pain he/she felt. All clinical procedures were performed and measures were recorded by the same pediatric dentist (A.H.S).

Outcomes

I.Primary outcome measure considered was CD:H scores.

II.Secondary outcome measures considered were:

1. Child's response to CFSS-DS.
2. Physiological parameters—pulse rate.
3. Wong-Baker FACES Pain Rating Scale scores.

Statistical analysis

Data analysis was performed with IBM SPSS Statistics 25.0 program (IBM Corporation, Armonk, NY, USA). The Shapiro-Wilk test was used to determine whether the numerical variables were normally distributed, and the homogeneity of variances was investigated with the Levene test. Discrete numerical variables were expressed as mean ± standard deviation or median, while categorical variables were expressed as number of cases and %. The significance of the differences between the groups for normally distributed variables was evaluated with the Student's t test, and non-normally distributed variables was evaluated with Mann-Whitney U test. The results were considered statistically significant at $p<0.05$. However, in all possible multiple comparisons, Bonferroni correction was made to control the Type I error.

RESULTS

All the patients included in the study answered the questionnaires (CFSS-DS) and completed the drawings (for CD:H). The distribution of the patients in terms of mean age, gender and Frankl scale were found to be statistically similar between the study and control groups ($p>0.05$) (Table 1).

Comparisons between the groups in terms of pulse rate measurements are shown in Table 2. There was no statistically significant difference between the groups in terms of mean pulse rate level before, during and after the dental treatment ($p=0.145$; $p=0.673$ and $p=0.829$).

Table 1. Demographic characteristics of the patients according to the control and study groups

	Control (n=26)	Study (n=26)	P Values
Mean age (years)	7.2±1.2	6.8±1.0	0.179†
Sex	n (%)	n (%)	0.781‡
Girls	11 (42.3%)	13 (50.0%)	
Boys	15 (57.7%)	13 (50.0%)	
Frankl Scale	n (%)	n (%)	>0.999‡
III	11 (42.3%)	12 (46.2%)	
IV	15 (57.7%)	14 (53.8%)	

Data were expressed as mean±standard deviation or n (%). † Student's t test, ‡ $\chi 2$ test with continuity correction

Table 2. The pulse levels of the patients according to the groups and follow-up times

	Control (n=26)	Study (n=26)	P Values †
Before the precedure	97.8±13.0	93.1±9.8	0.145
During the precedure	101.2±16.1	99.4±15.2	0.673
After the precedure	93.1±12.0	92.5±9.5	0.829

Data were expressed as mean±standard deviation. † Student's t test.

There was no statistically significant difference between the study and control groups in terms of median CFSS-DS scores (p=0.614). The distribution of anxiety levels between the study and control groups in terms of the CFSS-DS scores were also statistically similar (p=0.422) (Table 3).

There was no statistically significant difference between the study and control groups in terms of the average CD:H scores (p=0.891). The distribution of anxiety levels between the study and control groups in terms of the CD:H were also found to be statistically similar (p=0.771) (Table 4). There was no statistically significant difference between the groups in terms of Wong Baker scores after anesthesia (p=0.434).

Although the Wong Baker scores decreased after dental procedure in the control group compared to after the application of local anesthesia, this change was not statistically significant (p=0.070). In the study group, there was a statistically significant decrease in the Wong Baker scores after dental procedure compared to after the application of local anesthesia (p=0.004). There was no statistically significant difference between the groups in terms of the Wong Baker scores after treatment (p=0.992). There was no statistically significant difference between the study and control groups in terms of the decrease in the Wong Baker scores after the procedure compared to after local anesthesia (p=0.293) (Table 5).

Table 3. CFSS-DS scores of the patients according to the groups

	Control (n=26)	Study (n=26)	P Values
CFSS-DS score	24.5 (19.7-31.2)	26.0 (19.7-34.0)	0.614†
CFSS-DS	n (%)	n (%)	0.422‡
Low anxiety	20 (76.9%)	19 (73.1%)	
Moderate anxiety	4 (15.4%)	2 (7.7%)	
High anxiety	2 (7.7%)	5 (19.2%)	

Data were expressed as median or n (%). † Mann Whitney U test, ‡ Fisher Freeman Halton test.

Table 4. Drawing hospital scores of patients according to study and control groups

	Control (n=26)	Study (n=26)	P Values
Drawing hospital score	78.8±13.8	78.2±19.8	0.891†
Anxiety level			0.771‡
Low	18 (69.2%)	16 (61.5%)	
Average	8 (30.8%)	10 (38.5%)	

Data were expressed as mean±standard deviation or n (%). † Student's t test, ‡ $\chi 2$ test with continuity correction

Table 5. Wong Baker scores of patients according to study and control groups and follow-up times

	After local anesthesia application	After the procedure	P values †	Change
Control (n=26)	4.0 (1.5-6.0)	0.0 (0.0-4.0)	0.070	-1.0 (-2.5 – 0.5)
Study (n=26)	4.0 (1.5-6.5)	2.0 (0.0-4.0)	0.004*	-2.0 (-6.0 – 0.0)
P values ‡	0.434	0.992		0.293

Data were expressed as median. † Comparisons between the follow-up times within the groups, Wilcoxon Sign test, and Bonferroni correction for P<0.025 were considered statistically significant. †† Comparisons between groups, Mann Whitney U test, and Bonferroni correction for P<0.025 were considered statistically significant. Comparisons between the change the results were considered statistically significant for P<0.05. *Statictically significant difference

DISCUSSION

Dental procedures are often a source of anxiety and stress in children, and because they lead to increased pain reactivity it is crucial to use specific interventions to distract these patients' attention from the treatment procedures. For many years, a wide range of behavioral management techniques have been tried and used for this purpose. One of these techniques is distraction with the use of VR glasses. Although there are studies evaluating the effectiveness of this technique on anxiety level and perception of pain, none of them used a projective method that allowed children to express their subjective experience, such as the CD:H scale. The purpose of using projective techniques is to determine the level of fear and anxiety by telling the story through pictures or by depicting objects or living things that may be the object of fear.[19] Drawing allows a child to easily express unwanted emotions such as fear and anxiety, as well as wishes, happiness, and their dreams for the future.[20] The CD:H was developed for this purpose and has recently been used in dentistry; it was chosen for present study because of these advantages. As a result, the success of using VR as a distraction in children was compared in the current study to tell-show-do technique, which is still considered the gold standard.

VR was originally only developed for its entertainment value. However, over the last 10 years its application has been expanded to various clinical areas, including pain management, particularly in pediatric patients.[21] It is a safe and noninvasive technique that requires no prior education or training and has the long-term effect of creating more positive memories of treatment, which leads to a greater willingness to return.[22] Due to all these advantages, the aim of the current study was to evaluate its effects on anxiety and perception of pain.

One of the strengths of this study was the use of a combination of physiological, psychometric and projective measures for anxiety, including pulse rate, CFSS-DS and CD:H, which makes anxiety assessment in children more comprehensive and efficient due to their cognitive immaturity. Although the hypothesis of the current study was that the use of VR glasses would reduce anxiety, whether there was a difference in anxiety levels between the study and control groups was

evaluated separately with the CD:H, the CFSS-DS and pulse levels, and it was determined through all of these measurements that the use of VR glasses was not more effective in reducing anxiety. The conclusions of earlier research on the subject are inconsistent. In the study conducted by Ran et al., [23] VR distraction and tell-show-do method were evaluated with the CFSS-DS and mean anxiety levels were found to be lower in the VR group. In another study, the effect of VR distraction on anxiety was comparatively evaluated with tell-show-do with pulse rate measurements; and it was determined that there was statistically significantly lower anxiety in VR group.[24] In addition, present study's results are not consistent with those of Shetty et al.,[25] Niharika et al.,[22] Rao et al.,[26] and Al-Khotani et al.[27] who concluded that VR had significant effect in reducing fear and anxiety of children. Their results were different from current study's findings, which may be attributed to the different study design, use of different equipment, assessment of anxiety level during a more invasive procedure, and different scales for assessment of anxiety.

On the other hand, many studies have concluded that the use of VR during dental procedures had no significant effect on behavior or anxiety, which is parallel with the findings of current study.[28-31] Based on the results of nine randomized clinical trials, it was concluded that distraction with VR at various stages of dental restorative treatments (during local anesthesia, use of rubber dam, removal of caries and restorative procedures) did not provide a significant superiority over traditional methods in terms of anxiety levels.[32] In another recent study in which children's anxiety levels were evaluated with the Venham picture test, no difference was found between the groups in terms of anxiety levels after tooth extraction.[33] These findings suggest that using tell-show-do with efficient verbal communication by a skilled operator can reduce the requirement for distraction devices. Ghadimi et al.[34] stated that the use of virtual reality during dental treatment had no significant effect on the child's behaviour. This situation was explained by the fact that children's expectations and negative emotions increased when they could not see or hear what was going on around them.[34,35] Since it was observed in the current study that the use of VR in the first appointment of children without dental treatment experience caused the children to feel discomfort due to the loss of communication with the outside world. Therefore, it was thought that the use of VR might be more successful in reducing the anxiety levels in the next appointment when the children were familiar with the dental procedures.

Dental procedures, particularly the administration of local anesthesia, are frequently a source of anxiety and stress in children, leading to an increase in reactivity to pain. As a result of the current study, a statistically significantly higher perception of pain was reported during local anesthesia in the VR group. It has been stated in previous studies that the use of VR glasses during local anesthesia injection and dental treatment reduces the perception of pain, and this has been explained as due to VR reducing the patient's physical experience of pain by shifting their attention from an unpleasant environment to a pleasant and immersive world.[15,23,25,36,37] On the contrary, no statistically significant difference was found in the current study between the groups in terms of perceptions of pain both after the administration of local anesthesia and the dental procedure. The current study's findings are similar to those of Zaidman et al.[38] and Palaz et al.[39] studies, who found no significant difference in the Wong-Baker FACES Pain Rating Scale while applying local anesthesia with and without VR glasses. In addition, in the studies of Bagattoni et al.,[40] it was stated that the use of VR during both local anesthesia and dental restorative procedures

was not superior in reducing the perception of pain, and that therefore VR cannot replace traditional behavioral management techniques.

This study has some limitations. Children who had prior dental treatment and exhibited negative/absolutely negative behavior were excluded from the study, and the exclusion criteria used to provide a homogeneous sample that may have affected the results. Although the VR device offered a new experience to the children, many children in the study group stated that they could not see what was being done due to the use of glasses in the first restorative procedure, and that they felt uneasy from time to time because they could not fully understand the procedure. This may have resulted in an insufficient reduction in anxiety levels in the children in the VR group.

CONCLUSIONS

No statistically significant difference was found between the VR distraction and tell-show-do in terms of anxiety levels and pain perceptions during dental restorative procedures in pediatric patients. The use of VR glasses was not found to be superior to the traditional method in terms of reducing anxiety and the perception of pain. However, because VR is an inexpensive, simple and effective behavioral management technique that does not require additional training, clinicians may prefer to use it as an alternative to traditional methods.

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