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Research Paper

Comparison of Effectiveness of Virtual Reality, Audio & TSD Distraction Techniques in Management of Anxiety in 6 to 12 year-old Children Undergoing Restorative Treatment

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Abstract
Background:
A successful pediatric dental practice requires a positive psychological environment for each child. Anxiety during dental treatment is a common concern, and distraction techniques have gained popularity as non-invasive behavior management strategies. Virtual Reality (VR) and audio distraction are novel techniques that offer engaging alternatives to traditional methods such as the Tell-Show-Do (TSD) technique.
Objective:
The objective of this study was to compare and evaluate the effectiveness of Virtual Reality (VR), Audio Distraction, and Tell-Show-Do (TSD) techniques in the management of anxiety among 6- to 12-year-old pediatric dental patients undergoing restorative treatment.
Methodology
This randomized controlled clinical study was conducted at the Department of Paediatric & Preventive Dentistry,MGDCH in Jaipur. It involved 30 children aged 6-12 years with at least one carious tooth and no prior dental treatment. The participants were randomly assigned to three groups: Virtual Reality Distraction (Group 1), Audio Distraction (Group 2), and Tell-Show-Do Distraction (Group 3, control). Anxiety levels were assessed using Venham's Clinical Anxiety Rating Scale (VCARS) and Facial Image Scale (FIS), while physiological measures like pulse rate were recorded before, during, and after the treatment by the same operator.
Results:
A statistically significant reduction in anxiety was observed in all three groups. However, the VR distraction group showed the greatest reduction in anxiety levels, followed by the Audio distraction group, while the TSD group exhibited the least reduction.
Conclusion:
Distraction techniques such as VR and audio are effective in reducing anxiety among pediatric dental patients. VR distraction proved to be the most effective method and may be recommended for routine pediatric dental care to enhance patient cooperation and comfort.

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I. Introduction

Dental anxiety is a common issue in children, often resulting in uncooperative behaviour, avoidance of necessary dental care, and the development of negative dental experiences that can persist into adulthood. To address this challenge, various behaviour management techniques have been utilized, including Tell-Show-Do (TSD), pharmacological sedation, and distraction methods. Among these, non-pharmacological approaches such as Virtual Reality (VR) and Audio Distraction (AD) have gained considerable attention due to their proven effectiveness and minimal side effects.

Virtual Reality (VR) distraction works by immersing children in a virtual world, effectively capturing their focus and diverting attention from the dental procedure, thereby alleviating anxiety. On the other hand, Audio

Distraction (AD), which typically involves calming music or engaging storytelling, has been shown to significantly reduce stress and anxiety during both medical and dental treatments. In contrast, the TSD technique, which gradually exposes children to the dental procedure while providing a clear explanation of each step, remains the traditional and widely used behaviour management strategy in pediatric dentistry.

The aim of this study was to evaluate and compare the effectiveness of VR, audio distraction, and the conventional TSD technique in reducing dental anxiety in children aged 6–12 years who were undergoing restorative dental treatments. The study seeks to identify which of these techniques offers the most effective means of alleviating anxiety, potentially improving the overall dental experience for young patients.

II. Methodology

This randomized controlled clinical study was conducted at the Department of Paediatric & Preventive Dentistry, MGDCH, Jaipur, with ethical approval granted by the Institutional Ethics Committee. The study aimed to assess the effectiveness of different distraction techniques in reducing dental anxiety among children. A total of 30 children, aged between 6 and 12 years, with at least one carious tooth and no prior dental visits or treatment history, were recruited for the study. These children were screened during routine dental checkups and selected based on the inclusion criteria.

The children were randomly assigned into three distinct groups, each consisting of 10 participants:

1. Group 1: Virtual Reality (VR) Distraction Group
2. Group 2: Audio Distraction Group
3. Group 3: Tell-Show-Do (TSD) Distraction Group (Control)

The same experienced dental operator performed the procedures for all participants to minimize variability in treatment administration. Anxiety levels of the children were measured both before and after the dental procedure using two different scales: Venham's Clinical Anxiety Rating Scale (VCARS) and the Facial Image Scale (FIS). These tools provided valuable insights into the children's emotional state during the dental procedure.

Participants & Inclusion Criteria:

- Children aged 6–12 years requiring restorative treatment.
- No prior dental treatment history.
- No neurological disorders or severe behavioural issues (Frankl score 1 excluded).
- No visual or auditory impairments.

Exclusion Criteria:

- Children with neurological disorders or severe behavioural issues (Frankl score 1 excluded).
- Children with visual or auditory impairments.
- Children with a history of allergic reactions to dental materials.
- Children with acute dental infections or medical conditions that may interfere with the dental procedure.
- Children undergoing treatment for any chronic illness that could affect their response to the study.
- Children who were unable to understand or cooperate with the study procedures due to developmental delays or language barriers.

In addition to the traditional anxiety assessment, physiological measures were taken to gauge stress levels, such as pulse rate, which was recorded before, during, and after the procedure. This helped to provide a comprehensive view of the physiological impact of each distraction technique on the children.

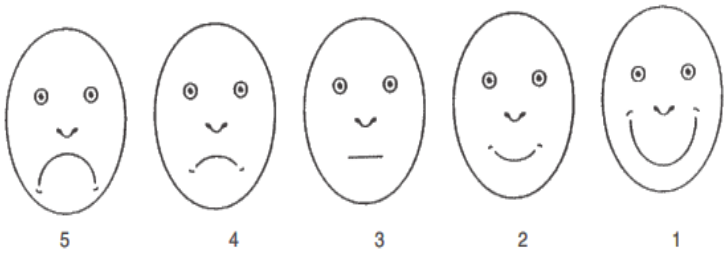
Assessment of Anxiety:

- Venham's Clinical Anxiety Rating Scale (VCARS) – A behavioural rating scale used to assess anxiety before and after treatment. (see table no. 1)

Score	Definition
0	Total cooperation. Best possible working conditions, no crying or physical protest.
1	Mild, soft verbal protest or (quiet) crying as a signal of discomfort, but does not obstruct progress. Appropriate behavior for procedure, i.e., slight start at injection, "ow" during drilling if hurting, etc.
2	Protest more prominent. Both crying and hand signals. May move head around making it hard to administer treatment. Protest more distracting and troublesome. However, child still complies with request to cooperate.
3	Protest presents real problem to dentist. Complies with demands reluctantly, requiring extra effort by dentist. Body movement.
4	Protest disrupts procedure, requires that all of the dentist's attention be directed toward the child's behavior. Compliance eventually achieved after considerable effort by dentist, but without actual physical restraint. May require holding child's hands or other parts of the body to start treatment. More prominent body movement.
5	General protest, no compliance, or cooperation. Physical restraint is required.

Table no. 1- Venham's Clinical Anxiety Rating Scale (VCARS)

- Facial Image Scale (FIS) – A subjective assessment tool where children chose images that represented their anxiety levels before and after treatment.(Figure no. 1)



Facial Image Scale (FIS).

Figure no.1- Facial Image Scale

- Physiological Measure: Pulse rate was recorded before, during, and after treatment using a pulse oximeter.

In the Virtual Reality (VR) Distraction Group (Group no.1,see Figure -no. 2) each child was immersed in a virtual environment(using JioDive VR Headset) where their favourite cartoon was displayed. This personalized approach was designed to capture their attention and divert it from the dental procedure, utilizing the engaging and entertaining nature of cartoons that resonate with the children's preferences. By being absorbed in a familiar and enjoyable visual experience, it was hoped that their anxiety would be significantly reduced during the treatment.

For the Audio Distraction Group (Group no.2), (see Figure no.3) children were provided with storytelling content(using noise cancelling wireless earphones) that was carefully selected based on their individual preferences. The stories were crafted to match their favorite genres, such as adventure, fantasy, or other types of narratives that appealed to each child. This personalized storytelling approach helped make the experience more

relatable and engaging, as it catered to the child's specific interests, thereby increasing the effectiveness of the distraction technique.

In the Tell-Show-Do (TSD) Distraction Group (Group no. 3), the standard pediatric dental technique was used. The process involved three steps: Tell—explaining the procedure in simple terms to the child; Show—demonstrating the dental tools to familiarize the child; and Do—performing the dental treatment while ensuring the child remained calm and comfortable.

A) B)

Figure no. 2 (A & B) – Virtual Reality Distraction method

Figure no. 3 – Audio Distraction method

III. Results

All three groups showed a significant reduction in anxiety post-treatment ($p < 0.05$).The VR distraction group had the greatest reduction in anxiety scores, followed by the audio distraction group, while the TSD group exhibited the least reduction. Pulse rate measurements correlated with subjective anxiety assessments, with the highest reductions observed in the VR group. The difference between the VR and TSD groups was statistically significant ($p < 0.01$).

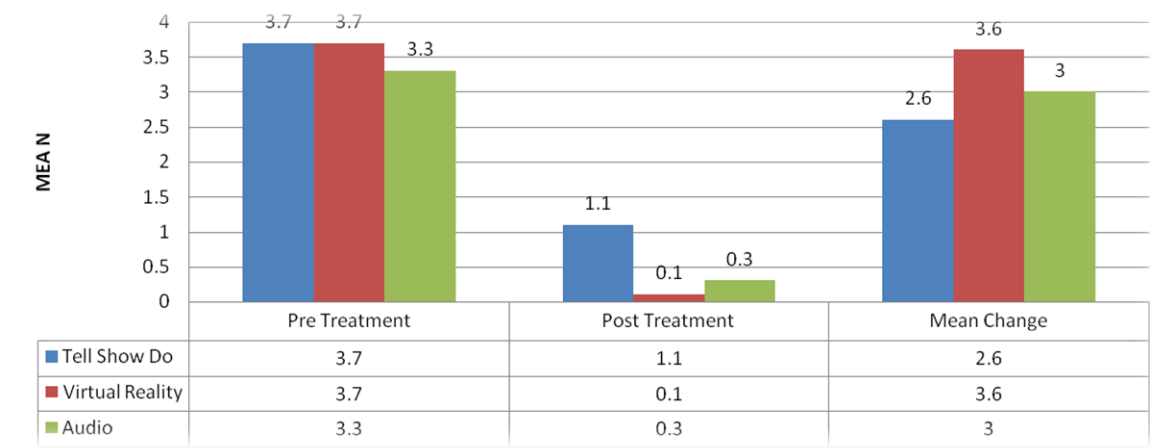
INTERGROUP COMPARISON OF THREE TECHNIQUES FOR MEAN CHANGE IN VCARS

The mean VCARS score at the pre treatment level was 3.70±0.483 in TSD Group, 3.70±0.483 in the Virtual Reality Group and 3.30±0.483 in the audio group. At the post treatment level the mean VCARS score was 1.100±0.737 in TSD Group, 0.100±0.316 in the Virtual Reality Group and 0.300±0.421in the audio group . The mean change from the pre treatment to post treatment levels was highest in the Virtual Reality Group (3.600±0.516) followed by Audio Group (3.000±0.567) and least in the TSD Group (2.600±0.697). The difference between the TSD and Virtual Realty , Virtual Reality and Audio was statistically significant whereas difference between Audio and TSD was statistically non-significant

	Pre Treatment	Post Treatment	Mean Change	F value	P value
Tell Show Do	3.70±0.483	1.100±0.737	2.600±0.697	6.659	0.004
Virtual Reality	3.70±0.483	0.100±0.316	3.600±0.516		
Audio	3.30±0.483	0.300±0.421	3.000±0.567		

Post Hoc Analysis

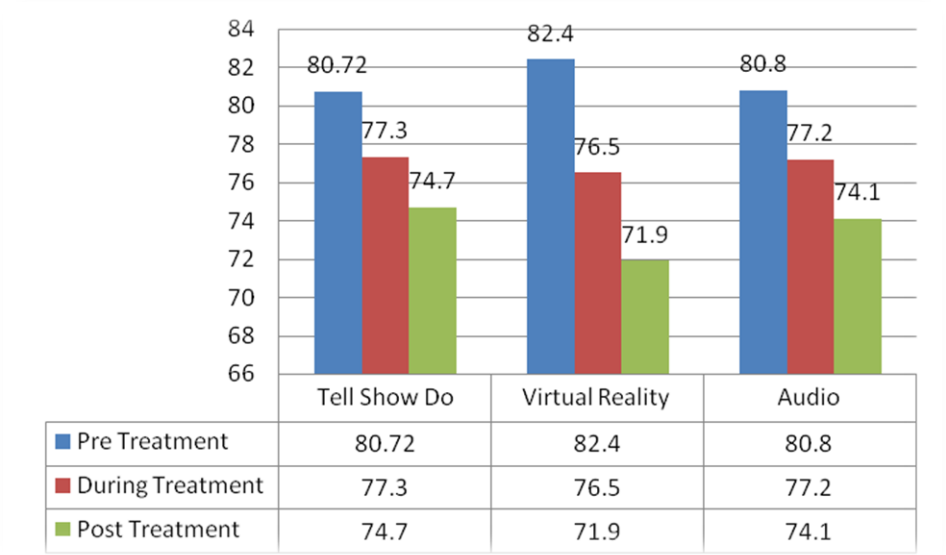
		Mean Change	Std Error	P value
Tell Show Do	Virtual Reality	-1.00	0.268	0.001
Tell Show Do	Audio	-0.400	0.268	0.079
Virtual Reality	Audio	0.600	0.268	0.043



INTRAGROUP COMPARISON OF CHANGE IN PULSE RATE FROM PRE INTERVENTION TO DURING INTERVENTION TO POST INTERVENTION LEVELS IN THREE GROUPS

The mean pulse rate at the pre treatment level was 80.70±2.79 in TSD Group, 82.40±3.56 in the Virtual Reality Group and 80.80±2.20 in the audio group. At the during treatment level the mean pulse rate score was 77.30±1.63 in TSD Group, 76.50±1.08 in the Virtual Reality Group and 77.20±2.39 in the audio group. At the post treatment level the mean pulse rate score was 74.70±1.71 in TSD Group, 71.90±0.89 in the Virtual Reality Group and 74.10±2.18 in the audio group. The intra group change from pre to post treatment level was statistically significant

	Pre Treatment	During Treatment	Post Treatment	Pre to During Treatment	Pre to Post Treatment
Tell Show Do	80.70±2.79	77.30±1.63	74.70±1.71	0.001 (Sig)	0.001 (Sig)
Virtual Reality	82.40±3.56	76.50±1.08	71.90±0.89	0.001 (Sig)	0.001 (Sig)
Audio	80.80±2.20	77.20±2.39	74.10±2.18	0.001 (Sig)	0.001 (Sig)



	Tell Show Do	Virtual Reality	Audio
Pre Treatment	80.72	82.4	80.8
During Treatment	77.3	76.5	77.2
Post Treatment	74.7	71.9	74.1

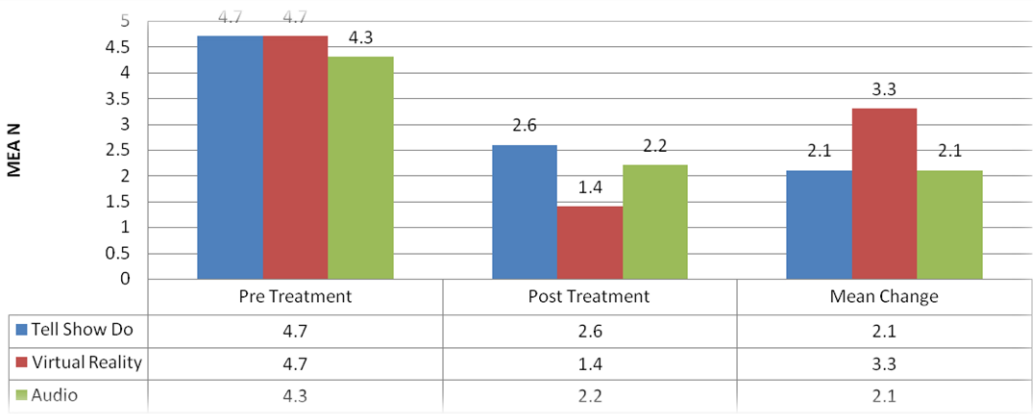
INTERGROUP COMPARISON OF THREE TECHNIQUES FOR MEAN CHANGE IN FSI

The mean FSI score at the pre treatment level was 4.70±0.483 in TSD Group, 4.70±0.483 in the Virtual Reality Group and 4.30±0.483 in the audio group. At the post treatment level the mean FSI score was 2.60±0.699 in TSD Group, 1.40±0.516 in the Virtual Reality Group and 2.20±0.421 in the audio group . The mean change from the pre treatment to post treatment levels was highest in the Virtual Reality Group (3.30±0.675) followed by Audio Group (2.10±0.567) and least in the TSD Group (2.10±0.994). The difference between the TSD and Virtual Realty , Virtual Reality and Audio was statistically significant whereas difference between Audio and TSD was statistically non-significant

	Pre Treatment	Post Treatment	Mean Change	F value	P value
Tell Show Do	4.70±0.483	2.60±0.699	2.10±0.994	8.151	0.002
Virtual Reality	4.70±0.483	1.40±0.516	3.30±0.675		
Audio	4.30±0.483	2.20±0.421	2.10±0.567		

Post Hoc Analysis

		Mean Change	Std Error	P value
Tell Show Do	Virtual Reality	-1.20	0.193	0.001 (Sig)
Tell Show Do	Audio	-0.00	0.193	1.000 (Non-Sig)
Virtual Reality	Audio	1.200	0.193	0.001 (Sig)



	Pre Treatment	Post Treatment	Mean Change
Tell Show Do	4.7	2.6	2.1
Virtual Reality	4.7	1.4	3.3
Audio	4.3	2.2	2.1

IV. Discussion

In this research, we compared the effectiveness of VR , Audio and TSD Distraction techniques in Management of Anxiety in Children Undergoing Restorative Treatment. Anxiety levels before and after the treatment procedure was assessed subjectively with FIS, VCARS and objectively with pulse rate. Studies by Messer et al (1977), confirmed that the physiological changes occur in the body as a result of dental anxiety. The

physiological changes like variation in pulse rate or oxygen saturation are very useful for measuring anxiety level in a patient.

The results of the present study confirm that use of VR distraction is an effective technique in decreasing anxiety level of children. Similar results were concluded in studies done by Weiderhold et al and Sullivan et al.

Virtual Reality distraction engages multiple senses, making it more immersive and engaging for children. It can captivate both the visual and auditory senses simultaneously, creating a more compelling distraction than audio alone. Research shows that multi-sensory experiences can be more effective in reducing anxiety and improving patient comfort (R. M. Sanders et al., 2016).

According to studies by Prabhakar et al. and Khandelwal et al., audio distraction was less effective when compared to audio video (AV) distraction which is in accordance with our study.

Audio distraction involved listening to their favourite cartoon episodes/audio stories but was not as effective as VR method due to lack of visuals. Audio distraction may not be sufficient for children who experience severe dental anxiety or have specific phobias related to dental procedures. Similar results were reported in the study conducted by Haugland & Sørensen in 2006.

Whereas, VR distraction can help occupy the child's cognitive resources more effectively by providing engaging visual content due to which children are less likely to focus on the dental procedure and more likely to be immersed in the distraction. This cognitive load diversion is more substantial with both visual and auditory input compared to auditory input alone (H. K. Choi et al., 2017).

On the other hand ,TSD technique remains the most commonly used technique in pediatric dentistry. The technique incorporates verbal explanations of procedures, appropriate to the developmental level of child (Tell); demonstrations of the procedure (Show); and then, reproducing the procedure in real time (Do). Following TSD technique, the treatment must be performed immediately according to Kreinces et al ,which is also followed in the current study.

So, the overall results revealed by all the parameters indicated that children were most relaxed in VR group, followed by audio group and were least relaxed in TSD group during dental visits. The benefits in VR group may be related to more immersive images in VR system. Also, the VR headset will block out real world sensory inputs from dental settings. The child's attention will be focused on the virtual world rather than the treatment settings. These observations were similar to the study conducted by Wismeijer et al ,2005 ; Kassem & Chahal, 2021.

V. Conclusion

- The mean reduction in the VCARS score, Pulse rate and FIS score form pre treatment to post treatment level was highest in the Virtual Reality Group followed by Audio Group and least in the Tell show do Group .
- Addressing anxiety in paediatric dentistry is essential for creating a positive dental experience and fostering better oral health habits in children.
- Hence VR distraction can be considered as a useful technique for behavior management of pediatric patients during a conventional dental treatment.

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