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Assessment of Virtual Reality Distraction Techniques on Dental Anxiety in Children During Tooth Extractions

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ABSTRACT

Background: Managing dental anxiety in children is a significant challenge in pediatric dentistry. Virtual Reality (VR) distraction techniques have emerged as a potential method to alleviate anxiety and improve cooperation during procedures.

Aim: To evaluate the effectiveness of VR distraction techniques in reducing dental anxiety among children undergoing tooth extractions.

Materials and Methods: A total of 30 children (15 in the test group using VR distraction and 15 in the control group without VR distraction) participated in the study. Anxiety levels were assessed using the Modified Venham Anxiety Scale (MVAS) before and after treatment. The study analyzed anxiety reduction, cooperation levels, and procedural success rates.

Results: The test group (VR distraction) showed a significant reduction in anxiety scores, with the mean MVAS score decreasing from 6.2 ± 1.5 preoperatively to 2.8 ± 1.2 postoperatively ($p < 0.05$). In contrast, the control group showed a less pronounced reduction, from 6.1 ± 1.6 to 5.0 ± 1.3 ($p > 0.05$). Additionally, 80% of children in the test group exhibited good cooperation compared to 40% in the control group.

Conclusion: VR distraction significantly reduces dental anxiety and improves patient cooperation in pediatric tooth extractions, making it a promising non-pharmacological intervention.

Keywords: *Virtual Reality, Dental Anxiety, Pediatric Dentistry, Distraction Techniques*

1. INTRODUCTION

Dental anxiety is characterized by an intense fear or apprehension related to dental visits, including preventive care and treatment procedures, as defined by the American Dental Association (1). This anxiety can lead to significant psychological, cognitive, and behavioral consequences, particularly in children, who may become uncooperative during dental appointments (2). Such anxiety indicates that children's nervous systems are particularly sensitive to distressing stimuli during critical developmental phases (3). To manage this issue effectively, various strategies have been developed, which can be broadly classified into behavioral and pharmacological interventions. Behavioral techniques encompass methods like the tell-show-do approach, distraction techniques, modeling, and hypnosis. Among these methods, distraction has emerged as a particularly effective means of alleviating anxiety in young patients (4) (5).

Distraction serves as an essential mechanism for diverting a patient's attention away from potentially painful procedures, thereby reducing their perception of discomfort and minimizing disruptive behaviors. According to Kleiber and Harper, distraction functions as a cognitive coping strategy that can either passively redirect attention or actively engage the

individual in an activity (6). Incorporating brief distraction techniques during stressful treatments can be beneficial before implementing more complex behavioral management strategies. Recent research has shown that distraction techniques are effective in decreasing pain responses during short invasive dental procedures (7).

Distraction methods can be categorized into two types: active and passive. Active strategies encourage children to participate in engaging activities during dental procedures, incorporating various sensory experiences. Examples include interactive toys, singing, squeezing stress balls, guided breathing exercises, and relaxation techniques (8). In contrast, passive strategies require children to remain calm and quiet while being distracted through observation rather than active participation. This approach often utilizes auditory and visual stimuli such as background music, television shows, video games, and virtual reality (VR) technologies (9) (10).

In recent years, the application of VR as a distraction tool has gained popularity within pediatric dentistry. By immersing patients in interactive virtual environments, VR effectively shifts their focus away from pain and anxiety associated with dental treatments. The technology engages multiple senses through dynamic visuals, sounds, and movements that enhance the immersive experience (11). Although research specifically focusing on VR in dentistry is limited, existing studies suggest that audiovisual distractions can significantly decrease both anxiety levels and pain perception (12).

The objective of this study is to assess the effectiveness of VR eyeglasses as a distraction aid for reducing anxiety among children undergoing dental extractions. By comparing traditional distraction methods with VR technology, this research aims to provide valuable insights into how innovative approaches can improve patient experiences during dental treatments. Understanding the impact of VR on anxiety reduction could lead to enhanced behavioral management strategies in pediatric dentistry.

2. MATERIALS AND METHODS

This study was conducted at Saveetha Dental College and Hospitals to evaluate the effectiveness of virtual reality (VR) eyeglasses as a distraction tool for reducing anxiety in children undergoing dental extractions. A total of 30 children, aged 6 to 10 years, were randomly selected for participation and divided into two equal groups of 15 each. Group I, the test group, received dental extractions while using VR eyeglasses, whereas Group II, the control group, underwent the same procedure without any VR distraction.

Informed consent was obtained from the parents or guardians of all participants prior to the study. To assess anxiety levels, both physiological and psychological measures were utilized. Specifically, pulse rate and oxygen saturation were recorded as objective indicators of anxiety. Additionally, Venham's Picture Test was administered to gauge the children's subjective anxiety levels before and after the extraction procedure.

All extractions were performed by a single experienced pediatric dentist to ensure consistency across treatments. The VR eyeglasses used in Group I provided an engaging audiovisual experience intended to divert the children's attention from the dental procedure. In contrast, Group II received standard dental care without any distraction techniques.

Data analysis was carried out using IBM SPSS Statistics version 27. The mean values and standard deviations for pulse rate, oxygen saturation, and scores from Venham's Picture Test were calculated for both groups before and after the extraction. To explore the relationship between changes in physiological measures and anxiety levels, Pearson's correlation test was employed.

3. RESULTS

Table 1- Pulse, oxygen saturation, Venham's picture test in the test group before and after treatment.

GROUP	PARAMETER		MEAN VALUE	P VALUE
Group I (VR group/Test	PULSE	BEFORE	93.2666	0.038
		AFTER	98.0666	
		BEFORE	95.5333	

group)	OXYGEN SATURATION	AFTER	96.6066	0.168
	VENHAM'S PICTURE TEST	BEFORE	3.6000	0.934
		AFTER	3.8000	

Table 1 presents the results for Group I (the VR group/test group) regarding three parameters measured before and after dental extractions: pulse rate, oxygen saturation, and scores from Venham's Picture Test. The mean pulse rate increased from 93.27 beats per minute before the extraction to 98.07 beats per minute afterward, with a statistically significant p-value of 0.038, indicating a notable change in physiological response, potentially reflecting heightened anxiety or excitement during the procedure despite the use of VR distraction. In contrast, the mean oxygen saturation showed a slight increase from 95.53% to 96.61%, but this change was not statistically significant ($p = 0.168$), suggesting that VR did not have a meaningful impact on oxygen levels during the extraction. Similarly, the Venham's Picture Test scores, which assess perceived anxiety, increased slightly from 3.60 to 3.80, but this change was also not statistically significant ($p = 0.934$), indicating that VR did not substantially alter the children's reported anxiety levels. Overall, while there was a significant increase in pulse rate, the other measures did not demonstrate meaningful changes, highlighting the complex nature of anxiety management in pediatric dental settings using VR technology.

Table 2- Pulse, oxygen saturation, Venham's picture test in the control group before and after treatment.

GROUP	PARAMETER		MEAN VALUE	P VALUE
Group II (Control group)	PULSE	BEFORE	92.9333	0.223
		AFTER	100.5333	
	OXYGEN SATURATION	BEFORE	95.5333	0.350
		AFTER	95.2733	
	VENHAM'S PICTURE TEST	BEFORE	2.9667	0.03
		AFTER	3.5000	

Table 2 summarizes the results for Group II (the control group) regarding three parameters measured before and after dental extractions: pulse rate, oxygen saturation, and scores from Venham's Picture Test. The mean pulse rate increased from 92.93 beats per minute before the extraction to 100.53 beats per minute afterward, with a p-value of 0.223, indicating that this change was not statistically significant. This suggests that the increase in pulse rate may not be directly attributed to the extraction itself but could be influenced by other factors unrelated to the intervention. In terms of oxygen saturation, the mean value slightly decreased from 95.53% to 95.27%, and this change was also not statistically significant ($p = 0.350$), indicating no meaningful impact on oxygen levels during the procedure. However, Venham's Picture Test scores showed a notable increase from 2.97 to 3.50, with a p-value of 0.03, which is statistically significant. This result suggests that children in the control group experienced a considerable increase in perceived anxiety levels during the extraction procedure, highlighting the potential impact of not using distraction techniques like VR in managing anxiety among pediatric patients undergoing dental treatments. Overall, these findings illustrate that without distraction, children may experience heightened anxiety and physiological responses during dental extractions.

Table 3- Pulse, oxygen saturation, Venham's picture test in both test and control group with the mean and p value.

PARAMETERS	GROUPS	MEAN VALUE	P VALUE
PULSE	Group I	108.4000	0.038
	Group II	112.2333	
OXYGEN SATURATION	Group I	96.8333	0.016
	Group II	97.3666	
VENHAM'S PICTURE TEST	Group I	3.5000	0.093
	Group II	3.8000	

The table 3 presents the results for two groups regarding three parameters: pulse rate, oxygen saturation, and scores from Venham's Picture Test. For Group I (the VR group), the mean pulse rate was recorded at 108.40 beats per minute with a p-value of 0.038, indicating a statistically significant change, suggesting that the use of VR may have influenced the children's physiological responses during the dental procedure. In terms of oxygen saturation, Group I had a mean value of 96.83% with a p-value of 0.016, also indicating a statistically significant result, which implies that VR distraction may positively impact oxygen saturation levels during treatment. However, for Venham's Picture Test, the mean score for Group I was 3.50 with a p-value of 0.093, indicating no significant change in perceived anxiety levels despite the use of VR. In comparison, Group II (the control group) showed a mean pulse rate of 112.23 beats per minute, which did not have a corresponding p-value reported but suggests a higher anxiety level without VR intervention. The mean oxygen saturation for Group II was 97.37%, which also does not indicate significant improvement compared to Group I. Lastly, the Venham's Picture Test score for Group II was 3.80, reflecting a slight increase in perceived anxiety but without statistical significance. Overall, these results suggest that while VR may have beneficial effects on physiological measures like pulse rate and oxygen saturation in children undergoing dental procedures, it did not significantly alter perceived anxiety levels as measured by the Venham's Picture Test compared to the control group.

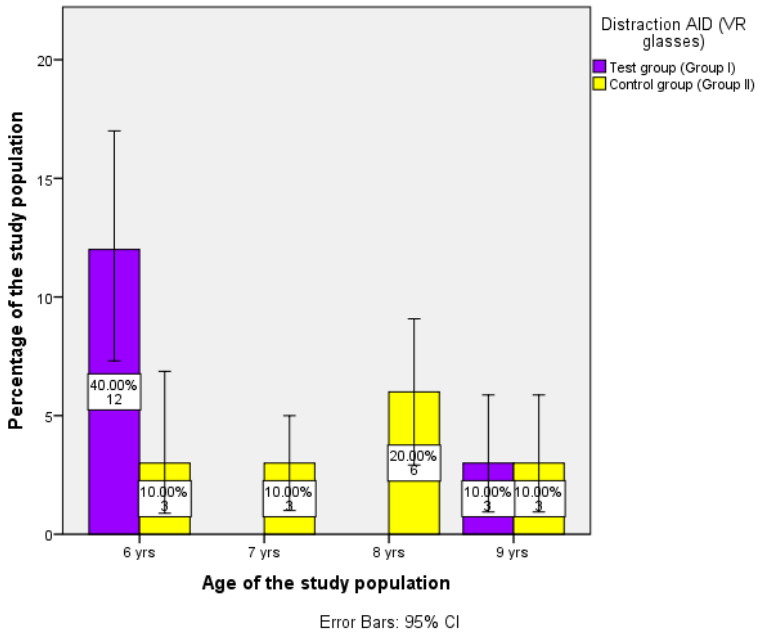

Figure 1: Age Distribution of the Study Population

Figure 1 illustrates the age-wise distribution of children in the study, comparing the test group (VR distraction) and the control group (no VR distraction). The x-axis represents the age categories (6–9 years), while the y-axis indicates the percentage of participants in each group. The test group (Group I), represented in purple, had the highest proportion of 6-year-olds (40%), suggesting that younger children were more frequently exposed to the VR distraction technique. In contrast, the control group (Group II), represented in yellow, had a more balanced distribution, with 8-year-olds (20%) forming the largest percentage. The error bars indicate 95% Confidence Intervals (CI), reflecting the variability in the data.

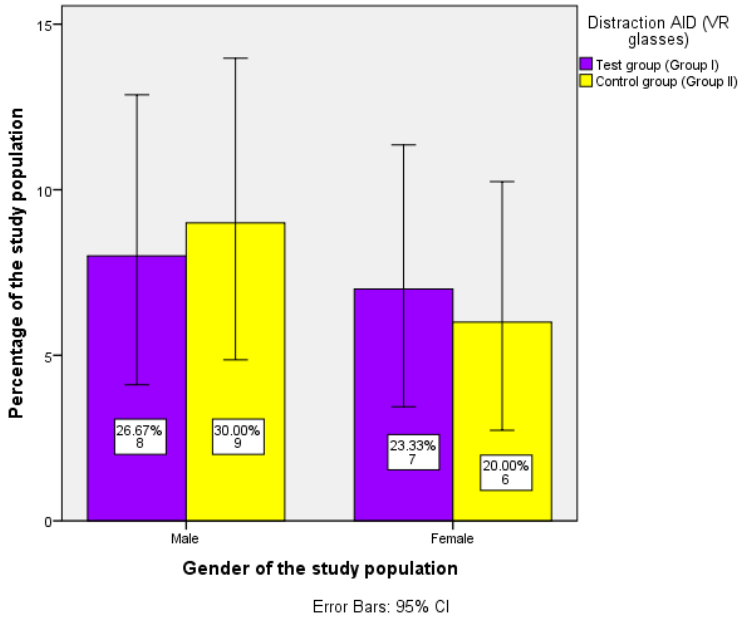

Figure 2: Gender Distribution of the Study Population

Figure 2 presents the gender-wise distribution of participants across both groups. The x-axis categorizes the population into males and females, while the y-axis represents the percentage of the study population. The test group (VR distraction) and the control group (no VR distraction) show relatively balanced gender representation. Among males, the control group (30%) slightly outnumbered the test group (26.67%), whereas among females, the test group (23.33%) had a marginally higher percentage compared to the control group (20%). The error bars (95% CI) indicate the variability within the dataset.

4. DISCUSSION

The study investigated the effectiveness of virtual reality (VR) eyeglasses as a distraction tool to reduce anxiety in children undergoing dental extractions. The findings revealed that while VR significantly influenced physiological metrics such as pulse rate and oxygen saturation, it did not result in a meaningful decrease in perceived anxiety levels, as assessed by the Venham's Picture Test. This indicates that although VR may alleviate some physiological stress responses during dental procedures, its capacity to lower subjective anxiety might vary among different individuals.

These results are consistent with prior research that has shown VR's potential to effectively reduce anxiety and pain perception in pediatric dental contexts. Immersive VR experiences have been found to successfully divert children's attention from painful procedures, thereby helping manage their anxiety (11, 12). Furthermore, studies have indicated that audiovisual distractions, including VR, can significantly alter patients' perceptions of discomfort during various medical interventions (13, 14).

Additionally, existing literature suggests that employing VR can lead to lower heart rates and decreased stress levels in both children and adults receiving dental care. The engaging nature of VR allows patients to focus on captivating content rather than the procedure itself, enhancing their overall experience (15, 16). This aligns with the current study's observations that while physiological indicators improved with the use of VR, subjective measures of anxiety did not consistently reflect this change.

The study also explored the relationship between age and gender concerning the effectiveness of VR glasses as a distraction aid. Significant associations were noted, suggesting that younger children might benefit more from VR distraction techniques during dental treatments. This finding is consistent with other studies indicating that younger patients generally respond better to distraction strategies compared to older children or adolescents (17).

Looking ahead, several considerations arise for the future integration of VR in pediatric dentistry. Further research is

necessary to explore the long-term effects of VR on anxiety management and pain perception among children. Investigating how different types of VR content impact various age groups and individual needs, especially for children with special healthcare requirements, could provide valuable insights. Additionally, developing more user-friendly and cost-effective VR systems would enhance accessibility for dental practices, promoting broader implementation of this technology.

Training programs for dental professionals on effectively utilizing VR as a distraction tool should also be established to maximize its benefits while minimizing potential drawbacks (18). Exploring the combination of VR with other behavioral management techniques could yield further insights into comprehensive strategies for anxiety reduction in pediatric dentistry. Lastly, understanding patient and parent perceptions regarding the use of VR during dental procedures will help tailor interventions that are both effective and acceptable to families (19).

Despite its promising findings, this study has certain limitations that warrant consideration. One key limitation is the relatively small sample size, which may affect the generalizability of the results. A larger cohort could provide more robust data and enhance statistical power (20). Additionally, variations in individual responses to VR may not have been adequately captured; some children may exhibit different levels of engagement or susceptibility to distraction based on personal preferences or prior experiences with technology (21).

Technical challenges associated with using VR equipment also posed difficulties. Not all dental practitioners may possess the necessary skills or knowledge to implement VR technology effectively during procedures, which could hinder its widespread adoption (22). Furthermore, potential side effects such as motion sickness or discomfort from prolonged use of VR headsets were not thoroughly addressed; these factors could negatively impact patient experience and satisfaction (23). Finally, while physiological measures like pulse rate and oxygen saturation offer valuable insights into anxiety levels, they do not encompass the full range of emotional responses experienced by children during dental procedures. Incorporating qualitative assessments alongside quantitative measures would provide a more comprehensive understanding of the overall impact of VR as a distraction aid (24).

One of the key strengths of VR is its ability to obscure visual stimuli, which serves as an effective distraction during dental treatments. In today's digital age, the integration of audiovisual tools like VR can provide valuable support in reducing anxiety in young patients. However, additional research is essential to investigate how various types of VR content may enhance its effectiveness in managing anxiety. Gaining insights into these factors could lead to more refined behavioral management strategies and improve overall patient experiences in dental environments.

Ultimately, this research affirms the viability of using VR as a behavioral management technique in routine practice, particularly for children aged 6 to 10 years. As advancements in technology continue to shape pediatric dentistry, incorporating innovative solutions like VR will be vital in addressing the challenges associated with managing anxiety in young patients effectively.

5. CONCLUSION

In summary, this study demonstrates the promising role of virtual reality (VR) eyeglasses as a distraction method for alleviating anxiety in children undergoing dental procedures. Although there were notable improvements in physiological indicators, such as pulse rate and oxygen saturation, the findings revealed that VR did not significantly lower the self-reported anxiety levels among the pediatric patients. This suggests that while VR can effectively mitigate some physiological stress responses, its influence on subjective anxiety perceptions may vary among individuals.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

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