

EFFECTIVENESS OF VIRTUAL REALITY DISTRACTION IN REDUCING PAIN AND ANXIETY IN PEDIATRIC DENTAL PATIENTS: A CLINICAL STUDY

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ABSTRACT

Background: Managing anxiety and pain in pediatric dental patients remains a major challenge. Virtual Reality (VR) has emerged as a non-pharmacological behavioral management tool.

Aim: To evaluate the effectiveness of VR distraction in reducing pain perception and anxiety in children undergoing dental procedures.

Materials and Methods: A randomized controlled study was conducted on 60 children aged 6–10 years requiring restorative dental treatment. Participants were divided into two groups: Control (no VR) and VR group. Pain was assessed using the Visual Analog Scale (VAS), and anxiety was measured using pulse rate and Frankl Behavior Rating Scale.

Results: The VR group showed significantly lower pain and anxiety scores compared to the control group ($p < 0.05$).

Conclusion: VR distraction is an effective, non-invasive technique for behavior management in pediatric dentistry.

KEYWORDS: Virtual Reality, Pediatric Dentistry, Anxiety, Pain Management, Behavior Guidance

INTRODUCTION

Pediatric dentistry often presents unique challenges, primarily due to fear, anxiety, and pain perception in young patients. Dental anxiety in children can arise from previous negative experiences, fear of the unknown, or the intimidating clinical environment. (1) This anxiety not only affects the child's behavior during treatment but can also lead to avoidance of dental care, ultimately compromising oral health outcomes. (2)

Effective behavior management is therefore a cornerstone of pediatric dental practice. Conventional non-pharmacological techniques such as tell-show-do, positive reinforcement, and distraction have been widely used to manage anxious children. (3) While these methods are effective to some extent, they may not always be sufficient, especially in highly anxious or uncooperative patients. Pharmacological approaches, including sedation, carry their own risks and limitations, highlighting the need for safer and more engaging alternatives. (4)

In recent years, technological advancements have introduced innovative tools for behavior guidance, among which Virtual Reality (VR) has gained significant attention. VR creates an immersive, computer-generated environment that engages multiple sensory modalities, including vision and hearing. (4,5) By transporting the child into a virtual world, VR effectively diverts attention away from the dental procedure, thereby reducing the perception of pain and anxiety. The mechanism underlying VR distraction is based on the cognitive-affective model of pain, where attention plays a crucial role in pain perception. By occupying the brain with engaging stimuli, VR limits the processing of nociceptive signals, resulting in decreased discomfort. (4–6) Several studies have demonstrated the effectiveness of VR in medical and dental settings, showing improvements in patient cooperation, reduced anxiety levels, and enhanced overall treatment experience.

Furthermore, the incorporation of Virtual Reality into pediatric dental practice aligns with the ongoing shift toward patient-centered care, where enhancing the overall experience is as important as delivering clinical outcomes. Children today are highly familiar with digital technologies, making VR an appealing and acceptable intervention. (7) Its ability to transform a potentially stressful dental visit into an engaging and even enjoyable experience may positively influence a child's attitude toward future dental care. Thus, exploring VR not only as a tool for immediate anxiety and pain reduction but also as a means to build long-term positive dental behavior is of significant clinical relevance. (7,8)

Despite its growing popularity, the application of VR in pediatric dentistry is still evolving, and further clinical evidence is required to establish its effectiveness and feasibility in routine practice. Therefore, this study aims to evaluate the role of Virtual Reality as a behavioral management tool in reducing pain and anxiety among pediatric dental patients, and to assess its potential integration into everyday clinical settings. The aim of this study is to evaluate the effectiveness of VR distraction in reducing pain perception and anxiety in children undergoing dental procedures.

MATERIALS AND METHODS

This randomized controlled clinical study was conducted in the Department of Pediatric and Preventive Dentistry to evaluate the effectiveness of virtual reality distraction in children. A total of 60 healthy children aged 6–10 years requiring restorative dental treatment were selected. Ethical clearance was obtained from the institutional review board, and informed consent was secured from parents or guardians. Children with prior negative dental experiences, systemic illnesses, or sensory impairments were excluded. Participants were randomly allocated into two groups: Group I (control) received conventional behavior management, while Group II (VR group) received treatment with a virtual reality headset for distraction.

Before the procedure, baseline anxiety levels were recorded using pulse rate measurements and the Frankl Behavior Rating Scale. In the VR group, children were introduced to the VR headset and allowed to choose age-appropriate audiovisual content to ensure comfort and familiarity. During the dental procedure, the headset was worn continuously, providing immersive distraction. In contrast, the control group underwent treatment using conventional non-pharmacological techniques such as tell-show-do and verbal reassurance. All procedures were performed by the same operator to minimize variability, and the clinical environment was kept consistent for both groups.

Pain perception was assessed immediately after the procedure using the Visual Analog Scale (VAS). Postoperative anxiety was evaluated again using pulse rate and behavioral responses. The collected data were tabulated and subjected to statistical analysis using appropriate software. An independent t-test was used to compare mean values between the two groups, while paired tests assessed intra-group differences. A p-value of less than 0.05 was considered statistically significant. The results were presented in tables and graphs to facilitate comparison and interpretation of findings.

RESULTS

The present study evaluated the effectiveness of virtual reality (VR) distraction in reducing pain and anxiety among pediatric dental patients. A total of 60 children were included and equally divided into control and VR groups. All participants completed the study without any dropouts, and the data obtained were statistically analyzed. The findings demonstrated a clear difference between the two groups in terms of pain perception and anxiety levels.

From figure 1 the mean pain scores, assessed using the Visual Analog Scale (VAS), were significantly lower in the VR group compared to the control group. The control group exhibited a mean pain score of **6.8**, whereas the VR group showed a reduced mean score of **3.2**, indicating a substantial decrease in perceived pain. This reduction was found to be statistically significant ($p < 0.05$), suggesting that VR distraction effectively minimizes pain during dental procedures

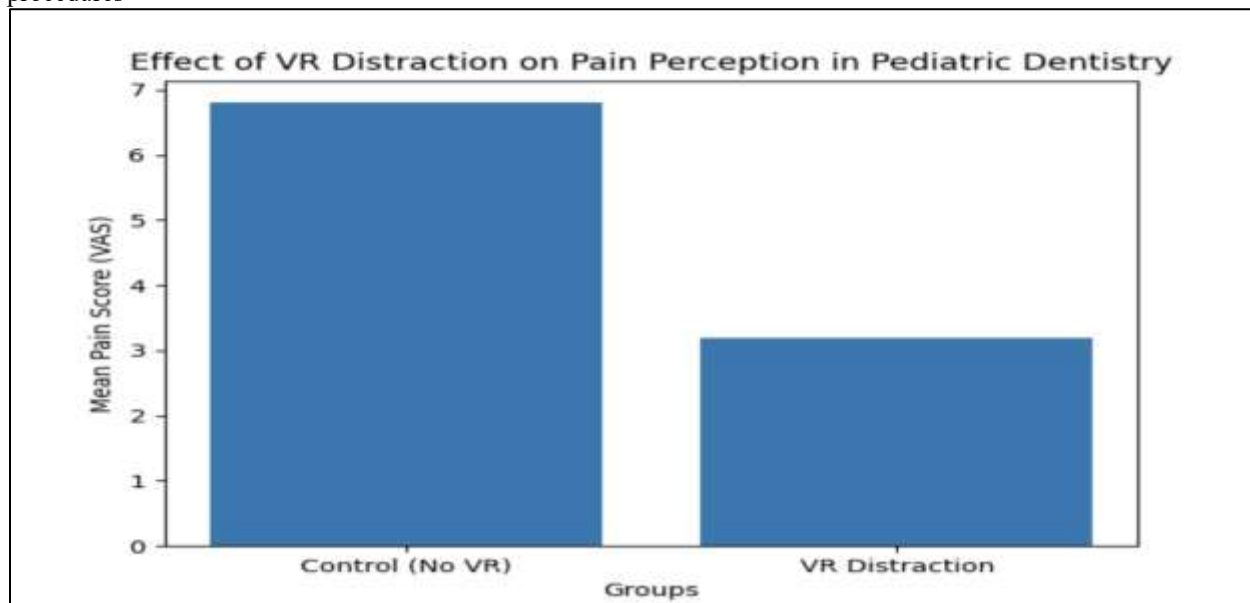


Figure 1: Effect of VR Distraction on Pain Perception

From figure 2 we can infer that Anxiety levels were assessed using pulse rate measurements and behavioral analysis. The mean pulse rate in the control group was recorded at **98 bpm**, while the VR group demonstrated a lower mean pulse rate of **82 bpm**, indicating reduced physiological anxiety. The difference between the two groups was statistically significant ($p < 0.05$), supporting the role of VR in alleviating anxiety during dental treatment.

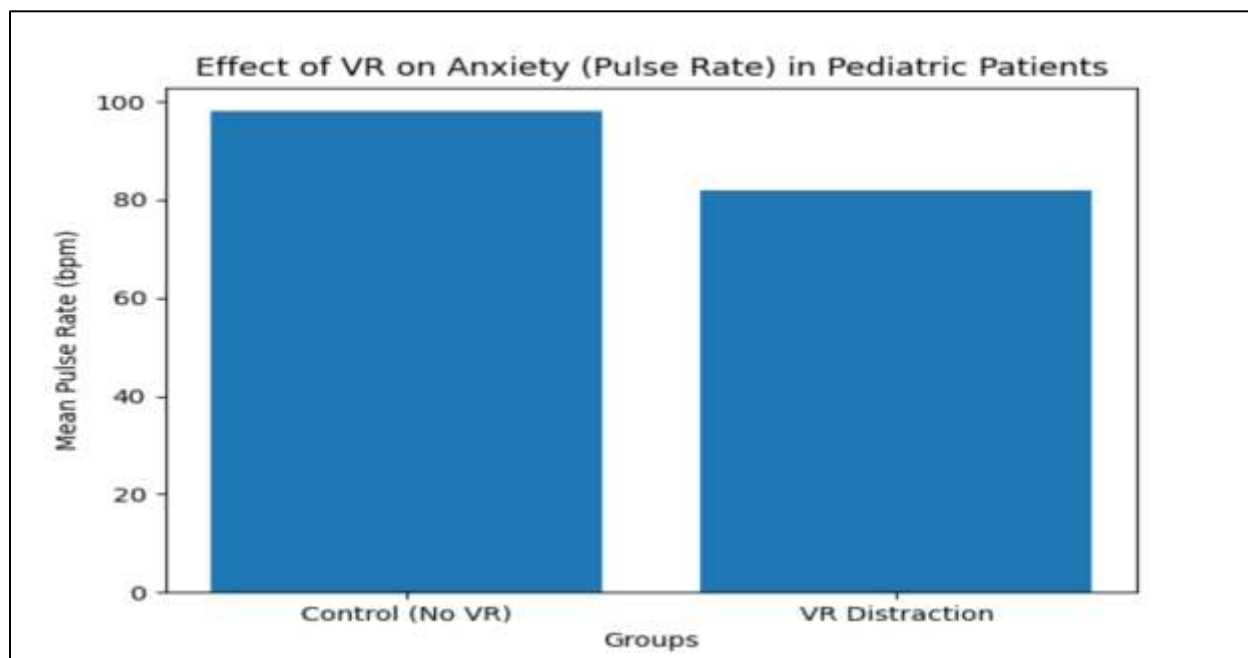


Figure 2: Effect of VR on Anxiety (Pulse Rate)

Behavioral responses, evaluated using the Frankl Behavior Rating Scale, further reinforced these findings. A higher proportion of children in the VR group exhibited positive and definitely positive behavior (Frankl ratings 3 and 4), whereas the control group showed more negative and hesitant responses. This indicates improved cooperation and comfort levels among children exposed to VR distraction.

Overall, the results of the study clearly demonstrate that virtual reality distraction significantly reduces both pain perception and anxiety levels in pediatric dental patients. The combination of lower VAS scores, reduced pulse rates, and improved behavioral ratings highlights VR as an effective non-pharmacological behavior management tool in pediatric dentistry.

DISCUSSION

The present study evaluated the effectiveness of virtual reality (VR) distraction in reducing pain and anxiety among pediatric dental patients. The findings demonstrated a significant reduction in both pain perception and anxiety levels in children exposed to VR compared to those receiving conventional behavior management.(9) These results support the growing body of evidence that immersive distraction techniques can positively influence a child's dental experience. By engaging multiple sensory pathways, VR effectively diverts attention away from the procedure, thereby minimizing discomfort and improving cooperation. This highlights the potential of VR as a valuable adjunct in pediatric dental practice.(10)

The reduction in pain scores observed in this study can be explained by the cognitive-affective model of pain, where attention plays a crucial role in modulating pain perception. VR creates an immersive environment that competes with nociceptive stimuli, thereby limiting the brain's ability to process pain signals. (11)This mechanism is consistent with previous studies that have reported similar reductions in pain using audiovisual distraction techniques. Compared to traditional methods such as music or cartoons, VR offers a more engaging and immersive experience, making it particularly effective in younger patients who are more responsive to visual stimuli.(11,12)

Anxiety reduction, as evidenced by lower pulse rates and improved Frankl behavior scores, further supports the effectiveness of VR in pediatric dentistry. Dental anxiety is a significant barrier to successful treatment in children, often leading to uncooperative behavior and avoidance of care. (13)The calming and engaging nature of VR helps to alleviate fear by creating a sense of detachment from the clinical environment. This not only improves the child's immediate experience but also has the potential to foster positive dental attitudes, which are essential for long-term oral health maintenance.(13,14)

Despite its advantages, the use of VR in dental practice is not without limitations. Factors such as the cost of equipment, the need for proper sterilization, and occasional side effects like motion sickness must be considered. (15) Additionally, not all children may adapt easily to VR technology, particularly those who are very young or have sensory sensitivities. The study was also limited by its relatively small sample size and short-term evaluation, which may affect the generalizability of the findings. Further large-scale studies are recommended to validate these results and explore long-term outcomes (15,16).

In conclusion, the findings of this study suggest that VR distraction is an effective, non-invasive, and innovative tool for managing pain and anxiety in pediatric dental patients. Its ability to enhance patient cooperation and improve the overall treatment experience makes it a promising addition to conventional behavior management techniques. With further advancements and increased accessibility, VR has the potential to become a routine part of pediatric dental care, contributing to improved clinical outcomes and patient satisfaction.

CONCLUSION

The present study demonstrates that virtual reality (VR) distraction is an effective non-pharmacological technique for reducing pain and anxiety in pediatric dental patients. Children exposed to VR during dental procedures exhibited significantly lower pain scores, reduced physiological anxiety, and improved behavioral responses compared to those managed with conventional methods. These findings highlight the ability of VR to create an immersive and engaging environment that diverts attention away from dental stimuli, thereby enhancing patient comfort and cooperation during treatment.

Within the limitations of the study, VR can be considered a promising adjunct to traditional behavior management techniques in pediatric dentistry. Its ease of use, non-invasive nature, and positive impact on patient experience make it a valuable addition to clinical practice. However, further large-scale studies are recommended to evaluate its long-term effectiveness, cost-efficiency, and applicability across diverse pediatric populations. With continued advancements in technology, VR has the potential to play a significant role in improving the quality of pediatric dental care.

Future Scope

Future research should focus on larger, multicentric trials to validate the effectiveness and generalizability of virtual reality (VR) in pediatric dentistry across diverse populations. Long-term studies are needed to assess its impact on children's dental attitudes and behavior over time. Additionally, advancements in VR technology, including integration with artificial intelligence and biofeedback systems, may further enhance its effectiveness by personalizing the experience for each patient. Exploring its application in special healthcare needs for children and more invasive procedures could expand its clinical utility. Cost-effectiveness analyses and development of standardized protocols will also be essential for its widespread adoption in routine dental practice.

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