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(REVIEW ARTICLE)

The use of Virtual Reality (VR) technology in the management of dental pain and anxiety: A study on fifty children in Nakhchivan city and A comprehensive review

Ali Manghabati * and Haniyeh Ghaderi

Dental student of the Republic of Azerbaijan, Nakhchivan State University.

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Abstract

Objective: This study critically examines the efficacy of virtual reality (VR) technology in alleviating pain and anxiety during dental treatments; however, it places particular emphasis on a practical experiment conducted with children in Children's hospital of Nakhchivan city, alongside a review of prevailing literature. Methods: The research encompasses two primary components: (1) an experimental study involving 50 children aged 10–12 at Nakhchivan Children's Hospital (who were undergoing tooth extraction). The children were systematically divided into two groups; one utilized VR tools, while the other engaged in traditional distraction methods (such as animation and toys). Their anxiety and cooperation levels were meticulously assessed using a standardized 10-point scale. (2) A comprehensive review of 12 clinical studies derived from six major databases, encompassing 1,522 participants aged 0–60, investigated the impact of VR on pain and anxiety during dental procedures. Although the initial findings are promising, further research is warranted because of the variability in results across studies. This suggests a nuanced understanding of VR's role in clinical settings is necessary.

The empirical investigation elucidated that 64% of children employing VR experienced minimal or negligible discomfort, in contrast to 37% within the traditional distraction cohort. VR also elicited superior cooperation metrics across five behavioral parameters. The comprehensive review corroborated these observations, demonstrating substantial diminutions in pain and anxiety among individuals utilizing VR. For instance, VR diminished pain indices from 7.2 to 1.2 in a singular study, while concurrently alleviating anxiety levels in both adults and children subjected to various dental interventions.

Discussion: VR manifests considerable potential as a non-pharmacological instrument for enhancing patient cooperation and mitigating dental pain and anxiety—particularly among children and those predisposed to anxiety. However, obstacles such as equipment expenditures, requisite training protocols and constrained personalization alternatives necessitate resolution.

Conclusion: Virtual reality proffers a promising and innovative paradigm for the management of dental pain and anxiety. Further inquiry and advancements in technology are imperative to broaden its accessibility and efficacy within clinical environments.

Keywords: Pain; Anxiety; Dentistry; Virtual Reality; Children; Adults; Distraction

1. Introduction

Pain and anxiety in dental treatments are major challenges faced by both patients and dentists. Many patients avoid going to the dentist due to the fear of pain or anxiety caused by the treatment, which leads to the exacerbation of oral

* Corresponding author: Ali Manghabati

and dental problems. Traditional methods of anxiety management and pain reduction include pharmaceutical methods such as local anesthesia, sedatives, and even general anesthesia, as well as non-pharmacological methods such as behavioral and distraction techniques. However, these methods have limitations and require new and more efficient methods.

Virtual reality (VR) as a new technology has gradually opened its place in various fields of medicine, including dentistry. By creating interactive and immersive 3D environments, this technology enables patients to be separated from the real world and transported to a relaxing virtual world. The main purpose of this article is to investigate the effects of virtual reality on pain and anxiety management in dental treatments.

2. Methodology

The study was based on two factors: experimental tests and a comprehensive review of past articles. In this research, our statistical population was 50 children aged 10 to 12 years old in the children's hospital of Nakhchivan, who needed anesthesia for tooth extraction during pre-orthodontic treatment, and the fear and anxiety caused by the anesthetic needle caused no cooperation with the dentist. Do not have 25 children were tested with anima and children's toys. This test is based on. The changes of five criteria, each criterion was given two points, and a total of ten points were given to each child. The facial expression of laughter and satisfaction accord and the g to the test of a child who scores at least 6 or higher is considered as an acceptable effect of that test.

In the second part, a comprehensive review of the articles published between 2000 and 2023 was done. Information sources included six valid databases (Cochrane Oral Health's Trials Register, Cochrane Central Register of Controlled Trials (Central), MEDLINE (PubMed), EMBASE, Scopus, and Web of Science). The search was performed using keywords related to virtual reality, dental treatment, pain, and anxiety. The inclusion criteria included studies tFurmanvestigated the use of virtual reality in the management of pain and anxiety in patients aged 0 to 60 undergoing dental treatment.

3. Results

Results of experimental studies , The results of the tests that were conducted on fifty children of Nakhchivan Children's Hospital in the first test that included the use of 25 children were tested using animation and children's toys. Out of these 25, 8 children cooperated with the doctor due to distraction by playing with animation and toys and creating d, distraction reduces fear and anxiety and improves mood. And chin children's behavior and pain were reduced. In the second experiment, 25 children cooperated with the virtual reality tool to play children's anime at a much higher speed, and this relief caused distraction reduced anxiety and fear, and improved moods. The pain of these children was reduced according to the evaluation based on the scale of complete cooperation out of 10. The virtual reality test was 10 out of 10 and the animation and toy test was 4. On the other hand, after the treatment, the children were asked a common question about the amount of pain, which was found in 8 children on the first test. 37% had felt a little pain, and the rest felt moderate or high pain. In the second test, 64% of the 25 children felt little or no pain, and the rest felt moderate pain.

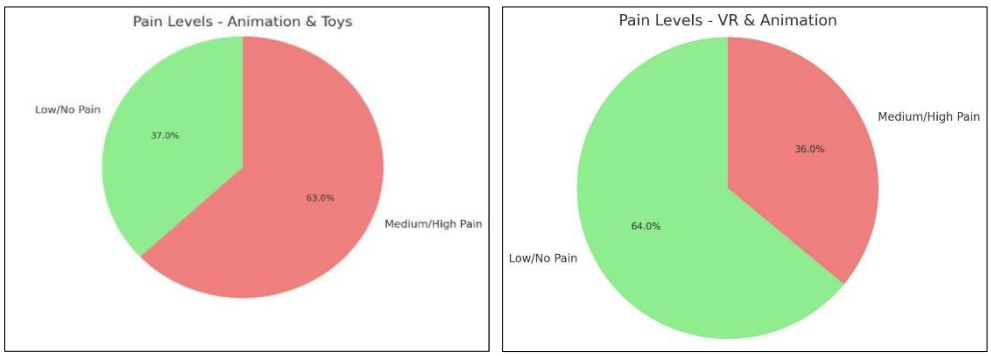

Figure 1 Pie chart In the first test (animation and toys), 37% of the children felt little pain, while 63% felt moderate or high pain

In the second trial (VR), 64% of children had little or no pain, indicating significant improvement in pain reduction.

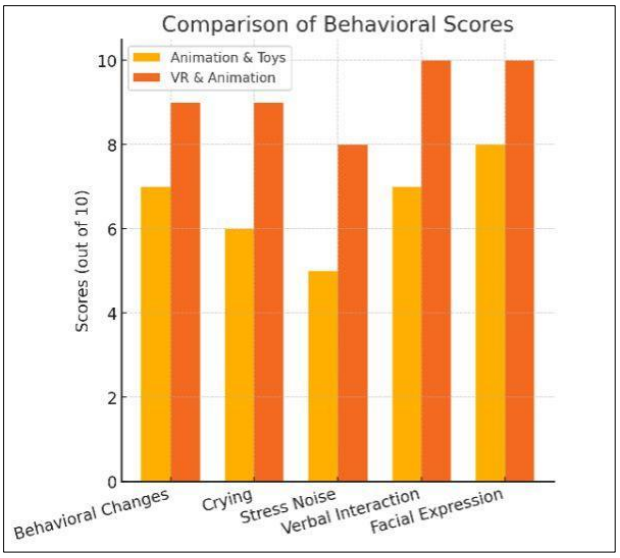

Figure 2 The bar chart shows that in all five criteria, the virtual reality (VR) test scored higher than the animation and children's toys test. This indicates the greater effectiveness of VR in improving cooperation and reducing children's anxiety

3.1. The effect of virtual reality on pain reduction

Several studies have shown the positive effect of virtual reality on reducing pain caused by dental treatments. For example:

Hoffman et al.'s study investigated whether immersive virtual reality can act as an effective non-pharmacological pain reliever for dental pain; in this study, patients undergoing periodontal treatment using virtual reality reported a significant reduction in their pain scores. Pain scores in the no-distraction condition were 7.2, while they decreased to 1.2 in the virtual reality use condition.{1}

Alshatrat et al.'s studies also showed that the mean pain scores when using virtual reality were significantly lower than those without using it, on average 1.76 versus 3.95. 7.8{2}{3}

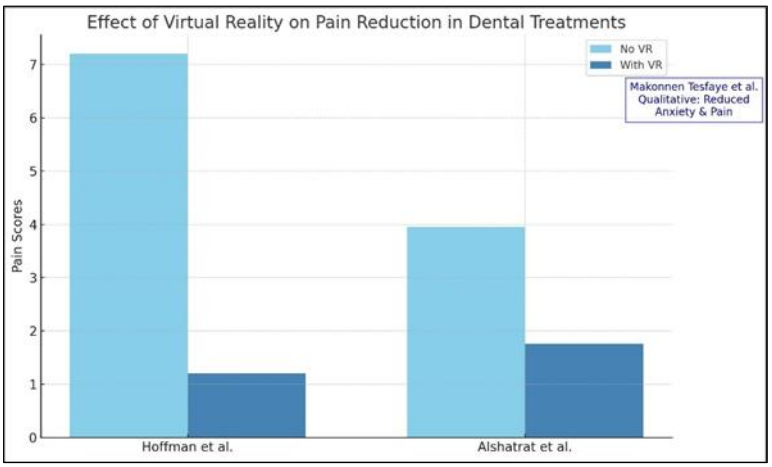

Figure 3 Bar chart comparing the quantitative results of the pain level in the researches reviewed by Hoffman et al. and the studies of Alshetrat et al., with annotations summarizing the qualitative findings of Makonnen Tesfaye et al

Essete Makonnen Tesfaye and colleagues study Dental anxiety is common after stroke, and many patients are unable to receive standard anesthetics. This study included two patients with a history of stroke and dental anxiety in a specialized dental clinic. Patients d 360-degree virtual reality videos in the dental chair using a head-mounted display. Finally, both patients used virtual reality during the procedure and reported that the device was comfortable, distracting, and had the potential to reduce anxiety/pain. {4}

3.2. The effect of virtual reality on reducing anxiety

Anxiety associated with dental treatments is another common problem that can affect the patient experience. Studies have shown that virtual reality can significantly reduce patients' anxiety:

This study examines the effects of virtual reality (VR) and artificial intelligence (AI) on the anxiety and behavior of people with mental disabilities during dental treatments. The study, conducted in Saudi Arabia, included 90 resident women with varying degrees of intellectual disability. Findings show that VR and AI interventions significantly reduce anxiety levels, - {5}

A comprehensive review by Fan et al. (2023) examines the efficacy of virtual reality (VR) as a distraction technique in managing dental pain and anxiety during treatment. This study combines data from 22 clinical studies involving 1,522 patients aged 0 to 60 years, and of these studies, 8 and 14 included adult and pediatric patients, respectively. They emphasize the field of dental treatment. VR is an innovative pain and anxiety management approach that helps dental treatment patients immerse themselves in a virtual world while using distractions to reduce pain and anxiety.{6}

study of Anna Ledwon and her colleagues, the effectiveness of virtual reality (VR) as a distraction tool to reduce anxiety in adult dental patients is examined. Naturalization is a significant barrier to receiving care that often leads to poor oral health. The research included 90 adult participants who were divided into three groups: two experimental groups that included visits and a control group that received traditional treatment. The results showed that patients exposed to VR showed a significant decrease in heart rate and stress levels, as well as lower anxiety scores than the control group.

This method included physiological measurements (heart rate, satiety, and stress levels) and psychological assessments (Modified Dental Anxiety Scale and Trait State Anxiety Questionnaire). This study demonstrated that VR distraction effectively reduces physiological stress and anxiety during dental procedures, demonstrating its potential as a valuable tool in the management of dental anxiety. {7}

In a study, the effect of using virtual reality glass (VRG) in the dental waiting room on reducing anxiety and improving the behavior of children aged 7 to 12 years during dental treatment was investigated. In this trial, 60 children were randomly divided into two intervention groups (VRG) and control. Anxiety was assessed with the MCDAS f scale and behavior with the FBRS scale. The results of the analysis showed that VRG significantly reduced anxiety and improved children's behavior. This method can help facilitate children's dental treatment. {8}

In a study that included 120 seven- to ten-year-old children, the classification was such that 60 children were placed in EG and 60 in CG, who were treated for tooth extraction and tooth extraction at the children's dental clinic. Data collection tools included the children's fear scale and the child's anxiety state scale. Data were analyzed using Chi-square, t-test, Shapiro-Wilk, mean, and percentage distribution.

The evaluations conducted by the researcher and the children indicated a statistically significant difference between the experimental and control groups in terms of their average scores of anxiety and fear following teething and tooth extraction treatment ($p<0.001$). After tooth extraction and extraction treatment, it was found that children in EG had lower average scores of anxiety and fear than children in CG.{9}

Furman et al.'s study investigated the analgesic effect of virtual reality (VR) compared to video viewing and control conditions during periodontal scaling and root planing (SRP). 38 patients were examined in three different treatment conditions (control, film, and VR). Pain and discomfort were assessed by visual analog scale (VAS), blood pressure (BP), and pulse rate (PR). {10}

3.3. The findings of Furmen et al s study

3.3.1. The mean VAS scores for the control, film, and VR conditions were 3.95, 2.57, and 1.76, respectively.

VAS, BP, and PR scores in VR conditions were significantly, ly lower than in the other two conditions ($P < 0.001$).

Most patients preferred the VR condition. VR can be used as an effective method to reduce pain and discomfort in periodontal treatments.{10}

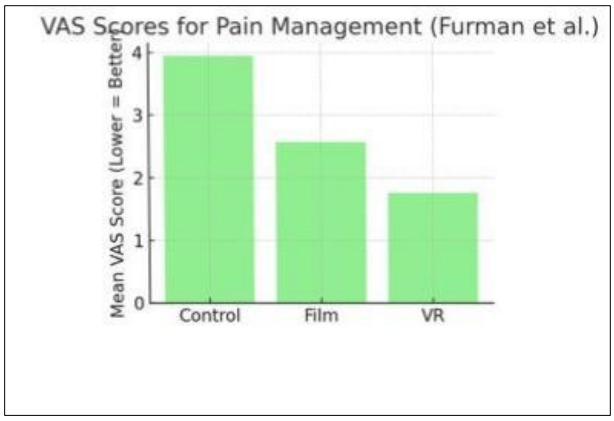

Figure 4 VAS Scores in Furman et al.'s Study:

VR significantly outperformed both the control and film conditions in reducing pain, as shown by the lower VAS scores.

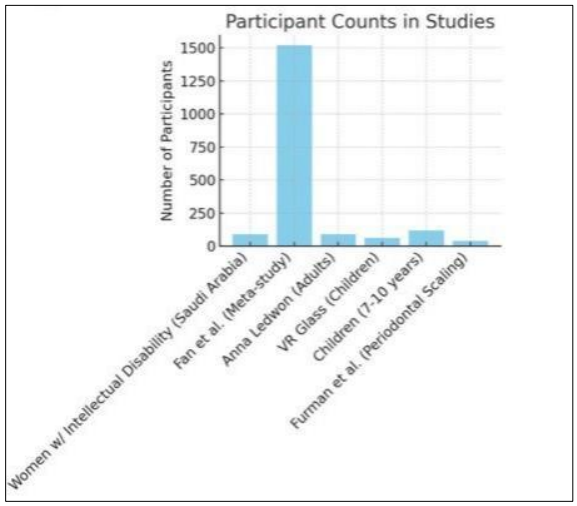

Figure 5 Participant Counts

The number of participants varies greatly, from small samples like Furman et al.'s 38 participants to Fan et al.'s meta-study with 1,522 participants. This variability might influence the generalizability of findings.

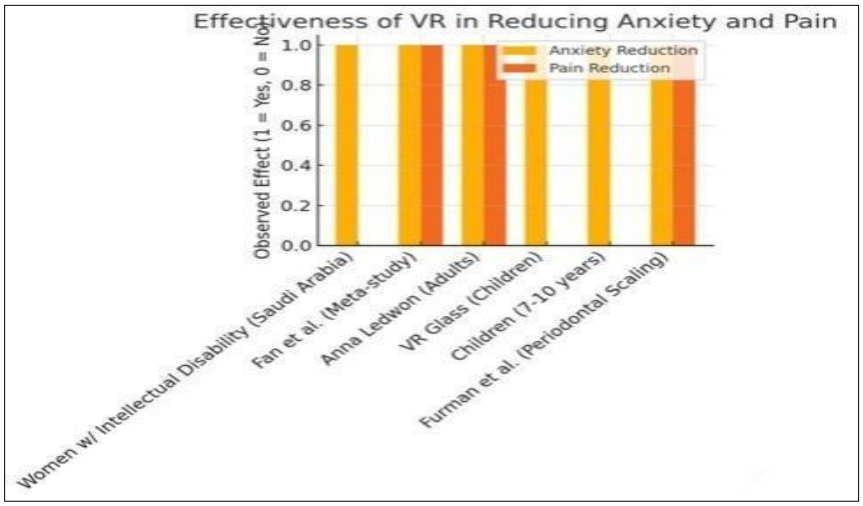

Figure 6 Effectiveness in Reducing Anxiety and Pain

All studies report that VR interventions reduce anxiety (bar height = 1). Pain reduction was less consistently observed, with only half the studies indicating significant pain relief.

3.4. Effects on children and adults

Virtual reality has had positive effects on pain and anxiety management in both children and adults. For example:

- In children, studies have shown that using interactive virtual reality games or watching relaxing videos can effectively distract children from painful treatments and reduce their anxiety levels.
- In adults, 3D virtual reality environments that include soothing images and sounds help reduce pain and anxiety during complex treatments.

However, the conducted research shows that the use of reality channels in children, teenagers, and middle-aged people up to 50 years old has better effects because these age groups have a better relationship and interaction with technology, and the age groups of 50 to 60 years mostly feel and have a good relationship with technology. They don't have new features and it reduces the effectiveness of virtual reality in this age group. For example, in a study conducted by Alireza Ghobadi and his colleagues

showed that younger patients are more willing to accept virtual reality technology than older people who often find it cumbersome.{11}

3.5. Possible side effects of virtual reality

Despite the many benefits, some studies have reported VR side effects such as nausea, dizziness, and headaches. These complications are usually observed in patients who use virtual reality headsets for a long time.

In addition to the side effects of the heavy weight and cost of the equipment, the absence or low variety of personalized virtual reality videos and games for dentistry, as well as the shape and structure of the equipment, reduces the dentist's visibility and access, the constant use of these facilities is necessary. Research and manufacture of newer devices with better features. It can be said that the impact of this science on dentistry is still in its infancy and requires more specialized research and engineering for use in dental offices and clinics.

4. Discussion

The findings of this review show that virtual reality is an effective non-pharmacological method for managing pain and anxiety in dental treatments. By creating interactive virtual environments, this technology diverts patients' attention from painful stimuli and makes the treatment experience more pleasant for them. Especially in children and anxious patients, virtual reality can help improve patient cooperation and reduce the need for sedatives.

However, for a wider use of virtual reality in dentistry, it is necessary to overcome possible obstacles such as the high cost of equipment and the need for staff training. Also, more research is needed to investigate the long-term effects and potential side effects of this technology.

5. Conclusion

Virtual reality, as a new and non-invasive method, has a high potential in managing dental pain and anxiety. This technology can help reduce dependence on sedatives and improve the treatment experience of patients. As the technology further develops and costs decrease, virtual reality is expected to become one of the standard tools in modern dentistry.

But to expand the use of this phenomenon in dentistry, there is a need for more scientific development and more expansion of facilities with a lower cost, as well as naturalization and more introduction of this technology so that patients of all ages can confidently accept this new phenomenon in treatment. It is obligatory and we can say that by reviewing the studies, we conclude that virtual reality in dental treatments, despite its great benefits and results, is still the first way of treatment and needs more studies and research.

Compliance with ethical standards

Disclosure of conflict of interest

There are no conflicts of interest in this article.

Statement of ethical approval

All studies on the behavior and interviews with the individuals present in this experiment were conducted with the permission and approval of the individual and their legal guardians or parents, and were conducted in a clinical setting without any psychological harm, and in order to protect the privacy of the individuals, the names of none of the individuals were mentioned in the studies. It should be noted that the studies were only on general behaviors and general questions in the experimental conditions, and no studies were conducted on the individuals' private information and behaviors.

Statement of informed consent

All studies and interviews are conducted with the full consent of the individual and their legal guardian or parent.

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