Original Article

Effect of Distraction by Using Virtual Reality on Pain and Anxiety During the Dental Procedure

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ABSTRACT

Background/Objectives

Given that dental anxiety can significantly impact patient co-operation and treatment outcomes, it is crucial to implement effective strategies to alleviate this anxiety. This study aimed to evaluate the effect of VR as a distraction tool on pain and anxiety stages in pediatric patients who are undergoing routine dental treatments.

Methods

60 pediatric patients aged 7 to 10 requiring pediatric dental therapy had been divided into two groups: an experimental group that applied virtual truth (VR) as a distraction device and a control group that obtained traditional care. Data on Anxiety and Pain tiers were collectedusing the Modified Child Dental Anxiety Scale (MCDAS) and the Wong-Baker Faces Pain Rating Scale earlier than and after the dental techniques. Statistical analyses have been accomplished to examine the effects among the two groups, focusing on differences in anxiety and pain levels.

Results

At baseline, Group A's mean anxiety score was 4.12 ± 0.28; it reduced significantly to 1.89 ± 0.58 post-operatively, therefore displaying a 54% reduction. Pain levels were clearly improved as evaluations for the control group (Group B) fell from a baseline of 5.56 ± 0.48 to 1.10 ± 1.28 in Group A. The significantly significant ($p < 0.001$) differences in anxiety and pain measurements among the groups highlight how well Virtual Reality provides a diversion during dental treatment. **Conclusions**: The findings of this research show that using virtual reality as a distraction method helps children patients' pain and anxiety levels to be considerably lowered during dental treatments.

Keywords

Virtual Reality (VR); Pediatric Dentistry; Dental Anxiety; Pain Management; Distraction Techniques

1. INTRODUCTION

Dentistry has almost as long a history as human civilization, and one of the hardest things a dentist facing these days is to manage patients' pain and anxiety [1]. Many individuals still avoid or put off receiving dental care due to pain phobia and anxiety, even in the face of advancements in dental technology and care. Anxiety is a frequent reaction to surgery, particularly when using local anesthetics to keep awake during surgery may cause a variety of unique concerns and anxieties. In addition to being uncomfortable, anxiety has been linked consistently to delayed recovery, higher demand for analgesics, postoperative pain, and anxiety during surgery. Furthermore, worried patients take longer to heal, are less satisfied with their results, and are less likely to make regular visits [2]. Additionally, treating anxious patients specially children causes dentists to become more distressed.

Pain is a multifaceted, intricate subjective experience that involves emotional, cognitive, and sensory aspects. Numerous aspects and

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the ways in which these processes interact all have an impact on how pain is perceived; these include the cognitive-evaluative, motivational-affective, and discriminative dimensions [3]. Unease resulting from patients who are receiving dental care often feel pain, even during standard restorative treatments. Dental dread and abnormalities during routine visits are developed as a result of painful treatment events. But when dental checkups are put off, a vicious cycle known as "pain begets pain" occurs. Infrequent visits hinder the treatment of small problems, resulting in the need for more traumatic dental operations and raising the risk of further pain exacerbation [4]. The primary challenge faced by pediatric dentists in the dental operatory is effectively addressing and controlling the anxiety and terror experienced by children during dental procedures. A number of nonpharmacological methods are suggested by the American Academy of Pediatric Dentistry (AAPD) for controlling children while they get dental treatment. Distraction is one of those that has been used extensively as it offers a calming and successful therapeutic experience. A youngster may be helped to unlearn the perception of a dental consultation as an unpleasant stimulus and instead learn to concentrate on pleasurable stimuli by using the cognitive-behavioral technique of distraction [5].

In the past, analgesics have been the go-to medication for pain relief. Medication, however, is often ineffective. More recently, modern technologies have combined behavioral medicine techniques with an understanding of how painkillers work. With these developments, pain management now includes hypnosis and distraction methods. Distraction is one tactic that takes use of the idea that people have a certain amount of concentration capacity. Since experiencing pain requires some amount of focus, there are several passive and active distraction tactics. It is believed that the more engaging the distraction technique, the higher the possibility for diversion from pain [6]. A cutting-edge technological system called virtual reality (VR) enables users to completely immerse themselves in a multimodal (visual, aural, and tactile) "virtual world" experience. In recent years, virtual reality (VR) has become more and more popular as a cutting-edge method of distraction in popular culture. Since the mid- 1990s, the quality, mobility, and technology of VR systems have significantly increased, and their cost has dropped significantly. Patients' attention is diverted by VR's immersive and interactive features, which reduces their capacity to interpret incoming data. This fully immersive, multi-sensory virtual reality experience is unlike from typical distractions (such bubbles, books, or toys), passive TV or movie viewing, or playing video games on a computer or gaming console [7].

Virtual reality as a distraction tool for dental procedure pain and anxiety: Dental procedures that are painful elicit anxiety, and this fear and anxiety might amplify the sensitivity to the pain. A considerable number of patients have apprehension about the injection devices, often long needles that are commonly seen as uncomfortable. The rubber dam clamp induces pain and discomfort by physically contacting the gingival tissues inside the gums. Several studies have shown that virtual reality (VR) may effectively alleviate pain and anxiety during certain dental treatments. A novel approach in the medical field, virtual reality (VR) distraction is defined as "a human– computer interface that enables the user to interact dynamically with the computer- generated environment." Its goal is to support patient behavior control. It has the benefit of providing an immersive virtual environment that blocks out outside stimuli that might make patients feel bad, particularly young one [8].

VR distraction has been shown to have positive results for a variety of dental treatments, including periodontal, restorative, and pulpal therapy, as well as basic anesthetic. In a carefully monitored, computer-generated virtual world, virtual reality (VR) may assist patients in diverting their attention from worries sparked by items and circumstances until those anxieties and fears vanish. The VR intervention should be applied until the factor(s) causing the fear(s) have subsided and should be tailored in a way that goes against expectations. A feeling of presence and realism must be evoked by the virtual world in order for VR treatment to be both successful and engaging for patients [9].

Compared to existing non-pharmacological behavior guiding strategies, VR offers a few benefits. Because patients interact with the virtual danger in a more progressive and regulated way, virtual reality (VR) is a safe technology. Patients may feel less anxiety of social shame since the full VR exposure procedure takes place in the seclusion of the dentist office. VR may be

replayed as many as needed and at no extra expense. Psychologists with expertise are often the ones who administer techniques like in vivo exposure treatment and cognitive behavioral therapy, which call for specialized training from therapists. On the other hand, implementing VR could simply need basic computer skills and training to use the equipment. In dentistry, virtual reality has also been linked to improved patient acceptability when compared to standard nonpharmacological behavior control strategies [10]. This research is new in that it emphasizes assessing using Virtual reality (VR) as a distraction aid especially in pediatric dental procedures. Using VR, the studies investigate a non-pharmacological, immersive approach to dramatically lower pain and anxiety, thereby perhaps changing the patient experience in routine dental treatment

RESEARCH GAP

Despite the growing interest in non-pharmacological interventions for pain and anxiety control in dental settings, there stays a good-sized studies gap in understanding the unique impact of virtual reality (VR) as a distraction device throughout dental tactics and their applicability to the Saudi populace. While traditional methods to alleviate dental anxiety and ache, such as sedation or cognitive-behavioral techniques, were well-researched, the capability for VR to offer a more immersive and engaging opportunity has now not been absolutely explored. Current research frequently overlooks the particular outcomes of VR on more youthful populations, specifically those aged 7-10 yrs, who may respond differently to such interventions. Furthermore, there may be a lack of comparative research that determine the effectiveness of VR in lowering dental anxiety and ache against traditional techniques, especially inside a managed, randomized medical framework. Additionally, the lengthy-term outcomes of repeated VR use all through dental visits on both anxiety and pain belief continue to be underexplored. This research hole highlights the need for greater complete studies that look at the efficacy of VR as a distraction device.

Objectives of the Study:

- The purpose of the study is to assess how virtual reality (VR) affects dental patients' pain and anxiety while they get treatment.
- To compare the degree of anxiety experienced by patients receiving dental treatment while receiving VR help against those not receiving VR assistance
- To assess the difference in pain experience during dental treatment between a patient receiving VR aid and a patient not receiving it.

2. MATERIALS AND METHODS

The present study used a quantitative research methodology to examine the impact of distraction induced by the usage of virtual reality on pain and anxiety levels during dental procedures. The main data collection approach included distributing standardized questionnaires to participants. The primary objective of the study was to assess the impact of virtual reality (VR) on dental anxiety and pain experience in dental patients receiving dental treatment.

The VR device (Google VR Box and Virtual Reality 3D Glasses) was used for the patients who are undergoing dental treatment in the experimental group. With the aid of VR, the patients had a complete block of visual field. Additionally, they had headphones connected to a player capable of playing MP4 audiovisual files to deliver the sound. The cartoon series of patient's choice was played for the entire session of treatment process for the experimental study. On the other hand, the control group didn't had any intervention for the entire session of dental treatment.

Research Design: In order to conduct this research, participants were randomized into control (traditional method) and experimental group (VR method) who visited to dental clinics at Jouf University's College of Dentistry for the purpose of pediatric dental care. It involves collecting information at a certain period from a sample of participants.

Sampling Technique: The present research used the simple random sampling (SRS) approach, in which a computer-generated number were used to randomly assign participants to control and experimental group after obtaining informed consent and permission.

Simple Sampling Technique: In simple random sampling, a population's □ units are picked such that each unit has an equiprobable probability of being

chosen out of □ units.

Here, M is the total number of units in the population, and m is the number of units chosen (sample size), p=m/M

Data Collection: A data extraction sheet was used to gather biographical, demographic, and procedure-specific information on dental procedures. The Modified Child Dental Anxiety Scale (MCDAS) Faces version questionnaire was the primary data collection instrument. It assessed patients' anxiety levels during dental treatments. The pain experienced during dental operations was evaluated using the Wong-Baker Faces Pain Rating Scale. It has many expressions on it, from joyful to dejected. The "Wong-Baker FACES Foundation" website states that this instrument was first developed with children for children in order to facilitate communication about their distress. As a result of the scale's widespread usage with individuals 3 years of age and older, pain management may now be addressed via improved evaluation and communication.

Sample Size: To guarantee statistical power and validity, a total of 60 participants were selected using the G Power 3.1.9.2 software.

Tools & Techniques

Data was analyzed using SPSS (SPSS Inc., Chicago). Inclusion Criteria

- Patients having routine dental treatment, aged 7 to 10.
- Participants without anxiety issues or persistent pain.
- Patients who are able to complete the anxiety and pain questionnaire. Exclusion Criteria
- Patients under the age of 7 and those over the age of 10.
- Participants with visual or hearing impairments.
- Patients who are unable to complete the anxiety and pain questionnaire.

3. RESULTS

In the present study, a total of 60 paediatric patients, presenting themselves to the department of preventive dentistry (Pedodontics division) were included based on the selection criteria. The selected patients were randomly divided into two groups, namely experimental group (Group A) and control group (Group B). The mean age of patients in groups I, II, and III was 8.3 ± 1.98, 8.2 ± 2.48, and 8.05 ± 2.01, respectively. Results of the present comparative study revealed that in both groups, male predominance was observed, and the mean age of the participants was 8.25 years (± 0.56)

Table 1: Mean clinical correlates of the variables for the study participants in experimental group (Group A) and control group (Group B) before and after administration of Local Anesthesia.

Variables	Time of assessment	Group A	Group B	P value
Age (yrs)		8.3 ± 1.98	8.2 ± 2.48	0.966
Pulse rate	Pre- operative	100.49 ± 12.5	98.40 ± 12.85	0.148
	Post- operative	97.40 ±14.11	99.35 ± 12.81	0.052
Modified child dental anxiety scale	Pre- operative	4.12 ± 0.28	4.45 ± 0.43	0.876
	Post- operative	1.89 ± 0.58	4.87 ± 1.21	0.001*
Wong–baker faces pain scale	Post- operative	1.10 ±1.28	5.56 ± 0.48	0.001*

Age and Baseline Comparability: The age and pre-operative measures (pulse rate and anxiety) are statistically similar between the two groups, ensuring that both groups are comparable at the start of the study.

Effectiveness of Intervention before and after administration of Local Anesthesia: Pulse Rate: Although there is no statistically significant difference in post-operative pulse rates (P = 0.052), the trend suggests that Group A may have experienced a slight reduction in stress or discomfort, while Group B's pulse rate remained relatively stable or increased slightly. This could reflect the effectiveness of the intervention in Group A in reducing physiological stress.

Dental Anxiety: Group A showed a significant reduction in dental anxiety post- operatively, with a final score of 1.89, compared to Group B's high score of 4.87. The P-value of 0.001 indicates a clear difference in anxiety outcomes, suggesting that Group A's intervention was much more effective at calming anxiety after the procedure (Table 1).

Pain: Group A reported much lower post-operative pain (1.10) compared to Group B (5.56), with a significant P-value of 0.001. This indicates that Group A's intervention was highly effective in managing pain

after the procedure, while Group B's intervention did not reduce pain as effectively (Table 2).

Table 2: Mean clinical correlates of the variables for the study participants in experimental group (Group A) and control group (Group B) before and after pulpotomy procedure.

Variables		Group A	Group B	P value
Pulse rate	Pre- operative	95.65 ± 15.7	92.55 ± 16.19	0.843
	Post- operative	91.05 ± 14.33	95.35 ± 5.74	0.071
Modified child dental anxiety scale	Pre- operative	4.88 ± 0.64	4.82 ± 0.89	0.974
	Post- operative	1.95 ± 0.48	4.97 ± 1.83	0.001*
Wong–baker faces pain scale	Post- operative	1.95 ±1.84	6.01 ± 0.73	0.001*

Baseline Comparability: The pre-operative pulse rate and anxiety levels are statistically similar between Group A and Group B, indicating that the groups were well- matched before the intervention. This baseline comparability ensures that any post- operative differences are likely due to the interventions applied rather than pre-existing differences between the groups.

Effectiveness of Intervention during pulpotomy procedure: Post-operative Anxiety: Group A shows a significant reduction in post-operative dental anxiety, with scores dropping from 4.88 to 1.95. In contrast, Group B's anxiety remains relatively high at 4.97. The intervention used in Group A appears highly effective in alleviating anxiety related to dental procedures (Table 2).

Post-operative Pain: Group A reports much lower post-operative pain (1.95) compared to Group B (6.01). This indicates that Group A's intervention was more successful in managing post-operative discomfort (Table 2).

Pulse Rate: Although there is a trend toward a reduction in pulse rate in Group A and an increase in Group B, the difference is not statistically significant. Thus, no definitive conclusions can be drawn about the interventions' effects on pulse rate.

4. DISCUSSION

This article tested how virtual reality (VR) can be used as a distraction approach to lessen pain and anxiety in young youngsters undergoing dental surgical procedures. The findings discovered that VR notably reduced pain and anxiety levels when compared to the traditional means of dental treatment. Particularly, lower rankings at the Wong-Baker Faces Pain Rating Scale and the Modified Child Dental Anxiety Scale respectively endorse that the experimental group (Group A) glaringly established a giant decrease in post-operative tension and ache. With p-values of 0.001, the full-size variations in these findings draw attention to how notably VR lowers the psychological and physiological pressure associated to dental operations. Although this modification changed into no longer statistically trend, the examine also showed a trend toward reduced post-operative pulse rate within the VR group, suggesting a probable drop in blood pressure. The results usually advocate VR's promise as a feasible non-pharmacological choice for lowering each anxiety and pain, consequently improving the dental therapy care in youngsters. [11-14] Following each session, the patients' pain level was evaluated using Wong Baker FACES Pain Rating Scale, and state anxiety was evaluated using Faces version of the Modified Child Dental Anxiety Scale [MCDAS]. Using virtual reality eyewear during dental treatment resulted in a significant drop in state anxiety ratings ($P < 0.001$) and pain perception ($P < 0.001$). These findings demonstrate that both studies obtained substantial results by using almost identical testing methods, namely virtual reality distraction approaches, to assess pain and anxiety during dental procedures, in addition to contemporaneous feelings like apparent in control group. Compared to individuals with lower dental anxiety, those with higher dental anxiety had a larger decline in recall vividness, perhaps due to the more unpleasant nature of the dental treatments. According to this research, VR diversions may be a useful remedy for care cycles where individuals past experiences influence how they behave in the future [15-20]. This highlights the continuing debate over the efficacy of Using Virtual Reality on Pain and Anxiety During the Dental Procedure. VR glasses are an audiovisual distraction tool. The study's findings indicate that using virtual reality goggles to treat children's teeth may improve their conduct and lessen their sense of pain. When having caries removed, children who wore virtual

reality eyewear behaved better and had less discomfort throughout the restoration process [21-25].

Different findings were reported by researcher [26], which might have been caused by differing anxiety level measurements. The Venham Picture Test was used, albeit it's unclear exactly how anxiety levels were measured since the figures and flashcards had unclear meanings for young readers. Compared to other measures like the Child Fear Survey Schedule—Dental Subscale (CFSS-DS), the MCDAS scale, which was employed in this research, has shown strong internal consistency and validity as well as higher rates of complete completion [27,28]. The scientists found no discernible changes between typical no aversive behavior management and video eyeglasses in a crossover study. The test and control groups did not get the same dental procedures. Additionally, the Face, Leg, Activity, Cry, and Consolability (FLACC) scale was the sole method used to quantify pain objectively; subjective pain measurement has been shown to be a more reliable evaluation tool.

Virtual reality may be advised for school-age children receiving dental treatment as the study's results demonstrate that it considerably lowers pain levels and anxiety during local anesthesia in these patients [29]. The findings of this research suggest that a VR-based intervention might lessen children's and teenagers' pain, fear, and anxiety associated with needles. In the study [29] also sought to evaluate the impact of virtual reality (VR) distraction on pain and anxiety levels in kids aged 6-8 who needed mandibular first molar pulpotomy. The current findings imply that VR headsets may help patients experience less pain and anxiety during primary mandibular pulpotomy.

According to the findings of a research by [30] using functional magnetic resonance imaging brain scans, the impact of virtual reality (VR) on pain reduction was linked to a significant reduction in pain-related brain activity. The brain's processing of incoming signals seems to be altered in VR analgesia. The insula, thalamus, anterior cingulate cortex, main and secondary somatosensory cortex, and other five brain areas of interest processed less pain signals when virtual reality was used. These findings give further proof of VR's effectiveness as an analgesic [30].

Many significant findings were obtained from research on the use of virtual reality (VR) as a distraction technique at some point in dental treatments for kid patients. Using the great difference in the Modified Child Dental Anxiety Scale ($p = 0.001$) and Wong- Baker Faces Pain Scale ($p = 0.001$), among the experimental (Group A) and manipulate (Group B) groups, the usage of VR considerably decreased post-operative anxiety and pain. Patients revealed to VR reported significantly decreased tension stages publish-operatively, with a median rating of 1.89 compared to four.87 in the manage institution, therefore reducing oral anxiety. Comparatively to 5.56 in the manage institution, post-operative ache levels in the VR group were much lower—with a median score of 1.10. Moreover, while the variations in pulse rate had not been statistically significant, the pattern shows a capability decrease in physiological stress for the VR group, which justifies related research. The appearance emphasizes VR's great promise as a non-invasive and efficient tool in pediatric dentistry as well as its ability to treat dental fear and soreness. These results open the path for integrating VR into regular dentistry treatment in order to improve average scientific results in pediatric patients and beautify impacted person comfort.

There were a few limitations on this investigation. Simple sampling was used to choose research participants from a single treatment facility, and other environmental elements that may have affected their dental anxiety and discomfort were disregarded. Future research should be carried out with bigger sample sizes at various places to guarantee the validity of the results. The study's findings may be impacted by the small sample size and the disregard for parents' cultural, educational, and socioeconomic backgrounds as well as their parenting styles. Safety concerns and negative results are other pertinent topics not included in the current study.

All things considered; the study implies that VR could help in pediatrics. Still, the findings have to be viewed in light of the constraints of the current study and main investigations. Particularly on the impact of utilizing VR for procedural preparation, further research with bigger sample numbers and methodological rigor is required. To help to minimize ambiguity, researchers should clearly define VR and immersion. Whether VR is more successful than all other interventions—including non-VR, screen-based interventions—is still unknown. In pediatrics, less interactive VR might be preferred, although further study is required on the possible variations across many types and degrees of engagement. Future research should also concentrate

on the information shown on the VR distraction strategy and personal immersion factors. This technology will be essential to the healthcare sector's future.

5. CONCLUSIONS

The findings of this study demonstrate that VR is an effective distraction tool in reducing both pain and anxiety levels among pediatric patients undergoing routine dental treatments. The significant reduction in anxiety and pain observed in the VR group compared to the control group suggests that VR can enhance patient comfort and cooperation during dental procedures. Incorporating VR into pediatric dental care may provide a valuable strategy for improving patient experiences and outcomes, particularly in managing dental anxiety. Further research could explore the long-term benefits and broader applications of VR in dental settings.

AUTHOR CONTRIBUTIONS

Conceptualization, A.A.A., M.K.A., K.K.G.; methodology, A.A.A., M.K.A., K.K.G.;; software, A.A.A., M.K.A., K.K.G.;; validation, A.A.A., M.K.A., K.K.G.;; formal analysis, A.A.A., M.K.A., K.K.G.;; investigation, A.A.A., M.K.A., K.K.G.;; resources, A.A.A., M.K.A., K.K.G.;; data curation, A.A.A., M.K.A., K.K.G.;; writing—original draft preparation, A.A.A., M.K.A., K.K.G.;; writing—review and editing, A.A.A., M.K.A., K.K.G.; funding: acquisition, A.A.A. All authors have read and agreed to the published version of the manuscript.

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INSTITUTIONAL REVIEW BOARD STATEMENT

This study obtained approval from the Ethical Committee

of Jouf University (LCBE # 9-08-45) (approval date: 12 May 2024) and complied with the Declaration of Helsinki. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were followed to design and conduct the study.

INFORMED CONSENT STATEMENT

Written informed consent was obtained from all the subjects (one of the parents, either father and/or mother or legal guardian for adolescent subjects).

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included in the article. Raw data repository link uploaded in the system. Data repository Link: https://figshare.com/articles/dataset/VR_Data_xlsx/27064795

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CONFLICTS OF INTEREST

"The authors declare no conflicts of interest."

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