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Virtual reality as a behavioral management technique in pediatric patients

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Abstract
Introduction: The use of distraction techniques in pediatric dental procedures is important, as it effectively reduces dental fear and anxiety, leading to better oral care habits and optimal treatment outcomes. Objective: To evaluate the effectiveness of the use of virtual reality as a behavioral management technique in pediatric dentistry, as well as the principles, possible benefits and challenges of its integration in comparison with other techniques.
Methodology: A search was carried out in the Pubmed, Google Scholar and Scopus databases using the keywords "virtual reality", "pediatric", "anxiety", "pain" and "fear" and 270 results were obtained. After selection of titles and review of abstracts, 40 articles were finally chosen for inclusion in this text.
Results: Virtual reality (VR) provides an interactive environment that diverts attention, occupying the brain with information and reducing pain signals. VR goggles significantly decrease pain perception and anxiety during dental treatment in both healthy and disabled pediatric patients. Despite the research, some of its side effects persist, although they are mostly mild. VR proves to be effective in decreasing pain and anxiety, overcoming normal care.
Conclusions: The use of VR as a distraction technique in pediatric dentistry care provides an immersive experience that diverts attention away from dental procedures that surpasses traditional distraction methods and consolidates as a behavioral management and pain reduction technique.

Keywords: Virtual reality, pediatric dentistry, anxiety, pain, fear, behavioral management

1. Introduction
Dental anxiety is a universal phenomenon that affects people of all ages around the world. It negatively affects children's oral health, their overall quality of life and their compliance with future dental treatment [1]. In dentistry, different distraction techniques have been used and have shown great results in the management of anxious pediatric patients, especially during the administration of local anesthesia [2]. Virtual reality (VR) distraction, defined as "a human-computer interface that allows the user to dynamically interact with the computer-generated environment" is intended to aid in behavioral management. It offers the advantage of an immersive experience that blocks external stimuli causing negative attitude, especially in children [2]. A key benefit of VR is that it can "transport" users into a virtual environment, giving them a sense of "presence." It can provide an effective avenue for exposure-based treatment [3]. The use of VR as a distraction technique in the pediatric dentistry practice is a topic of great importance due to the prevalence of dental anxiety among children. Analyzing its effectiveness can positively transform the dental experience, decrease fear, and improve treatment outcomes. Understanding the benefits and challenges of this tool is crucial to promote oral health by taking full advantage of technological advances. The objective of this review is to evaluate the effectiveness of using virtual reality as a behavioral management technique in the pediatric dentistry practice, as well as the principles, potential benefits and challenges of its integration into the practice compared to other techniques.

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2. Materials and Methods

Articles on the subject published through the PubMed, Scopus and Google Scholar databases were analyzed, with emphasis on the last 5 years. The quality of the articles was evaluated using guidelines, i.e., identification, review, choice, and inclusion. The quality of the reviews was assessed using the measurement tool for evaluating systematic reviews. The search was performed using Boolean logical operators AND, OR and NOT, with the keywords: Virtual reality, pediatric, anxiety, pain, fear. The keywords were used individually, as well as each of them related to each other.

3. Results and Discussion

3.1 Principles

The American Academy of Pediatric Dentistry (AAPD) recommends a number of nonpharmacologic management techniques for managing children during dental care, including distraction. Distraction is defined by the AAPD as "the technique of diverting the patient's attention from what may be perceived as an unpleasant procedure" [4]. It is widely used as it provides an effective and relaxing experience during treatment [5]. An effective distractor should be immersive, stimulating as many senses as possible and highly engaging. Research shows that the combination of visual and auditory distractor stimuli is more effective than the exclusive use of visual stimuli [6]. VR is defined as a highly interactive multimedia environment in which the user is involved in a computer-generated world. A real or imaginary environment is generated in the 3 dimensions of width, height, and depth, which could also provide an interactive visual experience of real-time motion accompanied by sound and possibly touch, and other forms of feedback [7]. "Being there" in the virtual world floods the brain with information. The brain is so preoccupied with processing information presented through VR that the patient has less attention available to process incoming pain signals [8]. With the use of head tracking, patients can look around them in a virtual environment (VE). VR can be a particularly effective method to distract attention by immersing the participant in a simulated environment and evoking the experience of presence in the VE [9]. Presence can be defined as feeling and acting as if one is actually located in a virtual world [10]. The working principle of VR distraction is that it does not interrupt pain signals but acts both directly and indirectly on pain perception and signaling. Several studies have evaluated the efficacy of VR in the fields of medicine and dentistry, and have shown virtuous results. Thus, VR has the potential to reduce pain perception [11].

AAPD recommends nonpharmacologic behavior management techniques such as distraction for the management of pediatric patients in the office. Effective distraction is immersive and multisensory, with research supporting a combination of visual and auditory stimuli. Virtual reality (VR) offers an interactive environment that diverts attention, occupying the brain with information and potentially reducing pain signals.

3.2 Benefits

There was a significant decrease in pain perception and anxiety state scores with the use of VR glasses during dental treatment [7]. The use of a VR device in children may reduce anxiety during temporary molar extractions as assessed by heart rate. VR devices could be an adjunct to high-quality dental care and other behavioral management methods [12, 13]. Comparing the duration of the dental procedure, the VR group had a shorter treatment time than the control group [14]. VR is an effective innovative technology in managing dental anxiety of pediatric patients during dental treatment. In addition, VR interventions could reduce the pain of pediatric patients during dental treatments [15]. The video-glasses/headset system is used as a distraction technique as children find VR a fascinating device. 3D images are displayed and projected right in front of the child's eyes, blocking out the real world and absorbing their mind into the VR during dental treatment. Being an audiovisual device, it increases the patient's detachment from the sight or noise of dental procedures while they are being performed [16]. Children who wore VR goggles behaved better during caries removal and showed lower pain perception during restoration [17]. Audio and VR distraction techniques can be successfully employed to reduce anxiety in children with mild intellectual disabilities and healthy children undergoing dental restorative treatment [18]. Visual distraction with VR glasses can be recommended as an effective distraction technique to reduce dental anxiety among children with hearing and speech disabilities [19]. VR glasses significantly reduce the perception of pain and anxiety during dental treatment in both healthy and disabled pediatric patients. The immersion and audiovisual distraction of VR make it an effective tool for decreasing dental anxiety, encouraging positive behavior in children during the consultation.

3.3 Challenges

Some limitations arise in the use of VR goggles. First, dentists must have basic knowledge of the hardware and software of the glasses. Second, the time required to fit the VR goggles and explain their use to children must be considered. In addition, VR goggles do not isolate noise resulting from the treatment and use of dental equipment; these noises can cause fear and anxiety [20]. Side effects of nausea have been reported during the use of VR equipment, which stem from low screen resolution [2]. Despite advances in VR technology, some participants still experience health and safety issues associated with its use, referred to as virtual reality-induced symptoms and effects (VRISE). The key concern in the literature is VR-induced illness, experienced by a large proportion of participants, but for most these effects are mild and disappear quickly [21]. Although the VR group was more prepared and had less stress in the perioperative period, perioperative pain was not affected by VR exposure [22]. The use of VR goggles decreased perceived pain during rubber dam placement among children, but has limited benefit during local anesthesia administration [20]. VR is an effective innovative technology in managing dental anxiety in pediatric patients during dental treatment, however it has limited beneficial action in the dental extraction procedure [15]. One of the most important limitations seems to be related to medical conditions that prevent the use of necessary equipment such as virtual glasses or headsets (e.g., patients with burns on the upper face or ears) [23]. Evidence reported that older children considered the VR technique as too simple a game and, therefore, had a lower level of distraction [24]. The use of VR glasses in the dental practice poses challenges, such as the need for dentists to be skilled in this technology, added time, and potential anxiety due to operative noises that fail to be blocked out. Despite research, some side effects persist, although mostly mild. VR reduces pain perception during certain treatments, but its effectiveness decreases during anesthesia administration and exodontia.

3.4 Comparison with other techniques

Digital distraction provides a modest reduction in pain and

anxiety for children undergoing painful procedures; its superiority over non-digital distractors has not been established. Context, preferences, and availability should guide distractor choice [25]. One study compared music and audiovisuals as distraction techniques in 60 anxious 4- and 8-year-old children. The visual technique was more effective relative to music [26]. VR was found to be significantly more effective in reducing pain and anxiety than normal care [27]. VR distraction is better than counter-stimulation in reducing injection anxiety in children undergoing extraction and pulpectomy [28]. Many techniques have been considered to reduce pain sensations, such as hypnosis, distraction of parents and medical staff, breathing tasks, suggestion, and VR during needle-related procedures, and it is suggested that distraction and hypnosis techniques should be used during needle procedures [6]. It compared VR with opioids and found that VR and opioid analgesics had the same equivalent results in terms of pain reduction. It was found that the combination of opioids with VR resulted in a significant reduction in pain signals [29]. This psychological pain management technique is equally well accepted by both parents and children, which is one of its major advantages. In other words, children want to try VR during dental procedures, and parents generally consent to allow their child to use VR [30]. A study was conducted comparing VR, audio distraction, and tell-show-do (DMH) techniques. The overall results revealed by all parameters confirm that children were more relaxed in the VR group compared to the audio distraction group or the DMH group [31]. Distraction techniques in pediatric attention have variable effectiveness. VR proves to be effective in decreasing pain and anxiety, surpassing normal care. Overall, VR is positioned as a promising technique that has been shown to be able to relax children and outperform other traditional distraction methods.

4. Conclusions

In conclusion, the use of VR as a distraction technique in pediatric dentistry provides an immersive experience that diverts attention away from dental procedures. The ability of VR to simulate presence in a virtual environment contributes to its effectiveness in reducing pain and anxiety, as well as reducing treatment time. Despite challenges, such as hardware/software management and side effects, VR outperforms traditional distraction methods and establishes itself as a behavioral management and pain reduction technique. Its wide acceptance among children and parents increases the potential of VR to innovate pediatric dental care.

Conflict of Interest

Not available

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5. References

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