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ORIGINAL ARTICLE

Effect of Virtual Reality Distraction on Pain Perception during Dental Treatment in Children

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ABSTRACT

Introduction: Behavior and pain management is crucial for success of a pediatric dental procedure. Distraction is the most commonly applied technique in this regard. This study was done to determine the effect of virtual reality (VR) distraction on pain perception during dental treatment in children.

Materials and methods: Thirty pediatric patients, aged 6 to 8 years, whose treatment plan consisted of pulp therapy in the mandibular primary molars, were randomly divided into an experimental and a control group. Children in the experimental group were shown a VR video during treatment, which consisted of administration of inferior alveolar nerve block followed by pulp therapy. Subjects in the control group received similar procedures without the use of VR distraction. At the end of the treatment, children in both groups were shown faces pain scale-revised and asked to point out the face which best showed the amount of pain perceived by them. Statistical analysis of the data was carried out.

Results: Significantly less pain was felt by children using the VR eyewear.

Conclusion: Results of this study show that VR eyewear can be successfully used to distract children and decrease the amount of pain perceived by them during dental procedures.

Keywords: Children, Dental treatment, Distraction, Pain, Virtual reality.

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INTRODUCTION

Pain management during dental procedures is crucial for successful behavior guidance. Prevention of pain can nurture the relationship between the dentist and the patient, build trust, allay fear and anxiety, and enhance positive dental attitudes for future visits.[1] Despite improvements in pain medication, effective pain and anxiety control continues to be a challenge for the pediatric dentists, making children wanting to avoid dental treatment. Distracting the child appears to be the most common nonpharmacological technique used for behavior management during dental procedures. Distraction is the technique of diverting the patient's attention from what may be perceived as an unpleasant procedure.[2]

The process of distraction appears to involve competition for attention between a highly salient sensation like pain and consciously directed focus on some other information processing activity. Although the precise mechanism of distraction is not yet well understood, cognitive-affective attention models may explain this phenomenon.[3] McCaul and Mallet[3] developed the existing theory by placing emphasis on the fact that the capacity of humans to pay attention is limited. They point out that an individual should concentrate on the painful stimuli in order to perceive pain; therefore, perception of pain decreases when a person's attention is distracted away from the stimulus.

In recent years, there has been an increase in behavioral research in virtual reality (VR) and virtual world. The VR refers to a human-computer interface that enables the user to interact dynamically with the computer-generated environment. In contrast to the less complex audiovisual (A/V) distraction, VR uses sophisticated systems, such as head-mounted, wide field of view; three-dimensional head-mount displays (HMDs) and motion sensing systems that measure the user's head and hand positions. This application may be superior to traditional distraction because it offers more immersive images due to the occlusive headsets that project the images right in front of the eyes of the user and, depending on the model used, block out real-world (visual, auditory, or both) stimuli. The VR even combines the audio, visual, and kinesthetic sensory modalities. Depending on how immersive the presented stimuli are, the person's attention will be more or less "drained" from the real world, leaving less attention available to real world processes, including painful stimuli. Immersion is particularly increased during VR, because the use of HMDs prevents patients from seeing what is happening in the real world,

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Fig. 1: EPSON MOVERIO BT-100

Fig. 2: Virtual reality smart glasses, detachable earphones, micro SDHC card

and directs the focus on what is going on in the virtual world. Therefore, the child's attention is focused on what is happening in the virtual world rather than on the surrounding environment.[4]

A review of the existing literature reveals limited studies using VR in pediatric dentistry. Hence, this study was done to determine the effect of VR distraction on pain perception during dental treatment in children aged 6 to 8 years.

Fig. 3: Virtual reality wearable Display

MATERIALS AND METHODS

Before the start of the study, the study protocol was approved from the ethics committee of the concerned institute. This study was a prospective single blinded randomised case-control study. Sample size was estimated by are method with a power of 91%. Thirty pediatric patients in the age group of 6 to 8 years, whose treatment plan consisted of pulp therapy in the mandibular primary molars, were selected for the study. The children were randomly divided into two groups—experimental and control. Children with any visual or auditory defect and patients who could not communicate efficiently due to language barriers were excluded from the study. Children were also excluded if they had previous invasive painful medical or dental history. Informed written consent from the parents was obtained before the start of the procedure.

The VR eyewear used in this study was Epson Moverio BT-100 (Fig. 1). The entire VR system consists of a VR device (Figs 2 and 3), computational software, advanced graphics, a tracking device, which helps to detect the movement of the user's head, thus causing the video to move along with head movement, an image, and audio display system.

Children in the experimental group were shown the VR eyewear before beginning the treatment and explained about their working. The VR eyewear was put on the patient and the 40 minute long video started, which in addition to serving as a distraction technique also, served as a dental education video. Once the child was engrossed in the video, the treatment was started. Topical anesthetic agent was applied to the injection site and inferior alveolar nerve block was administered, followed by a primary mandibular molar pulp therapy. Subjects in the control group received similar procedures without the use of VR distraction. At the end of the treatment, children in both groups were shown faces pain scale-revised (FPS-R) and asked to point out to the face which best showed the amount of pain perceived by them during the course of the treatment. The data obtained was passed blind to an independent statistician and subjected to statistical analysis.

RESULTS

The data obtained were tabulated based on the scores of FPS-R (Table 1) and further subjected to statistical analysis. The data thus obtained (Tables 2 and 3) were subjected to Mann–Whitney U test (Table 4). The p-value for the Mann–Whitney U test was found to be less than 0.05, which indicates significant difference between the

Table 1: Comparison of control and experimental group

	Groups	
	Control group	*Experimental group*
Score 0	1	5
Score 2	1	8
Score 4	1	1
Score 6	8	1
Score 8	4	0
Score 10	0	0

Table 2: Descriptive statistics

	Groups	
	Control group	*Experimental group*
Minimum	0.00	0.00
Maximum	8.00	6.00
Mean	5.73	1.73
Standard deviation	2.25	1.67

Table 3: Ranks table

Groups	*n*	*Mean rank*	*Sum of ranks*
Control group	15	21.40	321.00
Experimental group	15	9.60	144.00
Total	30		

Table 4: Mann–Whitney U-test results

	Test value
Mann–Whitney U	24.000
Wilcoxon W	144.000
Z	–3.793
p-value	0.000

control and experimental groups (Table 4). The sum of ranks value was found to be less for the experimental group than that of control group (Table 3). Hence, it can be concluded that significantly less pain is observed for the experimental group than that for the control group.

DISCUSSION

The video, selected for our study, was a Spiderman video in which the importance of regular toothbrushing was stressed upon. This video was selected because it is more appropriate to show familiar characters, such as animals or cartoon figures that they recognize, with bright backgrounds to children below 8 years of age, to avoid the onset of fear or anxiety from the introduction of an alien environment.[5] Hence, showing them cartoon characters they would know and like, would in turn help to hold their attention for a longer time. Distraction works through a process of attention. The greater the attentional capacity a distraction demands, the more effective it is at reducing perceived pain.[6]

It has also been demonstrated that distraction techniques are less effective in individuals who have a previous bitter pain experience.[7] Therefore, in this study, subjects were excluded if they had previous invasive painful medical or dental history.

In this study, a statistically significant difference was noted between the amount of pain perceived by the children in the experimental group and in the control group (Table 4). More children in the experimental group had lesser pain scores as determined by faces pain scale-revised (Table 1). These results are in accordance with the study carried out by Aminabadi et al,[8] who found a significant decrease in pain perception (using Wong-Baker faces pain rating scale) and state anxiety scores (using faces version of the modified child dental anxiety scale) with the use of VR eyeglasses during dental treatment in 120 children aged 4 to 6 years.

Similar results have also been found in adult dental patients. Hoffman et al[9] explored the use of VR as a nonpharmacologic analgesic for dental pain in two patients (aged 51 and 56) suffering from adult periodontitis. Both received periodontal scaling and root planning under three conditions: (1) VR distraction, (2) movie distraction, and (3) a no distraction control. Patients provided sensory and affective pain ratings on 0-10 point scales. For patient 1, mean pain ratings were equally severe while being exposed to a movie (7.2) or no distraction (7.2) but during the VR exposure, he only reported mild pain. Patient 2 reported moderate pain with no distraction (4.4), mild pain while watching the movie (3.3), and almost no pain with VR immersion (0.6).

These results are also in keeping with studies carried out in medical literature, where VR glasses have been used as a distraction to overcome pain, fear, and anxiety in a number of treatment procedures, such as treatment of burn care, chemotherapy, traumatic injuries, injection or blood sampling, and physiotherapy.[10-15]

The effect of VR distraction in decreasing perceived pain and anxiety can be attributed to a number of reasons. The application of VR distraction is based on the assumption that pain perception has a large psychological component and that pain attracts a strong attentive response because of the potential threat of damaged tissue associated with the sensation. The redirection (distraction) of this attention manipulates the pain perception, thereby reducing the intensity of pain. Recently, it has also been found that VR changes the way people interpret incoming pain signals and actually reduces the amount of pain-related brain activity.[16] Moreover, it can be concluded that VR engages the conscious attention of the patient, resulting in less pain perception by the patients.[17] By diverting attention from an unpleasant medical setting to a pleasant and absorbing virtual world, while also engaging higher cognitive and emotional centers of the

nervous system, VR can markedly diminish a patient's subjective pain experience.[12]

In case of pediatric dentistry, the anxiety-inducing appearance of the dental equipment and the continuous focus of the child on all the details of the procedure that is being carried out, are the most important reasons for stress associated with dental procedures in children. Therefore, the positive effects of VR distraction on the pain perceived by children in this study, are attributed to the complete blockage of children's visual fields by the VR device, and consequently, to a successful distraction technique.

The results of this study differ from those of a study conducted by Sullivan et al,[18] who found that the use of VR during dental treatment had no significant effect on the behavior (measured using the Frankl behavior rating scale) or anxiety (measured using the Koppitz method of evaluating drawings) in 26 children aged 5 to 7 years, however, significantly reduced the pulse on injection of local anesthesia in children wearing VR glasses as compared to children without VR glasses. The difference in results could be due to the difference in measuring scales used. A limitation of the Sullivan et al[18], study was the subjective interpretation of children's drawings by the examiners. The authors pointed out that there was a risk of over and under prediction by the examiners depending upon the cultural and developmental experiences and skills of the child. The significant decrease in pulse rate of the children on injection of local anesthesia in that study does indicate lowering of anxiety in the children.

CONCLUSION

Results of this study show that VR eyewear can be successfully used to distract children during dental treatment. The VR eyewear can decrease the amount of pain perceived by children during dental procedures. Use of VR eyewear can help in establishing a better rapport between the patient and the pediatric dentist and improving patient cooperation on recall appointments.

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