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ORIGINAL ARTICLE

Impact of Virtual Reality Goggles as a Distraction Technique on the Pain Perception and Heart Rate of Pediatric Dental Patients

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ABSTRACT

Objective: To assess the impact of virtual reality (VR) glasses on pain perception and heart rate during inferior alveolar nerve block in pediatric patients.

Methods: This quasi-experimental investigation was conducted at a dental hospital (University College of Dentistry), Lahore, Pakistan from June to February 2022. The study included healthy children aged four to twelve years who needed dental treatment involving an inferior alveolar nerve block. The distraction was done using VR glasses. Participants were arbitrarily divided into two groups, one with VR and the other without VR. The patients' behavior was recorded during the nerve block using the face, legs, activity, cry, and consolability (FLACC) behavioral pain assessment scale. The Pulse rate was monitored before, during, and after the procedure.

Results: Of the total 68 participants, the median age was 8 (7 – 9) years. There were 36 (52.9%) patients in the non-VR group and 32 (47.1%) patients in the VR group. The median FLAACC score was found to be significantly lower in the VR group as compared to the non-VR group i.e., 1.0 (1.0 - 2.0) vs. 5.0 (4.0 - 5.0) (p-value <0.001) respectively. Both groups showed significant median differences in face (p-value 0.008), legs (p-value <0.001), activity (p-value <0.001), crying (p-value <0.001), and consolability (p-value <0.001) scores. During treatment, the heart rate of VR participants was found to be significantly lower than the non-VR group i.e., 93.0 (90.0 – 96.0) vs. 100.0 (87.7 – 104.0) (p-value 0.044) respectively.

Conclusion: The study revealed that the use of VR goggles as a distraction method demonstrated a significant reduction in pain perception and heart rate.

Keywords: Dentists, Pain, Pediatric Dentistry, Virtual Reality.

INTRODUCTION

Dental anxiety is a common problem among children, with up to 80% experiencing fear or anxiety during dental visits, resulting in delayed dental care, decreased oral health, and an increased risk of developing dental phobia in adulthood.[1] Different distraction techniques are used to manage the behavior of pediatric patients. These distraction techniques range from needle disguise to virtual reality (VR) glasses, and in extreme situations, restraints, also known as protective stabilization, are used to control the non-cooperative behavior of pediatric patients.[2] Physical restraint or protective stabilization has many physiological and psychological downsides. Moreover, inappropriate restraint use can result in brachial plexus damage, sores, exhaustion, and energy loss. Children who are immobile for an extended period of time may experience physiological loss of their muscles' flexibility, strength, and peripheral blood flow.[3,4]

One potential solution to the problem of non-compliance is using VR glasses as a distraction technique during dental procedures. VR glasses are head-mounted devices that simulate a virtual environment and provide a 3D visual experience to the user. The glasses can be programmed to display various scenarios, such as a calming beach scene or a playful cartoon, which can help distract the patient from the dental procedure. By immersing the child in a virtual environment, the patient's focus shifts from the procedure to the virtual world, reducing anxiety and discomfort. Reportedly, VR distraction reduces anxiety

in pediatric patients with autism spectrum disorder (ASD).[5,6]

VR glasses can effectively distract patients from the dental procedure and reduce their anxiety. This distraction technique has been successfully used in other medical settings, such as during chemotherapy and radiology procedures, to reduce pain and stress. However, its use in pediatric dentistry is still in its infancy and requires further investigation.[7]

Healthcare in Pakistan is underfunded, like in other developing countries. The dental treatment services offered in Pakistan are highly variable in quality. Therefore, very little data is available when it comes to the use of various advanced distraction techniques to control the conduct and apprehension of children during dental treatment. Conventional methods of distraction and behavioral control are commonly practiced by Pakistani dentists; however, fewer practitioners have taken the initiative to use technology like VR glasses and gaming as distracting measures in their dental clinics.[8,9]

Further research is required to evaluate VR distraction's long-term effects and efficacy in various pediatric dental patient populations. Despite this, VR spectacles provide a non-invasive, safe, and effective alternative for the management of dental anxiety and discomfort in pediatric patients.[6]

The study aimed to assess the effectiveness of VR glasses on pain perception and heart rate during inferior alveolar nerve block in children. By exploring the utility of VR as a distraction technique in pediatric dentistry, we can enhance the quality of care, reduce anxiety, and ultimately contribute to better oral health outcomes for young patients.

METHODS

This quasi-experimental study was performed in a private dental hospital (University College of Dentistry) from June to February 2022 after approval from the Institutional Review Board of the University College of Medicine and Dentistry (UCD/ERCA/21/11gn). All participants' legal parents or custodians gave their written consent following an explanation of the study's objectives and a discussion of their ambiguities.

A systematic sampling technique was employed to ensure the randomization of subjects under the inclusion criteria. Every odd patient on the list was added to the non-VR group, whereas every even patient was added to the VR group. OpenEpi software was used for the estimation of sample size, taking a confidence interval of 95%, power of the test 90%, margin of error 5%, and mean oxygen saturation of group 1 96.2 ± 0.375 and group 2 97.3 ± 1.801.[10] The sample size was estimated to be 60. However, the sample size was raised to 68 participants, 32 in the VR group and 30 in the non-VR group. The inclusion criteria were healthy children between four and twelve years of age who needed treatment involving inferior alveolar nerve block, had no past bad dental experience, and were fully cooperative during a dental examination. Children with mental impairment, a history of seizures, and sensitivity to VR, and those who did not provide informed consent constituted the exclusion criteria.

The procedure was performed by the same demonstrator on both groups in the pediatric department. The inferior alveolar nerve block was given, and the behavior of the patient was documented using the face, legs, activity, cry, and consolability (FLACC) behavioral pain assessment scale.[10] The FLACC scale assesses pain in five categories, i.e., Face, Legs, Activity, Cry, and Consolability; each scored on a scale from 0 to 2, with 0 indicating no pain and 2 indicating the most severe pain. The sum of these individual scores yields a total FLACC score, ranging from 0 to 10.[11] Before the procedure, during the procedure, and after the procedure, the heart rate of the patient was measured using a pulse oximeter (CMS50D Pulse Oximeter). The documentation of the behavior pain assessment scale and heart rate was done by a trained postgraduate resident working in the pediatric department.

The distraction was done with VR glasses (LG 360 VR headset). These VR glasses employ modern technology to create virtual environments (VEs) that immerse and stimulate patients. These advanced technologies simulate images, sounds, and movements to facilitate immersion in the virtual world. These glasses have manually adjustable lenses customized to the patient's focal length. Built-in hearing aids were also provided along with these spectacles. The children were presented with three kinds of videos, including two cartoon videos and one documentary on wildlife, from which they had to select one. Before beginning the procedure, the patient was shown how to use the device using the tell-show-do technique.

Statistical Package for Social Sciences (SPSS) version 24 was used for statistical analysis. Median and interquartile range (IQR) were calculated for quantitative variables such as age, FLACC scale, and heart rate. Frequency and percentage were calculated for gender. The Normality of the data was checked by the Shapiro-Wilk test. The data were not normally distributed; therefore, non-parametric tests were applied. Inferential statistics were explored using the Mann-

Whitney U test to compare the FLACC scores and heart rate between VR and non-VR groups. The p-value of ≤0.05 was considered as significant.

RESULTS

In the investigation, 68 participants were enrolled. The median age of the patients was 8 (7 – 9) years. There were 38 (55.9%) females and 30 (44.1%) males. Almost one-half of the patients were in the non-VR group 36 (52.9%), and the remaining 32 (47.1%) were in the VR group.

Table 1 illustrates the mean FLACC behavioral pain assessment scores and their comparison between non-VR and VR groups. There was a significant difference in the median scores of the FLACC scale between the non-VR and VR groups (p-value <0.001). The patients in the VR group were more compliant and had reduced median score as compared to the non-VR group i.e., 1.0 (1.0 – 2.0) vs. 5.0 (4.0 – 5.0) respectively.

Comparing individual items of the FLACC scale revealed significant median differences in face (p-value 0.008), legs (p-value <0.001), activity (p-value <0.001), crying (p-value <0.001), and consolability (p-value <0.001) scores between the VR and non-VR group (Table 2).

An insignificant median difference was found between the VR and non-VR group heart rates before (p-value 0.116) and after (p-value 0.062) the procedure. However, during the procedure heart rate was found significantly lower in the VR group as compared to the non-VR group i.e., 93.0 (90.0-96.0) vs. 100.0 (87.7-104.0) (p-value 0.044) (Table 3).

Table 1: Comparison of FLACC BPS between VR and Non-VR group (n= 68)

Groups	Total	FLACC BPS		p-value
		Median (IQR)	Minimum - Maximum	
Non-VR Group	36	5.0 (4.0 – 5.0)	3 - 7	<0.001*
VR Group	32	1.0 (1.0 – 2.0)	0 - 2	

-FLAAC: Face, legs, activity, cry, and consolability, BPS: Behavioral pain scale, VR: Virtual reality, IQR: Interquartile range
Mann-Whitney U test applied, *p-value ≤ 0.05

Table 2: Comparison of Individual Components of the FLACC BPS Scale betweenVR and Non-VR group (n= 68)

Sub-groups	Groups	Median (IQR)	Minimum - Maximum	p-value
BPS Face	Without VR	1.0 (1.0 – 1.0)	0 - 2	0.008
	With VR	1.0 (0.0 – 1.0)	0 - 1	
BPS Legs	Without VR	1.0 (1.0 – 2.0)	1 - 2	<0.001*
	With VR	0.0 (0.0 - 0.0)	0 - 1	
BPS Activity	Without VR	1.5 (1.0 - 2.7)	0 - 3	<0.001*
	With VR	0.0 (0.0 - 0.0)	0 - 1	
BPS Crying	Without VR	1.0 (1.0 – 2.0)	0 - 3	<0.001*
	With VR	0.0 (0.0 - 0.0)	0 - 1	
BPS Consolability	Without VR	1.0 (1.0 – 2.0)	1 - 2	<0.001*
	With VR	0.0 (0.0 - 0.0)	0 - 1	

-FLAAC: Face, legs, activity, cry, and consolability, BPS: Behavioral pain scale, VR: Virtual reality, IQR: Interquartile range
Mann-Whitney U test applied, *p-value ≤ 0.05

Table 3: Comparison of heart rate between VR and Non-VR group (n= 68)

	Groups	Median (IQR)	Minimum - Maximum	p-value
Heart Rate Before Treatment	Without VR	101.0 (88.2 – 102.0)	76 - 103	0.116
	With VR	98.0 (96.0 – 100.0)	90 - 110	
Heart Rate During Treatment	Without VR	100.0 (87.7 – 104.0)	85 - 106	0.044*
	With VR	93.0 (90.0 – 96.0)	87 - 105	
Heart Rate After Treatment	Without VR	100.0 (85.7 – 102.5)	79 - 109	0.062
	With VR	92.0 (89.2 – 96.0)	85 - 100	

- VR: Virtual reality, IQR: Interquartile range
Mann-Whitney U test applied, *p-value ≤ 0.05

DISCUSSION

For years, pediatric dentists have tried and tested various techniques to reduce anxiety so that children can have a pleasant experience and receive optimum dental care. These include both pharmacolo-gical and non-pharmacological techniques.[12] Lately, a lot of emphasis has been placed on employing non-pharmacological techniques to prevent any associated adverse effects as well as the development of drug dependence. VR goggles have been previously reported to be an effective solution to reduce dental anxiety in children.[13]

In the current study, VR glasses significantly reduced pain perception and FLACC scores, which indicate better patient behavior and experience; the VR group showed only 'mild discomfort' as opposed to 'moderate pain' in the non-VR group. Studies conducted in Northern Ireland,[14] Spain,[15] the USA,[16] and the Netherlands[17] reported the efficacy of VR technology in lowering anxiety during dental procedures. Similar studies have been conducted in the Middle East, e.g., in Jordan,[18] as well as in the regional countries of India[19] and China,[20] and all of them have shown similar results. This consistent viewpoint in the studies conducted in recent years can be largely attributed to the advancement in VR technology, which seems to do a much better job at reducing dental anxiety as opposed to previous models of VR goggles.[21] These studies involved the use of wireless VR headsets, goggles, and helmets. Although the kind of VR technology used differed in each of these studies, it did not significantly impact the results.[22]

Heart rates were considerably lower in the VR group compared to the non-VR group during treatment in the current investigation, demonstrating the effectiveness of the VR goggles in distracting the patient to the extent that they felt relatively at ease during the procedure. These results were consistent with the previous data.[22-25] Moreover, the authors observed that the triggers of anxiety, such as sharp instruments and needles, were blocked out from view by the VR glasses. The patients were oblivious to these triggers and remained calm throughout the procedure. It is important to note that a change in heart rate is a well-known marker of anxiety and helps in distinguishing the onset of an anxiety attack. Mahmoud *et al.* reported that VR distraction was more effective for children who were more anxious before the procedure.[22] VR distraction significantly decreased discomfort and anxiety during dental treatments compared to traditional distraction approaches like watching TV or listening to music, according to a systematic review and meta-analysis including a total of 384 children.[23]

In the current study, the VR distraction was well-tolerated by children, and no adverse symptoms were reported. This could be attributed to the fact that the newer generation, i.e., Generation Alpha (born in the early 2010s), is more familiar with modern-day technology and adapts to new devices much more easily. The usefulness of VR distraction may depend on the child's age, developmental stage, and the type of procedure being performed. VR distraction may not be suitable for children who are prone to motion sickness or have a history of seizures.[5,11] VR can disrupt the sensory system and cause symptoms such as vertigo, dizziness, sweating, pallor, equilibrium loss, etc., which are collectively referred to as "VR sickness." These symptoms may appear within the first few minutes of use.[26] Most of the participants in the study who were given VR goggles as a distraction technique exhibited much lower anxiety. Not only does it make dental procedures more comfortable for the patients, but it also reduces chair side time. However, the same might not be said about children with preexisting dental phobias and anxiety disorders who may require pharmacological interventions.[27] One of the limitations of this was that different scales like the Visual Analog Scale (VAS) or Children Dental Anxiety Scale (CDAS) might be used to better understand the effectiveness of VR glasses. We recommend further exploring the development of more specialized and child-friendly VR glasses with customized experiences tailored to different age groups and specific dental procedures. Collaborations with child psychologists and ways to seamlessly integrate VR into routine dental care, along with training of dentists and dental hygienists, must be explored.

CONCLUSION

The use of VR goggles as a distraction method demonstrated a significant reduction in pain perception, as shown by lower FLACC behavioral pain assessment scores in the VR group compared to the non-VR group. Notably, individual components of the FLACC scale, including facial expression, leg movements, activity level, crying, and controllability, also showed substantial improvements in the VR group. Moreover, the VR group exhibited significantly lower heart rates during the dental procedure. These findings suggest that VR distraction is effective in alleviating pain and enhancing patient comfort during pediatric dental procedures.

ETHICAL APPROVAL: This study was approved by the Institutional Review Board of the University College of Medicine and Dentistry, The University of Lahore, Lahore with the No (UCD/ERCA/21/11gn, dated 21/10/2021).

AUTHORS' CONTRIBUTION: HH: Conception and design, critical revision of manuscript, statistical expertise, methodology, investigation and draft preparation. SAH: Conception and design, analysis and interpretation of data drafting, data duration. MF: Conception and design, drafting, critical revision of manuscript, interpretation of results. ZY & AS: Literature search, critical revision of manuscript and proof reading. All authors have approved the final version of the manuscript to be published.

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