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RESEARCH ARTICLE

VIRTUAL REALITY AS A DISTRACTION METHOD FOR PAIN CONTROL DURING ENDODONTIC TREATMENT: RANDOMIZED CONTROL TRIAL

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Abstract

Aim and Objective : The aim of the present study was to assess the effectiveness of virtual reality distraction on pain perception undergoing endodontic procedures.

Methodology: This randomised clinical trial has been written according to Preferred Reporting Items for Randomized Trials in Endodontics (PRIRATE) 2020 guidelines. An interventional study of 40patients of age group between 18-45 years was used in the study. The intervention was distraction with virtual reality eyeglasses. Participants were divided into two treatmentgroups: (a) without VR condition or (b) with VR condition. Blood pressure (BP) and pulse rate (PR) were measured. Patients were questioned about their discomfort and/or pain by using a visual analogue scale.Level of pain was measured by the Visual Analog Scale (VAS). Participants gave ratings using 0-10 scales with cut points on the scale indicating that (0) none, (1-3) mild, (4-6) moderate or (7-10) severe. Patients were asked regarding the treatment modalities they preferred.

Result: Data were analysed using SPSS® software. Paired t tests revealed that VAS scores were significantly ($P < .005$) lower during VR compared without VR condition. Paired t test revealed that on average, participants experienced significantly lower systolic BP after using VR ($M = 110.72$, $SE = 2.16$) than systolic BP after treatment without VR. Patients reported that they preferred the VR condition.

Conclusion: The results of this study suggest that use of immersive VR distraction may be an effective method of pain control during endodontic procedures.

Introduction:-

Patient's anxiety and fear related behaviour's not only are difficult to manage but also can affect dental treatment, compliance and oral health. According to dental literature, pain and anxious expectations about pain may be the primary reasons for dental treatment avoidance.[1]Patient's who experience pain may be more likely to avoid subsequent dental treatment. Unalleviated pain increases the likelihood of having physiological and psychological consequences, which can influence morbidity and mortality.[2,3]

Pain may arise due to either an endodontic cause or a periodontic cause, but the endodontic pain type variant is the most commonly encountered by the dentists in their dental offices.

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The endodontic pain is mainly caused due to the inflammation of the pulp tissueoccurring as a result of dental caries progressing deep into the tooth. This pain arises in response to either reversible or irreversible pulpitis.Thereversible pulpitiscanbe characterised by acute pain unlike the steady chronic pain in case of irreversible pulpitis. The acute pain is what brings the patient to a dental clinic due to its intolerable nature and so the precise diagnosis and systematic treatment would only relieve pain from the patient.

Pain management is an important element to address the patient's fears and/or needs. Endodontic procedures are painful, patients undergoing it may need local anaesthesia or other methods of pain control such as cognitive behavioural treatment, administration of nitrous oxide[4]or intravenous administration of sedatives.Clinicians also have useda number of techniques distraction techniques, such as watching movies, listening to music and playing video games, to reduce pain have been developed to assist in alleviating the procedural pain[5,6]. yet,pain management is still one of the main challenges in establishing regular dental visits.

One of the most interactive distraction techniques involves immersive virtual reality.Immersive virtual reality (VR) could possibly help clinicians make endodonticprocedures less painful, thereby improving health outcomes.

Virtual reality is defined as a human-computer interface that enables the user to be immersed and interact with a computer -generated environment. The most common applications of the VR are training simulators (flight simulators), entertainment (video games) and desensitization therapy (phobia treatment).[7] In addition, VR is used as a distraction technique for painful procedures.[8,9]

The use of VR as a pain management tool was initially introduced by Hoffman et al.[10]Many studies have examined the use of VR in reducing procedural pain in different populations and settings. VR has been used in many clinical trials like trauma rehabilitation[11,12], cancer treatments.[13] The use of VR to control pain and/or anxiety in the dental background is very limited.[14]Hoffman and colleaguesreported that during removal of staples from skin grafts in patients with burns, patients who used immersive VR experienced less pain than did those playing a video game. In addition, patients with burns who used VR noted that they spent less time thinking about their pain, their wound care procedures or both.[15]

We conducted this study to evaluate the analgesic effect of immersive VR during endodontic treatments. The specific aims were to determine whether there were differences in pain levels and vital signs (pulse rate [PR] and systolic and diastolic blood pressure [BP]) between patients in a control group and those in distraction groups.

Methodology:-

The study population included patients (18-45 years) who reported to the Department of Conservative Dentistry and Endodontics requiring a root canal treatment.A detailed medical and dental history were recorded to fulfill the inclusion/exclusion criteria.The formula used for sample size calculation was $n = f(\alpha, \beta) \times [\sigma 2/(\mu 1 - \mu 2)2]$, where σ is the standard deviation (SD) of the within-subject differences ($\mu 1 - \mu 2$), and $f(\alpha, \beta)$ is a function of power and significance level of 5% ($\alpha = 0.05$, $\beta = 10.5$ with 95% power). The forty patients taken up for the study were randomly allocated to one of the two study groups, each group having 20patients as follows:

1. Group 1, Access cavity n = 20 (Control group or without distraction)
2. Group 2, Access cavity n = 20 (Immersive VR application).

Inclusion Criteria:

1. Participants should be 18 years or older.
2. Good physical and mental health
3. Symptomatic irreversible pulpitis.

Exclusion criteria:

1. History of seizures or convulsive disorder.
2. Taking psychotropic drugs.
3. Pregnant women and lactating mothers.

Study Design:

The randomization procedure was performed before the clinical procedure by using the split mouth study design. In a split mouth design, there are two groups that are randomly assigned to left or right dentition sites. In group I

(control group), access cavity preparation (ACP) was done without wearing VR eyeglasses whereas in group II (VR group), ACP was done withwearing VR eyeglasses

BP and Heart Rate:patient's heart rate and BP was measured before and after the treatment using a sphygmomanometer and pulse oximetry. At the end of treatment, patients were asked to identify which of the two treatment conditions they preferred and recorded their responses.

Local anaesthesia (Lignox 2% with adrenaline 1:80,000) was administered. The technique employed for administration of local anaesthesia in the maxillary arch was the infiltration technique and the inferior alveolar nerve block technique was used in case of the lower arch. After the administration of block, access cavities were prepared and biomechanical preparation was carried out under rubber dam. The treatment conditions were control (no distraction) and distraction method (immersive VR) were carried for both the procedures during each patient in one appointment.After each of the procedures, patients completed a questionnaire between patients in a control group and in distraction groups and which treatment they preferred.

Visual Analog Scale Questionnaire: The dependent variable for this study was the level of pain. The level of pain was measured with the Visual Analog Scale (VAS). VAS is widely used to measure pain due to its simplicity and adaptability to different populations and settings. VAS is a common, valid, and reliable pain -measurement tool. This instrument has been used in previous studies to determine the level of pain and to evaluate the analgesic effect of immersive VR.The VAS is a self-report measure. It consists of a 10 cm horizontal line anchored by word descriptors at each end. The lower numbers of the VAS scale indicate less pain, while the higher numbers indicate greater pain. Patient is asked to indicate the current level or intensity of pain he or she is experiencing and then the patient marks the point that he or she feels represents the current perception of pain. Immediately after the procedure, patients completed a short questionnaire about their pain and discomfort level. The participants rated how much time they spent thinking about their pain during the session, how unpleasant the dental care was, how much their teeth bothered them during the procedure, their worst painand the average pain. Participants gave ratings using 0 –10 scales with cut points on the scale indicating (0) none, (1 –3) mild, (4 –6) moderate, or (7 –10) severe.Immediately after the VR treatment, participants were also asked three questions to assess presence, realism, and nausea. Hoffman and colleaguesused these three distraction-related questions to assess any negative physical effects and to determine the degree to which a patient's perception of presencespecifically pertaining to the VR environment might be relevant. We also asked patients to specify the treatment condition they preferred: no distraction or VR distraction.

Figure 1:- Virtual Reality Glasses 3D VR Box headsets.

Figure 2:- Endodontic procedure under VR.

Virtual Reality Equipment: An easy to maintain and simple to operate mobile -based immersive VR visualization system was used as a distraction method in this study. The system is composed of a binocular head -mounted display The head -mounted display provides a high - resolution visual display for each eye and stereo sounds through the headset, with noise - isolating mechanism delivering clear sound. In addition, the design of the VR provides less face contact, ensuring the highest level of comfort during use. The participants were asked to choose the type of video they wanted to watch: nature or comedy or animation videos.The VR device did not interfere with treatment and did not impair operator positioning and efficacy.

Results:-

Statistical analysis: The software package, SPSS Version 18was used to analyse the data with a 0.05 level of significance. The Wilcoxon signed -rank test (non -parametric procedures) was used to analyse the VAS data. The Wilcoxon signed -rank test was used to determine the difference in pain levels between the treatment group and the control group. Paired t - test was utilized to determine the difference in vital signs (BP and PR) after each treatment.The VR conditions resulted in statistically significantly lower pain level (lower VAS score) with that of control group.

Table 1:- Wilcoxon Signed-Ranks Test.

Question	**Z**	**P-value**	**r****
How much time did you spend thinking about your pain during this most recent session?	-2.860[a]	.004*	.29
How UNPLEASANT was the most recent session?	-3.908[a]	.000*	.39
How much did your teeth/gums BOTHER you during the most session?	-4.328[a]	.000*	.43
Rate your WORST PAIN during the most recent session:	-4.096[a]	.000*	.4
Rate your Average PAIN during the most recent session:	-4.030[a]	.000*	.4

As shown in Table 2, Vital Signs Data according to treatment condition, with paired t tests comparing control with virtual reality

	Mean (± Standard Deviation)		
Variable	Systolic Blood Pressure *	Diastolic Blood Pressure*	Pulse **
Control	116 (±16.6)	71.3 (±13)	74.4 (± 13.8)
Virtual reality	110.72(±15.3)	69.3 (±11.2)	75 (±9.3)
Control verses Virtual reality	**P =.014 *****	P =.977	P =.748

* Millimeters of mercury, mm Hg.
** Beats per minute, BPM.
*** Significant result, p<.00

Discussion:-

Supplementary care is needed in controlling acute pain, especially in burn injuries, multiple dressing changes and wound debridement are required. For chronic pain, use of opioidsand misuse, level of dependencyand limited efficacy in treating specific types of pain proved the need for different treatment modalities.There has been paradigm shift in the treatmentusing non -pharmacologic alternatives, especially in a continuous need for pain control and the long course of recovery. As a non -pharmacological alternative, VR can be of benefit over conventional analgesia.

The use of VR might be an alternative or adjunctive option for the treatment of pain. VR might influence the extent of opioid misuse and benefit -opioid dependent patients.[16]

This study thus tested the effectiveness of distraction using VR eyeglasses on pain perceptions undergoing the endodontic procedures.The results of our study show that use of VR was an effective pain management technique for patients undergoing SIP procedures. Most of the study population reported that they preferred VR distraction method during endodontic procedures and two patients did not prefer the distraction. Not only did patients preferred interacting with the VR environment and reported lower levels of pain.

The participants in this study reported a reduction of the amount of time spent thinking about pain when using VR which includes unpleasantness of the experience, tooth and gum discomfort and the ratings of worst pain and average pain, which are similar to the findings by Furman et al.[17] The vital signs (diastolic and pulse) of participants in the current study were not associated with the use of VR. This could be as the virtual environment in this study is neutral, nonviolent and inoffensivewhich did not cause a change in the vital signs.

Distraction is considered the most common technique applied to alleviate pain during short invasive medical procedures.[18]

According to McCaul and Malott, human beings have a limited capacity of attention and an individual must attend to a painful stimulus in order for it to be perceived as painful.[19] Therefore, if the individual is attending to another stimulus away from the noxious stimuli, they will perceive the painful stimulus as less intense.

Dental care demands repeated multiple visits for adequate preventive and restorative treatment. VR distraction is a relevant intervention for episodes of care in which people's previous experiences affect their behaviour for future treatment.If a dental patient, for example, has a more positive experience of treatment due to the VR distraction intervention, that patient might have less vivid memories and as a consequence might be less likely to postpone a future dental visit.[20]

Additional benefits of VR are ease of use, greater control of the therapy, safe in majority of the patients, no need for instructing the patients and the therapeutic personnel.[21]Frequent application of the technique does not decrease its positive effects. It can be used both in adults and children.[22]

Hoffman and colleagues conducted a study that involved the use of functional magnetic resonance imaging brain scans, the results concluded that VR analgesia reduced pain-related brain activity.[23]

The patients in our study, similar to the two patients in the study by Hoffman and colleagues, reported that VR significantly reduced their awareness of dental pain.[24]

Prolong exposure to VR environments may cause cybersickness which includes nausea, dizziness, headache, blurred vision, and feeling of moving through space.[25]Along with exposure also depends upon type of simulation and complexity of the devices. In the present study, participants did not feel nausea as the exposure duration was short and stimulation was simple.

The results of this study explained that the participant's senses are being blocked out of the real world by immersive images projected right in front of his/her eyes with the special headsetwhich increases the immersive feeling and presence in the virtual environment.Another distinguishing characteristic is that VR gives the illusion that objects which do not exist in the real world exist inside a computer-generated VE.[26]

Thus, the present study shows that use of VR distraction is effective in decreasing pain perception and anxiety level in during routine dental treatment.

Conclusion:-

The results of this study suggest that immersive VR distraction may be an effective method of pain control during endodontic procedures.Future studies should include larger patient populations, more practitioners using different types of immersive reality environments. The current study is a novel approach in minimizing discomfort and anxiety in various endodontic procedures.

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Conflicts of interest:
There are no conflicts of interest.

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