

Content available at: <https://www.ipinnovative.com/open-access-journals>

IP Indian Journal of Orthodontics and Dentofacial Research

Journal homepage: <https://www.ijodr.com/>

Original Research Article

Effectiveness of Virtual Reality (VR) technology towards pain management during initial fixed orthodontic procedures: A case-control study

Bikash Ranjan Bindhani¹, Pritam Mohanty¹, Ashish Kamboj^{2,*}, Subhas Seth³, Debapreeti Mohanty¹, PV Samir¹¹Kalinga Institute of Dental Sciences, KIIT-DU, Bhubaneswar, Odisha, India²Dept. of Orthodontics, Government Dental Centre, Leh (UT of Ladakh), India³Guru Nanak Institute of Dental Sciences and Research, Kolkata, West Bengal, India

ARTICLE INFO

Article history:

Received 03-08-2022

Accepted 12-08-2022

Available online 27-10-2022

Keywords:

Virtual reality

Orthodontic pain

Anxiety

ABSTRACT

Aim: The goal of this research is to see how effective virtual reality (VR) is in reducing discomfort during early fixed orthodontic operations.**Materials and Methods:** The research comprised 70 individuals, all of whom were between the ages of 15 to 18 years randomly divided into two groups- research group (n=35) and the control group (n=35). Patients in the experimental group received a virtual reality headset and watched interesting movies during orthodontic procedures, while those in the control group received regular care. The VR headgear was placed over the patient's eyes as the dental procedure began in the study group, whereas the controls group's eyes were kept open as they viewed the clinic and dental procedures going on around them.**Result:** After adopting virtual reality movies before and after dental treatments, there was a statistically significant difference in pain levels between the control and study groups. The mean pain ratings during orthodontic treatment were 8.6 and 6.3 in the control and study groups, respectively. Following orthodontic treatment, the control and study groups reported mean pain levels of 7.4 and 6.7, respectively.**Conclusion:** VR is found to be an effective method in pain alleviation during initial fixed orthodontic procedures.This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.For reprints contact: reprint@ipinnovative.com

1. Introduction

One of the main issues that may deter a patient from getting orthodontic treatment is their fear of chronic pain. Orthodontic patients are typically advised that the insertion of separators and first arch-wires, as well as frequent orthodontic appliance adjustments, may cause varying degrees of pain and discomfort. It is a significant clinical issue that has a detrimental impact on their compliance, cooperation, and motivation to continue the treatment. Despite functional and aesthetic requirements, people have been observed to deliberately defer orthodontic

treatment.¹ Tension, pressure, tooth sensitivity, and pain are all symptoms of orthodontic discomfort, which is caused by immediate or delayed noxious stimuli of the periodontal ligament.²⁻⁴ Pain is a multifaceted idiosyncratic sensory perception that gets impacted by a variety of biophysiological and psychosocial variables in addition to the underlying condition.^{5,6} 91% of orthodontic patients experience discomfort, with 39% reporting pain at every phase of treatment.⁷

The most often prescribed medicines for the therapy of orthodontic pain are nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen. Because NSAIDs block prostaglandin production, they have been shown

* Corresponding author.

E-mail address: aashishkamboj@gmail.com (A. Kamboj).

to prevent orthodontic tooth movement. According to the available evidence, acetaminophen is the drug of choice for treating pain during orthodontic treatment inhibiting cyclooxygenase-3 in the brain reducing peripheral prostaglandin production.^{8–10} To alleviate pain, a variety of psychological techniques are also commonly used, including cognitive-behavioral and hypnotic techniques. Distraction is a psychological technique for managing the pain and anxiety imposed on by medical procedures. The effectiveness of this strategy has already been confirmed by a growing body of studies. Breathing exercises, soothing music, and watching a favorite show have all become popular distraction strategies.^{11,12}

VR has been widely employed in a variety of sectors in recent years, and it is intended to become a part of people's daily life. In a virtual reality scenario, there are three fundamental elements: participation, somatosensory, and interactivity in all aspects of the virtual world. Virtual reality shows a set of items in a 360° actual world and establishes the connections that govern them. A computer is usually used to create the virtual environment in virtual reality.¹¹ This technology has also made its way into the healthcare business. It's utilized as an interactive tool, teaching and therapy as a simulation. In healthcare system, virtual reality shows various applicability, including screening patients, counseling, and recuperation, as well as facility construction.¹³

The current study aims to appraise the effectiveness of virtual reality (VR) on discomfort during initial fixed orthodontic procedures.

2. Materials and Methods

The 2010 CONSORT- consolidated standards of reporting trials criteria were used to conduct this parallel randomized controlled trial. There were 70 participants included in the study within the age group of 15-18 years, and they were all referred to the Department of Orthodontics and Dentofacial Orthopaedics, KIIT Deemed to be University, Bhubaneswar. The research group (n=35) and the control group (n=35) were then assigned to the participants at random.

2.1. Eligibility criteria

The inclusion criteria for the study were patients of 15-18 years age group, without any visibility or hearing impairment and ability to understand and respond to the questionnaire. Patients with visual or auditory problems, as well as those who had trouble filling out the questionnaire, were thus eliminated. Hypersensitivity to the materials, as well as any fear of using the VR system, were also reasons for disqualification.

2.2. Sample size

70 adolescents between the ages of 15 and 18 were assessed in an orthodontic department, by an orthodontist for fixed orthodontic treatment. As a result, the sampling for each group was determined to be 35 individuals (95% confidence interval and 80% strength). The participants were chosen through convenience sampling. The control and therapeutic groups were allocated to patients on a random basis.

2.3. Randomization

All of the participants were initially numbered from 1 to 70. Then using software, 35 random integers were generated from 1 to 70. The study group was made up of 35 patients. The study and control groups were then tallied for age and gender.

2.4. Methodology

During orthodontic treatments, patients in the study group wore a virtual reality headset and watched interesting movies, while those in the control group received standard care. When the dental operation began in the study group, the VR headgear was put over the patient's eyes. Because the patients in this group couldn't view the clinic environment throughout the dental operation, they were intensely engaged in audiovisual communication with the VR device while experiencing a 360° motion picture. The controlled group's eyes were kept open as they observed the clinic and dental procedures going on around them. The major concern was a comparison of the two group's pain levels during and after the orthodontic therapy. Visual Analog Scale (VAS) was used to record the participant's anxiety level.¹⁴

2.5. Statistical analysis

Statistical data were interpreted using the SPSS software (Version 22). At the 0.05 significance level ($\alpha=0.05$), a variety of statistical tests were applied, including Spearman correlation coefficients, Mann-Whitney and Wilcoxon. The Kolmogorov-Smirnov statistical test was performed to determine the data's normality. The data were described as standard deviation and frequency in percentage. Furthermore, the alpha coefficient (internal consistency coefficient) was 0.92. With a one-week retest procedure, its validity varies by 0.75, and the correlation of its materials ranges from 0.30 to 0.76.

All participants, along with their parents, were informed about the research protocol. The patients gave their informed consent after being convinced that their participation was completely voluntary. During the therapy, participants in the study group were not allowed to remove the VR-headset at any point. However, these individuals were later removed from the research. The

patient in figure 1 gave their informed consent for their photograph to be published.

Before starting orthodontic treatment, all patients had visited twice or thrice for clinical assessment and study of their diagnostic data. Patients were asked to come to the clinic once a month for the duration of their orthodontic procedure, which usually lasts 18 to 24 months. Because most patients are confronted with new and old procedures, the initial session of an active phase of treatment in orthodontics can be regarded as the most painful. Patients often experience less discomfort after monthly visits since they are in a known atmosphere and are exposed to well-known techniques to some extent. The method was well described to the participants, and steps were taken to ensure their comfort. The study group wore a virtual reality headset (IRUSU MONSTER VR headset) (Figure 2), whereas the control group got standard care.

While the patients were reclining in the dental chair for orthodontic treatment, an engaging VR movie clip was played over the headset. There was no possibility for user engagement in the video, which was an amazing 30-minute 360-degree amazing video. During orthodontic treatment, participants in the study group were all shown the same VR film, and those in the comparison group were able to see the orthodontist and the clinical environment. The VAS score was determined by monitoring the range in between "no pain" attachment point and the participant's notation on a 10-cm line that used a ruler, includes a range of 0–100 mm. The pain is said to be more acute if the score is higher. Minimal pain (0–4 mm), sharp pain (5–44 mm), intense pain (45–74 mm), and extreme pain (75–100 mm) are the four pain VAS ratings.¹⁵

3. Results

According to descriptive data, the mean ages of the patients in the control and study groups were 15.85 ± 2.20 years and 15.15 ± 2.17 years, respectively. In the study group, there were 18.0 (51.4%) male patients and 16.0 (46.0%) in the control group (Table-1). The results showed that there was no statistically significant difference between the two groups in terms of age and gender ($P > 0.05$). The Mann Whitney U test revealed a statistically significant difference in pain levels between the control and study groups after using virtual reality videos during and after dental procedures. In the control and study groups, the mean pain ratings throughout orthodontic treatment were 8.6 and 6.3, respectively. The control and study groups had mean pain levels of 7.4 and 6.7, respectively, following orthodontic treatment. Both the control ($P = 0.034$) and research ($P = 0.004$) groups had statistically significant differences in pain levels during and after orthodontic treatment (Table 2). Furthermore, the Mann-Whitney U test revealed no statistically significant change in gender rating following intervention in the control (0.203) and

intervention ($P = 0.207$) groups.



Fig. 1: Patient wearing VR headset during dental procedure



Fig. 2: IRUSU MONSTER VR headset used for the research

4. Discussion

The present study aimed to determine how patients' anxiety levels were changed by seeing VR movies during dental operations. According to the findings, there had been a significance difference in pain levels in the intervention and control groups before and after orthodontic therapy. The intervention group's pain levels dropped after the intervention, proving that virtual reality technology (i.e., the use of VR entertainment movies) is beneficial in reducing patient discomfort during orthodontic operations. The outcome of the present investigation confirm those of Ram et al., who discovered that, VR glasses might help in visual distraction among the youngsters during dental

Table 1: Age and gender comparison of participants in the study and control groups during the orthodontic treatment.

Variable	Groups		Z- Value	P value
Age	Control		15.85±2.20 yrs	0.23
	Study		15.15±2.17 yrs	
Gender	Control	Male	16 (45.8%)	0.44
		Female	19 (54.2%)	
	Study	Male	18 (51.4%)	
		Female	17 (48.6%)	

Table 2: The comparison of the patient's pain levels in the study and control groups during and after orthodontic treatment

Group	Median VAS score (in cm)		Average	
Control	Mid-treatment	8.6	86.0%	P= 0.034
	Post-treatment	7.4	74.0%	Z= 0.07
Study	Mid-treatment	6.3	63.0%	P= 0.004
	Post-treatment	6.7	67.0%	Z= 2.89

treatment.¹⁶ Furthermore, Hua et al. shown that using virtual reality to treat burn patients may lower pain, anxiety, and treatment time.¹⁷ They claimed that employing a virtual reality system might help youngsters feel less discomfort and be more calm and obedient. Garrett et al. discovered that using virtual reality environment to alleviate and manage pain in people suffering from chronic diseases can help them feel better.¹⁸ Aliakbari et al. also looked at the impact of VR on psychological symptoms such as melancholy in patients suffering from cancer, and concluded with a difference between the experimental and control groups significantly. In the experimental group, pain in particular, were much decreased.¹⁹

This study's findings are similar to those of earlier research. A scoping review by Ahmadpour et al. concluded that, VR can be a viable choice for managing pain and anxiety in various procedures of medicine.²⁰ According to a previous research, the type of equipment or virtual reality devices used, maturity, anxiousness, and psychosocial outcomes of the patient, and the type of medic care provided has an influence on the management of discomfort, tension, and melancholy brought on by medicine therapy.^{17,21}

A research conducted by Al-Khotani et al. looked at how audiovisual diversion influences child's behaviour throughout medical attention, which found a statistical differences in average anxiousness and behaviour evaluations between the control and intervention groups (watching Virtual videos) showing lower average scores of the study group than those of the control group.²² Audio-visual and bimodal stimulus congruence can alter the subjective perception of emotions, according to Mitrakul et al.²³ Likewise, according to the findings of a study conducted by Prabhakar et al., visual distraction was more effective than auditory distraction during dental treatment.²⁴

Wiederhold et al. examined the effect of virtual reality systems on reducing anxiety and discomfort during dental procedures, and discovered that patients were less anxious

and in pain following VR therapy.²⁵ In terms of the pain component, the results of this study matched those of Wiederhold et al. Our study has the advantage of focusing specifically on the effectiveness of video clips on VR in reducing pain experience in teens who usually tend to worry while dental operations. VR is a novel type of non-pharmaceutical pain relief and diversion. The success of VR approaches in lowering treatment-related pain and anxiety can be ascribed to a number of factors.¹⁷

Patients who are anxious with dental procedures might find that, using distraction VR system is a helpful alternative. This technology might be used in dental clinics to assist minimise anxiety suffering, monotony, and the amount of time it takes to complete common dental operations. The present study found that participants who received VR-based amusing video clips had lower anxiety levels. This study suggests that VR-based strategies can help children and adolescents cope with the anxiety and suffering associated with dental procedures. As a result, the use of virtual reality technology in dental care may be more convenient for this age group. Because dentistry anxiety is a multifaceted issue with behavioural, intellectual, and emotional elements, pain following treatment might impact the development of this complication. As a result, all factors should be examined while assessing it. Patients' positive self-perceptions develop stronger as a result of using this technology throughout therapy, making them more robust to discomfort and suffering. Psychologically, it aids patients in developing optimal physiological responses to stress, sadness, and anxiety. It's possible that increasing a patient's VR engagement does not make them think about their health, concerns, or suffering more, which might be a crucial element in reducing anxiety in patients.

5. Conclusion

VR is found to be an effective method in pain alleviation during initial fixed orthodontic procedures.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

- Krishnan V. Orthodontic pain: from causes to management- A review. *Eur J Orthod.* 2007;29(2):170–9. doi:10.1093/ejocj1081.
- Oliver RG, Knapman YM. Attitudes to orthodontic treatment. *Br J Orthod.* 1985;12(4):179–88.
- Jones M, Chan C. The pain and discomfort experienced during orthodontic treatment: a randomized controlled clinical trial of two initial aligning archwires. *Am J Orthod Dentofacial Orthop.* 1992;102(4):373–81.
- Jian F, Lai W, Furness S, McIntyre GT, Millett DT, Hickman J, et al. Initial arch wires for tooth alignment during orthodontic treatment with fixed appliances. *Cochrane Database Syst Rev.* 2013;(4):CD007859. doi:10.1002/14651858.CD007859.pub3.
- Ngan P, Kess, Wilson. Perception of discomfort by patients undergoing orthodontic treatment. *Am J Orthod Dentofacial Orthop.* 1989;96(1):47–53.
- Kavaliauskiene A, Smailiene D, Buskiene I, Keriene D. Pain and discomfort perception among patients undergoing orthodontic treatment: results from one month follow-up study. *Stomatologija.* 2012;14(4):118–25.
- Lew K. Attitudes and perceptions of adults towards orthodontic treatment in an Asian community. *Community Dent Oral Epidemiol.* 1993;21(1):31–5. doi:10.1111/j.1600-0528.1993.tb00715.x.
- Brune K. The pharmacological profile of non-opioid (OTC) analgesics: aspirin, paracetamol (acetaminophen), ibuprofen, and phenazones. *Agents Actions Suppl.* 1988;25:9–19.
- Arias OR, and CMO. Aspirin, acetaminophen, and ibuprofen: their effects on orthodontic tooth movement. *Am J Orthod Dentofacial Orthop.* 2006;130(3):364–70. doi:10.1016/j.ajodo.2004.12.027.
- Corrêa AS, Almeida VL, Lopes BMV, Franco A, Matos FR, Quintans-Júnior LJ, et al. The influence of non-steroidal anti-inflammatory drugs and paracetamol used for pain control of orthodontic tooth movement: a systematic review. *An Acad Bras Cienc.* 2017;89(4):2851–63.
- Malloy KM, Milling LS. The effectiveness of virtual reality distraction for pain reduction: a systematic review. *Clin Psychol Rev.* 2010;30(8):1011–8.
- Marwah N, Prabhakar AR, Raju OS. Music distraction—its efficacy in management of anxious pediatric dental patients. *J Indian Soc Pedod Prev Dent.* 2005;23(4):168–70.
- Brey PAE. Virtual reality and computer simulation. In: Himma K, Tavani H, editors. *The handbook of information and computer ethics.* Hoboken (NJ/USA): Wiley; 2008. p. 361–84.
- Kelly AM. The minimum clinically significant difference in visual analogue scale pain score does not differ with severity of pain. *Emerg Med J.* 2001;18(3):205–7. doi:10.1136/emj.18.3.205.
- Aun C, Lam YM, Collett B. Evaluation of the use of visual analogue scale in Chinese patients. *Pain.* 1986;25(2):215–21.
- Ram D, Shapira J, Holan G, Magora F, Cohen S, Davidovich E, et al. Audiovisual video eyeglass distraction during dental treatment in children. *Quintessence Int.* 2010;41(8):673–9.
- Hua Y, Qiu R, Yao WY, Zhang Q, Chen XL. The Effect of Virtual Reality Distraction on Pain Relief During Dressing Changes in Children with Chronic Wounds on Lower Limbs. *Pain Manag Nurs.* 2015;16(5):685–91.
- Garrett B, Taverner T, Mcdade P. Virtual Reality as an Adjunct Home Therapy in Chronic Pain Management: An Exploratory Study. *JMIR Med Inform.* 2017;5(2):e11. doi:10.2196/medinform.7271.
- Aliakbari M, Alipor A, Ebrahimimoghadam H, Fekraty M. The Effect of Virtual Reality (VR) on Psychological Disorders in Cancer Cases. *Military Caring Sci.* 2017;4(1):49–57. doi:10.29252/mcs.4.1.49.
- Ahmadpour N, Keep M, Janssen A, Rouf AS, Marthick M. Design Strategies for Virtual Reality Interventions for Managing Pain and Anxiety in Children and Adolescents: Scoping Review. *JMIR Serious Games.* 2020;8(1):14565. doi:0.2196/14565.
- Walco GA, Conte PM, Labay LE, Engel R, Zeltzer LK. Procedural distress in children with cancer: self-report, behavioral observations, and physiological parameters. *Clin J Pain.* 2005;21(6):484–90.
- Al-Khotani A, Bello LA, Christidis N. Effects of audiovisual distraction on children's behaviour during dental treatment: a randomized controlled clinical trial. *Acta Odontol Scand.* 2016;74(6):494–501.
- Calderón S, Rincón R, Araujo A, Gantiva C. Effect of Congruence Between Sound and Video on Heart Rate and Self-Reported Measures of Emotion. *Eur J Psychol.* 2018;14(3):621–31.
- Prabhakar AR, Marwah N, Raju OS. A comparison between audio and audiovisual distraction techniques in managing anxious pediatric dental patients. *J Indian Soc Pedod Prev Dent.* 2007;25(4):177–82.
- Wiederhold MD, Gao K, Wiederhold BK. Clinical use of virtual reality distraction system to reduce anxiety and pain in dental procedures. *Cyberpsychol Behav Soc Netw.* 2014;17(6):359–65.

Author biography

Bikash Ranjan Bindhani, Post Graduate Trainee

Pritam Mohanty, Professor

Ashish Kamboj, Orthodontist

Subhas Seth, Reader

Debapreeti Mohanty, Senior Lecturer

PV Samir, Reader

Cite this article: Bindhani BR, Mohanty P, Kamboj A, Seth S, Mohanty D, Samir PV. Effectiveness of Virtual Reality (VR) technology towards pain management during initial fixed orthodontic procedures: A case-control study. *IP Indian J Orthod Dentofacial Res* 2022;8(3):156-160.