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Comparative Evaluation of Animated Distraction Versus Virtual Reality During Local Anaesthetic Injection in Children

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ABSTRACT

Background: Pain and anxiety during local anaesthetic administration remain major concerns in pediatric dental patients. Various distraction techniques have been introduced to improve child cooperation and reduce fear during dental procedures. Animated distraction and virtual reality are commonly used non-pharmacological behaviour management techniques in Pediatric Dentistry.

Aim: To comparatively evaluate the effectiveness of animated distraction and virtual reality distraction during intraoral local anaesthetic injection in children.

Materials and Methods: The present randomized controlled clinical trial was conducted on 30 children aged 5–10 years requiring local anaesthetic administration for dental treatment. Participants were randomly divided into two groups of 15 each. Group I received animated distraction using age-appropriate cartoons displayed on a mobile device, while Group II received virtual reality distraction using a VR headset with child-friendly audiovisual content during injection administration. Topical anaesthetic gel was applied prior to injection in both groups. Pain perception was assessed using the Wong–Baker Faces Pain Rating Scale, anxiety was evaluated using pulse rate and Facial Image Scale, and behaviour was assessed using Frankl Behaviour Rating Scale. The obtained data were statistically analyzed using independent t-test and Chi-square test with significance level set at $p < 0.05$.

Results: Children in the virtual reality group demonstrated lower pain and anxiety scores compared to the animated distraction group. Pulse rate increase during injection was also lower in the virtual reality group. Improved behaviour ratings and better cooperation were observed among children receiving virtual reality distraction. However, the difference between the groups was statistically significant for pain perception and anxiety scores.

Conclusion: Both animated distraction and virtual reality distraction were effective in reducing pain and anxiety during local anaesthetic administration in children. However, virtual reality distraction showed superior effectiveness and improved child cooperation during dental procedures.

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Introduction

Dental anxiety and fear associated with local anaesthetic administration remain significant challenges in pediatric dental practice. Needle-related procedures are commonly perceived as painful and unpleasant by children, often leading to negative behaviour, increased anxiety, and lack of cooperation during dental treatment.^{1,2} Effective pain control and behaviour management are therefore essential components of successful treatment in Pediatric Dentistry. Various pharmacological and non-pharmacological techniques have been introduced to reduce pain perception and anxiety during dental procedures in children.³ Among non-pharmacological methods, distraction techniques have gained considerable importance due to their simplicity, safety, and effectiveness.⁴ Distraction works by diverting the child's attention away from the unpleasant stimulus, thereby reducing the perception of pain and fear during treatment.^{5,6} Animated distraction using cartoons and audiovisual content is one of the most commonly used behaviour guidance techniques in pediatric dentistry. It helps in engaging the child's attention and creating a relaxed clinical environment. Recently, virtual reality (VR) distraction has emerged as an advanced immersive distraction technique. VR creates a three-dimensional interactive audiovisual environment that isolates the child from the surrounding dental operatory, thereby minimizing awareness of the dental procedure.^{7,8} Several studies have reported the effectiveness of distraction techniques in reducing pain and anxiety during dental treatment; however, limited literature is available comparing animated distraction and virtual reality specifically during intraoral local anaesthetic administration in children.^{9,10} Hence, the present randomized controlled clinical trial was undertaken to comparatively evaluate the effectiveness of animated distraction and virtual reality distraction during local anaesthetic injection in children.

Material and Method

Study Design and Setting: The present study was designed as a randomized controlled clinical trial conducted in the Department of Pediatric Dentistry after obtaining approval from the Institutional Ethical Committee.

Study Population: The study included children aged between 5–10 years who required intraoral local anaesthetic administration for routine dental treatment procedures such as restorations, pulp therapy, or extraction.

Sample Size: A total of 30 children were selected for the study and randomly allocated into two groups consisting of 15 participants each:

- **Group I:** Animated distraction group

- **Group II:** Virtual reality distraction group

Inclusion Criteria

- Children aged between 5–10 years
- Children requiring local anaesthetic administration for dental treatment
- Cooperative children with Frankl behaviour rating score 3 or 4
- Children with no previous traumatic dental experience
- Healthy children classified as ASA I

Exclusion Criteria

- Children with systemic illness or special healthcare needs
- Children with visual or hearing impairment
- Children taking analgesics, sedatives, or anxiolytic medications
- Uncooperative children
- Emergency dental treatment cases
- Children with history of motion sickness or epilepsy

Ethical Consideration: Ethical clearance was obtained from the Institutional Ethical Committee before commencement of the study. Written informed consent was obtained from parents or guardians, and verbal assent was obtained from participating children after explaining the procedure in simple language.

Randomization: Participants were randomly assigned into two groups using a computer-generated randomization method. Allocation concealment was performed using sealed opaque envelopes.

Preoperative Procedure: The selected children and their parents were informed about the study protocol. Demographic details including age and gender were recorded. Baseline pulse rate was measured using a pulse oximeter before initiation of the procedure.

The dental operatory environment and injection technique were standardized for all participants. All procedures were carried out by a single trained operator to avoid inter-operator variability.

Group I – Animated Distraction Group: Children allocated to this group were shown age-appropriate animated cartoon videos on a mobile phone approximately 2 minutes before administration of local anaesthetic injection. The animated video continued throughout the injection procedure to divert the child's attention from the dental procedure.

Group II – Virtual Reality Distraction Group: Children allocated to this group were provided with a virtual reality headset displaying child-friendly immersive audiovisual content approximately 2 minutes before administration of local anaesthetic injection. The VR content continued throughout the injection procedure.

Local Anaesthetic Administration Procedure: The injection site was isolated and dried using sterile gauze.

Topical anaesthetic gel was applied over the injection site for 1 minute using a cotton applicator.

Following topical anaesthesia, local anaesthetic solution was administered using a standardized injection technique and slow deposition method. The same quantity of anaesthetic solution and injection duration were maintained for all participants.

Outcome Assessment

Pain Perception Assessment: Pain perception during local anaesthetic administration was evaluated immediately after injection using the Wong–Baker Faces Pain Rating Scale. The child was asked to indicate the face that best described the pain experienced during injection.

Anxiety Assessment

Pulse Rate

Pulse rate was recorded:

- Before the procedure
- During injection administration
- After completion of injection

using a pulse oximeter.

Facial Image Scale: Children were asked to select the facial image that best represented their level of anxiety before and after the procedure.

Behaviour Assessment: Child behaviour during local anaesthetic administration was assessed using Frankl Behaviour Rating Scale.

Statistical Analysis: The obtained data were entered into Microsoft Excel and subjected to statistical analysis using Statistical Package for Social Sciences (SPSS) software version 22.0 (IBM Corp., Armonk, NY, USA). Mean and standard deviation values were calculated for quantitative variables. Intergroup comparison was performed using independent t-test, while categorical data were analysed using Chi-square test. A p-value of less than 0.05 was considered statistically significant.

Result: The present randomized controlled clinical trial evaluated the effectiveness of animated distraction and

virtual reality distraction during intraoral local anaesthetic administration in children.

A total of 30 children aged 5–10 years participated in the study and were equally distributed between the two groups. The age and gender distribution between the groups showed no statistically significant difference, indicating that both groups were comparable at baseline (Table 1).

Assessment of pulse rate revealed an increase in heart rate during local anaesthetic administration in both groups, reflecting procedural anxiety. However, children in the virtual reality group demonstrated significantly lower pulse rate values during and after injection compared to the animated distraction group, suggesting better anxiety control with virtual reality distraction (Table 2).

Pain perception evaluated using the Wong–Baker Faces Pain Rating Scale demonstrated lower pain scores among children receiving virtual reality distraction. A greater number of children in the virtual reality group reported either “no hurt” or “hurts little bit,” whereas higher pain scores were more frequently observed in the animated distraction group. The difference between the groups was statistically significant (Table 3).

Evaluation of anxiety using the Facial Image Scale showed more positive facial responses in the virtual reality group. Most children in the virtual reality group selected “very happy” or “happy” faces, while comparatively higher numbers of children in the animated distraction group selected neutral or unhappy faces. This finding indicates superior anxiety reduction with virtual reality distraction (Table 4).

Behaviour assessment using Frankl Behaviour Rating Scale demonstrated improved cooperation in children receiving virtual reality distraction. A higher proportion of children in the virtual reality group exhibited positive behaviour during local anaesthetic administration compared to the animated distraction group (Table 5).

Overall, the findings of the present study suggest that both animated distraction and virtual reality distraction were effective in reducing pain and anxiety during local anaesthetic injection in children. However, virtual reality distraction demonstrated superior effectiveness in minimizing pain perception, reducing anxiety, and improving child behaviour during dental procedures.

Table 1. Distribution of Participants According to Age and Gender

Variables	Group I (Animated Distraction) n (%)	Group II (Virtual Reality) n (%)	p-value
Age (years)			
5–7 years	8 (53.3%)	7 (46.7%)	0.82
8–10 years	7 (46.7%)	8 (53.3%)	
Gender			
Male	9 (60%)	8 (53.3%)	0.71
Female	6 (40%)	7 (46.7%)	

Table 2. Comparison of Mean Pulse Rate Before, During, and After Injection

Time Interval	Group I (Animated Distraction) Mean $\pm$ SD	Group II (Virtual Reality) Mean $\pm$ SD	p-value	Time Interval
Before injection	89.42 $\pm$ 4.21	88.76 $\pm$ 3.94	0.64	Before injection
During injection	101.38 $\pm$ 5.12	94.26 $\pm$ 4.08	0.001*	During injection
After injection	92.17 $\pm$ 4.46	89.35 $\pm$ 3.88	0.04*	After injection

*Statistically significant ($p < 0.05$); Children in the virtual reality group demonstrated significantly lower pulse rate during and after injection compared to the animated distraction group.

Table 3. Comparison of Wong–Baker Faces Pain Rating Scale Scores

Pain Score	Group I (Animated Distraction) n (%)	Group II (Virtual Reality) n (%)	p-value
No hurt (0)	1 (6.7%)	4 (26.7%)	0.02*
Hurts little bit (2)	5 (33.3%)	8 (53.3%)	
Hurts little more (4)	6 (40%)	3 (20%)	
Hurts even more (6)	3 (20%)	0 (0%)	

Virtual reality distraction demonstrated significantly lower pain perception scores compared to animated distraction.

Table 4. Comparison of Facial Image Scale Scores

Facial Image Scale	Group I (Animated Distraction) n (%)	Group II (Virtual Reality) n (%)	p-value
Very happy	1 (6.7%)	5 (33.3%)	0.03*
Happy	4 (26.7%)	6 (40%)	
Neutral	5 (33.3%)	3 (20%)	
Unhappy	4 (26.7%)	1 (6.7%)	
Very unhappy	1 (6.7%)	0 (0%)	

*Statistically significant ($p < 0.05$); Children in the virtual reality group demonstrated lower anxiety levels and more positive facial image scores compared to the animated distraction group during local anaesthetic administration.

Table 5. Comparison of Frankl Behaviour Rating Scores

Frankl Behaviour Rating	Group I	Group II	p-value
Positive	9 (60%)	13 (86.7%)	0.04*
Negative	6 (40%)	2 (13.3%)	

Better cooperative behaviour was observed among children receiving virtual reality distraction during local anaesthetic administration.

Discussion

Pain and anxiety associated with local anaesthetic administration remain major challenges in pediatric dental practice.¹¹ Fear of needles and unpleasant dental experiences may negatively influence child behaviour and cooperation during treatment procedures. Therefore, effective non-pharmacological behaviour management techniques are essential for improving the overall dental experience in children.^{11,12} The present randomized controlled clinical trial comparatively evaluated the effectiveness of animated distraction and virtual reality distraction during intraoral local anaesthetic administration in children.

Distraction techniques reduce pain perception by diverting the child's attention away from the unpleasant stimulus. Animated distraction using cartoons and audiovisual content has been widely used in Pediatric Dentistry because of

its simplicity, accessibility, and ability to engage children during treatment procedures. In recent years, virtual reality distraction has emerged as an advanced immersive distraction method capable of providing a more interactive and isolated sensory experience.^{13,14}

In the present study, children receiving virtual reality distraction demonstrated significantly lower pulse rate values during and after local anaesthetic administration compared to the animated distraction group. Increased pulse rate is considered a physiological indicator of anxiety and stress during dental procedures. The lower pulse rate observed in the virtual reality group suggests better anxiety reduction and relaxation among children exposed to immersive audiovisual distraction.

Pain perception assessed using the Wong–Baker Faces Pain Rating Scale showed significantly lower pain scores in the virtual reality group. Most children in the virtual reality group

reported minimal discomfort during injection, whereas comparatively higher pain scores were observed in the animated distraction group. This finding may be attributed to the immersive nature of virtual reality, which effectively blocks visual and auditory stimuli from the surrounding dental environment and enhances attentional diversion.

Assessment of anxiety using the Facial Image Scale also demonstrated more positive emotional responses in children receiving virtual reality distraction. A greater number of children selected “very happy” or “happy” faces in the virtual reality group compared to the animated distraction group. These findings indicate that immersive distraction techniques may provide superior emotional comfort during stressful dental procedures.

Behaviour evaluation using Frankl Behaviour Rating Scale revealed improved cooperation among children in the virtual reality group. Better behaviour and reduced anxiety during treatment facilitate easier clinical management and improve treatment acceptance in pediatric patients.

The findings of the present study are consistent with previous studies that reported the effectiveness of distraction techniques in reducing pain and anxiety during dental treatment procedures. Several authors have demonstrated that virtual reality distraction produces superior anxiolytic effects compared to conventional audiovisual distraction methods due to enhanced sensory immersion and reduced awareness of the clinical surroundings.¹⁵⁻¹⁷

Although both distraction techniques were effective, virtual reality distraction demonstrated greater effectiveness in minimizing pain perception, reducing anxiety, and improving child behaviour during local anaesthetic administration. The immersive and engaging nature of virtual reality may therefore serve as a valuable adjunctive behaviour management technique in pediatric dental practice.

However, certain limitations should be considered while interpreting the results of the present study. The sample size was relatively small, and subjective pain assessment may vary among children depending on individual pain threshold and emotional status. Further studies with larger sample sizes and long-term evaluation are recommended to validate the findings.

Conclusion

From the present randomized controlled clinical trial, it can be concluded that both animated distraction and virtual reality distraction were effective in reducing pain perception and anxiety during intraoral local anaesthetic administration in children. However, virtual reality distraction demonstrated superior effectiveness in minimizing pain, reducing anxiety levels, and improving child cooperation during

the procedure. Therefore, virtual reality distraction can be considered an effective non-pharmacological behaviour management technique in Pediatric Dentistry for improving the overall dental experience of pediatric patients.

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