

## Effect of virtual reality distraction on pain and anxiety during inferior alveolar nerve block administration in children aged 8–10 years: A randomized controlled clinical study

Dr. Savitha Sathyaprasad<sup>1</sup>, Dr. P Sharvari Aithal<sup>2</sup>

<sup>1</sup> Head, Department of Pediatric and Preventive dentistry, KVG dental college and Hospital, Sullia, Karnataka, India

<sup>2</sup> Department of Pediatric and Preventive Dentistry, KVG dental college and Hospital, Sullia, Karnataka, India

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### Abstract

**Background:** Administration of local anesthesia remains one of the most anxiety-provoking procedures in pediatric dentistry. Inferior alveolar nerve block (IANB) is frequently associated with fear, discomfort, and pain perception among children. Virtual reality (VR) distraction has emerged as a promising non-pharmacological behavior guidance technique that may reduce anxiety and pain during dental procedures.

**Aim:** To evaluate the effectiveness of virtual reality distraction in reducing pain and anxiety during inferior alveolar nerve block administration in children aged 8–10 years.

**Materials and Methods:** A randomized controlled clinical study was conducted among 32 children aged 8–10 years requiring IANB for dental treatment. Participants were randomly allocated into two groups: Control group (n=16) and VR group (n=16). Baseline anxiety was assessed using the Modified Child Dental Anxiety Scale (MCDAS). Anxiety before and after IANB administration was evaluated using the Venham Clinical Anxiety Scale. Pain perception was assessed using the FLACC scale and Wong–Baker Faces Pain Rating Scale. Children in the VR group viewed the animated cartoon “Shiva: The Cycle” using a VR headset before and during administration of local anesthesia. Statistical analysis was performed using non-parametric tests. Intergroup comparison was carried out using the Mann–Whitney U test and intragroup comparison using the Wilcoxon signed-rank test. Statistical significance was set at  $p < 0.05$ .

**Results:** No statistically significant difference was observed between groups regarding baseline anxiety scores assessed by MCDAS ( $p=0.432$ ) and preoperative Venham scores ( $p=0.675$ ). However, postoperative Venham anxiety scores were significantly lower in the VR group compared with the control group ( $p < 0.001$ ). FLACC scores and Wong–Baker pain scores were also significantly lower in the VR group ( $p < 0.001$ ).

**Conclusion:** Virtual reality distraction significantly reduced pain and anxiety during inferior alveolar nerve block administration and may serve as an effective adjunctive behavior guidance technique in pediatric dentistry.

**Keywords:** Virtual reality, pediatric dentistry, anxiety, pain, inferior alveolar nerve block, distraction

### Introduction

Dental anxiety is a common challenge encountered in pediatric dentistry and is frequently associated with uncooperative behavior, treatment avoidance, and negative future dental experiences [1]. Children who experience painful or unpleasant dental procedures may develop long-term dental fear that adversely affects oral healthcare utilization [2].

Among dental procedures, administration of local anesthesia is considered one of the most anxiety-provoking experiences in children [3]. Inferior alveolar nerve block (IANB) is routinely used for restorative and pulp therapy procedures involving mandibular teeth; however, the injection itself is often associated with pain and apprehension [4]. Consequently, pediatric dentists continually seek effective behavior guidance strategies to improve treatment acceptance and reduce procedural distress.

The American Academy of Pediatric Dentistry recommends the use of non-pharmacological behavior guidance techniques whenever possible to reduce anxiety and facilitate positive dental experiences [5]. Distraction is one such technique that diverts attention away from unpleasant stimuli and reduces pain perception. Conventional distraction methods include storytelling, music, audiovisual aids, and cartoons [6].

Virtual reality (VR) is an emerging technology that creates an immersive three-dimensional audiovisual environment capable of engaging multiple sensory pathways simultaneously [7]. VR distraction has been successfully utilized in several medical and dental settings to reduce procedural anxiety and pain [8]. The immersive nature of VR reduces awareness of the clinical environment and redirects cognitive attention away from painful stimuli [9].

Several recent studies have investigated the effectiveness of virtual reality distraction in pediatric dentistry. Shekhar *et al* [10] reported significant reductions in anxiety, pain, and negative behavior during administration of local anesthesia using distraction techniques. Zaidman *et al* [11] observed lower pain perception and improved cooperation among children receiving dental treatment with VR goggles. Bagher *et al* [12] demonstrated significant reductions in dental anxiety among anxious pediatric patients exposed to VR distraction. Furthermore, a systematic review and meta-analysis by Egly *et al* [13] concluded that immersive virtual reality shows considerable potential for reducing anxiety and pain during pediatric dental treatment. These findings support the growing use of VR as a behavior guidance technique in pediatric dentistry.

Due to conflicting evidence in the literature and limited data regarding the use of VR during inferior alveolar nerve block administration, further research is warranted. Therefore, the

present study was undertaken to evaluate the effectiveness of VR distraction using the animated cartoon “Shiva: The Cycle” in reducing anxiety and pain during IANB administration in children aged 8–10 years.

## Materials and Methods

### Study Design

A randomized controlled clinical study was conducted in the Department of Pediatric and Preventive Dentistry, K.V.G. Dental College and Hospital, Sullia.

Thirty-two healthy children aged 8–10 years requiring inferior alveolar nerve block for dental treatment were recruited.

#### Inclusion Criteria

- Children aged between 8 and 10 years.
- Requiring IANB for dental treatment.
- Cooperative children capable of understanding instructions.
- Parental informed consent obtained.

#### Exclusion Criteria

- Medically compromised children.
- Children with visual or hearing impairments.
- Children with neurological disorders such as epilepsy.
- Previous exposure to virtual reality devices.
- Children requiring pharmacological behavior management

A total of 32 children were included and randomly allocated into two groups comprising 16 participants each. Group I (Control Group) received conventional behavior management during IANB administration. Group II (VR Group) Children viewed the animated cartoon “Shiva: The Cycle” using a Virtual Reality VR Glasses/VR Helmet headset. The headset was placed approximately 2–3 minutes before administration of local anesthesia and remained in position throughout the injection procedure.

### Outcome Measures

Modified Child Dental Anxiety Scale (MCDAS) Used to assess baseline dental anxiety levels. Venham Clinical Anxiety Scale, Recorded before and after administration of local anesthesia. FLACC Scale, Pain was evaluated using the Face, Legs, Activity, Cry, and Consolability (FLACC) behavioral pain assessment scale. Wong–Baker Faces Pain Rating Scale, Self-reported pain perception was assessed using the Wong–Baker Faces Pain Rating Scale.

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS software. Frequency and percentage were calculated for categorical variables. Mean and standard deviation were calculated for continuous variables. Mann–Whitney U test was used for intergroup comparisons. Wilcoxon signed-rank test was used for intragroup comparisons. Statistical significance was set at  $p < 0.05$ .

## Results

### Demographic Distribution

A total of 32 children aged 8–10 years participated in the study. The participants were equally distributed between the control group ( $n=16$ , 50%) and the VR group ( $n=16$ , 50%).

Equal allocation ensured comparability between groups and minimized selection bias.

### Baseline Anxiety Assessment (MCDAS)

The mean MCDAS score was  $11.75 \pm 2.8$  in the control group and  $10.50 \pm 2.7$  in the VR group. Intergroup comparison using the Mann–Whitney U test revealed no statistically significant difference ( $p = 0.432$ ). This indicates that both groups had comparable baseline dental anxiety levels before the intervention, confirming successful randomization.

### Preoperative Anxiety Assessment (Venham Scale)

The mean preoperative Venham anxiety score was  $1.06 \pm 0.8$  in the control group and  $0.88 \pm 0.9$  in the VR group. The difference was not statistically significant ( $p = 0.675$ ), demonstrating that anxiety levels immediately before administration of local anesthesia were similar in both groups.

### Postoperative Anxiety Assessment (Venham Scale)

Following administration of the inferior alveolar nerve block, the mean Venham anxiety score increased to  $2.31 \pm 1.3$  in the control group, whereas the VR group demonstrated a substantially lower score of  $0.56 \pm 0.7$ . This difference was highly statistically significant ( $p < 0.001$ ). These findings suggest that virtual reality distraction effectively reduced anxiety associated with local anesthetic administration.

### Behavioral Pain Assessment (FLACC Scale)

The mean FLACC score in the control group was  $2.31 \pm 1.1$ , while the VR group demonstrated a significantly lower mean score of  $0.31 \pm 0.6$ . The difference was highly significant ( $p < 0.001$ ). This indicates that children using VR exhibited fewer behavioral signs of pain, such as facial grimacing, crying, body movement, and lack of consolability during the injection procedure.

### Self-Reported Pain Assessment (Wong–Baker Faces Pain Rating Scale)

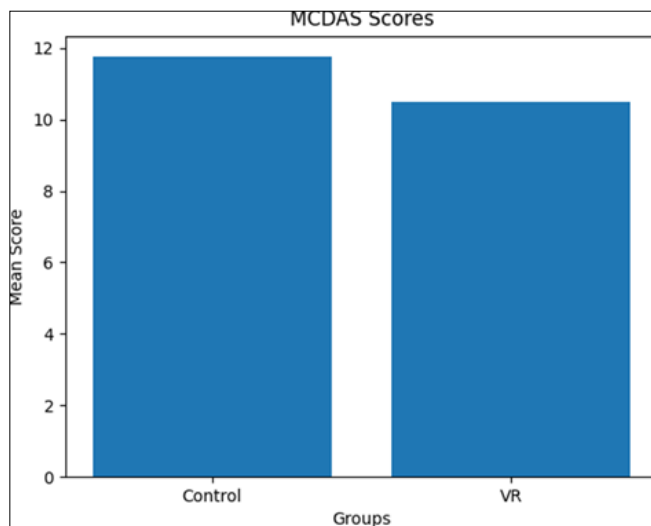
The mean Wong–Baker pain score was  $2.00 \pm 0.0$  in the control group compared with  $0.25 \pm 0.6$  in the VR group. The difference was highly statistically significant ( $p < 0.001$ ). This finding demonstrates that children exposed to VR distraction perceived significantly less pain during administration of the inferior alveolar nerve block.

**Table 1:** Distribution of Study Groups

| Group   | Frequency (n) | Percentage (%) |
|---------|---------------|----------------|
| Control | 16            | 50%            |
| VR      | 16            | 50%            |

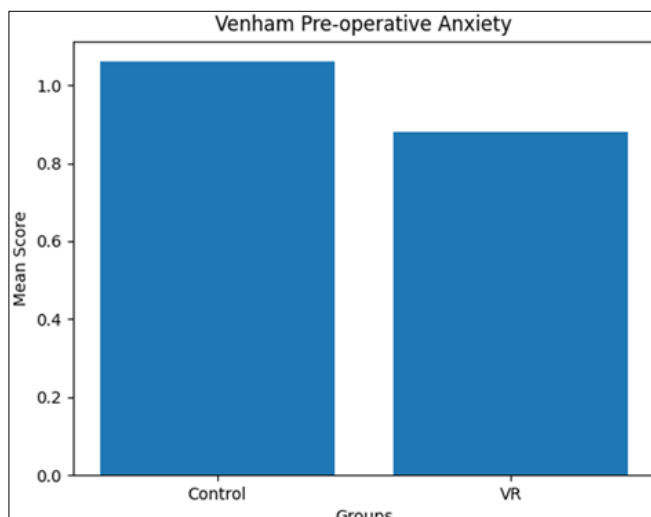
**Table 2:** Comparison of Mean Anxiety Scores (MCDAS)

| Group   | Mean $\pm$ SD   | p-value |
|---------|-----------------|---------|
| Control | $11.75 \pm 2.8$ |         |
| VR      | $10.50 \pm 2.7$ | 0.432   |



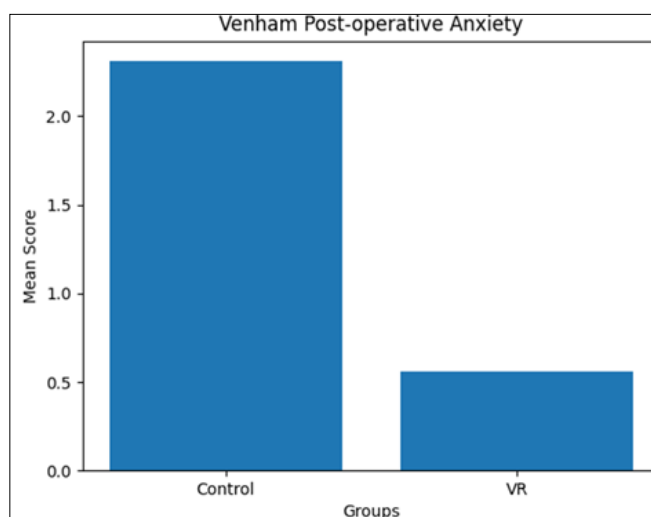
**Table 3:** Comparison of Venham Anxiety Scores Pre-operative

| Group   | Mean ± SD  | p-value |
|---------|------------|---------|
| Control | 1.06 ± 0.8 |         |
| VR      | 0.88 ± 0.9 | 0.675   |



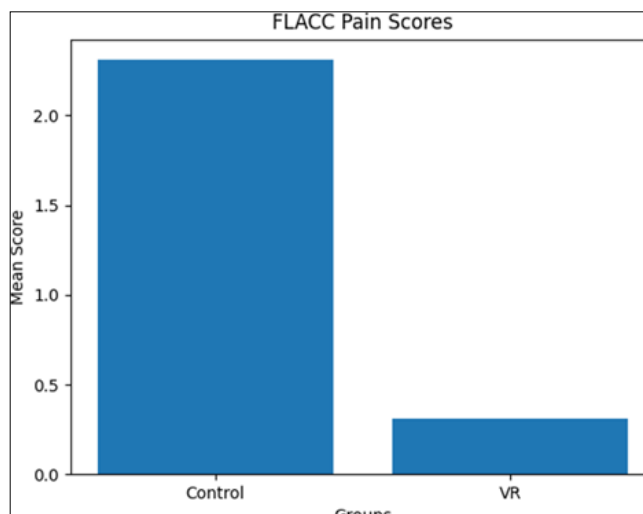
**Table 4:** Comparison of Venham Anxiety Scores Post-operative

| Group   | Mean ± SD  | p-value |
|---------|------------|---------|
| Control | 2.31 ± 1.3 |         |
| VR      | 0.56 ± 0.7 | <0.001* |



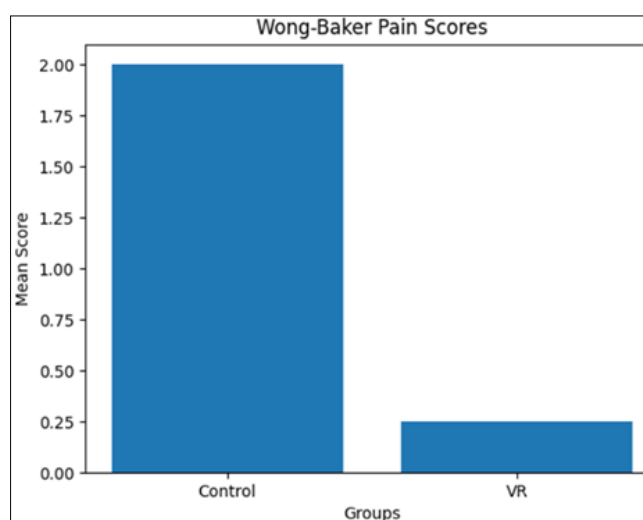
**Table 5:** Comparison of Pain Scores (FLACC)

| Group   | Mean ± SD  | p-value |
|---------|------------|---------|
| Control | 2.31 ± 1.1 |         |
| VR      | 0.31 ± 0.6 | <0.001* |



**Table 6:** Comparison of Pain Scores (Wong-Baker)

| Group   | Mean ± SD  | p-value |
|---------|------------|---------|
| Control | 2.00 ± 0.0 |         |
| VR      | 0.25 ± 0.6 | <0.001* |



## Discussion

The present study evaluated the effectiveness of virtual reality distraction in reducing anxiety and pain during inferior alveolar nerve block administration in children aged 8–10 years. The results demonstrated that VR distraction significantly reduced postoperative anxiety and pain perception when compared with conventional behavior management.

Baseline anxiety scores assessed using MCDAS and preoperative Venham scores were comparable between the groups, indicating successful randomization and homogeneity of study participants. However, children exposed to VR distraction demonstrated significantly lower postoperative anxiety scores. These findings suggest that immersion within a virtual environment effectively diverted attention away from the injection procedure and reduced anticipatory fear.

Pain assessment was performed using both behavioral and subjective methods. The FLACC scale was selected because it provides reliable behavioral assessment of procedural pain in pediatric patients [14]. The Wong–Baker Faces Pain Rating Scale was used because it is simple, valid, and widely accepted among children [15].

The significantly lower FLACC and Wong–Baker scores observed in the VR group indicate that virtual reality distraction effectively reduced both observed and self-reported pain responses during administration of local anesthesia. These findings support the concept that immersive audiovisual stimulation can decrease awareness of painful stimuli by competing for cognitive attention resources.

The findings of the present study are consistent with contemporary evidence supporting the use of immersive virtual reality in pediatric dentistry. Zaidman *et al* [11], reported significantly reduced pain perception among children using VR goggles during dental treatment. Similarly, Bagher *et al* [12], demonstrated lower anxiety levels among pediatric patients receiving VR distraction. Anchala *et al* [14], compared kaleidoscopes, virtual reality, and video games and concluded that virtual reality was among the most effective techniques for reducing dental anxiety during local anesthesia administration. These findings support the significant reductions in postoperative Venham, FLACC, and Wong–Baker scores observed in the present study. However, Felemban *et al* [15], reported no additional benefit of VR over conventional screen distraction, which may be attributed to differences in study design, patient age, distraction content, and type of local anesthesia administered.

The results differ from those reported by Felemban *et al* [15], who found no additional benefit of VR over conventional screen distraction during infiltration anesthesia. The discrepancy may be attributed to differences in study design, distraction content, age groups, and outcome measures. In the present study, children viewed the highly engaging animated cartoon “Shiva: The Cycle,” which may have enhanced immersion and attentional diversion during the injection procedure.

The effectiveness of VR can be explained by the gate control theory of pain. According to this theory, sensory and cognitive distraction reduce transmission of painful stimuli to higher cortical centers. By simultaneously engaging visual and auditory pathways, VR creates a powerful distraction capable of reducing pain perception and anxiety. One of the strengths of the present study was the randomized controlled design. Multiple validated scales were utilized to assess both anxiety and pain, thereby improving reliability of findings. Furthermore, the study focused specifically on inferior alveolar nerve block administration, which is recognized as one of the most anxiety-provoking procedures in pediatric dentistry.

Certain limitations should be acknowledged. The sample size was relatively small and participants were recruited from a single institution. Observer blinding during FLACC assessment was not possible due to the visible presence of the VR headset. Additionally, only immediate procedural outcomes were evaluated. Future multicentric studies with larger sample sizes and assessment of patient satisfaction and long-term behavioral outcomes are recommended.

## Conclusion

Virtual reality distraction significantly reduced anxiety and pain during inferior alveolar nerve block administration in children aged 8–10 years. Children exposed to VR distraction demonstrated lower postoperative anxiety scores, lower behavioral pain responses, and lower self-reported pain scores compared with those receiving conventional behavior management. Virtual reality may therefore be considered an effective, non-invasive, and child-friendly adjunctive behavior guidance technique in pediatric dentistry.

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