

Effect of Virtual Reality Distraction versus Positive Pre-Visit Imagery Intervention on Children's Dental Fear and Anxiety during Local Anaesthesia Injection: Implications for Evidence-Based Practice

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Abstract

Background: Virtual Reality (VR) immerses children in a simulated environment and diverts their attention away from Dental Fear and anxiety (DFA). Likewise, Positive Pre-Visit Imagery (PPVI) intervention serves as a psychological preparation vehicle for the Local Anaesthesia (LA) injection in an attractive approach. Aim: this study aimed to investigate the effect of VR distraction versus PPVI intervention on children's DFA during LA injection. **Design:** A quasi-experimental study was conducted at Pedito-dentist Clinic, Dental Center, Alexandria. A sample of 90 children aged from 4-6 years were observed for their anxious behaviors in the waiting room. Participants randomly received routine unit care, VR distraction, or PPVI intervention, and their fear and anxious behavioral responses were quantified during LA injection. **Findings:** Majority of the VR group (83.3%) and 46.7% of the PPVI group experienced mild fear levels during dental LA injection compared to none of the children in the control group. Regarding children's anxiety, 36.7% of the VR group and 10.0% of the PPVI group were relaxed during the LA injection, while 43.3% of children in the control group were out-of-contact during the injection procedure. **Conclusion:** Both VR distraction and PPVI intervention showed positive effects and had excellent potential as evidence-based interventions for minimizing children's DFA during LA injection.

Keywords: Child behavior, Dental Anxiety, Dental Fear, Virtual Reality, Positive Pre-Visit Imagery, Local Anaesthesia Injection.

Introduction

Promoting children's health is a crucial nursing role. Dental health and psychological well-being are considered fundamental components of health promotion practices (Hockenberry & Wilson, 2015). Literature refers to early childhood dental caries as "the presence of one or more decayed with or without a cavitation lesion, missing teeth (due to caries), or filled surfaces in any primary tooth during early childhood" (Colak et al., 2013). This has been attributed to many causes like bottle-fed associated tooth decay and lack of dental hygiene. The cavitation process usually starts early from the age of 3 and becomes a significant health problem by the age of 4-6 years. This problem leads to severe pain and suffering among young children, thereby necessitates an urgent dental intervention (Colak et al., 2013). Dental

procedures, especially Local Anaesthesia (LA) injection, are among the most unpleasant experiences for young children. Basically, Dental Fear and Anxiety (DFA) are pervasive psychological problems coupled with avoiding dental treatments among young children. Consequently, they adversely affect their oral and psychological health (Beena et al., 2013 & Srivastava et al., 2008).

It is incredibly important for nurses to understand why children experience DFA, and their impact on the children's thoughts, feelings and behaviours. The roots of these psychological problems, DFA, can be interpreted in the light of the diversity of developmental theories. From the Freudian perspective, all fears are acquired during infancy, and early childhood since their ego has not been fully developed yet (Passer & Smith, 2016). In that sense, preschool-age children usually experience fear from many

factors, including, but not limited to, unknown and unexpected situations, dealing with strangers, separation from parents, loss of control, and body injuries (Morgan & Porritt, 2017). In the dental clinic environment, the health care professional with white uniforms, sounds, smells, instruments, needles, dental chair, and a spotlight may also elicit fear in this age group. According to Piaget, preschool-age children are not equipped to apply logical reasoning to abstract problems like the importance of LA injection in restorative dental interventions (Passer & Smith, 2016). In this stage, children also use language symbolically and are concerned with the "why" and "how" of things. For instance, they symbolize a needle as "something that hurts" (Passer & Smith, 2016). Such painful experiences take on new significance because memory is linked with the specific event, and consequently, fears are more likely to be developed (Beckett, 2002). From a behaviorist standpoint, children can condition the dental visit generally with an unpleasant experience. This leads to aversive feelings of fear and triggering the possibility of avoidance or delaying dental treatment (Passer & Smith, 2016).

Nurses play diverse roles in both clinical and non-clinical aspects in the pediatric restorative dental procedures as well as they act as advocates for children's physical and psychological safety. Clinically, they prepare the dental equipment, instruments, and materials and carry out the sterilization and infection control measures. Increasingly, they check stock, refer to the ordered laboratories and radiographs, and perform some administrative work. They also provide health teaching for children and their mothers about areas that might need more attention, e.g., the importance of tooth brushing and risk factors that aggravating dental caries (Coleman, 2005). Moreover, they create a psychological climate that is enriched with support and reassurance. In fact, nurses face a great challenge to minimize DFA and stabilize young children psychologically during restorative dental procedures. Such stabilization is the cornerstone of successful LA injection and facilitates the dentist's mission. Thus, nurses working in the dental clinics are responsible for

adopting innovative non-pharmacological manoeuvres to alleviate DFA. Among the most effective measures are Virtual Reality (VR) distraction and Positive Pre-Visit Imagery (PPVI) (Marshman & Williams 2017).

Virtual reality is a human-computer interface in which the users are completely immersed in a computer-generated environment and dynamically interact with this virtual world (Khadr et al., 2018; Rao et al., 2019). It integrates multiple perceptual senses, including; the visual, auditory, and kinaesthetic stimulation modalities. However, the PPVI intervention is a form of psychological preparation that provides children with a step-by-step explanation of the dental LA injection in an attractive approach. It helps children to anticipate, deal with, and be empowered to gain mastery over the dental events they will experience (Newton et al., 2012). This strategy serves as a non-pharmacologic, simple, self-regulative, cost-effective, and appropriate method for alleviating children's fears and counteracts the distorted beliefs that invading children's conscious awareness (Gangwal et al., 2014).

Theoretical Framework

Both VR distraction and PPVI interventions are rested under the umbrella of the cognitive-behavioral interventions (Williams et al., 2016; Rao et al., 2019). Such techniques are substantial potentiators that reshape children's catastrophic thoughts and negative expectations toward dental treatment. Virtual reality utilizes the effective behavior guidance technique that diverts children's attention away from the negative feelings associated with an unpleasant experience. Therefore, the children's attention is focused on what happened in the virtual world, and they are completely detached from the surrounding environment (Niharika et al., 2018). Meanwhile, the PPVI intervention incorporates a package of two different strategies including; informational provision and modeling (Do, 2004). The informational provision is based on the premise that introducing children with some degree of information about what they expect and what actually happens in the dental situation may facilitate dental treatment. The modeling techniques imply teaching children

the appropriate behaviors by watching children-model images reacting positively to dental experience (Gooding et al., 2017). Taken together, the integration between the adequate provision of information and the visual appeal of pictures could act as a catalyzing factor in reducing DFA among preschool-age children (Carter et al., 2014).

Since DFA are associated with anticipatory procedural distress, the American Academy of Pediatric Dentistry (2017) prompted the need to utilize the updated Evidence-based practice (EBP) that paves the road for adaptive psychological coping and serves as an outlet for these stressful situations. Therefore, nurses should adopt such strategies before and during the ambiance of the dental treatment.

Aim of the study

This study aimed to investigate the effect of VR distraction versus PPVI intervention on children's DFA during LA injection. A further objective is to examine the association between children's demographic characteristics, dental history, and their DFA levels.

Research Hypotheses

1. Children who receive virtual reality distraction exhibit less fear and anxiety level during local anaesthesia injection than those who do not.
2. Children who receive positive pre-visit imagery intervention exhibit less fear and anxiety level during local anaesthesia injection than those who do not.
3. Children who receive virtual reality distraction exhibit less fear and anxiety level than who receive pre-visit imagery intervention during local anaesthesia injection.

Method

Design and setting:

The investigators employed a quasi-experimental study with two intervention groups at Pedito-dentist Clinic, Dental Center, Alexandria.

Participants

The Epi info program version 10 was used to estimate the sample size using the following parameters; population size of 117, confidence coefficient= 95%, expected frequency of 50%, and acceptable error of 5%. The minimum sample size was 90 children.

Children whose ages ranged from 4-6 years with dental LA injection experience were included in the study. However, those who had visual, auditory deficits, anxiety disorders, or mental disabilities were excluded. Eligible preschool-age children who fit the inclusion criteria and their guardians agreed upon their participation were randomly assigned to three equal groups, as illustrated in Figure 1.

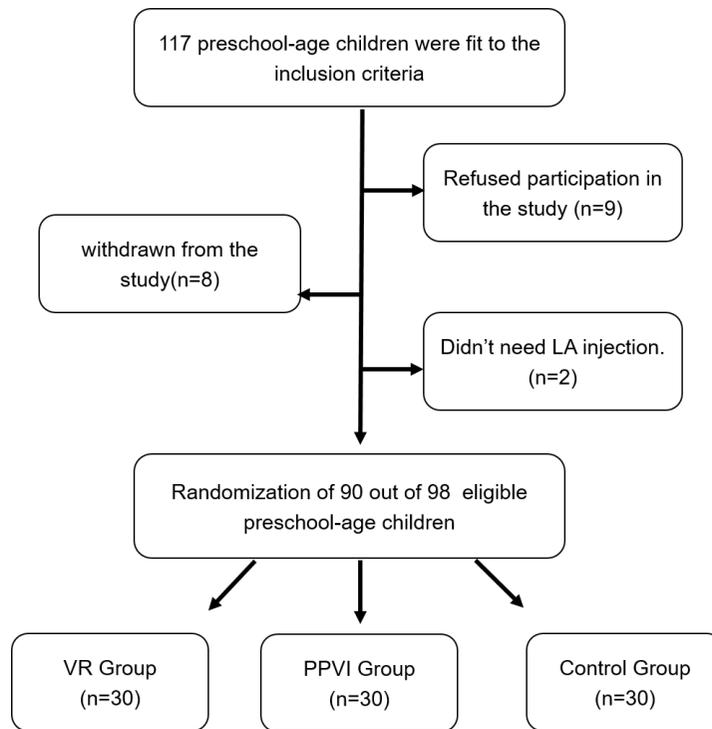


Figure 1: Flow chart of participants' recruitment process.

Measurement Tools

Waiting-Room Observational Scale

This scale was developed by Eden et al. (2008) to observe the young children's anxious behavioral expressions in the waiting room. It encompasses 27 items that concerned with observing two basic dimensions namely, children's behavioural expressions such as crying intensively and physiological features, such as sweating and vomiting. The items rated on a two-points Likert scale; score one denotes the presence of anxious behavior, while score zero indicates the absence of the anxious behavior. This valid scale demonstrates high reliability (Cronbach's alpha coefficient was 0.80).

Demographic characteristics and dental history of children were attached to this tool.

Dental Local Anaesthesia Injection Fear Scale (DLAIFS)

This scale was developed by the researchers after a thorough review of related literature to measure children's dental

fear during dental LA injection (Riba et al., 2017 & Malhotra et al., 2018). It consisted of 15 items that emphasized observing children's fear behavioral response. The scale comprises two main categories including avoidant behaviours such as refuse to leave caregiver, sit on the dental chair or open mouth in addition to over-exaggerated behaviors such as cries during injection, attempts to dislodge syringe, kicks the doctor and leave the chair. Each item was measured on a two-point Likert scale ranging from zero "behavior is not present" to one "behavior is present". This scale was submitted to a jury of five experts in pediatric and psychiatric nursing fields to test its content validity. Necessary modifications were done accordingly. The tool was valid (0.91). A pilot study was carried out on nine pre-school age children to test the tool's applicability, clarity and feasibility. These children were excluded from the total study subjects. Two trained raters independently recorded their observations of the children's fear behavioral response during LA injection. The Intraclass Correlation Coefficient was used to assess the inter-rater reliability that revealed good

agreement (0.89). The reliability of DLAIIFS was also ascertained by measuring the internal consistency of its items using the Cronbach alpha coefficient test ($\alpha = 0.83$). The total score ranged from 0-15. The fear levels were categorized as follows; "no fear" score zero, "mild fear" scores 1-5, "moderate fear" scores 6-10 while, "severe fear" scores 11-15.

Venham's Dental Clinical Anxiety Rating Scale (VCRS)

This scale was developed by Venham and Kremer (1979) to quantify the anxious behaviors of 4-6 years-old children during situational dental anxiety. It consists of 6 items that ranged from relaxed to out of contact and were given numeric digit from zero to five respectively as follows:

- **0 = Relaxed:** smiling, willing, able to conserve, displays behavior desired by the researcher.
- **1 = Uneasy:** concerned, may protest to indicate discomfort, hands remain down or partially raised. Tense facial expression, 'high chest'. Capable of cooperating.
- **2 = Tense:** tone of voice, questions and answers reflect anxiety. During stressful procedure, verbal protest, crying, hands tense and raised, but not interfering very much. Protest more distracting and troublesome. Child still complies with request to cooperate.
- **3 = Reluctant:** pronounced verbal protest, crying. Using hands to try to stop procedure. Treatment proceeds with difficulty.
- **4 = Interference:** general crying, body movements sometimes needing physical restraint. Protest disrupts procedure.
- **5 = Out of contact:** hard loud swearing, screaming unable to listen, trying to escape. Physical restraint required.

The scale was reliable and valid and can be easily integrated in clinical or research activities. Its content validity was 0.91 and test-retest reliability revealed to be 0.93.

Ethical considerations:

The study was approved by the Ethical Research committee, Faculty of Nursing, Alexandria University. Also, official permission for conducting the study was obtained from the director of the previously mentioned setting. The researchers approached guardians of the children who met the inclusion criteria. The study's aim was explained, and their free decision to voluntarily participate in the study was emphasized. The researchers also stressed the guardians' right to refuse the participation or withdraw from the study. After their agreement, written informed consent was obtained from the child's guardian. Privacy and anonymity were considered, and confidentiality of the obtained data was also assured.

Procedure and Data Collection

In the waiting room, the researchers established rapport with the children of the three groups. This was done within an empathetic atmosphere that conveys caring, tolerance, and simple communication accompanied by verbal reassurance and compassion. Then they assessed the children's demographic characteristics, dental history, and anxious dental behaviors using Tool one.

1- As for study group one, the VR distraction was applied as follows:

- The researchers prepared the VR device (Google VR Box and Anti-Tank Virtual Reality 3D Glasses). Then selected three dimensional (3D) MP4 audiovisual files for different cartoon series suitable for this age group such as "Tom and Jerry, snow-white.....etc."
- The researchers introduced themselves for children and their caregivers then they are explained the aim of using VR.
- The researches adopting tell-show-do technique in introducing VR Glasses. Where they provided explanations on how to use a headset in VR according to the child level of understanding (tell); and simultaneously show them the way of selecting and displaying the cartoon movie (show); and allow the child to apply it (do).
- Once VR device headset adapted to the child's head size and adjusted in front of

his/her eyes, the selected cartoon movie (3D Aquarium VR) application was played in the waiting area, during entry to the dental clinic with help of the researchers and throughout the procedure of local dental anesthesia injection without taking the VR headset off.

- The VR device blocked the visual field of the child completely and had headphones to deliver the high definition sound.
- After ensuring that the child is fully immersed in the cartoon movie, a needle of local anesthetic agent was prepared and injected after brief explanation.
- The procedure of local dental anesthesia preparation, explanation and injection lasted about 3 minutes, during this time the children shouldn't take off the (VR) headset.

As for study group two, The PPVI Intervention was operated as follows:

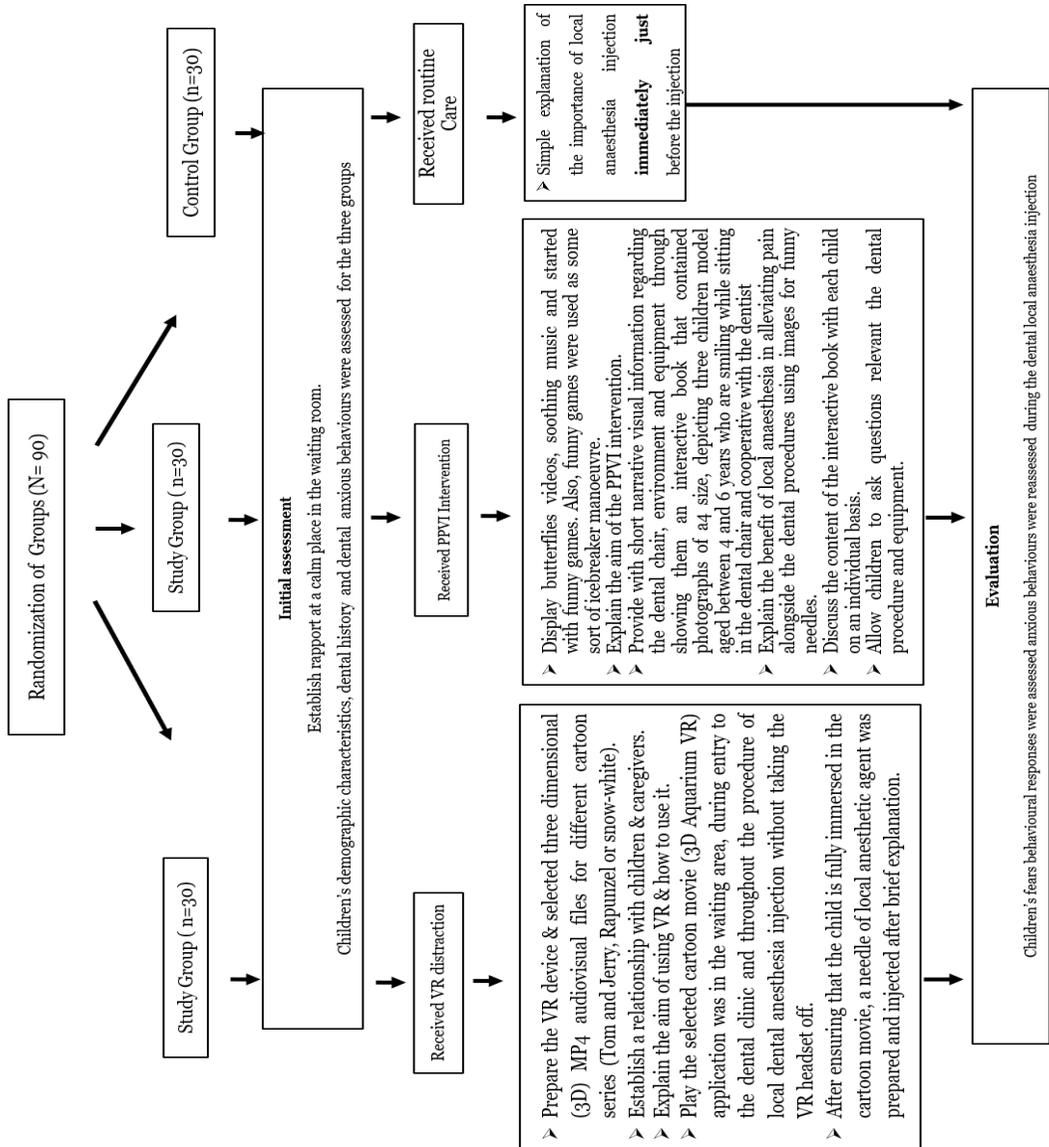
- The researchers greeted children at the waiting room area then they explained the aim of the intervention.
- The researchers displayed butterflies videos and soothing music with the aim of inducing relaxation and emotional calmness for children. In addition, funny games were used as some sort of icebreaker manoeuvre, which help children to feel more relaxed and comfortable.
- During the session, the researchers provide children with simple short narrative visual information regarding the dental chair, environment and equipment. This information was provided according to their level of understanding. It was done through showing them an interactive book that contained photographs of A4 size, depicting three children model aged between 4-6 years who are smiling while sitting in the dental chair and cooperative with the dentist; a Teddy bear sitting in the dental chair and advised children to be cooperative with the dentist. In addition, the researchers explained the benefit of LA

in alleviating pain alongside the dental procedures using images for funny needles.

- Then the researchers started to discuss the content of the interactive book with each child on an individual basis. The following statements were used; the doctor is removing the bad caries that inducing toothache so that the child model is showing cooperation throughout the dental procedure, strengthen your spirit abilities, and you can do it and manage the situation effectively like our model.
- The researchers also explored the children's reflection of the children model in the interactive book by asking them the following questions:
 - How does the child in the picture feel?
 - Do you feel like the child in the picture? If not, what would you do to help yourself feel better?
- Information provision creating context in which children are able to ask relevant questions that preoccupied their mind regarding the dental procedure and equipment.
- Throughout the implementation of intervention, the researchers were always keen to keep the children motivated and actively involved. This was done through continuous encouragement and positive reinforcement (i.e: in the form of positive verbal praise, or tangible reward as stickers, small toys etc....). The average time needed for completing the PPVI Intervention depended on the number of questions that were raised by the child or his/her parent around (15-20 minutes).

Children in the control group received routine care in the pediatric dental clinic that entailed a simple explanation about the importance of LA injection and the presence of a TV screen.

Finally, the children's fear and anxious behavioral responses were assessed during the dental LA injection using Tool two and three (Figure 2).



Data Analysis

The Statistical Package for Social Sciences (SPSS) version 22 was utilized for data analysis. Descriptive statistics included number, percentage, the mean, and standard deviation to describe children's demographic characteristics and dental history, their DFA behavioral responses, and levels. Kolmogorov-Smirnov test was used to check the normality of study variables, and it showed that they were not normally distributed. In Analytical statistics, Kruskal-Wallis tests (χ^2) were used to compare the differences between the total mean scores of

children's anxiety and fear behavioral responses. Moreover, the Chi-square test and Fisher's Exact tests were used to test the significance of between DFA levels. Ordinal regression analysis was performed to predict the influencing factors for developing DFA and Odds ratios (ORs) with 95% confidence intervals were obtained. All of the statistical analyses were considered significant at $P < 0.05$.

Results

Table 1 revealed that more than half of children in the VR, PPVI, and control groups

were crying intensively in the waiting room (53.3%, 60%, and 60%, respectively). Moreover, 73.3% of children among the VR group, 60.0% among the PPVI group, and 56.7% among the control group refused to interact with medical staff wearing white uniforms. Additionally, 73.3% of children in the VR group, 63.3% of the PPVI group, and 70.0% of the control group looked at everyone with fearful eyes. More than three-quarters of children among the three groups did not leave their parents (80.0%, 80.0%, and 76.7%, respectively). The differences between the three groups regarding the mean scores of anxiety before the LA injection were not statistically significant.

Table 2 shows children's fear behavioral response during dental local anesthesia injection. Concerning the children's avoidant behaviors, 80.0% of children in the control group refused to sit on the dental chair compared to 26.7% and 36.7% of VR and PPVI groups, respectively. As regards children's over-exaggerated behaviors, it is revealed that 83.3% of the children in the control group exhibited overreaction to pain compared to 30.0% of the VR group and 56.7% of the PPVI group. Additionally, 86.7% of children in the control group cried during injection compared to 26.7% of the VR group and 43.3% of the PPVI group. Also, 86.7% of children in the control group attempted to dislodge the syringe during injection compared to 33.3% of the VR group and 40.0% of the PPVI group, and the differences were statistically significant. In addition, the mean fear score of the children in the control group was 11.4 ± 2.40 compared to 4.13 ± 2.08 and 6.3 ± 2.49 of VR and PPVI groups, respectively.

Figure 3 clarifies that 83.3% of children among the VR group and 46.7% of the PPVI group had mild fear compared to none of those in control one. However, 66.7% of children among the control group had severe level of fear compared to only 3.3% and 6.7% of the VR and the PPVI groups, respectively. Significant statistical differences were found between VR and control groups ($P_1 = <0.001$), PPVI, and control groups ($P_2 = <0.001$).

Figure 4 shows that 36.7% of children in the VR group and 10.0% of the PPVI group were

relaxed during injection compared to none of the control group children. Meanwhile, 43.3% of control group children were out of contact during the injection compared to none of the children in either VR or PPVI groups. The differences were significant statistically between VR and control groups, PPVI and control groups, and VR and PPVI groups ($P_1 = <0.001$, $P_2 = <0.001$, and $P_3 = 0.005$, respectively).

Table 3 illustrates that 76.7% of the children in VR and 73.3 of the PPVI groups aged from 4 to less than 5 years old compared to 70.0% of children among the control one. Regarding dental history, 53.3% and 50.0% of the children in the VR and PPVI groups had 1-2 carious molars compared to 56.7% of the control one. Regression analysis shows an association between the children's fear levels during LA injection and their children's demographic Characteristics and Clinical data. Being the first child is a risk factor for developing dental fear among children in both VR and PPVI groups (OR=139.91, 95% CI:15.71-21.95, $p < 0.001$ & OR=6.01, 95% CI: 1.71-6.33, $p = 0.001$ respectively). Similarly, having 1-2 carious molars among VR group was also significantly associated with the degree of their dental fear (OR=302.39, 95% CI: 17.13-21.48, $p < 0.001$). The age of 4 to less than 5 years was associated with the children's fear level among only the control group (OR= 4.39, 95% CI: 0.163-4.92, $p = 0.041$).

Table 4 reveals that there is an association between the children's anxiety level and their age of 4 less than 5 years among both the PPVI and control groups (OR=5.55, 95% CI: 1.47-7.11, $p = 0.018$ & OR=7.31, 95% CI: 1.810-8.08, $p = 0.007$ respectively). Regarding the birth Order, the first child, is associated with increased children's anxiety levels among the PPVI group (OR=13.55, 95% CI: 2.80-9.17, $p < 0.001$).

Table (1): Children's Anxious Behaviors at the Waiting Room of the Restorative Dental Clinic

Children's Behaviors	VR Group (n=30)	PPVI Group (n=30)	Control Group (n=30)	Significance	
	Yes No. (%)	Yes No. (%)	Yes No. (%)	X2	P value
1. Cries intensively	16 (53.3)	18 (60.0)	18 (60.0)	0.36	0.831
2. Makes lot of noise, want to go	21 (70.0)	22 (73.3)	17 (56.7)	2.1	0.356
3. Vomits	3 (10.0)	5 (16.7)	4 (13.3)	F ^{ET} =0.93	0.645
4. Sweats	14 (46.7)	10 (33.3)	11 (36.7)	1.22	0.551
5. Red face	17 (56.7)	20 (66.7)	18 (60.0)	0.66	0.720
6. Refuses people in white uniforms	22 (73.3)	18 (60.0)	17 (56.7)	2.01	0.371
7. Shows high activity	23 (76.7)	22 (73.3)	24 (80.0)	0.37	0.833
8. Looks to everyone with fearful eyes	22 (73.3)	19 (63.3)	21 (70.0)	0.70	0.692
9. Excessive and unnecessary talk	21 (70.0)	17 (56.7)	18 (60.0)	0.47	0.792
10. Speaks loudly	21 (70.0)	17 (56.7)	18 (60.0)	1.23	0.541
11. Impatience	21 (70.0)	24 (80.0)	27 (90.0)	3.75	0.152
12. Gets angry easily	25 (83.3)	19 (63.3)	20 (66.7)	3.35	0.192
13. Nil biting	16 (53.3)	14 (46.7)	15 (50.0)	0.27	0.887
14. Swings while sitting	12 (40.0)	18 (60.0)	17 (56.7)	2.76	0.271
15. Do not want to contact the dentist	21 (70.0)	21 (70.0)	20 (66.7)	0.10	0.950
16. Always looks in front of him/herself	23 (76.7)	21 (70.0)	21 (70.0)	0.44	0.801
17. Do not want to leave parents	24 (80.0)	24 (80.0)	23 (76.7)	0.13	0.942
18. Stands up just close to parents	25 (83.3)	29 (96.7)	27 (90.0)	2.96	0.231
19. Behaves timidly	24 (80.0)	22 (73.3)	21 (70.0)	0.82	0.661
20. Tight and sulky face	23 (76.7)	18 (60.0)	20 (66.7)	1.93	0.382
21. Fast and frequent eye movement	20 (66.7)	18 (60.0)	18 (60.0)	0.38	0.835
22. Do not look round	18 (60.0)	19 (63.3)	18 (60.0)	0.09	0.954
23. Do not speak with parents	9 (30.0)	13 (43.3)	12 (40.0)	1.23	0.543
24. Lip biting	19 (63.3)	16 (53.3)	19 (63.3)	0.83	0.663
25. Regressive behavior	15 (50.0)	16 (53.3)	14 (46.7)	0.27	0.871
26. kneed hands	17 (56.7)	17 (56.7)	16 (53.3)	0.09	0.962
27. Always plays with something	10 (33.3)	16 (53.3)	22 (73.3)	0.64	0.730
Mean±SD	17.1±3.18	16.5±2.59	16.5±2.64	kw ² =0.54	0.76

X²: Chi-Square Test F^{ET}: Fisher's Exact Test kw-χ²: Kruskal-Wallis * Significant P ≤0.05

Table 2: Effect of Virtual Reality Distraction and Positive Pre-Visit Imagery Intervention on Children's Fear during Local Dental Anesthesia Injection

Children's Behaviors	VR Group (n=30)	PPVI Group (n=30)	Control Group (n=30)	Significance	
	Yes No. (%)	Yes No. (%)	Yes No. (%)	X2	P value
<u>Avoidant Behaviors</u>					
1. Refuses to enter dental clinic	7 (23.3)	10 (33.3)	22 (73.3)	9.64	0.001**
2. Cries, clings and refuses to leave caregiver	9 (30.0)	11 (36.7)	22 (73.3)	10.58	0.001**
3. Refuses to sit on the dental chair	8 (26.7)	11 (36.7)	24 (80.0)	17.14	<0.001**
4. Refuses to open mouth	11 (36.7)	13 (43.3)	23 (76.7)	11.04	0.004**
5. Closes eyes during injection	4 (13.3)	20 (66.7)	23 (76.7)	27.87	<0.001*
<u>Over-exaggerated Behaviors</u>					
6. Complains verbally.	12 (40.0)	16 (51.7)	26 (86.7)	14.65	0.001**
7. Conveys verbal message to terminate	13 (43.3)	16 (53.3)	26 (86.7)	12.9	0.002**
8. Overreacts to pain	9 (30.0)	17 (56.7)	25 (83.3)	18.25	<0.001**
9. Cries during injection	8 (26.7)	13 (43.3)	26 (86.7)	22.67	<0.001**
10. Assumes rigid posture	10 (33.3)	13 (43.3)	21 (70.0)	8.62	0.013**
11. Attempts to dislodge syringe	10 (33.3)	12 (40.0)	26 (86.7)	20.35	<0.001**
12. Kicks the doctor	7 (23.3)	12 (40.0)	19 (63.3)	9.92	0.007**
13. Rolls over	10 (33.3)	18 (60.0)	27 (90.0)	21.29	<0.001**
14. Needs to be restrained	6 (20.0)	12 (40.0)	25 (83.3)	25.21	<0.001**
15. Leaves chair	0 (0.0)	1 (3.3)	8 (26.7)	17.33	0.001**
Mean±SD	4.13±2.08	6.3±2.49	11.4±2.40	kw ² =53.13	<0.001*

X²: Chi-Square Test kw²: Kruskal-Wallis *Significant at P≤0.05

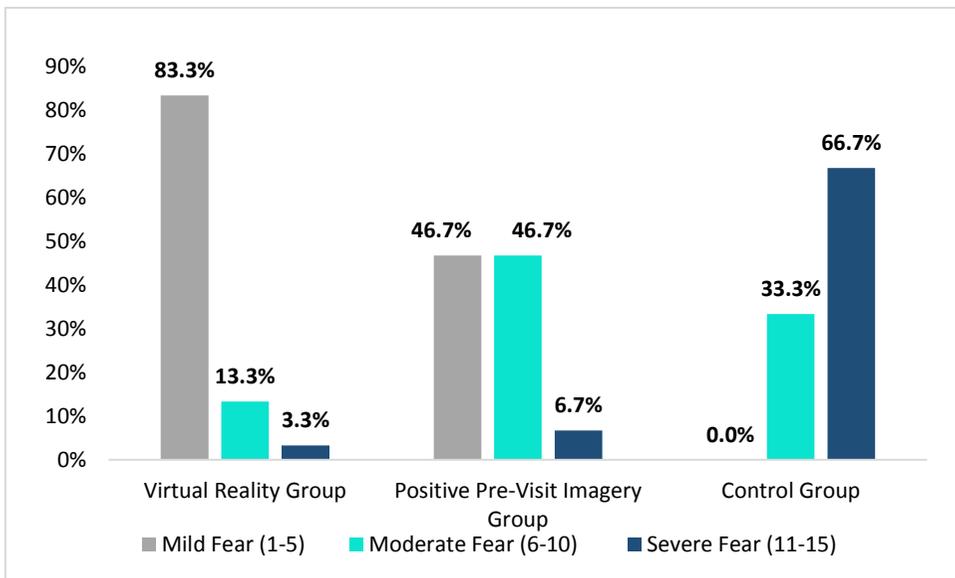


Figure 3: Children's Fear Level during LA Injection.

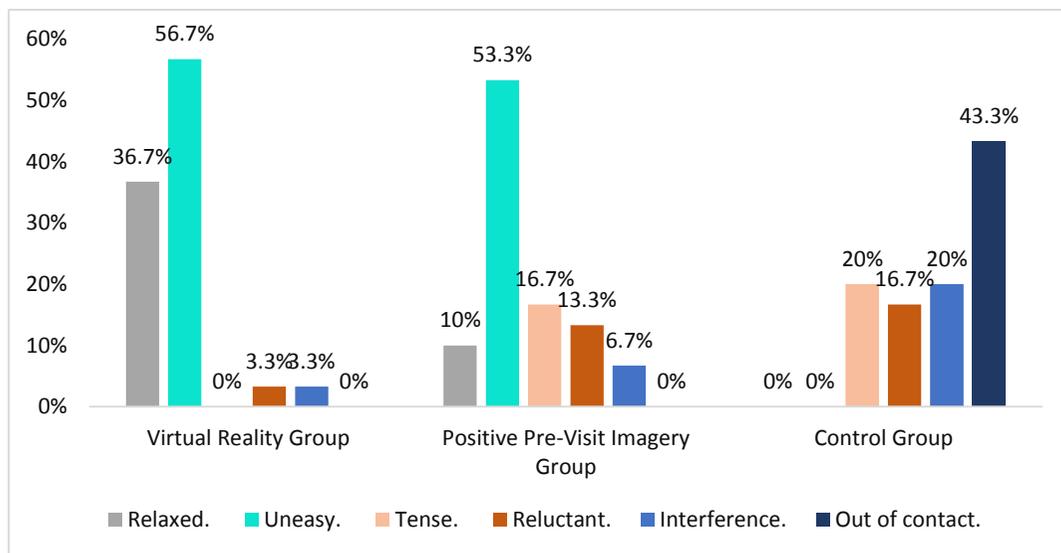


Figure 4: Effect of Virtual Reality Distraction and Positive Pre-Visit Imagery Intervention on Children's Anxiety during Local Dental Anesthesia Injection

Table 3: Regression Analyses for Children's Fear levels during LA Injection by Their Demographic Characteristics and Dental history

Demographic Characteristics and Dental history			Children's Fear levels during LA Injection			(95) Confidence Interval	P Value
			Mild No. (%)	Moderate No. (%)	Severe No. (%)		
Virtual Reality Group							
Age	4-	23 (76.7)	12(40)	2(6.7)	0(0.0)	1.04 [-4.40-1.13]	0.251
	5-6	7(23.3)	13(43.3)	2(6.7)	1(3.3)		
Gender	Male	11 (36.7)	9(30.0)	1(3.3)	1(3.3)	0.88 [-5.68-1.30]	0.224
	Female	19(63.3)	16(53.3)	3(10)	0(0.0)		
Birth Order	1st	12(40.0)	7(23.3)	4(13.3)	0(0.0)	139.91 [15.71-21.95]	<0.001*
	2 nd	11(36.7)	8(26.7)	0(0.0)	1(3.3)		
	3rd& more	7(23.3)	10(33.3)	0(0.0)	0(0.0)		
Number of Carious Molars	1-2	16 (53.3)	14(46.7)	1(3.3)	1(3.3)	302.39 [17.13-21.48]	<0.001
	3-4	12 (40.0)	10(33.3)	2(6.7)	0(0.0)		
	5-6	2 (6.7)	1(3.3)	1(3.3)	0(0.0)		
Pre-visit Imagery Group							
Age	4-	22 (73.3)	9(30)	11(36.7)	2(6.7)	2.04 [-0.67-4.24]	0.152
	5-6	8(26.7)	5(16.7)	3(10.0)	0(0.0)		
Gender	Male	19 (63.3)	7(23.3)	10(33.3)	2(6.7)	0.20 [-1.56-2.47]	0.663
	Female	11 (36.7)	7(23.3)	4(13.3)	0(0.0)		
Birth Order	1st	9(30.0)	1(3.3)	6(20.0)	2(6.7)	6.01 [1.71-6.33]	0.010*
	2nd	8(26.7)	5(16.7)	3(10.0)	0(0.0)		
	3rd& more	13(43.3)	8(26.7)	5(16.7)	0(0.0)		
Number of Carious Molars	1-2	15 (50.0)	8(26.7)	7(23.3)	0(0.0)	0.71 [-1.83-4.57]	0.403
	3-4	13 (43.3)	5(16.7)	7(23.3)	1(3.3)		
	5-6	2 (6.7)	1(3.3)	0(0.0)	1(3.3)		
Control Group							
Age	4-	21 (70.0)	0(0.0)	6(20.0)	19(63.3)	4.39 [0.163-4.92]	0.041*
	5-6	9(30.0)	0(0.0)	4(13.3)	1(3.3)		
Gender	Male	12 (40.0)	0(0.0)	4(13.3)	8(26.7)	0.02 [-1.93-2.22]	0.895
	Female	18 (60.0)	0(0.0)	6(20.0)	12(40)		
Birth Order	1st	9(30.0)	0(0.0)	2(6.7)	7(23.3)	0.88 [-1.42-4.02]	0.352
	2nd	10(33.3)	0(0.0)	4(13.3)	6(20)		
	3rd& more	11(36.7)	0(0.0)	4(13.3)	7(23.3)		
Number of Carious Molars	1-2	17 (56.7)	0(0.0)	3(10.0)	14(46.7)	0.01 [-3.04-2.69]	0.916
	3-4	12 (40.0)	0(0.0)	7(23.3)	5(16.7)		
	5-6	1 (3.3)	0(0.0)	1(3.3)	0(0.0)		

OR= odds ratio; CI =Confidence Interval *Significant at *P≤0.5

Table 4: Regression Analyses for Children's Anxiety during LA Injection by Their Demographic Characteristics and Dental history

Demographic Characteristics and Dental history	Children's Anxiety during LA Injection						(95) Confidence Interval	P Value	
	Relaxed	Uneasy	Tense	Reluctant	Interference	Out of contact			
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)			
Virtual Reality Group									
Age	4-	4(13.3)	9(30.0)	0(0.0)	0(0.0)	1(3.3)	0(0.0)	0.66 [-0.842-2.04]	0.42
	5-6	7(23.3)	8(26.7)	0(0.0)	1(3.3)	0(0.0)	0(0.0)		
Gender	Male	4(13.3)	6(20.0)	0(0.0)	1(3.3)	0(0.0)	0(0.0)	0.72 [-1.28-3.24]	0.40
	Female	7(23.3)	11 (36.7)	0(0.0)	0(0.0)	1(3.3)	0(0.0)		
Birth Order	1 st	4(13.3)	7(23.3)	0(0.0)	0(0.0)	1(3.3)	0(0.0)	0.07 [-1.68-2.21]	0.79
	2 nd	4(13.3)	6(20.0)	0(0.0)	1(3.3)	0(0.0)	0(0.0)		
	3 rd & more	3(10.0)	4(13.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)		
Number of Carious Molars	1-2	7(23.3)	7(23.3)	0(0.0)	1(3.3)	1(3.3)	0(0.0)	0.69[-1.49-3.70]	0.40
	3-4	3(10.0)	9(30.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)		
	5-6	1(3.3)	1(3.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2.10[-.72-4.78]	0.15
Pre-visit Imagery Group									
Age	4-	1(3.3)	9(30.0)	4(13.3)	2(6.7)	2(6.7)	0(0.0)	5.55 [1.47-7.11]	0.018*
	5-6	2(6.7)	7(23.3)	1(3.3)	2(6.7)	0(0.0)	0(0.0)		
Gender	Male	1(3.3)	9(30.0)	4(13.3)	3(10.0)	2(6.7)	0(0.0)	3.09[-0.21-3.85]	0.08
	Female	2(6.7)	7(23.3)	1(3.3)	1(3.3)	0(0.0)	0(0.0)		
Birth Order	1 st	0(0.0)	3(10.0)	0(0.0)	4(13.3)	2(6.7)	0(0.0)	13.55 [2.80-9.17]	<0.001*
	2 nd	1(3.3)	5(16.7)	2(6.7)	0(0.0)	0(0.0)	0(0.0)		
	3 rd & more	2(6.7)	8(26.7)	3(10.0)	0(0.0)	0(0.0)	0(0.0)		
Number of Carious Molars	1-2	2(6.7)	8(26.7)	2(6.7)	3(10.0)	0(0.0)	0(0.0)	0.48[-1.59-3.32]	0.49
	3-4	1(3.3)	7(23.3)	3(10.0)	1(3.3)	1(3.3)	0(0.0)		
	5-6	0(0.0)	1(3.3)	0(0.0)	0(0.0)	1(3.3)	0(0.0)	0.70[-1.45-3.62]	0.40
Control Group									
Age	4-	0(0.0)	0(0.0)	3(10.0)	3(10.0)	6(20.0)	13(43.3)	7.31 [1.810-8.08]	0.007*
	5-6	0(0.0)	0(0.0)	3(10.0)	2(6.7)	0(0.0)	0(0.0)		
Gender	Male	0(0.0)	0(0.0)	2(6.7)	2(6.7)	3(10.0)	5(16.7)	0.09[-1.81-1.34]	0.77
	Female	0(0.0)	0(0.0)	4(13.3)	3(10.0)	3(10.0)	8(26.7)		
Birth Order	1 st	0(0.0)	0(0.0)	2(6.7)	2(6.7)	2(6.7)	3(10.0)	0.10[-2.05-1.48]	0.75
	2 nd	0(0.0)	0(0.0)	2(6.7)	2(6.7)	2(6.7)	4(13.3)		
	3 rd & more	0(0.0)	0(0.0)	2(6.7)	1(3.3)	2(6.7)	6(20.0)		
Number of Carious Molars	1-2	0(0.0)	0(0.0)	2(6.7)	3(10.0)	3(10.0)	9(30.0)	0.59[-1.09-2.48]	0.44
	3-4	0(0.0)	0(0.0)	4(13.3)	2(6.7)	3(10.0)	3(10.0)		
	5-6	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(3.3)	0.76[-.99-2.59]	0.39

OR= odds ratio; CI =Confidence Interval *Significant at *P≤0.5

Discussion

Children's over-exaggerated reactions to LA injection might interfere with the dental procedure's performance (Riba et al., 2017). In this context, the present study results revealed that high percentages of children among the three groups exhibited anxious behaviors at the dental clinic's waiting room. The subsequent change in the children's

behaviors reflects their limited communication skills and inability to cope with these stressful events.

Children initially use virtual reality for entertainment. Recently, several studies have utilized its unique distractive nature in various therapeutic-directed goals. In this regard, the current study findings illustrated that VR is a useful distraction method in minimizing young

children's DFA. These findings could be justified in light of the fact that using distraction limits the brain's capacity to focus attention on the painful stimulus while its attention is diverted toward other attractive stimuli. Therefore, distractive activities successfully compete with the nerve signals from the noxious stimuli. Florella et al. (2010) claimed that VR distraction's immersive nature had positive impacts on pain and anxiety among children due to the complete blockage of their visual fields where the cartoon movies with high definition sounds are projected directly in front of the children's eyes. Thereby, young children are deeply engaged in the virtual world rather than in the surrounding dental clinic environment, procedures, equipment, and needles. Eijlers et al. (2019) also cited in their systematic review and meta-analysis study that VR is a crucial distraction technique for pain and anxiety reduction in pediatric patients. Increasingly, Aminabadi et al. (2012) concluded that VR integrated many perceptual senses and captured a greater degree of attention among children aged 4-6 years.

Virtual reality distraction is a safe and non-invasive technique that does not require any previous training and links the dental visit with a fantastic experience (Shetty et al., 2019 & Custódio et al., 2020). In this regard, the current study results revealed that the percentages of children in the VR group who exhibited avoidant or over-exaggerated behaviors were extremely smaller than the control group. Similar results were reported by Niharika et al. (2018), who recorded that VR distraction is a clinically viable technique with a high potential to alleviate anxiety associated with various dental procedures among children aged 4-8 years. It also has long-lasting effects in terms of more positive memories of the treatment leading to a greater willingness to return for treatment. On the other hand, Custódio et al. (2020), in their meta-analysis, reported no statistical differences regarding the anxiety levels during local anaesthesia.

The impactful effect of the PPVI intervention in reducing the children's DFA was proven in the present study findings where children have been fond of the interactive book that portrayed the positive images about the expected dental procedures. Moreover, they favored watching the butterflies' videos that played with a soothing music tone to induce a

sense of emotional calm. Presumably, the combination of both information provision and relaxation maneuvers could enhance the children's way of thinking. They can plausibly focus on the positive aspects of this unpleasant situation and ignore the previously annoying experience (Do, 2004). From another perspective, children in this age group may not be fully aware of their own feelings. Simply stated, exploring children's feelings provides them with the chance to introspect inside themselves to identify their own emotions. Then, they made up their inferences of why the children model in the displayed pictures had experienced such positive emotions. This, in turn, widens the studied children's horizons of thinking to bridge the gap between their sense of DFA and being cooperative with dental treatment (Williams et al., 2016). These results are in the same line with Fox and Newton's (2006) findings, who found that viewing positive images of dental procedures results in reducing anticipatory anxiety among children. In parallel, Gangwal et al. (2014) claimed that introducing children with positive dental images was superior in reducing their anxiety compared to neutral images.

Regression analysis in the current study showed associations between the fear levels and being the first child in the family among children in PPVI groups as well as age group (4 to less than 5 years) and birth order, first child, were significant risk factors for increasing the anxiety level among the same group. This reflected that being a young child with limited previous experience with the dental procedure might diminish their ability to obtain the desired outcome of PPVI. However, Panda et al. (2015) concluded that providing an attractive physical environment in the waiting room, such as gazing at an aquarium and sitting on beanbags, is significantly correlated with the higher reduction of children's anxiety. In contrast, Ramos-Jorge et al. (2011) found no statistical difference in the anxiety levels among children exposed to both positive and neutral images. Similarly, Fux-Noy et al. (2019) found no significant difference in anxiety levels among children who waited either in a multisensory or conventional dental waiting room.

Collectively, both the VR distraction and PPVI intervention had a salient effect on reducing the children's sense of fear and anxiety associated

with injection of local anaesthetic agent. VR distraction creates a more compelling illusion of presence in the simulated world. Whereas, the PPVI enables children to master their emotional and cognitive abilities to adaptively deal with such unpleasant experience.

Conclusion

Based on the study findings, it can be concluded that using both virtual reality (VR) distraction and positive pre-visit imagery intervention (PPVI) were effective in minimizing the pre-school age children's fear and anxiety during local anaesthesia injection. Moreover, children in VR group experienced slightly less dental fear and anxiety than those in the PPVI group.

Recommendations:

- Continuous educational training program should be provided for nurses enrich and update their knowledge and skills about VR distraction and PPVI to allay children's fear and anxiety.
- Virtual reality and positive pre-visit imagery should be incorporated in the dental clinic's protocol of care including written guidelines about the appropriate way of their application.

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