



Original research:

Comparative Analysis of Effectiveness of Audio-Visual Distraction Using Virtual Reality Glasses along with WAND Injection System vs Conventional Injection Technique in Reducing Dental Anxiety in Children Using Salivary Cortisol as an Anxiety Marker: An in-vivo Study

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Abstract

Objectives: To compare and assess the levels of dental anxiety in children before and after administration of local anesthesia using audiovisual distraction, WAND injection system, and Audiovisual distraction along with WAND injection system compared to the conventional injection technique using salivary cortisol as a marker of dental anxiety and SEM and VAS as Anxiety assessment tools.

Methods: The study was conducted in the Department of Pediatric and Preventive Dentistry, Krishnadevaraya College of Dental Sciences & Hospital, Bengaluru, with a sample of 48 children aged 6-12 years who required local infiltration anesthesia for various dental procedures. They were randomly divided into 4 main groups viz Conventional LA with Audiovisual distraction, Conventional LA without Audiovisual distraction, WAND LA with Audiovisual Distraction, and WAND LA without distraction, they were then subdivided into 4 sub-groups according to their

Introduction

Frankl behavior scale. Local anesthesia was administered to all children, and their preoperative and postoperative SEM scores, VAS scores, and salivary cortisol levels were recorded and then subjected to statistical analysis. Intra- and inter-group comparisons were performed with the one-way ANOVA Statistical test ANOVA and the unpaired T-test, respectively.

Results: The Results showed a highly significant difference in reducing Dental Anxiety among all the groups, The most effective group in reducing dental anxiety was WAND LA with Audiovisual distraction, followed by WAND LA without distraction and Conventional LA with Audiovisual distraction in all Frankl groups. The least effective method was Conventional LA without any distraction in all Frankl groups.

Conclusions: WAND injection along with the use of Audiovisual Distraction with VR Glasses have shown good promise in reducing dental anxiety in young children with both positive and negative Frankl behaviors during administration of local anesthesia.

Keywords: Local Anesthesia, WAND, Children, Saliva, Dental Anxiety

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Introduction

McElroy stated that “Although operative dentistry may be perfect, the appointment is a failure if a child departs in tears”.^[1] This was the first mention in the literature where importance was given to behavior management in pediatric patients. Various behavior management techniques have been used to provide children with a positive experience in the dental office, with the distraction technique proving to be very successful in recent years.

Regarding dental anxiety, studies have shown that anxiety is more pronounced during the administration of local anesthesia than during other simple dental procedures such as scaling and fillings.^[2] Therefore, an innovative computerized system for slow delivery of anesthetic (WAND) has been developed to reduce the pain associated with local anesthetic injections. In this process, the local anesthetic solution is automatically administered at a fixed pressure-to-volume ratio, independent of variations in tissue resistance, resulting in a controlled, highly effective,

and comfortable pain-free injection, even in resilient tissues such as the palate and periodontal ligament.^[2] Cortisol, commonly known as the stress hormone, is involved in the body's response to stressful conditions through a complex hormonal system, the hypothalamic-pituitary axis (HPA AXIS)^[3]. Therefore, the measurement of salivary cortisol is considered the tool of choice for measuring human stress levels (physiological or psychological)^[3]

Anxiety can be assessed using a variety of scales, of which the visual analog scale is the most commonly used. This is a 10-point scale ranging from 0 to 10, meaning no pain to unbearable pain. The child marks the point on the scale that represents the amount of pain felt by the child when administered LA. Another scale used for better reliability is the Sound Eye Motor Scale (SEM), which has four points (1 to 4) ranging from no discomfort to severe discomfort in each category. This scale is scored by the operator only. Therefore, the primary objective of the study is to assess the level of dental anxiety in pediatric patients with audiovisual distraction and WAND injection technique during the administration of local anesthesia compared with conventional technique (without distraction) in children with both positive and negative Frankl behavior using salivary cortisol as a dental anxiety marker and with the VAS and SEM scales as anxiety assessment tools.

Methodology:

The study was conducted in the Department of Pediatric and Preventive Dentistry, Krishnadevaraya College of Dental Sciences and Hospital, Bengaluru. The sample included 48 patients aged 6 to 12 years who required infiltration local anesthesia for any of the invasive dental procedures. Ethical approval was obtained from our institution's ethics committee. (KCDSEC/01/2017-18). The study was carried out from January 2019 to July 2019. The materials required were VR glasses, a WAND injection system with ampoules, a local anesthetic: lignocaine hydrochloride with epinephrine 1:80,000, a 2.0 ml syringe, and saliva collection tubes.

Patients were selected according to the following criteria:

1. Patients with no previous dental experience.
2. Patients aged 6-12 years of either gender
3. Patients requiring infiltration local anesthesia for an invasive dental procedure.
4. Patients with positive and negative Frankl behavior.
5. Parents/guardians who had given consent to perform the procedure.

Exclusion Criteria:

1. Patients with Previous dental history,
2. Patients with Systemic diseases in history,
3. Physically/mentally challenged children,
4. Patients with known allergy to local anesthetics,
5. Patients requiring nerve block for invasive procedures were excluded.

Forty-eight healthy patients of both genders, aged 6-12 years, in whom local anesthesia (infiltration) was indicated were selected for this study. The selected samples were then randomly divided into four groups as follows - Group 1:conventional injection without any distraction, Group 2: conventional injection with audiovisual distraction with VR glasses, Group 3: Computerized injection without any distraction and Group 4:computerized injection together with audiovisual distraction with VR glasses (Cartoons of choice were played) shown in Figures 1a to 1d. A preoperative unstimulated saliva sample of approximately 3 ml was collected 15 minutes before the patients were seated in the dental chair (Fig. 1). Preoperative dental anxiety was assessed using 3 parameters: 1. SEM – Sound, Eye, Motor Scale – assessed by the operator. 2. VAS - Visual Analog Scale – assessed using the child’s response. 3. Salivary cortisol level was also determined. Local anesthesia was then administered as follows: Subsequently, a postoperative salivarycortisol sample – was collected 10 to 15 minutes after the administration of LA. Postoperative dental anxiety was assessed using 3 parameters: 1. SEM – sound, eye, motor scale – scored by the operator. 2. VAS - Visual Analog Scale – assessed using the child’s response. 3. Determination of cortisol levels in saliva. The collected saliva samples were then centrifuged and sent to a laboratory for determination of salivary cortisol levels. The results were determined and statistically analyzed.



Figure 1 (a) Collection of saliva (Group I); (b) Administration of local anesthesia (Group II); (c) Administration of local anesthesia (Group III) (d) Administration of local anesthesia (Group IV)

Results:

The total number of patients included in our study was 48 patients, out of which 22 were female and 26 were male patients belonging to the age group of 6-12 years. These 48 patients were divided into all 4 categories of Frankl behavior rating as 12 patients each. The differences in the mean score of the SEM scale between the preoperative and postoperative recordings of all groups and subgroups (Figure 2). The audiovisual distraction using the VR glasses along with the WAND injection system showed the highest reduction in both the Frankl positive and negative groups. This Audio-visual distraction was very effective in reducing the anxiety of the negative and clearly negative children. Only a few children belonging to a definitely negative group, who were either from a low socioeconomic status or were very young, were initially frightened by the appearance of the VR glasses. However, after several demonstrations and sessions on other patients, the patients found the glasses more relaxing and eventually showed cooperative behavior in the administration of local anesthesia.



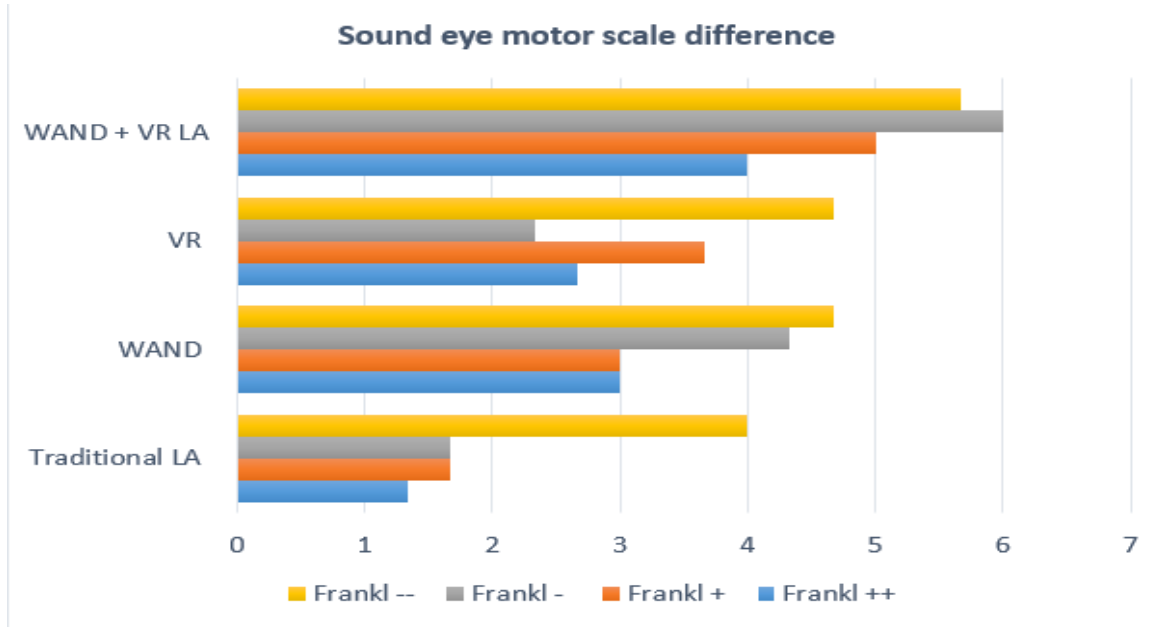


Figure 2: Comparison showing SEM scale scores among the main groups and sub-groups in which WAND LA with Audiovisual distraction has shown good results in reducing dental anxiety among the children

Figure 3 shows the differences in mean VAS score between the preoperative and postoperative recordings of all groups and sub – groups. Audio-visual Distraction using the VR glasses together with the WAND injection system showed the highest reduction in the Frankl-negative groups. The WAND injection system without any distraction was equally

effective in reducing anxiety in all Frankl groups. Patients felt very comfortable and relaxed with the computerized injection alone, but when the VR glasses were used with computerized injection, very few children were initially frightened by the appearance of the VR glasses. The least effective was the conventional injection technique, which tended to cause anxiety in the children.

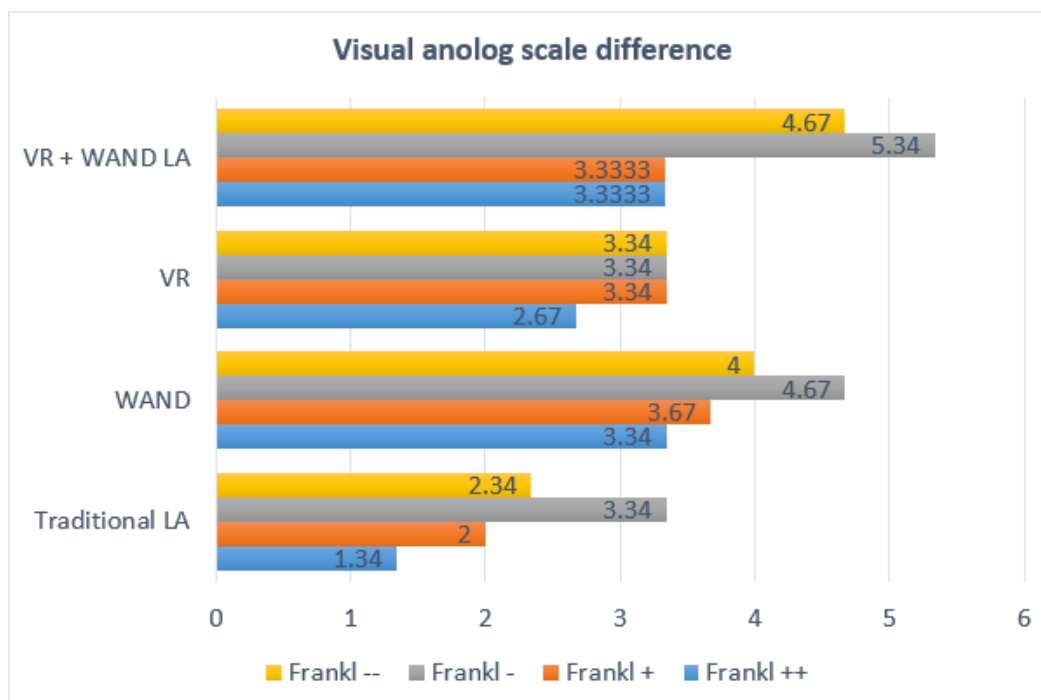


Figure 3: comparison showing VAS scores among the groups and sub-groups in which WAND LA with Audiovisual distraction has shown good results in reducing dental anxiety among the children

Figure 4 shows the mean differences in salivary cortisol levels between the preoperative and postoperative recordings in all groups and subgroups. The highest difference in levels was seen with audio-visual distraction along with the WAND injection

system, and again the lowest difference was seen with conventional injection without any distraction. These results correlate well with the other assessment parameters, again demonstrating that this is an effective and reliable marker of anxiety in children.

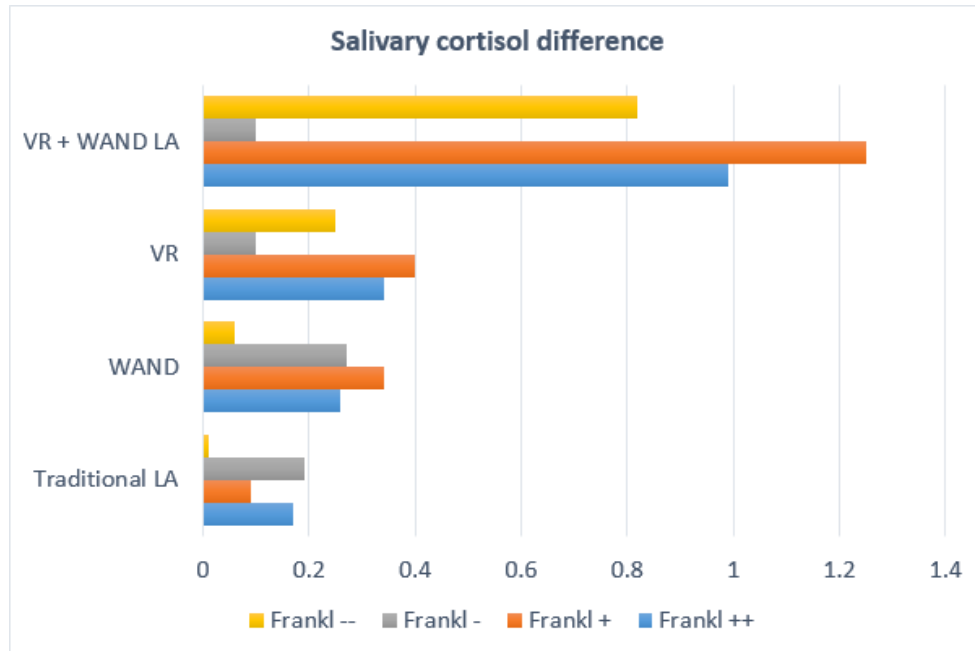


Figure 4: Comparison showing salivary cortisol levels among the groups and sub-groups in which WAND LA with Audiovisual distraction has shown good results in reducing dental anxiety among the children

SCORE	DESIGNATION	SOUNDS	EYES	MOTOR
0	Comfort	No sounds indicating pain	No eye signs of discomfort	Hands relaxed, no apparent body tenseness
1	Mild discomfort	Non-specific possible pain indication	Eyes wide show of concern, no tears	Hands show some tension
2	Moderately painful	Specific verbal complaint	Watery eyes	Random movement of arms / body grimace, twitch
3	Painful	The verbal complaint indicates intense pain	Crying, tears running down the face	Movement of hands to make aggressive physical contact, pulling head away punching

Figure 5. Sound Eye Motor Scale

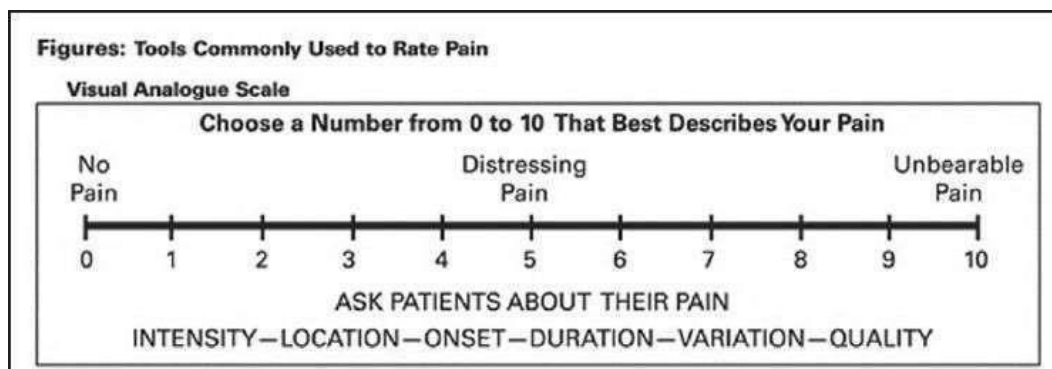


Figure 6. Visual Analog Scale

Discussion:

Anxiety and fear of the dentist are common in the pediatric population. The management of dental anxiety is recognized as an important issue in dental practice because many people avoid or delay dental treatment because they experience anxiety and fear, and the expectation of pain is one of the main barriers to seeking dental treatment. Patients with dental anxiety tend to visit the dentist only when they are in pain, increasing the likelihood that the dental visit will be associated with pain and reinforcing their anxiety^[4]. Pediatric dentists must be able to assess and evaluate the child's psychological, personal, and behavioral responses to determine if treatment methods need to be modified to reduce dental anxiety^[5]. Several rating scales have been developed to assess children's behavior during dental visits. Frankl introduced a behavior rating scale in 1962^[5], which is one of the most reliable instruments for measuring behavior. It consists of a determination scale numbered from 1 to 4, each defining a specific behavior. Wright^[5] gave the symbols for Frankl's 4 types of behavior. However, Al-Namankany et al. concluded in their analysis of dental anxiety scales in children that there is no gold standard for anxiety scales and further development is needed^[5]. In our study, we have divided groups according to the Frankl behavior rating scale to determine which method is effective in reducing dental anxiety while administering Local anesthetic in children with positive and negative Frankl ratings. Our study is probably the only study to date that has included children with all four Frankl behavior ratings

Distraction is the newer method of behavioral control in which the patient is distracted from the sounds and/or sights of dental treatment in order to reduce anxiety^[6]. The main goal is to relax the patient and reduce anxiety during treatment. An ideal distracter requires an optimal level of attention involving multiple sensory modalities (visual, auditory, and kinesthetic), active emotional involvement, and patient participation to compete with the signals of noxious stimuli^[6]. Audiovisual distraction is an effective distraction tool because it pleasantly takes control of two types of sensory input, hearing and vision^[6]. At the same time, it succeeds in partially isolating the patient from the sounds and sights of the unfriendly medical environment. The development of wireless audio-visual eyeglasses that are easy to use, inexpensive, and convenient for both the dentist and

the child, has opened up further possibilities for their use in pediatric dental treatment^[6].

Local anesthesia is considered the most anxiety-provoking procedure in dentistry for both children and adult patients^[7]. Therefore, it is necessary to employ techniques that minimize patients' pain for their satisfaction with the treatment. An innovative computerized system for slow delivery of local anesthetic, WAND, has been developed as a potential solution to reduce pain during local anesthetic injections. The WAND device delivers precise pressure and volume ratios (flow rate) of anesthetic solution from standard cartridges and needles. This new system produces a precisely controlled flowrate of anesthetic and eliminates the manual pressure that operators must apply during the injection. The WAND has been recommended for infiltration injections, nerve blocks, and intra-ligament injections. Therefore, it may play an important role in reducing the likelihood of disruptive behaviors among children while administration of local anesthetic^[7]. Therefore, our study highlights the use of computerized injection technology to reduce dental anxiety and fear in the pediatric population. In our study, the visual analog scale (VAS) was used to assess dental anxiety in children. However, because VAS alone is not a reliable tool for assessing anxiety in children, the Sound Eye Motor scale (SEM)^[8], which is rated by the operator, was included. To further increase reliability and validity, a physiological assessment using salivary cortisol levels was also performed. The sound-eye motor scale (SEM) is used to assess the efficiency of pain control during the anesthetic procedure. The patient's slightest eye, sound, or motor sensation is graded into four levels: comfort, mild discomfort, moderate pain, and pain^[8].

Saliva is increasingly used as a good diagnostic or disease activity marker in many diseases and in stress research. This fluid can be easily obtained without adverse effects. In some recent studies, measurement of stress hormone levels in saliva has been used as a non-invasive method that is easy to obtain and painless to assess psychological stress. Therefore, salivary cortisol was used as an anxiety marker in our study. In the present study, audiovisual distraction using VR glasses together with computerized injection showed significantly lower anxiety in subjects belonging to the Frankl-negative groups, followed by the sole use of computerized injection without any distraction. Audio-visual distraction combined with conventional injection did not significantly reduce anxiety in pediatric patients. Instead,

they elicited slightly more anxiety in children with negative behavior. This could be due to several factors, of which children's socioeconomic status and their innate anxiety (trait anxiety) play a crucial role. Children who belong to a lower socioeconomic status are not as exposed to technology, which in turn leads to their limited perception of virtual reality glasses. In addition, anxiety makes the patient more fearful and more aware of the environment, which in turn leads to the child refusing to wear the virtual reality goggles. In contrast, audiovisual distraction with the VR glasses along with computerized injection showed a significant reduction in Frankl positive groups which was then followed by virtual reality distraction and computerized injection, which showed comparable results in reducing anxiety. The results of our study are consistent with those of Fakhruddin et al, who investigated the efficacy of audiovisual distraction with computerized anesthesia in the placement of stainless steel crowns in children with Down syndrome.^[9] He found that audiovisual distraction along with computerized injection was an effective behavior management technique compared to the control group^[9].

Keith et al investigated the efficacy of a computer-controlled injection device in reducing pain behaviors during injections in preschool-aged children. In this study, there was a significant reduction in pain behavior in the children, and none of the exposed children needed to be restrained during the first interval, whereas the children who received a conventional injection required some form of immediate restraint. The results of our study were consistent with this study, which showed good results with computerized injection^[10]. Ram et al compared the response of children who received LA for anesthesia of the maxillary incisors with a computer-assisted device (PDL injection with the palatal approach of ASA nerve block) with conventional buccal infiltration. In this study, most children responded negatively during the injection with conventional buccal infiltration, whereas they responded positively with the WAND injection. The results were in agreement with our results where WAND injection was found to be more effective than conventional LA^[11].

Mittal et al studied pain perception during computerized and traditional anesthesia for buccal and palatal infiltrations in children in the age group of 8-12 years. VAS was used for subjective assessment and SEM for objective assessment of pain perception.

Heart rate was also measured using a pulse oximeter as a physiological parameter for objective assessment. The results of the study showed that patients experienced significantly less pain with computerized anesthesia than with conventional injection, which was consistent with our study^[2]. Aminabadi et al investigated the influence of virtual reality eyeglasses on the level of pain and anxiety during dental procedures in pediatric patients in the age group of 4 to 6 years. The results showed that pain perception and anxiety decreased significantly when virtual reality eyeglasses compared with the control group (without distraction). These results were consistent with our findings^[12]. Nuvvula et al evaluated the effect of audiovisual distraction with 3D glasses on anxiety in children in the age group of 7 to 10 years who received local anesthesia and found that anxiety decreased significantly in the audiovisual group compared with the control group. These results are also consistent with our study^[13]. Chaturvedi et al conducted a study to correlate stress and anxiety with levels of salivary cortisol (SC) and salivary alpha-amylase (SAA) in patients undergoing routine dental extraction. The levels of SC and SAA were examined before and after extraction in the saliva samples of 20 children, and it was found that the levels of cortisol and alpha-amylase increased significantly after extraction. There are various studies^[15-25] focused on distraction in pediatric clinical settings and this is the first of its kind study involving the evaluation of salivary cortisol levels among children. This is consistent with our study in which salivary cortisol levels were decreased by audiovisual distraction and the use of the WAND injection system, demonstrating their effectiveness in reducing dental anxiety in children^[14]. The primary limitation of our study was a smaller sample size. A larger sample in a general clinical setting could have elucidated the differences in the use of AV distraction based on measures of anxiety and behavior. Another limitation of the study was the design of the eyewear system. This design allows little visual access to the environment, and the size of the glasses also initially frightened the children at a very young age.

Conclusion:

To conclude, a computerized injection system along with audiovisual distraction can be used as the technique of choice for behavior management in both positive and negative Frankl-rated children during the administration of local anesthesia and also during other anxiety-provoking procedures. Virtual Reality glasses have a bright future in pediatric dentistry as a step toward distraction, which can be of great importance in reducing

dental anxiety in children. Also, these Virtual Reality glasses and the WAND injection can form an important team in reducing dental anxiety even in Frankl's definitely negative behaviors. And in our study, it has been shown that salivary cortisol determination along with the use of the VAS and SEM scales can be a reliable tool for assessing anxiety

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References:

1. Kaur R, Jindal R, Dua R, Mahajan S, Sethi K, Garg S. Comparative evaluation of the effectiveness of audio and audiovisual distraction aids in the management of anxious pediatric dental patients. *J Indian SocPedodPrev Dent.* 2015; 33: 193-203.
2. Mittal M, Kumar A, Srivastava D, Sharma P, Sharma S. Pain Perception: Computerized versus Traditional Local Anesthesia in Pediatric Patients. *J ClinPediatr Dent.* 2015; 39 (5): 470-74.
3. Greabu M, Purice M, Totan A, SpinuT, Totan C. Salivary cortisol – marker of stress response to different dental treatments. *Rom J Intern Med.* 2006; 44 (1): 49–59.

4. Tanja-Dijkstra K, Pahl S, White MP, Andrade J, May J, Stone RJ, et al. Can virtual nature improve patient experiences and memories of dental treatment? A study protocol for a randomized controlled trial. *Trials.* 2014; 15:90.
5. Riba H. A review of behavior evaluation scales in pediatric dentistry and suggested modification to the Frankl scale. *EC Dental Science.* 2017; 16:269–275.
6. Florella M, Sarale C, Ram RD. (2010). Audiovisual-iatrosedation with video eyeglasses distraction method in pediatric dentistry: Case history. *J Int Dent Med Res.* 2010; 3:133-6.
7. Srivastava B, Bhatia H, Singh A, Gupta N, Solanki N. Pediatric Local Anaesthesia- Made Easier. *Heal Talk.* 2010; 16-20.
8. Melo EAC, Moreira JJS, Gondim NJO, Diniz-Rebouças P. Comparative Evaluation Related to Pain in Children Submitted to Dental anesthesia with or Without Vibration. *Pediatr Dent Care.* 2016; 1:125.
9. Fakhruddin KS, El Batawi H, Gorduysus MO. Effectiveness of audiovisual distraction with computerized delivery of anesthesia during the placement of stainless steel crowns in children with Down syndrome. *Eur J Dent.* 2017; 11: 1-5
10. Allen Keith D, Kotil Darin, Larzelere Robert E, Hutfless Susan, Beiraghi Soraya. Comparison of a computerized anesthesia device with a traditional syringe in preschool children. *Pediatr Dent.* 2002; Jul-Aug; 24(4):315–320.
11. Ram D, Kassirer J. Assessment of a palatal approach- anterior superior alveolar (P-ASA) nerve block with the Wand® in paediatric dental patients. *Int J Paediatr Dent.* 2006; 16:348–351.
12. AslAminabadi, N., Erfanparast, L., Sohrabi, A., Ghertasi Oskouei, S., Naghili, A. The impact of virtual reality distraction on pain and anxiety during dental treatment in 4–6 year-old children: A randomized controlled clinical trial. *Journal of Dental Research, Dental Clinical, Dental Prospects.* 2012; 6(4), 117–124.
13. Nuvvula S, Alahari S, Kamatham R, Challa RR. Effect of audiovisual distraction with 3D video glasses on dental anxiety of children experiencing administration of local analgesia: A randomised clinical trial. *Eur Arch Paediatr Dent.* 2015; 16:43-50.
14. Chaturvedi Y, Chaturvedy S, Marwah N, Chaturvedi S, Agarwal S, Agarwal N.. Salivary Cortisol and Alpha-amylase—Biomarkers of Stress in Children undergoing Extraction: An in vivo Study. *Int J ClinPediatr Dent.* 2018; 11(3):214-218.
15. Ghaderi F, Banakar S, Rostami S. Effect of pre-cooling injection site on pain perception in pediatric

- dentistry: A randomized clinical trial. *Dent Res J*. 2013; 10: 790-4.
16. Bhusari BN, Hugar SM, Kohli N, Karmarkar S, Gokhale N, Saxena N. Comparative evaluation of anxiety level during restorative treatment using no music, monaural beats, and binaural auditory beats as audio distraction behavior guidance technique in children aged 6-12 years: A randomized clinical trial. *J Indian Soc Pedod Prev Dent*. 2023 Apr-Jun;41(2):156-162. doi: 10.4103/jisppd.jisppd_104_23.
17. Dahlan M, Alsaywed R, Alamoudi R, Batarfi AA, Basodan OY, Gazzaz Y, Alqarni YA, Alamoudi A. Assessment of Different Distraction Behavioral Methods in Pediatric Dental Clinic: A Systematic Review. *Cureus*. 2023 Jul 24;15(7):e42366. doi: 10.7759/cureus.42366
18. Ega S, Nuvvula S, Mallineni SK. Influence of parent-provided distraction and interactive distraction with a handheld video game on the child's responses during local anesthesia administration. *J Indian Soc Pedod Prev Dent*. 2020 Oct-Dec;38(4):413-418. doi: 10.4103/JISPPD.JISPPD_486_20.
19. Nunna M, Dasaraju RK, Kamatham R, Mallineni SK, Nuvvula S. Comparative evaluation of virtual reality distraction and counter-stimulation on dental anxiety and pain perception in children. *J Dent Anesth Pain Med*. 2019 Oct;19(5):277-288. doi: 10.17245/jdapm.2019.19.5.277.
20. Sahithi V, Saikiran KV, Nunna M, Elicherla SR, Challa RR, Nuvvula S. Comparative evaluation of efficacy of external vibrating device and counterstimulation on child's dental anxiety and pain perception during local anesthetic administration: a clinical trial. *J Dent Anesth Pain Med*. 2021 Aug;21(4):345-355. doi: 10.17245/jdapm.2021.21.4.345. Epub 2021 Jul 30. Erratum in: *J Dent Anesth Pain Med*. 2023 Apr;23(2):121.
21. Janiani P, Gurunathan D, Nuvvula S. Influence of Temperament on the Acceptance of Two Conscious Sedation Techniques in Toddlers Undergoing Dental Treatment: A Randomised Cross Over Trial. *Pain Res Manag*. 2023 Aug 22;2023:6655628. doi: 10.1155/2023/6655628.
22. Felemban OM, Alshamrani RM, Aljeddawi DH, Bagher SM. Effect of virtual reality distraction on pain and anxiety during infiltration anesthesia in pediatric patients: a randomized clinical trial. *BMC Oral Health*. 2021 Jun 25;21(1):321. doi: 10.1186/s12903-021-01678-x.
23. Sharma Y, Bhatia HP, Sood S, Sharma N, Singh A. Effectiveness of Virtual Reality Glasses Digital Screens and Verbal Command as a Method to Distract Young Patients during Administration of Local Anesthesia. *Int J Clin Pediatr Dent*. 2021;14(Suppl 2):S143-S147. doi: 10.5005/jp-journals-10005-2094.
24. Nuvvula S, Alahari S, Kamatham R, Challa RR. Effect of audiovisual distraction with 3D video glasses on dental anxiety of children experiencing administration of local analgesia: a randomised clinical trial. *Eur Arch Paediatr Dent*. 2015 Feb;16(1):43-50. doi: 10.1007/s40368-014-0145-9.
25. Alshatrat SM, Sabarini JM, Hammouri HM, Al-Bakri IA, Al-Omari WM. Effect of immersive virtual reality on pain in different dental procedures in children: A pilot study. *Int J Paediatr Dent*. 2022 Mar;32(2):264-272. doi: 10.1111/ipd.12851.

