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Research article

Comparison of effectiveness of three distraction techniques to allay dental anxiety during inferior alveolar nerve block in children: A randomized controlled clinical trial

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ABSTRACT

Background: Among the numerous methods used to control anxiety, distraction is the most popular method for controlling behavior during dental procedures in children. The present study aimed to use a fidget spinner, kaleidoscope, and virtual reality as distraction techniques individually and observe the effects on the anxiety levels of children subjected to inferior alveolar nerve block (IANB).

Methods: In this parallel-group randomized clinical trial, 102 children aged 6–9 years requiring IANB for various dental treatments were screened and 60 children who met the inclusion criteria were enrolled and randomly assigned into four groups of 15 each; Group 1 fidget spinner (FS), Group 2 kaleidoscope, Group 3 virtual reality (VR) and Group 4 no distraction (Control). The child's self-reported anxiety levels using Venham's picture test (VPT); the pulse oximeter was used to measure physiological signs of oxygen saturation and pulse rate at three intervals i.e. before, during, and after the IANB procedure. The collected data were statistically analyzed with SPSS 21 software. Paired t-test and One way ANOVA were used to compare the VPT, oxygen saturation, and pulse rate values.

Findings: Groups 1, 2, and 3 showed significantly lower mean VPT scores compared to Group 4. Groups 1 & 3 showed lower mean pulse rates and Group 2 showed comparable mean pulse rates to Group 4 respectively during the IANB procedure. Oxygen saturation levels remained non-significant between all the Groups ($p > 0.05$).

Interpretation: Fidget spinner, kaleidoscope, and virtual reality seem to be effective distraction methods and can be recommended as effective approaches to help alleviate children's dental anxiety during IANB procedures.

1. Introduction

New and potentially threatening situations often incite anxiety in children [1]. The administration of local anaesthetic is the most typical anxiety-provoking and frightening experience for children in the dental operatory [2], in particular, IANB (inferior alveolar nerve block) [3]. The primary goal of the paediatric dentist is to reinforce a positive dental experience, and to accomplish this, a variety of behaviour guidance techniques are employed, including distraction, which is a technique for redirecting a child's focus away from an unpleasant treatment [4].

Distraction, which involves diverting children's attention away from painful stimuli during invasive dental procedures, helps to alleviate the child's fear and anxiety and is most effective when tailored to the child's developmental level. Distraction appears to be safe and inexpensive, and it can result in a shorter procedure duration [5, 6, 7]. In addition, parents prefer non-invasive techniques over general anaesthesia, sedation, restraint, and hand over mouth [8]. Deep breathing, listening to soothing music, and watching a favourite video are prevalent distraction interventions [9].

Multiple sensory modalities (visual, aural, and kinesthetic) are required for an effective distracter, as well as active emotional involvement and patient participation to compete with the signals from the unpleasant stimuli [10, 11, 12, 13], VR (virtual reality) distraction is an effective technique in decreasing pain perception and anxiety levels in

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children. Users interact with a computer-simulated three-dimensional environment in VR. VR technology creates a multi-sensory immersive experience that helps with distraction [14].

Fidget spinners (FS) are said to reduce stress and help children focus on daily tasks. Despite limited evidence, many parents believe in the alleged benefits of using a Fidget spinner toy in the classroom [15]. Kaleidoscope, with the help of mirrors and reflected lights, displays a variety of ever-changing shapes and colour schemes. The results of a study involving 7 to 12-year-old children revealed that the distraction provided by the kaleidoscope considerably reduced the level of pain and anxiety in the experimental group compared to the control group [16]. Although virtual reality has been assessed as a distraction tool in dentistry, the usefulness of fidget spinners and kaleidoscopes in decreasing dental anxiety in children has not been evaluated.

Therefore, the current study intended to employ fidget spinner (FS), kaleidoscope, and virtual reality (VR) as distraction techniques and observe the effects on the anxiety levels of children undergoing inferior alveolar nerve block (IANB).

2. Material and methods [Figure 1]

This 6-month parallel-group randomized clinical study was done in the Department of Pediatric and Preventive Dentistry following the CONSORT statement from March to August 2019. Due to the apparent nature of the research, neither the children nor the researchers were blinded. Based on the results obtained after conducting a pilot study, the data were analyzed, and the sample size was determined as per the standard protocol [17, 18]. A total of 102 children were screened and 60 children (6–9years) meeting the inclusion criteria with no previous dental experience and who were very aware of their surroundings, requiring IANB for dental treatment after the application of 'rule of 10' [19] were selected. Children who were allergic to any of the anaesthetic agents used in the trial, children who were medically challenged or disabled, and children who had any type of dentofacial abnormality or syndrome were excluded from the study [Figure 2]. Both the selected children and their parents/guardians verbally and in writing granted their informed consent. The Institutional Ethical Committee approved the current study (Protocol/IRB/12B/2015-18). Using sealed envelopes containing the group allocation, the selected children were randomly separated into four groups of 15 based on the method of distraction utilized. Gender-wise evaluation was not aimed in our study.

3. Clinical procedure

For all the 4 Groups, basic behaviour modification techniques, tell-show-do, positive verbal reinforcements, and euphemisms were applied which was followed by topical application of Lidocaine containing nummit spray (ICPA Health Products, Mumbai, India) to the area of injection 1 min before the IANB procedure.

Group 1 children were instructed to actively participate in fidget spinner (Toykart, India) play throughout the IANB procedure.

In Group 2, the children were asked to see a kaleidoscope (Adraxx, India) for various colors and patterns throughout the IANB procedure.

For Group 3, a virtual reality headset (MI VR Headset, India) that totally obscured the children's field of vision, along with earphones to transmit the sound, was placed on the children's head. To minimize bias, instead of allowing the children to select their favourite video only one episode of 'Chota Bheem' was played throughout the IANB procedure.

In Group 4, no distraction method (Control) was applied throughout the IANB procedure.

Each child in Groups 1, 2, and 3 were given 5 min to get habituated to the distraction aid before the IANB procedure began. All the distraction methods implementation and administration of IANB were performed by one paediatric dentist. The technique used to administer IANB involved the gradual injection of 1.8 ml of lidocaine with adrenaline using a 2 ml disposable luer lock syringe with a 26 gauge x 1½ inch needle (Unolok, Hindustan Syringes and Medical Devices Ltd., India) at a rate of 1 ml/minute. The Luer lock syringe was chosen because it allows the needle hub to rotate over the tip of the barrel and locked into place, resulting in a secure connection and preventing the needle from being accidently removed [20].

The level of the child's anxiety, oxygen saturation (SpO2), and pulse rate were measured before, during, and after the IANB procedure. Data was recorded by another pediatric dentist who was aware of the

Figure 1. Materials used for the study.

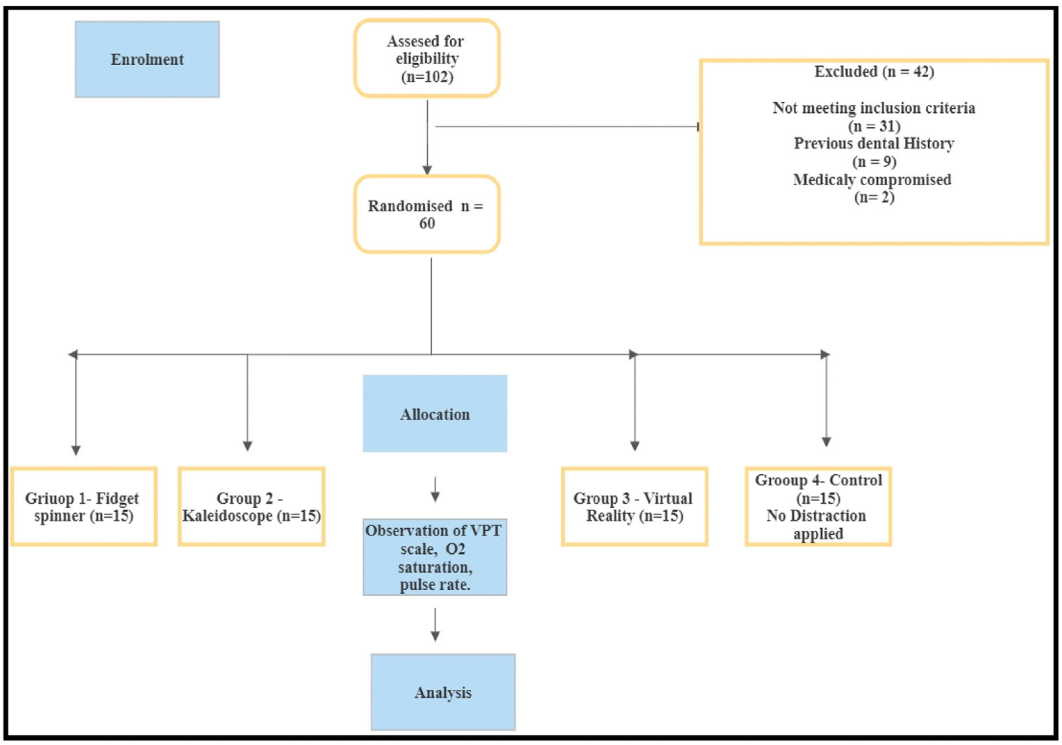

Figure 2. Consort flow diagram.

distraction methods used. Self-reported anxiety was measured using Venham Picture Test (VPT) [21] and Physiological levels of anxiety were measured by recording oxygen saturation (SpO2) and pulse rate by utilizing a fingertip pulse oximeter (CMS Medical, New Delhi, India).

The collected data were statistically analyzed with SPSS 21 software. Paired t-test and One way ANOVA were used to compare the VPT, SpO2, and pulse rate values. P-values of <0.05 and <0.001 were considered significant and very significant, respectively.

4. Results

The mean Venham Picture Test (VPT) scores, oxygen saturation (SpO2), and pulse rate levels with p-values using One way ANOVA were presented in Table 1 and inter Group comparison of p-values using paired t-tests were presented in Table 2.

Observations from Tables 1 and 2 showing the comparison between the four groups concerning mean VPT scores, mean oxygen saturation rate, and mean pulse rate are described below.

4.1. Comparison of mean VPT scores

Mean VPT scores for Groups 1, 2, 3 and 4 were 1.1111 ± 1.2472, 2.2667 ± 2.7086, 1.8444 ± 1.7832 and 4.1111 ± 2.7898 [Table1]. As indicated in Table 1, the comparison between the four groups was statistically highly significant ($p < 0.001$). Whereas, in intergroup comparisons of [Table 2] Groups 1, 2, and 3 showed significant difference compared to Group 4. Intergroup comparison of Groups 2 and 3 showed a non-significant difference ($p = 0.038$).

4.2. Comparison of mean SpO2 scores

Mean SpO2 Scores for Groups 1, 2, 3 and 4 were 98.48 ± 0.9914, 98.33 ± 1.5076, 98.75 ± 0.6794 and 98.2 ± 1.7003 respectively. The comparison between four groups [Table 1] and the intergroup comparison between the four groups [Table 2] was found to be statistically non-significant ($p > 0.05$).

4.3. Comparison of mean pulse rate scores

Mean pulse rate scores for Groups 1, 2, 3, and 4 were 97.4103 ± 16.3312, 107.7692 ± 18.6123, 100.4103 ± 13.446, and 112.9487 ± 13.2572 respectively. The comparison between the four groups was found to be statistically highly significant ($p < 0.001$) as shown in [Table 1]. Intergroup comparison between Groups 1 and 3, Groups 2 and 4 showed a non-significant difference with p-values of 0.771 and 0.182 respectively. Intergroup comparisons of Group 1 with Groups 2 and 4, Group 2 and 3 & Group 3 & 4 showed a statistically significant difference ($p < 0.05$) as shown in [Table 2].

Table 1. Groupwise comparison of mean scores of VPT, SpO2, and pulse rates throughout the IANB procedure.

Parameters	Group 1		Group 2		Group 3		Group 4		Total		p-value
	Mean Score	S.D	Mean Score	S.D	Mean Score	S.D	Mean Score	S.D	Mean Score	S.D	
VPT	1.1111	1.2472	2.2667	2.7086	1.8444	1.7832	4.1111	2.7898	2.333	2.4722	<.00001*
SpO2	98.4889	0.9914	98.3333	1.5076	98.7556	0.6794	98.2	1.7003	98.444	1.2912	0.170
Pulse rate	97.4103	16.3312	107.7692	18.6123	100.4103	13.446	112.9487	13.2572	104.6346	16.4458	<.00001*

One way ANOVA; S.D = standard deviation; * p-value < 0.001 highly significant.

Table 2. Intergroup comparison of mean VPT, SpO2, and pulse rate scores throughout the IANB procedure.

Groups Comparison		Mean VPT Score		Mean SpO2 Score		Mean pulse rate Score	
		Mean Difference	P-value	Mean Difference	P-value	Mean Difference	P-value
Group 1	2	-2.667	0.002**	0.1559	0.572	-9.08	0.001*
	3	-0.7334	0.016**	-0.2661	0.141	-1.022	0.770
	4	-0.6722	<0.00001*	0.288	0.305	-13.575	<0.001*
Group 2	1	-2.667	0.002**	0.1559	0.572	-9.08	0.001*
	3	0.4223	0.382	-0.422	0.113	8.066	0.014**
	4	-1.4441	0.007**	0.133	0.623	-4.4886	0.182
Group 3	1	-0.7334	0.015**	-0.2661	0.141	-1.022	0.771
	2	0.4223	0.382	-0.422	0.113	8.066	0.014**
	4	-2.2666	<0.00001*	0.555	0.057	-12.55	<0.00001*
Group 4	1	-0.6722	<0.00001*	0.288	0.304	-13.575	<0.001*
	2	-1.4441	0.007**	0.133	0.630	-4.4886	0.182
	3	-2.2666	<0.00001*	0.555	0.058	-12.55	<0.00001*

Paired t test; **p-value < 0.05 significant; * p-value < 0.001 highly significant.

5. Discussion

Distraction is divided into two main categories: passive distraction, which requires the child to remain silent while the dental health care professional is actively distracting him. Watching movies, listening to music through headphones, reading a book to the child, or telling him a tale are all different forms of passive distraction. On the other hand, active distraction encourages the child to participate in the activities during the procedures. Active techniques include singing songs, compress balls, relaxation, breathing, and playing with electronic devices [22].

The most typical anxiety-inducing stimuli, particularly in little children who are likely having their first visit to a dental clinic seems to be the anticipation of needle injury. Therefore, it is very essential to use selective interventions for distraction [9]. Hence, this study was carried out to compare the effects of different distraction techniques (fidget spinner, kaleidoscope, and virtual reality) on children's anxiety levels. Also, blocking the inferior alveolar nerve in children was affirmed to be one of the most painful and stressful procedures in pediatric dentistry [3], hence IANB was chosen to compare distraction approaches.

Venham Picture Test (VPT) has been considered to be the most reliable method of self-reported anxiety in children [7] and hence was used to measure the self-reported anxiety levels of children. The results of the present study showed that Groups (Groups 1, 2, 3) that implied distraction had lower mean VPT scores compared to the non-distraction group and the results were statistically significant indicating that all the distraction methods used were able to reduce the anxiety levels throughout IANB procedure.

Fidget spinners decrease stress and anxiety-provoking habits during medical procedures by allowing social interactions and conversations among like-minded children [15]. According to a previous study, hyperactive movements like fidgeting help children perform better on attention tasks [23]. Such toys can be used to motivate children for the completion of daily tasks, improve social bonding efforts, or reduce repetitive behaviours [14]. In the present study, FS group children showed the lowest mean VPT scores compared to other groups. Fidget spinners vary from other sensory toys, such as sensory putty, rubber bands, and squeeze balls, because they generate a whirring noise and are visually distracting when used which may explain why anxiety scores were lower. Also, fidget spinners have high reward sensitivity and were useful in diverting child's attention in the initial phases of treatment as reported by Graziano et al [24].

Kaleidoscope has been used in the medical field as an effective distraction aid during procedures [16]. Canbulat et al [25] investigated the effect of colored cards and kaleidoscopes as visual distraction tools, compared their impact on the pain levels, and found that the pain level of the kaleidoscope group was lower than the control group. In a multicentre study conducted by Carlson et al [26], observed that using kaleidoscope distraction method during venipuncture affected pain levels; however, it did not reduce pain levels statistically significantly. To date, kaleidoscope has not been evaluated as a distraction aid in Pediatric Dentistry. Bulut et al discovered a significant difference in postoperative pain, fear, and anxiety levels between intervention and control groups in favour of the kaleidoscope group [27]. Similarly, we observed that kaleidoscope distraction was beneficial in decreasing anxiety among children when compared to the control group and the results were statistically significant ($p < 0.05$). The mean VPT scores in Group 2 were marginally higher as compared to FS and VR groups. This can be explained by the fact that kaleidoscope only offers visual distraction as compared to fidget spinner and virtual reality which offer both audiovisual and sense perceptive distraction [5, 14].

Audiovisual distraction (AD) actively engages both the visual and auditory senses while inducing a positive emotional reaction, resulting in a relaxed experience [28, 29]. Virtual reality (VR) technology creates an immersive, multisensory, and three-dimensional (3D) environment that allows users to alter their perceptions of reality by bringing about a sense of "presence" [30, 31]. In the present study, when the mean VPT scores of Group 3 were compared, we observed a significant difference with group 1, a highly significant difference with group 4, and a non-significant difference with group 2. The significantly lower mean VPT scores might be because VR stimulates the visual, auditory, and proprioception senses and thus acts as an effective distraction method [31]. The results of our VR Group study were consistent with a review of the literature, which found that the majority of studies using VR distraction showed a reduction in stress levels [29, 32, 33, 34].

We observed that the control group had the highest mean VPT scores and results were statistically highly significant ($p < 0.001$). Even though basic behaviour management techniques and topical anesthetic spray application before the insertion of the needle were performed for all the groups, control group children's vision to the dental equipment was not blocked partially or completely and could visualize the entire IANB procedure which involves time-consuming deposition of local anesthetic at the rate of 1ml/minute could have made them more anxious. This result further emphasizes the importance of utilizing economical distraction aids for stressful IANB procedures in Pediatric Dentistry.

Pulse rate has been proven to be a direct measure of physiologic arousal in dentally apprehensive children [35] and hence it was included as one of the measures of dental anxiety in the current investigation. Instead of a traditional bedside pulse oximeter, a small cost-effective fingertip device was used, which was extremely beneficial clinically, less threatening for children, and has the advantages of high portability, ease of use, and battery operation [9, 36]. In the present study, we

observed highest Mean pulse rate with the control group closely followed by the kaleidoscope group and results were non-significant. Kaleidoscope showed a highly significant difference compared to the FS Group and a significant difference with the VR Group. Whereas, FS and VR Groups had significantly lower Mean pulse rates than Group 4 and the results were highly significant.

We observed no statistically significant difference in SpO2 levels as the pulse rate was comparatively lower and oxygen saturation marginally higher in FS and VR Groups as compared to kaleidoscope and control group wherein pulse rates were marginally higher with lower SpO2 rates. The observed results of FS and VR groups were in conjunction with previous research done by Yelderman et al [35] and Prabhakar AR et al [29] who had noticed a similar type of pattern.

In our study, when all mean VPT, SpO2, and pulse rates scores were observed kaleidoscope was not as effective as FS and VR groups as a non-significant difference in Mean VPT was noted with group 3 and significant difference with FS and control groups. Whereas, the mean pulse rates in the kaleidoscope group were comparable to that of the control group ($p = 0.182$) which was significantly higher than FS and VR groups. Even though kaleidoscope was less effective in reducing anxiety levels than FS and VR Groups it performed better than the control group. Kaleidoscope had only visual distraction with its colorful mirror images and partially blocked the child's field of view as compared to VR where the entire child's field of view was engaged with the VR headset.

Although FS does not block the child's field of view, making the child more aware of their surroundings and requires practice, still it proved to be marginally better than VR. This could be due to the increased concentration on the performance of the act levied by FS group children as they were more occupied with the fidget spinner play. In comparison to FS in the present study, the marginally lower performance of virtual reality can be attributed to its bulkiness and children may have felt claustrophobic with its use which might have affected the anxiety levels in these children [37].

The current study found that all three distraction approaches had a significant positive effect on reducing dental anxiety in children when compared to no distraction. Overall FS and VR proved to be marginally better distraction aids as compared to kaleidoscope. The limitations of the present study include smaller sample size and blood pressure was not taken into consideration which might have added additional parameters to assess the anxiety level scores. VPT anxiety scoring has some drawbacks, such as the fact that the figures on the scale are identical, which may be difficult for a young patient to identify with. VPT pictures resemble western faces and the WBPRS scoring range is from 0 to 10 with only 6 facial expressions, so children maybe unable to assume the missing facial expressions. Also, the ambiguous nature of some figures on the VPT scale is confusing for the child to choose [38]. Hence, further research with a larger sample size including various other anxiety levels assessing parameters such as Wong-Baker Pain Rating Scale and Animated visual faces pain/anxiety rating scale are recommended.

6. Conclusions

Within the limitations of this study, it can be concluded that fidget spinner, kaleidoscope, and virtual reality were effective in reducing dental anxiety throughout IANB administration in children and can be recommended as effective distraction aids in Pediatric Dentistry.

Declarations

Author contribution statement

Aditya PVA: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Madu Ghana Shyam Prasad: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Ambati Naga Radhakrishna: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Nagothu Sleeva Raju, Duvvi Naveen Babu: Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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