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ORIGINAL SCIENTIFIC ARTICLE

Comparison of the effects of cognitive behavioural therapy and inhalation sedation on child dental anxiety

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Abstract
Aim To compare the effectiveness of inhalation sedation with nitrous oxide/oxygen (N_2O/O_2) and cognitive behavioural therapy (CBT) in reducing dental anxiety in preschool children.
Study design Randomised controlled clinical trial.
Methods This study was conducted on 45 preschoolers with moderate to severe dental anxiety (determined by the Children's Fear Survey Schedule Dental Subscale), who required pulp treatment of at least one primary mandibular molar. Baseline anxiety and cooperation levels were determined using Venham Clinical Anxiety and Cooperation Scales (VCAS and VCCS) and Venham Picture Test (VPT) at the first dental visit (dental prophylaxis and fluoride treatment). Before the second dental visit (pulp treatment), the children were randomly assigned to one of three groups—1: control, 2: N_2O/O_2 and 3: CBT. In group 1, the usual behaviour management techniques were used, in group 2, nitrous oxide/oxygen gas was used and in group 3, unrelated play, Benson's breathing and positive self-talk and modelling were used. Anxiety and cooperation levels were determined at three periods: injection, rubber dam placement and the application of a high-speed handpiece with VCAS and VCCS and VPT. Finally, anxiety and cooperation differences between the two dental visits were compared within the three groups.
Statistics Chi square, ANOVA and Kruskal–Wallis and Mann–Whitney *U* tests were used.
Results N_2O/O_2 and CBT significantly resulted in lower anxiety and higher cooperation in the second visit (at all three periods) compared to the control, although there was no significant difference between these two treatment methods.
Conclusion Both test methods were effective in reducing dental anxiety in preschoolers. Considering the adverse effects and necessity of equipment and trained personnel when using nitrous oxide and oxygen inhalation sedation, cognitive behavioural therapy is preferable because of its better applicability.

Keywords Dental anxiety · Child · Preschool · Conscious sedation · Nitrous oxide · Cognitive behavioural therapy

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Introduction

Prevalence of dental fear and anxiety has been shown to be high among children. The high prevalence of severe dental anxiety in Iranian school-aged children during early years of school has been reported (Paryab and Hosseinbor 2013). Moreover, it has been shown that dental fear is potentially the most important predictor of children and adolescents dental behaviour management problems (DBMP) (Gustafsson et al. 2010). Anxiety is also a determinant factor in the perception of pain which plays a critical role in the pain reaction of children (Kuscu and Akyuz 2008).

There are several scales available to assess the level of anxiety in children including the Venham scale, which comprises two components, an anxiety scale and a behavioural scale. Accordingly children are categorised to six definitive groups (0–5) based on their behaviour. Validity and reliability of these scales have been established (Venham et al. 1980).

Venham Picture Test (VPT) is a self-reporting measure of anxiety, which employs pictures. This test can be described briefly to a child and needs just about 1–2 min to be completed. Also, its administration and scoring are relatively easy and its validity has been demonstrated (Buchanan and Niven 2002). Children's Fear Survey Schedule Dental Subscale (CFSS-DS) is another tool for assessing children's anxiety. It has been shown to be both reliable and valid (Boman and Lundgren 2008).

Regarding evaluation scales to measure child anxiety, it has been shown that none of the scales is better than others, nor can act as a gold standard (Foster and Park 2012). However, using multiple anxiety scales simultaneously may be a means for achieving more realistic results (Foster and Park 2012). In the present study, several scales were used: the Venham clinical anxiety scale (VCAS) (Venham et al. 1980) that was measured by an observer; VPT, a self-reporting measure of anxiety that uses pictures (Buchanan and Niven 2002); and CFSS-DS (Boman and Lundgren 2008) were employed to assess anxiety. Additionally, the Venham Clinical Cooperation scale (VCCS) (Venham et al. 1980) was used to measure children's cooperation.

Dentists use a wide variety of non-pharmacological and pharmacological techniques to assist them in the management of anxious children. Among the non-pharmacological techniques, one strategy which seems promising for pain control in stressful medical situations is teaching the child to use behavioural (Pawlicki 1991) and cognitive (Fernandez 1986) coping skills, or a combination of both techniques (Tan 1982). It has been shown that cognitive behavioural therapy (CBT) is an effective treatment for anxiety disorders of children and adolescents (James et al. 2013) and can be effective in reducing dental anxiety (Getka and Glass 1992; Prangnell and Green 2008). As reported in multiple studies, these behavioural and/or cognitive interventions can be used ahead of, during or after finishing the dental treatment. They include behavioural modelling, medical play, audiovisual distraction, hypnosis, breathing relaxation, positive self-talk and positive reinforcement (Stokes and Kennedy 1980; Nocella and Kaplan 1982; Zahr 1998; Prabhakar et al. 2007; Howard and Freeman 2009).

Additionally, an alternative approach to non-pharmacological management is the sedative method that provides the means for children to avoid psychologically traumatic experiences that might inhibit regular oral health care when they become adults. The most frequently used sedative agent is nitrous oxide/oxygen (N_2O/O_2) (Dean et al. 2011). In some studies, the positive effect of nitrous oxide conscious sedation on eliminating child uncooperative behaviour in stressful dental procedures has been proved (Nathan et al. 1987).

As there is lack of studies comparing conscious sedation and combinations of cognitive behavioural strategies in eliminating the uncooperative behaviours and dental anxiety of children, the aim of this study was to assess and compare the effect of N_2O/O_2 conscious sedation and CBT on children's anxiety and uncooperative behaviours in dental situations.

Materials and method

Subjects

For this randomised controlled clinical trial study (unblinded parallel-group study), 45 children aged 3–6.5 years old were selected from patients referred to the Paediatric Dentistry Department of the Mashhad Dental Faculty for their dental visit and written informed consent was obtained from parents. Figure 1 shows the case selection and randomisation processes.

The inclusion criteria were the absence of mental retardation, no history of current episodes of medications or drug therapy, absence of systemic or congenital disorders, aged between 3 and 6.5 years old, presence of moderate to severe dental anxiety, presence of at least one mandibular primary molar needing pulp treatment and a history of previous dental visit.

Sample size

As there was no similar research at the time this study was performed, this study was considered a pilot study and sample size was determined to be 45 children.

Randomisation

The randomisation process was performed using the Research Randomiser software (Urbaniak and Plous 1997). According to age and gender of participants, children were assigned into three equal groups ($n = 15$). The principle investigator performed the randomisation process before beginning the study. Each participant received an opaque, sealed envelope containing a number to assign him/her to one of the three groups.

Determination of baseline values of anxiety and cooperation (Fig. 1)

The children's anxiety level was assessed using CFSS-DS questionnaires filled out by parents and then those children

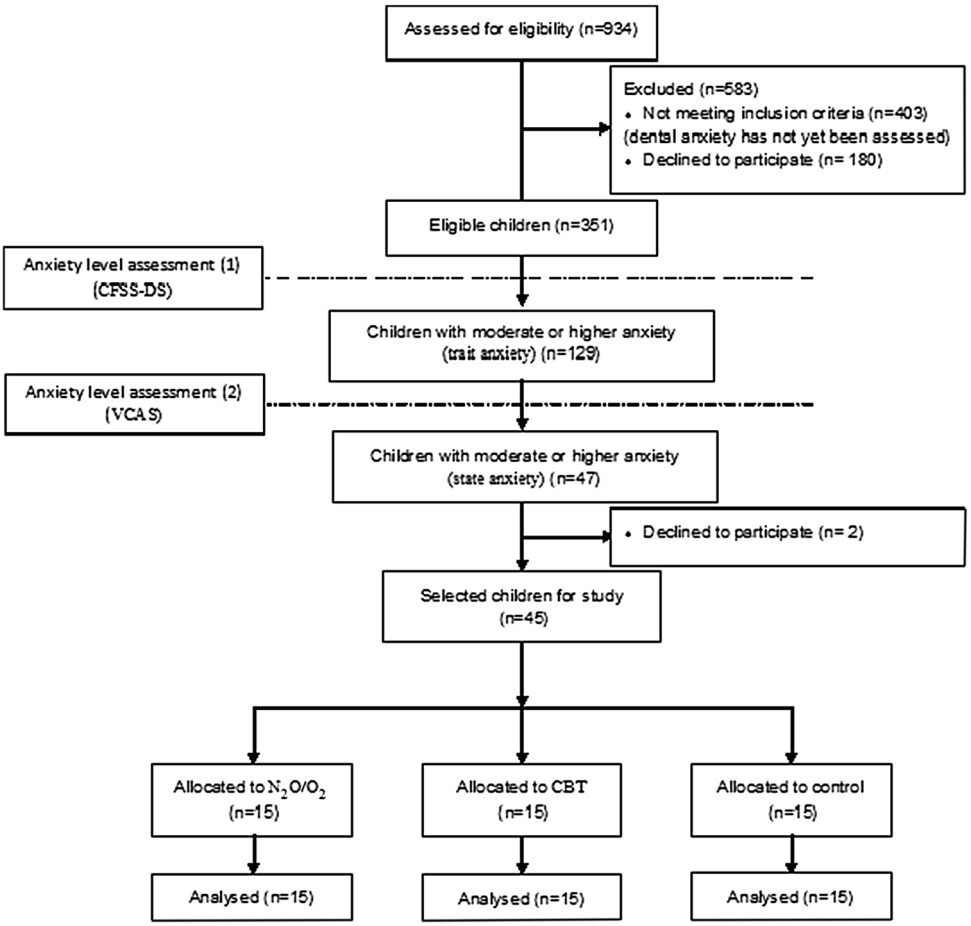

Fig. 1 Flow chart of patients who met inclusion/exclusion criteria for the study. *CBT* cognitive behavioural therapy, *CFSS-DS* children's fear survey schedule dental subscale, *VCAS* venham clinical anxiety scale, N_2O/O_2 nitrous oxide/oxygen

with moderate and severe anxiety were selected. As this index shows trait anxiety, to verify the anxiety state of the child, a prophylaxis and fluoride therapy visit was arranged. This dental visit was recorded and according to VCAS, anxious children with a score of 1–5 were selected. Moreover, to determine the initial cooperation of children, VCCS was used. The same two people assessed all the records in the study.

Interventions to reduce dental fear and anxiety (DFA)

Group 1 (the control group): this group received conventional behavioural management techniques including tell-show-do, voice control, positive reinforcement, distraction and non-verbal communication.

Group 2 (the conscious sedation group): children were sedated by the rapid induction method (Casamassimo et al. 2013) by means of N_2O/O_2 gases.

Group 3 (the cognitive behaviour technique group): children had the opportunity to play for 4 min in a playroom with a painting board, colour pencils, play dough, and some other toys such as dolls and toy cars, and meanwhile the dentist tried to establish a rapport with him/her. Then, in the modelling phase, a film of a happy 5.5 year-old child cooperatively going through dental prophylaxis and fluoride therapy was shown to the child. The dentist drew the child's attention to the happiness of the child being treated and answered the child's questions about dental procedures shown in the film.

Afterwards, in the Benson's relaxation phase (Leahy and Holand 2007), by means of a glove puppet in the dentist's hand, the Benson's breath method was taught to the child. While the dentist's hand was placed on the child's stomach, the child was asked to fill it with air like a balloon, hold it for 2 s and then empty it slowly in approximately 4 s. Afterwards, in the cognitive phase, dentist told the child that by emptying the balloon (stomach), all of his/her fears and concerns will empty out and to take the place of those negative feelings, the child should use positive self-talk, by means of reinforcing positive sentences such as "I am powerful" and "I am brave". This phase lasted for 8 min. After 16 min in the playroom, the child entered the operating room and dental treatment was performed on him/her. The children were asked to do the Benson's

breathing during the injection of local analgesia, the application of a rubber dam and during the use of a high-speed handpiece or in cases of the child suffering from anxiety, acting uncooperatively or struggling.

Dental procedures

At the first visit, dental prophylaxis and fluoride were performed to assess the children's baseline anxiety and cooperation. At the second visit, children were treated with pulp therapy after receiving anxiety-reducing procedures. It is important to note that all children received an inferior alveolar nerve block injection.

It should be noted that parents accompanied their child only when the child was playing in the playroom (for group 3) and entering the dental operation room in the first dental visit (for all of the groups). However, parents were not allowed to stay in the dental operation room while the dentist performing dental treatment in the first and second dental visits.

Dental treatment procedures were video-recorded using a camera (Panasonic, NV-GS35GC) and the recorded video was viewed separately by two observers. Anxiety and cooperation of the child were scaled into three stressful stages of treatment (i.e. local analgesia injection, rubber dam placement and using a high-speed handpiece). VCCS was used in order to evaluate the cooperation of the participants and VCAS for assessing the children's anxiety. In a common session, the assigned scores (VCCS and VCAS) of the two observers for each child were compared and in cases of disagreement, the recorded video was reviewed and they reached a conclusion on a single score. Also, one self-report anxiety scale (VPT) was considered. Finally, the differences of the first and second visit scores were compared between the groups.

Blinding of assessment

In the inhalation sedation group, placement of a mask on the child's face was needed, and in the CBT group, the dentist had to remind the child to breath according to the Benson method; hence, blindness of this study was impossible.

Statistical analysis

Chi-square and ANOVA tests were used for the homogeneity of the treatment groups for their gender and age. ANOVA and post hoc analyses were used to compare the treatment groups in terms of CFSS-DS or VPT scores and changes of VCAS and VCCS scores during local analgesia injection. For other non-parametric analyses, the Kruskal–Wallis and Mann–Whitney *U* tests were used.

Table 1 Mean ± SD of CFSS-DS and VPT and mean rank of VCCS and VCAS scores (the baseline values)

Scores	Control ($N = 15$)	N_2O ($N = 15$)	CBT ($N = 15$)	*P* value
CFSS-DS	43.00 ± 5.11	40.00 ± 3.96	41.86 ± 5.58	0.26
VPT	4.71 ± 2.13	4.67 ± 1.72	4.93 ± 1.39	0.90
VCCS	18.77	22.87	27.37	0.26
VCAS	19.50	22.73	26.77	0.16

CBT cognitive behavioural therapy, *CFSS-DS* children's fear survey schedule dental subscale, *VCAS* venham clinical anxiety scale, *VCCS* venham clinical cooperation scale, *VPT* venham picture test, *N_2O/O_2* nitrous oxide/oxygen

Results

There was no statistically significant difference between the mean age of participants in the N_2O sedation group [4.87 ± 0.89 years], CBT group [4.92 ± 0.95 years] and control group [5.15 ± 0.86 years] ($F = 0.43$, $P = 0.66$), nor was there a statistically significant gender difference in the N_2O/O_2 sedation (53.3 %), CBT (66.7 %) and control groups (69 %) ($\chi^2 = 1.26$, $P = 0.53$).

As is shown in Table 1, the mean of baseline anxiety and cooperation (according to CFSS-DS and VPT, VCCS and VCAS scores) did not show any significant differences between the treatment groups.

Comparison of the mean VPT score of participants in the second dental visit and the mean difference of VPT scores between the two treatment sessions did not show any significant difference between the treatment groups (Table 2).

Comparison of the changes of the means of the first and second dental visit's VCCS and VCAS scores during local analgesia injection, rubber dam placement and using a high-speed handpiece, between the participants in the intervention and control groups are shown in Table 3. Children in the N_2O/O_2 and CBT groups showed a significantly higher decrease in anxiety and uncooperative behaviours in comparison to the children in the control group.

Discussion

In this study, no statistically significant differences were seen between age, gender and initial cooperation of participants between all the groups. As anxiety significantly correlates to age and gender (Klingberg and Broberg 2007), homogeneity of groups in this regard is an essential part of every similar study. Furthermore, the presence of anxiety and uncooperative behaviours in the first dental visit can affect validity of the results and should not be overlooked.

Table 2 Mean ± SD of VPT score at the second dental visit and the mean difference of VPT scores between 2 treatment sessions

VPT score	Control ($N = 15$)	N_2O ($N = 15$)	CBT ($N = 15$)	P value (Kruskal–Wallis)
Second visit	4.28 ± 2.09	3.26 ± 1.98	2.33 ± 2.89	0.097
Difference	−0.42 ± 2.21	−1.40 ± 2.10	−2.60 ± 3.18	0.08

CBT cognitive behavioural therapy, *VPT* Venham Picture Test, N_2O/O_2 nitrous oxide/oxygen

Table 3 The mean changes of anxiety and cooperation between the two dental visits during injection (mean ± SD), using high-speed hand piece and placing rubber dam (mean ranked)

Dental procedures	Scales	Groups			P value (test)
		Control ($N = 15$)	N_2O ($N = 15$)	CBT ($N = 15$)	
Injection	VCCS (mean ± SD)	-1.33 ± 0.74^a	-2.00 ± 1.13^b	-1.67 ± 0.901^b	0.00 (ANOVA)
	VCAS (mean ± SD	-0.13 ± 0.74^a	-2.00 ± 1.13^b	$-1.67 + 0.90^b$	0.00 (ANOVA)
High-speed hand piece	VCCS (mean)	31.30^a	18.60^b	19.10^b	0.00 (Kruskal–Wallis)
	VCAS (mean)	30.60^a	18.73^b	19.67^b	0.01 (Kruskal–Wallis)
Rubber dam	VCCS (mean)	13.17^a	18.53^b	19.30^b	0.00 (Kruskal–Wallis)
	VCAS (mean)	31.00^a	18.63^b	19.37^b	0.01 (Kruskal–Wallis)

Within each row, means with the same superscript letters a or b are not statistically different from each other

CBT cognitive behavioural therapy, *VCAS* venham clinical anxiety scale, *VCCS* venham clinical cooperation scale, N_2O/O_2 nitrous oxide/oxygen

In this study, according to the absence of significant differences between the groups in terms of the initial level of cooperation and anxiety, any difference observed in the second dental treatment session could be attributed to pharmacological or behaviour management techniques used in each group.

The results of this study have shown that the CBT technique can be significantly effective in both improving the cooperation of children and reducing their anxiety. Moreover, several experiments using different methods have also shown its effectiveness. Stokes and Kennedy (1980) examined positive reinforcement and modelling and reported it to be effective in reducing 7-year old children's disruptive behaviours to acceptable levels during restorative procedures. In a study by Nocella and Kaplan (1982), children assigned to a stress-inoculation group, who received instruction in relaxation and positive self-talk, exhibited fewer verbalisations and body movements during the dental treatment than children in the control groups. Furthermore, some researchers have documented the effectiveness of a multicomponent CBT technique (Del Gaudio and Nevid 1990; Getka and Glass 1992; Levitt et al. 2000). In the present study, modelling, Benson's relaxation breathing methods and positive self-talk and unrelated play have been used effectively to reduce children's anxiety for dental treatment.

Through behavioural modelling, without being actually treated, the children learn about dental procedures and methods to reduce their fear-induced behaviours (Howard and Freeman 2009); therefore, it can be an effective means in reducing dental anxiety. The Benson's relaxation breathing method and positive self-talk were practised prior to the treatment session by means of a glove puppet. Participants in this study were in the pre-operational stage of Piaget and they needed audiovisual stimuli for cognition of their surroundings. Pre-operational stage lasts from about 2 to 6 years of age, and at this stage, children do not yet understand concrete logic and cannot mentally manipulate information (Piaget 1965); therefore using a glove puppet helped in understanding the dentist's instructions. Another advantage of a glove puppet is that the child can express his/her feelings in the words of a third party. It was shown that medical play (related play) might be an effective means for improving the cooperation of children in medical settings (Zahr 1998). This study focused on CBT techniques and not on play therapy, which needs special equipment and time; hence, it was preferred to use non-related play just to have an opportunity to communicate better with children.

Moreover, in the present study, sedated children with N_2O/O_2 cooperated better and were less anxious than the control group. Significant reductions in anxiety and disruptive behaviours of dental patients have been observed by means of N_2O/O_2 conscious sedation, in other studies (Nathan et al. 1987; Primosch et al. 1999; Arch et al. 2001; Alexopoulos et al. 2007). Nathan et al. (1987) showed that N_2O/O_2 can reduce mild to moderate anxiety and disruptive behaviours of children during stressful procedures of dental treatment, but is not effective in cases of severe anxiety and uncooperativeness. In a study by Alexopoulos et al. (2007) N_2O/O_2 reported on a significant reduction in the anxiety levels of dental paediatric patients (5–17 year

old children). In a study by Arch et al. (2001) significant reduction of anxiety in 9–15 year old children was reported by means of N_2O inhalation sedation during dental extractions. In Primosch et al.'s (1999). study, 40 % N_2O/60 % O_2 inhalation was significantly more effective in improving 60–116-month-old children's behaviours in comparison to 100 % oxygen inhalation.

In the present study no significant differences were shown between the N_2O/O_2 conscious sedation and CBT in reducing the uncooperative behaviours and dental anxiety of children.

Aartman et al. compared the effect of behaviour management techniques (including ''tell-show-do'', gradual exposure and relaxation exercises) with N_2O/O_2 regarding dental anxiety reduction. Although behaviour management technique revealed better performance in decreasing the anxiety of patients, the difference was not statistically significant (Aartman et al. 1999). Willumsen et al. (2001) compared the effects of CBT (cognitive restructuring and in vivo exposure), applied relaxation and N_2O/O_2 sedation and their results did not show any significant difference in anxiety reduction. A Cochrane review in 2013 on the relative efficacy and long-term effect of CBT versus non-CBT active treatments and medication has concluded that although CBT seemed promising for the treatment of children and adolescent anxiety disorders, whether the long-term effect of CBT is better than active controls is not yet well recognised (James et al. 2013).

N_2O/O_2 has some side-effects such as nausea/vomiting and might cause diffuse hypoxia. In addition, in contrast to the CBT technique, the conscious sedation technique requires special techniques and expert personnel (Dean et al. 2011). Therefore, with regard to the statistically comparative results of the conscious sedation technique and CBT technique, it seems that the CBT technique is preferred to N_2O/O_2 in clinical situations.

There were some limitations in this study. Blindness to the study was impossible because a mask was required to be used on the child's face in the inhalation sedation group and the dentist had to remind the child to perform Benson's breathing in the CBT group. Moreover, if there was more time, it would have been better to have one or two restorative sessions before doing pulp therapy; however, it was a M.Sc. thesis and according to our dental school policy, there was a limited time and were confined to only two sessions of treatment. Also, finding children with moderate to severe anxiety and at least one primary mandibular molar requiring pulp treatment, which compelled their parents to bring their child for treatment sessions, was very difficult, accordingly only 15 children were included in each group.

Conclusions

Both cognitive behavioural therapy and N_2O/O_2 sedation methods were effective in reducing dental anxiety in preschoolers. Considering the adverse effects and necessity of equipment and trained personnel, cognitive behavioural therapy is preferable because of its better applicability.

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