Original Article

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Evaluation of the effect of essential oil aromatherapy on anxiety and pain during administration of local anesthesia in children: a randomized clinical trial

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Background: The key to a child's treatment success in a pediatric dental setting is to control discomfort and anxiety. The proposed method supports the execution of a non-aversive behavior management scheme. This study aimed to evaluate the effects of essential oil aromatherapy on anxiety and pain associated with the administration of local anesthesia (LA) in children.

Methods: This study included 176 children (87 girls and 89 boys) aged 6–9 years, who were randomly divided into two groups. Group 1 received aromatherapy with essential oil using a nebulizer for 2 min with a 10-min induction period before the administration of LA. Group 2 (control group) was managed using non-pharmacological behavioral techniques. Baseline anxiety levels were recorded for all children before the intervention. LA was administered according to a standard protocol. Postprocedural pain and anxiety were assessed using the Wong–Baker Faces Pain Rating Scale (WBFPRS); Visual Analog Scale (VAS); Sound, Eye, Motor (SEM) scale; and Modified Child Dental Anxiety Scale (MCDAS)(f). Data were analyzed using SPSS version 21.0.

Results: The Mann–Whitney U test revealed a statistically significant difference in anxiety MCDAS(f) scores between the groups at both baseline (P = 0.022) and post-procedure (P = 0.001). The Wilcoxon signed-rank test also indicated a statistically significant change in anxiety scores within each group from baseline to post-procedure (P = 0.001). Furthermore, VAS, analyzed using the Mann–Whitney U test, demonstrated a significant difference between the groups (P = 0.001). Pain scores measured using WBFPRS and SEM scales were significantly lower in the aromatherapy group, as determined using the chi-square test.

Conclusion: Prior use of essential oil aromatherapy can effectively reduce anxiety and pain in children during the administration of LA.

Keywords: Anxiety; Aromatherapy; Children; Essential oil; Local Anesthesia; Pain.

INTRODUCTION

Fear and anxiety regarding dentist visits in many children and teenagers is a serious area of interest [1]. Neglecting dental care for an extended period owing to the fear of a dentist can lead to a decline in oral health, resulting in pain and suffering [2]. The sights, noises, drills, odor of cut dentin, medications, and sensation of high-frequency vibration are some factors that can make young children anxious in a dental setting [3]. Local anesthesia (LA) is a primary cause of anxiety and fear. LA, a common practice in pediatric dentistry to alleviate pain, often triggers discomfort in children. Research shows that anxiety can intensify the perception and duration of pain through attentional mechanisms [4]. Studies have shown that attentional bias towards pain can exacerbate anxiety and increase perceived pain [5]. In addition, higher anxiety

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levels are linked to lower pain tolerance, and worry is a significant predictor of pain intensity after oral surgery [6]. Several investigations have discovered that odors can affect a person's cognition, mood, and behavior [7,8]. Modern and alternative medical practices, including aromatherapy, which uses fragrant, volatile liquid substances such as essential oils, have recently gained attention in dentistry and medical contexts [8-10].

Aromatherapy involves the topical or aromatic use of essential oils for therapeutic or medical purposes [11,12]. Plant-based oils are used to treat illnesses and improve physical and mental well-being [13]. Aromatherapy using essential oils, such as those of lemons, oranges, apples, chamomile, and bergamot, offers therapeutic benefits in dental care. It is an affordable and non-invasive approach that enhances well-being, relaxation, and comfort during dental procedures [14]. Aromatic oils are believed to have antiviral, antifungal, and antioxidant effects, as well as varying degrees of antibacterial action [15]. Aromatherapy can be applied topically or through massage, inhalation, compression, and baths [16]. When volatile oil molecules are inhaled via humidifiers, nebulizers, or soaked gauze, they reach the lungs, quickly diffuse into the blood, and activate the brain via systemic circulation [17]. These compounds also interact with the olfactory receptors, triggering an electrical response that travels to the brain. This response affects odor perception and reaches regions of the limbic system, such as the amygdala and hypothalamus, where hormone levels and emotions are controlled, likely activating the neocortex [18].

Aromatherapy can enhance dental practice by reducing patient anxiety and creating a more relaxed environment. Essential oils have calming effects that improve patient comfort and cooperation during procedures. As a noninvasive and easy-to-implement method, aromatherapy serves as a useful complementary tool to improve the overall patient experience in dental settings.

Relatively little research has been conducted on the use of aromatherapy in children undergoing dental treatment. The current study was undertaken to regulate the impact of essential oils used in aromatherapy on dental anxiety and discomfort in children receiving LA administration. The null hypothesis was 'there is no effect of aromatherapy in alleviating dental anxiety and pain perception during LA administration in children undergoing dental procedures.'

METHODS

1. Study Design

This study was conducted at the Department of Pediatric and Preventive Dentistry, Teerthanker Mahaveer Dental College & Research Centre (TMDC&RC), affiliated with Teerthanker Mahaveer University (TMU), Moradabad, India. Ethical approval was obtained from the TMDC & RC Institutional Ethical Committee in Moradabad under the reference number TMDCRC/IEC/1-22/PPD1. The study was registered with the Clinical Trials Registry of India (CTRI) under the registration number CTRI/2022/08/04474.

The eligibility criteria for the study were as follows:

- **Inclusion criteria:**
  1. Children aged 6–9 years requiring LA in the maxilla or mandible for pulp therapy or tooth extraction.
  2. Children with a score ≥ 12 on the Modified Child Dental Anxiety Scale (MCDAS)(f).
  3. Children in good physical and mental health.
- **Exclusion criteria:**
  1. Children with significant behavioral problems.
  2. Children with a score of < 12 on MCDAS(f).
  3. Children with dental or medical emergencies or systemic disorders.
  4. Children who refused to wear the nebulizer mask.
  5. Children whose parents refused to provide consent.

Excluding children with a score < 12 on MCDAS(f) likely ensured that the study concentrated on participants with significant dental anxiety. Children with lower scores may have had little or no anxiety, which could weaken the measured effects and affect the reliability of the study. By including only those with scores ≥ 12, the

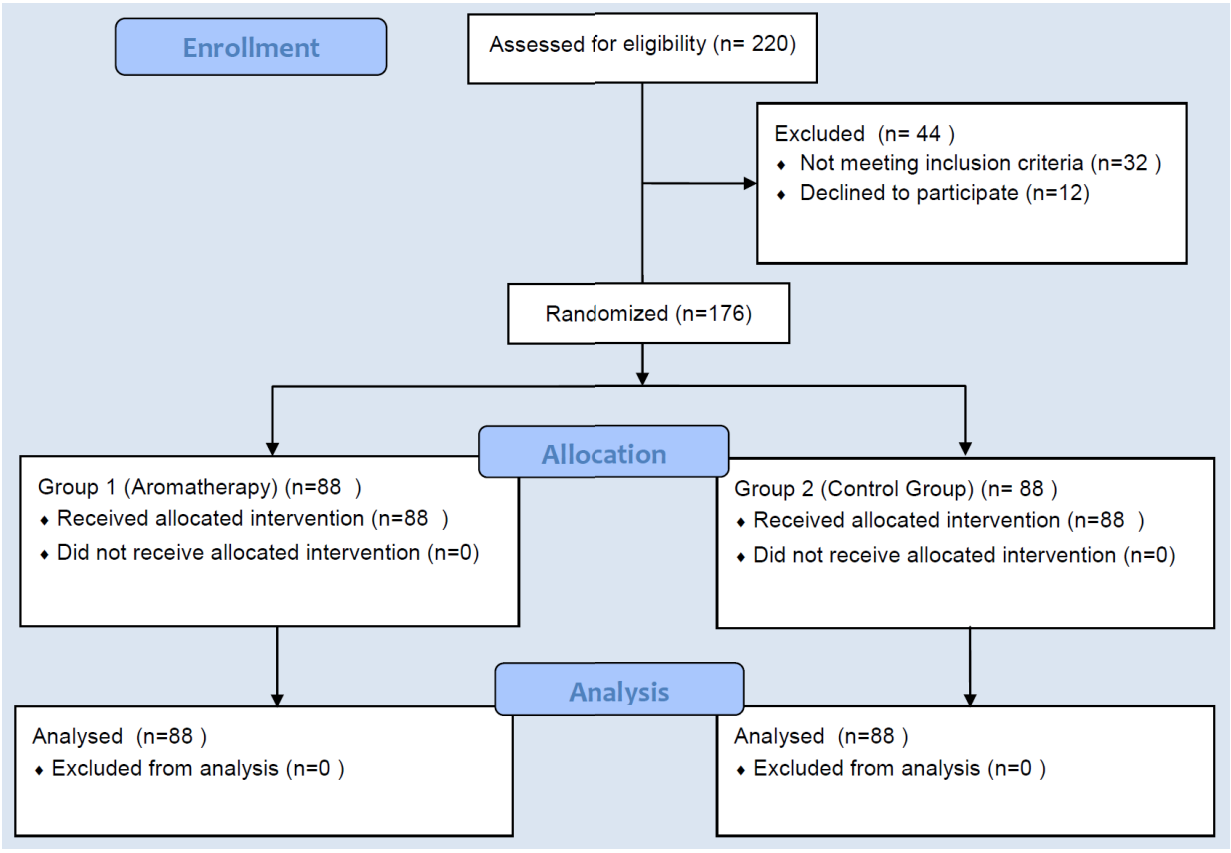

Fig. 1. Consolidated standards of reporting trials flow diagram. n, number.

study targeted individuals who needed anxiety-reducing interventions the most. This criterion helps preserve the internal validity of the study and ensures that the interventions are pertinent and effective for the intended population.

2. Sample size

The G power version 3.1.9.6 program written by Franzfaul University, Kiel, was used to estimate the sample size. Based on the 95% power of the study, 5% type I error, and an effect size of 0.50, the sample size was 176 (88 samples per group).

Two hundred and twenty children were initially screened for inclusion and exclusion criteria, of which 176 (87 females and 89 males) met the requirements and were enrolled in the study over a period of 18 months (August 2022–February 2024). Two groups were randomly selected to comprise 176 patients:

Group 1: Aromatherapy

Group 2: Control (behavioral management without pharmacological assistance)

3. Randomization

The investigator did not perform the randomization technique; rather, it was another pediatric dentist. Participants had to select one of two paper chits from a bowl: one for the aromatherapy group and the other for the control group (Fig. 1).

4. Interventions and Analysis

Instruments and equipment utilized in the current investigation include:

1. Nebulizer (Ambitech, Phoenix Innovative Healthcare Manufacturers Pvt. Ltd., Mahape, Navi Mumbai, India) (Fig. 2A).
2. Pediatric oxygen mask (MCP, Medicare Products Inc., New Delhi, India) (Fig. 2B).
3. Essential oil (Nature's Tattva, Ahmedabad, India)

Fig. 2. (A) Nebulizer, (B) Pediatric Oxygen Mask, (C) Sweet Orange Essential Oil, (D) Saline Respules

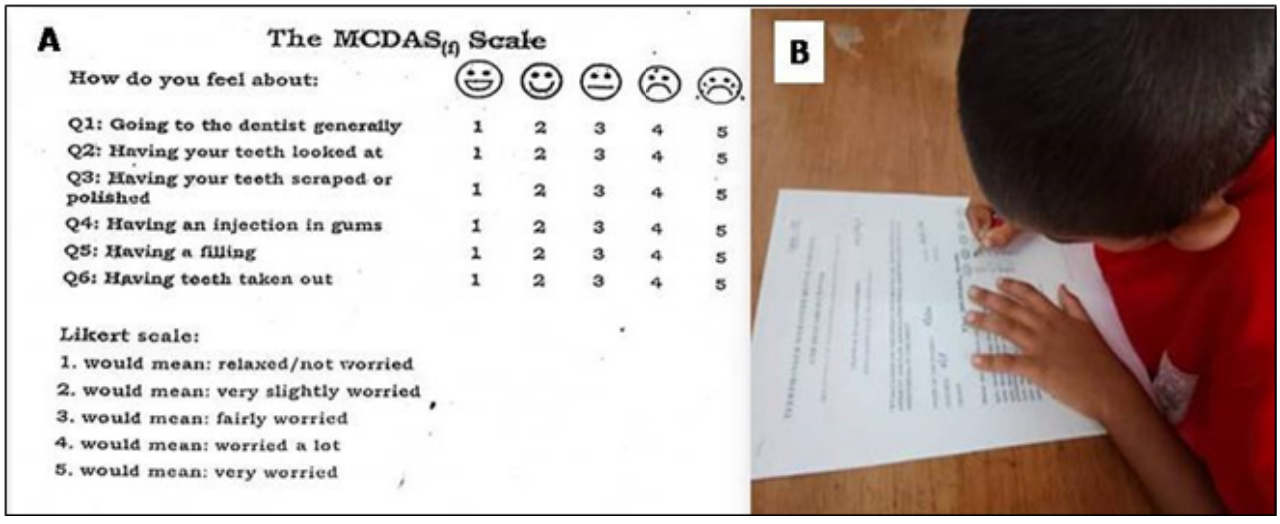

Fig. 3. (A) MCDAS(f) Scale, (B) Patient completing the MCDAS(f) form. MCDAS, Modified Child Dental Anxiety Scale.

(Fig. 2C)

4. Saline responses (Cipla, Akums Drugs and Pharmaceuticals Ltd., Ranipur, and Haridwar, India) (Fig. 2D).

The departments' patients were chosen based on qualifying standards. All children, irrespective of their group assignment, underwent preoperative assessments using MCDAS(f) (Fig. 3A and 3B).

The MCDAS uses a five-point Likert scale to measure dental anxiety, with scores ranging from "relaxed/not worried" (1) to "very worried" (5). The total MCDAS score varies from 5, indicating minimal or no dental anxiety, to 40, indicating severe dental anxiety. The scale was adapted into a facial version, known as the MCDAS(f), by incorporating facial expressions that aligned with a Likert scale. This modification makes it easier to assess dental anxiety in both younger and older children, particularly when considering any decrease in age-appropriate cognitive functioning due to the anxiety-inducing nature of dental settings. The goal of summing the individual MCDAS(f) items was to create an overall anxiety score that offered a broad measure of a child's general dental anxiety. This combined score allows for a more comprehensive comparison of the overall effectiveness of interventions such as aromatherapy between different groups, providing a wider perspective than analyzing each item on its own.

When comparing individual items, the focus shifted to specific aspects of anxiety such as fear of needles or particular dental procedures. Analyzing these differences can help identify the specific areas of anxiety that are most influenced by the intervention, offering more detailed and targeted insights [19,20].

Informed consent was obtained from Group 1, who underwent aromatherapy with sweet orange essential oil. Aromatherapy was delivered for 2 min using a nebulizer containing one drop of sweet orange essential oil diluted in 6 mL of 7% saline solution by a trained dental professional (pediatric dentist) (Fig. 4).

A qualified researcher (pediatric dentist) administered LA (nerve block) following the application of surface anesthesia (lidocaine topical aerosol USP, 15% w/w), which was applied after a 10-min induction period. The Sound, Eye, and Motor (SEM) scale was used to quantify pain during LA administration. The SEM scale assesses pain in children by evaluating vocalizations, facial expressions, and physical reactions, providing a total score to indicate pain severity [21].

The Visual Analog Scale (VAS) and the Wong–Baker Faces Pain Rating Scale (WBFPRS), which are self-reported measures of pain, were used to assess pain after nerve block administration. The VAS measures pain intensity with a 10-cm line labeled from "no pain" to "worst pain imaginable," where patients mark their pain level, and the distance from the start is measured to quantify their pain [22]. The VAS can be used for individuals starting from the age of 5 years [23]. The WBFPRS is used to assess pain, particularly in children or those who struggle to express pain verbally. It consists of faces ranging from happy (no pain) to crying (severe pain). Patients select the face that best reflects their pain level. Each child's MCDAS(f) score was reassessed after nerve block administration.

Fig. 4. Administration of Aromatherapy

Using MCDAS(f), anxiety levels of the control group were measured during the preoperative period. Non-pharmacological methods have been used, including modelling, euphemisms, and the tell-show-do method. Subsequently, LA was administered after the application of surface anesthesia (lidocaine topical aerosol USP, 15% w/w). Using the SEM scale, pain levels were assessed during the administration of LA. Following the administration of L.A., self-reported measures of pain were measured using the VAS and WBFPRS. Every child in the control group underwent a new assessment using

Table 1. Distribution of the subjects based on age

Age		Groups		Total
		Aromatherapy	Control	
6 years	Count	21	25	46
	%	23.9%	28.4%	26.1%
7 years	Count	28	19	47
	%	31.8%	21.6%	26.7%
8 years	Count	23	25	48
	%	26.1%	28.4%	27.3%
9 years	Count	16	19	35
	%	18.2%	21.6%	19.9%
Total	Count	88	88	176
	%	100.0%	100.0%	100.0%
Chi-square value- 2.41				
P value- 0.49				

Table 2. Distribution of the subjects based on gender

Gender		Groups		Total
		Aromatherapy	Control	
Females	Count	46	41	87
	%	52.3%	46.6%	49.4%
Males	Count	42	47	89
	%	47.7%	53.4%	50.6%
Total	Count	88	88	176
	%	100.0%	100.0%	100.0%
Chi-square value- 0.56				
P value- 0.45				

Table 3. Comparison of the MCDAS(f) scores between the groups at baseline and post procedure using Mann Whitney U Test

Time interval	Groups	N	Minimum	Maximum	Mean	SD	Mean diff	P value
Baseline	Aromatherapy	88	14.0	27.0	19.85	3.46	2.927	0.017*
	Control	88	13.0	27.0	18.65	3.47		
Post procedure	Aromatherapy	88	7.0	25.0	14.91	3.76	7.312	0.001*
	Control	88	15.0	30.0	22.23	3.31		

*significant. MCDAS, Modified Child Dental Anxiety Scale; N, number; SD, standard deviation.

Table 4. Comparison of the MCDAS(f) scores within the group between baseline and post procedure using wilcoxon sign rank test

Time interval	Groups	N	Minimum	Maximum	Mean	SD	Wilcoxon Sign Rank	P value
Aromatherapy	Baseline	88	14.0	27.0	19.85	3.46	7.832	0.001*
	Post Procedure	88	7.0	25.0	14.91	3.76		
Control	Baseline	88	13.0	27.0	18.65	3.47	7.292	0.001*
	Post Procedure	88	15.0	30.0	22.23	3.31		

*significant. MCDAS, Modified Child Dental Anxiety Scale; N, number; SD, standard deviation.

the MCDAS(f).

5. Statistical Analysis

SPSS version 21 (IBM Corp., Armonk, NY, USA) was used for the statistical analysis. Descriptive statistics, such as the mean, standard deviation, frequency, and proportions, were computed for both quantitative and qualitative variables. The Chi-square test for qualitative variables, the Wilcoxon sample test for comparing MCADS(f) within the same group at different periods (baseline vs. post-procedure), the Mann–Whitney U test for comparing quantitative parameters (MCADS(f) and VAS scores) between groups, and the Kruskal–Wallis test for age-wise comparison between the groups are examples of inferential statistics. The significance level was set at 5%.

RESULTS

Table 1 shows the age distribution in the aromatherapy group; 23.9%, 31.8%, 26.1%, 18.2% were 6, 7, 8, and 9 years old, respectively. In the Control group, the age distributions were 28.4%, 21.6%, 28.4%, and 21.6% at 6, 7, 8, and 9 years, respectively. Table 2 presents the sex distribution. In the aromatherapy group, 52.3% were female and 47.7% were male, while in the control group, 46.6% were female and 53.4% were male. Age and sex distributions between the groups were not statistically significant as determined using the chi-square test.

Table 3 shows that at baseline, the Aromatherapy group had a mean MCDAS(f) score of 19.85, which was significantly higher than the Control group's mean score

Table 5. Gender wise comparison of MCDAS(f) scores in the control group and aromatherapy group using Mann Whitney U test

Time interval	Groups	N	Minimum	Maximum	Mean	SD	Wilcoxon Sign Rank	P value
Aromatherapy Group	Female	46	7.00	25.00	14.695	3.909	0.684	0.580*
	Male	42	8.00	22.00	15.142	3.612		
Control Group	Female	41	15.00	30.00	22.804	3.558	1.541	0.123*
	Male	47	16.00	28.00	21.723	3.033		

*Non-Significant difference. MCDAS, Modified Child Dental Anxiety Scale; N, number; SD, standard deviation.

Table 6. Age group wise comparison of MCDAS(f) scores in the control group and aromatherapy group using Kruskal Wallis test

Time interval	Groups	N	Minimum	Maximum	Mean	SD	Kruskal Wallis value	P value
Aromatherapy Group	6 Years	21	11.00	22.00	15.285	3.164	0.664	0.882*
	7 Years	28	7.00	25.00	15.071	4.512		
	8 Years	23	11.00	21.00	14.608	2.950		
	9 Years	16	10.00	22.00	14.562	4.304		
Control Group	6 Years	25	18.00	28.00	22.2000	3.14907	1.436	0.698*
	7 Years	19	15.00	30.00	22.3684	4.09892		
	8 Years	25	16.00	28.00	22.6400	2.67519		
	9 Years	19	17.00	28.00	21.5789	3.57951		

*Non-Significant difference. MCDAS, Modified Child Dental Anxiety Scale; N, number; SD, standard deviation.

Table 7. Comparison of the VAS scores between the groups using Mann Whitney U test

Groups	N	Minimum	Maximum	Mean	SD	Mean diff	P value
Aromatherapy	88	0.0	9.0	2.77	2.24	8.841	0.001*
Control	88	1.0	10.0	7.03	2.53		

*significant. diff, difference; N, number; SD, standard deviation; VAS, visual analogue scale.

Table 8. Gender wise comparison of VAS scores in the control group and aromatherapy group using Mann Whitney U test

Time interval	Groups	N	Minimum	Maximum	Mean	SD	Wilcoxon Sign Rank	P value
Aromatherapy Group	Female	46	.00	7.00	2.478	2.030	0.975	0.199*
	Male	42	.00	9.00	3.095	2.437		
Control Group	Female	41	1.00	10.00	7.219	2.770	0.681	0.585*
	Male	47	1.00	10.00	6.872	2.327		

*Non-Significant difference. N, number; SD, standard deviation; VAS, visual analogue scale.

of 18.65, as indicated by the Mann–Whitney U test. After the intervention, the Aromatherapy group's mean score decreased to 14.91, while that of the Control group increased to 22.23, with both changes being statistically significant. Table 4 further confirms, using the Wilcoxon signed-rank test, that there was a significant decrease in the Aromatherapy group's score and a significant increase in the Control group's score.

Table 5 shows that in the Aromatherapy group, the mean MCDAS(f) scores were 14.69 for females and 15.14 for males, with no significant difference between sexes. Similarly, in the Control group, the mean scores were 22.80 for females and 21.72 for males, also indicating no significant difference by sex. Table 6 shows that age-based comparisons of MCDAS(f) scores in both groups were statistically non-significant, with p-values of 0.882 for the Aromatherapy group and 0.698 for the Control group.

Table 7 shows that the mean VAS score was 2.77 in the Aromatherapy group and 7.03 in the Control group, with a significant difference favoring the Control group, as determined by the Mann–Whitney U test. Table 8 shows that within the Aromatherapy group, the VAS scores were 2.478 for females and 3.095 for males, indicating no significant difference by sex. Similarly, in the Control group, the scores were 7.219 for females and 6.872 for males, also showing no significant difference based on sex.

Table 9. Distribution of the subjects based on SEM scale

SEM		Groups		Total
		Aromatherapy	Control	
.0	Count	27	3	30
	%	30.7%	3.4%	17.0%
1.0	Count	35	25	60
	%	39.8%	28.4%	34.1%
2.0	Count	23	28	51
	%	26.1%	31.8%	29.0%
3.0	Count	3	32	35
	%	3.4%	36.4%	19.9%
Total	Count	88	88	176
	%	100.0%	100.0%	100.0%
Chi-square value- 45.38				
P value- 0.001*				

*significant. SEM, Sound, Eye, Motor.

Table 10. Distribution of the subjects based on Wong Baker faces scale

Wong baker faces		Groups		Total
		Aromatherapy	Control	
0.0	Count	21	2	23
	%	23.9%	2.3%	13.1%
2.0	Count	25	6	31
	%	28.4%	6.8%	17.5%
4.0	Count	22	9	31
	%	25%	10.2%	17.6%
6.0	Count	16	19	35
	%	18.2%	21.6%	17.9%
8.0	Count	4	26	30
	%	4.5%	29.6%	17.0%
10.0	Count	0	26	26
	%	0.0%	29.6%	14.6%
Total	Count	88	88	176
	%	100.0%	100.0%	100.0%
Chi-square value- 80.60				
P value- 0.001*				

*significant

Table 11. Gender wise comparison of Wong Baker Scale in aromatherapy group and control group

		Female	Male	Total	Chi Sq	P value
Aromatherapy Group	Score 0	16	11	27	7.452	0.110*
		34.8%	26.2%	30.7%		
	Score 2	15	10	25		
		32.6%	23.8%	28.4%		
	Score 4	12	10	22		
		26.1%	23.8%	25.0%		
	Score 6	3	7	10		
		6.5%	16.7%	11.4%		
	Score 8	0	4	4		
		.0%	9.5%	4.5%		
Control Group	Score 0	2	0	2	9.991	0.099*
		4.9%	.0%	2.3%		
	Score 2	3	3	6		
		7.3%	6.4%	6.8%		
	Score 4	4	5	9		
		9.8%	10.6%	10.2%		
	Score 6	6	15	21		
		14.6%	31.9%	23.9%		
	Score 8	9	15	24		
		22.0%	31.9%	27.3%		
	Score 10	17	9	26		
		41.5%	19.1%	29.5%		

*Non-Significant difference

Table 9 shows that, based on the SEM scale, the intergroup comparison between the two groups was statistically significant. A higher percentage of subjects in the Aromatherapy group had Scores 0 and 1, while a higher percentage of subjects in the Control group had Scores 2 and 3. This difference between the groups was statistically significant, as determined by the Chi-square test.

Table 10 shows that, according to the Wong–Baker scale, the comparison between the two groups was statistically significant. The Aromatherapy group had a higher percentage of participants with scores of 0, 2, and 4, while the Control group had those with scores of 6, 8, and 10. This difference between the groups was statistically significant, as determined by the Chi-square test. Table 11 shows that within both the Aromatherapy and Control groups, the sex-wise differences in Wong–Baker scale scores were statistically non-significant when analyzed using the Chi-square test.

DISCUSSION

This study introduced a novel approach of using aromatherapy along with dental treatment in children, focusing on the calming effects of orange scents to reduce anxiety. This study revealed a significant decrease in anxiety in the intervention groups with aromatherapy, and the differences between groups for each metric were statistically significant; however, no significant difference was found between sexes.

According to the study's preferences for essential oils,

sweet orange was used because citrus fruits such as oranges are rich in flavonoids, known for their antioxidant properties. Orange peel essence is valued for its clarity, pleasant aroma, and freshness, reflecting the health benefits of oranges. Its popularity in natural medicine makes it a versatile choice for various therapeutic applications [24]. Studies have demonstrated that it is effective in reducing both pain [25] and anxiety. It causes a 16% decrease in sympathetic nervous system activity and a 12% increase in parasympathetic nervous system activity.

Orange essence is often preferred over lavender oil in dental settings because of its refreshing and invigorating qualities that can enhance patient mood and engagement. Citrus scents, such as orange essence, are associated with increased alertness and can effectively reduce anxiety, as shown by studies such as those by Lehrner et al. (2000); although lavender is known for its calming effects, it may not provide the same level of immediate relief from acute anxiety [26]. Additionally, orange essence may offer practical benefits in terms of its stability and ease of application in clinical environments (Lehrner et al., 2005; Kritsidima et al., 2010) [8,10].

Fitzgerald et al. examined the impact of sex and ethnicity on children's preferences and attitudes. They concluded that children have odor and taste preferences distinct from adults and are more likely to use essential oils such as those of sweet orange or lemon [27].

Ghaderi and Solhjou (2020) found that lavender essential oil could decrease children's perceptions of stress and discomfort during dental treatment [28]. Arslan et al. (2020) conducted a study showing that inhaling lavender oil reduced discomfort during tooth extraction [14]. In a comprehensive review, the efficacy of aromatherapy in treating dental anxiety was found to be superior to that of negative controls, suggesting the need for further randomized trials [29].

Several studies have examined the effects of sweet orange scent. Lehrner et al. (2000) focused on the effects of orange scent in females and found reduced anxiety and enhanced mood [26]. Five years later, they conducted another study comparing the effects of orange and lavender odors with music and a control condition, showing that these scents could influence emotional states and lower anxiety in dental patients [8]. These findings are consistent with those of this study. Faturi et al. (2010) observed an anxiolytic effect of sweet orange essence in Wistar rats. They also assessed behavioral responses to different oils, suggesting that the observed calming effects were specific to orange essential oils [30].

A study investigating the effect of aromatherapy on needle-related anxiety in children found that those who received aromatherapy before and during needle procedures experienced significantly lower anxiety levels than those who did not receive aromatherapy. In the present study, similar outcomes were observed after administering aromatherapy [31].

In a study involving student volunteers to assess the effects of sweet orange scent on anxiety levels, researchers found no clear relationship between dosage and effectiveness in reducing anxiety [32]. The optimal dosage of fragrances for anxiety relief remains inadequately researched, with no established guidelines on exposure duration to achieve the desired calming effects. Further investigation is necessary to determine the direct correlation between the amount of sweet orange scent consumed and its effects on anxiety reduction. Therapists typically recommend exposure durations ranging from a few breaths to a few minutes; however, precise dosage estimation is challenging because of the variability in oil types and dropper sizes [33]. However, in the current study, aromatherapy involved 2 min of exposure to one drop of sweet orange oil in 6 mL of 7% saline solution.

This study differs from previous research in evaluating the effectiveness of aromatherapy for both pain and anxiety simultaneously, which is a rare approach in the existing literature. Similar outcomes were observed in a study by Nirmala et al. (2021), which investigated the impact of aromatherapy on dental pain and anxiety [13]. Inhalation was selected as the preferred method of administration because of the absence of documented negative effects associated with essential oils,

highlighting safety considerations. Aromatherapy delivered via a nebulizer notably reduced pain scores, confirming its efficacy. These findings align with earlier research supporting aromatherapy as a nonpharmacological and noninvasive alternative for addressing various health issues [13]. In our study, the sample size was 176 children aged 6–9 years old. Children in this age group are generally noncooperative, which helps to ensure unbiased results and allows for an accurate assessment of the effectiveness of aromatherapy in the pediatric population. In contrast, the study conducted by Nirmala et al. had a smaller sample size and involved different age groups. Another key aspect of our study was the use of nebulizers as the primary equipment. These devices convert liquids into a mist that is inhaled through a pediatric oxygen mask, which was essential for our investigation. In contrast, Nirmala et al. did not use pediatric oxygen masks for inhalation. Pediatric oxygen masks enhance the efficiency of aroma inhalation by preventing it from dispersing into the atmosphere. The key benefit of nebulizers is their ability to deliver a consistent and gentle stream of essential oil molecules, which underscores their significance in the present study.

The findings of this study highlight the need to provide additional support to children undergoing invasive dental procedures. For a secure and efficient method, aromatherapy should be used along with other prescriptions, and dosage changes should not be necessary when stopping the treatment. Given that no negative effects were observed in this trial, combining aromatherapy with behavioral approaches to manage pain and anxiety seems to a reasonable approach. Furthermore, during dental operations, aromatherapy helps reduce unpleasant odors that may cause anxiety in younger patients.

The utilization of only pure essential oils and results backed by a well-calibrated sample size established by effect size analysis are the two strengths of this study. This thorough analysis clarified the possible advantages of incorporating aromatherapy into pediatric dentistry procedures to enhance patient comfort and satisfaction.

The small sample size of children in one age group is a notable limitation, which could limit how broadly the results can be applied to the pediatric community. Therefore, not all children may benefit equally from the conclusions of this study. Another limitation of this study is that to better understand the psychological aspects of essential oil perception in anxiety and pain management, a pediatric oxygen mask without essential oil should be used as a control group to evaluate the placebo effect of aromatherapy. It is crucial to understand that the purpose of this study was to use aromatherapy in addition to conventional treatments and not as per their preference.

Conclusion: The conclusions drawn from this research are:

1. Essential oil aromatherapy is effective in reducing dental anxiety and pain associated with the administration of LA in children.
2. Aromatherapy can be integrated as an effective behavioral management tool in pediatric dental practice.
3. In addition, aromatherapy has similar effects in both males and females, with no sex-specific advantage.

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REFERENCES

1. Chhabra N, Chhabra A, Walia G. Prevalence of dental anxiety and fear among five to ten year old children: a behaviour based cross sectional study. Minerva Stomatol 2012; 61: 83-9.
2. Meng X, Heft MW, Bradley MM, Lang PJ. Effect of fear on dental utilization behaviors and oral health outcome. Community Dent Oral Epidemiol 2007; 35: 292-301.
3. Venkataramana M, Pratap KVNR, Padma M, Kalyan S, Reddy AA, Sandhya P. Effect of aromatherapy on dental patient anxiety: a randomized controlled trial. J Indian Assoc Public Health Dent 2016; 14: 131-4.
4. Arntz A, Dreessen L, De Jong P. The influence of anxiety on pain: attentional and attributional mediators. Pain 1994; 56: 307-14.
5. Keogh E, Ellery D, Hunt C, Hannent I. Selective attentional bias for pain-related stimuli amongst pain fearful individuals. Pain 2001; 91: 91-100.
6. Eli I, Bar-Tal Y, Fuss Z, Silberg A. Effect of intended treatment on anxiety and on reaction to electric pulp stimulation in dental patients. J Endod 1997; 23: 694-97.
7. Millot J, Brand G. Effects of pleasant and unpleasant ambient odors on human voice pitch. Neurosci Lett 2001; 297: 61-3.
8. Lehrner J, Marwinski G, Lehr S, Johren P, Deecke L. Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office. Physiol Behav 2005; 86: 92-5.
9. Hainsworth JM, Moss H, Fairbrother KJ. Relaxation and complementary therapies: an alternative approach to managing dental anxiety in clinical practice. Dent Update 2005; 32: 90-2, 94-6.
10. Kritsidima M, Newton T, Asimakopoulou K. The effects of lavender scent on dental patient anxiety levels: a cluster randomised-controlled trial. Community Dent Oral Epidemiol 2010; 38: 83-7.
11. Shin BC, Lee MS. Effects of aromatherapy acupressure on hemiplegic shoulder pain and motor power in stroke patients: a pilot study. J Altern Complement Med 2007; 13: 247-51.
12. Boehm K, Büssing A, Ostermann T. Aromatherapy as an adjuvant treatment in cancer care—a descriptive systematic review. Afr J Tradit Complement Altern Med 2012; 9: 503-18.
13. Nirmala K, Kamatham R. Effect of aromatherapy on dental anxiety and pain in children undergoing local anesthetic administrations: a randomized clinical trial. J Caring Sci 2021; 10: 111-20.
14. Arslan I, Aydinoglu S, Karan NB. Can lavender oil inhalation help to overcome dental anxiety and pain in children? a randomized clinical trial. Eur J Pediatr 2020; 179: 985-92.
15. Purohit A, Singh A, Purohit B, Shakti P, Shah N. Is aromatherapy associated with patient's dental anxiety levels? a systematic review and meta-analysis. J Dent Anesth Pain Med 2021; 21: 311-9.
16. Soni S, Bhatia R, Oberoi J. Evaluation of the efficacy of aromatherapy on anxiety level among pediatric patients in a dental setting: a randomized controlled trial. Int J Oral Care Res 2018; 6: 44-9.
17. Maddocks-Jennings W, Wilkinson JM. Aromatherapy practice in nursing: literature review. J Adv Nurs 2004; 48: 93-103.
18. Jafarzadeh M, Arman S, Pour FF. Effect of aromatherapy with orange essential oil on salivary cortisol and pulse rate in children during dental treatment: a randomized controlled clinical trial. Adv Biomed Res 2013; 2: 10.
19. Boka V, Arapostathis K, Kotsanos N, Karagiannis V, van Loveren C, Veerkamp J. Relationship between child and parental dental anxiety with child's psychological functioning and behavior during the administration of local anesthesia. J Clin Pediatr Dent 2016; 40: 431-7.
20. Manepalli S, Nuvvula S, Kamatham R, Nirmala S. Comparative efficacy of a self-report scale and physiological measures in dental anxiety of children. J Investig Clin Dent 2014; 5: 301-6.
21. AlHareky M, AlHumaid J, Bedi S, El Tantawi M, AlGahtani

M, AlYousef Y. Effect of a vibration system on pain reduction during injection of dental anesthesia in children: a randomized clinical trial. Int J Dent 2021; 2021: 8896408.
22. Mahmoud NR, Fayed HM. Efficacy of low-level laser therapy in the management of myofascial pain dysfunction syndrome: comparative controlled clinical trial. Egypt Dent J 2023; 69: 1799-809.
23. Sansone L, Gentile C, Grasso EA, Di Ludovico A, LaBella S, Chiarelli F, et al. Pain evaluation and treatment in children: a practical approach. Children 2023; 10: 1212.
24. Kharghani S, Tafrishi R, Sheikh S, Fazeli F, Barkhordari Ahmadi F, Norouziasl S, et al. A systematic review of the effect of aromatherapy and storytelling on anxiety in children during dentistry. Int J Pediatr 2020; 8: 11261-9.
25. Posadzki P, Alotaibi A, Ernst E. Adverse effects of aromatherapy: a systematic review of case reports and case series. Int J Risk Saf Med 2012; 24: 147-61.
26. Lehrner J, Eckersberger C, Walla P, Pötsch G, Deecke L. Ambient odor of orange in a dental office reduces anxiety and improves mood in female patients. Physiol Behav 2000; 71: 83-6.
27. Fitzgerald M, Culbert T, Finkelstein M, Green M, Johnson A, Chen S. The effect of gender and ethnicity on children's attitudes and preferences for essential oils: a pilot study. Explore (NY) 2007; 3: 378-85.
28. Ghaderi F, Solhjou N. The effects of lavender aromatherapy on stress and pain perception in children during dental treatment: a randomized clinical trial. Complement Ther Clin Pract 2020; 40: 101182.
29. Cai H, Xi P, Zhong L, Chen J, Liang X. Efficacy of aromatherapy on dental anxiety: a systematic review of randomised and quasi-randomised controlled trials. Oral Dis 2021; 27: 829-47.
30. Faturi CB, Leite JR, Alves PB, Canton AC, Teixeira-Silva F. Anxiolytic-like effect of sweet orange aroma in wistar rats. Prog Neuropsychopharmacol Biol Psychiatry 2010; 34: 605-9.
31. Cho MY, Min ES, Hur MH, Lee MS. Effects of aromatherapy on the anxiety, vital signs, and sleep quality of percutaneous coronary intervention patients in intensive care units. Evid Based Complement Altern Med 2013; 2013: 381381.
32. Goes TC, Antunes FD, Alves PB, Teixeira-Silva F. Effect of sweet orange aroma on experimental anxiety in humans. J Altern Complement Med 2012; 18: 798-804.
33. Olleveant NA, Humphris G, Roe B. How big is a drop? a volumetric assay of essential oils. J Clin Nurs 1999; 8: 299-304.