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Original Article

The effects of lavender, chamomile and peppermint inhalation aromatherapy on dental anxiety in children: A randomized controlled trial

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KEYWORDS
Aromatherapy;
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Abstract *Background/purpose:* Management of dental anxiety and fear in children can be challenging. The aim of this study was to evaluate the efficacy of lavender, chamomile and peppermint aromatherapy in reducing dental anxiety in children.
Materials and methods: A total of 100 children aged from six to nine years receiving pulp therapy were randomized into four equal groups: a control group with no essential oil inhaled and three experimental groups using lavender, chamomile or peppermint essential oils. Children received aromatherapy through nebulizers. Oxygen saturation (pulse oximeter percentage), pulse rate (manual beat/minute) and dental anxiety (using Animated emoji scale) were measured before and after treatment.
Results: The difference in before and after measurements in oxygen saturation showed insignificant difference between all groups ($P = 0.78$). For pulse rate chamomile group (-22.84 ± 5.86) demonstrated significantly the highest decrease ($P < 0.001$), and for dental anxiety there was significant difference between all groups ($P < 0.001$), the control group showed an increase in anxiety score (0.04 ± 0.84), while the highest reduction in anxiety score was demonstrated in chamomile group (-2.04 ± 0.79), and lavender group (-1.80 ± 0.91) with insignificant difference between them followed by peppermint group (-0.68 ± 1.31).
Conclusion: Chamomile aromatherapy reduced dental anxiety levels in children comparable to lavender aromatherapy while peppermint aromatherapy reduced dental anxiety levels but to a lesser extent.

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Introduction

Dental anxiety is a common condition characterized by a sense of apprehension or fear when thinking about or attending dental appointments.[1] Dental anxiety can lead to avoidance of dental visits, resulting in neglected oral hygiene and potentially more severe dental issues in the long run.[2] This avoidance not only impacts the individual's oral and overall health but also has broader implications for community health services. The presence of untreated oral health issues within a population can increase healthcare costs and burden community resources.[3]

A variety of pharmacological and non-pharmacological methods have been proposed to address this issue.[4] Techniques including hypnosis, behaviour modification, and audio-visual distraction have been employed to alleviate anxiety in paediatric patients.[5] In instances where these strategies prove insufficient, the administration of sedation or general anaesthesia becomes a necessity for those facing significant challenges in cooperation.[6]

Aromatherapy has emerged as a popular alternative non-drug approach, with increasing interest for its potential benefits.[7] Aromatherapy involves the use of plant-derived, volatile essential oils to promote physical, emotional, and spiritual health.[8] The olfactory system's direct connection to the brain's emotional centres makes aromatherapy a unique approach to modulate mood and anxiety levels.[9] This can be provided throughout different modes of application as oil infused cloths/cotton balls, nasal sticks or patches, oxygen masks, aroma tabs, aroma sticks, or via room diffusion.[7,8]

Aromatherapy in managing dental anxiety has been the subject of recent systematic reviews, which have found promising results.[7,10,11] The majority of clinical trials on dental patients were on lavender (*Lavandula angustifolia*), with fewer studies on orange (*Citrus sinensis*) and only one study on roman chamomile (*Anthemis nobilis*).[7]

Few research has been conducted to assess the impact of aromatherapy on alleviating dental anxiety in children undergoing restorative procedures.[12–14] Furthermore, the application of peppermint has not been studied in the context of reducing dental anxiety. Consequently, this study aimed to explore the potential benefits of aromatherapy using lavender, chamomile, and peppermint to diminish dental anxiety among children receiving pulp therapy for primary molars.

Materials and methods

Study design

This was a randomized controlled trial that evaluated the clinical efficacy of aromatherapy using three different essential oils for reducing anxiety and fear of children undergoing pulp therapy. The trial was divided into four groups: 1) control group, 2) experimental group receiving lavender essential oil, 3) experimental group receiving chamomile essential oil, and 4) experimental group receiving peppermint essential oil. The study followed the Declaration of Helsinki guidelines and was conducted according to CONSORT recommendations. This study was approved by the Institutional Review Board and Ethical committee of the Faculty of Oral and Dental Medicine, Ahram Canadian University with research number: IRB100012891#132.The study was also registered in the Pan African Clinical Trials Registry under the code PACTR202411502237433. All patients provided informed consent before starting treatment.

Participation and recruitment

This was a randomized controlled study conducted in Paediatric Dentistry Department, Faculty of Dentistry, Ahram Canadian University, Egypt. The inclusion criteria were: 1) children aged six to nine years; 2) having primary molars indicated for pulp therapy; 3) being in their first dental visit; 4) with score two (positive) according to the Frankle behaviour rating scale; and 5) voluntary and with the consent from the parent. Exclusion criteria were: 1) having respiratory tract infections or lung diseases; and 2) having a history of allergy to local anaesthesia, oil allergy or essential oils.

The sample size was calculated using G power software based on a previous study.[15] The effect size was 0.663, so the calculated sample size 25 per group when applying 80 % power, and level of significance of 0.05.

Randomization and blindness

Randomization was performed according to a random sequence generator using the www.random.org website, they were randomized into four groups. For allocation concealment, once the patient consented to participate, the operator will telephone the principal investigator that issues the treatment allocation.The following steps were taken to achieve blindness: The patients, operator and the outcome assessor were blinded to the allocation. The nebulizer and essential oil bottles were placed as part of the clinic's and waiting room's equipment throughout the study's period only labelled by numbers. Also, the statistician who analysed the study's results were blinded, only knew the study's groups as one, two, three and four.

Outcomes and measures

The main measured outcomes in the current study were oxygen saturation (pulse oximeter percentage), pulse rate (manual beat/minute), and dental anxiety (using Animated emoji scale scoring from 1 to 5 from, 1 = not nervous at all to 5 = very nervous). They were measured before and

immediately after the intervention. The Animated emoji scale has five graphic interchange formats of animated emoji faces showing different feelings ranging from very happy/laughing to very unhappy/sad and crying (most positive to most negative feelings). The child was asked to choose one of these animated emojis on the electronic display that best matched their feelings at that moment. The scale had scores from 1 (very happy emoji) to 5 (very unhappy emoji).[14]

Interventions

Aromatherapy with nebulizers was carried out in a closed air-conditioned room. For those in lavender oil group, 80 ml of distilled water, as a medium, was dispensed into the water tank of the nebulizer, followed by six drops of essential oil. For those in chamomile group, for 80 ml of distilled water, eight drops of essential oil were added. For peppermint group, for 80 ml of distilled water, eight drops of essential oil were added. All the children were subjected to aromatherapy for about 2 min followed by 15 min of induction period while the control group received no application. This was followed by the routine local anaesthetic administration by a single trained operator.

Nebulizer is an electric or battery powered machine that turn liquid into mist. It works on ultrasonic action and has humidifier action. It has 100 ml capacity water tank, ultrasonic frequency of 2.4 MHz and automatic off technology.[12]

Statistical analysis

Statistical analysis was performed with SPSS 16 ® (Statistical Package for Scientific Studies, SPSS Inc, Chicago, USA). Exploration of the given data was performed using Shapiro–Wilk test and Kolmogorov–Smirnov test for normality which revealed that data originated from normal data regarding before and after measurements. Accordingly, comparison between four different groups was performed by One Way ANOVA test followed by Tukey's Post Hoc test for multiple comparison, while comparison between before and after measurements was performed by using Paired t test. On the other hand, normality test demonstrated that difference between before and after measurements revealed non-parametric data, accordingly comparison between different groups was performed by using Kruskal Wallis test followed by Dunne's test for multiple comparisons. The significance level was set at $P \leq 0.05$.

Results

A total of 100 children with mean age of 6.9 ± 1.14 years were included in this study and were divided into four groups (Fig. 1). There was insignificant difference in the mean age of children of the different groups ($P = 0.99$).

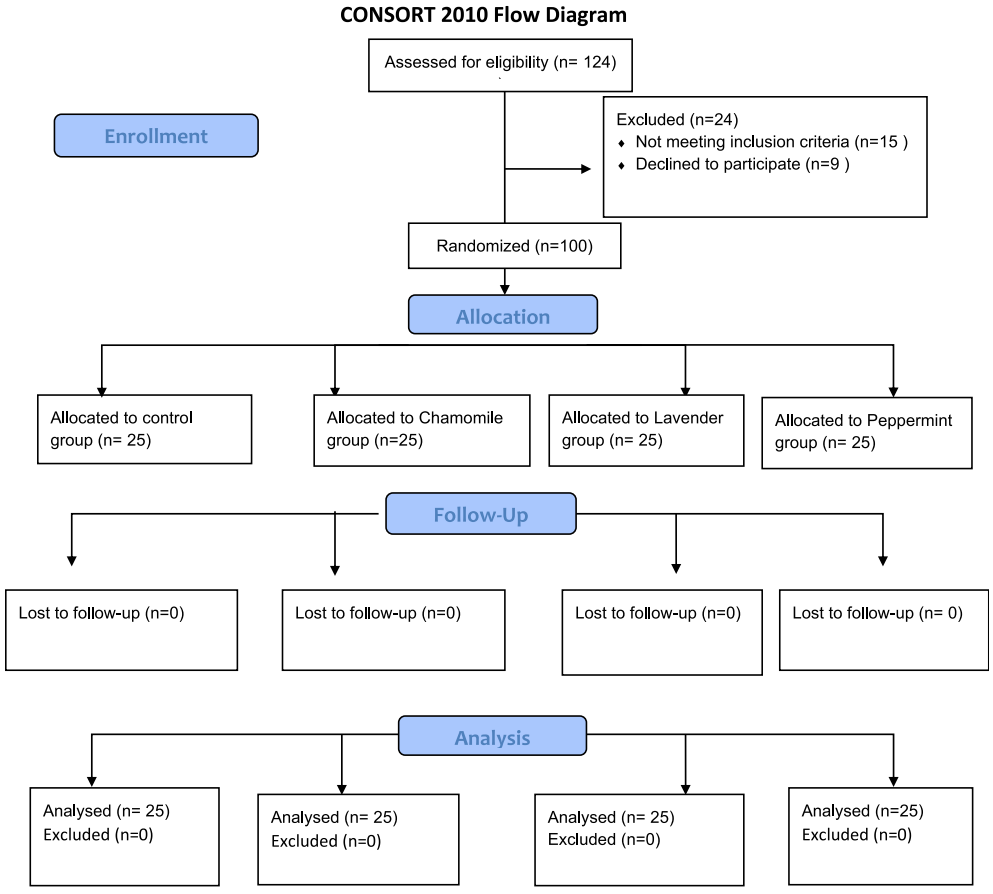

Figure 1 The CONSORT flow diagram.

Table 1 Mean and standard deviation of oxygen saturation and pulse rate in control, chamomile, lavender, and peppermint.

Oxygen saturation	Control		Chamomile		Lavender		Peppermint		*P* value
	M	SD	M	SD	M	SD	M	SD	
Before	96.88	1.59	97.04	1.54	96.76	2.09	96.60	1.76	0.83
After	97.16	1.65	96.96	2.15	97.16	1.72	96.84	2.29	0.92
Difference	0.28	2.26	−0.08	1.71	0.40	1.58	0.24	1.13	0.78
P value	0.54		0.81		0.21		0.29		
Pulse rate	**Control**		**Chamomile**		**Lavender**		**Peppermint**		***P* value**
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	
Before	100.2^{a}	6.371	100.64^{a}	5.28	100.20^{a}	6.37	100.40^{a}	6.37	0.99
After	112.7^{a}	11.56	77.80^{b}	4.00	85.60^{c}	6.01	85.00^{c}	6.61	0.0001*
Difference	12.48^{a}	13.86	-22.84^{b}	5.86	-14.60^{c}	8.67	-15.20^{c}	8.25	0.0001*
P value	<0.001*		<0.001*		<0.001*		<0.001*		

M: mean SD: standard deviation.
*Significant difference as $P < 0.05$.
Means with the same superscript letters were insignificantly different as $P > 0.05$.
Means with different superscript letters were significantly different as $P < 0.05$.

Oxygen saturation

There was insignificant change in oxygen saturation ($P = 0.54$, 0.81, 0.21, 0.29) regarding control, chamomile, lavender, and peppermint groups respectively, for intragroup comparisons as well as for intergroup comparisons between all groups for the before measurements ($P = 0.83$), after measurements ($P = 0.92$), and the difference between before and after measurements ($P = 0.78$), as presented in Table 1.

Pulse rate

For intragroup comparison, there was a significant increase in pulse rate in control group ($P < 0.001$), while there was significant decrease in pulse rates in all interventional groups ($P < 0.001$),. For intergroup comparison, there was insignificant difference between all groups regarding before measurements ($P = 0.99$), while in after measurements the control group (112.7 ± 11.56) demonstrated significantly the highest pulse rate ($P < 0.001$), chamomile group (77.8 ± 4) demonstrated significantly the lowest pulse rate, while there was insignificant difference between lavender (85.6 ± 6.01) and peppermint (85 ± 6.61) groups. Moreover, regarding the difference between before and after measurements, there was significant difference between groups. The chamomile group (−22.84 ± 5.86) significantly demonstrated the highest decrease in pulse rate, while there was insignificant difference between lavender (−14.6 ± 8.67) and peppermint (−15.2 ± 8.25) groups, as presented in Table 1 and Fig. 2.

Dental anxiety measured through animated emoji scale

For intragroup comparison, there was an insignificant increase in control group anxiety score with 0.04 ± 0.84 ($P = 0.81$), while there was a significant decrease in chamomile group with −2.04 ± 0.79 ($P < 0.001$), lavender group with −1.80 ± 0.91 ($P < 0.001$), and peppermint group with −0.68 ± 1.31 ($P = 0.01$). For intergroup comparison, there was insignificant difference between all group regarding before measurements ($P = 0.87$), while in after measurements there was significant difference ($P < 0.001$) as the control group (4.48 ± 0.71) demonstrated the highest anxiety score, then peppermint group (3.64 ± 1.04), while the lowest anxiety score was demonstrated in chamomile group (2.32 ± 0.69), lavender group (2.64 ± 0.7) with insignificant

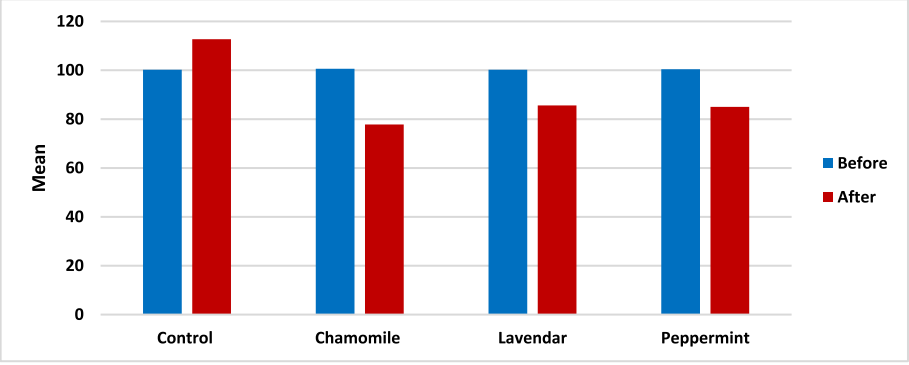

Figure 2 Pulse rate in the control, chamomile, lavender, and peppermint groups.

Table 2 Mean and standard deviation of anxiety score in control, chamomile, lavender, and peppermint groups.

Anxiety score	Control		Chamomile		Lavender		Peppermint		*P* value
	M	SD	M	SD	M	SD	M	SD	
Before	4.44[a]	0.51	4.36[a]	0.49	4.44[a]	0.58	4.32[a]	0.85	0.87
After	4.48[a]	0.71	2.32 [b]	0.69	2.64 [b]	0.70	3.64[c]	1.04	0.0001*
Difference	0.04[a]	0.84	−2.04 [b]	0.79	−1.80 [b]	0.91	−0.68[c]	1.31	0.0001*
P value	0.81		<0.001*		<0.001*		0.01*		

M: mean SD: standard deviation.
*Significant difference as P < 0.05.
Means with the same superscript letters were insignificantly different as $P > 0.05$.
Means with different superscript letters were significantly different as $P < 0.05$.

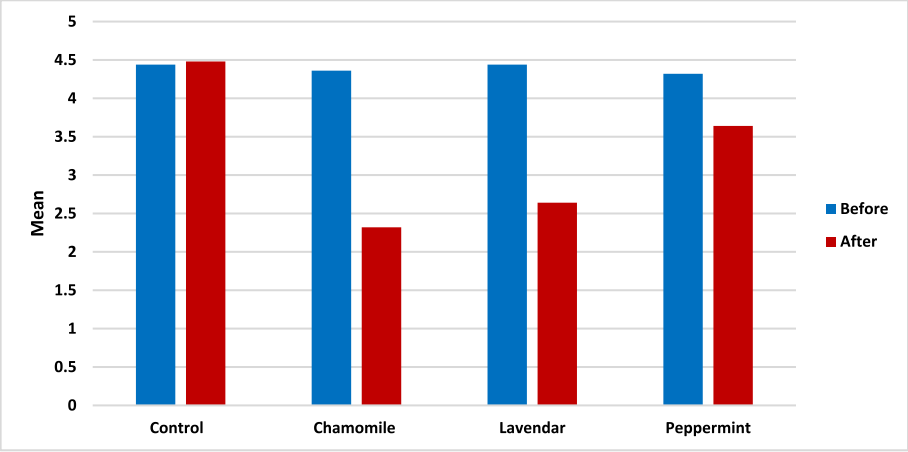

Figure 3 Anxiety scores in the control, chamomile, lavender, and peppermint groups

difference between them. Also, in difference between before and after measurements, there was a significant difference between groups, as presented in Table 2 and Fig. 3.

Discussion

Children's dental anxiety and fear are major problems in dental services as they deprive them from cooperation and increase dental treatment failures resulting in a decrease in the children's quality of life.[16]

It is widely believed that fragrances have the power to influence emotional states in humans.[17] Recently, contemporary and alternative medicine approaches such as aromatherapy have been considered in dental settings.[4] This method supports the concept that common oils can produce positive pharmacological, psychological, and physiological effect on humans by its aroma.[18,19]

The psychological effect acts via the sense of smell or olfactory system which, in turn, may cause a physiological effect. The physiological effects are considered to act through the limbic system, particularly the hippocampus and amygdala.[20] The anxiolytic neurotransmitters such as serotonin and endorphins which are happiness hormones are released due to stimulation by the pleasant scent, and the same time stress hormones (adrenaline, noradrenaline, catecholamines, and corticosteroids) are inhibited.[20]

Lavender essential oil was the most used oil in aromatherapy against dental anxiety.[5,10,12,21] It has been proposed that lavender may increase the activity of gamma-aminobutyric acid in the amygdala in a similar way to benzodiazepines.[20] While Chamomile oil which is used for stress relief and pain relief, had showed positive effect on dental anxiety once before, but its use was not widely investigated.[22] As for peppermint oil, this is to the best of our knowledge the first clinical trial to evaluate its effect on dental anxiety, however it was previously reported to significantly reduces anxiety of cardiac patients in emergency department.[23]

In this study nebulizers were used as the mode of inhalation rather than inhalers as they had better impact on reducing the level of dental anxiety scores.[12] The application of aromatherapy in waiting room of dental office has been tested for its positive influence on dental anxiety.[12,19]

Muzzarelli et al.[24] recommended that aromatherapy can be more useful at a moderate level of anxiety. Anxiety in children alters the levels of pulse rate, blood pressure, and oxygen saturation.[21] The physiological parameters considered in the present study was both oxygen saturation and pulse rate. Regarding oxygen saturation, our results showed insignificant change in oxygen saturation levels in both intervention and control groups either before or after the dental procedure, in accordance with two previous studies that used lavender aromatherapy in dental procedures for children.[5,21]

Pulse rate was also previously recorded in studies on dental anxiety.[12,21,25] In the current study the pulse rate decreased significantly in all the aromatherapy groups compared to the control one after pulp therapy. Similarly previous studies reported lower pulse rates in the aromatherapy groups compared to control group after their dental procedures whether it is pulp therapy/extraction in Nirmala et al. study[12] using Lavender aromatherapy or local anaesthesia in Rama et al. study[21] combining both lavender-neroli aromatherapy with music. Another study showed also decrease in the pulse rate after intervention, but they were using a different aromatherapy with orange and their dental treatment was a non-invasive and painless one including oral prophylaxis and fissure-sealant painless, so they supposed that any changes in the pulse rate might be because of stress and not because of pain.[25]

In our study, the chamomile group was associated with the greatest decrease in the pulse rate and no difference was observed between lavender and peppermint, while there were no studies comparing between them before.

The effect of aromatherapy on dental anxiety has been assessed before but only few studies evaluated the effect of aromatherapy on children's dental anxiety.[10] In a study performed by Fitzgerald et al.; the effect of gender and ethnicity on preferences and attitudes in children was investigated. They reported that children are very different from adults in their odours and taste preferences, and they are likely to use essential oils, which they find pleasant. They found aromatherapy attractive and acceptable for school-age children.[26]

In the current study we used the Animated emoji scale which utilizes motion emotions and Animoji's to assess the anxiety levels in children. It is a validated tool that is more appealing and coincides with the contemporary children's fascination with multimedia and their inclination towards motion movies on electronic devices as opposed to static images on paper.[18] That is why this scale was used rather than other anxiety assessment tools as the face image scale[5] or modified child dental anxiety scale - faces version[12] or Venham picture scale.[15]

Regarding anxiety in the current study, it was reduced in all aromatherapy groups but not in the control group that was associated with the highest anxiety score. Chamomile and lavender groups were associated with more decrease in anxiety score compared to peppermint group.

The positive effect of aromatherapy on dental anxiety was reported in previous studies whether on adult populations[18,19,27] or in children populations.[5,13,21] Aligning the results of our current study, Arslan et al. revealed the positive analgesic and anxiolytic effects of lavender aromatherapy on 6—12 years old children undergoing tooth extraction.[5] Nirmala et al.[12] reported decreased anxiety levels in children aged 8—12 years who were exposed to aromatherapy with lavender and orange essential oils receiving local anaesthesia for either pulp therapy or extraction. Tripathy et al.[13] reported that lavender and patchouli oils were associated with significant reduction in anxiety in children receiving dental treatment aged 6—12 years. Janthasila et al.[28] revealed the effectiveness of aromatherapy alone or when combined with music in reducing dental anxiety in children during different dental procedures Lastly, Rama et al. study reported that there were significantly lower anxiety scores in lavender-neroli aromatherapy with music group compared to the control group of children aged 6—10 years old who received with inferior alveolar nerve block anaesthesia.[21]

As for the positive effect of chamomile oil on dental anxiety, it was only shown in a previous study on adult patients undergoing extraction[22] but none of the studies before tested their effect on children. The same for peppermint oil effect on dental anxiety that was never evaluated before.

As it was mentioned before, the studies evaluating the effect of aromatherapy with different essential oils on dental anxiety in children are few. The evidence from our study concurs with that of other published research, showing the positive effect of aromatherapy with different essential oils on reducing dental anxiety.

Aromatherapy can be safely utilized alongside other medications and does not require gradual reduction for cessation. This can be confidently incorporated into behavioural guiding strategies to alleviate anxiety and pain, as the current study found no detrimental effects. Aromatherapy aids in alleviating unpleasant odors that may induce fear in youngsters within the dental operatory. However, the current study is limited by the small sample size. Also, we included a definite age range which may limit the generalizability of findings in addition to being a single centre study. We recommend aromatherapy to be used as an adjunct not to be used as the main treatment. Also, we recommend future large scale randomized controlled trials to investigate the best aromatherapy with the most effective dose in various settings and different age groups.

Declaration of competing interest

The authors have no conflict of interest relevant to this article.

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