Research Article

Comparative Evaluation of Bubble Breath Play, Thaumaturgy Magic Book Technique, and Smartphone Dentist Games on Dental Anxiety in Children Aged 6–9 Years: A Randomized Clinical Trial

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ABSTRACT

Background:
Dental anxiety remains a significant challenge in pediatric dentistry, particularly during administration of local anaesthesia. Newer distraction techniques have gained popularity as safe and effective adjuncts to conventional behaviour management. Bubble Breath Play (BBP), the Thaumaturgy Magic Book Technique (TMBT), and Smartphone Dentist Games represent three such active distraction approaches, with different cognitive and physiological mechanisms to reduce procedural anxiety.

Aim:
To compare the effectiveness of Bubble Breath Play, Thaumaturgy Magic Book Technique, and Smartphone Dentist Games in reducing dental anxiety in children aged 6–9 years undergoing dental procedures requiring inferior alveolar nerve block (IANB) administration.

Materials and Methods:
A randomised trial was conducted on 45 healthy children aged 6–9 years allocated equally into three groups: Group I – Bubble Breath Play, Group II – Thaumaturgy Magic Book Technique, and Group III – Smartphone Dentist Game. Anxiety was assessed at three time points (T1: baseline; T2: post-distraction; T3: after local anaesthesia administration) using pulse rate, Venham Clinical Anxiety Rating Scale (VCARS), and Facial Image Scale (FIS). Intragroup comparisons were performed using the Friedman test and intergroup comparisons using one-way ANOVA and Kruskal –Wallis tests

Results:
All three groups demonstrated statistically significant intragroup reductions in pulse rate, VCARS, and FIS scores across time points ($p < 0.05$). Intergroup comparisons at T2 and T3 revealed no statistically significant differences among the three techniques. Numerically, the Smartphone Dentist Game group showed the greatest immediate reduction in anticipatory anxiety (VCARS ↓ 85.71% at T2), while Bubble Breath Play demonstrated more stable physiological control during the injection phase.

Conclusion:
All three behavior management techniques — Bubble Breath Play, Thaumaturgy Magic Book Technique, and Smartphone Dentist Game — are equally effective in reducing dental anxiety in children aged 6–9 years. These age-appropriate distraction strategies serve as valuable additions to the pediatric dental behavior management armamentarium.

Keywords: Dental anxiety; Pediatric dentistry; Bubble Breath Play; Thaumaturgy; Smartphone games; Distraction; Local anesthesia; Behavior management.

INTRODUCTION

Dental anxiety remains one of the most significant challenges in pediatric dentistry, affecting a substantial proportion of children worldwide. (1)The global prevalence of dental anxiety among children has been reported to range from 23.9% to 52%, with higher rates in preschool and school-aged children compared to adolescents.(2) Dental anxiety not only affects the child's behavior in the dental setting but also their oral health-related quality of life, and they are more frequently affected by dental caries than others.(3,4) When left unaddressed, repeated negative dental experiences can consolidate into persistent avoidance behaviours, ultimately compromising long-term oral health outcomes.

Among the various dental procedures, administration of Local Anaesthesia (LA) is consistently identified as the most anxiety-provoking experience for young children.(5) The sight of the anaesthetic needle is the trigger that is most strongly associated with fear in children receiving dental treatment.(6) This heightened anxiety not only complicates the delivery of care but may also negatively shape the child's attitude towards dentistry through adulthood.(7)

Behaviour guidance in pediatric dentistry has evolved considerably, moving beyond conventional non-pharmacological approaches to newer non-pharmacological distraction techniques. Distraction leverages the child's limited attentional capacity to redirect attention away from unpleasant stimuli. It is broadly classified as either active or passive.(8) Active distraction demands direct cognitive or physical engagement, while passive distraction relies on stimuli requiring only sensory observation. Evidence suggests that active distraction is generally more effective than passive distraction.(9)

Among emerging active distraction techniques, thaumaturgy — commonly known as magic tricks — has gained increasing attention in pediatric dentistry. Thaumaturgy distracts and relaxes the child while allowing the dentist to perform necessary treatment. The child's cognitive development dictates selection of an appropriate technique. Konde et al. demonstrated that the thumb and light trick reduced anxiety in children aged 2–7 years, the book trick in children aged 7–11, and item prediction tricks in children aged 11–13 years.(10) This age-stratified effectiveness was supported by Gupta et al. in a larger randomised clinical trial of 360 children.(11)

Bubble Breath Play Therapy (BBPT) is a straightforward relaxation technique that teaches children to breathe deeply and deliberately while fostering mind–body awareness. By directing a child's attention to controlled exhalation through a bubble wand, this technique provides both respiratory relaxation and playful engagement. Padmanabh and Bhise demonstrated that BBPT was more effective than hand-held video gaming and conventional tell-show-do (TSD) in reducing dental anxiety in children aged 6–12 years.(12)

Smartphone-based dental games capitalise on children's familiarity with digital devices. Engagement with interactive games causes children to lose awareness of their surroundings and ignore tactile and verbal cues.(13) While digital distraction offers greater child engagement, relying on screen-based distraction raises concerns about the dentist–patient relationship. A direct three-way comparison of these three techniques in the 6–9 year age group remains unexplored, forming the rationale for the present study.

MATERIALS AND METHODS

Ethical approval and registration

The study received approval from the Institutional Ethics Committee and was conducted in accordance with the Declaration of Helsinki. The trial was registered in the Clinical Trials Registry of India (CTRI).

Sample size Calculation

The sample size for this study was calculated using G*Power software (version 3.1), based on a one-way ANOVA design comparing three groups. Assuming a large effect size (f = 0.5), a significance level of 5%, and 80% power, the minimum required sample size was calculated to be 14 per group. This was rounded up to 15 children per group, giving a total sample size of 45, to allow for possible dropouts and to strengthen the reliability of the results.

Study design and population

This randomized clinical trial was conducted in the Department of Pediatric and Preventive Dentistry,GDCH Kadapa,Andhra Pradesh. Forty-five healthy children aged 6–9 years requiring local anesthesia (IANB for pulpectomy or extraction) were enrolled and equally divided into three groups of 15 children each.

Inclusion criteria

- Children aged 6–9 years
- Frankl behaviour rating score 2(Negative)
- Healthy children (ASA Class I and Class II)
- Requiring dental procedures under IANB
- Parents/guardians willing to provide informed consent

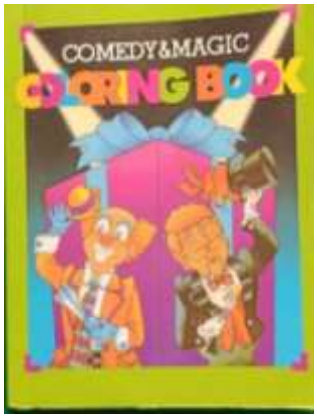
Exclusion criteria

- Children with special health care needs
- History of allergy to local anaesthetic agents
- Children requiring emergency dental management
- Parents unwilling to provide consent

Group allocation and randomization

Participants were randomly allocated using a simple lottery method: Group I – Bubble Breath Play (BBP), Group II – Thaumaturgy Magic Book Technique (TMBT), Group III – Smartphone Dentist Game (n=15 each).

Group 1 : Bubble breath play



Group 2: Thaumaturgy Magic Book

Group 3: Smartphone Dentist Game

Behavior management techniques

Group I – Bubble Breath Play (BBP): Children were provided with a bubble solution and wand and instructed to blow bubbles slowly and continuously for 10 minutes prior to LA. Deep inhalation followed by slow exhalation was encouraged.(12)

Group II – Thaumaturgy Magic Book Technique (TMBT): A magic coloring book displaying blank pages, black and white images, and colored images sequentially on the same leaf was used. The operator interactively demonstrated the magic effect and engaged the child for approximately 10 minutes before the procedure.(10,11)

Group III – Smartphone Dentist Game: Children were allowed to play an age-appropriate dentist simulation game on a smartphone under supervision for 10 minutes prior to the dental procedure. (13)

Group I

Group II

Group III

Anxiety assessment

Anxiety was evaluated at three standardised time points: T1 (baseline- at reception area), T2 (post-behavioural distraction, pre-LA), and T3 (post-LA). Objective assessment included pulse rate (pulse oximeter, mean of two readings) and VCARS (0–5, observer-rated by a blinded coinvestigator). Subjective assessment used the Facial Image Scale (FIS), a validated self-report tool.(14)

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 26.0. Continuous variables were summarised as mean ± standard deviation, while ordinal anxiety scores were presented similarly for ease of comparison. Baseline differences among the three study groups were evaluated using one-way ANOVA. Changes in pulse rate, VCARS, and Facial Image Scale scores across the three assessment time points within each group were analysed using the Friedman test, which is appropriate for repeated non-parametric data. Between-group comparisons at each assessment time point were performed using one-way ANOVA for pulse rate and the Kruskal–Wallis test for VCARS and Facial Image Scale scores. Percentage reduction from baseline was also calculated descriptively to compare the magnitude of anxiety reduction among the interventions. Statistical significance was set at $p < 0.05$

RESULTS

A total of 45 children aged 6–9 years were enrolled, with 15 in each group. All three groups were comparable at baseline with respect to pulse rate , VCARS, FIS with no statistically significant difference.

Table 1: Baseline Comparison Among the Three Groups

Variable	Bubble Breath Play (Mean±SD)	Magic Book (Mean±SD)	Smartphone Game (Mean±SD)	p-value
Pulse Rate (T1)	107.13 ± 10.91	102.93 ± 8.37	99.60 ± 7.86	0.090
VCARS (T1)	1.67 ± 0.82	1.33 ± 0.49	1.40 ± 0.51	0.524
Facial Image Scale (T1)	3.00 ± 0.85	3.33 ± 0.98	2.80 ± 1.01	0.401

No significant baseline differences were observed ($p > 0.05$).

Pulse Rate

Within-group analysis using the Friedman test demonstrated statistically significant reductions in pulse rate across the three time points in all groups. In Group I (BBP), the mean pulse rate declined from 107.13 ± 10.91 at T1 to 99.60 ± 14.16 at T2 and 94.20 ± 7.24 at T3 ($p=0.003$). In Group II (TMBT), reduction was from 102.93 ± 8.37 to 93.73 ± 9.51 at T2, with a rise to 102.93 ± 17.93 at T3 ($p=0.001$). In Group III (Smartphone), values declined from 99.60 ± 7.86 to 91.00 ± 8.26 at T2 and 95.73 ± 7.06 at T3 ($p<0.001$).Although not statistically significant , increase of pulse rate from T2 to T3 was observed in smartphone group and thaumaturgy group , compared to BBPT where a further decrease was observed.

Table 2: Intragroup Comparison of Pulse Rate using Friedman Test

Group	T1 (Mean±SD)	T2 (Mean±SD)	T3 (Mean±SD)	p-value
Bubble Breath Play	107.13 ± 10.91	99.60 ± 14.16	94.20 ± 7.24	0.003
Magic Book	102.93 ± 8.37	93.73 ± 9.51	102.93 ± 17.93	0.001
Smartphone Game	99.60 ± 7.86	91.00 ± 8.26	95.73 ± 7.06	<0.001

Table 3: Intergroup Comparison of Pulse Rate by One-way ANOVA

Time Point	Bubble Breath (Mean±SD)	Magic Book (Mean±SD)	Smartphone (Mean±SD)	p-value
T2	99.60 ± 14.16	93.73 ± 9.51	91.00 ± 8.26	0.101
T3	94.20 ± 7.24	102.93 ± 17.93	95.73 ± 7.06	0.112

Intergroup comparison revealed no statistically significant difference in pulse rate at T2 or T3 ($p > 0.05$).

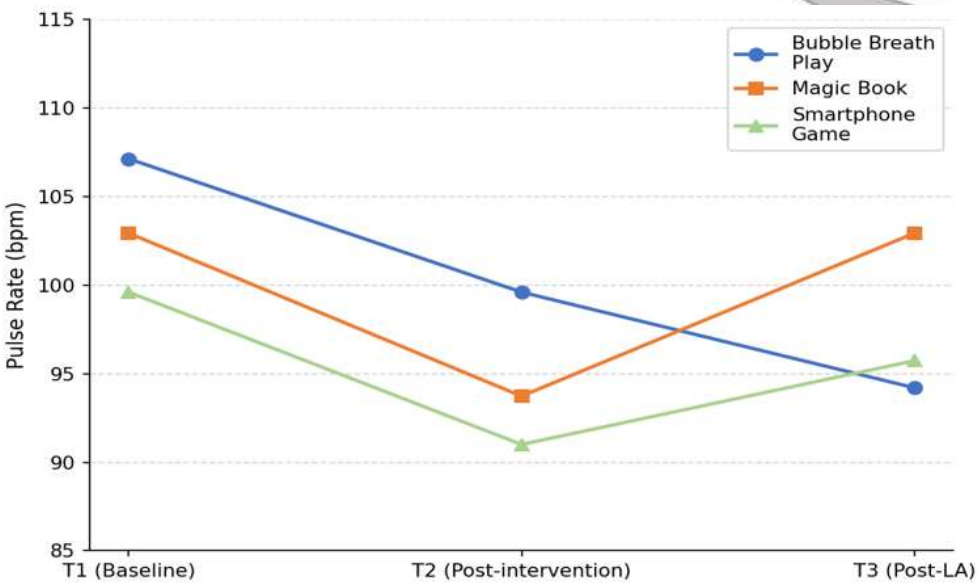


Fig 1 : Mean pulse rate across timelines

Venham Clinical Anxiety Rating Scale (VCARS)

A significant intra group reductions in VCARS scores were observed across all groups (Friedman test, $p < 0.001$). Group I VCARS declined from 1.67 ± 0.82 at T1 to 0.40 ± 0.83 at T2 and 0.60 ± 0.51 at T3. Group II declined from 1.33 ± 0.49 to 0.33 ± 0.49 (T2) and 0.87 ± 0.64 (T3). Group III showed the greatest anticipatory reduction, from 1.40 ± 0.51 to 0.20 ± 0.41 at T2 and 0.73 ± 0.59 at T3.

Table 4: Intragroup Comparison of VCARS using Friedman Test

Group	T1 (Mean±SD)	T2 (Mean±SD)	T3 (Mean±SD)	p-value
Bubble Breath Play	1.67 ± 0.82	0.40 ± 0.83	0.60 ± 0.51	<0.001
Magic Book	1.33 ± 0.49	0.33 ± 0.49	0.87 ± 0.64	<0.001
Smartphone Game	1.40 ± 0.51	0.20 ± 0.41	0.73 ± 0.59	<0.001

Table 5: Intergroup Comparison of VCARS by Kruskal–Wallis Test

Time Point	Bubble Breath (Mean±SD)	Magic Book (Mean±SD)	Smartphone (Mean±SD)	p-value
T2	0.40 ± 0.83	0.33 ± 0.49	0.20 ± 0.41	0.723
T3	0.60 ± 0.51	0.87 ± 0.64	0.73 ± 0.59	0.511

No statistically significant intergroup differences were observed for VCARS scores at T2 or T3.

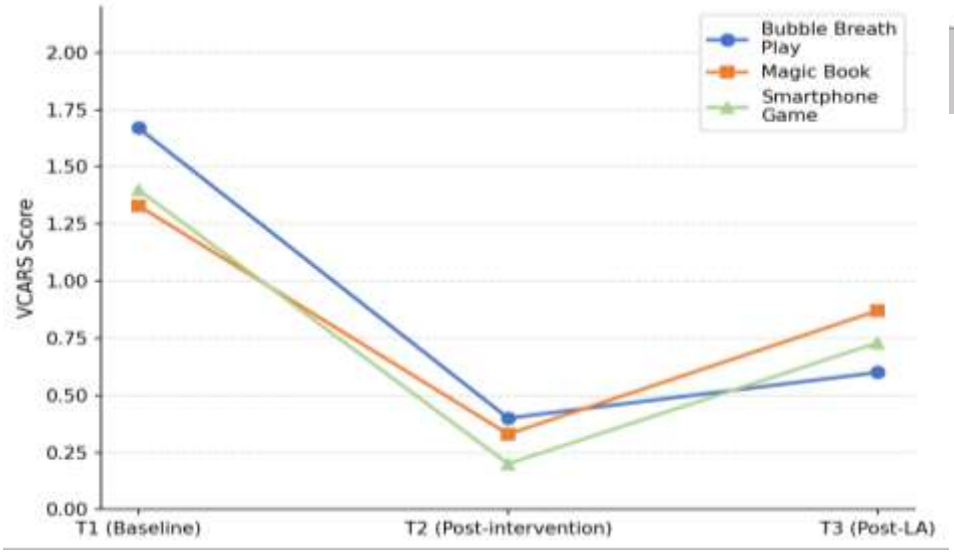


Fig 2: Mean VCARS across time

Facial Image Scale (FIS)

Statistically significant reductions in FIS scores were observed within all three groups (Friedman test, $p < 0.001$). Group I FIS declined from 3.00 ± 0.85 at T1 to 1.60 ± 0.74 at T2 and 2.07 ± 0.88 at T3. Group II showed a greater reduction from 3.33 ± 0.98 to 1.73 ± 0.88 (T2) and 2.47 ± 0.92 (T3). In Group III scores declined from 2.80 ± 1.01 to 1.53 ± 0.64 (T2) and 2.27 ± 0.80 (T3).

Table 6: Intragroup Comparison of Facial Image Scale (Friedman Test)

Group	T1 (Mean±SD)	T2 (Mean±SD)	T3 (Mean±SD)	p-value
Bubble Breath Play	3.00 ± 0.85	1.60 ± 0.74	2.07 ± 0.88	<0.001*
Magic Book	3.33 ± 0.98	1.73 ± 0.88	2.47 ± 0.92	<0.001*
Smartphone Game	2.80 ± 1.01	1.53 ± 0.64	2.27 ± 0.80	<0.001*

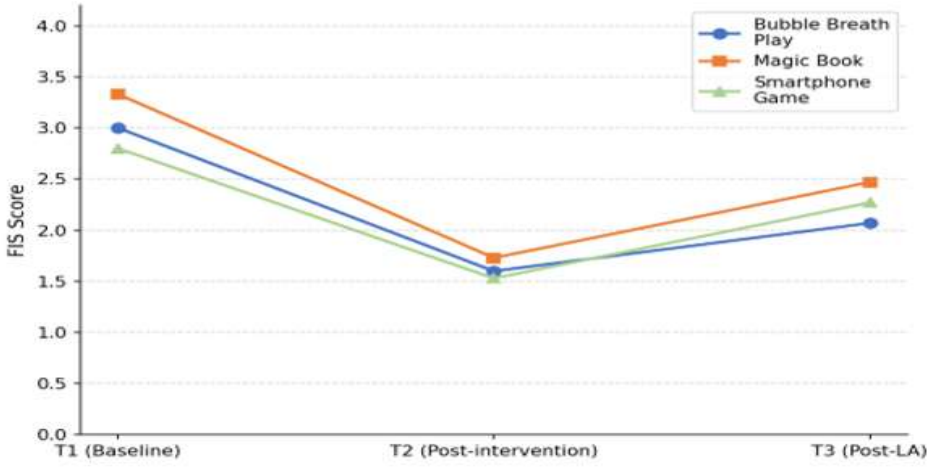


Fig 3: Mean FIS across timelines

Percentage Reduction in Anxiety Parameters

Table 7: Percentage Reduction in Anxiety Parameters from Baseline

Group	Pulse ↓% (T2)	Pulse ↓% (T3)	VCARS ↓% (T2)	VCARS ↓% (T3)	FIS ↓% (T2)	FIS ↓% (T3)
Bubble Breath Play	7.03%	12.07%	76.00%	64.00%	46.67%	31.11%
Magic Book	8.94%	0.00%	75.00%	35.00%	52.00%	36.00%
Smartphone Game	8.63%	3.88%	85.71%	47.62%	45.24%	23.81%

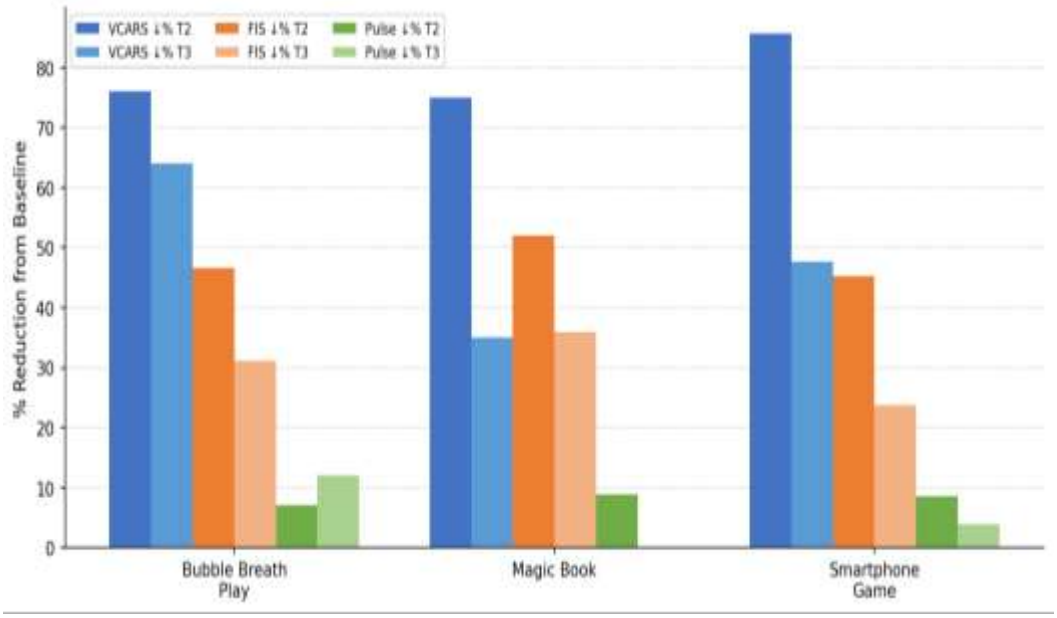


Fig. 4: Percentage Reduction in Anxiety Parameters (VCARS, FIS, Pulse Rate) by Group

DISCUSSION

The present study evaluated the effectiveness of three innovative non-pharmacological behaviour management techniques — Bubble Breath Play, Thaumaturgy Magic Book Technique, and Smartphone Dentist Game — in reducing dental anxiety in children aged 6–9 years receiving local anaesthesia. The principal finding was that all three behavioural interventions produced statistically significant reductions in anxiety across all time points within the group , while no statistically significant differences were observed between groups.

These results are consistent with the previous literature supporting distraction as an effective strategy for anxiety reduction in pediatric dentistry.(8) Distraction exploits the limited attentional capacity of children to divert cognitive focus from nociceptive dental stimuli, resulting in decreased pain perception from dental procedures that may elicit pain.(9)

Dental anxiety activates the autonomic nervous system, manifesting as elevated heart rate and pulse rate.(15)The significant within-group reduction in pulse rate across all three groups supports the genuine physiological effectiveness of active distraction. This finding aligns with Kothari et al., who reported significant decreases in pulse rate in children receiving thaumaturgic distraction during IANB administration.(2) Similarly, Padmanabh and Bhise observed significant pulse rate reductions with bubble breath therapy compared to TSD.(12)

Although the decrease in pulse rate was smaller than the reduction seen in FIS and VCARS scores, this finding is consistent with previous studies on anxiety assessment in children. Pulse rate is a physiological measure that is naturally regulated by the body and therefore shows less variation compared with psychological anxiety scales.(14) Moreover, the needle insertion during IANB can itself increase the pulse rate due to the physical sensation of the procedure, regardless of the child's emotional state. This may reduce the apparent effect of distraction on pulse rate.(16)

On the other hand, FIS and VCARS more directly reflect how the child feels and behaves when experiencing anxiety. Since distraction techniques mainly work by shifting the child's attention away from the dental procedure, their effect is more likely

to be clearly reflected in these psychological and behavioural measures. Studies have also shown that physiological measures such as pulse rate do not always strongly correlate with self-reported anxiety in children.(14)(17) This suggests that these measures assess different aspects of anxiety. Therefore, the smaller reduction in pulse rate, despite the marked improvement in FIS and VCARS scores in the present study, is an expected difference between physiological and psychological measures of anxiety rather than a failure of the distraction intervention.

The Bubble Breath Play technique operates through a well-established psychophysiological mechanism, where slow exhalation activates the parasympathetic nervous system, producing vagally-mediated heart rate deceleration and a calming effect.(18) The playful nature of bubble blowing transforms this exercise into an engaging activity ensuring child compliance. Bargale et al. demonstrated that breathing exercises significantly reduced anxiety during buccal infiltration anesthesia in children aged 6–12 years.(18) The BBP group demonstrated the greatest percentage reduction in pulse rate at T3 (12.07%), suggesting that the breathing habit acquired during the intervention continued to exert physiological calming effects through the injection phase.

The Thaumaturgy Magic Book Technique derives its effectiveness from the cognitive characteristics of children in this age group. Children aged 6–9 years transit from Piaget's preoperational to concrete operational stages, In this age group, the left hemisphere of the brain begins to develop which is responsible for semi-logical reasoning, analytical thinking, and verbal skills.(10) The magic coloring book draws attention of children by presenting an interesting and enthusiastic phenomenon; their inability to logically reason out the trick keeps them occupied and fascinated throughout the procedure.(11)Konde et al. found the book trick significantly reduced anxiety in children aged 7–11 years,(10) and Gupta et al. confirmed this in 360 children.(11) Peretz and Gluck, who were the first to introduce magic tricks as a behavior management strategy in pediatric dentistry, also reported that magic tricks were superior to tell-show-do in strong-willed children.(19)Padmanabh and Gangurde further demonstrated that thaumaturgy outperformed both Bach Flower Therapy and conventional TSD in reducing dental anxiety during pulp therapy. (20)The present study findings in 6–9 years old corroborate this evidence base.

The Smartphone Dentist Game produced the greatest numerical reduction in anticipatory anxiety at T2, reflected in a VCARS percentage reduction of 85.71% — the highest of all three groups. This is consistent with the broader evidence for video game-based distraction in pediatric settings. Active digital distraction engages auditory, visual, and kinesthetic modalities concurrently, creating a multisensory immersive experience.(13) However, a mild increase in anxiety indicators at T3 was observed in the Smartphone group, suggesting that digital distraction may be less sustained once the device is no longer accessible during the delivery of LA.

A mild rise in anxiety scores at T3 compared to T2 was observed across all groups, which is clinically expected as the child experience mild pain due to LA deposition. The transition from waiting to the active injection phase naturally elevates anxiety regardless of prior distraction, as the child now experiences direct sensory stimulation. Nonetheless, T3 scores in all groups remained lower than T1 baseline values, indicating better — though not complete — anxiety control through the procedure.

The absence of statistically significant intergroup differences is itself an important finding, as it suggests genuine clinical flexibility in choosing among these techniques based on child preference, available equipment, and clinical setting. The Smartphone Dentist Game offers simplicity and near-universal child acceptability but involves screen exposure. Bubble Breath Play offers physiological benefits and builds positive dentist–child interaction. The Thaumaturgy Magic Book fosters social engagement and wonder especially valuable for children encountering the dental environment for the first time.

The limitation of this study is the relatively small sample size of 15 per group. Future studies with larger samples, longer follow-up, and age-stratified subgroup analyses would strengthen the generalizability of these findings.

CONCLUSION

Within the limitations of the present study, all three behavior management techniques — Bubble Breath Play, Thaumaturgy Magic Book Technique, and Smartphone Dentist Game — were equally effective in significantly reducing dental anxiety in children aged 6–9 years undergoing local anesthesia. While digital distraction offered rapid anticipatory relief, active engagement through bubble play provided more stable physiological control during the LA administration. Integrating these age-appropriate, safe, and low-cost distraction strategies into routine pediatric dental practice can meaningfully improve the child's experience and cooperation, thereby contributing to more positive long-term dental attitudes.

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