Comparative evaluation of the effectiveness of a mobile app (Little Lovely Dentist) and the tell-show-do technique in the management of dental anxiety and fear: a randomized controlled trial

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Background: Behavior guidance is a technique used to subdue inappropriate behavior by establishing communication that meets the needs of a child. This study aimed to measure the effectiveness of a mobile app (Little Lovely Dentist) compared to the tell-show-do (TSD) technique in managing anxious children during their first dental visit.

Methods: Fifty children (30 boys and 20 girls) without any past dental experience, aged from 7 to 11 years, were randomly allocated into either the dental app group or the TSD group. The pre- and post-operative anxiety of children who underwent prophylactic cleaning was assessed both physiologically and subjectively using a heart rate measurement and the RMS pictorial scale, respectively.

Results: The intragroup comparison of heart rate and RMS scores for children allocated to the dental app group was statistically significant (P value $\leq$ 0.001). However, a significant reduction only occurred in the RMS scores, but not the heart rate measurements, in the TSD group. Conversely, there was an increase in heart rates in the TSD group.

Conclusion: Educating the child prior to a dental procedure using a smartphone application such as Little Lovely Dentist can significantly alleviate the anticipatory anxiety and engage children in dental treatment during their first visit.

Keywords: Anxiety; Behavior Guidance; Dental Application; First Dental Visit; Tell-Show-Do.

INTRODUCTION

Dental anxiety is "an abnormal fear or dreadful feeling of visiting the dentist for preventive care or therapy and unwarranted apprehension over dental procedures." During their first dental visit, children experience dental anxiety, which has an impact on their future behavior during dental treatment and can lead to dental neglect [1,2].

Dental anxiety is a primary concern for dental care providers, since it can potentially prevent children from seeking dental care and can create a challenging, uncooperative environment for effective treatment [3]. Some children vocalize their fears and anxiety, while others exhibit behaviors such as crying, agitation,

cessation of talking or playing, or even attempting to flee. This anxiety is accompanied by a chain of physiological reactions, which in turn leads to significant fluctuations in blood pressure and heart rate [4].

A child's first dental visit is a pivotal moment for the reduction or extension of dental anxiety [5], since they are new to the dental equipment and do not have any previous experience. An unpleasant experience during the child's first visit negatively influences further treatment which in turn can lead to dental anxiety [6,7].

Raadal et al. [8] reported that 19.5% of urban children in the United States aged 5-11 years were found to have high levels of dental anxiety out of a sample of 895. Cuthbert et al. [9] found that the most considerable dental anxiety exists between the ages of 6 and 7 years. Herbertt and Innes [10] found that children aged 8-9 years were the most troubled with dental anxiety and the least cooperative during dental treatment.

The sight of needles and air-turbine drills, the sounds of drilling and screaming, the smell of eugenol and cut dentine, and the sensations of high-frequency vibrations in the dental setting can also trigger anxiety [11]. Treating an anxious patient is stressful for a dentist because reduced cooperation can mean more treatment time and resources will be required, leading to an unpleasant experience for both the patient and the dentist [12]. Thus, anxiety can jeopardize the quality and efficacy of dental care provided to children [13].

Behavior guidance is a teaching technique that requires interactions between the dentist, dental team, patient, and parents. It involves communication and education, which ultimately builds trust and alleviates fear and anxiety [14]. It is the cornerstone of success in pediatric dentistry, since behavior guidance techniques enable children to learn appropriate behavior and coping skills to reduce anxiety, which allows the dentist to deliver effective oral care. Tell-show-do (TSD), modeling, and positive and negative reinforcements are the most frequently used techniques by dentists to alleviate a child's anxiety or fear [15,16]. Of these, pediatric dentists often choose the TSD method, which was introduced by Addelston and relies on the principle of learning theory [17,18].

Currently, children from all age groups interact with mobile phones for playing games, browsing the internet for knowledge, and entertainment. Since dental fear and anxiety is a common problem in children and adolescents worldwide, new strategies are being investigated to manage the challenging situation [19]. Panchal [20] reported that the use of a smartphone application to determine the risk and prevent the development of caries led to a significant improvement in the dietary and oral hygiene habits of the participants

Ongoing research of mobile apps that are used for behavior guidance has led to the development of virtual reality immersion. This is a promising distraction technique for children since it allows them to adapt to the dental operatory while also allowing for excellent communication between the child and clinician [21,22].

Hence, this clinical trial aimed to evaluate the effectiveness of a mobile app (Little lovely Dentist) compared to the TSD technique in the management of dental anxiety and fear in pediatric patients during their first dental visit.

MATERIALS AND METHODS

1. Source of data

This was a trial with a parallel-arm design and a uniform allocation ratio of 1:1. Clearance for the trial was given by the Institutional Ethical Review Committee (NDC/IECC/PEDO/STS/12-18/07), and the trial was conducted in the department of Pediatric and Preventive Dentistry. Signed informed consent was obtained from the parents or guardians of the children after information about the procedures involved in the study were provided. The study was conducted over a period of one month (September 2019).

We initially examined 218 children aged 7-11 years who visited our department. The sample size was calculated according to the formula n = $\frac{1n = 1n(1-\gamma)}{1n = 1n(1-\gamma)}$.

Fig. 1. Little Lovely Dentist app

Fig. 2. Educating a child about the procedure using the dental app

The confidence was 0.95, the probability was 0.05, and a sample size of 46 was obtained. However, considering the risk of subjects dropping out, we selected a sample size of 50 children and recruited them randomly into the trial based on the following inclusion criteria:

1. Children without any prior experience with the dental environment or treatment procedures
2. Children without any systemic or mental disorders.
3. Children whose behavior could be rated as positive (+) or negative (-) based on Wright's modification of the Frankl behavior rating scale [16].
4. Children who were willing to participate in the study.

2. Exclusion criteria

1. Children with systemic or mental disorders.
2. Children or parents who refused to participate in the study
3. Children whose behavior could be rated as definitely positive (++) or definitely negative (--) according to Wright's modification of the Frankl behavior rating scale [16]
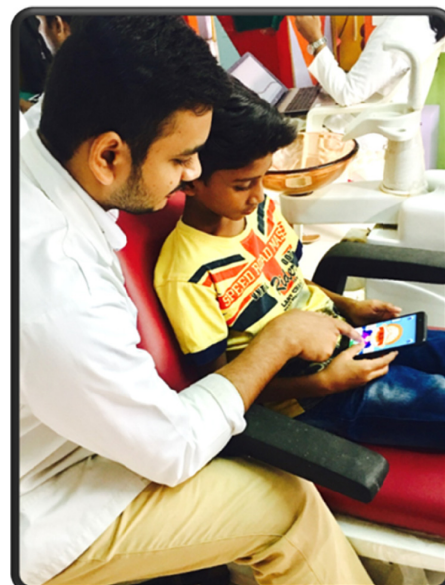
3. Randomization and Blinding

Fifty children were randomly selected and allocated into two groups using block randomization (Group I: dental app, and Group II: TSD) with 25 subjects in each group. The children included in the trial were not aware of the type of educational intervention they were going to receive. To prevent selection bias, the size and order of the blocks were also blinded.

"Little Lovely Dentist" is an application developed by Leaf cottage software and Shanghai Edaysoft Co., Ltd. available on the Google Play Store and App Store, respectively. It can be used for playfully educating children about treatment procedures such as prophylactic cleanings, pit and fissure sealants, restorations, and extractions, while also explaining the importance of oral hygiene maintenance through brushing, especially the interdental areas (Fig. 1 & 2). For the TSD technique, the 'tell' phase involves a verbal explanation of the procedure appropriate to the developmental level of the child. In the 'show' phase, they become familiar with the treatment armamentarium and a demonstration of the procedure in a carefully defined, non-threatening manner (Fig. 3). Finally, in the 'do' phase, the dentist begins the treatment without deviating from the explanation and

Fig. 3. Conditioning the child using tell-show-do

Fig. 4. Performing the oral prophylaxis procedure and recording procedural anxiety using a pulse oximeter
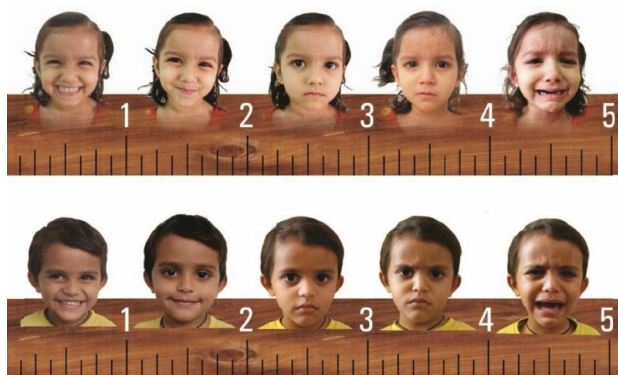

Fig. 5. RMS pictorial scale used for assessing pre- and post-operative anxiety

prophylactic cleaning procedure. The child was then encouraged to act as a dentist and perform dental treatment virtually on the dental app. Alternatively, the children in the TSD group received information about the prophylactic cleaning procedure through an explanation and demonstration of the instruments in a non-threatening fashion. After conditioning, the children in both groups received prophylactic cleaning by the same trained dentist.

Anxiety levels during the treatment procedure were assessed by recording the heart rate (physiologic measurement) using a portable finger pulse oximeter device. Post-operative anxiety was measured using both a pulse oximeter and the RMS pictorial scale (which is different for male and female children). A single dentist who was blinded to each participant's group allocation recorded both the heart rate and the RMS scores for all the children.

4. Outcomes measured

1. The primary outcome measured was the heart rate, which is a physiological representation of anxiety or fear
2. The secondary outcome measured was the anxiety score using the RMS pictorial scale

5. Statistical methods

All statistical analyses were performed using a standard software (SPSS 20.0 for Windows, SPSS Inc., Chicago, USA). A paired t-test was performed for intergroup and

demonstration for the duration of the procedure as shown in Fig. 4 [14].

The physiological and subjective measures of the children's anxiety in the operatory period were evaluated and recorded using a pulse oximeter and the RMS pictorial scale, respectively (Fig. 5). The children's pre-operative anxiety in both groups was recorded before the initiation of the intervention (during education about the procedure using the dental app or the TSD technique) using both the pulse oximeter and the RMS pictorial scale.

Children in the dental app group used the "Little Lovely Dentist" app where they were educated about the
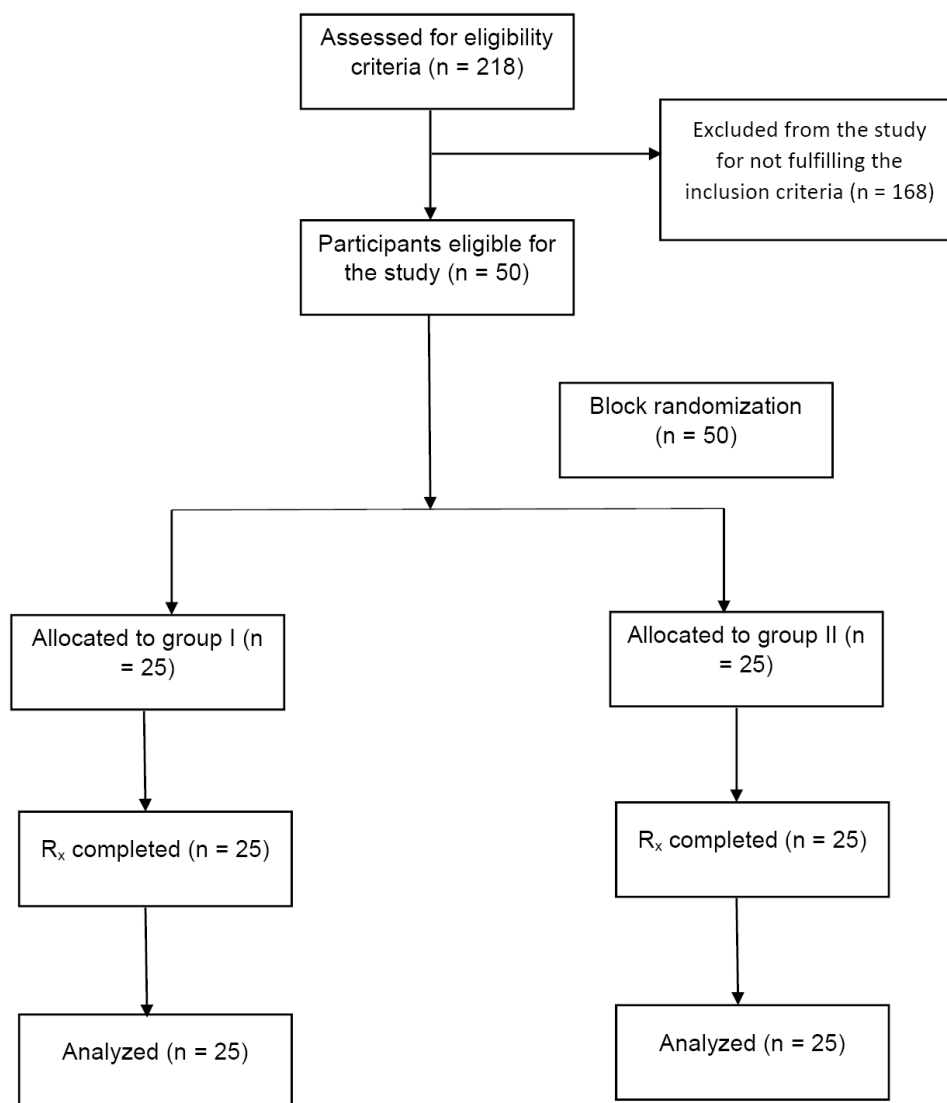
Fig. 6. CONSORT flow diagram of the study design

intragroup heart rate comparisons. To analyze the difference in anxiety scores between the two groups according to the RMS scale, the Mann-Whitney test was used. A P value < 0.05 was considered statistically significant.

RESULTS

A total of 30 boys and 20 girls were randomly recruited and allocated into two groups, which is represented in the CONSORT flow diagram (Fig. 6). There was an equal distribution of male and female children in both groups (15 boys and 10 girls in each group) (Table 1). The

Table 1. Demographic distribution of male and female participants

Group	Male	Female	Total participants
Group I (Dental app)	15	10	25
Group II (TSD)	15	10	25

TSD: tell-show-do

intragroup comparison demonstrated a statistically significant reduction in heart rate for the children recruited to the dental app group at all three points of the procedure: before vs during (P value ≤ 0.001), before vs after (P value ≤ 0.001), and during vs after (P value = 0.007). In contrast, for the children in the TSD group,

Table 2. Intragroup comparison of heart rates in the dental app and TSD groups

Group	Intragroup comparison	Pulse rate Mean ± SD	P-value
Group I (Dental app)	Before vs during	108.2 ± 12.8 vs 100.4 ± 13.6	≤ 0.001**
	Before vs after	108.2 ± 12.8 vs 97.4 ± 12.3	≤ 0.001**
	During vs after	100.4 ± 13.6 vs 97.4 ± 12.3	0.007*
Group II (TSD)	Before vs during	95.9 ± 10.0 vs 98.3 ± 9.3	0.106 NS
	Before vs after	95.9 ± 10.0 vs 97.2 ± 12.3	0.32 NS
	During vs after	98.3 ± 9.3 vs 97.2 ± 9.7	0.45 NS

TSD: tell-show-do; SD: standard deviation; P-value: ** Very highly significant; * Significant; NS: Non-significant

Table 3. Intragroup comparison of RMS scores in both groups

Group	Dental app group	Mean ± SD	P-value*
Group I (Dental app)	Before the procedure	3.20 ± 1.04	≤ 0.001**
	After the procedure	1.32 ± 0.5	
	Before vs after	3.20 ± 1.04 vs 1.32 ± 0.5	
Group II (TSD)	Before the procedure	2.6 ± 0.8	≤ 0.001**
	After the procedure	1.5 ± 0.6	
	Before vs after	2.6 ± 0.8 vs 1.5 ± 0.6	

TSD: tell-show-do; SD: standard deviation; P-value: ** Very highly significant

Table 4. Intergroup comparison of heart rates and RMS scores for both groups

Parameters	Intergroup comparison	Dental app Mean ± SD	TSD Mean ± SD	P-value
Pulse rate	Before the procedure	108.2 ± 12.8	95.9 ± 10.0	≤ 0.001**
	During the procedure	100.4 ± 13.6	98.3 ± 9.3	0.51
	After the procedure	97.4 ± 12.3	97.2 ± 9.7	0.93
RMS scale	Before the procedure	3.20 ± 1.04	2.6 ± 0.8	0.02
	After the procedure	1.32 ± 0.5	1.5 ± 0.6	0.34

RMS: RMS pictorial scale; SD: standard deviation; TSD: tell-show-do; P-value: ** Very highly significant

there was no significant reduction in heart rate (Table 2).

The comparison of intragroup subjective anxiety using the RMS scores demonstrated a significant reduction in anxiety (P value ≤ 0.001) for all the children in both groups (Table 3). However, there was no significant difference in the intergroup comparison (Table 4).

Although there was no significant difference in heart rate measurements between the two groups during the procedure (P value = 0.51) and after the procedure (P value = 0.93), a clear reduction in the mean heart rates was evident in the dental app group. In the TSD group, there was an increase in the mean heart rate during the procedure, which decreased slightly after the procedure

was completed (Table 4).

A statistically significant difference in both the physiological and subjective measures of anxiety was demonstrated only in the children who were educated using the dental app. For the children who were educated using the TSD technique, there was a significant difference (P value ≤ 0.001) for the RMS scores but not for the heart rate.

DISCUSSION

For many years, dental anxiety has been recognized as a crucial source of trouble in managing children during

dental treatment [23,24]. It can be a major hurdle to adequate dental care and the early detection of pathological processes, which may significantly affect the psychological well-being of the child [25].

Children who are visiting a dentist for the first time often exhibit poor behavior at their appointment [26]. Anxiety during dental treatment can hamper the effective delivery of oral care [27] since it can manifest in diverse ways, often as disruptive or interruptive behaviors [28].

The emotional quality of the first dental visit can have more effect on anxiety than the number of previous visits, since positive dental experiences may lead to less apprehension at future visits [26]. The dental team should provide effective and efficient treatment through instilling a positive attitude in the child during their first dental visit by utilizing appropriate behavior guidance [29]. Most comprehensive approaches aim to help develop communication between the child, dentist, and parents by understanding their cognitive, emotional, and social development [30,31]. Therefore, a comprehensive approach is more beneficial than the individualization of techniques in eventually building trust through alleviating fear and anxiety [14].

TSD is the most common technique for the effective management of children's anxiety at their pretreatment visit. It familiarizes them with new procedures, thus reducing their anticipatory anxiety [32].

In the world Smartphone market, India is the third largest in end users [33]. Research has shown that, in India, the frequency of mobile phone use was 68.6% and the rate of use by children was 56.6%. Rates also show that around 40% of children aged 10 years use a smartphone and this number increases gradually with age [34]. The World Health Organization has proposed the new term mobile Health, which is a component of eHealth, and defined as "medical and public health practice strengthened by mobile devices, such as mobile phones, patient monitoring devices and personal digital assistants" [35]. Therefore, healthcare professionals have been discovering novel ways of providing services and teaching patients using mobile applications designed for

use in the medical and dental fields [36]. These applications can be used to reduce patients' anxiety by educating patients about dental treatment and encouraging them to appropriately cope with the treatment [37].

Due to the limited availability of information regarding the use of smartphones in the reduction of anxiety, this study was conducted to assess the efficacy of smartphone applications to reduce anxiety during a child's first dental visit.

Anxiety developed during dental treatment can significantly affect systolic and diastolic blood pressures and heart rates even while the patient maintains a steady oxygen saturation level [38]. Therefore, physiological measures such as heart rate can be utilized to assess dental anxiety appropriately and is a safe physiological measurement to use during dental treatment [39,40].

All the children who participated in the present study exhibited anxiety since they did not have any prior exposure to dental treatment for various reasons. One of the significant reasons could have been exposure to another child or a relative who had an unpleasant dental experience.

A significant reduction in heart rate was elicited only for the children in the dental app group, which indicates a decrease in anxiety levels. This reduction of anticipatory anxiety can be attributed to exposure to the procedure in an interactive, joyful, and playful manner through the dental app called "Little Lovely Dentist." Another important aspect that may have aided in the reduction of anxiety could have been exposure to the process and the sounds of the procedure during the virtual procedure simulation.

Conversely, the heart rates of the children in the TSD group did not decrease significantly. Even though the children in the TSD group were educated using appropriate language in a non-threatening fashion, it was not playful and interactive, which could have contributed to the increase in heart rate in this group.

The RMS scores decreased for all the children in both the groups, before and after the treatments. The significant decrease in RMS scores in the TSD group can

be attributed to the potentially counterproductive effect of elaborate explanation about the dental procedures before the treatment.

According to the results of the present study, in terms of physiological and subjective measures, educating a child using a dental app is an effective method to reduce anticipatory anxiety during their first dental visit compared to the TSD technique. These results are similar to the findings of Patil et al. [41] and Shah et al. [42]. Additionally, Lee et al. [43] claimed that engaging a child with smartphone applications can be a distraction in the behavior guidance technique and suggested that smartphones were modest and effective in reducing preoperative anxiety in children.

A small sample size and unequal distribution of the children's ages can be a possible limitation of this study. Since the treatment in this study was limited to a non-invasive procedure (prophylactic cleaning), future studies with invasive procedures using local anesthesia such as restorations or extractions should be conducted using the dental app as a behavior guidance technique to confirm its efficacy.

From the above interpretations, behavior guidance using a dental app is more effective than TSD in managing the anxiety of a child without any past dental experience by educating him/her about the procedure and virtually simulating the treatments in an interactive manner prior to the treatment. Thus, a dental app is worth utilizing in pediatric dentistry to guide the behavior of children during their first dental visit by reducing their anticipatory anxiety.

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