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ORIGINAL RESEARCH

Anxiety during the dental care of children aged 4 to 6 years over three consecutive visits

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Abstract

Managing the anxiety of children during dental care is a major aspect of a pediatric dentist's work. Only a sparse body of literature is available regarding anxiety during dental care over consecutive visits. The purpose of the study was to investigate anxiety over three consecutive visits for pediatric dental treatment using an electrodermal activity (EDA) device. We also investigated how patient age, gender, the type of dental care performed and previous dental experience, exerted effect on anxiety.This was an observational cohort study. Anxiety was assessed during treatment, using an EDA device. We also recorded Frankl's behavior rating, previous dental experience, behavior guidance technique, heart rate and the type of dental care. Our cohort included 30 healthy children aged 4–6 years who needed dental care over at least three visits. Frankl scale scores, EDA values and heart rate did not differ significantly between visits. Behavior and anxiety during treatment did not differ significantly according to gender and age. At the second visit, the Frankl score was higher in children who received pulp treatments and crowns than those who received restorations (p = 0.012). At the third visit, children who received pulp treatments and crowns had higher heart rates than those who received restorations (p = 0.011). Heart rate was significantly higher in children who had negative dental experiences when compared to those with positive experiences (p = 0.030). The levels of anxiety in children aged 4–6 years did not change significantly over three consecutive dental treatments. Therefore, varied and meticulous behavior management methods should be maintained throughout consecutive visits.

Keywords

Dental anxiety; Pediatric dental care; Child behavior; Consecutive visits

1. Introduction

Dental anxiety causes neglect of oral health and increases the risk of tooth decay. The level of dental anxiety varies between social groups and between people in the same society [1]. About 10–20% of children and adolescents present with dental anxiety and behavioral problems [1–3].

Little is known about anxiety during dental care over consecutive visits. Several previous studies have reported a gradual reduction of anxiety over sequential visits. Ramos-Jorge *et al.* [4] investigated anxiety during dental treatment by applying the modified Venham picture test (VPT) over six consecutive sessions attended by children who were 8–11-years-of-age; anxiety decreased from the onset of the fifth visit. Children with dental pain presented with a higher level of anxiety than those who had never experienced such pain. In another study, Bagchi *et al.* [5] reported reduced anxiety, as assessed by blood pressure and heart rate, in patients aged 3–6 years, in the second and third consecutive dental treatments when compared to the first. Rank *et al.* [6] assessed anxiety by using the facial image scale (FIS) in children aged 4–6 years. These authors found that the distraction technique during dental treatment failed to reduce anxiety on the first visit but resulted in reduced levels of anxiety on the second visit. Collectively, the literature suggests that the level of anxiety in children declines from the first to the next visit when assessed using VPT, FIS, blood pressure or heart rate.

Electrodermal activity (EDA) is an international standard technique for measuring activity of the autonomic nervous system as a parameter that reflects the degree of arousal. EDA variations depend on the quantity of sweat secreted by eccrine sweat glands. These glands are mainly located in the hypodermis of palmar and plantar regions and generate sweat that is excreted through sweating ducts. This form of secretion is under the control of sympathetic innervation, which transmits signals from the central nervous system to the eccrine glands. Variations in sweating may serve as biomarkers of emotion, novelty or attention. Stimulation of the sympathetic branch of the autonomic nervous system increases secretion by the eccrine sweat glands, thus increasing conductivity of the skin [7, 8]. EDA has been used to investigate anxiety in the dental environment. For example, Shapiro *et al.* [9, 10] used EDA to investigate the effect of the dental environment on the level of anxiety in children during plaque removal; analysis showed greater relaxation in a sensory-adapted dental environment, especially in children with developmental disabilities.

The main objective of the present study was to identify potential differences in the degree of anxiety (improvement or deterioration) during dental treatment over three consecutive dental visits. Specifically, we examined EDA, heart rate and Frankl behavior scale scores in three visits per patient. The null hypothesis was that dental anxiety will not change over three consecutive dental visits. We further investigated possible associations of these variables with other patient characteristics such as gender, age, the dental treatment performed at each visit, and previous dental experience (no previous experience, positive experience, negative experience).

2. Materials and methods

2.1 Study design

This observational cohort study was designed to investigate the degree of anxiety during dental treatment over three consecutive dental visits.

2.2 Study group

Study participants were recruited from the Department of Pediatric Dentistry, Hadassah Medical Center, Jerusalem, Israel. The inclusion criteria were as follows: (1) healthy children as determined by the American Society of Anesthesiologists (ASA score of 1); (2) aged 4–6 years on the day of the examination, and (3) children in need of routine dental care over at least three visits. The exclusion criteria were as follows: (1) developmental disabilities; (2) compromised health status (ASA scores of 2–5); (3) attendance for emergency treatment and dental pain; (4) failure to attend subsequent appointments; (5) a child's refusal to have the EDA device installed on their fingers, and (6) treatment by more than one dentist. The participants were treated by five dentists; all the treatments for the same child were performed by the same dentist. All dentists were residents at the final stage of residency in pediatric dentistry. The principal investigator collected the data from all participants.

2.3 Study tool

Anxiety level was assessed using an EDA device; these involved electrodes connected *via* tape to two fingers in the child's palm. Assessment started upon agreement by the child at entry into the treatment room and continued throughout the treatment. When the sympathetic branch of the autonomic nervous system is greatly aroused, the activity of the sweat gland increases; this increases the conductivity of the skin. Conversely, the lower the conductivity and the smaller the numerical value of EDA, the calmer the child. For each session, a mean EDA value was calculated per participant. At each session, the following parameters were recorded: heart rate, Frankl behavior scale (scored as 1–4; a higher score indicates better behavior), behavior guidance technique (pharmacological and non-pharmacological) and the dental treatment performed. Dental treatments were further classified into one of four groups: (1) a non-invasive (such as dental and radiographic examinations, plaque removal, fluoride application and fissure sealants); (2) restorations with local anesthesia (3) extractions with local anesthesia, and (4) other treatments with local anesthesia (pulp treatments, stainless steel crowns). Heart rate was recorded every 5 minutes and a mean value was calculated for each participant on each visit. In addition, demographic data (age, gender) were collected, as well as information relating to previous dental experience (none, positive or negative).

2.4 Sample size calculation

The sample size was calculated in G*Power software (latest ver. 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) according to the *t*-test for paired samples, a medium effect size of 0.6, an intensity of 0.85 and a significance level of 0.05. A sample size equal to 27 participants was required.

2.5 Statistical analysis

Descriptive statistics of the background variables and the research indices are presented as absolute numbers and percentages for categorical variables and as means and standard deviations for continuous variables. Differences in anxiety and behavior between the three sessions were examined using repeated measures analysis of variance (ANOVA). Differences in anxiety and behavior between boys and girls were examined using a *t*-test for independent samples. Pearson's correlation test was used to investigate the association between participant age and anxiety. Differences in the indices relative to the treatment performed at each visit were examined using the median and Kruskal-Wallis tests. The effect of previous dental experience on EDA, heart rate and the Frankl index was examined using a one-way variance test.

3. Results

Thirty-four participants were recruited for this study. Four children were excluded from the analysis: one because the child did not attend the third treatment, one because the child was treated by a second dentist after two treatments, and two because they did not cooperate in the first session and were referred for dental treatment under general anesthesia.

The final sample included 30 children, aged 4–6 years (mean $\pm$ SD; 5 $\pm$ 0.5 years), who attended for routine dental treatment on at least three sessions: 13 boys (43%) and 17 girls (57%). Sixteen (53%) children had no previous dental experience, 10 (33%) had a previous positive experience, and 4 (13%) had a previous negative experience.

Table 1 presents the treatment data over the three visits. The range of Frankl scores was 2–4 over the three visits. A score of 4 (definitely positive behavior) was assigned to 30% of children in the first session; this proportion decreased incrementally over subsequent visits. Conversely, a score of 2 (negative behavior) was assigned to 23% of the children on the first visit; this decreased to 13% on the second visit and increased again to 23% on the third visit. The mean EDA was

TABLE 1. Treatment data for the three dental visits.

Treatment data	1st session		2nd session		3rd session		Repeated measures ANOVA *p*-value
	N	%	N	%	N	%	
Visit purpose							
Examination	10	33	0	0	0	0	
Examination with sedation	8	27	0	0	0	0	
Operative treatment	0	0	2	7	1	3	
Operative treatment with sedation	12	40	28	93	29	97	
Behavior guidance							
Inhaled/moderate sedation	20	67	28	93	29	97	
Non-pharmacologic	10	33	2	7	1	3	
Treatment type							
Non-invasive	18	60	3	10	1	3	
Restorations with local anesthesia	7	23	20	67	24	80	
Extractions	2	7	1	3	0	0	
Other treatment with local anesthesia	3	10	6	20	5	17	
Frankl behavior scale							
1	0	0	0	0	0	0	
2	7	23	4	13	7	23	0.590
3	14	47	19	63	17	57	
4	9	30	7	23	6	20	
	Mean	SD	Mean	SD	Mean	SD	
EDA*	8985	1640	8715	1086	9176	918	0.231
Heart rate	91.2	11.0	92.0	11.0	91.5	10.0	0.894

**EDA: electrodermal activity; SD: standard deviation; ANOVA: analysis of variance.*

lower on the second visit (8715) than on the first visit (8985) but increased on the third visit (9176). Repeated measures ANOVA found no statistically significant differences between the three visits in terms of Frankl behavior scale (F (2, 58) = 0.53, p = 0.590, η^2 = 0.02), in EDA values (F (2, 58) = 1.5, p = 0.231, η^2 = 0.05) and heart rate (F (2, 58) = 0.11, p = 0.894, η^2 = 0.004).

No statistically significant differences were found between the boys and girls in terms of mean Frankl scores (t (28) = 1, p = 0.325), EDA (t (28) = 0.25, p = 0.808) and heart rate (t (28) = 0.76, p = 0.455) (Table 2).

Pearson's correlation analysis found no statistically significant relationships between patient age and Frankl score (r = −0.14, p = 0.461), EDA (r = 0.185, p = 0.329) or heart rate (r = −0.174, p = 0.357).

To identify associations between Frankl score and the type of dental treatment, the Mood's median test was conducted for each of the three visits. There were no statistically significant associations for the first visit (χ^2 = 0.975, p = 0.807) or the third visit (χ^2 = 0.260, p = 0.878), but significant associations were detected on the second visit (χ^2 = 8.29, p = 0.040). On the second visit, the median Frankl score was higher for children who received pulp treatment and crowns (six children) than those who received restorations (20 children) (p = 0.012). There were no statistically significant differences in EDA scores according to the type of dental treatment on the first visit (χ^2 = 1.155, p = 0.764), the second visit (χ^2 = 4.52, p = 0.210) or the third visit (χ^2 = 0.48, p = 0.785). There were no statistically significant differences in heart rate according to the type of dental treatment on the first visit (χ^2 = 5.71, p = 0.127) or the second visit (χ^2 = 6.62, p = 0.085). However, on the third visit (χ^2 = 6.42, p = 0.040), heart rate was higher for children who received pulp treatment and crowns (five children) than those who received restorations (24 children) (p = 0.011).

No significant differences in EDA and Frankl score were found between the three dental experience categories (none, positive and negative). In contrast, heart rate differed between the visits (F (2, 27) = 4.24, p = 0.025). According to a *post-hoc* test with Bonferroni correction, the heart rate was significantly higher in patients with previous negative experience than those with previous positive experience (p = 0.030) and without experience (p = 0.037) (Table 3).

TABLE 2. Results arising from the *t* test for comparisons between boys and girls in terms of EDA, heart rate and Frankl behavior scale scores.

Variable	N	Mean	SD	*t*	*df*	*p*
Frankl score						
Boys	13	3.15	0.48	1.001	28	0.325
Girls	17	2.96	0.55			
EDA*						
Boys	13	9006.74	786.68	0.245	28	0.808
Girls	17	8921.84	1041.67			
Heart rate						
Boys	13	89.87	6.61	−0.757	28	0.455
Girls	17	92.00	8.33			

EDA: electrodermal activity; SD: standard deviation.*

TABLE 3. One-Way ANOVA test results for EDA, heart rate and Frankl behavior score based on previous dental experience (Mean (standard deviation)).

Variable	No previous experience (N =16)	Previous positive experience (N = 10)	Previous negative experience (N = 4)	*F*	*p*
Frankl	3 (0.50)	3 (0.58)	3.25 (0.57)	0.35	0.706
EDA*	9134 (870)	8971 (738)	8227 (1406)	1.60	0.220
Heart rate	90 (7.5)	89 (6.0)	100.3 (5.5)	4.24	0.025

EDA: electrodermal activity; ANOVA: analysis of variance.*

4. Discussion

Our analysis found no significant change in the level of anxiety in children aged 4–6 years over three consecutive visits for dental treatment, as reflected by EDA, heart rate and behavior. This finding contradicts previous reports of reductions in anxiety over sequential visits [4–6]. A possible explanation for this discrepancy may be related to the study tools used. While Ramos-Jorge *et al.* [4] and Rank *et al.* [6] used subjective measures that relied on the self-reporting of children, such as VPT and FIS, we used the objective measures of EDA and heart rate. Although the Frankl behavior scale is also subjective, it is reported by the dentist and not the patient. While self-reported assessments measure the cognitive elements of dental anxiety directly from the child's perspective, physiological assessment measures the physiological component of dental anxiety and are more objective measures [11].

The lack of previous dental experience among half the study group could have also influenced our results, since children who had never visited the dentist are known to report higher scores of dental fear [12]. Children who have never visited a dental clinic usually have incorrect assumptions about dental procedures, and prior dental visits have been suggested to reduce dental fear by reducing negative thoughts about dentistry. Accordingly, we would have anticipated that s anxiety would decrease from one visit to the next; however, this was not the case.

In this study, no differences were detected between boys and girls in the levels of anxiety and behavior during treatment. In contrast, Alsadat *et al.* [1] found that fears and anxieties were more common among females than males. In addition, Lima *et al.* [13] reported greater levels of fear and anxiety in girls than boys, aged 6–9 years. With regards to behavior during treatment, our results are consistent with other studies that did not detect significant associations between patient gender and behavior throughout treatment [4, 14].

In the present study, no associations were found between participants age, anxiety and behavior over three consecutive dental visits. The small age range of the patients (4 to 6 years) may explain the lack of difference according to age. This age range was selected because younger children are usually in the pre-cooperative stage, and children aged 4–6 years have the potential to cooperate [15]. Notably, a number of studies have shown that fear and anxiety are more common in younger children, and the prevalence of these issues decreases with increasing age [13, 16]. Improvements in behavior and cooperation have also been demonstrated with increasing age [5]. Katsouda *et al.* [17] examined behavior over three consecutive sessions among children aged 4–12 years who underwent dental treatment. These authors found that children with definitely positive behavior were significantly older. Furthermore, children who were rated negative during their initial appointment were more likely to receive negative Frankl ratings during the final appointment. Children who were rated negative during the second appointment were also more likely to be rated as negative during the final appointment.

This study also examined relationships between the type of dental treatment, anxiety and behavior. Although no association was detected between anxiety and the type of dental care performed, we did identify a difference in children's behavior on the second visit and in heart rate on the third visit. A surprising finding was that behavior on the second visit was better in children who underwent pulp treatments and received crowns; whereas on the third visit, these treatments resulted in a higher heart rate when compared to restorations. Pulp treatments and crowns are known to cause more post-operative pain [18, 19], although current research has demonstrated that during treatment itself, these treatments are not a source of higher anxiety or behavioral disorders.

In our cohort, anxiety assessed by EDA and Frankl scores did not differ significantly between patients according to their previous dental experiences. In contrast, heart rate was higher, indicating greater levels of anxiety, among patients with previous negative experience than in those with positive experience. Similarly, Goettems *et al.* [20] reported that a positive experience reduced fear in children and improved the quality-of-care and the quality-of-life. Lima *et al.* [13] reported that children who had not previously visited a dentist showed more fear and anxiety than those who had a previous experience at a dental clinic. The avoidance of dental visits, or infrequent dental visits, have been associated with higher levels of dental fear and anxiety in children and adolescents. Sporadic dental attendance as a child, compared to regular attendance, was associated with increased dental fear and anxiety [21].

This study has several limitations that need to be considered. The sample size was relatively small and subgroups of dental history differed in size to such an extent that comparisons were impossible. It would be more valuable to have the same number of children with the same experience. In addition, since most of the children were treated with the same behavioral guidance method, comparing the effects of various behavioral guidance methods on anxiety and behavior in subsequent visits was not possible. The same issue also applies to the types of dental treatments performed on each visit, since not all treatments (1, 2, 3 and 4) were applied to each patient and the same procedures were not performed in the same sessions. Furthermore, our study involved five different dentists; consequently, full standardization was not possible. Moreover, the behavioral management style and gender of the dentist involved may cause different perceptions/stress levels in children.

5. Conclusions

In conclusion, the anxiety levels of children aged 4–6 years did not change across three consecutive dental treatments. Therefore, varied, and meticulous behavioral management methods should be maintained across consecutive visits. Further studies are now needed with a larger and more heterogeneous research group.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

AFN, AS, EH, DR and MM—contributed to study conception and design; AFN, RZ and MM—Material preparation, data collection and performed analysis; AFN—written the first draft of the manuscript. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the committee on research involving human subjects of the Hebrew University-Hadassah Medical School, Jerusalem, Israel (Date: 05 November 2018/No.0652-18-HMO). Freely-given, informed consent to participate in the study was obtained from the parents or legal guardians of each participant.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Diana Ram is serving as one of the Editorial Board members of this journal. We declare that Diana Ram had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to GAF.

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