Evaluation of the effect of perceived control on dental fear of children with salivary cortisol level and pulse oximeter

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ABSTRACT

AİM: It was aimed to evaluate the effect of the mobile patient-physician communication system, which was developed based on the perceived control principle, on dental fear in children with salivary cortisol level, pulse and oxygen saturation (SpO2).

METHODS: The study was performed on children aged 7-9 years with an indication for extraction of their upper primary second molars. Forty-four patients with a score of 38 or higher on the Fear of Dentistry in Children (CFSS-DS) were randomly divided into two groups. The experimental group was asked to use the mobile patient-physician communication system called 'Dental Anxiety' downloaded to the tablet when they needed it during the treatment. Venham Picture Test was applied to all patients before and after treatment. To evaluate the salivary cortisol levels, saliva samples were taken from patients at five stages and analyzed by ELISA test. SpO2 and heart rate values were recorded at the same stages. After the measurements, the data were analyzed using Chi-square and Independent Two Sample t tests.

RESULTS: Statistically significant difference was found between the patients' VPT values, heart rate according to time, mean cortisol values and heart rate values according to the groups after the treatment ($p<0.001$). However, no significant difference was found between the SpO2 values between the groups ($p>0.05$).

CONCLUSION: The results of the study showed that the mobile patient-physician communication system based on perceived control is effective in the management of anxiety in children aged 7-9 years.

KEY WORDS: Perceived control, Dental anxiety, Salivary cortisol, Pulse rate

INTRODUCTION

Anxiety is a state of intense unrest that occurs subconsciously against an unknown danger. Also; it is a systemic response to imminent danger influenced by memory, personal history and social context, which are reflected by the combination of biochemical changes.[1] Dental fear and anxiety are the most frequently encountered problems in paediatric dentistry. The first thing that dentists should do is to understand the anxiety and fear of the patient and determine the level of anxiety and fear. There are many scales used for this purpose. Psychometric measurements are in the form of mutual questions and answers with the child and are based on verbal expressions. Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) and Corah Dental Anxiety Scale (DAS) are the most frequently used questionnaires for children or parents.[2-4] The Venham Picture Test (VPT) and Facial Image Scale (FIS) have come to the fore as projective measurement techniques that can be used in the younger patient group.[5-7] Stress is defined as a physiological and psychological reaction that activates the defence mechanism of the organism against internal or external threats and has at least two components. The first of these components leads to the activation of the hypothalamic-pituitary-adrenocortical gland (HPA) axis and the release of glucocorticoids (e.g. cortisol) into the bloodstream. The second component provides activation of the autonomic nervous system and the release of catecholamine (e.g. norepinephrine) into the bloodstream. Dental anxiety and fear can lead to an increase in cortisol release with the activation of the HPA axis and an increase in blood pressure as a result of the increase in catecholamine levels. Stress-induced catecholamine levels can rise to 10 times the basal level. This results in an increased heart rate.[8,9] Among the methods used for salivary cortisol analysis, ELISA is the most commonly used and reliable method that provides results in a short time. In physiological measurements, dental anxiety is tried to be determined by making somatic evaluations such as pulse rate, blood pressure, and arterial oxygen saturation (SpO_2) also.[12,13] Children with high levels of anxiety or phobia may need specific pharmacological support as well as behavioural management techniques.[16,17] Perceived control communication system is a new perspective to anxiety control and behaviour management. In recent years, where technology has been effective in all areas of daily life lives; developing software-based programs on perceived control communication systems in anxiety management, downloaded to tablets or phones, ensure the patient to communicate actively with the physician during treatment.[18-22] The aim of this study is; to evaluate the effectiveness of a new mobile perceived control communication system, on children with dental anxiety. It was hypothesized that this new system used in the study will decrease the anxiety levels of children and maintain comfort in dental treatment.

MATERIAL AND METHOD

This study was carried out with children aged 7-9 years who were referred to Gazi University Faculty of Dentistry Department of Paediatric Dentistry with extraction indication of upper secondary primary molar teeth. Patients with orofacial congenital syndromes/deformities, patients with systemic or mental disorders as well as patients using medication and patients who had prior experience of injection/extraction procedures were excluded from the study. Procedures followed during the study were by the Helsinki Declaration, written consents were taken and ethical approval was obtained with the number 21071282-050.99 from Clinical Research Ethical Clearance Committee of Gazi University, Faculty of Dentistry. Following power analysis, which included a total sample size of 44 to detect with a power of 80% at the 5% significance level and 0.4 effect size. Among 158 patients who ensure the inclusion criteria, those who agreed not to take any food in the last 1 hour and with high anxiety scores of 38 and above due to the Turkish version of CFSS-DS which validity and

reliability study was performed by Seydaoğlu et al.[23] were selected for the study. Finally, 44 children (26 girls and 18 boys) were included in the study and informed consent were taken from all patients and their parents. The children were randomly divided into two groups. Perceived control communication programme named 'Dental Anxiety' which was downloaded to a tablet introduced to the test group and were asked to use it when needed during the treatment. The control group did not use any device. In the study, VPT was used as the psychometric measurement method. In physiological measurements, besides measuring pulse rate and arterial oxygen saturation, salivary cortisol levels were determined. The treatment of all patients and collection of saliva samples were carried out by the same physician. All patients were treated in the same clinic between 09.00-11.00 hours. The treatment procedure was explained to the patients using the "tell-show-do" method. Primary teeth extractions were done under routine conditions.In both groups, pulse rate and SpO2 values of the patients were recorded 10 minutes before treatment, during anaesthesia, 10 minutes after anaesthesia, during treatment, and 10 minutes after treatment with a pulse oximeter device (G-Life BM1000A, Dusseldorf, Germany). First saliva samples were taken from all patients in the test and control groups 10 minutes before the treatment and their anxiety before the treatment was determined by applying VPT. In the test group who were explained to use the 'Dental Anxiety' application during the treatment in detail, infiltrative anaesthesia was applied while the tablet was in the patient's hand. In the control group, infiltrative anaesthesia was applied after VPT and the first saliva sample was taken. Second saliva samples were taken from all patients 10 minutes after anaesthesia. In the test and control groups, after the extraction and bleeding control in 10 minutes, a clean gauze tampon was applied to the extraction area and the third saliva sample was taken. After the treatment, VPT was applied to the patients and their anxiety status at the end of the treatment was evaluated. A special kit Salivette® Cortisol Sarstedt (Nümbrecht, Germany) was used for the collection of saliva samples. The sterile cotton pellet in the Salivette® tube was placed in the patient›s mouth and asked to wait for at least two minutes. After making sure that it was completely wet with saliva, the cotton pellet was carefully removed from the patient's mouth and placed into the collection tube. The samples were centrifuged at 1000g (2850 rpm) for 2 minutes in Gazi University Faculty of Dentistry, Department of Pathology laboratory within a maximum of 1 hour and frozen at -20°C. The same procedures were applied to a total of 132 samples taken from 44 patients and stored under appropriate conditions. Cortisol Saliva Elisa DiaMetra (Perugia, Italy) kit was used to analyse the samples. The mobile perceived control communication system application called "Dental Anxiety" that we used in our study was designed by Nalcı [20]. The developed software was produced in Gazi University, Department of Computer Engineering. This software works on mobile devices with Android 4.4 and above the Android Communication system. The software can store historical data with SQLite Data Base. Detailed reporting can be made in Microsoft Excel (.xls) format by using this data. (Figure.1)

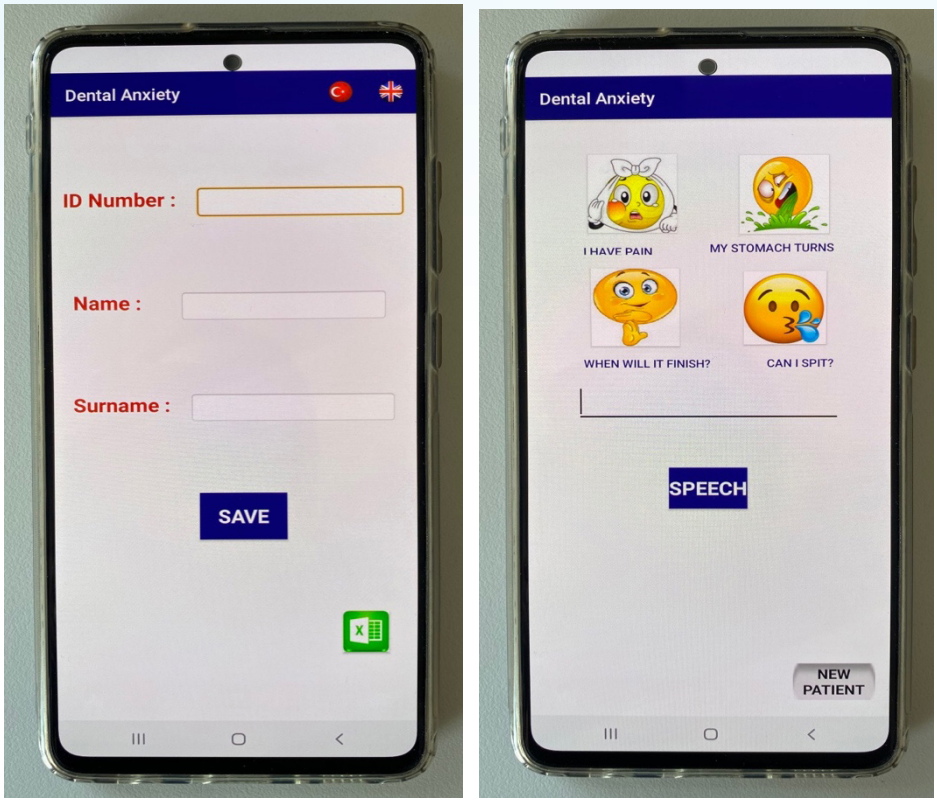


Figure 1. First and second interfaces of the mobile application

The application consists of two interfaces. For physicians who want to keep a record, the first interface contains personal information such as the patient's identity number, name and surname. The second side of the application is planned for the use of the patient. When the patient touches the button he wants, the program voices that option and allows the patient to reach the physician audibly. If the patient wishes to express a complaint other than these options, he can type the sentence he wants using the keyboard at the bottom of the page. In addition, when the speak button is clicked, the sentence written is voiced verbatim and delivered to the physician. The application has both English and Turkish language options. Data were analysed with IBM SPSS V23. Conformity to normal distribution was examined using the Shapiro-Wilk test. The Chi-square test was used to compare categorical variables according to groups. Independent Two-Sample t-test was used to compare the data normally distributed to paired groups. Repeated analysis of variance was used to

compare normally distributed data over three or more times. Paired Two-Sample t-test was used to compare normally distributed data according to dual time. The relationship between variables was analysed using Pearson Correlation analysis. Analysis results are mean ± s for quantitative data. It was presented as deviation and median (minimum-maximum), and as frequency (percentage) for categorical data. The significance level was taken as p<0.05.

RESULTS: CFSS-DS results of the patients included in the present study with high anxiety scores of 38; the most disturbing situations for children are injection application with 3.95 points (61.36%), breathlessness with 3.68 points (45.46%) and the sound of rotating instruments with 3.43 points (43.18%). When CFSS-DS scores were compared according to gender, no statistically significant difference was found (p>0.05). The average age of the patients included in the study was 7.67 years. The mean age of the patients in the test group was 7.75 years and the mean age of the patients in the control group was 7.62 years. The number of the children were equal in groups (13 girls and 9 boys for both groups). As a result of the statistical analysis, there was no significant difference between the age (p=0.789) and gender (p=1,000) distributions of the patients according to the groups. There was no statistically significant difference according to gender for VPT, SpO_2, pulse rate and cortisol values measured between the groups (p>0.05).The mean of VPT, SpO_2, pulse rate and salivary cortisol values of the patients between and within groups and their comparisons are given in Table 1.

Table 1. Comparison of VPT, SpO2, pulse and salivary cortisol values between and within groups

	Test	Control	Total	p*
VPT Before treatment	4,09 ± 1,02	4 ± 0,76	4,05 ± 0,89	0,739
VPT After treatment	2,73 ± 1,2	4,32 ± 0,84	3,52 ± 1,3	<0,001
p**	**<0,001**	0,110		
SpO_2 10 min. before treatment	95,27 ± 1,93^{ab}	95,32 ± 2,15	95,3 ± 2,02	0,941
SpO_2 During anesthesia	95,55 ± 1,97^{ab}	95,95 ± 1,86	95,75 ± 1,91	0,483
SpO_2 10 min. after anesthesia	95,18 ± 1,71^{a}	95,86 ± 1,58	95,52 ± 1,66	0,177
SpO_2 During treatment	96,09 ± 1,34^{ab}	95,95 ± 1,94	96,02 ± 1,65	0,788
SpO_2 10 min. after treatment	95,82 ± 1,65^{b}	95,82 ± 1,71	95,82 ± 1,66	1,000
p***	**0,018**	0,254		
Pulse rate 10 min. before treatment	105,32 ± 6,27^{b}	104,91 ± 6,33^{a}	105,11 ± 6,23	0,831
Pulse rate During anesthesia	110,27 ± 6,87^{c}	115,32 ± 6,47^{b}	112,8 ± 7,07	0,016
Pulse rate 10 min. after anesthesia	103,86 ± 6,3^{b}	109,14 ± 5,05^{c}	106,5 ± 6,25	0,004
Pulse rate During treatment	103,95 ± 3,99^{b}	112,82 ± 6,64^{b}	108,39 ± 7,03	<0,001
Pulse rate 10 min. after treatment	99 ± 4,05^{a}	105,91 ± 4,8^{a}	102,45 ± 5,61	<0,001
p***	**<0,001**	**<0,001**		
Cortizol 10 min. before treatment	10,41 ± 2,07^{a}	9,54 ± 1,45^{a}	9,98 ± 1,82	0,112
Cortizol 10 min. after anesthesia	8,01 ± 1,72^{b}	9,45 ± 1,64^{a}	8,73 ± 1,81	0,007
Cortizol 10 min. after treatment	5,61 ± 0,91^{c}	7,81 ± 1,44^{b}	6,71 ± 1,63	<0,001
p***	**<0,001**	**<0,001**		

* Independent Two-Sample t test, ** Paired Two Sample t test, *** Repeated analysis of variance, a–c: There is no difference between times with the same letter within groups.

VPT values of the test group after treatment showed a significant difference from the control group (p<0,001). Also, there was a statistical importance in before and after treatment VPT values of the test group (p<0,001). Although, no significant difference was found between the groups in SpO_2 values (p>0, 05), there was a statistically important difference between the mean pulse rate values over time (p<0,001) in both groups. A statistically significant difference was found between the pulse rate values according to the groups (p<0, 05). There was a statistically significant difference between the mean cortisol values measured at different times in both groups (p<0,001). The mean post-anaesthesia cortisol values according to the test group showed a statistically significant difference (p=0,007). There is a statistically significant difference between the means of cortisol values 10 minutes after treatment according to the test group also (p <0.001). There was no significant correlation between pulse and cortisol values (p>0.05) (Table 2).

Table 2. Examining the relationship between pulse and cortisol values

	Pulse rate		10 min. before treatment	10 min. after anesthesia	10 min.after treatment
Cortisol	10 min. before treatment	r	-0,182	-0,227	-0,295
		p	0,236	0,139	0,052
	10 min. after anesthesia	r	-0,153	0,097	0,099
		p	0,321	0,531	0,524
	10 min.after treatment	r	0,015	0,329	0,370
		p	0,924	0,154	0,114

r: Pearson's correlation coefficient

DISCUSSION

Since anxiety level cannot be fully assessed using a single method, measurement of anxiety with more than one scale is recommended. In our study, both the psychometric, projective and physiological anxiety measurement methods were used for patient selection and anxiety evaluation in groups. When the relationship between dental anxiety and age was investigated, it was reported that there was a negative correlation between them[24,25]. Our study group was composed of children 7-9 age group as the application used in our study require literacy knowledge. And there was no statistically significant difference found between the age distributions of the patients according to the groups (p=0.789). Also, CFSS-DS scores and VPT, SpO_2, pulse rate and cortisol values measured at different times between groups showed no statistically significant difference between genders (p>0.05) in this study. This result is in corroboration with the study of Coutinho [26] et al. reporting that dental anxiety is not related to gender. VPT is the most reliable measure of self-reported anxiety in children and is used in many studies[6,7]. In a study conducted in 2020, the attractiveness and comprehensibility of the projective anxiety determination methods of VPT, RMS pictorial scale and FIS for children were evaluated. In our study, there was no significant difference in VPT values between the groups at the beginning of the treatment (p>0.05). This indicates that the initial anxiety levels of the groups were similar. However, there was a significant decrease in the anxiety levels of the patients using the mobile perceived control communication system (p<0.001) at the end of the treatment, whereas a slight increase was seen in the anxiety levels of the patients in the control group. In recent studies, physiological measurement methods such as pulse rate, oxygen saturation, respiratory rate, systolic-diastolic pressure, saliva alpha-amylase level, cortisol level and total protein values give more objective results than projective and psychometric methods are preferred in determining anxiety levels [22,28-30]. Goyal et al. [30] made use of physiological parameters such as pulse rate, SpO_2 and respiratory rate in their study where they compared local anaesthesia techniques. They determined that there was an increase in physiological parameters during anaesthesia. Lundgren et al [12] used heart rate to measure anxiety level in a study they conducted in Sweden. A 2-minute dental treatment was watched in the video to two groups, with and without dentist fear and the heart rates of the individuals were recorded. The heart rate of the group with fear of dentists was found to be higher than the control group during the video. Venham and Quatrocelli[13] reported that the heart rate of children increases in the injection procedure and it is lower in the examination and filling procedures.In our study, a pulse oximeter device was used to evaluate the pulse rate and SpO_2 values of the children and the time intervals chosen were determined similarly to the literature, as they were coordinated with cortisol studies.[10,32] When the results were examined, the highest average of pulse rate values was obtained during anaesthesia in both patient groups supporting the study of Venham and Quatrocelli[13]. There is a significant difference between the means of pulse rate values between the groups (p=0.016). Although there was no significant difference between the SpO_2 values of the groups (p>0.05) a significant difference was found in the test group according to time (p=0.018). The reason for this is that SpO_2 values remain in a narrow range (96–98%) even within physiological limits and are not a parameter that can change as quickly as the pulse rate.[8] On the other hand, it is stated that with the increase of stress, the level of cortisol in the blood increases and the cortisol level can be used as a stress indicator. 9 Saliva sampling is preferred primarily for cortisol determination in paediatric patients because it is much easier and more practical than blood sampling.[10,11]. As salivary cortisol levels can be affected by systemic drugs, antidepressant drugs and foods; attention was paid to the fact that the patients did not use any medication and did not take any food in the last hour before the procedure. All patients were treated in the same clinic between 09.00-11.00 hours also. These hours are the hours when cortisol release peaks and salivary cortisol can be followed easily. Furlan et al. [27] concluded that the pulse rate and saliva biomarkers are effective in determining the level of anxiety in 84-95 months' children whereas no significant correlation was observed between them. Gadicheria et al.[8] examined the correlation between salivary cortisol and other hemodynamic parameters in adult patients who underwent tooth extraction. Salivary cortisol is a successful method in determining anxiety while there was no significant relationship between hemodynamic parameters and salivary cortisol. In this study, saliva samples were taken from the patients in three-time intervals by similar literature [10,27]. A significant difference was found between the mean cortisol values measured at different times in the test and control groups (p <0.001). The gre-

ater decrease in cortisol levels in the test group can be considered as a positive indicator of perceived control on anxiety. Similar to the study results of Furlan et al[27] and Gadicheria et al.[8], no significant correlation was found between heart rate and cortisol values in our study. In recent years, where technology has been in every aspect of our lives, new methods have been developed in dental anxiety management. There are studies in the literature investigating the effects of various devices such as three-dimensional glasses, social robots and mobile applications on dental anxiety in children[19,29]. Corah[18] conducted a signalling device for paediatric patients aged 8.5 years to reduce stress in the dental chair. As a result of this study, it was determined that patients who used the signal device were more compatible with the treatment process. Singh et al.[19] developed an electronic communication system called 'Touch's Tell'. The system, which consists of a two-piece monitor and remote control, was used during the endodontic treatment of patients with high anxiety levels. This communication device indicates five problems (pain sensation, dizziness, need to spit, TMJ pain due to mouth opening, learning when the treatment will end) that may be encountered intra-operatively. This system, which is based on the perceived control principle, has been found very successful in anxiety management. In another study evaluating the effect of Smartphone applications on dental anxiety in paediatric patients, systolic-diastolic pressure, pulse rate and oxygen saturation parameters were evaluated and it was found that all parameters decreased in the group using Smartphone applications during treatment[28]. In their study evaluating the effect of a mobile application named 'Little Lovely Dentistry' on anxiety, Elicherla et al.[22], used RMS pictorial scale and pulse rate values as evaluation parameters and a significant decrease were reported in both pulse rate and RMS values in children using the mobile application. Coutinho et al.[26] evaluated the anxiety of children between the ages of 6-10 during dental treatment by using the application named 'Hello, Dentist!'. CFSS-DS results of the patients using the application were found significantly lower. When the results of our study were evaluated, it was observed that there was a significant decrease in VPT ($p<0.001$), pulse rate ($p<0.001$) and cortisol values ($p<0.001$) of the patients using the perceived control communication system 'Dental Anxiety', compared to the control group. The data we have obtained support the results of studies examining the perceived control principle.[18,19] With the fun interface of the mobile perceived control communication system which used in our study, it has been observed that while distracting children, they also make them feel part of the treatment. Positive feedbacks were received from the patients who used the application even during the information phase of the application. So the hypothesize of the study was approved by maintaining comfort in the dental treatment of children with the use of the perceived control communication system 'Dental Anxiety'.

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