Objective and subjective measurements for assessing dental fear in adolescents: a pilot study

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KEYWORDS

Adolescents, Dental Fear, Measurement of the skin moisture, Physical parameters.

ABSTRACT

Aim *The aim of the present study was to evaluate and compare the parameters for assessing dental fear in adolescents through a multilateral approach in order to define the most eligible method for its evaluation.*
Methods *A sample of 40 adolescents (20 girls and 20 boys) were randomly selected for the study from students aged 12-14 years in the area of Debrecen (Hungary) having at least 2 decayed teeth. Subjects were administered the Corah's Dental Anxiety Scale questionnaire and asked to indicate their degree of anxiety (scores ranging from 4 to 20). Patients with a DAS score above 13 were enrolled into the anxious group. Blood pressure, pulse rate and sweating score were recorded, and salivary samples were taken to measure salivary cortisol concentration and amylase activity before and 20 minutes after treatment. Data were analyzed for statistical significance using the Chi-Square test in the case of categorical variables, while Student's t-test was applied for continuous variables. A p value less than 0.05 was considered significant.*
Results *The change of objective parameters reflected the increasing or decreasing of dental fear during treatment, so these changes were calculated and were used to compare the methods. Positive correlations were observed between the parameters considered. No significant correlation between the DAS score and results of objective methods was obtained in the present study when assessing dental fear, except for the salivary cortisol level and the sweating score. Sweating is an indirect and reliable measurement of dental fear; this was performed by measuring skin moisture based on the Corneometer® method (capacitance measurement of a dielectric medium through a skin probe).*
Conclusion *Measurement of salivary cortisol level, blood pressure, pulse rate and sweating score were valuable objective methods to measure dental stress with high fidelity; however sweating scores reasonably well reflected the parameters of the objective measurements and the use of the Corneometer® method proved reliable and comfortable for the patients.*

Introduction

Fear and anxiety is a common health care problem in adolescents, since treatment may be a stressful situation because of a variety of potentially unpleasant stimuli. Therefore, the measurement of stress is essential for the diagnosis of fear and allowing for the effective management of these subjects. Stress may be short-term (acute) or long-term (chronic). Acute stress is the reaction to an immediate threat that can be any situation experienced as a danger.

Since acute stress is a multifactorial phenomenon, it can be measured both subjectively and objectively. The subjective methods are the age-specific direct scales and indirect questionnaires completed by the parents.

The Corah's Dental Anxiety Scale (DAS) is one of the most frequently applied questionnaires for evaluation of dental anxiety (1). The questionnaires are suitable for measuring the overall fear in an appointment, but the monitoring of fear during treatment is difficult by the use of questionnaires.

In a stressful situation the salivary cortisol and amylase concentrations are elevated (2), rate of respiration, blood pressure, heart rate, muscle tension and sweat gland excretion (sweating) are increased, while skin temperature and saliva production are reduced (3). Thus the objective measurement of stress may involve the measurement of salivary cortisol concentration or alpha-amylase activity, in addition to measurement of blood pressure, pulse rate, respiratory rate, muscle tone, skin temperature and sweating.

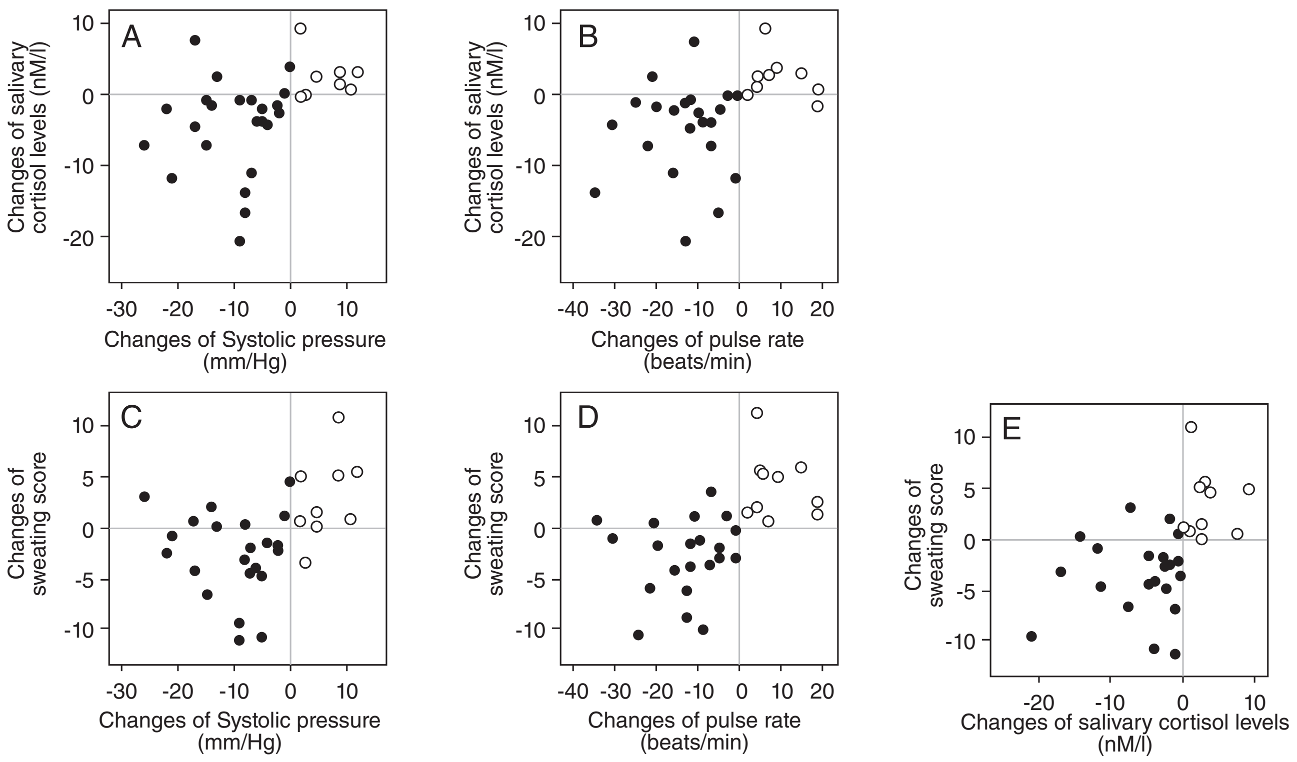

Figure 1 Correlation between changes of the systolic pressure, pulse rate, sweating score and salivary cortisol concentration during treatment. Filled symbols represent cases where the parameter displayed on the abscissa was greater after the treatment than its pre-treatment baseline value. In contrast, open symbols indicate data where the parameter displayed on the abscissa increased during the treatment.
A, B: Salivary cortisol concentration plotted against the systolic pressure and pulse rate, respectively.
C, D: Changes of sweating score as a function of the systolic pressure and pulse rate.
E: Correlation between changes of the sweating score and salivary cortisol concentration.
All the correlation shown were statistically significant ($p<0.05$)

The aim of the present study was to evaluate and compare the parameters obtained using several subjective and objective methods for assessing dental fear in adolescents. Using this multilateral approach the most suitable method to monitor fear during treatment can be identified, as a quick, easily applicable, reliable and harmless as well as comfortable for the patient.

Methods

For the study, which was approved by the Regional and Institutional Ethics Committee (Medical and Health Science Center, University of Debrecen, Debrecen, Hungary), 500 students aged 12-14 years took part on a dental screening. From the subjects having at least 2 decayed teeth, 40 adolescents (20 girls and 20 boys) were randomly selected.

The procedures and possible discomforts were thoroughly explained to the adolescents and their parents, and informed consent was obtained from the parents or guardians of the students, who served as subjects.

In the first visit the oral health status was assessed using a dental mirror, probe and standard lighting. In the second visit the patients had dental restorative treatment with local anaesthesia lasting approximately for 30 minutes. The same pediatric dentist and dental assistant treated all patients. The visits were at a fixed time between 8-9 a.m. Eight boys failed to come to the second visit.

Before the treatment the students were asked to fill the Corah's Dental Anxiety Scale questionnaire translated into Hungarian (4). Patients were asked to indicate their degree of anxiety in 4 dental treatment-related situations using a five-point scale yielding total scores ranging from 4 to 20. The cut off value for DAS was 13, above this value the patients were enrolled into the anxious group (5). Blood pressure, pulse rate and sweating were recorded, and salivary samples were taken to measure salivary cortisol concentration and amylase activity before and 20 minutes after the treatment. Blood pressure and pulse rate were measured using a Pulsoxymeter Nonin® 8500M (Nonin Medical, Plymouth, MN, USA), sweating (skin surface hydration) was measured using a Corneometer® CM 825 (Courage+Khazaka Electronics, Cologne, Germany), applied always on the same point of the forehead. For salivary cortisol and

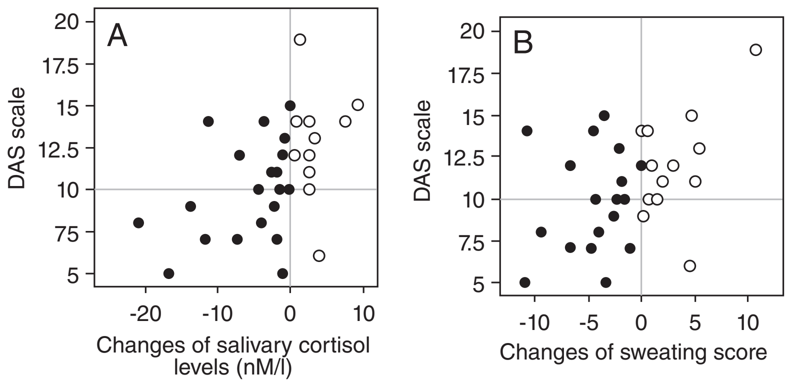

Figure 2 Correlation between changes of the salivary cortisol concentration (A), sweating score (B) and results obtained with the dental anxiety scale. Filled and open symbols represent cases where the parameter displayed on the abscissa was higher or lower, respectively, than the respective parameter before the treatment. Correlations were statistically significant (p<0.05).

Measured parameters	Pearson correlation	Significance
Salivary cortisol concentration - Systolic pressure	0.404	p=0.022*
Salivary cortisol concentration - Pulse rate	0.416	p=0.018*
Salivary cortisol concentration - Sweating score	0.476	p=0.006*
Sweating score - Pulse rate	0.555	p=0.001*
Sweating score - Systolic pressure	0.412	p=0.019*
Salivary α-amylase concentration - Systolic pressure	0.151	p=0.409
Salivary α-amylase concentration - Sweating score	0.056	p=0.763
Salivary α-amylase concentration - Pulse rate	0.112	p=0.543
Salivary α-amylase concentration - Salivary cortisol concentration	0.066	p=0.720
Dental anxiety scale - Salivary cortisol concentration	0.374	p=0.035*
Dental anxiety scale - Salivary α-amylase concentration	0.106	p=0.563
Dental anxiety scale - Sweating score	0.405	p=0.022*
Dental anxiety scale – Pulse rate	0.315	p=0.079
Dental anxiety scale – Systolic pressure	0.080	p=0.664
*p<0.05		

Table 1 - Correlation between the subjective and objective measuring methods of dental fear

amylase analysis, the patients were instructed to rinse their mouth with water, and to collect their saliva into two plastic tubes before the treatment. This protocol was repeated 20 minutes after treatment. The samples were free of any blood contamination and were stored in a freezer at -20 °C until used. After being thawed the samples were centrifuged for 10 minutes at 1500 g to obtain clear supernatant (6). After 10 times dilution with physiological saline, the amylase activity was measured using an enzymatic colorimetric EPS-2 method with Cobas Integra-800 analyzer (Roche Ltd, Mannheim, Germany). Salivary cortisol levels in the undiluted samples were measured by means of a competitive radioimmunoassay kit (CORT-CT2, CIS bio International, Gif-sur-Yvette, France). Analyses were performed in duplicate serial sets: 150 µl of standard, control and salivary samples were dispensed, and 500 µl of 125 iodine-cortisol was added into each coated tube. After incubation at 37 °C for 30 minutes, the supernatant was decanted, and the remaining radioactivity bound to the tubes was measured by a gamma scintillation counter calibrated for 125 Iodine. The reference interval was 6.2-38.1 nmol/l (7). The intraassay coefficient of variation (CV) of salivary cortisol concentration and amylase activity determination was 7.06% and 1.4%, respectively. Arithmetic mean ± standard deviation of the mean (SD) was determined. Data were analyzed for statistical significance using Chi-Square test in the case of categorical variables, while Student's t-test was applied for continuous variables. A p value less than 0.05 was considered significant.

Results

In the present study the average DAS score was 10.84±3.25. The DAS did not show any significant difference between genders, so the 32 students were considered one group statistically. There were 9 fearful students (28%), having DAS scores of 13 or higher. The change of objective parameters reflected the

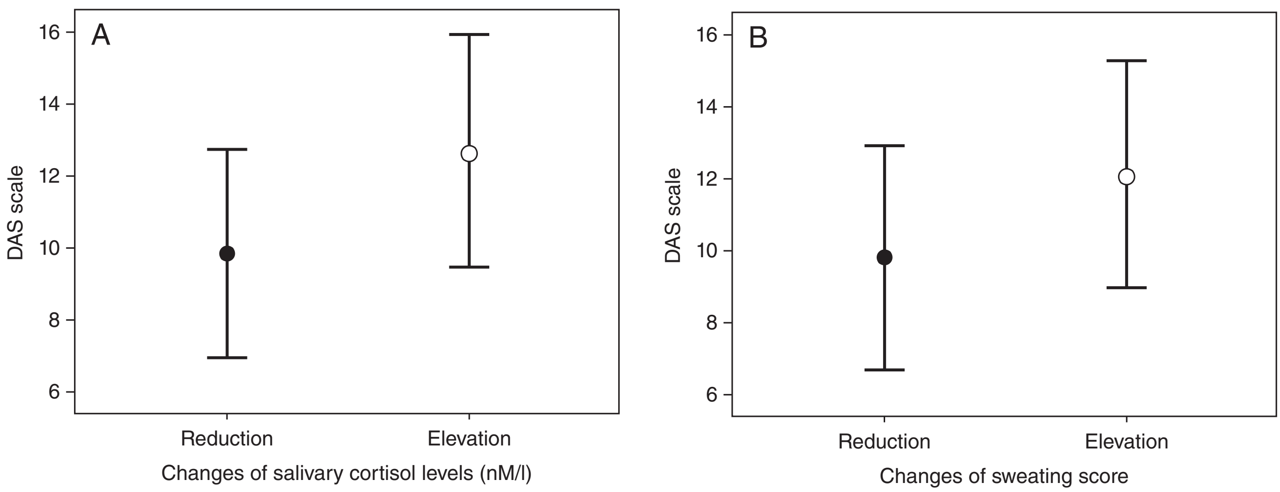

Figure 3 Patients were divided into two groups according to changes (elevation or reduction) in salivary cortisol concentration (A) and sweating score (B) during treatment, and mean DAS scores of the two groups were compared. Symbols and bars denote arithmetic means ± S.D. values. Differences were statistically significant ($p<0.05$) in both cases

increase or decrease of dental fear during treatment, so these changes were calculated and were used to compare the methods.

Positive correlations were observed between the change of systolic pressure, pulse rate, sweating scores and salivary cortisol concentration (Figure 1). The change of salivary cortisol concentration significantly correlated with the change of systolic pressure ($p=0.022$) (Figure 1A) and pulse rate ($p=0.018$) (Figure 1B). Similarly, significant correlation was obtained between the change of systolic pressure and sweating score ($p=0.0019$) (Figure 1C) and also between the change of pulse rate and sweating score ($p=0.0001$) (Figure 1D). Finally, the change of sweating score showed significant correlation with the change of salivary cortisol level ($p=0.006$) (Figure 1E). However, the change of salivary alpha-amylase activity failed to correlate significantly with any of the other parameters studied, i.e. with systolic pressure ($p=0.409$), pulse rate ($p=0.543$), sweating score ($p=0.763$), or salivary cortisol concentration ($p=0.720$). From the determined objective parameters only the change of salivary cortisol concentration ($p=0.0035$) and sweating score ($p=0.0022$) showed significant correlation with the score of the dental anxiety scale (Figure 2A, 2B). Surprisingly, the change of pulse rate ($p=0.079$), systolic pressure ($p=0.664$) and salivary alpha-amylase concentration ($p=0.563$) showed no correlation with dental anxiety scale. Significances of correlation are summarized in Table 1 for the sake of better comparison. According to our results, the students can be divided into two groups. In the first one, systolic pressure, pulse rate, sweating score and salivary cortisol concentration decreased after the treatment compared to baseline. In the second group these values increased after treatment. Those adolescents, whose salivary cortisol concentration had increased after treatment, had significantly higher DAS scores, compared to those showing decreased or unchanged salivary cortisol levels after treatment ($p=0.02$, Figure 3A). Similarly, increased sweating scores were also associated with significantly higher DAS values ($p=0.04$) (Figure 3B).

Discussion and conclusion

Several techniques are currently available for the measurement of fear, including subjective and objective methods. Measurements of salivary cortisol concentration, salivary alpha-amylase activity, heart rate, and rate of respiration, blood pressure, tension of skeletal muscles, skin temperature, and sweating are considered objective, while the subjective methods are based on direct and indirect questionnaires. The stress response is controlled by two primary neuroendocrine systems. In the first line there is an activation of the autonomic sympathetic nervous system resulting in release of catecholamines from the adrenal medulla. The second line involves the increased secretion of glucocorticoid hormones (mainly cortisol) from the adrenal cortex due to activation of the limbic hypothalamic-pituitary-adrenal axis. Concentration of cortisol in the serum, saliva, or urine can easily be determined, and is frequently applied as a peripheral indicator of hypothalamic neural activity (8).

The determination of salivary cortisol is considered superior to the measurements from other sources (i.e. plasma or urine), because the technique is non-invasive and collection of the sample is easy, especially in children (9). Salivary cortisol increases with dental stress, strongly correlate with cortisol concentration in blood (10). Salivary cortisol concentration is a valid measurement technique of fear. Corah's Dental

Anxiety Scale is suitable to measure the overall dental fear. In the present study the mean DAS score was 10.84±3.25, a value comparable to data (10.7±3.7) previously reported by Fábián et al. (11), who studied dental fear scores in Hungarian primary school children, although it was higher than data (8.4-9.3) obtained by others (12). No significant correlation between the DAS score and results of objective methods was obtained in the present study when assessing dental fear, except for the salivary cortisol level and the sweating score. Earlier studies produced conflicting results.

In agreement with our findings, several investigators observed significant correlation between DAS score and cortisol concentration (13, 14), although Brand (15) failed to explore the correlation between these variables. Furthermore, similarly to the results of Krueger et al. (16), we found that patients with high salivary cortisol level were more aroused and anxious and had significantly higher DAS scores, than those with decreased cortisol concentration.

Based on previous results, salivary alpha-amylase concentrations were believed to be good predictors of plasma catecholamine levels (particularly in the case of norepinephrine), since they were shown to highly correlate with changes in the norepinephrine concentrations in response to stress (2). Thus salivary alpha-amylase was supposed to be a useful indicator of stress, however, several factors (like smoking, caffeine, tea, as well as the time elapsed from meals) are known to induce instability of alpha-amylase levels (6, 17). Indeed, the vast majority of the most recent studies, in line with our present results, showed marked individual differences in alpha-amylase, and these values failed to correlate with salivary cortisol concentration during stress (2,18). Today it is a matter of debate whether salivary alpha-amylase may be an indicator of sympathetic activity, or not. Our results, in accordance with those of Rohleder et al. (2), indicate that salivary alpha-amylase is not a specific marker of stress. Sweating is an indirect and reliable measurement of dental fear (19, 20). Sweating is triggered (among other stimuli) by stress, fear and anxiety. Measurement of the skin moisture is based on the internationally recognized Corneometer® method. The measuring principle of the Corneometer® is based on the capacitance measurement of a dielectric medium. Any change in the dielectric constant due to skin surface hydration variation alters the capacitance as detected by a precision measuring capacitor. With the probe of the Corneometer® CM 825 single measurements as well as continuous monitoring are equally feasible. The software running under Windows helps in all fields of application. The data can be stored, printed out and exported for statistical use. In the present study sweating scores reasonably well reflected the parameters of the objective measurements.

According to our results, measurement of salivary cortisol level, blood pressure, pulse rate and sweating score were valuable objective methods to measure dental stress with high fidelity. The measurement of salivary cortisol concentration is time consuming and restricted to specific laboratory background. Furthermore, the measurement of salivary cortisol concentration and the subjective questionnaires are not suitable to monitor the fear during the treatment. Monitoring of fear can help us to understand which the most fearful point is during the treatment, and this is essential to help the patient to get through fear and anxiety. The use of Pulsoxymeter Nonin® 8500M and Corneometer® CM 825 can be effective to measure dental fear not just before and after the treatment, but also during it. Although the use of Pulsoxymeter is a simple method, the adolescents are cognizant of the measurement, and felt this method uncomfortable. On the contrary, the application of Corneometer® CM 825 can help us to measure dental fear within 1 second without causing any discomfort in patients. They do not even realize when the measurement is taken, so Corneometer® monitoring is quite simple during the treatment, the dental assistant can do it as well. Although this study was made in dentistry, Corneometer® CM 825 can also be used in general practice, whenever it is necessary to monitor the change of anxiety during any type of treatments.

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