Factors affecting psychological stress in children who cooperate with dental treatment: a pilot study

**ABSTRACT**

**Aim** Few studies have examined psychological stress and personal anxiety in children exhibiting cooperative behaviour during dental treatment. We assessed psychological stress and personal anxiety during dental treatment in cooperative children, and investigated the influence of various factors.

**Materials and methods** We measured pre- and post-treatment salivary alpha amylase (sAA) levels of 28 children aged 8–13 years and their parents. Children completed the State-Trait Anxiety Inventory for Children (STAIC); their parents completed the STAI. The IA group included children whose sAA levels increased >10%, whereas the DA group included children whose sAA levels decreased >10%. We used regression models to calculate the power of variables to predict children’s psychological stress.

**Results** The mean anxiety trait score in the IA group was significantly higher than in the DA group (t-test, P = 0.021). For children with higher STAIC Trait scores, the OR for increasing sAA was 1.16 (95% CI [1.02–1.31]). Parental or treatment factors did not significantly contribute to incremental sAA levels in children.

**Conclusion** Well-behaved children with high anxiety traits may experience high stress levels during dental treatment; however, parental and dental treatment factors may not affect psychological stress in these children.

**Keywords** Children; Dental anxiety; Fear; Parents; Salivary alpha amylases.

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**Introduction**

Most patients consider dental treatment to be an unpleasant experience. Paediatric patients, in particular, often exhibit uncooperative behaviour during dental procedures. The prevalence of dental fear among children is 5–20%, with a mean prevalence of 11% [Klingberg and Broberg, 2007]. Although many case-controlled studies have assessed dental fear in uncooperative paediatric patients [Arnrup et al., 2007; Gustafsson et al., 2010], few studies have focused on psychological stress and personal anxiety in children who exhibit cooperative behaviour during dental treatment. Eli et al. [2008] suggested that many dentists are not sufficiently aware of the stress that dental procedures can cause, or its possible effect on their patients. Moreover, few studies have considered the psychological stress and personal anxiety experienced by parents during their children’s dental treatment and the possible influence on their children’s stress and anxiety.

Children’s responses to dental treatment are typically measured based on self-reported questionnaires, external behavioural responses, and internal physiological changes. Although self-reported questionnaires are frequently used to assess children’s personal anxiety or dental fear [Spielberger et al., 1973; Cuthbert and Melamed, 1982], the correlation of these questionnaires with other physiological indices is unclear. External behavioural responses are generally assessed using behavioural scales such as the Frankl Behaviour Rating Scale (FBRs) [Frankl et al., 1962]. Internal physiological changes are typically evaluated by measuring heart rate and blood pressure and quantifying biomarkers in the blood, urine, or saliva during a procedure [Miller et al., 1995]. However, the use of a syringe to collect blood samples can also cause physiological and psychological stress for subjects. Thus, the issue of whether quantifying biomarkers in blood can precisely evaluate stress levels remains controversial. In addition, urine analysis for children requires cooperation from their guardians.

Saliva sampling, a non-invasive procedure, makes multiple sampling easy, and does not cause distress to the subjects. Alpha amylase, which is one of the major salivary enzymes in humans, is secreted in response to sympathetic stimuli, and increases during distress [Chatterton et al., 1996]. Thus, we measured patient levels of salivary alpha amylase (sAA), since it indicates an individual’s internal physiological state, and can be used as an index of psychological stress. We previously investigated the reliability of measuring sAA level as a stress response biomarker in the clinical setting, and have indicated its reliability [Aoyagi et al., 2011; Karibe et al., 2011].

The aims of this pilot study were: to assess levels of psychological stress and personal anxiety during paediatric dental procedures in cooperative children; and to compare cooperative children who showed
psychological stress during dental procedures and those who did not in terms of dental fear, personal anxiety, parental factors, and dental treatment factors.

Materials and methods

Participants
The study population included 54 children (28 girls, 26 boys; mean age, 8.6 years) who visited paediatric dental clinics in the Tokyo, Japan area and their accompanying parents. Children with abnormal psychological development, developmental retardation, pervasive developmental disorder, severe sensory-motor impairment, and salivary gland disorder were not included. We also excluded accompanying parents if they had salivary gland disorders, mental disorders, developmental illnesses, or were using any medication that could influence salivation and/or autonomic nervous system activity. The inclusion criteria required that the children were between the ages of 8 and 13, had previously visited a dental clinic and received dental treatment, and had not been diagnosed with an acute oral disease. After fully explaining the purpose of the study to the children and their parents, we obtained written consent to participate. This study was approved by the Ethical Review Board of the School of Life Dentistry, Nippon Dental University, Japan.

All children received a comprehensive dental examination routinely provided in paediatric dental clinics by one of seven paediatric dentists, including four females and three males between 33 and 68 years of age (average age = 50.9 years) who were certified by the Japanese Society of Paediatric Dentistry. Before the initial consultation, all parents completed several forms and provided demographic and health history information. Before the comprehensive examination, we recorded a detailed history of chief complaint(s), associated symptoms, and previous treatments received for the chief complaint(s).

Study design and procedures
We assessed psychological stress levels in children and their parents by measured sAA levels before and immediately after dental treatment. To assess personal anxiety levels, the children completed the State-Trait Anxiety Inventory for Children—Trait (STAIC-T) before treatment, and the STAIC–State (STAIC-S) before and after treatment (pre-STAIC-S and post-STAIC-S) [Spielberger et al., 1973]. Parents completed the State-Trait Anxiety Inventory—Trait (STAI-T) before their children’s treatment, and the STAI–State (STAI-S) before and after their children’s treatment (pre-STAI-S and post-STAI-S) [Spielberger et al., 1970]. We assessed dental fear in the children and their parents using the Children’s Fear Survey Schedule—Dental Subscale (CFSS-DS) [Cuthbert and Melamed, 1982] and the Dental Fear Survey (DFS) [Kleinknecht et al., 1973]. All psychometric tests used in this study were Japanese versions, and the validity and reliability of these tests have been verified [Nakazato and Shimonaka, 1989; Nakai et al., 2005; Yoshida et al., 2009].

We recorded the children’s anxiety levels, dental fear, and sAA levels before treatment in the waiting room, and the sAA levels after treatment in the treatment room. We recorded the same parameters for parents in the waiting room. We also documented specific information related to each dental treatment, including the number of dental visits, time slot of the dental visit, treatment time, age/gender of the dentist, presence of the parent in the treatment room, course of dental treatment, use of local anaesthesia, use of dental drill, and external behavioural responses of the children. Two examiners assessed the external behavioural response of each child during the dental procedure using the FBRS [Frankl et al., 1962].

Measurement of sAA levels
In this study, we measured sAA levels using a hand-held sAA monitor (Nipro; Osaka, Japan). We collected saliva from participants using a disposable test strip positioned under the tongue for 30 s. We then inserted the test strip into the monitor and recorded the sAA level. The hand-held monitor employs a dry-chemical system that enables measurement of sAA levels with a high degree of accuracy [Aoyagi et al., 2011]. Previous studies have shown extensive differences in sAA levels among individuals [Karibe et al., 2011]; therefore, we calculated the rate of change in sAA levels between pre- and post-treatment in order to compare this biomarker.

Classification of the groups
Our previous study [Aoyagi et al., 2011] showed that the mean coefficient of variance for the sAA measurement was 7.2%. Thus, we set the cut-off point for the rate of change in sAA levels between pre- and post-treatment as ±10%. We divided children into the following two groups.

1. The increased amylase (IA) group, consisting of children whose rate of change in sAA level increased more than 10% during dental treatment.
2. The decreased amylase (DA) group, consisting of children whose rate of change in sAA level decreased more than 10% during dental treatment.

Parents were also divided into these two groups based on their children’s rate of change in sAA level, not their own rate of change in sAA level.

Statistical analyses
We evaluated differences between the groups using the Student’s t-test, Chi-square test, and Fisher’s exact test. Before performing these comparisons, we assessed gender-based differences and variability using the Student’s t-test with a significance level of P ≤ 0.05.
We used a logistic regression model to estimate the odds ratio (OR) and 95% confidence interval (CI) for the predictive value of psychological stress during the dental procedure. Variables were considered for the multivariate models if their univariate P-values were <0.10. We performed all analyses using SPSS 15.0J for Windows (SPSS Japan Inc., Tokyo, Japan).

Results

Of the 54 children who were enrolled, 28 were classified into 2 groups: the IA group (n = 14) and the DA group (n = 14). The remaining 26 children were excluded; 16 children were less than 8 years of age; 2 children indicated uncooperative behavior with FBRS scores of 2 (negative) or 1 (definitely negative) during the dental treatment; 5 children showed less than ±10% of rate of change in sAA levels; and 3 children had missing items on the self-reported questionnaire. There were no significant gender-based differences in children with respect to age, treatment time, number of dental visits, sAA levels, anxiety levels, and dental fear levels. Hence, we did not perform any gender-based analysis for the children. Table 1 shows the demographics of the study subjects, categorised by the 2 groups. On average, children in the IA group showed a 95% increase in sAA during dental treatment, and children in the DA group showed a 33% decrease in sAA. However, no significant differences in age or gender ratio were found between the 2 groups. Table 2 presents the mean scores for dental fear and personal anxiety experienced by the subjects in each group. The table also presents the age and the rate of change of sAA in parents. Children in the IA group scored higher for dental fear compared to those in the DA group, but the difference was not statistically significant. The mean score for the anxiety trait in the IA group was significantly higher than that in the DA group (P = 0.021). Of the 14 parents in the IA group, 13 were mothers and 1 was a father. The 14 parents in the DA group were all mothers. Parents in the IA group showed a 5% increase in sAA during their children’s dental treatment, and parents in the DA group showed a 29% decrease in sAA, but the difference was not statistically significant. In contrast to the children, parents in the DA group scored higher for dental fear than those in the IA group, but not significantly.

All 28 children received bloodless dental treatment without local anaesthesia. The 2 examiners assessed children as having FBRS scores of 3 (positive) or 4 (definitely positive), with 100% agreement, indicating that all children were well-behaved during their dental treatments. Table 3 shows a comparison of dental treatments between the 2 groups. The dental treatments included orthodontic treatment, dental prophylaxis, topical fluoride treatment, composite resin restorations, and application of pit and fissure sealants. The prevalence of each type of dental treatment did not differ significantly between the 2 groups.

Tables 4 and 5 present a comparison of dental treatment factors between the 2 groups. There were

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Sample characteristics in the 2 groups (mean ± SD).</th>
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<tbody>
<tr>
<td></td>
<td>IA GROUP(a) (N = 14)</td>
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<tr>
<td>sAA change rate (%)</td>
<td>95.0 ± 95.2</td>
</tr>
<tr>
<td>Age (years)</td>
<td>9.6 ± 1.7</td>
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<tr>
<td>Gender ratio (f/m)</td>
<td>6/8</td>
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</tbody>
</table>

\(a\) Children whose rate of change in salivary alpha amylase (sAA) level increased more than 10% during dental treatment.
\(b\) Children whose rate of change in sAA level decreased more than 10% during dental treatment.
\(†\) t-test and Fisher’s exact test

<table>
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<th>TABLE 2</th>
<th>Comparison of individual and parental factors between the 2 groups (mean ± SD).</th>
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<tbody>
<tr>
<td></td>
<td>IA GROUP (N = 14)</td>
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<tr>
<td>Children</td>
<td></td>
</tr>
<tr>
<td>CFSS-D5(a) score</td>
<td>29.1 ± 11.4</td>
</tr>
<tr>
<td>STAIC-T(b) score</td>
<td>37.8 ± 9.3</td>
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<tr>
<td>Pre-STAIC-S(c) score</td>
<td>28.1 ± 10.3</td>
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<tr>
<td>Post-STAIC-S(d) score</td>
<td>25.7 ± 8.8</td>
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<tr>
<td>Parents</td>
<td></td>
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<tr>
<td>Age (years)</td>
<td>43.4 ± 4.0</td>
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<tr>
<td>Rate of change of sAA(e) (%)</td>
<td>4.5 ± 74.2</td>
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<tr>
<td>DFS(f) score</td>
<td>36.1 ± 14.4</td>
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<tr>
<td>STAI-T(g) score</td>
<td>42.4 ± 12.9</td>
</tr>
<tr>
<td>Pre-STAI-S(h) score</td>
<td>35.4 ± 7.2</td>
</tr>
<tr>
<td>Post-STAI-S(i) score</td>
<td>34.6 ± 9.1</td>
</tr>
</tbody>
</table>

\(a\) Children’s Fear Survey Schedule – Dental Subscale
\(b\) State-Trait Anxiety Inventory for Children – Trait
\(c\) Pre-treatment State-Trait Anxiety Inventory for Children – State
\(d\) Post-treatment State-Trait Anxiety Inventory for Children – State
\(e\) salivary alpha amylase
\(f\) Dental Fear Survey
\(g\) State-Trait Anxiety Inventory – Trait
\(h\) Pre-treatment State-Trait Anxiety Inventory – State
\(i\) Post-treatment State-Trait Anxiety Inventory – State
\(†\) t-test
no significant differences in terms of the number of dental visits, treatment time, and age of the dentist between the groups. With regard to the various dental treatment factors, time slot of dental visit, gender of dentist, presence of parent in the treatment room, 2 or more dental treatments at one visit, use of dental drill, and positive behaviour rating, no significant differences were found between the groups.

Table 6 presents the results of the logistic regression for contributing risk factors for increased sAA during dental treatment. For children with higher STAIC-T scores, the odds ratio for increased sAA during dental treatment was 1.16 (95% CI [1.02–1.31]). However, no other factors significantly predicted the value of psychological stress during the dental procedure.

### Discussion

We assessed levels of psychological stress and anxiety states before and after paediatric dental procedures, as well as the levels of dental fear and anxiety traits in 8 to 13-year-old children and their parents. All of the children adapted to their dental treatments, and the mean anxiety state score for children decreased after dental treatment in both groups. However, in the IA group, 9 out of 14 children indicated more than a 50% increase in sAA level during their dental procedures. This indicates that a psychological stress response is present in some children who are cooperative during dental procedures.

Brand [1999] reported remarkable individual differences in mean cardiovascular responses during comparable dental treatment. Namely, some patients did not show any change in heart rate or blood pressure (non-reactors), some showed a limited increase in these parameters (reactors), and some patients showed a very marked increase (hyper-reactors). Such results suggest that there are significant individual variations in how people respond to stressful situations. Dentists tend to believe that children who are cooperative during dental procedures do not experience any psychological stress during treatment. However, the present data suggest that some paediatric patients do experience
psychological stress despite being cooperative during dental procedures. Therefore, these results highlight the necessity for dentists to reconsider their approach to treating such children.

Previous studies suggested that parental dental fear was positively correlated with the level of dental fear in their children [Rantavuori et al., 2009; Lee et al., 2008]. In our study, the mean CFSS-DS scores in the IA and DA groups were not significantly different and were similar to values reported as normal for Japanese children (27.7 ± 10.6) [Nakai et al., 2005]. Moreover, the mean DFS score for parents in the DA group tended to be higher than those in the IA group. A recent study indicated that parents and their 11 to 16-year-old children could not recognise each other’s dental fear [Luoto et al., 2010]. A structured review confirmed a relationship between parental and child dental fear, but this relationship was most evident in children under 9 years of age [Themessl-Huber et al., 2010]. The present study did not include children under 8 years old, as the subjects were required to complete the psychometric tests by themselves. This tactic may have minimised parental influence on their children’s ratings of dental fear.

Despite the fact that parents in the DA group tended to show higher levels of dental fear, they showed a decreased rate of change in sAA (-29.1%) compared to the parents in the IA group (4.5%) during dental treatment. Furthermore, scores for the DFS, STAI-T, pre-STAI-S, and post-STAI-S, and the rate of change in sAA for parents were not significantly different between the 2 groups. These results may indicate that parental dental fear, anxiety, or psychological stress do not affect the psychological stress in their children.

An experimental study reported that physiological responses to fear-inducing conditions reflect the degree of dental fear in patients [Lundgren et al., 2001]. As mentioned before, all of the children in our study adapted to their dental treatments, and mean scores for the CFSS-DS in both groups were not significantly different. Unexpectedly, these results may indicate that dental fear in children does not affect their psychological stress during dental treatment. However, the mean STAIC-T score in the IA group was significantly higher than that in the DA group. The OR and 95% CI also showed that the anxiety trait in children was a significant contributing risk factor for assignment to the IA group. A recent study indicated that development of dental anxiety is not necessarily associated with the anxiety trait [Fuentes et al., 2009]. Thus, from these results, the anxiety trait in children may influence their psychological stress during dental procedures more than their dental fear.

In our study, the children's dental treatments did not differ statistically between the 2 groups. Miller et al. [1995] investigated the adrenal stress response to various dental treatments in healthy adults. They reported that cortisol levels measured at the start of a dental procedure decreased by the end in patients undergoing static dental procedures such as routine examinations. Conversely, cortisol levels following extractions were elevated compared to baseline cortisol recordings [Miller et al., 1995]. Children who received invasive dental treatment with use of local anaesthesia were not included in our analysis. Even so, children in the IA group showed increased sAA levels during bloodless dental treatment. Thus, the present findings are not consistent with the previous adult study, but show individual variations in stress response.

After comparing treatment factors between the 2 groups and the results of the logistic regression model, we found that treatment factors such as number of dental visits, treatment time, age of the dentist, or parental presence did not contribute to psychological stress during dental treatment. However, we found a significant relationship between the children's anxiety traits and psychological stress during dental treatment. A recent study reported that behaviour management problems in 2 to 8-year-old children during dental treatment was associated with a child’s younger age, negative guardian expectations, presence of toothache, and presence of anxiety [Xia et al., 2011]. Holst et al. [1988] reported 3 non-dental predictors of behaviour management problems in 3 to 16-year-old children: problems during medical visits, dental fear in the parent, and anxiety when meeting unfamiliar people. These findings partly support our results. Future studies involving more social/parental factors are necessary to elucidate other factors contributing to psychological stress.

When interpreting the present study, several limitations should be considered. First, the 7 dentists who participated in this study were certified paediatric dentists. Paediatric dentists are better trained to treat children with behaviour management challenges than are general dentists. This might have influenced the children's responses while undergoing dental treatments. Future studies should include general dentists to determine if children are differentially affected by their dentist’s level of training in working with children. In addition, a larger cohort of cooperative children undergoing dental treatment and a larger cohort of paediatric dentists are required to validate these results. Furthermore, as most of the parents in our study were women, our findings might not be broadly applicable to examining parental responses to paediatric dental procedures as we primarily measured maternal stress responses. In the future, more paediatric patients and male parents could be included in studies to explore psychological aspects and associative relationships related to paediatric dental treatment.

Conclusions

- Some children experience psychological stress
during dental procedures even when the stress is not manifest behaviourally.
• Eight- to thirteen-year-old well-behaved children with high anxiety trait scores may experience high levels of stress during dental procedures; however, parental and dental treatment factors may not affect psychological stress in these children.
• In order to establish a relationship of mutual trust with children undergoing dental treatment, paediatric dentists should consider the relationship between personal anxiety and psychological stress that can occur in all patients, both cooperative and uncooperative, during paediatric dental procedures.

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