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Effect of oral hygiene instruction and scaling on oral malodour in a population of Turkish children with gingival inflammation

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Summary. *Aim.* Oral malodour affects a large proportion of the population, and may cause a significant social or psychological handicap to those suffering from it. The condition has a positive correlation with the accumulation of bacterial plaque in the oral cavity. The aim of the present study was twofold: first, to determine whether oral malodour and periodontal disease parameters are associated with one another in 150 Turkish subjects (mean age ± SD = 9·1 ± 2·7 years; age range = 7–12 years); and secondly, to investigate the impact of oral hygiene instruction and scaling on oral malodour.
Design. The parameters measured included whole-mouth odour judge scoring, halimeter measurements, saliva pH scores, gingival index, plaque index, and probing depth before and after the treatment procedures.
Results. Odour judge scores were significantly associated with halimeter findings. However, gingival index, plaque index and probing depth were significantly associated with odour judge scores and halimeter scores. The statistical analysis revealed that periodontal treatments caused a significant reduction ($P < 0{\cdot}001$) in volatile sulphur compound formation.
Conclusion. These results suggest that, in the population studied, periodontal health and oral malodour are associated with one another. Oral malodour levels were significantly reduced after treating gingival inflammation. Thus, in order to avoid oral malodour in children, oral care should not be neglected.

Introduction

Oral malodour affects a large proportion of the population, and may cause a significant social or psychological handicap for those affected by it [1]. There are various compounds which produce unpleasant smells in the human oral environment, such as hydrogen sulphide, methanethiol, dimethylsulphide, *n*-dodecanol, *n*-tetradecanol, phenol, indole, diphenylamine, pyridine and others [2]. Oral malodour in particular originates within the oral cavity itself because of the degradation of proteins by specific bacteria, with the consequent production of volatile sulphur compounds (VSCs) [3]. Oral bacteria found on the tongue and in the supra- and subgingival plaques produce these compounds. Ratcliff and Johnson [4] have reported the potential importance of VSCs in the transition of periodontal tissues from clinical health to gingivitis and then to periodontitis. Patients with periodontal disease frequently suffer from unpleasant mouth odour associated with accumulated debris and an increased rate of putrefaction [5]. Periodontal conditions which favour the bacterial growth and retention of debris contribute to oral malodour. Interproximal spaces and periodontal pockets are conducive to anaerobic growth and microenvironments for the production of VSCs. These subgingival and interproximal periodontal malodours make a significant contribution to overall oral malodour [6]. The association among periodontal pathogenic microorganisms, periodontal disease and oral malodour has been strongly implicated, but not proven. Although oral malodour is probably not caused by periodontal disease, there is ample evidence to suggest that periodontal disease increases the severity of oral malodour [7], and periodontal diseases also contribute to an increased tongue coating, with higher production of VSCs [8,9].

The aim of this study was to confirm the relationships between oral malodour and gingival inflammation,

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and to investigate whether treating gingival inflammation with nonsurgical periodontal treatment procedures can decrease the effect of oral malodour. The authors used a study of population of paediatric patients because severe oral malodour can cause future physiological problems and overall physiological defects are more common in childhood.

Subjects and methods

Study population and clinical parameters of periodontal conditions

The study population consisted of 150 patients with an average age of 9·1 ± 2·7 years (male:female ratio = 79:71) who were referred to the Periodontology Clinic at the Faculty of Dentistry, Atatürk University, Erzurum, Turkey, by pedodontists because of these children's poor oral hygiene and oral malodour. Each participant completed a medical and dental history, and signed an informed consent document for this study. The inclusion criteria were that the subjects should be aged between 7 and 12 years of age, and dentate. Both males and females were included. Subjects who had received antibiotic treatments within the past 3 months, who showed evidence of any systemic disease that could influence oral malodour, who had an estimated organoleptic rating (OR) of 0–1 (described below), who had no detectable VSCs, who had clearly diagnosed pseudohalitosis/halitophobia, who presented a probing depth of > 3 mm, or who had less than 20 natural teeth were excluded from this study.

Subjects and parents were informed about the study, and were required to fill out a consent form and a medical history questionnaire. This study was also approved by the ethics review board of Atatürk University.

Clinical evaluation

Clinical evaluation of periodontal status was performed before and after treatment, using the plaque index (PI) [10], the gingival index (GI) [11], the periodontal probing depths (PPDs) of the teeth and a pH meter (Inolab pH-Meter Level 2, Wissenschaftlich-Technische Werkstätten, Weilheim, Germany) to determine the salivary pH of the patients. The PI, GI and PPD scores were recorded on four tooth surfaces (i.e. mesial, distal, buccal and lingual) for all teeth and the quantity of supragingival plaque was assessed at the cervical area of every tooth. The scores for the PI were defined as follows: (0) no plaque in the gingival area; (1) a film of plaque adhering to the free gingival margin and adjacent area of the tooth – the plaque can only be recognized by running a probe across the tooth surface; (2) moderate accumulation of soft deposits within the gingival pocket, and on the gingival margin and/or adjacent tooth surface that can be seen by the naked eye; and (3) an abundance of soft matter within the gingival pocket, and/or on the gingival margin and adjacent tooth surface. The scores for the GI were defined as follows: (0) normal gingiva; (1) mild inflammation, slight change in colour, slight oedema, but no bleeding on palpation; (2) moderate inflammation, redness, oedema and glazing, and bleeding on probing; and (3) severe inflammation, marked redness and oedema, ulceration, and tendency to spontaneous bleeding. The numerical scores of the PI and GI were obtained according to the formula:

Score per person = sum of individual scores/number of teeth present for each patient

Subsequently, the group score was calculated by adding together the individual scores and dividing the number of patients included by the total.

Testing of oral malodour

Organoleptic assessment. The organoleptic method was used as described by Rosenberg [12]. Subjects were asked to exhale briefly through their mouth towards the nose of the organoleptic judge. In this organoleptic evaluation, the examiner is positioned 10 cm from the subject, and instructs the subject to keep her or his mouth closed for a period of 2 min and to breathe through her or his nose. If the odour emanated from the nose while the mouth was closed, the odour was accepted as existing for systemic reasons and the patient was excluded from the study. Individuals were included from the study if the odour was only present when the mouth was open. Malodour was graded on a scale of 0–5 as follows [12,13], allowing for scoring between the integers: (0) no appreciable malodour; (1) barely noticeable malodour; (2) slight but clearly noticeable malodour; (3) moderate malodour; (4) strong malodour; and (5) extremely strong malodour.

Halimeter (volatile sulphide monitor). Volatile sulphides were tested using a halimeter (Interscan,

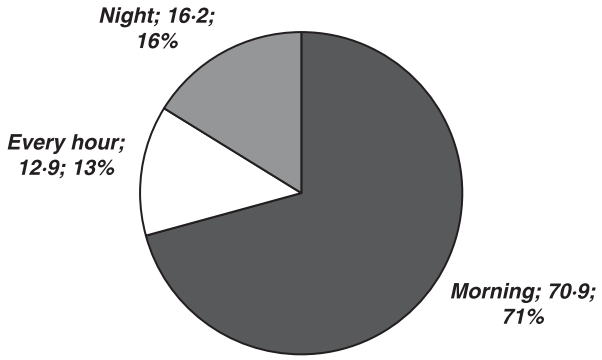

Fig. 1. Distribution of the times at which the parents detected their children's oral malodour.

Chatsworth, CA, USA) as previously reported [12,13]. A plastic straw connected to the monitor inlet via tubing was inserted approximately 4 cm into the partially open mouth of the subject while the subject inhaled and exhaled through the nose. Subjects were asked to refrain from speaking for at least 1 min prior to the test. Measurements were repeated three times and the peak parts per billion value was recorded for each trial.

Assessment of oral malodour. Organoleptic rating measurements or VSC measurements were performed on subjects at least 1 h after any oral activity, such as eating, drinking, smoking and any oral hygiene habits. At the beginning of the experimental period, the data were recorded before the treatment at 0800 h. The measurement was repeated after the end of the periodontal treatments for each subject. Before the measurements, the volunteers refrained from toothbrushing, drinking, eating, gargling and using scented cosmetic products [14].

Treatment procedures

Routine oral care procedures and periodontal treatment methods were employed to tackle gingivitis. Patients were given instruction in oral hygiene and the subsequent initial preparations included scaling. During their instruction in oral hygiene, patients were taught how to brush their teeth correctly (at least twice a day), and how to clean the surface of their tongues using a toothbrush. The subjects and their parents were also informed about the importance of cleaning the surface of the tongue to protect against oral malodour. During the lessons in oral hygiene, mouth rinse had not been given to the patients so as not to affect the oral malodour measurements. The periodontal treatments took approximately 3 weeks, and all patients received instruction and were monitored for 2 weeks by a periodontist (C.K.) to ensure adequate oral hygiene was maintained.

Statistical analysis was performed using a one-sample *t*-test.

Results

The subjects of this study were 150 children with oral malodour and periodontal diseases. The distribution of the times at which the patients exhibited oral malodour is shown in Fig. 1. Most parents detected their children's oral malodour in the morning (70·9%). At the beginning of this study, there was no significant difference in the periodontal condition of the 150 participants, meaning that their PI, GI and PPD scores were similar prior to the therapy. Treatment scores changed significantly between the beginning and end of the study ($P < 0{\cdot}001$) (Table 1). However, it was also determined that periodontal treatment procedures increased the subjects' oral pH, and this was found to be statistically significant ($P < 0{\cdot}001$) (Table 2).

Improvements in numerical evaluations are shown in Table 3, and the distribution of subjective improvement is shown in Table 4. The type of improvement experienced by each subject was investigated once all the treatment procedures for

Table 1. Comparison of values for plaque index, gingival index and periodontal probing depth obtained before and after treatment: (SD) standard deviation.

Variable	Number	Plaque index (mean ± SD)	Gingival index (mean ± SD)	Periodontal probing depth (mm) (mean ± SD)	*P*-value
Before treatment	150	1·81 ± 0·16	1·11 ± 0·15	1·56 ± 0·44	
After treatment	150	0·37 ± 0·12	0·18 ± 0·03	1·12 ± 0·23	< 0·001*

*Comparison of plaque index, gingival index and periodontal probing depth values for the averages before and after treatment by one-sample *t*-test ($P < 0{\cdot}001$).

Table 2. pH values of saliva before and after treatment, measured by pH meter: (SD) standard deviation.

Variable	Number	pH (mean ± SD)	*P*-value
Before treatment	150	7·42 ± 0·06	
After treatment	150	7·53 ± 0·07	< 0·001*

*Comparison of pH values for the averages before and after treatment by one-sample *t*-test ($P < 0·001$).

Table 3. Numerical scale indicating degree of improvement of halitosis in the patients.

Evaluation	Decrease in degree of halitosis				
Full improvement	5→0	4→0	3→0	2→0	1→0
Slight improvement	5→4	4→3	3→2	2→1	
No improvement	5→5	4→4	3→3	2→2	1→1

Table 4. Statistical analysis of halitosis scores obtained before and after treatment procedures.

	After treatment	
Level of improvement	Number	Total relief (%)
Full improvement	150	124 (83)
Slight improvement	150	26 (17)
No improvement	150	0 (0)

gingivitis were complete. Full improvement after treatment was observed in 83% of subjects. Odour judge scores were significantly associated with halimeter measurements (Table 5). The statistical analysis revealed that periodontal treatments caused a significant reduction ($P < 0·001$) in VSC formation (Table 5).

Discussion

The effects of nonsurgical periodontal treatments on oral malodour in children were evaluated using organoleptic methods, halimeter measurements and clinical findings.

Oral malodour, which is commonly noticed by patients, is an important clinical sign and symptom that often aids clinicians in establishing a diagnosis of underlying pathology [1–4,15]. It has been demonstrated that the intensity of clinical bad breath is significantly associated with the level of intraoral VSCs [12,13]. Volatile compounds come into existence as a result of food putrefaction, mostly in the form of Gram-negative bacteria. These compounds are either VSCs, such as hydrogen sulphide, methyl mercaptan and dimethyl sulphide, or volatile organic compounds, such as ethyl alcohol, acetaldehyde and acetone. Such compounds are indicators of odour in the breath, and hydrogen sulphide and methyl mercaptan account for 90% [16].

There are two main methods which are used in the evaluation of oral malodour: subjective evaluation (organoleptic assessment), and objective evaluation (quantitative measure of VSCs, gas chromatography and monitor analysis) [1]. While most researchers use a combination of both methods, some prefer the objective method in order to obtain a numeric value. However, others use only the organoleptic method because it is economical and easier to perform. The authors used both subjective and objective evaluations in this study to control their data.

Hunger and 'morning breath' are causes of temporary oral malodour. Morita and Wang reported that this state is the result of stagnation of epithelial and food debris [17]. The present authors evaluated the degree of oral malodour in subjects at various times, in order to investigate whether time of day affected the degree of oral malodour. Oral malodour was most often present in subjects in the morning, and therefore, it is likely that the primary cause of this odour is oral dryness, which occurs during sleep. This finding is consistent with other studies which have indicated that oral dryness is an important source of oral malodour [18,19].

Table 5. Comparison of organoleptic and volatile sulphur compound scores obtained before and after treatment: (p.p.b.) parts per billion; and (SD) standard deviation.

Variable	Number	Organoleptic score* (mean ± SD)	Volatile sulphur compound concentration (p.p.b.)† (mean ± SD)	*P*-value
Before treatment	150	3·67 ± 0·54	271·65 ± 19·86	
After treatment	150	0·54 ± 0·62	81·59 ± 15·12	< 0·001‡

*A score of ≥ 2 is associated with malodour.
†A level of > 200 p.p.b. is associated with malodour.
‡Comparison of organoleptic score and volatile sulphur compound scores for the averages before and after treatment by one-sample *t*-test ($P < 0·001$).

The influence of periodontal tissues on the risk of developing oral malodour has been the subject of much discussion in the literature. Hydrogen sulphide and methyl mercaptan, two major VSCs associated with oral malodour, play an important role in the pathogenesis of periodontal disease [1,4], and the periodontal pocket is also an ideal environment for VSC production with respect to the bacterial profile and sulphur source [1]. The amount of VSCs in mouth air increased with a rise in the number and depth of periodontal pockets (> 3 mm) [20]. Soils-Gaffer *et al.* [21] measured hydrogen sulphide production in 240 gingival crevicular fluid (GCF) samples. A positive correlation was observed between GI, GCF volume and hydrogen sulphide production.

According to these studies and the majority of authors, individuals suffering from periodontal disease are at increased risk of developing oral malodour. However, there is a small group of researchers who have not found any increased risk. For example, in an extensive study involving over 127 Canadian subjects, periodontal disease parameters and oral malodour measurements were not significantly associated with one another [22].

These results indicate that oral malodour and periodontal parameters are significantly associated with one another. Mean oral malodour was significantly associated not only with whole-mouth malodour, but also with GI and PPD. These data suggest the possibility that oral malodour may be a dependent factor linking periodontal disease and the periodontal diseases contribute to increase the severity of oral malodour. The results presented in this paper support the premise that oral malodour and periodontal disease levels are directly related.

Effective methods for treating malodour reduce anaerobes by improving oral hygiene and periodontal health through basic dental care. Therefore, all patients in this study were given lessons in oral hygiene and nonsurgical periodontal treatment methods, including scaling.

The accumulation of bacterial plaque on the tongue is an important factor that contributes to oral malodour in children. Oral malodour levels were significantly reduced after cleaning the surface of the tongue [23]. Thus, tongue care should not be neglected in avoidance of oral malodour. Tongue brushing should be a part of daily home oral hygiene procedures. In this study, patients were taught how to brush their teeth correctly (at least twice a day), and how to clean the surface of the tongue using a toothbrush. Patients and their parents were also informed about the importance of cleaning the surface of the tongue to protect against oral malodour. As a result, along with a conventional hygiene, tongue brushing is often an effective form of treatment and the authors saw its positive effect for their patients.

Saliva is a very important agent that has some antimicrobial effect on many different microorganisms, thereby protecting the oral cavity [24]. At physiological concentrations and neutral pH, saliva prevents bacterial glycolysis by inhibiting the pH-dependant glucose uptake of the bacteria and it potentiates the antibacterial defence mechanisms as a bacteriostatic agent [25]. Even though saliva has beneficial antimicrobial effects, sometimes these may not be sufficient to kill some specific bacteria which can exist at oral pH values of 6–8, or those which can survive at a low pH and to continue producing acid and VSCs [26]. In this study, the present authors found that the subjects' oral pH values were low prior to the therapy. This shows that the microorganisms which are responsible from oral malodour in children cause an acidic environment in the oral cavity. After appropriate periodontal therapy and optimization of oral hygiene, the oral environment becomes more pH neutral. In conclusion, the authors believe that the measurement of salivary pH values can be beneficial for the diagnosis and treatment of the microorganisms which are responsible from oral malodour.

The results presented in this paper support the premise that oral malodour and periodontal disease levels are directly related in children, and that instruction in oral hygiene and scaling is effective in reduce oral malodour.

What this paper adds

- Periodontal health and oral malodor are associated with one another.
- Treating periodontal diseases with non-surgical periodontal treatment procedures can decrease the effect of oral malodor.

Why this paper is important to paediatric dentists

- Physiologic defects are usually seen in childhood and severe oral malodor may cause some physiological problems on the paediatric patients in the future.
- Because of this, by the direction of paediatric dentists, these patients should attend to oral hygiene education and oral health prevention programs.

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