Reduction of Oral Levels of Volatile Sulfur Compounds (VSC) by Professional Toothcleaning and Oral Hygiene Instruction in Non-halitosis Patients

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Purpose: The aim of the study was to determine the longitudinal effect of an oral hygiene program on oral levels of volatile sulfur compounds (VSC).

Materials and Methods: The study subjects were randomly selected from patients attending a student course in operative dentistry and from staff members of our dental clinic. The test group (n = 30) received an oral hygiene training including professional toothcleaning (PTC), oral hygiene instruction, and motivation. The control group (n = 10) received no particular treatment. None of the subjects suffered from bad breath nor performed regular tongue cleaning. At baseline, immediately after PTC, one week, and four weeks thereafter we measured the oral hygiene status by means of the papillary bleeding index (PBI) and the oral concentrations of VSC by using a portable sulfide monitor (Halimeter®).

Results: Immediately after PTC, as well as one week, and four weeks after entering the program the PBI and the VSC-levels were significantly decreased as compared to the baseline values and the control group. VSCs were decreased by 34.9% (± 6.3) after PTC, 33.2% (± 7.1) one week, and 27.9% (± 5.8) four weeks thereafter.

Conclusion: The present study shows that in a group of patients without bad breath, an oral hygiene training program including professional toothcleaning, motivation and instruction of self-applied oral hygiene procedures is capable of reducing both papillary bleeding and oral levels of VSC Halimeter® readings over the observation period of four weeks.

Key words: oral hygiene, oral volatile sulfur compounds (VSC), sulfide monitor

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Bad breath is mainly caused by volatile sulfur compounds (VSC) which are produced by microbial putrefaction in the oral cavity (Rosenberg, 1996; van Steenberghe, 1997). The main components of VSC have been identified as hydrogen sulfide, methyl mercaptan, and to a lesser extent as dimethyl sulfide (Tonzetich, 1971; Tonzetich and Richter, 1964). VSC can easily be identified by a portable sulfide monitor, an instrument commonly used in clinical studies and bad breath clinics (Rosenberg et al, 1991). The odor producing microbes can be found in grooves, fissures, and interpapillary areas of the tongue as well as in periodontal pockets and interdental spaces. Therefore, oral hygiene plays an important role in the etiology and treatment of all forms of bad breath (Yaegaki and Coil, 2000a).

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Oral levels of VSC have been found to increase in the absence of oral hygiene (Kostelc et al, 1984) and decrease immediately after oral hygiene procedures such as toothbrushing (Tonzetich, 1978). Thus, oral levels of VSC might be used to motivate patients to improve their oral hygiene status. However, only limited data have been published regarding the longitudinal effect on oral levels of VSC by ongoing oral hygiene regimes, such as toothbrushing, interdental cleaning and professional tooth cleaning, especially in regular patients without oral malodor (Kostelc et al, 1984; Morris and Read, 1949). In a recent study with dental students we could demonstrate that a comprehensive oral hygiene training program applied during a clinical course resulted in decreased levels of VSC up to four weeks after the last intervention (Seemann et al, 2001). Therefore, the aim of this study was to elucidate the longitudinal effect on oral levels of VSC by means of an oral hygiene program which is generally applied to all new patients in our dental clinic during their initial treatment phase. This program includes oral hygiene instruction, motivation, and PTC.

MATERIALS AND METHODS

Subjects

The study population consisted of 40 subjects between 23 and 51 years of age. All subjects signed an informed consent form and were observed over a period of four weeks. The individuals of the control group (n = 10) received no particular treatment and were randomly selected from staff members of the dental school. The members of the test group (n = 30) initially attended an oral hygiene training program in a student course in operative dentistry. An objectionable oral malodor could not be determined by organoleptic measurement at baseline in any of the subjects, and none of the subjects performed regular cleaning of the tongue. Individuals with systemic diseases, removable dentures, less than 24 teeth, active periodontitis (probing pocket depth > 4 mm), mucosal lesions, medication on a regular basis within three months before and/or during the study, were excluded. The subjects should not use a mouthwash regularly. The smoking status was recorded (10 smokers in the test group, no smokers in the control group). If the subjects were smokers, the last cigarette should have been smoked at least two hours before each examination.

Oral Hygiene Training Program

The oral hygiene program which is generally applied to all initial patients in our department includes:
- the elimination of conditions which could hinder the performance of appropriate self-applied oral hygiene procedures (elimination of filling overhangs, destroyed teeth etc.)
- PTC using scalers, curettes, and rotating rubber cups together with a fluoride prophy paste
- motivation and supervision in toothbrushing and interdental cleaning.

This part of the program is carried out at the first appointment. A further visit (usually one week later) includes the re-evaluation of the patients' self-applied oral hygiene efforts and if necessary an individual re-motivation. At the beginning of each visit a papillary bleeding index (PBI) is registered on 24 sites as an indirect measure of oral hygiene status (Saxer and Mühlemann, 1975). The PBI at the first visit was used as the baseline measurement. In the control group, the PBI was determined at baseline, then at one week and four weeks thereafter.

VSC Measurements

The concentration of volatile sulfur compounds (VSC) was determined by using a portable sulfide monitor (Halimeter® , Interscan Corp., Chatsworth, CA, USA) connected to a pen recorder. The subjects were asked to keep their mouths closed for five minutes prior to measurement while the monitor was adjusted to zero at ambient air. A disposable plastic straw was mounted at the mouthpiece and was inserted approximately 4 cm into the partially opened mouth of the subject. During the measurement, the subjects were asked to breathe through their nose. The mean value of two peak readings was calculated and recorded as parts per billion (ppb) sulfide equivalents.

In the test group, VSC readings were performed at the beginning of the first visit (baseline), at the same visit directly after PTC, and one (week 1) and four weeks (week 4) thereafter. All readings were taken operator blind by one examiner (G.P.) between 2.00 pm and 4.00 pm. The subjects were asked to

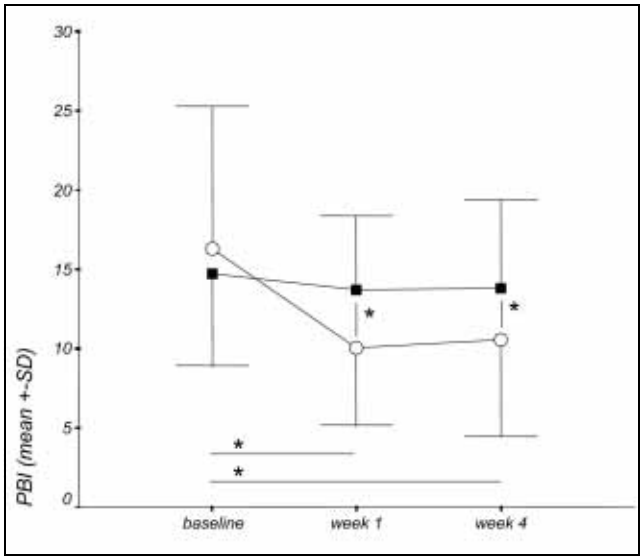

Fig 1 Mean PBI values (± standard deviation) in the test and the control group at baseline, one week (week 1) and four weeks (week 4) thereafter (*p < 0.05). ■ control group; O test group.

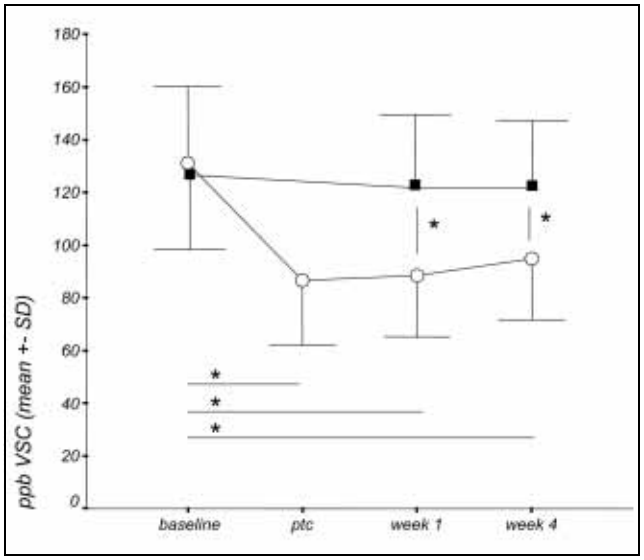

Fig 2 Mean VSC values (± standard deviation) in the test and the control group at baseline, after professional toothcleaning (PTC), one week (week 1) and four weeks (week 4) thereafter (*p < 0.05). ■ control group; O test group.

refrain from oral hygiene procedures such as tooth-brushing, flossing and utilization of oral rinses after lunch (12.00 noon). The smoking status and the time span since smoking of the last cigarette was recorded. All subjects were asked not to eat onions or garlic at least one day prior to the appointment.

In the control group the VSC readings were gathered at baseline and one week (week 1) and four weeks (week 4) thereafter.

Statistics

The statistical analysis was carried out with the SPSS 9.0 program using ANOVA and ANOVA for repeated measures. The probability level for statistical significance was set at $p < 0.05$.

RESULTS

The PBI and the VSC baseline values did not differ significantly between the test and the control group (Figs. 1 and 2). In the control group both PBI and VSC showed no significant changes over the study period of four weeks (Figs. 1 and 2). In the test group the PBI was significantly lower after one and after four weeks compared to baseline (Fig 1). The VSC values immediately after PTC, and the values at week 1 and week 4 were significantly decreased as compared to the baseline value and the control group respectively (Fig 2). The relative VSC reductions from baseline in the test group are displayed in Table 1.

Table 1 Relative VSC – reductions from baseline in the test group after professional toothcleaning, one week and four weeks thereafter

	mean (%)[a]	SD (%)[a]	range (%)[a]
PTC[b]	34.9	6.3	23.1 – 50.0
week 1[c]	33.2	7.1	20.8 – 50.0
week 4[d]	27.9	5.8	16.7 – 38.5

a = % reduction from baseline
b = professional toothcleaning
c = one week after first visit
d = four weeks after first visit

DISCUSSION

Recently, we could show for a group of dental students that a comprehensive oral hygiene training

program significantly decreased the levels of VSC Halimeter® readings up to four weeks after the last intervention (Seemann et al, 2001). Since the above-mentioned oral hygiene training was mutually performed during a course of preventive dentistry and because dental students can be generally regarded as a particularly motivated group the aim of the present study was to investigate the influence of oral hygiene training on oral levels of VSC in subjects from the general population without oral malodor.

Our data reveal that the oral hygiene training program which is generally applied to all initial patients in our department is capable of reducing gingival bleeding as a leading sign of gingival inflammation, suggesting a slight increase in the oral hygiene level over the observation period of four weeks. Oral levels of VSC were also significantly reduced immediately after PTC, one week and four weeks thereafter, suggesting that the VSC levels measured with the Halimeter® could reflect the beneficial outcome of such a program.

The reduction in VSC levels was achieved only by means of PTC and oral hygiene instruction, although the dorsum of the tongue is regarded as a major source for the production of VSC (McNamara et al, 1972; Yaegaki and Sanada, 1992). However, tongue cleaning was not a part of the program, because we were interested in the VSC reducing effect of oral hygiene procedures commonly used for the prevention of caries, gingivitis and periodontitis. Thus, only subjects who did not perform regular tongue brushing at home nor were suffering from bad breath were included.

The reduction of VSC levels by 27.9% after four weeks and the finding that an increase in VSC levels could be observed in none of the subjects may lead to the speculation that VSC Halimeter® readings might be used as an additional instrument to increase patient motivation toward better oral hygiene. After all, bad breath has a noticeable psychological component (Iwakura et al, 1994; Yaegaki and Coil, 2000b) and a reduction in VSC would be a direct and noticeable benefit from daily oral hygiene efforts. A recent study showed that the acceptance of dental flossing is higher in patients who have been diagnosed to suffer from bad breath in contrast to subjects without oral malodor (Rosenberg, 1996).

It has been demonstrated by Rosenberg et al (1991) that repeated measurements with the Halimeter® showed a surprisingly high reproducibility. This is supported by the data from the control group in the present study and by previous work of our group (Seemann et al, 2001). However, the Halimeter® lacks the specificity of gas chromatography, since it cannot distinguish between the proportions and species of different VSCs (such as H_2S, CH_3SH, CH_3SCH_3 or CS_2) (Furne et al, 2002) but represents a simple device which is easily applicable to chair side measurements. Regarding the purpose of the study, absolute values for concentrations of VSC are not the main point of interest but the changes over time.

All measurements were taken operator blinded at the same time of day (2.00 pm to 4.00 pm) after lunch, so that the effect of eating on the VSC levels would be negligible. Since tobacco products contain sulfur compounds which might have an effect on the Halimeter® readings, we registered the smoking status of the subjects and the time since the last cigarette had been consumed. The VSC values were equally distributed between smokers and non-smokers and showed similar changes during the study (data not shown). Therefore, the smoking status should not bias the effect of the oral hygiene efforts on detectable VSC levels.

In conclusion, the present study reveals that in a group of patients without bad breath, an oral hygiene training program with professional tooth cleaning, motivation and instruction in self-applied oral hygiene procedures is capable of reducing both papillary bleeding and oral levels of VSC Halimeter® readings over the observation period of four weeks. On the basis of these findings, further studies should elucidate whether Halimeter® readings might be used to elevate patient motivation to improve their oral hygiene levels.

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