Effect of Tongue Cleansing on Morning Oral Malodour in Periodontally Healthy Individuals

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Purpose: The aim of this randomised single-blind, cross-over trial was to assess the effect of tongue cleansing on morning oral malodour in periodontally healthy subjects.

Materials and Methods: Ten systemically healthy non-smoker subjects (6 males, 4 females), 24–38 years of age, completed two 4-day periods of oral hygiene cessation with a 7-day wash-out period. In one of these test periods, subjects were instructed to clean their tongues with a tongue scraper 2–3 times a day. Participants presented at least 20 teeth, without cavities, overhanging restorations/prostheses or periodontitis, and had no history of previous periodontal therapy or use of antibiotics in the 3 months prior to the study. Volatile sulphur compounds (VSC; Interscan Halimeter) and organoleptic scores were measured in exhaled mouth air once a day, early in the morning, by one examiner. Comparisons were performed using Wilcoxon's signed rank test and Friedman's test ($\alpha = 0.05$).

Results: VSC levels at baseline were 206.3 ppb (SD 139.8) and 191.4 ppb (SD 127.7) for periods of usage and non-usage of the scraper respectively ($p > 0.05$). VSC levels did not change significantly during the 4 days, independent of tongue cleansing (Friedman, $p > 0.05$). Only at day 3 did the use of the tongue scraper lead to a significantly lower level of VSC compared with controls (131.1 ppb and 199.3 ppb respectively). No significant differences in organoleptic scores were observed between groups at baseline. During the whole experimental period, there were also no significant changes in organoleptic scores when individuals used or did not use the tongue scraper.

Conclusion: Tongue cleansing with a scraper was unable to prevent morning oral malodour in the absence of tooth cleaning in periodontally healthy individuals.

Key words: halitosis, oral malodour, oral hygiene, tongue

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Halitosis has become more importent in recent years because of the social and behavioural consequences on people's lives. Different conditions have been associated with the occurrence of halitosis. However, it is estimated that more than 90% of the causes are localised intra-orally. In these situations, halitosis is referred to as oral malodour or oral bad breath (Delanghe et al, 1997), characterised by the release of unpleasant odours, mainly volatile sulphur compounds (VSC), as a result of the degradation of substances, especially by microorganisms, present in biofilms (Loesche and Kazor, 2002). Thus therapeutic and preventive approaches are targeted at controlling dental and tongue biofilms, which are responsible for production of VSC and volatile organic compounds.

A strong association has been observed between plaque-related periodontal diseases and oral malodour (Tonzetich, 1978; Yaegaki and Sanada, 1992a, 1992b; Morita and Wang, 2001). Nevertheless, a pro-

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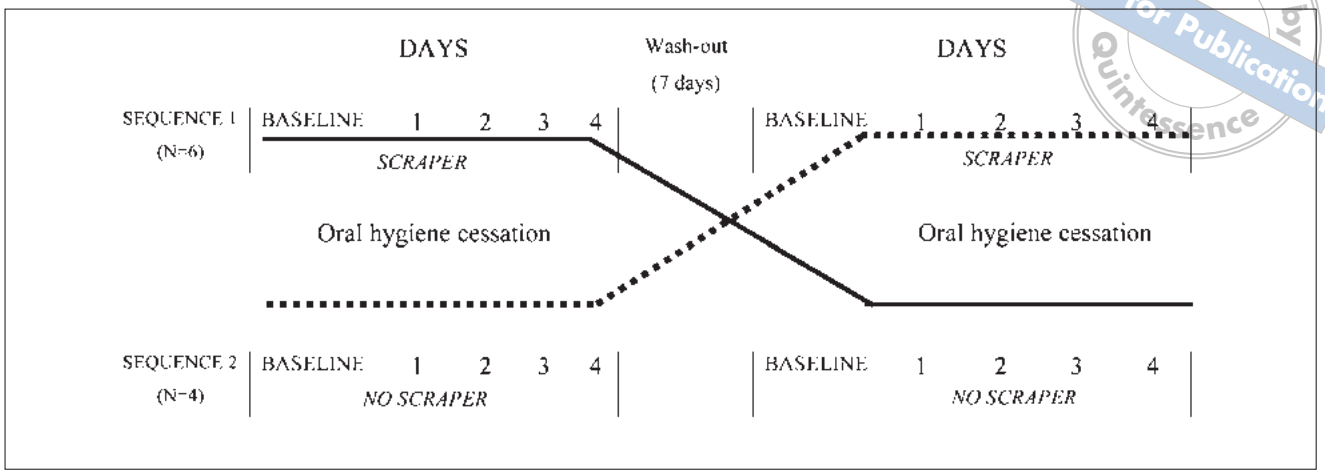

Fig 1 Study design.

portion of periodontally healthy individuals also demonstrate clearly noticeable oral bad breath (Bosy et al, 1994). This suggests other possible causes for oral malodour. In this context, the biofilm on the dorsum of the tongue has been considered as one of the major aetiological factors of oral bad breath (De Boever and Loesche, 1995; Miyazaki et al, 1995). This evidence was generated mainly from observational studies with strong limitations in establishing causality. Therefore experimental studies would be helpful to elucidate this issue.

Although the role of tongue biofilm and coating has been extensively claimed, the literature concerning the effect of tongue cleansing on oral malodour is scarce (Tonzetich and Ng, 1976; Seemann et al, 2001; Pedrazzi et al, 2004; Quirynen et al, 2004). However, tongue cleansing has been indicated as one method for management of oral bad breath (Loesche and Kazor, 2002). The evidence supporting both tongue cleansing and the use of tongue scrapers remains weak. Two recent studies demonstrated reductions in oral halitosis (Pedrazzi et al, 2004) and substrata for putrefaction (Quirynen et al, 2004) with the use of scrapers. However, the effect of these devices compared with the absence of tongue cleansing on the development of halitosis was not assessed.

The aim of the present study was to evaluate the effect of controlling or not controlling the tongue dorsum biofilm with a scraper during cessation of tooth cleansing procedures on morning bad breath in periodontally healthy subjects.

MATERIALS AND METHODS

This study was a randomised, single-blind, cross-over, controlled clinical trial. Ten subjects (6 males, 4 females), 24–38 years of age (28.3 ± 4.4 years), read and signed informed consent before entering the study. The protocol was approved by the Committee of Ethical Affairs of the Faculty of Dentistry of the Federal University of Rio Grande do Sul, Brazil.

Participants were recruited from undergraduate and graduate students from the Faculty of Dentistry of the Federal University of Rio Grande do Sul. All subjects received an intra-oral examination for evaluation of dental caries and periodontal disease before the start of the study. They also responded to a questionnaire about demographics, systemic health and oral hygiene habits. They had no complaints regarding halitosis. Inclusion criteria included good general health and presence of at least 20 teeth, without cavities, overhanging restorations/prostheses or periodontitis. Smokers, individuals with previous history of periodontal therapy or use of antibiotics in the 3 months prior to the study, individuals with tongue coating, gastric disorders, tonsillar and/or pharyngeal infections and sinusitis or other nasal conditions were not included in the study.

Study design

The individuals were randomly assigned to two experimental groups. Both groups participated in two 4-day experimental periods of cessation of any mechanical or chemical oral hygiene. However, individuals in the test

Table 1 Mean concentrations and standard deviations, in ppb, of volatile sulphur compounds during the experimental period for individuals who cleaned (scraper) and did not clean (no scraper) the tongue dorsum

	Baseline	Day 1	Day 2	Day 3	Day 4
Scraper	206.3 ± 139.8	186.0 ± 112.5	213.7 ± 127.0	131.1 ± 85.9	169.3 ± 60.5
No Scraper	191.4 ± 127.7	234.6 ± 99.4	220.6 ± 107.5	199.3 ± 102.4	221.8 ± 107.4
Between-groups p (Wilcoxon)	0.878	0.139	0.953	0.013	0.093

group were instructed to clean their tongues with a tongue scraper 2–3 times a day during the 4-day period. A wash-out period of 7 days was given between the two experimental periods. Randomisation was performed by the flip of a coin: 6 individuals started using the scraper (sequence 1) and 4 individuals started as controls (sequence 2). Fig 1 illustrates the study design.

Subjects were instructed on how to use the tongue scraper according to Quirynen et al (2004). Briefly, they had to use the scraper with a minimum of two pulling strokes along the linea mediana and two at the borders of the lateral sides of the tongue, 2–3 times a day during the entire experimental period.

Outcomes

Oral malodour was assessed once a day, in the morning, always at the same time for each participant (between 7:00 am and 9:00 am). A fasting period of 8 hours, with no liquid intake, was required before measurements. Individuals were allowed to eat, drink or clean the tongue just after halitosis measurements. Oral halitosis was assessed by means of volatile sulphur compounds (VSC) measurement using Halimeter (Interscan, Chatsworth, Canada) and also by an organoleptic scale. The reproducibility of Halimeter was previously checked by the manufacturer with standard gases of hydrogen sulphide and methyl mercaptan. The organoleptic scoring preceded the VSC assessment.

For the VSC measurement, participants were asked to close their mouth for 3 minutes and levels were recorded in exhaled mouth air by one trained examiner in parts per billion (ppb). The same examiner performed the organoleptic assessment using a scale described by Rosenberg et al (1991). In this organoleptic evaluation, the examiner is positioned 10 cm from the participant, and instructs them to keep their mouth closed for a period of 2 minutes and to breathe through the nose. Scores were then registered from exhaled mouth air as follows: 0, no appreciable odour; 1, barely noticeable odour; 2, slight, but clearly noticeable odour; 3, moderate odour; 4, strong odour; and 5, extremely foul odour. The examiner was apart from the randomisation process to ensure blindness.

Examiner reproducibility

One single examiner performed the organoleptic scoring. Repeated measurements of organoleptic scores, with 20 minute intervals, were performed on 100 individuals. An exact percentage agreement of 82% and a kappa coefficient of 0.73 were obtained.

Statistical analysis

VSC levels and organoleptic scores for individuals who cleaned and did not clean the tongue dorsum were compared using Wilcoxon's signed rank test. These variables were also compared during the experimental period with Friedman's test. The individual was the unit of analysis and the significance level was set at 5%.

RESULTS

A preliminary analysis was performed to evaluate differences in VSC levels at baseline between sequences 1 and 2 in order to identify possible Hawthorn and carry-over effects. No differences were observed between individuals who used the scraper in the first cycle (sequence 1) and those who used it in the second cycle (sequence 2), with no evidence of these effects (results not shown).

A significant correlation between the two outcome measurements was observed. Spearman correlation coefficients of 0.52 and 0.45 were observed between VSC levels and organoleptic scores when the individuals used and did not use the scraper respectively ($p < 0.001$).

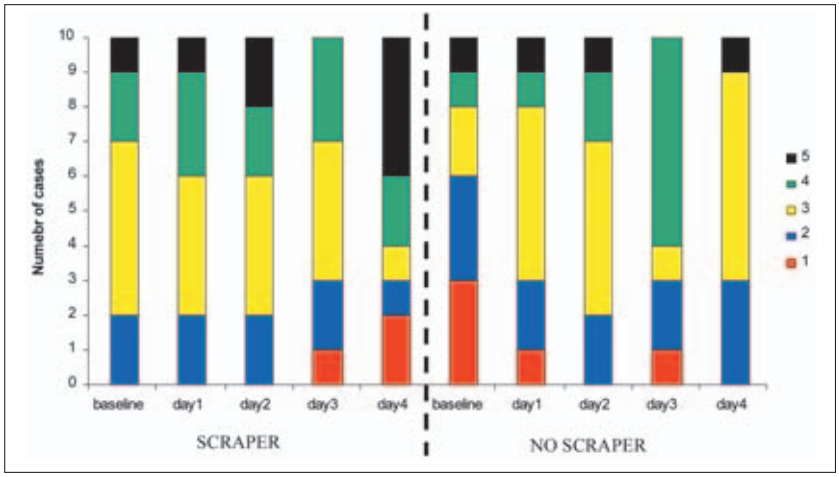

Fig 2 Distribution of organoleptic scores for individuals who cleaned (scraper) and did not clean (no scraper) the tongue dorsum during the experimental period.

Table 1 shows changes in VSC concentrations during the study. VSC levels at baseline were 206.3 ± 139.8 ppb (mean ± SD) and 191.4 ± 127.7 ppb in test and control groups respectively. No statistically significant difference was detected at baseline. During the 4 days of oral hygiene cessation, VSC levels did not change significantly, independent of whether subjects used or did not use the tongue scraper (Friedman's test, $p > 0.05$). At the end of the 4 days, VSC concentrations were 169.3 ± 60.5 ppb and 221.8 ± 107.4 ppb for test (scraper) and control (no scraper) groups respectively. However, at day 3, the use of the tongue scraper led to a significantly lower level of VSC compared with not using it (131.1 ppb and 199.3 ppb respectively; Wilcoxon $p = 0.013$). At day 4, this difference was slightly reduced to 52.5 ppb and statistical significance was not achieved ($p = 0.093$).

The distribution of organoleptic scores is shown in Fig 2. None of the individuals scored 0 (no appreciable odour) at baseline. Although there was a higher frequency of scores of 3 when individuals used the scraper and a higher frequency of scores of 1 when they did not use the scraper, this difference was not statistically significant at baseline. A tendency of lower scores of bad breath at the third day when the scraper was used (fewer scores of 4) was observed. However, during the whole experimental period, no significant differences in organoleptic scores when individuals cleaned or did not clean the tongue dorsum were detected.

DISCUSSION

Biofilm from the dorsum of the tongue and tongue coating have been associated with the development of oral malodour in observational studies (Bosy et al, 1994; De Boever and Loesche, 1995; Miyazaki et al, 1995). There is a biological plausibility supporting this association – the tongue represents an important reservoir of anaerobic Gram-negative bacteria capable of producing compounds responsible for oral malodour (De Boever and Loesche, 1995; Tanaka et al, 2004). The present randomised, controlled clinical trial demonstrated that cleaning the tongue during 4 consecutive days exerted a small effect on the development of morning oral bad breath in the absence of oral hygiene methods in periodontally healthy subjects.

Significantly lower VSC levels were detected only at the third day when individuals used a tongue scraper as compared with controls. However, these results were not confirmed by the organoleptic scores. High correlations between organoleptic scores and VSC levels are reported in the literature (Rosenberg et al, 1991; Miyazaki et al, 1995). However, some authors suggest the use of two methods to assess oral halitosis, since the portable VSC monitor measures the concentration of only two main compounds (hydrogen sulphide and methyl mercaptan), and malodour can occur in the presence of many other compounds (Rosenberg and McCulloch, 1992). This could be the case in the present investigation, as there was a greater variability for the organoleptic scores (Fig 2), even with a significant correlation between the two diagnostic

methods. Additionally, it was demonstrated that methyl mercaptan is more difficult to reduce to acceptable levels, since it exhibits a lower threshold of objectionability compared with hydrogen sulphide (Tonzetich and Ng, 1976). However, the method used in the present study (Halimeter) cannot discriminate the concentration of different sulphur compounds, making it difficult to assume the absence of effect of tongue cleansing on methyl mercaptan levels. This would only be possible with the aid of gas chromatography.

Halitosis has a multifactorial aetiology (van Steenberghe, 1997; Morita and Wang, 2001). Consequently, studies evaluating the effects of aetiological factors must control for possible confounders, such as smoking, drugs, oral hygiene, and oral and nasopharyngeal diseases. Morning halitosis is a frequently used study model (Tonzetich and Ng, 1976; Carvalho et al, 2004; Pedrazzi et al, 2004), although it should be recognised that a true validation of the model has not yet been performed.

Selection criteria were applied in the present investigation to obtain a sample where the effect of tongue biofilm in the development of morning oral bad breath could be isolated. The present study evaluated a sample of periodontally and systemically healthy non-smokers, who had no complaints about halitosis. As cessation of oral hygiene was established during a cross-over design, the amount of gases produced and released inside the mouth was compared when the tongue biofilm was being controlled or not being controlled (scraper and no scraper groups respectively).

Few interventional studies have evaluated the effect of controlling tongue biofilm on oral malodour. A pivotal study from the 1970s was published by Tonzetich and Ng and described the immediate effects (30 to 60 minutes after) of different oral hygiene methods on morning malodour in eight non-smoker healthy individuals (Tonzetich and Ng, 1976). More recently, the effect of several treatment modalities, including tongue brushing, on the concentrations of oral sulphur-containing gases using gas chromatography in a sample of eight healthy individuals was assessed (Suarez et al, 2000), similar to the design of the present investigation. Both studies demonstrated higher VSC reductions immediately after tongue cleansing (1 to 8 hours) compared with tooth brushing alone, suggesting that the tongue is the major source of unpleasant odours. However, the effect of tongue cleansing on a regular basis was not assessed. In contrast, the present study investigated the effect of controlling the tongue biofilm on morning malodour during 4 consecutive days.

Another cross-over trial evaluating the use of a tongue scraper and a toothbrush as tongue cleaning methods in 10 volunteers demonstrated that both were able to reduce VSC levels (Pedrazzi et al, 2004). Seemann et al (2001) also found some reduction in VSC levels with different tongue cleaning methods. However, the authors concluded that there was a limited duration of the effect, questioning its clinical efficacy. Direct comparisons between these two reports and the present study are difficult to perform since the study by Pedrazzi and co-workers evaluated VSC with a hand-held sulphide monitor that provides a result in a categorical scale of VSC concentration (from odourless/normal to strong odour). In contrast, the present investigation evaluated oral malodour with a previously validated (Rosenberg et al, 1991) portable sulphide monitor (Halimeter) by measuring the exact VSC levels. Additionally, the lack of a negative control group (absence of tongue cleansing) limits the interpretation of the results reported from these two studies (Seemann et al, 2001; Pedrazzi et al, 2004).

An intervention study in adolescents also demonstrated reductions of organoleptic scores after tongue cleansing with a hard toothbrush wetted in 0.12% chlorhexidine and standard home oral care for 4 weeks (Cicek et al, 2003). However, these reductions could be a result of the use of an adjunctive antiseptic with proven efficacy in reducing oral bacteria and malodour (Carvalho et al, 2004; Sreenivasan and Gittins, 2004), and not a result of the mechanical removal of tongue biofilm.

The present study did not aim to test treatment protocols for halitosis, but intended to study the role of tongue biofilm in the aetiology of oral malodour. Thus in order to allow similar plaque formation during both experimental periods, we decided to ask volunteers to refrain from their tooth-cleaning habits.

The results of the present study demonstrated that there might be some individuals where the tongue biofilm does not play a determinant role in the development of morning bad breath. Thus the control of tongue biofilm would not be able to prevent halitosis. Treatment protocols with mechanical and chemical control of tongue coating demonstrated significant reductions in oral malodour (Tonzetich and Ng, 1976; Rosenberg et al, 1992; Carvalho et al, 2004). It was also demonstrated that tongue cleaning improves taste sensation, even without significant changes in tongue bacterial load (Quirynen et al, 2004). This would be a better reason for instructing patients to clean the tongue. Although there is limited information on long-term reductions of halitosis and no standard treatment approaches, tongue cleansing should not be disregarded.

It can be concluded that tongue cleansing with a scraper was unable to prevent morning bad breath in the absence of tooth cleaning in periodontally healthy individuals. These findings suggest that the tongue biofilm may not be the major source of morning bad breath in healthy subjects.

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