J Clin Periodontol 2004; 31: 506–510 doi: 10.1111/j.1600-051X.2004.00507.x
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Journal of Clinical Periodontology

Impact of tongue cleansers on microbial load and taste

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Quirynen M, Avontroodt P, Soers C, Zhao H, Pauwels M, van Steenberghe D. Impact of tongue cleansers on microbial load and taste. J Clin Periodontol 2004; 31: 506–510. doi: 10.1111/j.1600-051X.2004.00507.x. © Blackwell Munksgaard, 2004.

Abstract

Objectives: Tongue cleaning has been advocated to improve oral malodor and to reduce reinfection of periodontal niches by eliminating tongue coating and/or reducing putrefaction by bacteria.

Material and Methods: This cross-over, single-blind study on periodontitis-free, non-smoking, subjects with habitual oral hygiene ($n = 16$), evaluated the effect of tongue cleaning (with either plastic scraper or nylon multi-tufted toothbrush), on the microbial load of the tongue dorsum (anterior and posterior of the *sulcus terminalis*), the extent of tongue coating, and taste sensation for bitter, sweet, salt, and sour. Both devices had been used twice daily for 2 weeks (toothbrush three forward–backward movements along the *linea mediana* and for each longitudinal third of the tongue; two strokes with the scraper along the *linea mediana* and along the borders of the tongue).

Results: Two weeks of tongue brushing or scraping resulted in only negligible reductions in aerobic and anaerobic bacteria on the tongue (reductions < 0.5 log). The amount of tongue coating, however, decreased significantly ($p < 0.05$), with both devices. The taste sensation improved after 2 weeks of tongue cleaning, especially with the scraper (significant improvements for quinine and sodium chloride).

Conclusion: Tongue cleaning improves taste sensation and seems to reduce the substrata for putrefaction, rather than the bacterial load.

Keywords: breath odour; microbiology; taste sensation; tongue brushing; tongue coating

Accepted for publication 12 August 2003

Breath malodor, a large-scale social problem, can be caused by a number of etiologic factors (Preti et al. 1995, Delanghe et al. 1997, van Steenberghe 1997), both intra- and extra-oral (gingivitis/periodontitis, nasal inflammation, chronic sinusitis, diabetes mellitus, liver insufficiency, uremia, lung carcinoma, liver cirrhosis, trimethylaminuria, etc.). In the majority of cases, however, it arises from the oral cavity (Delanghe et al. 1997).

The principal components of oral malodor are volatile sulfur compounds (VSC), especially hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH), and dimethyl sulfide [$(CH_3)_2S$] (Tonzetich 1977). These compounds result from the proteolytic degradation by predominantly anaerobic gram-negative oral microorganisms of various sulfur-containing substrates found in the mouth, such as food debris, saliva, blood, and epithelial cells (Tonzetich 1977). Since most of these bacteria are periodontopathogens (e.g. *Porphyromonas gingivalis*, *Prevotella intermedia*, spirochetes, etc.), it was logical to assume a positive correlation between VSC levels in the mouth air and the extent of periodontal pocket depths, and the gingival bleeding tendency (Coli & Tonzetich 1992, Yaegaki & Sanada 1992a). However, not all patients with gingivitis and/or periodontitis present oral malodor and vice versa (Bosy et al. 1994). One possible explanation is the fact that tongue coating also correlates strongly with malodor (Coli & Tonzetich 1992, Bosy et al. 1994, Rosenberg 1996). The fissures and crypts of the tongue harbor large amounts of the above-mentioned bacterial species (De Boever & Loesche 1995, 1996). The degree of tongue coating also plays a significant role in the breath odour formation (Yaegaki & Sanada 1992a, b, Bosy et al. 1994, De Boever & Loesche 1996). Tongue coating is composed of blood components and other nutrients, large amounts of desquamated epithelial cells and bacteria. It can thus be responsible for putrefaction (Yaegaki & Sanada 1992a, b). Some papers even stated that the tongue and not the dental plaque is the principal source of oral malodor (Tonzetich & Ng 1976).

To prevent putrefaction on the tongue dorsum, tongue cleaning has been advocated to reduce the amount of coating and the bacterial load on this surface. Whereas some papers suggest a significant reduction in bacterial load or of specific bacteria on the tongue after cleaning (Gilmore & Bhaskar 1972, Gilmore et al. 1973, De Boever & Loesche 1995, 1996, Christensen 1998) others failed to prove such a

relationship (Menon & Coykendall 1995, Quirynen et al. 1998). Tongue cleaning also improved taste sensation at threshold level but not at the supra-threshold level in geriatric patients (Hyde et al. 1981).

The aim of this study was to examine changes in microbial load (aerobic and anaerobic flora), tongue coating, taste perception, and gag reflex after a period of tongue cleaning with either a brush or a scraper.

Material and Methods

Experimental design

A group of 16 non-smoking volunteers, aged 21–50 years, with a healthy periodontium and some degree of tongue coating, were recruited for this single-blind, cross-over study. They had at least 24 teeth with no signs of ongoing periodontitis, had no caries or extensive dental restorations, and had not been exposed to systemic antibiotic treatment during the past 6 months. After several weeks of habitual oral hygiene without tongue cleaning, they were randomly allocated to one of the two tongue-cleaning devices (tooth brush or scraper) for a test period of 14 days. After a so-called washout period of 21 days with habitual oral hygiene without tongue cleaning, they were instructed to use the remaining device. The following tongue cleaning devices had been selected:

- nylon, multi-tufted, small headed toothbrush (Sensodyne, Stafford-Miller, Belgium);
- plastic loop-formed tongue scraper (Dentaid S.A., Spain).

During the entire study the participants continued their habitual oral hygiene and were instructed not to take any antibiotics unless in case of urgency. At baseline the subjects were instructed to use one of the devices twice daily. With the brush three forward and backward strokes were performed along the *linea mediana* and at each lateral part of the tongue, while for the scraper two pulling strokes along the *linea mediana* and two at the borders of the lateral sides of the tongue had to be completed.

Tongue coating

At day 0 (baseline) and day 14 of each test period, the extension of the tongue coating was scored using an index (Miyazaki et al. 1996) with a single score for the entire tongue and per tongue area (anterior and posterior to the *sulcus terminalis*, each region further divided in two by the *linea mediana*). The score ranged from 0 to 3 (0 being no coating, 1 less than 1/3, 2 less than 2/3, and 3 more than 2/3 of the surface coated). The scores from the four areas were counted together in order to receive a value ranging between 0 and 12.

Microbiological parameters

At baseline and day 14, microbiological samples ($n = 3$) were collected from unstimulated saliva and tongue dorsum (anterior and posterior to the *sulcus terminalis*, respectively). The saliva sample was retrieved by rinsing the mouth with a 2 ml sodium chloride solution for 10 s; 0.5 ml of this solution was further dispersed in 3 ml RTF (Syed & Loesche 1972). The two microbial samples of the tongue dorsum were taken by wiping a sterile cotton swab (Biomérieux S.A., Montalieu-Vercieu, France) over a standard area of 3 cm^2 for 10 s (Danser et al. 1994). The tips of the cotton swabs were collected in screw-capped vials, containing 3 ml RTF. The vials were flushed with CO_2 before closing and coded for blind microbiological analysis (in less than 24 h).

For all samples, dilutions 10^{-1}–10^{-5} were plated by means of a spiral plater (Spiral Systems®, Inc., Cincinnati, OH, USA) onto non-selective blood agar plates (Blood Agar Base II®, Oxoid, Basingstoke, UK), supplemented with hemine (5 mg/l), menadione (1 mg/l), and 5% sterile horse blood. After 7 days of aerobic and anaerobic culturing (80% N_2, 10% CO_2 and 10% H_2) at 37°C, the number of aerobic and anaerobic colony forming units (CFU/ml) was counted.

Evaluation of taste sensation

During the same visits the subjects were submitted to recognition tests for salt, sweet, sour, and bitter. For all tastes (sodium chloride, saccharose, citric acid, and quinine), different concentrations (with 1/3 concentration reductions) were prepared. Starting with the lowest concentration of a randomly chosen flavour, one drop was put on the tongue, using a dropping bottle. The concentration was increased in successive trials until the given flavour was correctly identified (Helms et al. 1995).

Questionnaire

At day 14 of each test period, the subjects were asked to complete a questionnaire concerning side-effects of both cleaning devices such as gag-

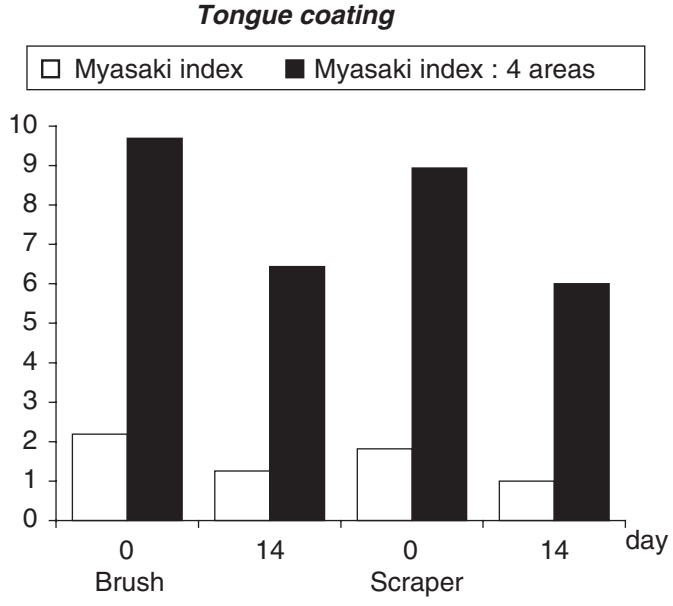

Fig. 1. Effect of tongue cleaning on tongue coating for the entire tongue, or as a sum of the scores for four different areas of the tongue (i.e. anterior and posterior to the *sulcus terminalis*, each region further divided in two by the *linea mediana*) sorted by device. The scores ranged from 0 to 3 (0 being no coating, 1 less than 1/3, 2 less than 2/3, and 3 more than 2/3 of the surface coated I.

ging reflex, taste sensation, and comfort. All answers had to be filled in on a visual analog score (0–100%). At the end of the study they were also asked which tool they preferred.

Statistical analysis

Differences between the two devices and/or with baseline values were looked for via a set of pair wise comparisons. Before each analysis, the residuals were tested for normality by a normal QQ-plot. In case of a deviation from normality, data were transformed by a log or power transformation.

Results

Tongue coating

At baseline, relatively high tongue-coating indices were noticed. These values showed a significant reduction ($p < 0.001$) at day 14, for both tools (Fig. 1). This reduction was more evident for the anterior part of the tongue. There were no differences between both devices in reaching these improvements.

Microbial load

The numbers of CFU (aerobic and anaerobic culturing) in samples from the saliva remained constant over time (differences within 0.3 log) (Fig. 2A). The microbial data for the tongue (anterior and posterior part) are depicted in Figs 2B and C, respectively. No major changes could be detected neither between baseline and day 14, nor between the two devices ($p > 0.10$). The differences remained less than 0.5 log. For the posterior area, in general higher numbers of CFU/ml were observed, when compared with the anterior part.

Taste sensation

For both devices, a slight improvement in taste recognition was found at day 14 (Fig. 3). After these 2 weeks of tongue scraping these improvements even reached a level of significance for the recognition of sodium chloride ($p = 0.008$) and quinine ($p < 0.003$), while they were borderline for sucrose ($p = 0.06$).

Subjective evaluation of devices

The scraper resulted in less gagging and scored slightly better for comfort, clean-

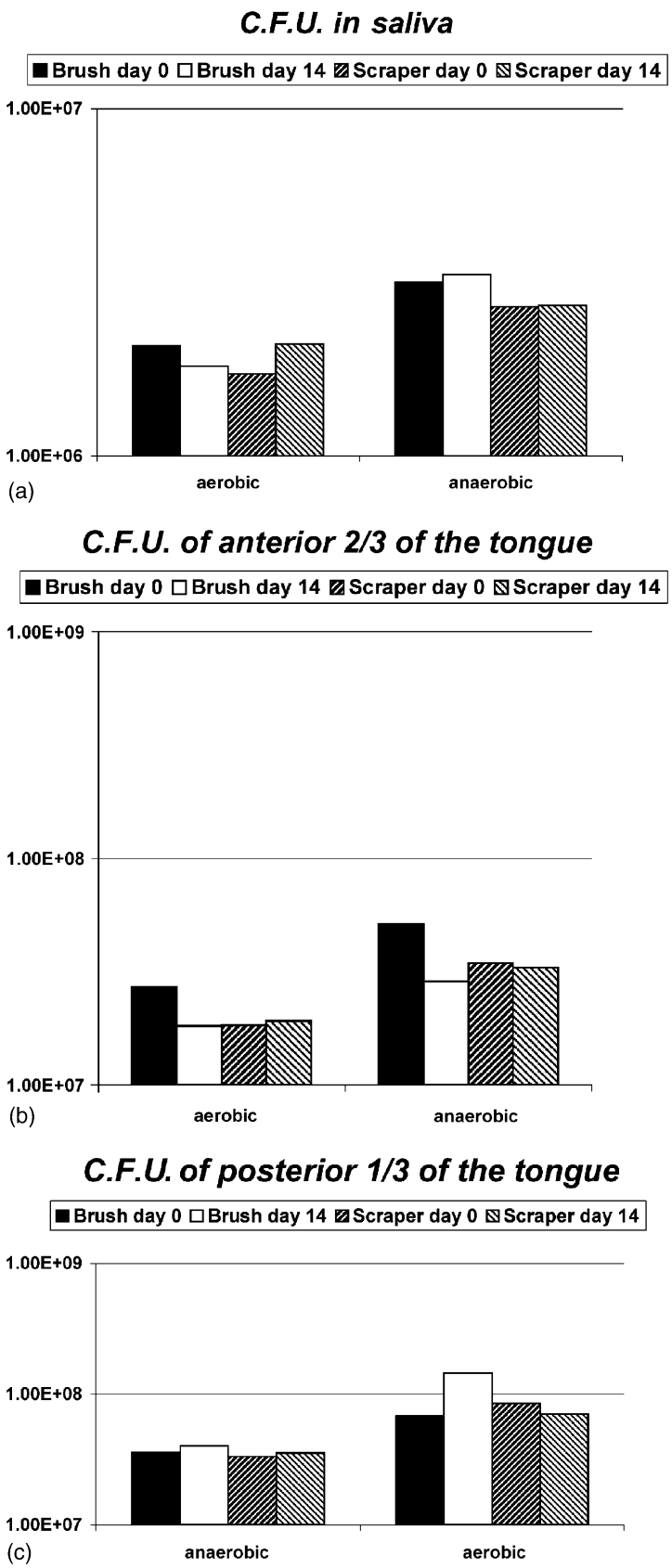

Fig. 2. The number of CFU in the saliva (A) and the effect of tongue cleaning on the microbial load of the anterior 2/3 (B) and posterior 1/3 (C) of the tongue (aerobic and anaerobic CFU/ml). Data are sorted by day and tool.

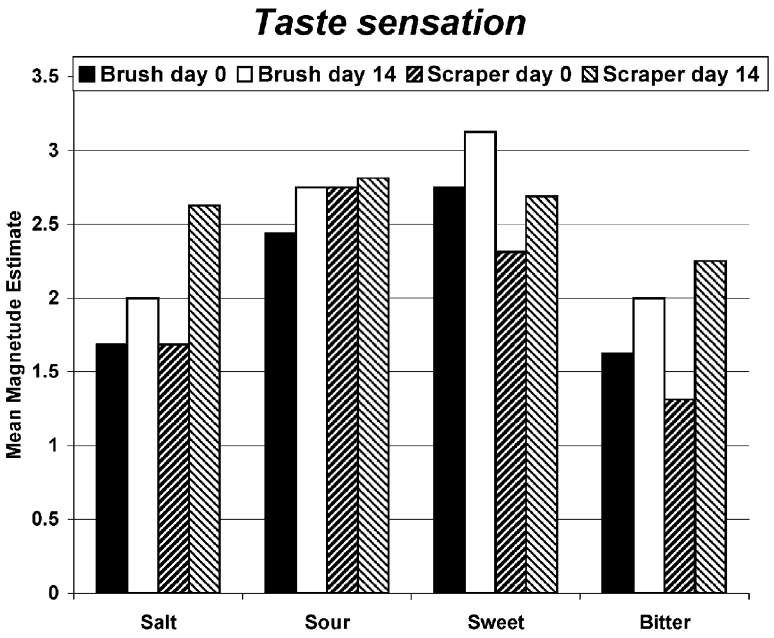

Fig. 3. Total scores for concentration series of the four tastes. Data are sorted by day and tool.

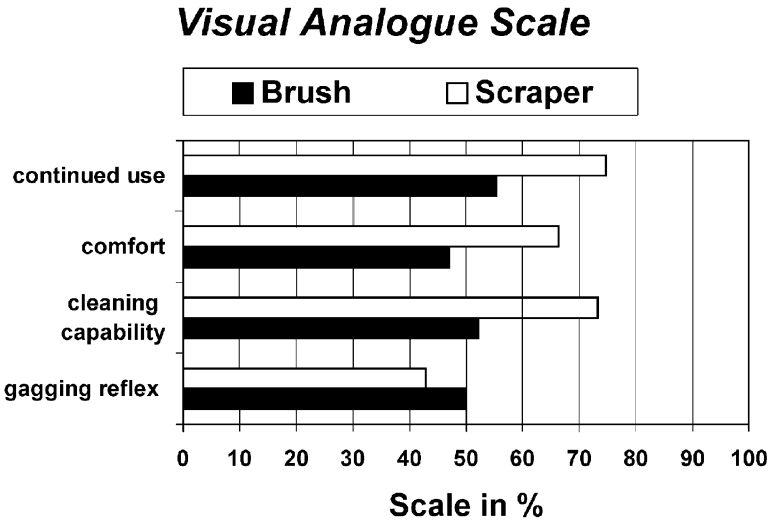

Fig. 4. Subjective evaluation for the tested tongue cleaning devices on a visual analog scale. Data are sorted by tool and subjective aspect.

ing capacity, and preference (Fig. 4). When the subjects were asked to compare both devices, 11 of the 16 noticed more gagging reflexes with a toothbrush. Thirteen of the 16 volunteers expressed their preference for the scraper.

Discussion

The data of this study, in contrast to several previous reports, indicate that tongue cleaning, although notably reducing the degree of coating, does not significantly reduce the bacterial load. A detailed analysis of these reports explains this apparent contradiction. The data of Gilmore & Bhaskar (1972) indicated that from the six subjects that started tongue brushing, two showed an increase in CFU and only four a reduction, with changes that remained within 0.5 log value. The paper by Gilmore et al. (1973) only reported a reduction in the number of Streptococci without presenting data. The paper by Gross et al. (1975) mentioned a reduction in plaque formation on teeth when cleaning the tongue, but did not examine the changes on the tongue itself. In the experiment of De Boever & Loesche (1995), tongue cleaning was combined with the use of chlorhexidine (both as rinse and as paste), which by itself might already explain the 74% bacterial reduction on the tongue. Our data are in agreement with Menon & Coykendall (1995), who also reported small changes in bacterial load after tongue scraping, and with our previous observations (Quirynen et al. 1998). The difficulty in reducing the bacterial load on the tongue is not surprising, taking into consideration the surface characteristics of the tongue dorsum. The dorsal tongue mucosa, with an area of 25 cm^2 (Collins & Dawes 1987), shows a very irregular surface topography (Schroeder 1991). The posterior part exhibits a number of oval cryptolymphatic units, which roughens the surface of this area. The anterior part is even rougher, due to the high number of papillae (the filiform papillae with a core of 0.5 mm length, a central crater and uplifted borders, the fungiform papillae with a length of 0.5–0.8 mm, the foliate papillae located at the edge of the tongue separated by deep folds, and the vallate papillae 1 mm height and 2–3 mm diameter). These innumerable depressions in the tongue surface are ideal niches for bacterial adhesion and growth, sheltered from cleaning actions. The impact of surface roughness on bacterial adhesion and growth has indeed been underlined in other studies (for review see Quirynen et al. 1999).

The effect of tongue cleaning on taste sensation has so far not been examined extensively. Winkler et al. (1999) found that tongue brushing increased taste acuity in geriatric patients (especially in denture wearers) by removing the thick layer of tongue plaque. A similar observation was found in our subjects with slight increases in taste recognition for the four flavours, especially for salt and bitter. Why these two tastes are most influenced remains unclear since all four basic tastes can be perceived on all different taste buds over the tongue (Bartoshuk 1993).

About the subjective evaluation of the two instruments used, the main complaint of the test persons was the gagging reflex. The latter causes the unpopular profile of tongue-cleaning devices (Rowley et al. 1987, Christensen 1998). Our observation of reduced gagging with the scraper in comparison

with a brush, however, confirms previous observations (Rowley et al. 1987). So far, more people accept a brush to clean the tongue because it does not require an additional tool (Rowley et al. 1987).

Conclusion

Our study demonstrates that one can achieve a significant reduction in tongue coating but only a limited reduction of the bacterial load when using a tongue cleanser such as a brush or a scraper. This seems to indicate that the beneficial effect of tongue cleaning on oral malodor is primarily related to the removal of the substratum for bacteria, and not to the reduction of the bacterial load itself.

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