Abstract: To compare the effectiveness of full- and partial-mouth disinfection for halitosis control, patients were assigned to treatment with full-mouth therapy (complete scaling and root planing in one stage within 24 h) or conventional therapy in quadrants (scaling and root planing performed by quadrant over a period of 4 weeks) \((n = 90\) for each group). Both groups were then subdivided: half the patients scraped their tongue daily and half did not. The patients were then evaluated by halimeter, organoleptic testing, and tongue coating index. Halimeter evaluation showed greater reduction of sulfide gases after full-mouth therapy than after conventional therapy \((P < 0.001)\). However, organoleptic testing and the tongue coating index showed no difference among the four treatment groups. There was also no difference in relation to tongue scraping. In conclusion, halimeter evaluation showed that the reduction in volatile sulfur compounds was significantly greater after full-mouth therapy than after conventional therapy. However, this difference was not observed in organoleptic evaluation. (J Oral Sci 57, 1-6, 2015)

Keywords: halitosis; periodontitis; scaling and root planning; bad breath; full-mouth.

Introduction

Halitosis can be a serious social problem, but standard dental treatments and mouthwashes (1), which contain chlorhexidine (CHX) or chlorine dioxide (2), are not ideal treatments. The main cause of halitosis is bacterial putrefaction of organic substrates in the oral cavity (3). These bacteria may be present in subgingival plaque, and there is no specific bacterial species responsible for production of volatile sulfur compounds (VSC) (4). Bacteria that produce VSC colonize the lingual dorsum and are responsible for development of halitosis (1). Porphyromonas, Prevotella, Actinobacillus, and Fusobacterium species are the most frequently identified organisms. However, only a small number of studies have investigated bacterial colonization in detail (5).

Periodontal patients have high levels of VSC and may have more tongue coating as compared with healthy patients (6,7). Periodontal treatment removes dental calculus and cement contaminated with toxins or microorganisms (8). Debridement with conventional instrumentation is performed by quadrant (with a 1-week interval between quadrants) or at a single session (full-mouth disinfection), the preferred approach for treatment of periodontal infections (9).

Halitosis treatment attempts to eliminate oral pathologies and control bacterial biofilm, thereby efficiently reducing the oral microbiota. Treatment must be accompanied by professional dental prophylaxis, i.e., removal of dental cavities and plaque retentive factors (10). Intraoral conditions such as insufficient dental hygiene, periodontitis, and tongue coating are the leading causes
of halitosis (85% of cases). Therefore, dental care professionals are the first to be confronted with this problem (5).

Tongue cleaning removes about 70% of oral sulfides and is therefore essential in oral care (11). Effective halitosis treatment is believed to require the use of scrapers to remove the tongue coating and biofilm covering the tongue dorsum (12). This removal is often described as the most effective treatment for halitosis (13). A clear treatment plan should be designed for patients with halitosis, which are mainly periodontal patients (14).

In the present study we compared the effectiveness of full- and partial-mouth disinfection for control of halitosis.

**Materials and Methods**

**Study design**

This intervention study (Fig. 1) was performed between May 2010 and September 2011 and was designed (15-17) to compare the effects of conventional and full-mouth periodontal treatments on halitosis in periodontal patients.

Consecutive patients with periodontal disease were randomly divided into four groups:

- PTSS+CHX+TS: Full-mouth periodontal therapy in a single session plus CHX mouthwash, with tongue scraping
- PTSS+CHX: Full-mouth periodontal therapy in a single session plus CHX, without tongue scraping
- PTQ+TS: Conventional periodontal therapy in quadrants, with tongue scraping
- PTQ–TS: Conventional periodontal therapy in quadrants, without tongue scraping

The patients in groups PTSS+CHX+TS and PTQ+TS received tongue scrapers daily and appropriate instruction in tongue scraping technique. CHX was included based on the results of a previous study of full-mouth periodontal therapy (15). The 15-mL solution of 0.2% CHX, without alcohol, was used twice daily for 60 s.

**Patient selection**

Patients were selected if they satisfied the inclusion criteria, namely, absence of dental decay; presence of generalized chronic periodontitis (8) with at least 20 teeth and a probing pocket depth (PPD) ≥5 mm in at least six sites; absence of systemic disease, as documented by their primary care physician; no periodontal treatment in the previous 12 months; no use of antibiotics in the previous 6 months; no history of radiation therapy for the neck or head; and no current smoking. Factors such as diet, food impaction, oral hygiene, and hyposalivation were also well controlled in this study by the examiner at each appointment.

All participants were informed of the importance and purpose of the study and provided written informed consent. The study was previously approved by the Ethics Committee of University of the Estate of Rio de Janeiro (0082.0.228.000-10).

Sample size was determined based on the findings of previous studies. The estimated number of individuals required to reach a power of 0.8 for the design of this study was 15 patients per group (standard deviation of the error, 1.84; detectable difference, 2.43). Therefore, we enrolled 90 participants, 44 women and 46 men, aged 38-66 years (average 47.74 ± 14.26).

**Experimental phase**

No specific instruction was given for brushing/rinsing technique, but the volunteers were strongly encouraged...
to use the same technique on each test day. Patients assigned to tongue scraping were instructed to use a Kolbe cleaner to scrape their tongue, using three strokes over the dorsum of the tongue. The participants were also instructed to avoid eating/drinking on the evening before treatment, until they were tested. Test participants reported to the dental school in the morning at the scheduled time.

The patients were instructed to avoid oral hygiene measures in the morning, to permit measurement of morning bad breath (2). The presence of halitosis was evaluated with a previously calibrated halimeter (Interscan Corp. Halimeter, Chatsworth, CA, USA) and organoleptic testing. The halimeter was a VSC monitor that collects volatile sulfur gases from the mouths of patients and expresses VSC concentrations in parts per billion (ppb) (18). The organoleptic test is considering the gold standard for evaluation because of its clinical relevance: the human nose can inhale more than 10,000 odors, not only sulfur gases (19). In addition, organoleptic testing was performed by the same calibrated examiner, who inhaled breaths from the mouths of patients and assigned a score of 0–4 (0 = no odor; 1 = natural odor; 2 = distance about 15 cm; 3 = about 50 cm; 4 = >50 cm) (19). The kappa coefficient of agreement was 0.930 for the organoleptic test.

The patients were also evaluated with the visible plaque index (VPI) (20), which evaluates the presence (1) and absence (0) plaque, and with the gingival bleeding index (GBI) (20). All surfaces of four sites of the teeth were examined, and the presence or absence of gingival bleeding was determined by light inspection of the gingival sulcus with a periodontal probe. The number of gingival margins with bleeding was expressed as a percentage of the total number of gingival margins.

Assessment of an index of tongue coating (Winkel Tongue Coating Index; WTCI) (21) was done as follows: the dorsum of the tongue was divided into six sextants: three in the back and three in the front. The tongue coating in each sextant was scored as 0 (no coverage), 1 (mild coverage), or 2 (severe coverage). The total value for tongue coating was the sum of the values from the six areas (score range, 0–12). The tongues of participants were photographed, and these photographs were clinically assessed by the same calibrated examiner. The kappa coefficient of agreement was 0.871.

A periodontal examination was performed at baseline and at 30, 60, and 90 days after treatment. These examination also included (22) assessment of probing on pocket depth (PPD) (the distance from the gingival margin to the bottom of pocket), clinical attachment level (CAL) (the distance from the cement-enamel junction to the bottom of the pocket), and bleeding on pocket probing (BoP) (presence/absence of bleeding 30 s after probing). These measurements were performed at four points (mesial, buccal, distal, and palatal/lingual) by a calibrated examiner using a periodontal probe (University of North Carolina type, 15 mm; Hu-Friedy, Chicago, IL, USA; kappa coefficient, 0.988).

Periodontal therapy was then performed for all teeth, with ultrasonic debridement (tip P10; Cavitron, Dentsply, Tulsa, OK, USA) and McCall 13/14 and 17/18 and Gracey 5/6, 7/8, 11/12, and 13/14 manual curettes and Hirschfeld #5-11 periodontal files (Hu-Friedy) for root planning and supra- and subgingival scaling with anesthetic blocking of the region.

Conventional therapy required four visits per patient; full-mouth therapy required one visit. The first re-evaluation (PPD, CAL, and BoP) was performed 30 days after the end of treatment (22). The same measurements were made at 60 and 90 days after the end of treatment.

The patients did not receive supragingival or subgingival treatment after the initial periodontal treatment, only instruction in oral hygiene, when necessary. The treatments successful, and no patients required dental surgery during 90 days after completion of treatment.

**Statistical analysis**

The Shapiro-Wilk test was used to determine if the values were parametric. The significance of differences between treatment groups was analyzed using ANOVA and then the Tukey test. All differences were considered significant at $P < 0.05$. Statistical analyses were performed using the SigmaPlot statistical software package (Systat Software Inc., San Jose, CA, USA).

**Results**

ANOVA showed significant differences ($P < 0.001$) among groups in halimeter, organoleptic, and WTCI values. Tables 1 and 2 show the results of periodontal and halitosis assessment in the different treatment groups at baseline and 90 days after treatment.

Halimeter testing showed similar results between full-mouth treatments (PTSS+CHX+TS vs. PTSS+CHX; Fig. 2) and between conventional treatments (PTQ+TS vs. PTQ–TS; Fig. 2) at 30, 60, and 90 days. Reduction of VSC was significantly greater ($P < 0.001$) in patients receiving a full-mouth treatment (PTSS+CHX+TS and PTSS+CHX; Fig. 2) than for those receiving a conventional therapy (PTQ+TS and PTQ–TS).

Organoleptic testing at 30, 60, and 90 days showed no significant difference between treatment groups.
WTCI at 30, 60, and 90 days showed a reduction of tongue coating in all groups but no significant difference between the four treatment groups. At 90 days, patients who had received full-mouth treatment with tongue scraping (group PTSS+CHX+TS) had a greater reduction in tongue coating. There was no significant difference between patient groups in baseline tongue coating index.

Organoleptic testing showed a significant difference when compared the different periods (30, 60, and 90 days; \( P < 0.001 \)) in group PTQ+TS, which experienced a decrease in halitosis throughout the 90-day observation period.

At 90 days there was no statistical difference in periodontal parameters between full-mouth and conventional therapies. However, PPD, CAL, and BoP showed that both therapies significantly reduced clinical parameters at 30, 60, and 90 days, as compared with baseline values.

**Discussion**

Several reports have identified periodontitis as an important cause of halitosis (7,23-26). In this interventional study, patients received one of four treatments in order to compare the effectiveness of full-and partial-mouth disinfection for control of halitosis. A previous study (16) restricted enrollment to patients with a tongue coating index greater than 4 on the WTCI and an organoleptic measurement greater than 2. The present study used different inclusion criteria, as did another previous study (4).

A previous study (15) found that full-mouth treatment was more effective than conventional therapy in quadrants at controlling halitosis. Patients who received the combination of full-mouth treatment+CHX+CPC for 2 months improved on organoleptic testing but not on VSC halimeter testing. The authors of that study used only nonsurgical periodontal treatment, without tongue scraping. The present results showed the opposite: halimeter testing at 30, 60, and 90 days showed a better result in patients receiving full-mouth treatment than in those receiving conventional treatment. No difference was seen on organoleptic testing. Another study from the same group (27), found a significant reduction in VSC

| Table 1 | Baseline values for periodontal and halitosis variables, by intervention group |
|---------|-------------------------------------------------|
|         | PTSS+CHX+TS | PTSS+CHX | PTQ+TS | PTQ-TS |
| VPI (%) | 24.65 ± 8.36 | 22.80 ± 9.37 | 19.40 ± 6.37 | 20.30 ± 7.44 |
| GBI (%) | 38.47 ± 19.66 | 39.44 ± 19.45 | 31.44 ± 18.38 | 34.44 ± 18.35 |
| BOP (%) | 78.69 ± 22.56 | 85.49 ± 21.44 | 90.33 ± 19.54 | 89.23 ± 18.24 |
| PPD (mm) | 6.28 ± 1.02 | 6.37 ± 1.12 | 6.56 ± 1.33 | 6.27 ± 1.33 |
| CAL (mm) | 7.25 ± 1.56 | 7.15 ± 1.42 | 7.18 ± 1.40 | 7.08 ± 1.61 |
| OLS (mean ± SD) | 1.5 ± 0.3 | 1.8 ± 0.2 | 2.2 ± 0.3 | 1.9 ± 0.4 |
| VSC (mean ± SD) | 109 ± 32 | 98 ± 23 | 112 ± 44 | 108 ± 37 |
| WTCI (mean ± SD) | 4.7 ± 1.9 | 6.1 ± 2.7 | 5.6 ± 3.7 | 4.9 ± 2.7 |

PTSS: periodontal therapy in a single session (full-mouth), CHX: chlorhexidine rinsing, TS: tongue scraping, PTQ: conventional periodontal therapy in quadrants, VPI: visible plaque index, GBI: gingival bleeding index, PPD: pocket probing depth, CAL: clinical attachment level, BOP: bleeding on probing, OLS: organoleptic score (0-4), VSC: volatile sulfide compounds (ppb), WTCI: Winkel tongue coating index (0-12).

| Table 2 | Values for periodontal and halitosis variables at 90 days after treatment, by intervention group |
|---------|-------------------------------------------------|
|         | PTSS+CHX+TS | PTSS+CHX | PTQ+TS | PTQ-TS |
| VPI (%) | 6.99 ± 4.38 | 7.89 ± 5.30 | 7.66 ± 4.12 | 8.64 ± 3.99 |
| GBI (%) | 16.56 ± 8.25 | 17.37 ± 10.22 | 16.55 ± 11.26 | 15.35 ± 12.28 |
| BOP (%) | 13.52 ± 15.90 | 14.80 ± 22.30 | 16.29 ± 25.63 | 17.28 ± 29.43 |
| PPD (mm) | 3.99 ± 1.22 | 4.77 ± 1.43 | 4.60 ± 1.22 | 4.88 ± 1.61 |
| CAL (mm) | 6.01 ± 1.73 | 6.11 ± 1.83 | 6.03 ± 1.89 | 6.10 ± 2.22 |
| OLS (mean ± SD) | 0.4 ± 0.3 | 0.6 ± 0.3 | 0.2 ± 0.4 | 0.5 ± 0.5 |
| VSC (mean ± SD) | 53 ± 12 | 44 ± 13 | 62 ± 7 | 54 ± 11 |
| WTCI (mean ± SD) | 1.6 ± 0.5 | 0.8 ± 0.3 | 1.8 ± 0.9 | 1.9 ± 0.7 |

PTSS: periodontal therapy in a single session (full-mouth), CHX: chlorhexidine rinsing, TS: tongue scraping, PTQ: conventional periodontal therapy in quadrants, VPI: visible plaque index, GBI: gingival bleeding index, PPD: pocket probing depth, CAL: clinical attachment level, BOP: bleeding on probing, OLS: organoleptic score (0-4), VSC: volatile sulfide compounds (ppb), WTCI: Winkel tongue coating index (0-12).
and tongue coating among patients with moderate periodontitis who received full-mouth therapy, as was noted in the present study.

Two studies (23,28) found a compatible concentration of VSC and the periodontal parameters, the authors showed that periodontal patients had more VSC. In the present study, we noted a nonsignificant reduction in periodontal parameters (data not shown) in all periodontal groups.

A previous study (29) measured VSC in 210 periodontal pockets of 70 patients and found that PPD and radiographic bone loss were positively associated with VSC levels. In another study (16), VSC concentrations were not significantly correlated with average PPD, CAL, or VPI. Only BoP was related to VSC concentrations. These findings suggest that halitosis is more severe in persons within inflammatory conditions (30). In the current study, the reduction in BoP was greater at 30 and 60 days, but not at 90 days, in patients receiving full-mouth therapy.

A previous study (31) evaluated the effects of periodontal treatment and tongue cleaning on oral halitosis parameters and found that periodontal treatment was quite important and that tongue cleaning was somewhat important in reducing halitosis in periodontitis patients. A study (32) comparing full-mouth scaling and root planning with quadrant scaling and root planning in 40 patients with chronic periodontitis over a period of 6 months found that full-mouth therapy was not more effective. Nevertheless, both modalities were efficacious. Those findings were confirmed by our results.

A halimeter study (4) of 127 patients showed a significant decrease in VSC after rinsing with CHX for 7 days. The authors concluded that, in addition to periodontal treatment, use of antiseptics can reduce halitosis. However, in the present study we found a reduction in halitosis in all groups; thus, CHX was not the determining factor. Some studies (27,30,33) that compared full-mouth and conventional therapies and included CHX groups and placebo found no effect for CHX during 6 months of follow-up. In the present study, the patient groups receiving full-mouth treatment also received CHX, but the results for these groups did not significantly differ, which confirms the findings of earlier studies. A systematic review (34) showed that full-mouth treatment, with or without antiseptics, had no significant clinical benefit for patients with chronic periodontitis.

In conclusion, halimeter evaluation showed that reduction in halitosis was significantly greater after full-mouth therapy than after conventional therapy. However, organoleptic testing showed no difference between treatment groups. Tongue scraping had no effect on halitosis.

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