

Comparison of halitosis parameters and sialometry between patients subjected to head and neck radiotherapy and patients with periodontal disease

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Abstract

Aim: The aim of this study was to evaluate halitosis parameters and sialometry in patients subjected to head and neck radiotherapy compared to patients with periodontal disease, establishing a relationship between oral concentration of volatile sulfur compounds (VSCs) and tongue coating presence, salivary flow rate and BANA_{TM} test. **Methods:** Thirty-eight patients were examined and divided into 2 groups: *group I*: patients with chronic generalized periodontal disease previously diagnosed and not treated; *group II*: patients subjected to head and neck radiotherapy. All volunteers were subjected to halitosis measurements through a sulphide monitor, evaluation of tongue coating weight, stimulated and non-stimulated sialometry and BANA_{TM} test. **Results:** The results were analyzed by analysis of the variance, Pearson's correlation coefficient and Student's t-test, showing that both groups presented halitosis. There was also a relationship between tongue coating presence and VSC levels in both groups and the irradiated patients showed lower salivary flow rates. **Conclusions:** Under the tested conditions, it may be concluded that halitosis can be considered as an adverse effect of radiotherapy, associated with low salivary flow and poor oral health, which seems to be the main contribution to bad breath, since patients with periodontal disease also showed halitosis.

Keywords: halitosis, radiotherapy, head and neck neoplasms, periodontitis.

Received for publication: January 28, 2011

Accepted: May 20, 2011

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Introduction

Radiotherapy, alone or associated with surgery or chemotherapy, is the therapeutic method indicated in cases of oral cancer and has produced a significant increase in cure rates for several malignancies of the head and neck¹. The adverse effects of head and neck radiotherapy are very important for the dental surgeon, who has a key role in preventing and/or minimizing their occurrence. Salivary

glands are radiosensitive and the atrophic and acinar degeneration caused by radiotherapy commonly result in reduction of the saliva production²⁻⁵.

Halitosis is highly associated with the amount of saliva⁶. It has been shown a relationship between hyposalivation and radiotherapy, as well as between halitosis and periodontal disease. However, the association among these variables is not well known. There is only one study which established a correlation between halitosis and head and neck radiotherapy, through evaluation of halitosis and sialometry in patients who had undergone radiotherapy when compared to healthy and non-irradiated individuals⁷. However, there are no studies comparing halitosis between irradiated patients and patients with periodontal disease.

The aim of this study was to establish a correlation between halitosis and head and neck radiotherapy, through evaluation of halitosis and sialometry in patients who had undergone radiotherapy in comparison to patients with periodontal disease.

Material and methods

This study was approved by the Human Research Ethics Committee of Bauru Dental School, University of São Paulo, Brazil (process #104/2005) and is in accordance with the Helsinki Declaration of 1975, revised in 1983. All volunteers signed an informed consent form. The sample was composed of 38 patients, divided into two groups: Group I: 13 patients from the screening sector of the Bauru Dental School, with generalized chronic periodontal disease previously diagnosed but not treated; Group II: 25 volunteers selected among patients from Manoel de Abreu Hospital, referenced for cancer treatment in the city of Bauru, SP, Brazil. The sample size was justified by the fact of many patients have not finished the radiotherapy treatment at the moment of the consultation and only volunteers with the treatment completed were included in the study. In Group I, patients with localized or treated periodontal disease were excluded, which reduced the initial sample size. All patients were selected among a population of each Institution, both with spontaneous demand. Careful exam and screening of these patients according to the exclusion and inclusion criteria led to the reduction of the sample; however, according to the statistician responsible for this study, the sample size was appropriated.

Patients of Group I presented periodontal pockets > 5 mm in all molars and incisors, bleeding on probing and generalized vertical bone loss observed radiographically. The diagnosis of these patients was chronic generalized periodontal disease. Patients of Group II were subjected to radiotherapy as the main or complementary treatment of head and neck tumors. The radiation area covered at least one of the major salivary glands or part of them. The radiotherapy treatment of all patients had already been concluded and they were under continuous monitored from 1 to 6 months after the last radiotherapy session. It is important to emphasize that all patients of Group II were periodontally healthy, that is, they did not present bleeding on probing or

periodontal pockets > 4 mm). Also, the sequelae of the radiotherapy treatment (e.g.: radiation caries and mucositis) were treated in the period between the radiotherapy and this research.

The management of the patients was similar to a previous study⁷. All patients underwent two appointments conducted by the same examiner. In the first one, the patients received some guidelines for the procedures to be carried out in a further moment: avoid spicy and/ or flavored food 24 h before the clinical appointment; avoid brushing the teeth, using dental floss, chewing gum, drinking alcoholic drinks and smoking 3 h before the clinical appointment and not being using perfume at the moment of the appointment.

Halimetry

The halimetry values in all individuals were obtained using a sulfide monitor (Halimeter; Interscan Corporation, Chatsworth, NJ, USA). Before measurements, patients were kept seated, relaxed and without talking for 1 min, with their mouth closed. A disposable plastic tube connected to the monitor was introduced 4 cm inside the patient's mouth⁷. The patients were instructed to leave their mouth slightly opened on the tube without inhaling or exhaling during the analysis. Those measures were taken three times, which resulted in a final average.

Evaluation of tongue coating and new halimetry measurements

After removing the excess of humidity of the tongue with gauze, the tongue coating was removed with a tongue cleaner and placed in a previously weighted filter paper. The material was stored for 24 h for drying and weighing. The tongue coating weight was obtained using a digital precision scale (A&D System Co., Ltd. Tokyo, Japan). Immediately after removing the tongue coating, halimetry was performed again, in order to identify possible variations in the VSCs concentrations⁷.

BANATM Test (benzoyl-DL-arginine-2 naphthylamide)

The test was performed to identify a possible relation between the presence of microorganisms BANA positive and the values of halimetry. A small amount of tongue coating was collected and transferred to the BANA test strip (BANAMet LLC, Ann Arbor, MI, USA). A drop of distilled water was poured on the reagent strip, which was folded and kept this way with a paperclip, so that the reagent would be in contact with the organic material, left undisturbed for 24 h, as indicated by the manufacturer. After that period, the reaction was noted and the result obtained, classified as negative and positive, according to the obtained color⁷.

Sialometry

After remaining 5 min at rest, with the eyes opened, without stimulating salivation, each patient spit out all saliva obtained in that period in a recipient graded in millimeters (mL) to obtain the non-stimulated salivary flow. After this

procedure, each patient was given a piece of sterile hyperboloid which was used to stimulate salivation through mastication for 5 min, and the saliva obtained was also placed in a recipient graded in mL to obtain the stimulated salivary flow⁷.

Radiotherapy treatment protocol

The radiotherapy treatment protocol was the same for all patients of Group II. All selected patients have had at least one of the major salivary glands involved in the area of radiation and the protocol of radiotherapy was the same used in the patients of a previous study⁷.

Statistical analysis

The results were analyzed by ANOVA and Tukey's test for the variables that quantified halitosis before and after removing tongue coating. The relationship among oral halimetry, dry weight of tongue coating and stimulated/non-stimulated salivary flow rate were analyzed by Pearson's correlation test. Student's t-test was used to verify the correlation between halimetry and BANA test. A significance level of 5% was used for all analyses. The computer software used was Microsoft Office Excel 2007.

Results

Group I presented lower initial halimetry average (148.102 ppb) when compared to Group II (143.747 ppb), with no statistically significant difference (Table 1). The dry weight of tongue coating in Group II (0.016mg) was smaller than in Group I (0.0245 mg), but this difference was not significant (Table 1). Group II showed a decrease in salivary flow, in stimulated and non-stimulated sialometry, with a statistically significant difference ($p < 0.001$) (Table 1).

In the evaluation of the correlation between the studied variables and halitosis, in Group I this correlation was noted between initial halimetry and presence of tongue coating ($p = 0.012$) and between initial and final halimetry ($p < 0.001$) (Table 2). Group II, showed a significant correlation between initial halimetry and presence of tongue coating ($p = 0.043$), between initial and final halimetry ($p < 0.001$) and between stimulated and non-stimulated salivary flow ($p < 0.001$) (Table 3).

In both groups, the number of negative BANA_{TM} tests

Table 2 - Pearson's correlation test between the variables and halitosis in Group I.

Variables	r	p
IH x TC	0.672	0.012*
IH x NSSF	0.238	0.434
IH x SSF	0.037	0.904
IH x FH	0.971	0.000*
TC x NSSF	0.132	0.668
TC x SSF	0.269	0.374
NSSF x SSF	0.049	0.873

*- statistically significant difference ($p < 0.05$). **IH** – initial halimetry; **FH**- final halimetry – after removing the tongue coating (ppb); **TC** – dry weight of tongue coating (mg); **NSSF** – non-stimulated salivary flow (mL); **SSF**- stimulated salivary flow (mL)

Table 3 - Pearson's correlation test between the variables and halitosis in Group II.

Variables	r	p
IH x TC	0.407	0.043*
IH x NSSF	0.021	0.918
IH x SSF	0.197	0.344
IH x FH	0.861	0.000*
TC x NSSF	0.069	0.740
TC x SSF	0.172	0.411
NSSF x SSF	0.882	0.000*

*- statistically significant difference ($p < 0.05$). **IH** – initial halimetry; **FH**- final halimetry – after removing the tongue coating (ppb); **TC** – dry weight of tongue coating (mg); **NSSF** – non-stimulated salivary flow (mL); **SSF**- stimulated salivary flow (mL)

($n = 25$) was greater than the positive results ($n = 23$), with a statistically significant difference among the negative and positive results and halimetry in Group I ($p = 0.017$) and when the entire sample was analyzed together ($p = 0.003$) (Table 4).

Table 4 - Student's t-test for comparison between halimetry and positive and negative BANA_{TM} test groups.

	Negative mean \pm sd		Positive mean \pm sd		T	p
All	104.1	51.2	157.3	67.1	-3.10	0.003*
Group I	100.7	44.1	177.7	50.2	-2.80	0.017*
Group II	128.1	45.6	167.1	77.6	-1.58	0.126

*- statistically significant difference ($p < 0.05$)

Table 1 - Mean (SD) obtained for the variables IH, FH, TC, NSSF and SSF in Groups I and II.

Variables	Group I mean \pm sd		Group II mean \pm sd		p value
IH	148.102	60.324	143.747	62.092	ns
FH	137.846	57.887	123.453	49.670	ns
TC	0.0245	0.009	0.016	0.017	ns
NSSF	4.26	1.386	1.448	1.015	0.000*
SSF	9.085	1.664	2.548	1.660	0.000*

*statistically significant difference ($p < 0.05$); ns - non statistically significant difference. **IH** – initial halimetry; **FH**- final halimetry – after removing the tongue coating (ppb); **TC** – dry weight of tongue coating (mg); **NSSF** – non-stimulated salivary flow (mL); **SSF**- stimulated salivary flow (mL)

Discussion

Regarding oral halimetry, Group I presented lower initial average when compared to Group II (Table 1), but without statistically significant difference. However, in the present study, the use of the sulfide monitor enabled the evaluation only of the relation between VSCs and halitosis. This is a limitation of methodology since bad breath is caused by other volatile organic compounds and other gases⁸.

Final halimetry was performed soon after tongue cleaning. A previous study⁷ demonstrated that the values of halimetry can decrease substantially immediately after the tongue cleaning. It is known that tongue coating is an important etiological factor of halitosis⁹. Waler¹⁰ showed that the largest production of VSCs is in the tongue dorsum. Yaegaki and Sanada¹¹ reported that removing tongue coating reduced by 50% the production of VSCs. Albuquerque et al.⁷ found a relationship between presence of tongue coating and VSCs levels, with a decrease in the values of halimetry after removing tongue coating. Boever and Loesche¹² noticed that the score of oral breath was highly connected to the odor of the tongue, presence and extension of coating. In this work, the values of initial halimetry were greater than final halimetry in both groups. However, there was no statistically significant difference (Table 1). Since the tongue cleaner shows a higher percentage of reduction of VSCs than the tooth brush¹³, it justifies the use of this tool in the methodology of this research. In our study, the amount of tongue coating was evaluated quantitatively after drying, confirming methodologies used by other studies^{7,11,14}. The dry weight of tongue coating in patients with periodontal disease was greater than in the irradiated patients, but the difference was not statistically significant. This finding is a little surprising because it is well established that the tongue coating is a result of the hyposalivation⁷. Salivary reduction provides the implantation of the tongue coating because the saliva becomes more viscous, with higher amounts of mucin, increasing the adherence of microorganisms and epithelial debris in the tongue. As the bacteria present in the tongue coating and in the periodontal pockets are similar (anaerobic proteolytic), colonization of the tongue can be favored in patients with periodontal disease. However, it does not explain the higher amounts of tongue coating in Group I than in Group II, since irradiated patients have an outstanding decrease in salivary flow, the main etiological factor of tongue coating. Perhaps the poor hygiene, which is common in patients with periodontal disease, can explain this finding of the present work.

Regarding salivary flow, there was significant difference between the groups in stimulated and non-stimulated sialometry (Table 1). All patients in Group II showed a decrease in the amount of saliva. The value of 0.1 mL/min for salivary flow without stimulus was considered severe glandular hypofunction. There was a decrease in sialometry without stimulus from group II of 66.03% compared to Group I. Albuquerque et al.⁷ found a decrease in sialometry without stimulus in irradiated patients of 56.51% when compared to healthy patients.

In Group I, correlation between the studied variables and halitosis was noted between initial halimetry and presence of tongue coating and between stimulated and non-stimulated salivary flow (Table 2). In group II, a significant correlation was observed between initial and final halimetry, between initial halimetry and presence of tongue coating and between stimulated and non-stimulated salivary flow (Table 3).

The BANA_{TM} test - an enzymatic method used as an indicator of the presence of microorganisms responsible for periodontal diseases - was performed in Groups I and II. Similarly to a previous study⁷, in both groups the number of negative tests was greater than positive results. In Table 4, it is noted that there was a significant difference among the negative and positive results and halimetry in Group I and when the entire sample was together. Some authors have not noted relation between the levels of VSCs and the results of lingual BANA_{TM} test¹⁵. According to Monteiro-Amado et al.¹⁴, there is not a relation between the value of BANA_{TM} test and the values of halimetry.

Irradiated patients did not have main complaint of halitosis. However, when they were questioned about oral bad breath, the majority answered that felt it. Patients with periodontal disease did not ask for treatment of halitosis, but they had complaints of bad breath and presented indication for periodontal treatment.

According to Conceição et al.¹⁶, halimetry above 100 ppb can be considered as halitosis. In this study, all evaluated patients, of both groups, presented halitosis, since the values of initial and final halimetry were greater than 100 ppb. However, there was no statistically significant difference between the groups, confirming the fact that the oral health condition is an important etiological factor of halitosis, and bad breath is strongly associated with periodontal disease. It is known that saliva incubation of patients with periodontal disease produces VSCs quickly, inducing an intense bad breath. The saliva of these patients produces more VSCs than the saliva of healthy people. Halitosis may occur in any individual, but it is emphasized when inflammatory and degenerative processes are present. For example, gingivitis and periodontitis are almost always associated with halitosis, which corroborates the findings of the present study.

The present work is a continuation of a previous study, which detected halitosis and hyposalivation in irradiated patients when comparing them with healthy people⁷. It is believed that the comparison of periodontally healthy irradiated patients, which recognizably have halitosis, and patients with periodontal disease can show the true degrees of halitosis in each group as well as demonstrate that both conditions play important roles in bad breath development.

It is known that hyposalivation is a definitive sequel of head and neck radiotherapy and that this condition plays a keyrole in halitosis pathogenesis⁶. We believe that the significant reduction in the amount of saliva is the most important parameter in the bad breath development in irradiated patients, since, in this research, they had a satisfactory oral condition. On the other hand, the significant differences among the negative and positive results and

halimetry of the BANA_{TM} tests in Group I show the substantial role of periodontopathogenic microorganisms in the development of halitosis in patients periodontally affected. Additionally, despite the lack of statistical significance, the dry weight of tongue coating in Group I was greater than in Group II, showing a close relationship between periodontitis and tongue coating, since the bacteria that colonize the tongue and periodontal pockets are the same. For these reasons, we agree that the most expressive factors that influence the halitosis formation in patients with periodontal disease are tongue coating and presence of periodontopathogenic microorganisms.

Summarizing our findings, halitosis was detected in patients with periodontal disease and patients subjected to head and neck radiotherapy and that there was relation between presence of tongue coating and VSCs levels in the studied groups. There was a significant decrease in the values of halimetry after removing tongue coating in both groups. Also, stimulated and non-stimulated salivary flow was extremely reduced in irradiated patients. According to the results obtained under the tested conditions, it is possible to conclude that halitosis is an adverse effect of head and neck radiotherapy and is strongly associated with periodontal disease.

Acknowledgements

The authors would like to thank Professor José Roberto Lauris for the support in the statistical analysis of this study. This investigation was supported by CAPES.

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