

Determining the association between oral malodor and periodontal disease: A case control study

Appaiah Chowdary Bolepalli, Chandrashekar Munireddy¹, Srujankumar Peruka¹, Tejaswin Polepalle, Leela Subhashini Choudary Alluri, Shiva Mishael²

Department of Periodontology, Sibar Institute of Dental Sciences, Guntur, Andhra Pradesh, ¹Department of Periodontics, Sri Sai College of Dental Surgery, Vikarabad, Telangana, India, ²Department of Periodontics, Islamic Azad University, Tehran, Iran

Corresponding author (email: <apchowdary15@gmail.com>)

Dr. Appaiah Chowdary Bolepalli, Department of Periodontology, Sibar Institute of Dental Sciences, Takkellapadu, Guntur, Andhra Pradesh, India.

Abstract

Aim: To assess the role of periodontal health in oral malodor causation and compare the two methods (organoleptic and Halimeter) of malodor measurement. **Materials and Methods:** A total of 240 subjects (60 subjects without any evidence of periodontal disease and 180 patients with gingivitis and periodontitis) were evaluated for periodontal and oral malodor parameters. Periodontal parameters included Plaque Index (PI), Gingival Index (GI), mSBI, calculus component of OHIS, pocket depth (PD), and clinical attachment level (CAL), and oral malodor was assessed by organoleptic scores, Halimeter readings, and Tongue Coating Index (TCI). **Results:** 80% of the sample when assessed organoleptically (i.e. 192 subjects) and 74.6% when assessed with Halimeter (i.e. 179 subjects) presented with varying degrees of halitosis. All the clinical parameters were significantly associated with oral malodor ($P < 0.001$). The amount of tongue coating and bleeding on probing played the most important role in increasing VSC concentration, followed by periodontal status, plaque indices, and calculus component. **Conclusion:** There was a high prevalence of halitosis in the present study population. All the clinical parameters were significantly related to oral malodor in this study, and the results indicate that determining VSC levels with Halimeter is a useful means of diagnosing halitosis objectively.

Key words: Halimeter, oral malodor, organoleptic assessment, tongue coating

INTRODUCTION

Bad breath (halitosis, oral malodor) is, for the most part, an oral condition^[1] and often is also associated with ENT, respiratory, gastrointestinal tract infections, certain systemic diseases, metabolic disorders, and carcinomas. It is an awkward and embarrassing problem for millions, and can also be a warning sign of medical and dental disease.^[2]

Vast majority of the causes of oral malodor relate to the oral cavity with gingivitis, periodontitis, and tongue coating as the predominant factors.

Although oral malodor is not caused by periodontal disease, there is ample evidence to suggest that periodontal disease increases the severity of malodor and periodontal diseases also contribute to an increased tongue coating and

Access this article online	
Quick Response Code:	Website: www.jispcd.org
	DOI: 10.4103/2231-0762.165929

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Bolepalli AC, Munireddy C, Peruka S, Polepalle T, Alluri LS, Mishael S. Determining the association between oral malodor and periodontal disease: A case control study. J Int Soc Prevent Communit Dent 2015;5:413-8.

higher production of volatile sulfur compounds.^[3] The association between periodontal disease and oral malodor, however, has been a matter of debate. While no significant association was noticed by one group of researchers,^[4,5] another major group did find an association.^[6-11]

The clinical assessment of oral malodor is usually subjective, and the various methods used to diagnose and assess halitosis are organoleptic method, portable sulfide monitors like Breathtron and Halimeter®, gas chromatography, OralChroma, electronic nose, dark-field or phase-contrast microscopy, and saliva incubation test. A recent development, the Halimeter, is a portable sulfur monitor which has widened the horizons of halitosis research.

The aim of the present study was to determine the association between periodontal disease and bad breath by recording periodontal health of subjects with conventional methods and the use of Halimeter [Figure 1]. Throughout this article, the terms bad breath, oral malodor, and halitosis are used synonymously.

MATERIALS AND METHODS

The study population consisted of 240 systemically healthy patients who were categorized into the following groups:

- Group A: Systemically healthy with good oral hygiene, Plaque Index (PI; Silness and Loe) score ≤ 0.9 , and calculus component of oral hygiene index simplified (OHIS) (Green and Vermillion) ≤ 0.6
- Group B: Systemically healthy subjects with chronic gingivitis, Gingival Index (GI; Loe and Silness) score of ≤ 3
- Group C: Systemically healthy with mild to moderate chronic periodontitis with clinical attachment level (CAL) of 1–4 mm, involving at least nine sites of six Ramfjord index teeth



Figure 1: Halimeter

- Group D: Systemically healthy with severe chronic periodontitis with CAL of ≥ 5 mm, involving at least nine sites of six Ramfjord index teeth.

Patients with known systemic diseases, any other oral pathological conditions, overhanging restorations/prosthesis, grossly decayed teeth, and adverse habits like smoking, alcohol consumption, or gutkha chewing were excluded from the study. Patients with a history of periodontal therapy in the preceding 6 months or those with a history of antibiotic use 3 months prior to the study were also excluded.

A single examiner performed all the clinical and malodor measurements. The clinical measurements were taken at the sites of Ramfjord index teeth, i.e. 16, 21, 24, 36, 41, 44. Pocket depth (PD) and CAL were assessed using UNC-15 probe at six sites around the teeth, i.e., mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, and distolingual. The other indices recorded were: PI (Silness and Loe, 1964),^[12] GI (Loe and Silness, 1963),^[13] calculus component of OHIS (Green and Vermillion, 1964), and modified sulcus bleeding index (Mombelli *et al.*, 1987).^[14]

Tongue coating was evaluated on a scale of 0–2 by inspecting the area of tongue coating.^[15] The dorsum of the tongue was divided into six areas, i.e. three in the posterior and three in the anterior part [Figure 2]. The tongue coating in each sextant was scored as follows: 0: no coating and no discoloration; 1: light coating; 2: severe coating. The final score for the individual was expressed as values ranging from 0 to 12.

Oral malodor assessment

Subjects were asked to refrain from oral activities including eating, drinking, chewing, brushing, using



Figure 2: Dorsum of tongue divided into six areas

scented cosmetics, and mouth rinsing 3 h prior to each appointment. Organoleptic assessment was performed by directly sniffing the expelled air from the patients' mouth. Subjects remained quiet (abstained from talking) and kept their lips closed for 2 min. They were then asked to exhale through the mouth briefly with a moderate force at a distance of approximately 10 cm from the nose of the evaluator. Organoleptic score was estimated on a scale of 0–5^[16] as follows: 0: no odor; 1: barely noticeable odor; 2: slightly but clearly noticeable odor; 3: moderate odor; 4: strong odor; 5: extremely foul odor.

The examination involving Halimeter involved strict adherence to manufacturer's instructions as given in their manual. Each subject was instructed to sit quietly without talking for 3 min prior to the measurement. A disposable plastic straw was attached to the air inlet of the monitor. The subjects were instructed to slightly open their mouth and the straw was inserted at a depth of approximately 1–2 inches, resting on the back of the tongue. The subjects were then asked to close the lips allowing a slight gap between the lips and the straw and continue breathing through the nose during the measurement [Figure 3]. A series of three separate 30 s samples were collected from each subject. The peak ppb values were displayed at the end of each sample period, after which an average peak ppb value for all three samples was displayed. There was a 3 min re-stabilization period before each sample was taken. Also, 110 ppb was used as a standard above which presence of halitosis was determined.

Statistic analysis

All the analyses were done using SPSS version 17 (SPSS Inc., Chicago, IL, USA). Mean scores of various clinical parameters among the four study groups were compared



Figure 3: Recording with Halimeter

using analysis of variance (ANOVA) with Games Howell *post-hoc* test. Correlations of clinical parameters with Halimeter and organoleptic measurements were done using Pearson's and Spearman's ranked correlation coefficient. Reliability between Halimeter and organoleptic measurements was assessed using kappa coefficient.

RESULTS

We found that 80% of the sample when assessed organoleptically (i.e. 192 subjects) and 74.6% of the sample when assessed with Halimeter (i.e. 179 subjects) presented with varying degrees of halitosis [Table 1].

The mean scores of PI, GI, calculus index simplified (CI-S), mSBI, Tongue Coating Index (TCI), PD, and CAL showed significant difference among the four groups ($P < 0.001$ respectively) [Table 2]. *Post-hoc* analysis showed that groups C and D had significantly higher mean scores for all the clinical parameters than groups A and B [Table 2].

The periodontitis groups (C and D) showed maximum tongue coating scores (7.67 ± 3.04 , 8.77 ± 2.44) as compared to groups A and B, with $P < 0.001$ [Table 2]. Groups B and C did not differ much in terms of mean TCI. However, severe periodontitis group showed a higher mean TCI as compared to groups A and B. Also, 87% of the subjects with severe halitosis exhibited higher tongue coating scores.

There was a significant positive correlation between organoleptic and Halimeter measurements with all the clinical parameters, i.e. PI, GI, CI-S, modified sulcus bleeding index (mSBI), TCI, PD, and CAL [Table 3].

The mean PD was highest in group D (5.20 ± 0.46) and decreased from group C to group A with $P < 0.001$ [Table 4]. Probing depths of <4 mm were associated with absence of halitosis and probing depths of >4 mm were associated to a greater extent with moderate to severe halitosis.

Table 1: Dichotomous analysis of subjects based on halitosis and periodontitis

	No periodontitis	Periodontitis	Total (N=240)
Halimeter®			
No halitosis	56 (91.8)	05 (8.2)	61 (25.4)
Halitosis	64 (35.7)	115 (64.2)	179 (74.6)
Organoleptic			
No halitosis	46 (95.8)	02 (4.2)	48 (20)
Halitosis	74 (38.5)	118 (61.4)	192 (80)

Table 2: Intergroup comparison of mean scores of various clinical and oral malodor parameters

Clinical parameters	Groups				P value	Post-hoc test
	Mean±SD					
	A (1)	B (2)	C (3)	D (4)		
PI	0.54±0.36	1.73±0.42	1.86±0.43	1.95±0.45	<0.001	2, 3>1, 4>1, 2
GI	0.58±0.31	1.69±0.44	1.90±0.41	2.01±0.39	<0.001	2>1, 3>1, 2, 4>1, 2
CI-S	0.48±0.21	1.77±0.47	1.91±0.50	2.12±0.42	<0.001	2, 3>1, 4>1, 2
mSBI	0.24±0.20	1.58±0.43	1.56±0.45	1.73±0.47	<0.001	2, 3, 4>1
TCI	2.67±3.30	7.62±2.24	7.67±3.04	8.77±2.45	<0.001	2, 3>1, 4>1, 2
HAL	79.43±42.24	245.32±129.69	278.23±150.99	372.32±198.64	<0.001	2, 3>1, 4>1, 2, 3
ORG	0.45±0.53	2.12±1.06	2.33±1.16	2.93±1.07	<0.001	2, 3>1, 4>1, 2, 3
PD	2.04±0.08	2.93±0.73	3.59±0.40	5.20±0.46	<0.001	4>3>2>1
CAL	0.08±0.14	1.76±1.04	3.60±0.40	4.54±0.45	<0.001	4>3>2>1

Statistically significant if $P \leq 0.05$. PI=Plaque Index, GI=Gingival Index, TCI=Tongue Coating Index, HAL=Halimeter® reading, ORG=Organoleptic assessment, PD=Pocket depth, CAL=Clinical attachment level, CI-S=Calculus index simplified, mSBI=Modified sulcus bleeding index

When the TCI, Halimeter readings, and Organoleptic assessment were correlated, significant correlations were found between the organoleptic scores and Halimeter readings ($r = 0.955, P < 0.001$), organoleptic and TCI scores ($r = 0.926, P < 0.001$), and Halimeter readings and TCI scores ($r = 0.935, P < 0.001$) [Table 4].

The reliability between the methods of assessment, i.e. organoleptic and Halimeter, was evaluated with the kappa statistic [Table 5]. It showed good agreement (0.772) between the two methods. The sensitivity and specificity of Halimeter was 92.2% and 91.7%, respectively, in comparison to the gold standard (organoleptic measurement).

DISCUSSION

The prevalence of halitosis when assessed organoleptically was 80% and with Halimeter was 74.6% in subjects with varying degrees of periodontal disease, which is a notable feature of the present study.

Previous studies have shown that males have significantly higher organoleptic score and volatile sulfur compounds (VSCs) than females,^[7] while others have shown that females are associated with increased malodor scores.^[8] The elevated VSC levels in females is attributed to various menstrual and luteal factors.

In our study, group D was associated with the highest mean plaque scores and also with highest malodor scores. However, this observation is contrary to the reported absence of any such correlation in other studies.^[8]

A positive correlation between bleeding scores and malodor has been reported in the literature.^[8] In our study, mSBI showed the strongest correlation with

Table 3: Correlation coefficient between oral malodor and periodontal parameters

Clinical parameters	Halimeter®		Organoleptic	
	r value*	P value	r value**	P value
PI	0.722	0.001	0.836	0.001
GI	0.747	0.001	0.844	0.001
CI	0.769	0.001	0.874	0.001
mSBI	0.816	0.001	0.908	0.001
TCI	0.763	0.001	0.902	0.001
PD	0.662	0.001	0.726	0.001
CAL	0.621	0.001	0.692	0.001

*r=Pearson's correlation coefficient, **r=Spearman's correlation coefficient, Statistically significant if $P \leq 0.05$. PI=Plaque Index, GI=Gingival Index, TCI=Tongue Coating Index, PD=Pocket depth, CAL=Clinical attachment level, CI-S=Calculus index simplified, mSBI=Modified sulcus bleeding index

Table 4: Pearson correlations between oral malodor parameters and tongue coating

	TCI	ORG	HAL
TCI			
Correlation coefficient		0.926**	0.935**
P value		<0.001	<0.001
N		240	240
ORG			
Correlation coefficient	0.926**		0.955**
P value	<0.001		<0.001
N	240		240
HAL			
Correlation coefficient	0.935**	0.955**	
P value	<0.001	<0.001	
N	240	240	

**Statistically significant $P \leq 0.05$. TCI=Tongue coating index, ORG=Organoleptic assessment, HAL=Halimeter® reading

both organoleptic as well as Halimeter scores, when compared to other parameters.

The tongue coating surface (TCS) observed in the present study showed a steady increase from group A

Table 5: Sensitivity and specificity of Halimeter® in relation to organoleptic assessment

	ORG		Sensitivity	Specificity
	Absent	Present		
HAL				
Absent	44 91.7%	15 7.8%	92.2%	91.7%
Present	4 8.3%	177 92.2%		

Kappa=0.772. ORG=Organoleptic assessment, HAL=Halimeter® reading

to group D, with maximum mean values in group D. This is in agreement with other studies where chronic periodontitis patients exhibited more tongue coating compared to healthy subjects.^[17] It is also reported that VSC production by the tongue coatings was four times higher in periodontal patients than in controls.^[17] Oral malodor is evidenced to be more strongly associated with tongue coating rather than the severity of periodontitis.^[18]

There are significant correlations reported in literature, where halitosis is found to be associated with increased number and depth of periodontal pockets,^[17] increased gingival crevicular fluid (GCF) volume, increased radiographic bone loss,^[7] and presence of periodontal pathogens. In the present study, there was a high correlation between the oral malodor readings and periodontal status.

It was also observed that as the probing depth and CAL increased from group A to D, so did their oral malodor scores. If we dichotomize groups A, B, C, and D into two groups, i.e. A, B (<4 mm PD) and C, D (>4 mm PD), groups C and D showed very high correlation with halitosis. This is in agreement with other studies where probing depths of >4 mm were found to be significantly associated with increased malodor.^[17]

The degree of halitosis in our study was assessed with two methods, i.e. organoleptically and with a Halimeter. The organoleptic method is the gold standard for the evaluation of halitosis. Although it lacks objectivity,^[19] it is used in large-scale surveys as well as in clinical settings if appropriate calibration is carried out.

In the present study, high correlation was found between organoleptic scores and Halimeter readings. Rosenberg and Delanghe found significant correlation between the two methods of assessment ($r = 0.603$ and $r = 0.273$, respectively). However, our study shows higher values ($r = 0.955$, $P < 0.001$).

CONCLUSION

There was a high prevalence of halitosis in the present study and within the limits of the study, it can be concluded that periodontal disease in its various levels has a significant contributory role in causation of oral malodor. At the same time, the role of tongue coating in the severity of oral malodor cannot be ignored. Tongue coating, organoleptic scores, and Halimeter readings either alone or in consort reflect oral malodor adequately.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Rosenberg M. Bad breath and periodontal disease: How related they are they? *J Clin Periodontol* 2003;33:29-30.
- Rosenberg M. First international workshop on oral malodour. *J Dent Res* 1994;73:586-9.
- Sato H, Ohkushi T, Kaizu T, Tsunoda M, Sato T. A study of the mechanism of halitosis occurrence in periodontal patients. *Bull Tokyo Dent Coll* 1980;21:271-8.
- Stamou E, Kozlovsky A, Rosenberg M. Association between oral malodour and periodontal disease-related parameters in a population of 71 Israelis. *Oral Dis* 2005;11(Suppl 1):72-4.
- John M, Vandana KL. Detection and measurement of oral malodour in periodontitis patients. *Indian J Dent Res* 2006;17:2-6.
- Loesche WJ, Kazor C. Microbiology and treatment of halitosis. *Periodontol* 2000 2002;28:256-79.
- Morita M, Wang HL. Relationship between sulcular sulfide level and oral malodor in subjects with periodontal disease. *J Periodontol* 2001;72:79-84.
- Liu XN, Shinada K, Chen XC, Zhang BX, Yaegaki K, Kawaguchi Y. Oral malodor-related parameters in the Chinese general population. *J Clin Periodontol* 2006;33:31-6.
- Yokoyama S, Ohnuki M, Shinada K, Ueno M, Wright FA, Kawaguchi Y. Oral malodor and related factors in Japanese senior high school students. *J Sch Health* 2010;80:346-52.
- Tsai CC, Chou HH, Wu TL, Yang YH, Ho KY, Wu YM, *et al.* The levels of volatile sulfur compounds in mouth air from patients with chronic periodontitis. *J Periodontol Res* 2008;43:186-93.
- Makino Y, Yamaga T, Yoshihara A, Nohno K, Miyazaki H. Association between volatile sulfur compounds and periodontal disease progression in elderly non-smokers. *J Periodontol* 2012;83:635-43.
- Silness J, Loe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. *Acta Odntol Scand* 1964;22:121-35.
- Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odntol Scand* 1963;21:533-51.

14. Newbrun E. Indices to measure gingival bleeding. *J Periodontol* 1996;67:555-61.
15. Winkel EG, Roldán S, Van Winkelhoff AJ, Herrera D, Sanz M. Clinical effects of a new mouthrinse containing chlorhexidine, cetylpyridinium chloride and zinc-lactate on oral halitosis. A dual-center, double-blind placebo-controlled study. *J Clin Periodontol* 2003;30:300-6.
16. Rosenberg M, McCulloch CA. Measurement of oral malodor: Current methods and future prospects. *J Periodontol* 1992;63:776-82.
17. Yaegaki K, Sanada K. Biochemical and clinical factors influencing oral malodor in periodontal patients. *J Periodontol* 1992;63:783-9.
18. Morita M, Wang HL. Association between oral malodor and adult periodontitis: A review. *J Clin Periodontol* 2001;28:813-9.
19. Van Steenberghe D. Breath malodor. *Curr Opin Periodontol* 1997;4:137-43.