Self Reported Halitosis in Relation to Glycated Hemoglobin Level in Diabetic Patients

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Abstract: *Objective:* This study was conducted to examine the relationship between the glycated hemoglobin level (HbA1c) and halitosis status among diabetic patients affected with periodontitis and to examine if there is a relationship between halitosis and different periodontal parameters.

Methods and Materials: Consecutive type 2 diabetic patients were recruited from patients presented for treatment at a University hospital. Age, gender and smoking were recorded. A structured questionnaire on patients' perception of their oral health, halitosis and diabetes severity and control was completed. Peripheral blood samples were obtained and analyzed for HbA1c levels. In addition, periodontal clinical parameters including probing depth, clinical attachment level, bleeding on probing and plaque scores were recorded.

Results: A total of 38 type 2 diabetic patients were selected. The mean age was 52.1 (±8.8) years. Sixteen subjects (42.1%) reported halitosis. Of these, 62.5% were females, and only one subject was a current smoker. The mean levels of HbA1c were significantly different between those with and without halitosis, mean 9.6 (±2) and 8.2 (±1.6), respectively (p=0.03). No significant differences were found in the mean periodontal parameters between those with and without halitosis.

Conclusion: The results of this study suggest an association between halitosis and increased levels of HbA1c. Further studies are needed to explain the nature of this association.

Keywords: Halitosis, Bad Breath, Glycated Hemoglobin, HbA1c. Diabetes, Periodontitis.

INTRODUCTION

Halitosis is a generic term defined as an unpleasant or offensive odor emanating from the oral cavity whether it originates from intra or extra oral sources, leading to personal discomfort and social isolation [1, 2]. Halitosis can also be referred to as bad or foul breath, breath malodor, oral malodor, and foetor oris. Halitosis is considered the third reason, after caries and periodontal disease, for patients to seek dental care [3]. The prevalence of halitosis in the general population was reported to range from 23% to 50% [4-8]. In about 80-90% of subjects suffering from halitosis, the condition was attributed to oral factors, hence the term oral malodor [9, 10].

Several factors play a role in oral halitosis including periodontal diseases, tongue coating, peri-implant diseases, deep carious lesions, exposed necrotic tooth pulp, pericoronitis, mucosal ulcerations, healing wounds, impacted food or debris, unclean dentures, and factors causing decrease salivary flow rate [5, 11].

Halitosis arises from microbial degradation of organic substrates present in saliva, crevicular fluids, oral soft tissues, and retained debris [12, 13]. This degradation leads to production of Volatile Sulfur Compounds, particularly Hydrogen sulphide (H_2S), methyl mercaptan (CH_3SH), and dimethyl sulphide [$(CH_3)2S$] [2, 11, 12]. Hydrogen sulphide (H_2S) and methyl mercaptan (CH_3SH) mainly contribute to intra oral halitosis, while dimethyl sulphide [$(CH_3)2S$] is mainly found in extraoral halitosis [14]. It has been reported that the Volatile Sulfur Compounds level in mouth breath of patients with periodontal disease is 8 times greater than control patients [15].

Extra-oral halitosis could be caused by disturbances in the upper and lower respiratory tract, metabolic diseases, medications, carcinoma, and other systemic diseases such as diabetes which gives rise to ketone bodies (ketoacidosis) in the breath [16, 17].

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Table 1. Relationship between Gender, Smoking and Halitosis

		Total (n=38)		Halitosis (n [%])		
		n	**%**	**Yes**	**No**	**p-Value**
Gender	Male	19	50	6 (31.6)	13 (68.4)	0.19*
	Female	19	50	10 (52.6)	9 (47.4)	
Smoking	Ever	10	26.3	3 (30)	7 (70)	0.64*
	Never	28	73.7	13 (46.4)	15 (53.6)	

*Not significant, based on Chi square (χ^2) test

Diabetic patients have increased susceptibility to chronic infection and inflammation of the oral tissues especially when they are poorly controlled. Oral manifestations in diabetes include periodontal diseases, oral candidiasis and dry mouth [18, 19]. Diabetic patients are three times more prone to have periodontitis than non diabetics and the progression of periodontal disease in uncontrolled diabetic patients is more severe than in controlled patients [20]. Furthermore, periodontal disease has been shown to worsen the glycemic control [21, 22].

Fig. (1). Boxplot graph showing the glycated hemoglobin level by halitosis status.

Therefore, the aims of this study were to examine the relationship between the glycated hemoglobin level (HbA1c) in the blood and halitosis status among diabetic patients affected with periodontitis and to examine if there is a relationship between severity of periodontal destruction and halitosis among the selected sample.

METHODS AND MATERIALS

This study was a cross sectional study conducted in complete accordance with the Helsinki declared ethical principles. Consecutive type 2 diabetic patients were recruited from patients presented for treatment at King Abdulaziz University hospital. Informed consent was obtained from each participant prior to enrollment in the study. The inclusion criteria were age ≥ 35 years, confirmed diagnosis of type 2 diabetes, generalized moderate to severe chronic periodontitis and at least 20 remaining teeth. Pregnant women and patients who received periodontal treatment or antibiotic therapy three months prior to the study were excluded.

A complete medical and dental history was gathered from all participants. Participants thencompleted a structured questionnaire on self perceived halitosis, oral health, and diabetes severity and control. Full periodontal examination was performed by two calibrated examiners. The inter-examiner reliability for detecting probing depth within 1mm was 86% and the intra-examiners reliability for both examiners was more than 92%. The following periodontal parameters were measured at six sites per each tooth: probing depth (PD), gingival recession (GR), clinical attachment loss (CAL) and plaque (PI) and bleeding (BI) scores. Peripheral blood samples were also obtained and the levels of glycated hemoglobin (HbA1c) were measured. Samples were coded to insure blindness during the laboratory analysis. HbA1c assay (The dimension® and Flex® HA1C kit, Dade Behring Limited, Kent, UK) was used. All data were collected before 12 noon prior to any oral hygiene instruction or periodontal treatment.

Chi square (χ^2) test was used to examine if there was a relationship between halitosis and smoking and gender. Student's t-tests were used to evaluate mean differences in age, periodontal parameter and HbA1c levels between subject with and without halitosis. The association between halitosis and HbA1c levels, after controlling for periodontal condition was examined using multivariable logistic regression analysis.

Statistical analyses were conducted using the Statistical Package for Social Science (SPSS, version 16, Chicago, IL).

RESULTS

A total of 38 diabetic patients were enrolled in the study. The mean age of the study sample was 52.1(±8.8). Halitosis was reported by 16 subjects (42.1%). Of those, 62.5% were females, and only one subject was a current smoker. Chi square test showed that there is no significant relationship between halitosis, and smoking and gender, $p>0.05$ (Table **1**). Mean age was also similar among those reporting and not reporting halitosis (51±8.3 and 53±9.1 years, respectively).

The mean HbA1c level in the blood was 8.8 % (±1.9) in the total sample. The mean levels of HbA1c for subjects with and without halitosis, were 9.6 (±2) and 8.2 (±1.6), respectively. The minimum, first quartile, median and third quartile for HbA1c among those with and without halitosis are shown in Fig. (**1**). A significant difference was found in the mean levels of HbA1c between subjects with and without halitosis, $t_{df=36} = 2.3$, $p = 0.03$ (Table **2**).

Table 2. Summary of the Means and Standard Deviations of Glycated Hemoglobin and Periodontal Parameters in Patients with and without Halitosis

	Total Sample		Halitosis				
			Yes		No		p-Value
	Mean	(SD)	Mean	(SD)	Mean	(SD)	
HbA1c	8.79	(1.89)	9.57	(1.99)	8.22	(1.62)	0.03*
Mean PD (mm)	3.10	(0.48)	3.22	(0.45)	3.01	(0.48)	0.18
Mean clinical attachment (mm)	4.20	(1.08)	4.25	(0.98)	4.14	(1.18)	0.77
Percentage of sites with:							
- PD > 4mm	25%	(19)	29%	(20)	22%	(18)	0.22
- Bleeding on probing	79%	(20)	83%	(15)	73%	(23)	0.21
- Plaque deposits	87%	(17)	89%	(14)	86%	(20)	0.70

SD = standard deviation, * = significant $p<0.05$

The relation between HbA1c and halitosis remained significant even after controlling for the mean probing depth in the multivariable logistic regression as shown in Table **3**. There was also a trend toward worse periodontal health among those with than those without halitosis. However, the difference was not statistically significant between the two groups in any of the measured periodontal parameters (Table **2**). Also, no difference was found between those with and without halitosis in regard to self reported diabetes control and severity, gum condition, oral and periodontal health, gingival bleeding, and frequency of recurrent oral infection, pain, and abscess formation, ($p > 0.05$).

DISCUSSION

Diabetes mellitus is a chronic metabolic disease characterized by elevated level of glucose in the blood. Glucose elevation is caused by an increase in cellular resistance to the insulin action or insulin secretion deficiency. The elevation of glucose level may lead to many pathological mechanisms, such as activation of the sorbitol pathway, formation of advanced glycation end products and lipid metabolism alteration. Common clinical complications caused by diabetes include nephropathy, macrovascular disease, neuropathy, retinopathy and poor wound healing. Periodontitis is considered the sixth complication of diabetes mellitus [23, 24].

In this study, the relationship of self reported halitosis, levels of glycated hemoglobin and different periodontal parameters were studied. Almost half of the subjects reported suffering from halitosis. The results showed a significant difference in the mean levels of glycated hemoglobin in subjects reporting and not reporting halitosis. Furthermore, the association between the level of glycated hemoglobin and self reported halitosis was significant even after controlling for probing depth. A one percent increase in the HbA1c was associated with a 50% increase in the likelihood of having halitosis. Although there was a trend toward having a worse periodontal condition among those reporting halitosis, this was not statistically significant. This is in contrast to previous findings where periodontal disease had been found to be related to halitosis when subjects with and without periodontal disease were compared [5, 11, 15]. A possible reason for this finding is that all patients in the present study were affected with moderate to severe periodontitis which could have prejudiced the ability to discriminate between the groups.

Previous studies focused mainly on the relationship between halitosis and oral conditions [25]. This is the first study that evaluated the relationship between self-reported halitosis and HbA1c level among type 2 diabetic subjects. The findings of this study suggest that the risk of halitosis increases with elevated levels of HbA1c. Thus, poorly controlled diabetics may be more susceptible to having halitosis. There are plausible reasons that can explain the association between halitosis and elevated levels of HbA1c. A possible reason could be related to the ketoacidosis phenomenon associated with poorly controlled diabetes. In fact, several hundred volatile compounds are detected in exhaled breath and many of which represent byproducts of endogenous biological process [26]. Recent studies suggest that integrated analysis of exhaled air in diabetic patients has the potential to serve as a marker of blood glucose level [27, 28]. This could be a potential subject for further studies. Another reason could be attributed to a dry mouth which is a common manifestation among diabetic subjects and a contributing factor to halitosis [18, 20, 29]. An additional reason would be the increased probability of infections among diabetic patients which lead to oral ulcerations [21, 22]. Also, it has been reported that anaerobic microbiota covering the tongue is involved in the occurrence of halitosis by releasing of sulfur-containing compounds (VSC) [30].

In the present study halitosis was measured using self reports of halitosis. This has been argued in the literature where one study showed a weak correlation between objective and self-reported halitosis [31]. In contrast, Iwanicka-Grzegorek *et al.*, [32] reported an agreement between self-perceived and objective evaluation of halitosis. Objective methods for measuring halitosis are organoleptic measurement, gas chromatography, and sulfide monitoring. Even

Table 3. Odds Ratio (OR) and 95% Confidence Interval (CI) for Glycated Hemoglobin and Probing Depth in Relation to Halitosis

	OR	95% CI	p-Value
Mean glycated hemoglobin*	1.51	1.01-2.27	0.045
Mean probing depth*	2.45	0.53-11.43	0.25

*Variables were modeled as continuous variables.

though organoleptic is the most common simple method used by examiners, it lacks reliability and reproducibility [33]. When precise measurements are needed, gas chromatography is the method of choice. The main draw back of sulfide monitoring method is that odorants other than volatile sulfur compounds are not detected which may result in false negative results [33]. Future studies to assess possible correlation between objective and self-reported halitosis and glycated hemoglobin levels are warranted.

CONCLUSION

The findings of this study suggest a positive relationship between HbA1c levels and halitosis among diabetic patients. However, no association was found between halitosis and periodontal parameters among the study sample. Further studies to investigate the mechanism underlying the association between HbA1c and halitosis are suggested.

CONFLICT OF INTEREST

None declare.

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