The Correlation of Organoleptic and Instrumental Halitosis Measurements

Flavio Brunner
Miranda Kurmann
Andreas Filippi

Department of Oral Surgery,
Oral Radiology and Oral Medicine
School of Dental Medicine,
University of Basel, Switzerland

Corresponding author
Dr. med. dent. Flavio Brunner
Department of Prosthodontics,
Albert-Ludwigs-University, Freiburg,
Hugstetter Strasse 55
D-79106 Freiburg, Germany
Tel. +49 761 270 4968
Fax +49 761 270 4925
E-mail:
flavio.brunner@uniklinik-freiburg.de

Schweiz Monatsschr Zahnmed 120: 402–405 (2010)

Accepted for publication:
12 October 2009

Key words: halitosis, oral malodor, organoleptic measurement, instrumental measurement

Summary Numerous detection systems are available for measuring halitosis. In order to examine their agreement, a study was conducted comparing four selected measuring methods in 100 subjects (52 females, 48 males; mean age: 25 years). Organoleptic halitosis measurement was carried out by an odor judge, and compared with instrumental halitosis measurement by sulfide monitoring using Halimeter, Fresh Kiss, and Halitox (halitosis linked toxin detection assay), with which both VSC (volatile sulphur compounds) and polyamines can be detected. The results show that the values recorded by the Halimeter correlated best with the organoleptic assessment and the least with the results of Fresh Kiss.

Introduction

To detect halitosis ("bad breath" or oral malodor), a number of different monitoring methods are available. There are two fundamental means of evaluating oral malodor: organoleptic or instrumental. In the organoleptic method, oral malodor is evaluated at various distances from the oral cavity by the examiner's sense of smell, or assigned a severity grade given a constant distance (Rosenberg et al. 1991a, Rosenberg et al. 1991b, Rosenberg 1996, Seemann 2001, Greenman et al. 2004). For instrumental measurement, various devices are used: gas chromatographs (e. g., Oral Chroma [Abilit]), electronic noses, and sulfide monitors (e. g., Halimeter [Interscan] and Fresh Kiss [Tanita]). Additionally, tests are available to specifically examine individual predilection sites (e. g., Halitox [Komstar]) (Richter & Tonzetich 1964, Tonzetich & Kestenbaum 1969, Tonzetich 1971, Tonzetich & Ng 1976, Tonzetich 1977, Tonzetich 1978, Rosenberg et al. 1991a, Rosenberg et al. 1991b, Mantini et al. 2000). The advantages of the organoleptic method are ease of performance and low costs. However, studies have shown that the results of organoleptic measurement are often not reproducible, because they depend on the subjective assessment of the examiner and other influencing factors (age, gender, time of day, etc.) (Tonzetich & Richter 1964, Tonzetich & Kestenbaum 1969, Tonzetich 1971, Tonzetich & Ng 1976, Tonzetich 1977, Tonzetich 1978, Rosenberg et al. 1991a, Rosenberg et al. 1991b, Mantini et al. 2000). Gas chromatographs are able to determine the quality and quantity of volatile sulphur compounds (VSC) in the sub-nanogram range (Richter & Tonzetich 1964). Due to their high acquisition cost and often demanding operating procedures, these devices are not particularly suited for routine use in the dental office (Rosenberg et al. 1991a).

Sulfide monitors can detect volatile sulphur compounds such as hydrogen sulfide, methyl mercaptan, and dimethyl sulfide, which play a key role in the development of halitosis (Tonzetich 1977, Persson et al. 1990, Yaegaki & Sanada 1992a). Other causal compounds, such as cadaverin, putrescine, indole, and skatole, are not detected by the monitor. Alcohol, chlorine compounds, and etheric oils can have a considerable influence on a sulfide measurement (Tonzetich 1978, Van Steenberghe et al. 2001). Tests such as Halitox enable a targeted examination of individual sites in the oral cavity by taking a smear. In addition to VSC, polyamines such as putrescine and cadaverin can also be detected in this manner.

The purpose of the present study was to compare different halitosis detection methods (organoleptic assessment, Halimeter, Fresh Kiss, Halitox). The Halimeter was used as a reference, since its measurements are proven to be reproducible (Rosenberg et al. 1991b).

Materials and Methods

The participants in this study comprised 100 students from the University of Basel (52 women and 48 men) between the ages of 19 and 46 years ($\bar{x}$: 25.9 years, standard deviation: 4.7), who were examined for halitosis. Exclusion criteria were: treatment with antibiotics in the past three weeks, and the consumption of onions or garlic in the past two days. On the day of the examination, the participants were told not to consume alcohol, nicotine, or products containing mint. Prior to measurement, each participant had to subjectively assess the intensity of his/her own oral odor.

In addition to the organoleptic assessment, the following quantitative or semi-quantitative methods were employed: Halimeter, Halitox and Fresh Kiss. The results were compared with those of the Halimeter. The sequence in which the methods were used was changed with every participant to minimize mutual influences. For each participant, the different measurements were taken within a period of 15 minutes. All measurements were conducted between 08:00 and 18:00.

The organoleptic measurement of breath was taken at distances of 10 cm (OM 10 cm) and 1.5 meters from the oral cavity. Severity grades were assigned as follows: 0: no oral malodor; 1: slight oral malodor; 2: moderate oral malodor; 3: strong oral malodor; 4: very strong oral malodor (Stassinakis et al. 2002). The assessments were always made by the same examiner (head of the halitosis clinic).

Three measurements each were taken with the Halimeter and Fresh Kiss, from which the arithmetic means were calculated. The Halimeter displays results in parts per billion (ppb), and Fresh Kiss yields results on a scale from 1 to 4, with 1 being no malodor and 4 strong.

Using Halitox, two smears each were taken from different sites on the dorsal surface of the tongue and placed in the proprietary liquid. The color change of the liquid indicates the result. The scale ranges from slight halitosis (grade 1) to strong halitosis (grade 3).

To determine associations between ordinal variables (measurement methods), non-parametric correlations (Spearman Rho) were calculated. Rho-values approaching 0 indicate poor correlation and values approaching 1 reflect better correlation. $p<0.05$ (two-sided) means the Rho-value differs significantly from 0. Fisher's exact test was employed to determine significant associations. The Halimeter results were first converted to log values in order to obtain a normal distribution. A p-value <0.05 (two-sided) was set as the level of significance for all test methods. Data were recorded using Microsoft Excel, and the statistical analyses were performed with SPSS for Windows (Version 13.0.1).

Results

When participants were asked to assess their own oral odor, 20 of them were unable to do so. Most of the participants (52 individuals) thought they had no oral malodor, 11 people rated their own halitosis as slight, and 16 participants rated themselves as having moderate halitosis. One person reported having strong halitosis. There was no statistically significant correlation between the subjective, personal assessments and the different measurement methods ($p>0.05$).

The organoleptic evaluation at 1.5 meters could not detect oral malodor in any participant. The assessment at 10 cm (OM 10 cm) detected 80 participants with no, 17 with slight, and 3 with strong oral malodor.

The Halimeter measurements yielded values between 32 and 211 ppb VSC ($\bar{x}$: 90.2 ppb, standard deviation: 47.3 ppb).

Using Fresh Kiss, the most frequent halitosis grade was 1 (1: n = 39, 2: n = 21, 3: n = 17, 4: n = 23). The Halitox method yielded a similar distribution (slight halitosis: n = 35, moderate: n = 40, strong: n = 25).

In none of the participants with Halimeter readings under 50 ppb was oral malodor detectable at 10 cm. With Halitox and Fresh Kiss as well, slight halitosis (grade 1) was the most frequent result (Tab. I). With Halimeter readings between 50 and 100 ppb, 90% of the participants were organoleptically rated as having no halitosis; in contrast, Halitox showed 47% of them to have moderate halitosis (grade 2). Halimeter values from 100 to 150 ppb were recorded in 55% of the participants without organoleptically perceptible halitosis, and in 45% of participants with grade 2 halitosis (OM 10 cm). In these par-

Tab. I Comparison of Halimeter with organoleptic assessment (at a distance of 10 cm), Halitox, and Fresh Kiss

Halimeter	**Organoleptic assessment at a distance of 10 cm**	**n**
<50 ppb	100% no halitosis	14
50–100 ppb	90% no halitosis	53
	8% grade 1	5
	2% grade 2	1
100–150 ppb	55% no halitosis	8
	45% grade 2	7
>150 ppb	35% no halitosis	4
	45% grade 1	5
	20% grade 2	3
	$p<0.01$, Rho = 0.493	
Halimeter	**Halitox**	**n**
<50 ppb	57% slight halitosis	8
	36% moderate halitosis	5
	7% strong halitosis	1
50–100 ppb	32% slight halitosis	19
	46% moderate halitosis	27
	22% strong halitosis	13
100–150 ppb	13% no halitosis	2
	44% moderate halitosis	6
	47% strong halitosis	7
>150 ppb	25% moderate halitosis	3
	75% strong halitosis	9
	$p<0.01$, Rho = 0.395	
Halimeter	**Fresh Kiss**	**n**
<50 ppb	57% grade 1	8
	36% grade 2	5
	7% grade 4	1
50–100 ppb	37% grade 1	22
	23% grade 2	14
	11% grade 3	6
	29% grade 4	17
100–150 ppb	33% grade 1	5
	20% grade 2	3
	20% grade 3	3
	27% grade 4	4
>150 ppb	33% grade 1	4
	25% grade 3	3
	42% grade 4	5
	$p<0.01$, Rho = 0.283	

ticipants, the most frequent Halitox result was strong halitosis (47%), whereas Fresh Kiss most frequently yielded grade 1 (33%) and grade 4 (27%).

Where Halimeter readings exceeded 150 ppb, 45% of the cases were organoleptically rated as having grade 1 halitosis and 20% as having grade 2 (OM 10 cm). Halitox indicated strong halitosis in 75% of these participants. Fresh Kiss most frequently yielded grade 4 (42%).

The Halimeter measurements correlate best with those of OM 10 cm ($p<0.01$, Rho = 0.493) and least with the Fresh Kiss results ($p<0.01$, Rho = 0.283).

Discussion

Organoleptic oral odor assessments are often not reproducible, as they depend on the subjective judgement of the examiner (Rosenberg et al. 1991a, Rosenberg et al. 1991b, Rosenberg & McCulloch 1992, Rosenberg 1996, Seemann 2000). To avoid interexaminer differences, all measurements in the present study were conducted by the same dentist. Instrumental measurements are also sensitive to external influences (Filippi 2005). Proper instruction of the participants prior to instrumental measurements minimized errors in the results. To exclude disturbing factors such as temperature, humidity, or drafts, measurements were always taken in the same treatment room under constant conditions. Not only the intensity but also the type of halitosis changes with the time of day, saliva flow, and oral hygiene. In addition, hormonal fluctuations can play a great role (Tonzetich 1978). To exclude such differences between the methods, all measurements from one participant were taken within a 15-minute period.

One critical problem in comparing instrumental measurement methods is that different scales are used. The Halimeter is the only device which presents the VSC concentration in ppb. It is therefore particularly well-suited for monitoring progress in the treatment of halitosis patients (Stassinakis et al. 2002). Other methods, such as organoleptic examination, Halitox, or Fresh Kiss, only allow a classification into categories. The methods' different numbers of categories further impairs comparison.

Halimeter values under 100 ppb VSC have been reported as the normal range (Stassinakis et al. 2002), but the manufacturer of the Halimeter describes the normal range as 50 to 150 ppb VSC. Still other authors give normal values as lying between 70 and 110 ppb VSC (Seemann 2000). Because hydrogen sulfide is largely recorded as methyl mercaptan or dimethyl sulfide, and the different compounds are perceived in varying intensities, it is not possible to clearly define a threshold value beyond which a pronounced odor occurs (Filippi 2005).

In the current study, no oral malodor was organoleptically detectable with measurements up to 50 ppb. The other methods showed different results. In participants with Halimeter reading up to 100 ppb, 90% had no organoleptically detectable oral malodor. However, some individuals were organoleptically rated as having grade 1 or 2 halitosis. At Halimeter values over 100 ppb, almost half of the participants were assessed as having grade 2 (OM 10 cm). In the remaining participants with Halimeter readings up to 100 ppb, no oral malodor was organoleptically perceptible. This confirms that although no clear threshold value can be defined with the Halimeter, halitosis becomes perceptible between 50 and 150 ppb VSC. Especially with values under 50 ppb, the Halimeter can reliably exclude the presence of halitosis.

Nevertheless, every measurement should be combined with an organoleptic examination in order to recognize false results caused by external influences (Baharvand et al. 2008). Numerous studies confirm the positive correlation of organoleptic and Halimeter results. The extent of this correlation is expressed as Rho = 0.49–0.82, $p<0.01$ (Rosenberg et al. 1991a, Rosenberg et al. 1991b, Shimura et al. 1997, Baharvand et al. 2008). Halimeter and Fresh Kiss are based on the same principle of measurement (sulfide monitors) and thus detect the same compounds (VSC). In spite of this, of all the tested measurement methods, the Fresh Kiss results correlated least with those of the Halimeter (Rho = 0.283). Comparable studies on this instrument have not yet appeared in the Medline-listed literature in English.

Taking tongue-smear samples to determine oral malodor presents an alternative in that most halitosis causing bacteria are located on the tongue (Gilmore & Bhaskar 1972, Gilmore et al. 1973, Jacobson et al. 1973, Yaegaki & Sanada 1992b, De Boever & Loesche 1995). Halitox measurements indicated strong halitosis (grade 3) in nearly 50% of the participants with Halimeter values of up to 100 ppb (Tab. I). One possible cause of this is the color of the tongue plaque: according to the manufacturer, in particular yellow plaque on the tongue can lead to false positive results.

The present study shows that the results of the different detection methods do not always agree and in some cases may even be clearly discrepant. Nevertheless, correlation between individual methods was evident. This is confirmed by earlier examinations in which the Halimeter yielded reproducible results that correlated well with organoleptic evaluation.

Due to the diverse influencing factors, proof of halitosis should always be obtained with two different methods. The combination of Halimeter and organoleptic approaches enables simple, reliable, and fast detection. It is very important to properly instruct the patients before measurements are taken, in order to eliminate disturbing influences. Should the two methods disagree, the authors recommend repeating the measurements at a later time.

Résumé

De nombreux systèmes de vérification sont disponibles pour mesurer l'halitos. Pour examiner leur concordance, une étude a été faite comparant quatre méthodes de mesure sur 100 sujets (52 femmes, 48 hommes, d'un âge moyen de 25 ans). D'une part la mesure organoleptique a été faite par un juge d'odeur, d'autre part la mesure a été faite à l'aide d'instruments: écran de sulfure (Halimètre et Fresh Kiss) de même que Halitox (halitosis linked toxin detection assay), avec lequel peuvent être prouvés les VSC (les composés de soufre volatils) et les polyamines. Il en ressort que les résultats obtenus par Halimètre correspondent le plus à l'évaluation organoleptique et le moins aux résultats du Fresh Kiss.

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