A Preliminary Study on Oral Malodor Measurement

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Ⅰ. Introduction

Oral malodor is a common condition affecting primarily the adult population[1]. In the large majority of cases, oral malodor originates in the oral cavity as the result of microbial metabolism and volatile sulfur compounds(VSC) have been cited as the predominant source of foul odor[2-5].

In the prevention and treatment of oral malodor, scientific assessment and validation of measurement for oral malodor is the most important part of all. However, measurement of oral malodor is complicated by various factors including complexity of gaseous molecular species, sampling difficulties, temporal variations, choice of suitable subject population, and lack of agreement on reference standards[6].

Since oral malodor is a perceived olfactory stimulus, direct sampling and assessment by human judges may be the most logical measurement approach. Organoleptic test is direct nasal sniffing of expelled mouth air and is the most simple and commonly used approach to sample and evaluate oral malodor[7]. However, organoleptic measurement is limited by several problems such as variations of inter-examiner and intra-examiner, a wide variety of confounding factors including psychological / physiological states, and difficulties to perform measurements exactly in the same manner. As with other psychophysical assessments, direct malodor measurements by the human nose may vary widely between judges and even within a judge, consequently cannot be reproduced confidently in other laboratories.

Therefore, more reliable methods of measurement have been introduced in the scietific investigations of oral malodor. Gas chromatographic (GC) measurement is one of them and has been used to evaluate oral malodor[8]. In comparison with organoleptic measurement, the GC measurement has several advantages including; 1) the ability of separation and quantitative measurement of individual gases; and 2) the possibility to measure gases of

extremely low concentration. Unfortunately, it also has some disadvantages including 1) relatively high cost ; 2) the need for skilled personnel ; 3) cumbersome and lack of portability ; and 4) the time required for detection and measurement[6].

To overcome the limitations of above measurement techniques, a simple and rapid technique using portable instrument was developed. this industrial sulfide monitor, Halimeter can detect the concentration of VSC which have been considered to be associated primarily with oral malodor. The measurement of oral malodor using Halimeter has been known to be more reproducible and sensitive than using organoleptic technique[7].

The aim of this study is to present preliminary data for using Halimeter in oral malodor measurement and to raise some prospects for future research in this area.

II. Materials and Methods

1. Subject

Twenty-one healthy volunteers without any dental and medical problem were included in this study. They were all dental college students or staffs of Dental Hospital, Seoul National University and composed of 11 males(25.4±1.4 years) and 10 females(23.6±3.5 years).

2. Methods

The Halimeter(RH17A, Interscan. Co.), which evaluates the values of VSC, was used in this study. Every procedure was performed according to the manufacturer's operating instruction [9]. The subjects were instructed to close their mouth and breathe via nose for 3 minutes prior to test. The operator inserted the straw probe 4 cm into slightly opened mouth and the straw position was maintained not to touch lips, teeth, or internal surface of mouth. During the few seconds of test duration, the subjects breathe via nose, then the intraoral air is inhaled into the Halimeter. The VSC value was recorded as soon as peak reading was reached. The recording procedure was performed 3 times and the mean values of VSC were analyzed.

The value of VSC was taken before breakfast without tooth brushing, 2 and a half hours after oral activities(breakfast and tooth brushing) and 2 and a half hours after lunch and tooth brushing to investigate the effect of time in a day. All of the subjects participated in this procedure.

After the subjects having a meal, VSC value was taken before and after tooth brushing to investigate the effect of tooth brushing. Two and a half hours after the meal, the values of VSC were taken before and after zinc chloride gargling to evaluate the effect of 0.25% zinc chloride gargle. All of the subjects were participated in this procedure.

The values of VSC were taken at 3 different straw position ie, 3 cm, 4 cm, and 5 cm from the lips to investigate the effect of the inserted depth of straw. The whole procedure was completed within 20 minutes and 12 subjects were participated in this procedure.

The values of VSC were taken in 5 subjects with plastic straw supplied by the manufacturer, glass straw, and paper straw to investigate the effect of the materials of straw. The whole procedure was completed within 20 minutes.

The values of VSC were taken after keeping saliva in mouth for 3 minutes to investigate the effect of film like role of saliva. And the value of VSC was taken again after instruction of holding their breath during the test. Twelve subjects were participated in this procedure.

The values of VSC were taken in 5 subjects when they opened their mouth widely and opened as 1-2 cm intermaxillary distance maintained.

All statistical evaluation was performed with SPSS PC+. Paired T-test was used to compare the VSC values in this study.

III. Results

The measured values of VSC in a day are presented in Table 1. The value of VSC was significantly higher on rising without any oral activities than any other time in a day.

The VSC reduction effects of tooth brushing and 0.25% zinc chloride gargling are presented in Table 2. Significant reductions of VSC values were observed after tooth brushing (after rising : 31 %, after breakfast : 16 %, after lunch : 18 %) and zinc chloride gargling (2.5 hours after breakfast : 15 %, 2.5 hours after lunch : 18 %)

The VSC values according to the inserted depth of straw are presented in Table 3. There were significant reductions of VSC values as the depth of plastic straw into the oral cavity decreased .

The influence of the kinds of straw material on VSC value is presented in Table 4. The kinds of material did not affect the value of VSC.

Table 1. VSC values along with period of time in a day

	EMG (a)	LMG (b)	LAG (c)
Subjects all	218±46	169±35	161±24
Sig.	***(ab)	N.S.(bc)	***(ac)

EMG : Early morning group ; group measured without any oral activities after rising.
LMG : Late morning group ; group measured more than 2.5 hours after the last oral activities in the morning.
LAG : Late afternoon group ; group measured more than 2.5 hours after the last oral activities in the afternoon.
N.S. : not significant
* : $p < 0.05$
** : $p < 0.01$
*** : $p < 0.001$

Table 2. The VSC values before and after tooth brushing / zinc chloride gargling

	Tooth-brushing		
	Before	After	Sig.
On rising	221 ± 46	152 ± 19	***
After breakfast	174 ± 44	146 ± 16	*
After lunch	185 ± 45	151 ± 16	**
	Zinc chloride gargling		
	Before	After	
2.5h after breakfast	165 ± 33	140 ± 16	***
2.5h after lunch	159 ± 27	130 ± 17	**

Table 3. The VSC values according to the inserted depth of straw

	2 cm(a)	3 cm(b)	4 cm(c)
VSC	147 ± 8	153 ± 8	161 ± 11
Sig.	** (ab)	** (bc)	*** (ac)

Table 4. The influence of the kinds of straw material on VSC values

	Plastic straw by manufacturer (a)	Glass straw (b)	Paper straw (c)
VSC	150 ± 3	149 ± 2	148 ± 3
Sig.	N.S. (ab)	N.S. (bc)	N.S. (ac)

Table 5. The VSC values in case of no saliva swallowing and holding breath

	Standard (a)	No saliva swalloing (b)	No nose breathing (c)
VSC	153 ± 8	139 ± 10	155 ± 7
Sig.	** (ab)	N.S. (bc)	N.S. (ac)

Table 6. The VSC values according to the degree of mouth opening

	Wide opening (a)	1-2 cm opening (b)
VSC	145 ± 4	148 ± 3
Sig.	N.S. (ab)	

Keeping saliva in mouth lowered VSC values significantly, but holding breath did not affect VSC values(Table 5).

The effect of the degree of mouth opening on VSC values is presented in Table 6. There was no significant difference in VSC values between wide opening and 1-2 cm opening.

IV. Discussion

In this study, the highest level of VSC was found in the early morning immediately after rising and it is consistent with previous studies[10]. The volatile sulfur compounds such as hydrogen sulfide and methyl mercaptane are considered to be the predominant factor of oral malodor and they are metabolic products of methionine, cysteine, and cystine degraded by intraoral microorganisms[1,11-13]. Self cleansing effect is decreased because the rate of salivary flow and the oral activities such as chewing or swallowing while sleeping is diminished[14]. Therefore the microorganisms, the available nutrients and the metabolic products are easily remained in the mouth. It may be the cause of the highest level of VSC in the early morning immediately after rising. The value of VSC measured more than 2.5 hours after oral activities in the morning was not significantly different from that measured more than 2.5 hours after oral activities in the afternoon in this study. But, Miyazaki et al[14]. reported that

the VSC value of late morning was significantly higher than that of late afternoon. And also they suggested that the reduction of salivary flow in the morning may be due to environmental stress. Further investigation with more subjects are needed in this case.

Tooth brushing and zinc chloride gargling had effect to decrease the VSC value in this study. The degrees of VSC value reduction in tooth brushing and in zinc chloride gargling are similar to the results of other studies[15-17]. Especially for the effect of zinc chloride, it is not confirmed whether the effect is caused by the simple cleansing or by the antimicrobial activity of zinc chloride. More investigations should be focused on the characteristics of zinc chloride in the future.

As the depth of insertion of the straw increased, the level of VSC increased in this study. For the effect of the depth of insertion, every procedure of VSC taking should follow the manufacturer's instruction for the standardization[9]. According to the instruction, the straw should be positioned 4 cm from lip and no touch is permitted with oral tissues such as teeth, tongue and so on.

The straw supplied by manufacturer is disposable and for only one time use. It may be the problem when a great majority of subjects are included. In this study, the material which made the straw did not affect VSC. The use of common straw, which can be easily supplied in the market like paper straw, is considered to be appropriate.

Saliva is known to have activity of a solvent for the VSC as well as antimicobial effect, buffer capacity and mechanical cleansing effect [17]. The VSC value taken after keeping saliva in mouth for 3 minutes decreased significantly in this study and it suggests that the effect of film like role of saliva for oral tissues.

The author presented the means of VSC value at various conditions but the simple comparison with other studies especially performed in foreign country has little meaning. The favor of sulfur containing foods like garlic in Korean people should be considered and the small size of the subject group in this study should also be considered. Further studies involving general population of Korea are needed to present epidemiologic data for Korean people.

According to the above results, it is recommended that the sampling of VSC should be performed at the same time in a day, at the same time after oral activities, and at the same depth of insertion of the straw. Not only the method but the salivary flow rate should be considered to get more reliable information for oral malodor reserach.

V. Conclusions

In modern society, oral malodor has been considered as an important problem to maintain a social and a private life. Therefore, attention to the prevention and the treatment of the oral malodor has been more increasing than the past. And also many researchers have been studying on the oral malodor.

In the studying on the oral malodor, an objective and precise measurement of it is the most important part.

This study was performed to obtain more knowledge on technique for using Halimeter and to raise some prospects for future research in the oral malodor.

This study was performed by the experiments of the definite time table on measurements, of the oral hygine, of the position of the straw to be placed in the oral cavity, of the kind of the straw, and of the amount of the saliva in the oral cavity.

Twenty one persons of SNU Dental Hospital students and staff were participated in this

study.

The obtained results were as follows ;

1. The value of VSC was significantly higher immediately after rising without any oral activities than any other time in a day.
2. Significant reductions of VSC values were observed after tooth brushing (after rising : 31 %, after breakfast : 16 %, after lunch : 18 %) and zinc choride gargling (2.5 hours after breakfast : 15 %, 2.5 hours after lunch : 18 %) ($p < 0.05$).
3. There were significant reductions of VSC values as the depth of plastic straw into the oral cavity decreased ($p < 0.05$).
4. The kinds of straw material used in VSC measurements with halimeter did not affect the VSC values .
5. Keeping saliva in mouth lowered VSC values significantly ($p < 0.05$), but holding breath did not affect VSC values.
6. No significant differece was observed according to the degree of mouth opening in VSC measurements between wide opening and 1-2 cm opening.

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국문초록

구취측정에 관한 예비 연구

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현대사회에서 구취의 유무가 가정 및 사회생활을 유지하는데 중요한 문제로 대두됨에 따라 구취의 예방과 치료에 관심이 증대되고 있다.

많은 연구자들에 의해 구취에 관한 연구가 이루어지고 있으며, 특히 구취의 연구에서는 객관적이며 정확한 구취의 측정이 중요한 과제가 되고 있다.

이에 저자들은 건강한 구강조직을 가진 서울대학교 치과대학생 및 치과병원 종사자 21명을 대상으로 시각차에 대한 실험, 구강세정에 대한 실험, 구강내로 삽입되는 straw의 구강내 위치에 대한 실험, straw의 종류에 대한 실험 및 구강내 타액의 양에 대한 실험을 실시한 결과 아래와 같은 결론을 얻었다.

1. 휘발성 황화합물의 농도는 하루중 기상직후 식사나 잇솔질하기 전에서 가장 높았다.
2. 잇솔질과 zinc chloride 양치후 휘발성 황화합물 농도의 유의한 감소를 보였다($p<0.05$).
3. 측정시 straw가 구강내로 들어가는 깊이가 줄어들수록 휘발성 황화합물의 농도가 유의하게 감소하였다 ($p<0.05$).
4. 측정에 사용된 straw의 종류는 휘발성 황화합물의 농도에 영향을 주지 않았다.
5. 구강내에 타액을 머금고 측정했을 때 휘발성 황화합물 농도의 유의한 감소가 관찰되었고($p<0.05$), 숨을 쉬지않고 측정했을 때는 변화가 관찰되지 않았다.
6. 구취 측정시 개구정도에 따른 측정값의 유의한 차이는 관찰되지 않았다.