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disadvantages of such instrumentation are relatively high cost, the need for skilled operators and lack of portability. In other words, these disadvantages of GC are the advantages of sulfide monitors. Portable and inexpensive measuring devices functionally near the GC has developed and is now available in private clinics.

Conclusion

Breath odor measurement by a GC is limited in a special place such as a university hospital, furthermore it may be impractical for practitioners to equip their offices with a GC. However, the GC must be gold standard in the instrumental analysis in clinical and the development of the instrument. Therefore, it is necessary not only for researchers but for clinicians of oral malodor to understand the structure and the principle of a GC.

References

A Gas Chromatography Equipped with Semiconductor Sensor for Oral Malodor Measurement

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Keywords: Oral malodor, gas chromatography, semiconductor sensor

Introduction

The presence of VSCs such as hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), and dimethyl sulfide ((CH₃)₂S) resulted from the decaying process in the oral cavity produced by bacteria activity. These gases are the main cause of halitosis. To measure the three gases of VSCs components and to calculate the ratio of each component is important for the diagnosis of halitosis. Until now, only the gas chromatograph equipped with flame photometric detector (GC-FPD) which was the first time used by Tonzetich et al (1971), has been considered as the gold standard in measuring the concentration of VSCs gases in the oral cavity. The measurement with GC-FPD shows highly objective and reproducible results. The procedure can be repeated, and the result will be the same.

Although GC-FPD shows objective measurement, gas chromatograph equipment requires a large scale system; the procedure requires a skillful operator, and
very costly (Yaegaki et al 2000). In addition to that, GC equipment is not compact or portable; therefore, it is impractical for practitioners to equip their clinic for GC or use GC for the purpose of a field study.

Portable sulfide monitor, such as, Halimeter™, (Interscan Co., Chatsworth, CA, USA) which has been widely used in measuring degrees of oral malodor can be used with quantitative values, but sulfide monitor only has high sensitivity for H₂S, but low sensitivity for CH₃SH (Rosenberg et al 1991). This instrument can also detect other volatile malodor substances, especially ethanol, methanol and acetone that can be found in the oral cavity even though the subject is not suffering from halitosis (Hanada et al 2003, Tonzetich & Ng 1976). Other disadvantage of this instrument is the necessity of periodic re-calibration (Rosenberg et al 1991). In other words, the measurements may be affected if the subject is wearing perfume, hairspray, deodorant, etc.

In search of the most reliable and practical procedure for evaluating a patient’s level of oral malodor, recently another type of gas chromatograph equipped with semiconductor sensor (GC-SCS) has been widely used to detect three individual gases of VSCs related to oral hygiene, periodontal disease and halitosis. The GC-SCS has been developed to fulfill the expectations of clinical practitioners because it is easy-to-operate, have high sensitivity to detect individual VSCs, simple, portable, and does not require skilled personnel to operate.

OralChroma™, is a compact and simple gas chromatograph with newly developed semiconductor gas sensor (SCS) from indium oxide (In₂O₃), that have high sensitivity for H₂S, CH₃SH and (CH₃)₂S (Hanada et al 2003, Murata et al 2006). This GC-SCS instrument can measure each VSC concentration separately and calculate the ratio of each component which is crucial for diagnosis of halitosis (Yaegaki & Sanada 1992).

**Configuration of GC analyzer system**

Briefly, this instrument is assembled as shown in the Figure. This apparatus consists of a carrier gas pump, a carrier gas purifying filter, a sample injection part, a Teflon™, column with a heater, a detector, a controller, and a display.

The data for analysis is obtained by the computer connected to the exterior port. The individual VSCs are calculated by the data handling software built in GC-SCS system. The dimensions of the analyzer are 400 mm x 280 mm x 130 mm, and weight about 5.5 kg.

**Collection of oral cavity air sample**

The recommended examination procedures are described below. Patients are instructed to refrain from ingesting any food or drink, to omit their usual oral hygiene practices, to refrain from using oral rinse and breath fresheners, at least 2 hour before the measurement.

Ten-milliliter disposable plastic syringe is inserted into the oral cavity as far as 5 cm, it is placed between the upper and lower anterior teeth, while the mouth remained closed. The syringe is placed carefully to avoid touching the tongue.

Prior to oral air sampling analysis, the subject is instructed to inhale deeply while keeping their mouth closed and to breathe through the nose quietly for 30 seconds. After the time reach to 30 seconds, the plunger of the plastic syringe is pulled slowly, then pushed it back in, afterward pulled it for the second time before removing the plastic syringe from the mouth.

After aspirating 1 ml of oral air sample, the needle
is attached back to the syringe and then starts ejecting the oral air sample as much as 0.5 ml by pushing the plunger. Finally, the remaining oral cavity air sample is injected into the injection port on the main unit of the GC-SCS (OralChroma™). The measurement will start automatically.

Data processing
The OralChroma Data Manager is a program that will process further analysis of measurement result received from main unit of OralChroma™. The data manager will automatically process the data measurement values and afterwards halitosis cognitive threshold are compared and then the assessment of the functional halitosis level is displayed on the PC.

The result data appears in graphic, curve, and numeric form consists of three causal gas components; H,S, CH₂SH, (CH₃)₂S and it comes in standard units of ng/10ml and ppb. This data processing program can provide graphical display on the PC including a short commentary evaluation about the measurement values that can help for data analysis. In addition, graphical display could be used by clinician to communicate and to educate patient regarding oral health issues. This program also provides historical display, so clinician can observe patient’s improvement and compliance.

Discussion
Knowing the ratios of H,S, CH₂SH and (CH₃)₂S in mouth air of a patient is very important to set up the diagnosis of halitosis. The concentration ratio of CH₂SH describes the characteristics of halitosis derived from the oral cavity (Yagaki & Sanada 1992, Yaegaki et al 2000, Coil et al 2002).

Physiological halitosis is suspected when H,S is detected as the predominant VSCs (Yaegaki & Sanada 1992, Coil et al 1992, Yaegaki et al 2000). Treatments for patient with physiological halitosis include routine oral hygiene procedures, mouth rinsing, and tongue cleaning can be performed (Coil et al 2002).

When both of the gases, H,S and CH₂SH, are detected as predominant VSCs, a periodontal disease as the etiology can be suspected. In this condition, professional therapy for the periodontal disease can be given if necessary (Coil et al 2002). Yamagata et al (2005) reported from a field study that concentration of CH₂SH was significantly higher in persons with periodontal disease than in persons with healthy periodontal condition. The authors defined a CH₂SH concentration ratio as CH₂SH/(CH₂SH + H,S).

Dimethyl sulfide (CH₃)₂S is usually as the lowest VSCs component, whereas H,S and CH₂SH are highly toxic, especially CH₂SH. There have been some reports that mentioned, CH₂SH is the cause of severe damage to the periodontal tissue and cells (Coli & Tonzetich 1992, Johnson et al 1992, 1996, Lancero et al 1996). CH₂SH is not only responsible for the occurrence of oral malodor but it is also contributes to the pathogenesis of periodontal disease. Hence, it is very important to measure the individual VSCs concentration for diagnosis and treatment rather than to measure only total VSCs concentration as usual VSCs monitors.

When properties of GC-SCS and GC-FPD were being compared to measure oral malodor, the quantitative accuracy and specificity to measure individual VSCs are similar. Until now, GC-FPD still considered as the gold standard of oral malodor examination, but GC-FPD is extremely costly. On the other hand, the cost of GC-SCS is 15% to 25% of a regular GC-FPD. GC-SCS is also more practical because it doesn’t require hydrogen and carrier gas, which are essential for GC-FPD (Murata et al 2006).

Conclusion
The new instrument, gas chromatograph equipped with a semiconductor indium oxide sensor (GC-SCS) can detect the concentration of individual VSCs related to oral hygiene, periodontal disease, and halitosis through mouth air analysis.

This instrument is easy-to-operate, have high sensitivity to detect oral malodor, simple, portable, and low in cost compared to conventional GC. Therefore, it is suggested to set up diagnosis of halitosis and periodontal diseases with this new instrument in daily practice, clinical or field studies.

References

Effect of Mouthwash, Toothpaste and Chewing Gum on Oral Malodor

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Keywords: Oral malodor, volatile sulfur compounds, mouthwash, toothpaste, chewing gum

Abstract
Mouthwash, toothpaste and chewing gum are simple and convenient self-care measures for controlling oral malodor. The mechanisms of antimalodorous activities and the efficacy of the self-care products are reviewed in this article, and it was suggested that the most preferable product for reducing oral malodor might be zinc-containing mouthwash.

Introduction
The major source of oral malodor is dorsal surface of the tongue. Therefore, there is no doubt that tongue cleaning is one of the most effective procedures to control oral malodor. On the other hand, use of oral hygiene products, such as mouthwash, toothpaste and chewing gum, are also very popular. Volatile sulfur compounds (VSC) such as hydrogen sulfide, methyl mercaptan and dimethyl sulfide in mouth air are main causes of oral malodor. The efficacy of the products should therefore be evaluated by measuring the reduction of intra-oral VSC concentration. This article briefly discusses what approaches can be used to suppress oral malodor evaluated by the determination of VSC concentration.

Approaches for controlling oral malodor
Most of oral hygiene products contain pleasant flavors. Actually, flavors can mask oral malodor, but usually causes only small reduction of VSC in mouth air.
Many products contain the antibacterial agents to decrease oral malodor by simply reducing the number of bacteria. The agents involve chlorhexidine, cetylpyridinium chloride, triclosan, essential oil and so on. Oxidizing agents, i.e., hydrogen peroxide and chlorine dioxide, interfere with oral malodor production by oxidation of VSC and sulfur-containing amino acids. The agents involve strong antibacterial effects, too.

Oral bacteria produce VSC at neutral to alkaline pH. As sucrose produces lower pH in the oral cavity by bacterial sugar metabolism, VSC productions are also inhibited. Zinc- and sodium bicarbonate (baking soda)-containing products are expected anti-halitosis effect through converting VSC to be non-volatile. The mechanisms whereby zinc reduces oral malodor also involve an inhibition of bacterial proteolytic enzymes.

Impacts of the products on oral malodor
Relationship between oral malodor intensity and VSC concentration follows Weber’s law. Therefore, more than 90% reduction of VSC concentration in mouth air is necessary to realize oral malodor suppression.