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Studies on Halitosis and Ward-Stench of Severely Handicapped Patients

2. Analysis of Sulfur-containing Stench Substances and the Effect of Dental Treatment

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Abstract

Sulfur-containing unpleasant stench substances in the ward air and the expired air of the handicapped patients were analyzed with GLC-FPD. The three principal peaks which are assigned as hydrogen sulfide, methane thiol, and methylsulfide were found in the ward air and the expired air. The similarity of chromatographic patterns suggested that the expired air is the main source of stench of the ward air.

Dental treatment given to handicapped persons decreased bad smelling sulfur compounds in the expired air and the ward air from a chromatographic point of view.

Key words: Handicapped person, Sulfur-containing stench substance, Expired air, Ward air, Effect of dental treatment.

Introduction

In the preceding paper[1], we examined the methods of sampling and analysis of the expired air of patients and the ward air in an institute for severely handicapped patients.

If it is shown that the unpleasant smell in the ward of the handicapped patients originates from halitosis of unhealthy oral cavity of these patients, and the stench is lessened by dental treatment, the effectiveness of the dental care program for the severely handicapped will be clearly recognized.

Sulfur-containing compounds such as hydrogen sulfide, thioalcohol, or thioether are

considered the most prominent substances in halitosis[2-6]. We adopted GLC-FPD to analyze these compounds. Although the retention time of GLC is not sufficient for identification, a comparison of chromatograms revealed the quantitative or compositional differences in the various samples. In this paper, the results of comparison among the expired air samples from the patients and the ward air against some standard samples before and after dental treatments are reported.

Method

The experimental methods are essentially the same as in the previous report[1].

Expired air samples were collected with 1 ℓ vacuum jar connected with teflon mouth piece. Sampling from the handicapped patients was easily carried out at a supine posture with the head resting on the operator's knee (Fig. 1). In a few cases, when the subjects were not cooperative, a mouth-prop was used.

The ward air samples were collected in vacuum sampling jars in the living and training room of patients (Fig. 2, ward hall).

Concentration and analysis by GLC of the air samples were described in the previous paper[1]. GLC analysis was not exactly quantitative because the sensitivity of this apparatus changed with the various concentrations of stench of air samples.

Results

1) Analysis of expired air

One of the typical GLC results is shown in Fig. 3. The chromatographically distinct peaks are found at 3 min, 3 min 30 sec, and 4 min 20 sec after the sample injection. Two small peaks are also found before and after the third main peak.

Fig. 1 Sampling of the expired air with the vacuum sampling jar connected teflon mouth piece from lain spine handicapped patient. Sample collection was carried out instantaneously without any trouble.

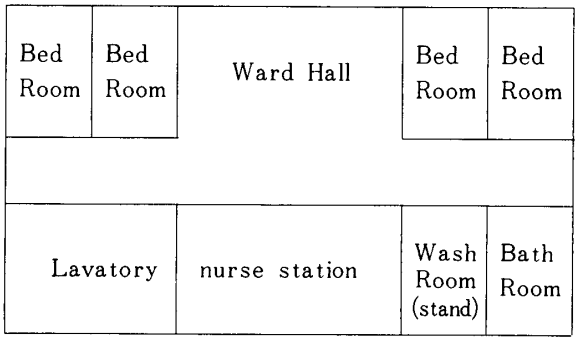

Fig. 2 Arrangement of the ward. The ward hall is surrounded with bed rooms and the nurse station.

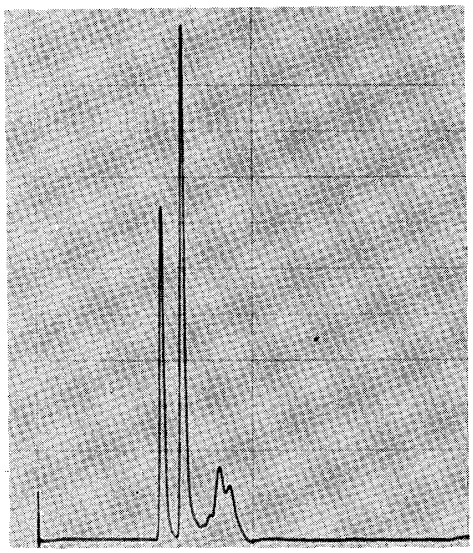

Fig. 3 A typical chromatogram of expired air. Sensitivity 10^3 x 64, chart speed 10 mm/min.

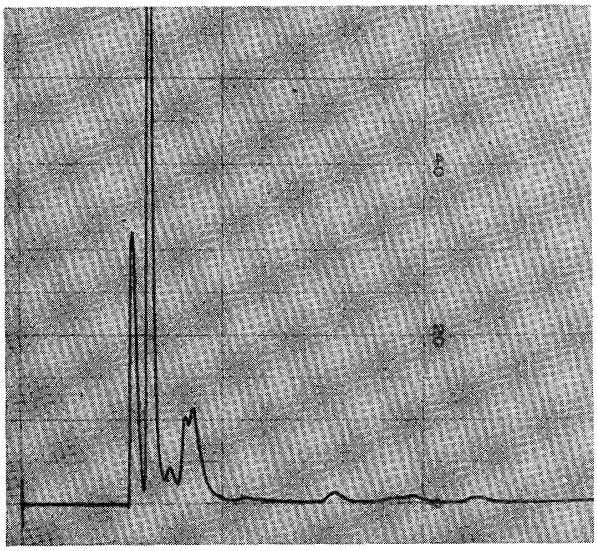

Fig. 4 A typical chromatogram of ward air. Sensitivity 10^3 x 64, chart speed 10 mm/min.

Three main peak and one or two minor peaks around the third main peak are found in almost all of the cases.

These results suggest that the expired air contains three to five sulfur-containing compound[3] including three principal compounds.

2) Analysis of ward air

The most distinct stench in the ward hall found just before lunch time because this is the place of rehabilitation and physical training for the patients for three hours every morning and every afternoon. Thus, sample collecting of the ward hall was done at 11 : 00 a. m..

One of the typical chromatograms is shown in Fig. 4. The main peaks are also found at 3 min, 3 min 30 sec, and 4 min 20 sec, and two minor peaks are detected around the third peak.

3) Comparison against standard samples

The preceding data suggested that these samples contained hydrogen sulfide (H_2S), methanethiol (methyl mercaptane CH_3SH), and methyl sulfide [thiobismethane or dimethyl sulfide $(CH_3)_2S$)]. To identify the stench in the air sample, standard gas samples are prepared and applied on the analytic apparatus. CH_3SH (1 $\mu g/\mu l$ benzene solution, WAKO Pure Chemicals) and $(CH_3)_2S$ (0.1 $\mu g/\mu l$ benzene solution, WAKO Pure Chemicals) that were commercially available were used. H_2S was prepared in Kipp's gas generator with ferrous sulfide (FeS) and hydrochloric acid (HCl). An aliquot of standard samples were transferred into the vacuum sampling jar with a microsyringe, then vaprorized samples were analyzed in the same manner as the expired air or the ward air samples. Retention times for standard sample are 3 min for (H_2S), 3 min 40 sec

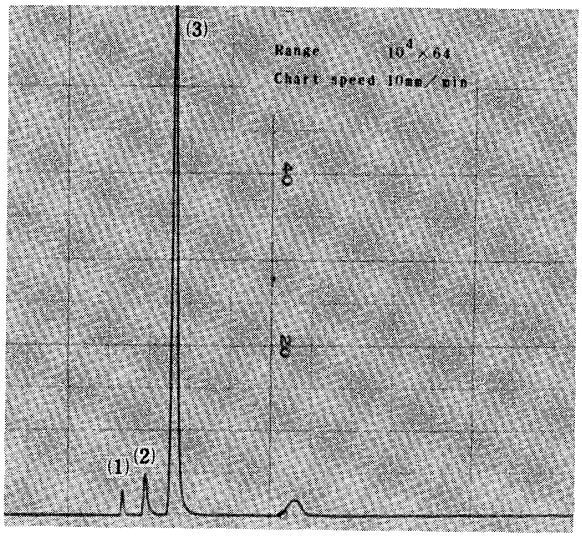

Fig. 5 A chromatogram of standard stench substance mixture.
Hydrogen sulfide(1), Methanethiol(2), and Methylsulfide(3) are injected into the sampling jar with microsyringe, then concentrated and analyzed by the same method.

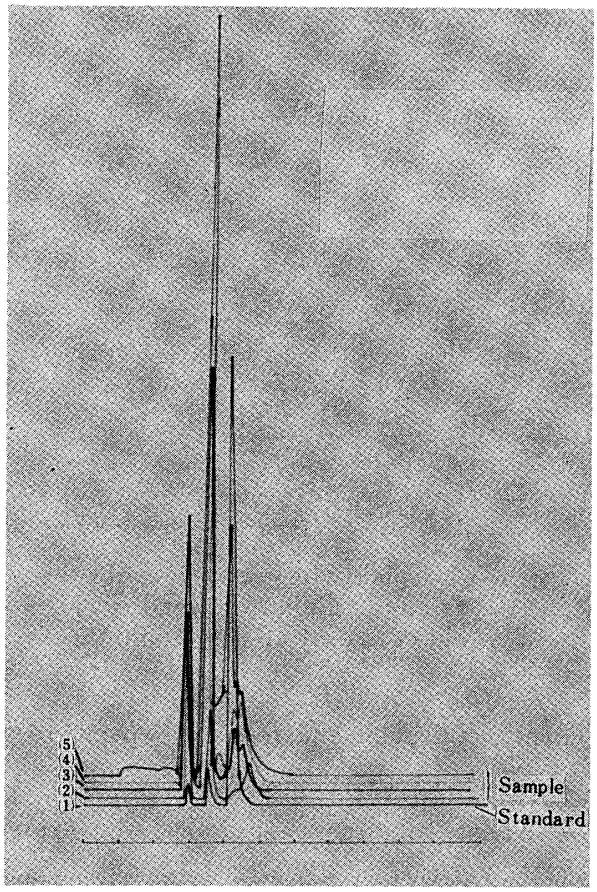

Fig. 6 Comparison of the chromatograms.
Data of standard(1), expired air(2,3), and ward air(4,5) were traced and piled on one chart.

(CH_3SH), 4 min 30 sec [$(CH_3)_2S$], and 7 min (benzene, used as the solvent).

One of the chromatograms of standard mixture is shown in Fig. 5. There are slight differences between air and standard samples regarding the retention times of the second and third peak. This is regarded to be within an acceptable range of technical error by heating of the sample concentration tube. Around the third main peak, there is a possibility of appearance of ethanethiol (ethyl mercaptane, CH_3CH_2SH). Third peak could not be confirmed by the other analytical methods such as mass-spectrography etc. in this experiment because the separated fractions were burnt in the FP detector.

Fig. 6 shows a comparison of these data traced and compiled in one chart. Almost all the standard mixture (1), the expired air (2, 3), and the ward air (4, 5) were in good agreement.

4) Effect of dental treatment

Oral cavities before and after dental treatment, which was done expired are analysis,

Fig. 7 Oral cavity before the treatment (maxillar).

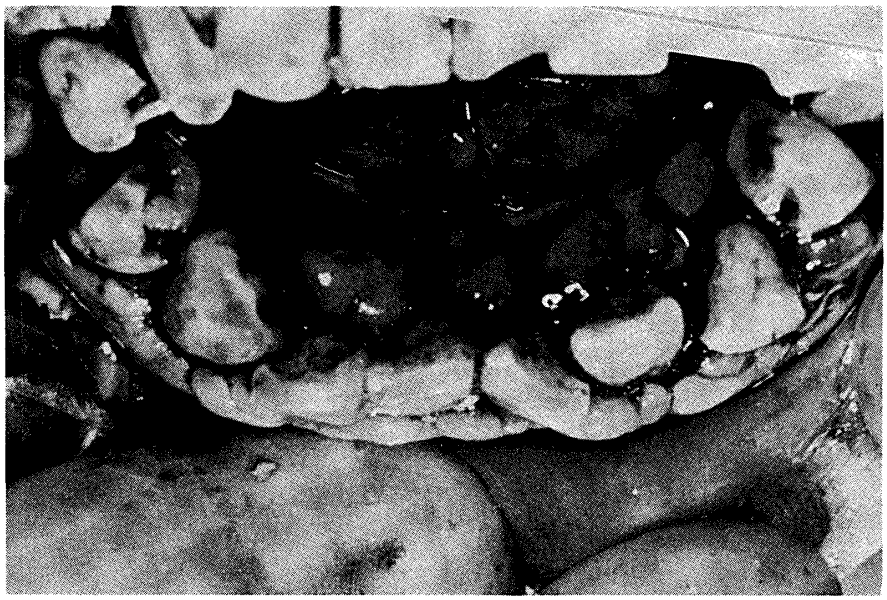

Fig. 8 Oral cavity before the treatment (mandibular).

are shown in Figs. 7, 8, 9. The patient was a 28 year old male who suffered from epilepsy and was severely mentally retarded. His oral cavity is shown in Figs. 7 and 8. An advanced inflamation was seen at his $\frac{\quad|\quad}{4+4}$ position, also hypertrophic gingivae with bleeding and oozing of pus were observed. His $\frac{\quad|1\ 2\ 3\ 4\quad 6}{6\ |\quad\quad 5\ 6}$ were residual roots buried into his own gingiva. Bleeding and oozing of pus are also observed.

His halitosis was so distinct that the consulting room reeked with his stench. The chromatogram of his expired air before the dental treatments was shown in Fig. 10.

The gingivectomy for $\frac{7\quad|\quad 1\quad 5-8}{8\ 7\ 5\ |\quad 4}$ and the extraction of residual roots for

Fig. 9 Oral cavity at 1 week after the treatment.

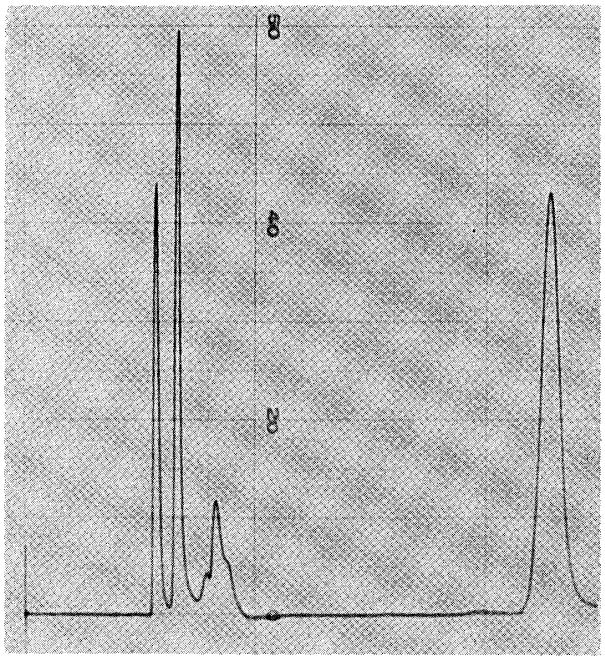

Fig. 10 Chromatogram from the serious case shown in Figs. 8 and 9. Sensitivity 10^3 x 64, chart speed 10 mm/min.

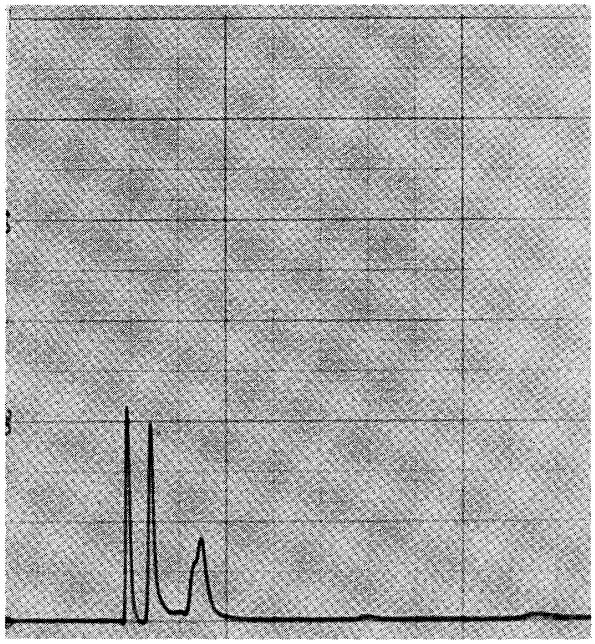

Fig. 11 Chromatogram from the same patient shown in Fig. 9 at one week after the treatment

$\begin{array}{l|l} & 1\ 2\ 3\ 4\quad 6 \\ 6 & \qquad\quad 5\ 6 \end{array}$ were carried out on this patient.

The expired air at one week after the operation was analyzed under the same analytical conditions as shown in Fig. 11. Three main peaks still remained but their peak heights are only 1/2 to 1/3. The state of the patient's oral cavity is shown in Fig. 9.

There were some technical restrictions for the treatment such as the use of electric knife or the avoidance of surgical packs to prevent swallowing by mistake after

the operation with special regards to his handicap. The healing of the operational wound is delayed because of these reasons. It was necessary to clean his oral cavity with a chlorhexidine gluconate (hibitane) immersed cotton rod after every meal.

His halitosis was almost not detectable. From these data it can be understood that the dental treatment is effective in curing the stench both to our senses and also chromatographically.

Discussion

Almost all the severely handicapped persons have neglected oral cavities because it is difficult for them to clean their mouths by themselves and the aid or the help by staff members are limited[7].

Severely carious teeth and gingival diseases of the handicapped persons are generally neglected without any dental care in most institutions[7]. The so-called institutions smell for the handicapped, that is, unpleasant stench in the wards, have been generally regarded to be a result of a general filthiness and leads to prejudice against them.

The present experiment shows composition of the sulfur-containing stench substances in the ward airs were the same as in the expired air of the patients which is mainly composed of hydrogen sulfide, methanethiol and methyl sulfide[2-6]. This suggests that the main source of stench in the institution which are thought to be soiled diapers or clothes or filthy conditions is the unsanitary conditions of the oral cavity of patients in the institutions. Evidence of decrease of stench by dental treatment supports this claim (Figs. 10 and 11).

There are many possible substances and causes of halitosis. It is commonly believed that the sulfur-containing stench substances are the metabolites of sulfur-containing amino acids by micro-organism. Hydrogen sulfide is easily produced from cystein or cystine anaerobicaly. Methionine is cleaved into methanethiol, ammonia and α-ketobutyrate by a micro-organic enzyme. These amino acids are abundantly supplied from the diseased or stripped mucous membrane cells of the oral cavity. Thus, one of the most important sources of stench in expired air is the neglected and unhealthy oral cavity.

The sulfur-containing stench substances found in the expired air of handicapped patients are essentially the same from ordinary patients with halitosis, which is well documented[3,5,6]. Handicapped people have been more neglected or left without any dental care compared to ordinary people[7]. Handicapped patients severely suffer from the dental diseases[7-12]. This is the main source of the so-called smell of institutions and prejudice.

Conclusion

Sulfur-containing stench substances in expired airs of subjects and ward-hall air of an institution for the severely handicapped were analyzed with GLC-FPD reported previously.[1] Both chromatograms revealed that the expired air is the main source of stench in the ward air.

Three principal peaks are observed in expired air and ward air. These may be assigned to hydrogen sulfide, methanethiol and methyl sulfide by runninig a comparing with the standard samples.

The stench of sulfur compounds decrease chromatographically after the radical dental treatments. Decrease of the ward stench is also observed from the senses.

Reference

1. Igarashi, S., Watanabe, S., and Ichida, T.: A Study on Halitosis and Ward-stench of Severely Handicapped Patients, 1. Examination of Sampling and Analytical Method, Higashi Nippon Dent., 4(1); 37—46, 1985.
2. Richter, V. J. and Tonzetich, J. : The Application of Instrumental Technique for the Evaluation of Odorilerous Volatiles from Saliva and Breath, Arch. Oral Biol., 19 ; 47—53, 1964.
3. Tonzetich, J.: Direct Gas Chromatografhic Analysis of Sulphur Compound in Mouth Air in Man, Arch. Oral Biol., 16 ; 587—597, 1971.
4. Jenkins, G. N. : The Physiology and Biochemistry of Mouth, Fourth Edition, 259—260, Blackwell Scientific Publication, London, 1978.
5. Tsuhoda, M. : Analysis of *fetor ex ore* by Gas Chromatography, J. Japan. Ass. Pedodont., 17 ; 1 —12, 1975. (in Japanese)
6. Kaizu, T., Tsunoda, M., Aoki, H., and Kimura, K. : Analysis of Volatile Sulphur Compounds in Mouth Air by Gas Chromatography, Bull. Tokyo Dent. Coll., 19 ; 43—52, 1978.
7. Igarashi, S., Watanabe, S., Baba, H., and Ichida, T. : Oral Environment of Mentally or Physically Handicapped Persons, 1. Actual Condition of Dental Disease Among those who are in a Asylum, Bull. Kanagawa Dent. Coll., 13 ; 35—46, 1985.
8. Issiki, Y. : Caries Incidence among Cerebral Palsied Children, Bull. Tokyo Dent. Coll., 9 ; 168, 1968.
9. Miller, J. B., and Taylon, P. P. : A Survey of the Oral Health of a Group of Orthopedically Handicapped Children, J. Dent. Child., 37 ; 331—332, 1970.
10. Shmark, K. L., and Bernstein, L. E. : Caries Incidence among Cerebral Palsy Children, J. Dent. Child., 28 ; 154—156, 1961.
11. Lyons, D. C. : Dental Health of a Group of Handicapped Children, J. Periodontal., 31 ; 52—55, 1960.
12. Nanjo, Y., Tachibana, H., Kadotani, K., Kawaguchi, Y., Takada, R., and Nishida, M. : Dental and Oral Condition of the Institutionalized Mental Retarded, Dentistry of the Handicapped., 4 ; 35—46, 1983.

重症心身障害者の口臭と施設臭に関する研究

2．硫黄成分悪臭物質の分析(GLC—FPD)と歯科治療効果

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抄　録

重症心身障害者の口臭（呼気）と施設内臭気を対象に，硫黄を含む悪臭物質を選択的に分析することができる炎光光度検出器（FPD）を用い，第1報で報告した採取法，分析法により，ガスクロマトグラフで分析した。

この結果，口臭および施設内臭気には3つのピークが観察され，標準試料のRetention timeと比較したところ，それらは硫化水素H_2S，メチルメルカプタンCH_3S，ジメチルサルファイド$(CH_3)_2S$と同定された。さらに施設内に存在する悪臭は障害者の不潔な口腔内の口臭に起因することが示唆された。また口臭の存在する患者（障害者）の歯科治療前後の口臭分析結果から臭気の減少が確認されたことより，入所している障害者の口腔内が健全な状態に改善されるならば、施設内臭気の減少も期待されることが明らかとなった。