Patologie 1-09 16.1.2009 14:36 Str. 2
proLékaře.cz | 6.10.2026

# ANALYSIS OF THE TRACHEAL CONTENTS USING HEADSPACE GAS CHROMATOGRAPHY-MASS SPECTROMETRY TO SCREEN FOR ACCELERANT USE

**Nobuyuki Adachi* **, Hiroshi Kinoshita*, Minori Nishiguchi*, Motonori Takahashi*, Harumi Ouchi*, Takako Minami*, Kiyoshi Matsui*, Takehiko Yamamura*, Hiroyuki Motomura***, Nao Ohtsu*, Shie Yoshida*, Kiyoshi Ameno**** and Shigeru Hishida***

*Department of Legal Medicine, Hyogo College of Medicine, 1-1 Mukogawa-cho, Nishinomiya, Hyogo, 663-8501, Japan
**Joint –Use Research facilities, Hyogo College of Medicine, 1-1 Mukogawa-cho, Nishinomiya, Hyogo, 663-8501, Japan
***Forensic Science Laboratory, Hyogo Prefectural Police Headquarters, 4-1, Shimoyamate -dori 5-chome, Chuo-ku, Kobe, 650-8510, Japan
****Department of Forensic Medicine, Faculty of Medicine, Kagawa University, 1750-1 Ikenobe, Miki, Kita, Kagawa, 761-0793, Japan

**Summary**

We describe here the usefulness of analysis of tracheal contents in a case of death by fire, which revealed that the deceased had used the accelerants. The analysis of tracheal contents provides useful information for the determination of the circumstances of the scene.

**Key words:** burning – accelerants, gas chromatography – mass spectrometry – alipathic hydrocarbons

**Souhrn**

**Analýza obsahu průdušnice plynovou chromatografií rovnovážné plynné fáze – hmotnostní spektrometrií, která stanoví, zda byly použity hořlaviny**

Autoři poukazují na užitečnost analýzy tracheálního obsahu v případě smrti uhořením, která odhalila, že zemřelá použila hořlavinu. Analýza obsahu průdušnice poskytuje důležité informace, které umožňují stanovit okolnosti na místě činu.

**Klíčová slova:** hoření – hořlaviny, plynová chromatografie – kvantitativní spektrometrie – alifatické uhlovodíky

*Soud. Lék., 54, 2008, No. 1, p. 2–3*

## INTRODUCTION

It is important in a forensic examination to determine any accelerants in cases of burned bodies [1]. Identification of the accelerant from the victim's biological samples such as blood or tissues has usually been performed by gas chromatography or gas chromatography-mass spectrometry (GC/MS) following solvent extraction, SPME-extraction or by the headspace method [1–5]. In previous reports of burning, accelerants analysis was performed not only on blood and/or tissues [1, 3–5], but on intratracheal gas [1] or contents [2, 3]. Here we report a case of death by fire and the presence of fuel components in tracheal contents, detected using headspace gas chromatography-mass spectrometry (HS-GC/MS).

## EQUIPMENT

Analysis of the tracheal contents was carried out according to previous reports with slight modification [6]. In brief, a GC/MS model QP-2010 (Shimadzu, Kyoto, Japan) was used. Chromatographic separation was done in a fused–silica capillary column DB-5MS (30 m X 0.25 mm I.D., 0.25 μm film thickness) (J&W Scientific, Folsom, CA, USA). The operating conditions for GC/MS were as follows. Helium was used as the carrier gas (30 ml/min). The injector temperature was set at 200 °C. The oven temperature was initially set at 40 °C for 2min, then programmed to rise at 20 °C/min to 220 °C, and be maintained at 220 °C for 7min. The MS system was operated in the electron-impact mode with electron energy of 70 eV and an ion source temperature of 250 °C. The identification of the each of the compounds was determined by their retention times and the confirmation ion. The selected ions were monitored at *m/z* 142, 71 and 57 for n-decane, *m/z* 156, 71 and 57 for n-undecane, *m/z* 170, 71 and 57 n-dodecane, and *m/z* 184, 71 and 57 for n-tridecane, respectively. The mass spectra were also identified.

## SAMPLE PREPARATION

The tracheal contents (1g) were added to 1ml of cold water in a glass vial, sealed with a silicon-rubber septum and

proLékaře.cz | 6.10.2026

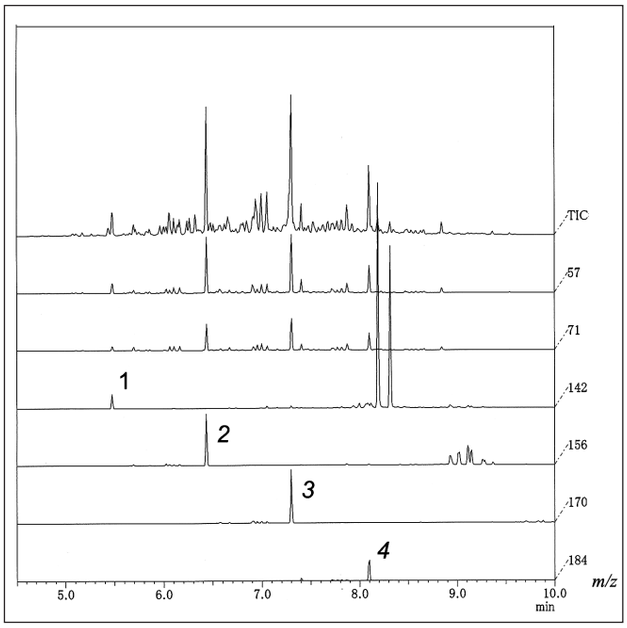


**Figure 1. Total ion and mass chromatograms for each ion are shown.**
**1: n-decane, 2: n-undecane, 3: n-dodecane, 4: n-tridecane.**

aluminium cap and incubated at 60 °C for 20 min. Approximately 0.1ml of the headspace gas was then injected into the GC/MS apparatus.

## CASE REPORT

A burned body was found in the debris of a house fire. The autopsy findings revealed that major joints of the body were in the flexion position. On the external surface of the body, we recognized carbonized skin remaining on only a part of the back, while the rest of the skin was badly burnt or burnt away. The tracheal wall was intact. There was a moderate amount of soot mixed with mucus with an oily smell in the trachea.

The dental findings led us to identify the corpse as that of a female living in this house. Postmortem samples including the left and right ventricle heart blood and tracheal contents were collected and kept at 4 °C until analysis. We performed chemical analysis of the tracheal contents using HS-GC/MS. Determination and quantification of ethanol and carbon monoxide in blood were performed using a HS-GC and spectrophotometer, respectively [7,8].

## RESULTS AND DISCUSSION

The headspace method is a simple, rapid and widely used procedure for the detection of volatile compounds without any special preparation [9, 10]. As shown in Figure 1, the total ion chromatogram and mass chromatogram of the tracheal contents identified saturated alipathic hydrocarbons, such as n-decane, n-undecane, n-dodecane and n-tridecane and also obtained those mass spectra (data not shown). These compounds are indicators of exposure to kerosene or light oil [1, 2]. Additional toxicological examination of the saturation of CO-Hb in the left and right ventricular blood revealed levels of 25.5 % and 36.5 %, respectively, which are relatively higher than that of a heavy smoker, while no ethanol was detected.

Volatile compounds in the intratracheal gas indicate that the body had been exposed to these compounds just before death [1–3]. These tracheal contents are easily collected at autopsy, and if the victim has been exposed prior to death, contain relatively high concentrations of volatile compounds with similar formulations [3].

The combined results of the toxicological examination and police investigation indicated that the deceased was alive when the fire broke out and had used accelerants prior to her death. Thus the results of the chemical analysis of the tracheal contents can play an important role in the estimation of the circumstances of the crime scene.

In the present case, we applied HS-GC/MS analysis to the tracheal contents, and identified alipathic hydrocarbons, which are the main constituents of petroleum fuels. Examination of the tracheal contents using HS-GC/MS is useful for the primary screening for accelerants. Further use in the field of forensic practice can be expected.

## REFERENCES

1 . **Takayasu, T., Ohshima, T., Kondo, T., Sato, Y.:** Intratracheal gas analysis for volatile substances by gas chromatography/ mass spectrometry - application to forensic autopsies. J Forensic Sci 2001; 46: 98–104.
2. **Takatori, T.:** Gas chromatographic determination of kerosene components from cadaveric hypopharyngeal contents. Hokkaido Igaku Zasshi. 1980; 55: 471–3.
3. **Yoshida, M., Watabiki, T., Tokiyasu, T., Akane, A., Ishida, N.:** Case of death by fire with kerosene - Analysis of contents of trachea and stomach-. Nihon Hoigaku Zasshi. 1994; 48: 96–104.
4. **Morinaga, M., Kashimura, S., Hara, K., Hieda, Y., Kageura, M.:** The utility of volatile hydrocarbon analysis in cases of carbon monoxide poisoning. Int J Legal Med 1996; 109: 75–79.
5. **Matsubar, K., Akane, A., Takahashi, S., Shiono, H., Fukui, Y., Kagawa, M., Maseda, C.:** Gas chromatographic determination for forensic purposes of petroleum fuel inhalated just before fatal burning. J Chromatogr, 1988; 424: 49–59.
6. Japanese Society of Legal Medicine Forensic Toxicology Working Group (ed). Kerosene and gasoline. In: Manual for Forensic Toxicology Analysis of the Japanese Society of Legal Medicine, Tokyo: Japanese Society of Legal Medicine, 2006, pp. 111–112.
7. **Kinoshita, H., Nishiguchi, M., Kasuda, S., Ouchi, H., Minami, T., Matsui, K., Yamamura, T., Motomura, H., Ohtsu N., Yoshida, S., Adachi, N., Aoki, Y., Nagasaki, Y., Ameno, K., Hishida, S.:** An autopsy case of poisoning with ethanol and psychotropic drugs. Soud Lek 2008; 53: 16–17.
8. Pharmaceutical Society of Japan (ed). Carbon monoxide. In: Standard methods of chemical analysis in poisoning – with commentary – (4th ed.) Tokyo: Nanzando, 1992, pp. 57–68.
9. **Seto, Y.:** Determination of volatile substances in biological samples by headspace gas chromatography. J Chromatogr A 1994; 674: 25–62.
10. **Takayasu, T, Kondo, T.:** Components of gasoline and kerosene. In: Suzuki O, Watanabe K. editors. Drugs and poisons in humans. A handbook of practical analysis. Berlin Heidelberg: Springer-Verlag, 2005, pp. 159–169.

*All correspondence concerning this paper should be addressed to:*
*Dr. H. Kinoshita,*
*Department of Legal Medicine, Hyogo College of Medicine,*
*1-1, Mukogawa-cho, Nishinomiya, Hyogo, 663-8501, Japan*
*TEL: +81-798-45-6578, FAX: +81-798-49-3279,*
*e-mail: kinochin@hyo-med.ac.jp*