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Detection of HFC-134a in a Case of Asphyxia Using a Plastic Bag

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Abstract

Introduction: We present a case involved with inhalation of HFC-134a, an alternative fluorocarbon widely used as propellant.

Case Report: A male in his thirties was found dead on the back seat of his car. His head was enclosed within a plastic bag. Autopsy findings revealed no pathological findings other than congestion of the organs.

Results: A drug screening test using a Triage™ (Biosite Diagnostic Inc., San Diego, CA, USA) panel yielded negative results, and subsequent toxicological examinations using liquid chromatography tandem mass spectrometry also showed negative results. Ethanol was not detected, but an unknown peak was detected from a blood sample by headspace gas chromatography. This unknown peak was subsequently identified by gas chromatography mass spectrometry as HFC-134a, an alternative fluorocarbon.

Conclusion: We speculate that the deceased had inhaled HFC-134a before death. However, as the toxicity of HFC-134a is relatively low, and its concentration was lower than reported in other cases, we concluded that the cause of death was asphyxia. This case suggests the importance of analysis of drug and chemicals to clarify the situation at the time of death.

Keywords: asphyxia; HFC-134a; toxicological examination; volatile substance

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INTRODUCTION

HFC-134a is a freon gas derivative that is widely used in propellants and blowing and cleaning agents (1). The gas may cause euphoria on inhalation and is sometimes abused for these purposes (2). HFC-134a is less toxic than other fluorocarbons such as CFC-113 or HFC-152a (2-6). Here we report a case of asphyxia following inhalation of HFC-134a, although a toxic effect was not necessarily indicated. We discuss the importance of screening for volatile substances.

CASE REPORT

A male in his thirties (height, 167 cm; weight, 63.5 kg) was found dead on the back seat of his car. His head was enclosed within a plastic bag, and an HFC-134a gas canister for use as an air gun propellant was found nearby (Figure 1).

Medico-legal autopsy showed no evidence of external injury. The heart weighed 369 g, containing approximately 260 mL of blood without coagulum. The left and right lungs weighed 761 g and 754 g, respectively, with severe congestion. The edematous brain weighed 1568 g, with no apparent injuries. No findings suggestive of natural disease were observed. Stomach contents comprised approximately 80 mL of red-brownish liquid, containing small amounts of food residue. Samples of blood, urine and stomach contents were collected for toxicological examinations.

Toxicological analysis using liquid chromatography tandem mass spectrometry (LC-MS/MS) was performed using a slight modification from the previously reported method (7). In brief, liquid chromatography

Figure 1. HFC-134a gas canister was found in his car (a: arrow, b).

separations were carried out using Ekspert™ UltraLC 100-XL (Eksigent part of AB Sciex, Framingham, MA, USA). An L-column2 ODS (1.5 mm × 150 mm, 5.0-µm particle size; Chemicals Evaluation and Research Institutes, Tokyo, Japan) was used with a mobile phase comprising solvent A (5% methanol containing 10 mM ammonium formate) and solvent B (95% methanol containing 10 mM ammonium formate), with a flow rate of 0.1 mL/min. A QTrap® 4500 tandem mass spectrometer (AB Sciex) was used to obtain the mass spectra.

A GCMS-QP2010 plus (Shimadzu, Kyoto, Japan) combined with a TurboMatrix 40 sampler (Perkin Elmer Japan, Yokohama, Japan) was used for headspace gas chromatography/mass spectrometry (HS-GC/MS). Chromatographic separation was performed with a capillary column (J&W DB-BAC2 UI, 30 m □ 0.32 mm i.d., 1.2-µm film thickness; Agilent, Santa Clara, CA, USA). Operating conditions were as follows: carrier gas, helium (1.2 mL min-1); injector temperature, 110 °C; oven temperature set at an initial temperature of 40 °C for 5 min, programmed to rise +10 °C/min to 100 °C with maintenance at 100 °C for 1 min. The MS system was operated in electron-impact mode, with an ion source temperature of 230 °C. We used t-butanol as an internal standard. Quantitation of ethanol was performed using headspace gas chromatography (HS-GC) (7).

RESULTS AND DISCUSSION

The autopsy revealed no pathological findings other than organ congestion. No specific drugs were detected from the TriageTM (Biosite Diagnostic Inc., San Diego, CA, USA) panel or LC-MS/MS. No ethanol was detected by HS-GC, but an unknown peak was detected (Figure 2). This unknown peak was subsequently identified

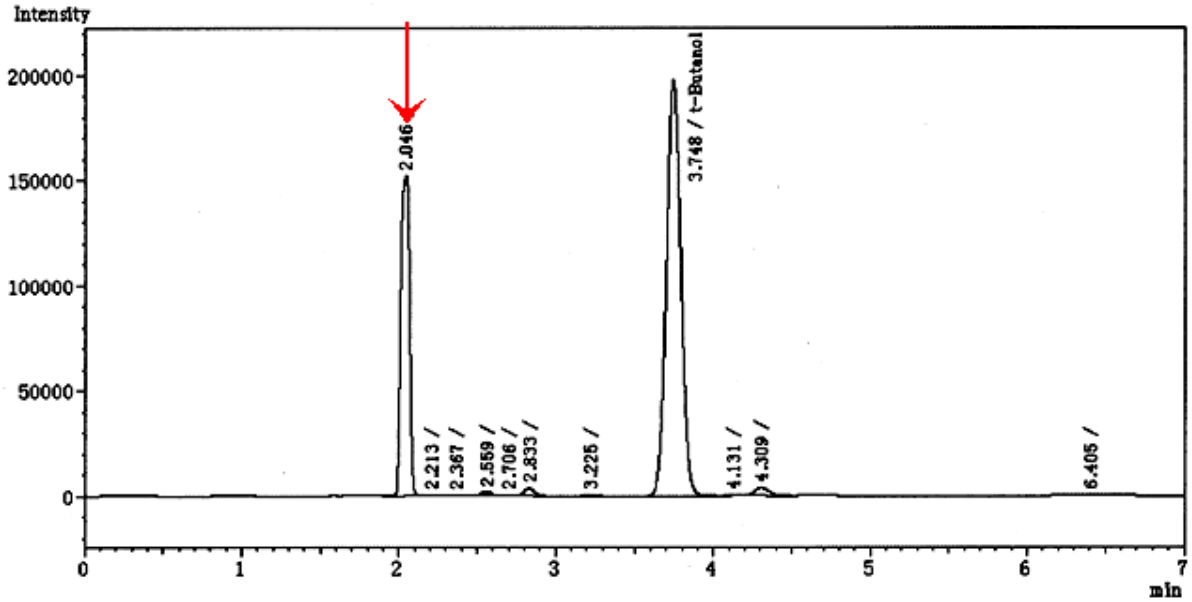

Figure 2. Unknown peak (arrow) was detected by routine HS-GC analysis.

by HS-GC/MS analysis as HFC-134a, with a concentration in femoral blood of 0.64 µg/mL.

Figure 3 shows the selective ion chromatogram and mass spectrum of HFC-134a in blood. HFC-134a has a weak odor and is a non-irritating gas, and mixture with air is non-flammable at room temperature. The gas is widely used as a refrigerant for household or industrial use as an alternative freon gas (4, 8). As an essentially inert, relatively stable gas, no adverse interactions with other substances in the human body have been identified (1).

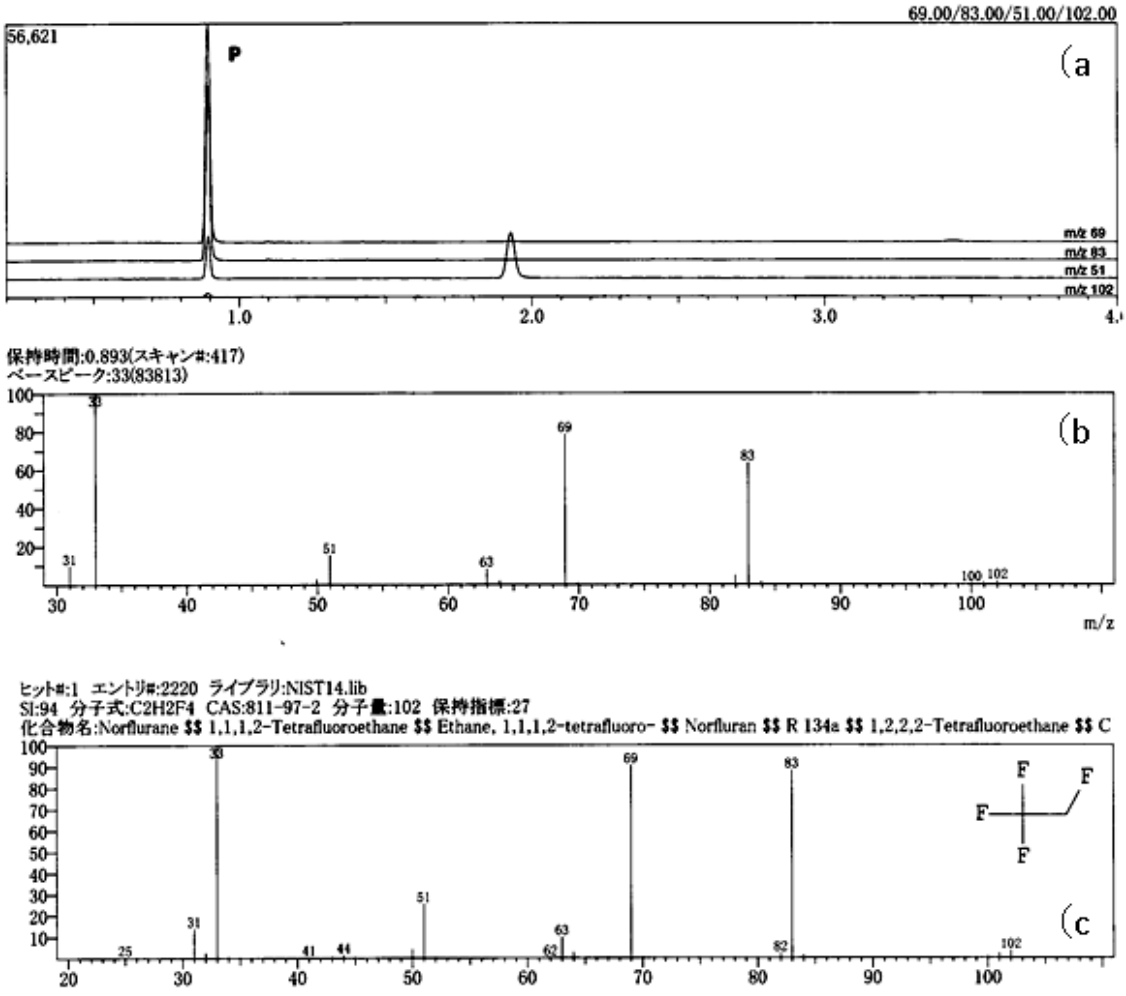

Figure 3. Selected ion monitoring chromatogram (a), mass spectrum of the unknown peak (Rt=0.893 min) (b), and mass spectrum of HFC-134a (c).

The inhalation toxicity of HFC-134a is relatively low, and inhalation of 8000 ppm for 1 h reportedly did not affect heart rate, blood pressure, electrocardiograms, lung function or respiratory parameters in healthy volunteers, with maximum blood concentrations of 7.2 ± 0.7 μg/mL (3). Although risk of arrhythmia was reported at 80,000 ppm in dogs, no mortality was seen among in rodents at a concentration of 81% (v/v) (1, 4). The 50% lethal concentration of HFC-134a exceeds 80% in air (inhalation: 4 h) (2). The inhalation toxicity of HFC-134a is thus very low.

The blood concentration of HFC-134a in the present case was low and seems likely to have contributed little to the cause of death. Based on the autopsy findings, the results of toxicological examinations and investigations by the authorities, we concluded that the cause of death was asphyxia due to suffocation, although the deceased had inhaled HFC-134a before death.

The results of volatile substance analyses in the present case were useful to clarify the situation at the time of death, as in other reports (9, 10). The detection of volatile substances is also useful for forensic diagnosis (11), such as measurement of acetone in the diagnosis of fulminant type I diabetes mellitus (12). This case indicates the importance of wide-ranging toxicological examination in daily forensic practice.

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Conflict of Interest Statement: The authors declare that they have no conflict of interest.

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