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Case Report

Detection of butane gas inhalation at 16 days after hypoxic encephalopathy: A case report

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ABSTRACT

In Japan, there are increasing reports of death by poisoning following butane abuse. To determine the specific cause of death in such cases, it is important to confirm the presence of fuel gas components in the body, although careful analysis is required because of their volatile properties. In most reported cases, the subject died suddenly during or immediately after butane aspiration. Thus, the butane concentration in the samples from the deceased should be relatively high. Herein, we present a case of an 18-year-old man found with cardiopulmonary arrest, who then exhibited hypoxic encephalopathy for 16 days in a hospital. At autopsy, we detected hypoxic encephalopathy, pneumonia, and ischemia-reperfusion injury of the myocardium, while the cause of cardiac arrest remained unclear. Toxicological analysis was then performed for fuel gas components in several specimens collected at autopsy. Results showed that n-butane and isobutane were detected in the adipose tissue at 16 days after inhalation, indicating a role of butane gas inhalation as the cause of death. These data suggest that adipose tissue may be the most appropriate analysis sample to be collected at postmortem in cases where involvement of volatile and fat-soluble gas inhalation is suspected.

1. Introduction

Butane (C_4H_{10}), a 4-carbon aliphatic hydrocarbon, is a highly lipid soluble and flammable gas contained in common commercial products including cigarette or charcoal lighter fluid, liquefied petroleum gas, hair spray, aerosol antiperspirants, and anticontagious plugging spray. These items, particularly cigarette lighter refills or cans for portable cooking stoves, are frequently used for inhalation abuse, particularly in young people in Japan [1–6], as they are easy and cheap to purchase. In the present study, we present a case of sudden cardiopulmonary arrest, who died after 16 days in hospital. As abuse of gas fuel was suspected, we analyzed his body fluids and tissues collected at postmortem for propylene, propane, isobutane, and n-butane, and successfully identified them in adipose tissue.

2. Case report

2.1. Clinical history

An 18-year-old man was found lying on his back on the balcony of his home. Cardiac arrest occurred immediately after he complained of chest pain. He was taken to an emergency room and successfully resuscitated. At the emergency room, the tests for drugs were done. Although a clinician doubted caffeine poisoning and measured his blood theophylline concentration, it was undetectable. Drug screening using the Triage TOX Drug Screen assay was negative. His blood alcohol concentration was not inspected.

However, he was diagnosed with anoxic encephalopathy followed by cardiac arrest, and he died after 16 days. The cause of the cardiopulmonary arrest was unknown during hospitalization. Through police investigation, he was suspected of butane gas aspiration from his social networking service data. A lighter refill was found in the garden under his balcony, but whether it was involved to him or not was unclear. A judicial autopsy was performed at 13 h after his death.

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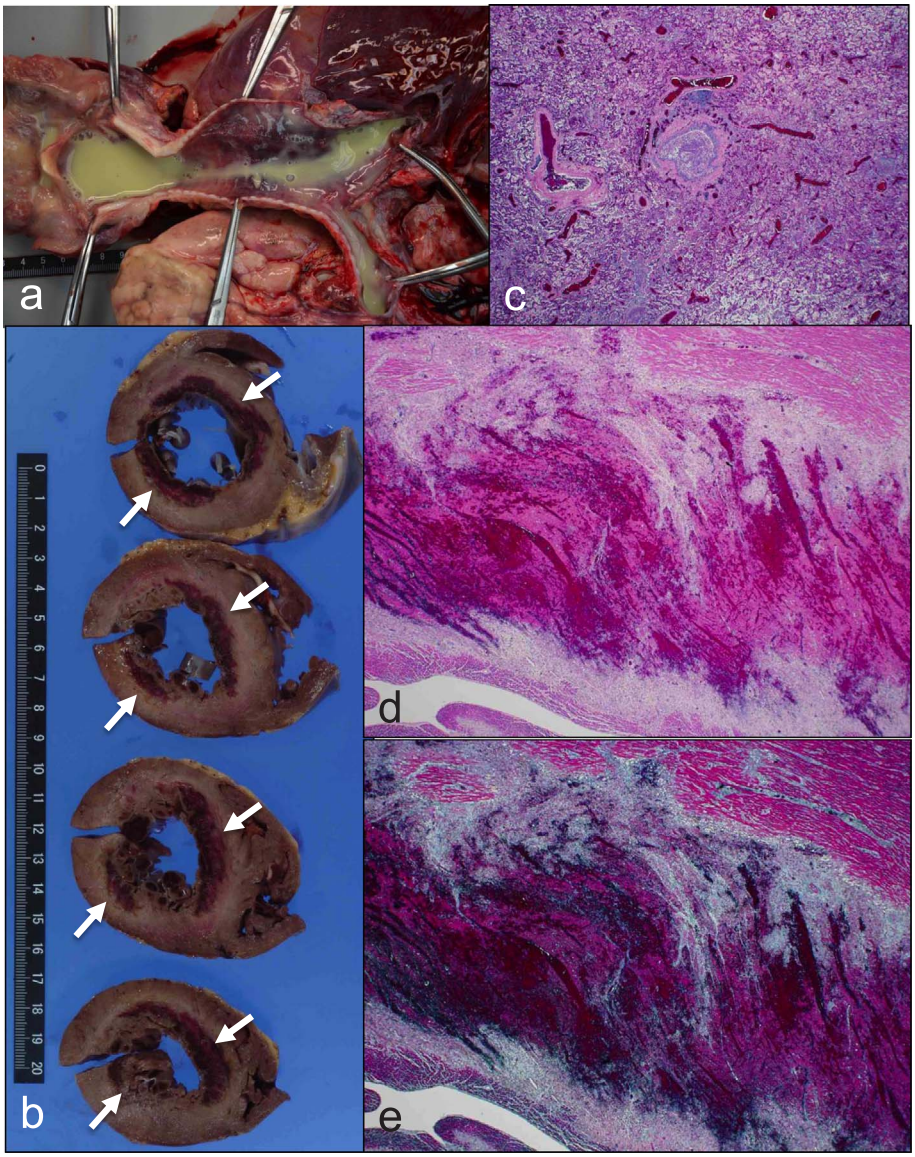

Fig. 1. Macroscopic and histological findings of the lung and heart. (a) Abundant purulent sputum was observed in the bronchus. (b) Cross section of the heart after formalin fixation showing near-circumferential subendocardial ischemia in the left ventricle (white arrows). (c) Inflammatory cells including leukocytes and neutrophils were detected in the alveoli and bronchi (Hematoxylin and eosin stain [H-E] staining, ×12.5 magnification). (d, e) Hemorrhage, necrosis, and fibrosis were observed in the subendocardial myocardium. (d) H-E staining, ×12.5 magnification. (e) Azan staining ×12.5 magnification.

2.2. Autopsy and histological findings

The victim was 179 cm in height and weighed 50 kg. His brain weighed 1488.6 g and was highly softened, with hemolysis deposited on the surface. The left and right lungs weighed 681.7 and 938 g, respectively, with evidence of abundant purulent sputum in the bronchus (Fig. 1a). His heart weighed 309.8 g and showed near-circumferential subendocardial ischemia in the left ventricle, which was caused by cardiopulmonary arrest (Fig. 1b). The other organs showed no abnormal findings. Histological examination revealed infiltration of inflammatory cells including leukocytes and neutrophils into the alveoli and bronchi in the lung (Fig. 1c), as well as hemorrhage, necrosis, and fibrosis in the heart (Fig. 1d, e). Hypoxic encephalopathy and cardiac muscle damage were suspected to have occurred following cardiopulmonary arrest, and then ischemia-reperfusion injury after successful resuscitation. The respiratory infection was suspected to be ventilator-associated pneumonia. Thus, the autopsy and histological findings did not indicate any preexisting pathological findings as a possible cause of death.

2.3. Toxicological analysis

At autopsy, blood, urine, brain, heart, lung, liver, kidney, iliopsoas muscle, and fat tissues (from axilla, hip, and mesenterium) were sampled, wrapped in a plastic film, and then immediately stored in polypropylene containers at −30 °C. Eight days after sampling, the blood and fat tissues from the hip were analyzed for propylene, propane, isobutane, and n-butane by headspace gas chromatography mass spectrometry. Each 1 mL or 1 g of the specimens (solid specimens were cut into small pieces) was placed into a 5.3 mL glass vial and rapidly sealed with a screw cap with a silicone septum. The vial was heated at 60°C for 20 min, and a 50 μl portion of the headspace gas was injected into a GCMS-QP2010 Ultra gas chromatograph equipped with a quadrupole mass spectrometer (Shimadzu, Kyoto, Japan). A CP-PoraPLOT Q capillary column (25 m × 0.32 mm internal diameter, film thickness 10 μm; Agilent technologies, Santa Clara, CA, USA) was used for chromatographic separation with helium as the carrier gas at a linear velocity of 60.0 cm/min and a split ratio of 5. The column oven temperature was initially maintained at 80 °C for 2 min, and then raised to 220°C at 20°C/min, with a final hold for 5 min. The injector and interface temperatures were both set at 220°C. The gas components were analyzed in the full-scan mode (m/z 20–300) by electron ionization at