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Case report

Detection of carbon monoxide poisoning that occurred before a house fire in three cases

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ABSTRACT

In our institutes, we perform a quantitative evaluation of volatile hydrocarbons in post-mortem blood in all fatal fire-related cases using headspace gas chromatography mass spectrometry. We previously reported that benzene concentrations in the blood were positively correlated with carbon monoxide-hemoglobin (CO-Hb) concentrations in fire-related deaths. Here, we present 3 cases in which benzene concentrations in the blood were not correlated with CO-Hb concentrations. A high CO-Hb concentration without a hydrocarbon component, such as benzene, indicates that the deceased inhaled carbon monoxide that was not related to the smoke from the fire. Comparing volatile hydrocarbons with CO-Hb concentrations can provide more information about the circumstances surrounding fire-related deaths. We are currently convinced that this is the best method to detect if carbon monoxide poisoning occurred before a house fire started.

1. Introduction

In an investigation of a fire, chromatographic profiles of fire debris samples are typically used to determine the accelerant (e.g., gasoline or kerosene) [1–3]. However, when a victim is found dead at the scene of a fire, this type of examination can provide only limited information regarding the cause of the fire and circumstances surrounding the corpse, but none on whether the victim was alive when the fire occurred or if petroleum fuel was used as an accelerant [2]. Analysis of volatile hydrocarbons in the blood can indicate if the deceased inhaled accelerant and/or smoke.

Kimura et al. proposed a method for hydrocarbon analysis in post-mortem blood to determine the conditions before death and suggested that it could be used to discriminate between gasoline and kerosene components in the blood [4]. Therefore, chromatographic analysis of volatile hydrocarbons in post-mortem blood from fire-related deaths could provide useful information regarding the circumstances surrounding the death of individuals in the fire.

Previously, we reported a quantitative evaluation of volatile hydrocarbons in post-mortem blood in forensic autopsy cases of fire-related deaths. The concentrations of volatile hydrocarbons were positively correlated with carbon monoxide-hemoglobin (CO-Hb) concentrations in the blood [5]. Of the hydrocarbons, benzene concentrations were the most positively correlated with CO-Hb concentrations. Fig. 1 shows the relationship between benzene and CO-Hb concentrations in the blood in 38 recent fire cases examined in our institute, excluding carbon monoxide poisoning and gasoline-related cases. However, since the publication of our findings, we experienced 3 cases in which the benzene and CO-Hb concentrations in the blood were not correlated (Fig. 1); instead, the CO-Hb concentrations were higher than we expected for the corresponding benzene concentrations. Here, we present these 3 cases.

2. Carboxyhemoglobin and volatile hydrocarbon analyses

The CO-Hb concentrations in blood were measured using a spectrophotometric method [6]. Volatile hydrocarbon analysis was performed, as previously reported [2,5]. As shown in Fig. 2, the volatile hydrocarbon concentrations in the blood could be classified into 3 typical patterns as reported by Yonemitsu et al. [5]. Cases where only benzene, toluene, and styrene were detected were classified as a normal construction fire with no accelerant (Fig. 2A). Cases where a high concentration of toluene was detected in addition to C3 alkyl-benzenes (propylbenzene, ethyltoluene, and trimethyltoluene), which are components of gasoline, were classified as gasoline-related fires (Fig. 2B). Similarly, cases where high

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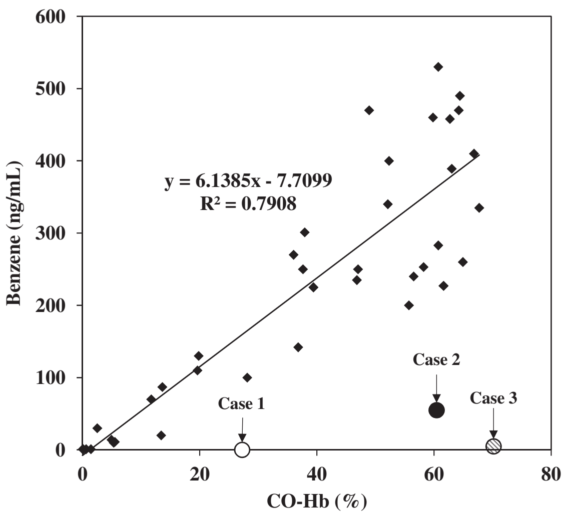

Fig. 1. Relationship between benzene and carbon monoxide-hemoglobin (CO-Hb) concentrations in the blood in 38 recent fire cases examined in our institute, excluding carbon monoxide poisoning and gasoline-related cases; the r-squared value is 0.79. The present cases (Cases 1, 2, and 3) are plotted separately.

concentrations of n-decane, n-undecane, and n-dodecane were detected were classified as kerosene-related fires (Fig. 2C) [5].

3. Case reports

3.1. Case 1

One winter morning, a house fire broke out, following which a burned body was found in the rubble of the house. The body was identified as a woman who lived in the house, aged in her 60s. A small Japanese portable stove used for cooking with coal briquettes was also found (Fig. 3A). The autopsy revealed many petechiae in her airway. The blood in her heart contained a lardaceous clot, indicating her death might have been gradual. The cardiac weight was 513 g. She also had severe coronary arteriosclerosis. No soot deposit was found in her airway (Fig. 3B). The average CO-Hb concentration in her blood was 26%, with hardly detectable levels of volatile hydrocarbons (Fig. 3C). Although she might have eventually died from cardiovascular disease, carbon monoxide poisoning before the house fire started was suspected.

3.2. Case 2

A house fire broke out at midnight in autumn. A body was found near a kerosene stove in the rubble (Fig. 4A) and identified as a man that lived in the house, aged in his 80s. Although the autopsy revealed little soot deposit in the airways (Fig. 4B), the average CO-Hb concentration was 60%. The volatile hydrocarbon analysis indicated a normal construction fire without kerosene as the accelerant (Fig. 4C). The benzene concentration was much lower than expected compared with the CO-Hb concentration. Therefore, carbon monoxide poisoning produced by the kerosene stove before the house fire started was suspected.

3.3. Case 3

A house fire broke out early on a winter morning. The body of the woman who lived in the house, aged in her 40s, was found in the rubble of the bathroom (Fig. 5A). Her upper airway was burned out, and only a little soot deposit was found in her lower airway (Fig. 5B). The average CO-Hb concentration was 70%, and volatile hydrocarbons, including benzene, toluene, and styrene, were detected at low levels in her blood (Fig. 5C). Her manner of death was unclear. However, the cause of death was suspected as carbon monoxide poisoning.

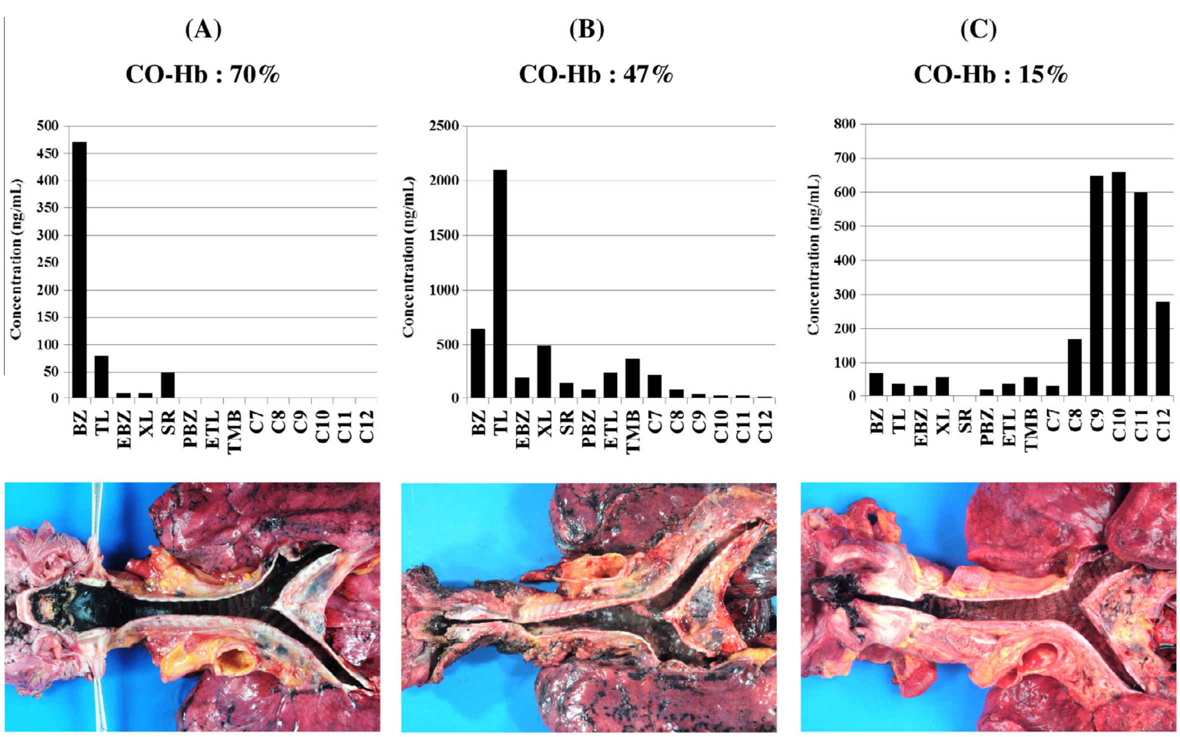

Fig. 2. Typical histograms of blood volatile hydrocarbon concentrations in three types of fires: (A) construction fire, (B) gasoline-related fire, and (C) kerosene-related fire BZ, benzene; TL, toluene; EBZ, ethylbenzene; XL, p-Xylene; SR, styrene; PBZ, propylbenzene; ETL, 3-ethyltoluene; TMB, trimethylbenzene; C7, n-heptane; C8, n-octane; C9, n-nonane; C10, n-decane; C11, n-undecane; C12, n-dodecane.