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Case Report

An Unexpected Death Related to Accidental Gasoline Inhalation

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Gasoline is a chemical compound of aliphatic and aromatic hydrocarbons, and it easily vaporizes because of its volatile characteristics. Gasoline inhalation may occur accidentally or intentionally in various situations which could result in acute non-lethal or lethal intoxication. Given that gasoline is widely used in everyday life, it is surprising that deaths related to gasoline inhalation rarely occur. We presented a rare case of unexpected death related to gasoline inhalation with the postmortem findings and features.

Key Words: Gasoline; Inhalation; Sudden death; Poisoning; Autopsy; Forensic toxicology

Introduction

Gasoline is a volatile chemical substance, comprised of a mixture of toluene, xylene, benzene, and other aliphatic and aromatic hydrocarbons. Because of its volatile characteristics producing invisible vapors, occupational exposure due to inhalation while handling gasoline can be anticipated. Such exposure has been known to cause acute toxicity, manifesting as skin, eye and/or respiratory tract irritation, central nervous system depression, and cardiac arrhythmias. In addition, gasoline can be an asphyxiant if its volatile vapors displace sufficient amount of oxygen from the air [1,2]. These features suggest that deaths related to gasoline inhalation could occur in various situations. Given that gasoline is widely used in everyday life; however, it is

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surprising that deaths related to gasoline inhalation occur less than expected [3].

Therefore, we reported here a rare case of unexpected death related to gasoline inhalation so that forensic pathologists can be aware of its postmortem findings and features and also review other reported cases.

Case Report

1. Case history

A 33-year-old man without significant medical history died suddenly in a gasoline tank. The tank was composed of two compartments. The top compartment was like a manhole; cylindrical, approximately 1.5 m in height and 0.7 m in diameter (Fig. 1). The bottom compartment was bigger than the one above and was used as a storage tank for unleaded gasoline. At that time, the lower compartment was nearly emptied for a regular inspection. He performed repair work, changing a gasket for the entrance hole connecting the two compartments. When he was almost finished with his repair, one of the repair tools fell into the bottom compartment. Because he was wearing a gas mask, he tried to go down into the lower compartment in order to pick it up. He had difficulty going through the entrance hole into the lower compartment, because its diameter was about 0.4 m. He perched on the entrance hole and rearranged his gas mask with a filter (3M 6003K) (Fig. 2). He then passed out unexpectedly, lost his muscle strength, and slipped into the lower compartment. People around him held onto his arm and tried to pull him out, but they failed and he fell into the lower compartment. Although an emergency medical response team was able to remove him and transported him to a hospital, he died. Cardiopulmonary resuscitation was performed by the emergency rescue team and medical staffs in the hospital. Because of his unexpected death, his case was consulted to our institute for postmortem examination.

2. Autopsy findings

The postmortem examination was performed less than 24 hours after his death. The deceased was a 33-year-old Korean male, 174 cm in height and 83.0 kg in weight. Rigor mortis was strong, manifested throughout his the entire body. A strong odor of gasoline could be smelled from the body. Extensive blistering and peeling of the skin were observed on the face, neck, left axilla, anterior chest, abdomen, back and upper and lower extremities. These findings were due to abrasions that occurred while slipping through the entrance hole, and to chemical burns due to prolonged gasoline exposure when he was in the lower compartment. His shoulder width was about 48 cm, and his hip breadth was about

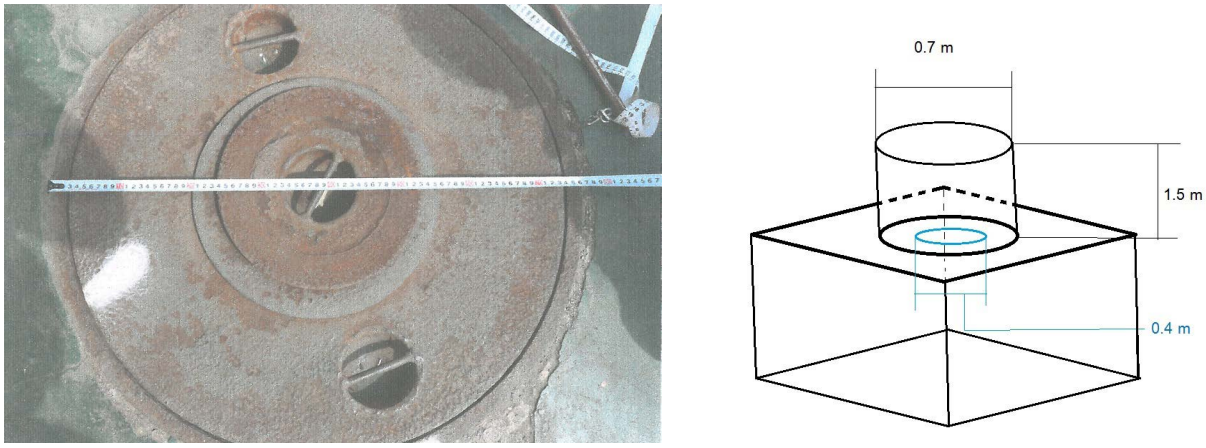

Fig. 1. (**A**) The cover of the upper compartment of the gasoline tank is shown. (**B**) The gasoline tank comprised two compartments; the upper compartment was like a manhole; cylindrical, approximately 1.5 m in height and 0.7 m in diameter, and the lower compartment as a storage tank for unleaded gasoline, was bigger than the upper one.

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Fig. 2. The mask which the deceased was wearing is shown. It seems to be a mask to prevent gas or dust, depending on what kind of filter is used.

38 cm. There were no other remarkable findings on external examination.

The heart weighed 370 g, and there were no pathologic finding in the myocardium. The left anterior descending coronary arteries exhibited moderate atherosclerosis. The ventricles, atria, valves, and endocardium appeared normal. Both lungs showed congestion and edema, and the bronchi contained a large amount of foam. The brain weighed 1,486 g and showed no anatomical or pathological abnormalities. The liver weighed 1,682 g and revealed mild fatty change. The strong odor of gasoline could also be smelled from the internal organs. Both lungs were sent immediately for toxicological test after we tied both bronchi. The peripheral blood, heart blood, brain, and gastric contents were sent for toxicological tests.

3. Postmortem toxicological test

Toxicological analysis was performed using gas chromatography-mass spectrometry (7890 GC/5977 MSD, Agilent Technologies Co., Santa Clara, CA, USA). The result revealed that methyl tert-butyl ether and tert-amyl methyl ether, which are major components of high quality gasoline, and other volatile components such as toluene, ethylbenzene, xylene, C3-alkybenzenes, and C4-alkylbenzenes were detected in the air collected from the lung, as well as in the lung and brain tissues, and blood. No other drugs, alcohol or toxins were detected. Thus, we assumed that the cause of death was related to gasoline inhalation.

4. Gas measurement at the scene

Investigation of the environment at the scene was performed by the National Occupational Safety and Health Agency about 30 hours after his death. The gas concentration in the air was directly measured at the entrance hole using a pocket gas concentration measuring device (model X5, Honeywell, Lincolnshire, IL, USA). Additionally some of the air was sampled for chemical analysis using gas chromatography (GC-FID analysis). Results of the direct measurement at the scene revealed that the oxygen concentration was within normal limits, but the level of volatile gas was above normal, about 83% of the low explosive level. The analysis of collected air samples revealed that the concentrations of benzene, toluene, xylene, and ethylbenzene were 63.1–17.8 ppm, 120.8–209.8 ppm, 35.8–67.1 ppm, and 17.2–32.1 ppm, respectively. The estimated concentration of volatile gasoline gas in the air was 3.8%–14.2% and the estimated concentration of oxygen in the air was 18%–20.2%.

Discussion

Occupation exposure can be expected in deaths related to gasoline inhalation in which the decedent's occupation requires activities such as filling the tanks of cars, spending time at a petrol station, or working in a petrol tank. In addition, exposure may also occur in a traffic accident, during petrol siphoning, or during intentional/recreational use. Except for inhalation, intentional ingestion of gasoline and accidental ingestion of contaminated water has also been known. Gasoline exposure in the respiratory tract can be proven by identifying the chemical compound of gasoline in the liver, lungs, and brain, but it may also be detected in the stomach and bile. Inhaled chemical components of gasoline may rapidly distribute to well-perfused organs like the brain and heart. With higher concentrations of the vapor, more rapid absorption through the lungs may be present within a few minutes of exposure, which may affect the central nervous system. When gasoline is ingested, it is absorbed slowly from the stomach.

Excretion primarily occurs by the lungs and kidneys [1–6]. In Korea, two cases of gasoline inhalation, one case of gasoline injection and one case of gasoline ingestion in which the victims survived have been reported [7–9]. To the best of our knowledge, we have presented the first case in our country of an unexpected death related to gasoline.

The mechanisms of death from gasoline inhalation vary depending on the situation; cardiac arrhythmia, reflex vagal inhibition, central nervous depression, aspiration of gastric contents under intoxication with suppression of swallowing reflex, coma or convulsion, and/or oxygen deficiency/deprivation. Lethal cardiac arrhythmias may occur due to sensitization of the myocardium to endogenous catecholamine. Gasoline vapors at 2,000 ppm may induce mild anesthesia within 30 minutes, and short-term exposure to more than 5,000 ppm would be lethal within less than 5 minutes of exposure [1–5].

It is critical to prove gasoline inhalation by forensic chemical analysis, because autopsy findings are usually unremarkable. Even though skin peeling was identified regionally on some parts of the body in our case, they were not sufficient to explain his sudden death. They were due to abrasions received while slipping through the entrance hole, and/or to chemical burn due to prolonged exposure to gasoline while he was in the lower compartment after he fell into there. Oxygen deprivation (insufficient oxygen) was unlikely in this case, based on the following findings: even though the upper compartment had a structure like a manhole, he had regularly performed the same task on previous occasions. Even on this occasion, some time had passed while he was working, and his consciousness was not affected during that time. However, he unexpectedly lost his consciousness when he tried to enter the lower compartment, a storage tank for unleaded gasoline. Ultimately, the results of the air analysis revealed that the oxygen concentration was within normal limit, notwithstanding that the measurement was performed more than a day after the incident. Therefore, we assumed that his unexpected death was related to gasoline inhalation, based on the following: He lingered at the entrance hole because the hole was too tight for his body to escape through and then, as soon as he rearranged his gas mask, he suddenly lost his consciousness, suggesting that he may have inhaled gasoline vapors from the lower compartment. Although the results of the air analysis at the scene showed that the concentration of each chemical component was less than 500 ppm, given that the half-life for hydrocarbons is short, their concentrations at the time of his unexpected death must have been much higher [2]. The toxicological tests revealed that major chemical components of gasoline were identified from the air in the lung, as well as in the lung and brain tissue and blood. In addition, there was no injury or pathologic findings on postmortem examination. Neither carbon monoxide-hemoglobin nor drugs were detected in the blood. Hence, lethal cardiac arrhythmia was most likely the mechanism of his death which may explain his sudden unexpected death.

This case brings up some questions surrounding his death because several factors may have played a role in his death. He was wearing a gas mask for protection at the time of his death. Its filter was approved for certain organic vapors, chlorine, hydrogen chloride, and sulfur dioxide or hydrogen sulfide or hydrogen fluoride. Given that he had rearranged his mask just before he lost his consciousness, the mask he was wearing to prevent gas inhalation might have had a defect, have been inadequate for his work environment, or he might have been wearing it incorrectly. Even the people around him while he was working did not know what kind of a mask he was wearing at the incident. Additionally there was doubt as to whether it was necessary for him to get down into the lower compartment in order to retrieve the fallen tool. Since answers to these potential forensic issues were not clear at the postmortem examination, we suggested further investigation.

We reported here a rare case of unexpected death related to gasoline inhalation. This case highlights the importance of taking special precautions when working near a gas station or tank, or in any situation of potential gasoline exposure. Autopsy findings are usually non-specific, and toxicological analysis is critical to confirm the cause of the death. The history surrounding the death, scene investigation, and a strong odor can suggest the possibility of gasoline inhalation as the cause of death. Air analysis of the lung, as well

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the lung and brain tissue, and blood should undergo toxicological tests. Finally, it is necessary to consider potential factors that may have contributed to death.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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