Sudden death in relation to inhaling lighter fluid in adolescents

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Abstract: Background. Sudden death as a consequence of lighter fluid abuse, though rare, happens during the adolescence period. The purpose of this study is to discuss the findings related to the deaths of young adults who died due to inhalation of lighter fluid.

Material and Methods. 4 cases who died due to lighter fluid inhalation are included in the study. The autopsy as well as toxicological and pathological procedures of the cases are conducted in Malatya Council of Forensic Sciences. The age, sex, height, weight, clinical findings before death, place of death, autopsy and histopathology findings are assessed in comparison to the toxicological results.

Findings. All the cases in the study are male. The ages are 15.75±1.25, heights are 167.75±12.68 cm and weights are 58.50±8.69 kg. In blood analyses, n-butane and isobutane are found in all of them while 3 of them has propane. Besides, 2 of the cases had Tetrahidrocannabinol in their blood and urine. Three of the deaths happened in the hospital while 1 of them was in the crime scene. In the autopsy of the cases, macroscopically, intensive point bleedings are detected while alveolar fresh bleeding centers are found in the histopathology.

Conclusion. Autopsy and histopathologic findings are non-specific and the decision shall be given by assessing toxicological findings, crime scene examination and witness statements. In suspicious adolescent death, the detection of propane, isobutane and n-butane in toxicological examination is the only finding that makes us think of the presence of lighter fluid inhalation.

Key Words: forensic toxicology, butane, propane, isobutane, sudden death.

INTRODUCTION

Volatile substances are commonly abused by young people since they are easily found, cheap and have a delightful effect [1]. Lighter fluid is a colorless and odorless gas and is a volatile substance used for igniting purposes. Generally it is inhaled into the body by squeezing it inside a nylon bag, soaking a cloth with it or inhaling directly. Its content include 54% n-butane, 20% isobutane and 26% propane [3]. Having a low molecular weight, lipophilic structure and aliphatic hydrocarbon structure, the n-butane leads to a sedative effect on central nervous system [7, 8]. Volatile substances such as n-butane are thought to be the responsible for the death as a result of lighter fluid inhalation [4]. The exchange of n-butane gas with oxygen in the lungs causes asphyxia effects in the body. These effects may lead to unconscious dangerous behaviors, vagal inhibition, respiratory depression as well as sudden sniffing death syndrome [5]. In autopsies for death cases due to sniffing volatile substances including lighter fluid, macroscopic and microscopic patognomic finding has not been described [6]. The purpose of this study is to discuss the findings related to the deaths of young adults who died due to inhalation of lighter fluid, and propose measures to prevent the abuse of volatile substances.

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MATERIAL AND METHOD

Four cases who died due to lighter fluid inhalation are included in the study and their autopsies are made by Council of Forensic Sciences Malatya Group Administration. Before the autopsy, the medical history of the cases are obtained from the families of the cases and from the law enforcement officers investigating the incidences. Crime scene investigation minutes are examined. In the autopsy operation, the liver, kidney, stomach content, inner eye fluid, bile, blood samples as well as the whole right lung which was tied from the bronchial level are extracted for toxicological examination. Brain, cerebellum, brainstem, lungs, liver, kidneys, pancreas and heart samples are taken for histopathologic examination.

The samples are sent to the chemistry laboratory to be examined for the presence of propane, isobutane, n-butane, drugs, hypnotics, stimulants, alcohol and other substances (medicines and toxic substances). The analysis of propane, isobutane and n-butane in blood and tissue samples are conducted by headspace gas chromatography (HS/GC) device. In toxicological examination, one milliliter or 1.0 gram sample and 2.0 mL water are mixed in 10 mL cylindric bottle. The cylindric bottle is closed with a teflon tap tightly and left in water bath at 55°C for 30 minutes. After balancing with room temperature, 1.0 mL sample gas is injected into chromatography device. The content of the gas is determined by Shimadzu GC device with ionisan detector. The gases are distinguished over capillary colon (GS-Q, 30m 0:53mm i.d.). After the injection, temperature of the colon is increased to 1500°C from 1250°C with an average change of 50°C/min. The injection port is 1500°C while the detector temperature is 2000°C. The speed of helium carrier is 5.8 mL/min. In the histopathologic examination, the tissues found to be at 10% formality are painted with hematoxylin and eosin after routine tissue tracking and assessed under light microscope.

The age, sex, height, weight, clinical findings before death, place of death, autopsy and histopathology findings are assessed in comparison to the toxicological findings. The obtained data is analyzed in SPSS 17.0 (Statistical Package for Social Science) software. The specified mean values are given in arithmetic mean ± standard deviation.

FINDINGS

The youngest of the cases is 14 years old while the oldest is 17, and the age average is 15.75±1.25.

Age, height, weight, BMI, place of death of the cases are given in Table 1.

It is found that the Case 1 felt unwell while playing football with his friends, was taken to the hospital by his friends and family but died despite all the medical effort. He had lighter fluid abuse and bally adhesive sniffing in his medical record.

It is found that the Case 2 felt unwell while at home, was taken to the hospital by his family but died despite all the medical effort.

Case 3 is found dead in the roof of their house. Lighter fluid tube and bally adhesive package are found near the corpse. In his medical record, his brothers said that they saw him abuse lighter fluid many times.

It is found that Case 4 felt unwell while inhaling lighter fluid in a empty field with his friends, emergent help team came and intervened in the scene and the patient died in the hospital while by treated.

In the autopsy, blood, stomach content, brain, lung and liver samples of 4 cases are examined for the presence of n-butane, isobutane and propane and given in Table 2.

In Case 1, aside from lighter fluid components, hashish metabolite Tetrahidrocannabinol of 43 ng/mL in blood and 106 ng/mL in urine is found.

In Case 3, aside from lighter fluid components, hashish metabolite Tetrahidrocannabinol of 26 ng/mL in blood and 47 ng/mL in urine is found.

No alcohol is found in any of the cases.

Histopathologic findings of the cases are given in Table 3.

In Case 2, bridging is found in the coronary vein in the heart. In histopathologic examinations of other cases, non-specific changes are found.

Macroscopic autopsy findings of the cases are given in Table 4.

DISCUSSION

Lighter fluid inhalation is an important public health problem causing sudden adolescent deaths in all the world. In a study on volatile substances including lighter fluid inhalation in Turkey, the abuse of volatile substance at least one time in life time is found to be 8.8% [12]. In a study on 12-17 year-old adolescents in Australia, the abuse of volatile substance at least one time in life time is found to be 27.3% [13].

Death due to lighter fluid inhalation are more common among adolescents and young adults [9, 10]. In our study, the age interval of the cases are between 14-17 while the average age is 15.75±1.25. These are the common age intervals for beginning the abuse of substance, we think that since lighter fluid is cheap, easy-to-find and legally attainable, its abuse among adolescents is increasing.

The death due to lighter fluid inhalation are generally caused by dangerous behaviours, vagal inhibition, respiratory failure and cardiac arrhythmia due to sudden sniffing death syndrome. Since there are no macroscopic and microscopic findings for diagnostic purposes in the autopsy, the cause of death is rarely found in the autopsy.
The content of the lighter fluid material found in the crime scene and the correlation of the inhaled substances detected in the toxicological examination of the samples are very important for the diagnosis [17]. Lighter fluid tubes are found near the corpses of Case 3 and 4, and gas components (n-butane, isobutane, propane) are also found in their blood and tissue samples. In Case 1 and 2, no lighter fluid tube is found in the crime scene. However, lighter fluid abuse history of these two patients are found. Lighter fluid components are found in the blood and tissue samples of these cases, too. Crime scene examination findings as well as medical histories of these cases have been very useful for understanding the causes of death. In sudden adolescent deaths, substance abuse, especially the increasingly used lighter fluid inhalation lately, shall be considered for definitive diagnosis. Crime

<table>
<thead>
<tr>
<th>Case No</th>
<th>Sex</th>
<th>Age (year)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>Body Mass Index (BMI) kg/m²</th>
<th>Clinical findings</th>
<th>The place of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>16</td>
<td>169</td>
<td>54</td>
<td>18.9</td>
<td>Sudden disturbance</td>
<td>Hospital</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>14</td>
<td>161</td>
<td>60</td>
<td>23.1</td>
<td>Sudden disturbance</td>
<td>Hospital</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>16</td>
<td>156</td>
<td>50</td>
<td>20.5</td>
<td>Sudden death</td>
<td>Crime scene</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>17</td>
<td>185</td>
<td>70</td>
<td>20.5</td>
<td>Sudden disturbance</td>
<td>Hospital</td>
</tr>
</tbody>
</table>

Table 2. Determined lighter gas types in toxicological analysis

<table>
<thead>
<tr>
<th>Toxochemical Samples</th>
<th>n-butane</th>
<th>isobutane</th>
<th>propane</th>
</tr>
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<tbody>
<tr>
<td>Case 1</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Case 2</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Case 3</td>
<td>+</td>
<td>+</td>
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</tr>
<tr>
<td>Case 4</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
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Table 3. Findings of histopathology

<table>
<thead>
<tr>
<th>Case</th>
<th>Brain</th>
<th>Cerebellum</th>
<th>Brainstem</th>
<th>Lungs</th>
<th>Liver</th>
<th>Kidney</th>
<th>Pancreas</th>
<th>Heart</th>
<th>Coronary arteries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Edema</td>
<td>Intraalveolar fresh bleeding Foreign body aspiration compatible with food content</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Edema</td>
</tr>
<tr>
<td>2</td>
<td>congestion</td>
<td>congestion</td>
<td>Point fresh bleeding</td>
<td>Intraalveolar fresh bleeding Edema</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Edema</td>
</tr>
<tr>
<td>3</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Intraalveolar fresh bleeding Edema</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Focal interstitial fibrosis</td>
<td>Edema</td>
</tr>
<tr>
<td>4</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Intraalveolar fresh bleeding Edema</td>
<td>congestion</td>
<td>congestion</td>
<td>congestion</td>
<td>Edema</td>
<td>Intraalveolar fresh bleeding Edema</td>
</tr>
</tbody>
</table>
scene examination reports and cases' medical histories are very important for detecting the cause of death in similar cases.

In the literature, it is reported that the components of lighter fluid are found in different amounts in blood and tissues [19]. In their study, Ozdemir et al. report that they found butane and/or isobutane and propane in blood samples of all their cases, and lighter fluid components were 55.6% in the lung samples, 61.1% in the kidney and liver samples [10]. In our study, we find n-butane and isobutane in blood samples of all the cases; propane in case 1, 3 and 4; n-butane in lung samples of case 1, 2 and 3; isobutane and propane in lung samples of case 1 and 4. We think that it is important to search for lighter fluid components in blood and lung samples in deaths due to lighter fluid. In such deaths, toxicological examination of blood, stomach content and tissue samples and their results may be the only evidence for determining the cause of death. For this reason, obtaining all toxicological samples including especially blood and lung samples and sending them immediately to the laboratory is necessary. Since volatile gases will be sought in this process, the person who will conduct the sampling shall be very careful.

The findings in the tissues after the histopathologic examination are non-specific and do not contribute much to understand the cause of death. No patognomic finding is obtained for the internal organs in our study. Changes such as intraalveolar fresh bleeding in the lungs and edema are non-specific and can be present in many situations (such as agopy period). We conclude that the detection of bridging in one case's left frontal coronary vein is an incidental finding and it increased cardiac side effects of lighter fluid.

Inhaling lighter fluid during a heavy physical activity increases risk of death [10]. Case 1 in our study felt unwell suddenly while playing football and died in the hospital due to ventricular fibrillation. Besides, we obtained information about the volatile substance abuse history of the case and found butane, isobutane and propane in the toxicological examination of the blood and lung samples. Heavy physical activity, sudden fear and discharge of catecholamine during sexual intercourse after butane and isobutane inhalation may cause ventricular fibrillation [20]. Although arrhythmia mechanism is not explained completely in the literature, as a result of toluen abuse, the cardiac voltage dependent Na+ channels are reported to be inhibited reversibly [14, 15]. We think that arrhythmia mechanism is similar to lighter fluid inhalation.

In studies on volatile substance abuse, it is reported that substance abuse is not limited to only one substance and is accompanied by other substances [16]. In our study, we have found n-butane, isobutane and propane in the bloods of case 1 and 3, additionally there was hashish metabolite Tetrahydrocannabinol in their urine and blood. Multiple and different volatile substance abuse by adolescents is in fact a step for using other sedative drugs. The struggle against these substances such as lighter fluid which are easy-to-find and legally sold can prevent other future drug addictions.

CONCLUSION

Smoking rate between 13-15 age is reported to be 8.8% in Turkey [18]. Most of them carry lighter with them. For this reason, finding materials such as lighter, lighter fluid, tube of lighter fluid in crime scene brings death due to lighter fluid inhalation into the mind. The abuse of lighter fluid in the medical history of these cases shall be investigated. In the autopsy procedure, the toxicological samples duly obtained in terms of volatile substance shall be transferred rapidly to the laboratory and the toxicology laboratory shall be notified of the possible presence of volatile substances (butane, isobutane and propane). Besides, we believe that the addition of bad smelling gases into the lighter fluid will be very beneficial for preventing the abuse of lighter fluid among young adults.

Conflict of interest. The authors declare that they have no conflict of interest concerning this article.

References


