



Butane Gas Inhalation Resulting in Death: Two Case Reports

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Abstract

Today, abuse of volatile substances is an increasingly common public health problem in Turkey, as throughout the world. These substances are attractive to children and adolescents as products containing inhalants are relatively inexpensive, legally and easily accessible, have a rapid effect and unwanted symptoms disappear quickly. Case No 1: A 16-year old male collapsed in the street who was intubated by paramedics and taken to the Emergency Department. A cigarette lighter and gas refill can were found in his pockets. Case No 2: The dead body of a 17-year old male who lived with his parents was found in the kitchen of their house. There was a court record of substance abuse inhalation. In the autopsies of both cases, the brain and cerebellum were observed to be hyperemic and oedematous. Hyperemia was also observed in tracheal and gastric mucosa. Toxicological and histopathological analyses were applied after the autopsies. Butane, as the active ingredient of lighter gas, was confirmed in samples of blood, bile and internal organs in the toxicology analysis. Histopathological examination of the brain, cerebellum, lung, liver and kidneys determined congestion. In this study, it was aimed to emphasize the importance of the causes of the increasing prevalence of inhalant abuse in children and young adults and the significance of forensic autopsy in the determination of the cause of death. To prevent inhalant abuse of substances which can be obtained cheaply and easily in our country, visual-auditory education-training and appropriate legal regulations are required.

Keywords: Abuse of volatile substances, butane, adolescent, autopsy, forensic medicine

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Introduction

The abuse of volatile substances is the inhalation of vapour with the intent of feeling pleasure or intoxicated. This problem is known to be becoming increasingly widespread in our country especially affecting adolescents and young adults of all socio-economic and cultural levels [1-4].

Despite the negative societal consequences and physical damage, volatile substance inhalation is repeatedly desired due to the pleasurable effects and is thus known as substance abuse. In addition, when substance use causes loss of control, tolerance or deprivation it is described as substance addiction [5].

The vast majority of volatile substances are easily accessible as they are used in many areas of daily life and can be abused as a psychotropic agent [6]. Reasons for choice are that the effects are quick, pleasurable and like mild drunkenness [7]. Volatile substances are volatile hydrocarbons such as toluene, n-hexane, methylbutyl ketone, trichlorethylene, trichlorethane, dichloromethane, petrol and butane [8]. Some of the most common substances which are abused are solvents, paints, varnish, regulatory fluids, butane and gasoline [4].

Volatile substances are attractive as they are easily obtainable in shopping centres, stationers, pharmaceutical depots, workplaces and homes, and are legal and relatively cheap (9,10). In comparison with other drugs, volatile substances differ in that they are easily obtained and have rapid effects which then disappear relatively quickly. Therefore, a child may inhale substances after school and still return home in a sober state [10].

In this study, with the presentation of two cases, it was aimed to draw attention to the various factors of the effect of the increasing problem in children, adolescents and young adults of volatile substance abuse and the related risk of sudden death. An evaluation was also made of the contribution of forensic autopsy to the determination of cause of death.

Case 1

A 16-year old male was found in a collapsed state in the street and when the ambulance services were called, they made the necessary interventions and took him to the hospital Emergency Department. In the physical examination in the Emergency Department, the

general condition of the patient was poor, he was unconscious and as ventricular fibrillation was determined, defibrillation was applied. Despite all the resuscitation procedures, the patient died after one and a half hours. The cause of death could not be identified and as a cigarette lighter gas refill can was found in the pocket of his clothing, the death was determined as suspicious and accepted as a forensic case.

In the documents of statements of the investigation, it was recorded that the patient had left school in the first year of high school, smoked cigarettes habitually and for approximately one and a half years had been inhaling lighter gas every day in isolated areas and derelict buildings. On that day he had inhaled lighter gas then had difficulty remaining standing and was talking incoherently.

In an external examination, a cigarette lighter was found in the trouser pocket and the lips and nails had a cyanotic appearance. In the autopsy, there was a shiny and oedematous appearance to the brain and cerebellum. Within the lateral ventricles, approximately 5cc haemorrhagic fluid was observed and bilaterally in the chest cavity, 50 cc serohaemorrhagic free fluid was observed, the left lung was weighed as 880gr and the right lung as 830 gr. In the lung sections, an outlet of compressed blood foaming fluid was observed, the trachea mucosa was hyperemic in appearance, 350cc serous free fluid was determined in the abdomen and the stomach mucosa was hyperemic in appearance.

In the toxicology test results, butane being the active agent in lighter gas was found in the blood, gallbladder and internal organ samples but not in the urine. In the histopathology test results, a small number of extravasal erythrocytes were determined in the subarachnoid area of the brain, congestion in the cerebellum and brain stem, congestion and emphysematous changes in the lungs, widespread alveolar oedema, alveolar erythrocytes, sporadic foci of mononuclear focal inflammatory cells, alveolar macrophages, congestion in the kidneys, liver and heart, and findings of autolysis in the mucosa of the stomach.

According to the findings obtained as a result of the postmortem examination, the autopsy findings and the toxicology-histopathology tests, it was concluded that the cause of death was cardiac arrhythmia (ventricular fibrillation) associated with butane gas poisoning.

Case 2

A 17-year old male was found dead on the kitchen floor of the family home where he lived together with his parents and as the death was considered suspicious, it was reported as a forensic case.

In the forensic records it was stated that the boy had started inhaling lighter gas approximately two years previously in addition to habitual use of alcohol and cigarettes, that he had an aggressive and difficult personality and experienced problems socialising appropriately with those around him. Due to recent financial problems he had started trying to sell motor cars and on that night had been drinking alcohol with three friends then left them to go home and after going to bed late that night was found dead in the kitchen the next morning by his family.

In the external examination, the nails of both hands, both ear lobes and the lips had the cyanotic appearance and white foam was determined to have come from the left nostril. In the autopsy, the brain and cerebellum sections had the appearance of oedema but no macroscopic pathology finding was determined. Free fluid was not seen in the chest cavity, the right lung was weighed as 530gr and the left lung as 350gr, there was a 1x1 cm bleeding area on the inferior external edge of the left lung superior lobe, in the lung sections, an outlet of a little compressed blood foaming fluid was observed, and when the bronchi were opened they were seen to be contaminated with foaming fluid.

In the toxicology test results, butane being the active agent in lighter gas was found in the blood, gallbladder and internal organ samples. In the histopathology test, congestion was determined in the brain, cerebellum and brain stem, congestion and emphysematous expansion in the lungs, congestion in the kidneys, liver and myocardial sections of the heart, and atheroma plaque narrowing the lumen by 45-50% in the coronary artery sections.

According to the findings obtained as a result of the postmortem examination, the autopsy findings and the toxicology-histopathology tests, it was concluded that the cause of death was associated with butane gas poisoning.

Discussion

Ma Use of volatile substances continues to become more widespread among adolescents due to the pleasurable effects, and that they are easily and cheaply obtained. For adolescents just starting to use volatile substances, it is evaluated as a social activity with a group of friends. In addition, the media representation of volatile substance use 'giving pleasure', which is reflected or directly shown as euphoria, excitement and cheerful behaviour, increases interest in these substances. However, the potential short and long-term side effects created by these substances are generally not known or not given any importance [3,11,12]. Both of the cases presented here used other substances (cigarettes, alcohol) in addition to volatile substance abuse, had a tendency to be in a group of friends and displayed antisocial behaviour.

Groups at risk of volatile substance abuse include children and adolescents, those in a problem family, those with a low socioeconomic level, street children, employees of workplaces where volatile substances are used (shoe, dye sectors etc.) and those with substance addictions [2, 3]. Of the cases presented here, the first was a cigarette smoker and the second had financial problems, was aggressive, maladjusted, used alcohol and cigarettes habitually; therefore both were seen as within risk groups for substance abuse.

In a study in Japan, it was reported that inhalation of volatile substances was widespread among the young and the most frequently used form was cigarette lighter gas refill cans containing butane, less frequently the butane gas in camping stove gas bottles and rarely, liquid petrol gas (LPG) containing propane [13]. In Case No 1, it was noticeable that he had a cigarette lighter and a refill can of lighter gas on his person for the purpose of volatile substance use as it is cheap, easily obtainable and there is no legal restriction.

Volatile substance users may have poor family, school and social relationships depending on their expectations of relationships, degree of substance addiction and satisfaction taken from this activity. In studies conducted in Turkey, it has been reported that in 86-90% of individuals using volatile substances, education had been negatively affected [14]. Case No 1 reported here had not continued education after the first year of high school and Case No 2 had relationship problems with his peers.

Those using volatile substances have been seen to go on to use another addictive substance and it has been reported that the use of volatile substances together with another addictive substance is widespread [14]. In one study of addictive substances, it was seen that 78% of volatile substance users smoked cigarettes, 29% drank alcohol and 8.1% used drugs (3). These findings are important in respect of showing that volatile substance use is a step towards other addictive substances. In the current cases, it was noticeable that there was cigarette and alcohol use.

In industrialized countries, there continues to be an increase in the numbers of deaths as a result of volatile substances. In England, currently more than 120 deaths per year are reported from this cause alone, mostly male and in the 15-19 years age group [15]. That the current cases were male, aged 16 and 17 years old is consistent with literature.

At the beginning of volatile substance inhalation, the release of catecholamines in explosive form may trigger ventricular fibrillation and cause 'sudden inhalation death' [16]. According to the medical records, in one of the current cases, cardiac arrhythmia and ventricular fibrillation had occurred before death.

After mixing with blood from the lungs, as volatile substances are lipophilic they are found in high concentrations in fat-enriched organs such as fat tissue and the brain and are not determined in organs such as the liver, the kidneys and the heart [17]. N-butane and isobutane have the anesthetic and narcotic effect on the central nervous system. Even at levels of 0,5-15% in the air, fatal arrhythmia can be induced [18].

More than half of the sudden deaths occurring as a result of volatile substance use have been reported to be associated with direct toxic effects, primarily cardiac [16]. In this context, a continuous increase is seen in the number of sudden deaths occurring because of causes such as cardiac arrhythmia, respiratory depression or hypoxia [19]. Therefore, despite autopsies of cases, the process of researching the origin and cause of death is very complicated [16]. In a study in the USA of 110 cases associated with volatile substance use, an epidemic of sudden death was determined, with no anatomic defect in the autopsy results to explain the sudden deaths. Therefore, it was thought that the deaths developed due to rhythm impairments originating in the ventricle [20]. Similarly, in the second case presented here, no traumatic finding was found in the autopsy which would explain the sudden death and in the toxicology

test results, as butane was determined in the blood, gallbladder and internal organs, the conclusion was reached that death was due to ventricular-originated rhythm impairment.

In a study by Sugie et al. [13] of three cases, one was a 14-year old male with a history of lighter gas inhalation abuse who died suddenly while inhaling from a lighter refill can containing butane. The other two cases were found dead. At the home of one, 24 empty cans were found which had each contained 250 gr of volatile liquid. The other case was a 19-year old male who was found dead as holding a hosepipe at jaw level coming from open LPG. In all three autopsies, no finding other than non-specific congestion could be determined so analysis was made for propylene, n-butane, propane and isobutane in the blood, urine, stomach contents, brain, liver, lungs, heart, kidneys and fat tissue. As a result of the analyses, the constituents of the inhaled materials were primarily determined to be consistent with n-butane in two cases and propane in the third. In the current cases; a cigarette lighter and a lighter refill gas can were found on Case No 1 for the purpose of volatile substance abuse and in the autopsies of both cases, no finding was determined other than congestion and hyperemia and butane was determined in the blood, gallbladder and internal organs.

In conclusion, it can be said that not enough interest is shown in the subject of volatile substance abuse, which is an increasing problem in Turkey, especially in adolescents and young adults. Educational programs should be applied to inform the families of the potential consequences of substance addiction and volatile system abuse, especially the families of high risk groups (problem families, those with a low socio-economic level, street children and those working in places where volatile substances are used such as the shoe and dye sectors). As these substances are currently easily obtained, there must be more stringent legal regulation related to sale and availability. In addition, in suspicious deaths with a history of substance abuse, taking a sufficient number of appropriate samples, primarily of fat tissue, where substances such as butane could be found, will facilitate the determination of the cause of death.

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