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Planned Complex Occupation-related Suicide by Sulfuric Acid Ingestion and Thorax Stab Wound: Case Report

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Abstract

Sulfuric acid is a colorless, odorless liquid, which causes typical injury patterns such as cutaneous and ocular burns, respiratory complications from inhalation, and ingestion injuries (coagulative necrosis of the mucosa, gastric and intestinal perforations) with significant dermal and mucosal injury because of its corrosive action. Most injuries caused by sulfuric acid ingestion are accidental, especially in the pediatric population. Intentional cases of ingestion have rarely been reported in adults as a method of suicide following a major depressive disorder. In this paper, we report the case of a 44-year-old woman who was found dead outside her home with a retained fillet knife embedded in her left chest wall and cutaneous chemical burns extending from her mouth down her chin and anterior torso. During the crime scene investigation, a half

empty bottle of chemical drain cleaner containing concentrated sulfuric acid was found next to her body. An autopsy revealed chemical burns to the tongue, trachea, larynx, pharynx and esophagus along with a blackish fluid in the peritoneal cavity. Histological analyses showed extensive corrosive changes in the gastrointestinal tract. Toxicological screening of blood and urine samples was negative; gastric contents contained a high quantity of concentrated ($\approx 96\%$) sulfuric acid with a pH value of < 1.0 . Death was attributed to shock following sulfuric acid ingestion. Circumstantial evidence and autopsy findings proved that the manner of death was suicidal. Complex suicides can be challenging for the forensic pathologist because of the plurality of methods used. The authors highlight the importance of systematical exhaustive postmortem investigation in order to ascertain the cause and manner of death in cases of planned complex suicide.

Key words: Planned complex suicide, Sulfuric acid, Stab wounds

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حالة انتحار مخطط ومرتبطة بالمهنة بواسطة حمض الكبريت وطعنة في الصدر: تقرير حالة المستخلص

يعد حمض الكبريت سائل عديم اللون والرائحة، وغالباً ما يتسبب بأذيات موضعية نموذجية مثل الحروق الجلدية والعينية، ومضاعفات في الجهاز التنفسي عن طريق الاستنشاق، وأذيات في الجهاز الهضمي (التنخرات التجلطية للأغشية المخاطية وقد تصل إلى ثقوب في جدار المعدة والأمعاء) وذلك بسبب تأثيره المخرّش.

ومعظم حالات التعرض لهذا الحمض تكون عرضية وبشكل خاص في مرحلة الطفولة. وتعتبر الحالات المتعمدة لتناول حمض الكبريت عند البالغين بهدف الانتحار قليلة جداً وفق تقارير الحالة المدروسة، والتي تكون غالباً نتيجة حالة اكتئاب شديدة. في هذه الورقة ناقش تقرير حالة لامرأة عمرها 44 عاماً وجدت ميتة خارج منزلها مع وجود سكين مطعونة في الجهة اليسرى لجدار الصدر، وحروق جلدية كيميائية تمتد من الفم إلى أسفل الذقن وحتى الجذع الأمامي، ومن خلال التحقيق في مسرح الجريمة، تم العثور بجوار جسدها على نصف زجاجة فارغة من منظف كيميائي خاص بالمصارف الصحية يحتوي على حمض كبريت مركز. وكشف تشريح الجثة حروق كيميائية تصل إلى اللسان والقصبات الهوائية والحنجرة والبلعوم والمريء، جنباً إلى جنب مع سائل أسود في التجويف البريتواني. وأظهرت التحاليل النسيجية تآكل واسع في طرق الجهاز الهضمي. وكان فحص السموم لعينات الدم والبول سلبياً؛ كما تضمنت محتويات المعدة كمية عالية من حمض الكبريت المركز (≈ 96%)، وكانت درجة حموضة محتويات المعدة أقل من 1.0. وتم تفسير سبب الوفاة بالصدمة التالية لتناول حمض الكبريت. ولقد أثبتت الظروف والأدلة المحيطة بالقضية ونتائج تشريح الجثة أن الوفاة الحاصلة هي انتحار. وتعد حالات الانتحار المعقدة تحدياً كبيراً للطبيب الشرعي بسبب تعدد الأساليب المستخدمة. ويؤكد المؤلف على الأهمية الكبيرة للإجراءات والتحقيقات الشاملة النظامية لحالات ما بعد الوفاة من أجل التأكد من سبب وطريقة الوفاة.

الكلمات المفتاحية: حالة انتحار معقدة ومخططة، حمض الكبريت، جروح الطعنات

Introduction

Deaths caused by self-inflicted injuries account for 1 – 5% of all deaths and are now listed as the 10th leading cause of death worldwide, even if in some countries the phenomenon goes unreported [1].

The definition of complex suicide as the use of more than one method to achieve death has been widely accepted in the forensic literature ever since it was introduced [2,3]. According to the literature, complex suicides nowadays account for 1.5 to 5% of all completed suicides [4]. Marcinkowski pointed out the difference between suicides in which a combination of two or more simultaneous methods is planned in order to avoid the failure of the first suicide method – *suicidium compositum paratum* - and those

cases in which further methods are implemented as a consequence of the failure of the first method (*suicidium compositum non paratum*) [5]. Indeed, planned complex suicides are also performed in order to guarantee or accelerate death or to avoid pain.

A correlation has been shown between murder-suicide within family members and complex suicide; in a remarkable percentage of perpetrators who choose to commit suicide after the murder, a combination of methods is used [6].

In complex suicides, the whole spectrum of methods enacted in simple suicides is generally observed. Some typical combinations are described in the literature; nonetheless, peculiar combinations are also reported [7].

Hanging and firearms are a common combination in planned suicide scenarios. Drugs are also commonly used in planned complex suicides involving asphyxial deaths. In this case, medical/illicit drugs can be utilized in order to buffer pain as soon as additional methods are activated; drugs can be otherwise chosen to produce intoxication per se. This kind of distinction based on the victim's will cannot be intelligible in some cases. For the aforementioned reason, the use of medical/illicit drugs is not taken into account as a suicide method by some authors, and a distinction between drug-related and non-drug-related complex suicide has been proposed [8].

Cut wounds are commonly the first choice in unplanned complex suicide; however, the resulting prolonged death compels the victim to kill himself by hanging or jumping from a height [4]. In this context, it is still a matter of debate if switching from cut to stab wounds should be considered complex suicide [9,10].

As with simple suicide, occupation-related complex suicide has also been described [11]. Characteristic features in this type of complex suicide are the availability of and easy access to occupational tools (i.e. captive-bolt guns), along with special knowledge and skills provided by the professional background of the victim. [12].

Recently, a new category has been distinguished from the complex suicide group. Complicated suicides involve self-inflicted deaths in which the primary method of choice does not work as intended and death occurs as a consequence of an unforeseen complication of the suicidal act [13].

Complex suicides can be challenging for the forensic pathologist because of the plurality of methods applied [14]. However, the use of several, at times astounding methods, in the act can raise suspicion of a homicide, trig-



gering the early involvement of a forensic investigator to solve the case [15].

Case Report

In the October of 2012, The body of a 44-year-old woman was found in the backyard of her house, just beneath a tangerine tree, with a retained fillet knife embedded in her left chest wall and dry blackish blood extending from the nostrils and mouth to the forehead, down to the chin and cheeks, and caudally to the neck and torso (Fig 1). A chin, neck and torso examination revealed extensive cutaneous burns spreading from the mouth. Three stab wounds were present on the left side of the neck.

Crime scene inspection showed a half empty bottle of chemical drain cleaner next to the body, containing 96% of sulfuric acid. On the tangerine tree branches, there was a bag containing an empty fillet knife sheath and a clean kitchen knife.

Victim's shirt and pants were highly damaged. The purple shirt was torn up by corrosion in the collar region and on the anterior part; the blue jeans were melted down on the anterior side. The exposed areas of skin presented purple and blue discoloration due to dye transfer from clothes. Blood rivulets, extending from the embedded knife area, were described on the left side of the shirt; blood stains were present on the anterior part of the shoes too.

The decedent was married with two sons, aged 8 and 6 years; she had a degree in chemistry. The relatives stated

the woman was probably depressed for troubles at work-place concerning the possibility of a permanent layoff. No previous suicidal ideation nor attempts were referred.

The night before the retrieval, the victim had a dinner with the family and then went to bed with his husband. During the night, the husband noticed she was not in bed and he found she left two farewell letters; letters recipient were the husband ("Forgive me, I have the heart of a child") and the decedent sons ("Keep loving each other").

The estimation of the time since death by body temperature measurement according to Henssge method confirmed the death occurred during the night.

A careful observation of the scene revealed a bluish stain on the grass in close proximity to the victim's feet. Blood traces were found exclusively beneath the head, neck and torso. No traces of blood were found inside the house.

The body was then transported to the local morgue, and a thorough external examination was performed. Fingerprints were collected from the handle of the fillet knife, and the decedent's nails were checked for DNA residues.

On the left side of the neck, three triangular stab wounds, ranging from 0.8 to 1 cm, were described, with triangle's vertices on the right side of the lesions. No defense injuries or "other" hesitation marks were observed.

The fillet knife was left embedded in the chest wall, in order to identify the trajectory of the blade in the thoracic cavity and the injured organs.



Figure 1- Crime scene.



Figure 2- Tongue and cutaneous burns.



Figure 3- *The trachea.*

The dry blood on the face, neck and torso was then carefully washed away, revealing extensive, well demarcated brownish cutaneous burns with ashen borders, extending from the mouth to the chin, cheeks, neck and torso (Fig 2). Further chemical burns were observed on both hands and thighs. The shape of the chemical burn on the left knee was highly suggestive of the victim's left hand. Ant's bite marks were observed in the abdominal and back region.

Autopsy findings

A complete medico-legal autopsy was performed nearly 30 hours after the estimated time of death (ETD). Cutaneous burns had changed from the previous observation, becoming yellowish, firmer, with a parchment-like texture, burns borders had become better demarcated.

The internal examination revealed charring chemical burns to the tongue, trachea, larynx, pharynx and esophagus mucosae (Fig 3). A stomach examination revealed blackish viscous residues and extensive mucosal liquefaction with exposure of the fibrous weave of the stomach. The stomach had several perforations (fundus, body); the pyloric antrum was liquefied and was completely detached from the duodenum (Fig 4). The ileum was perforated too, with 200 mL of blackish fluid in the peritoneal cavity. The left external jugular vein was dissected by a single stab wound, while the other two neck wounds were superficial.

The fillet knife was showed to perforate left pulmonary superior lobe with no lesion at the mediastinum organs;

500 mL of blood were collected in the corresponding pleural cavity (Fig 5). After removal of the knife, a 1.5 cm stab wound was described on the thoracic wall.

Upon dissection of the lungs, a moderate amount of gastric tar-like content was found in the bronchi. Histological analyses showed extensive corrosive changes in the gastrointestinal tract, with loss of the superficial mucosa of the lips, oral cavity and esophagus. Trachea's sections presented fibrin-blood exudate with coagulations of the respiratory epithelium. The lung parenchyma was extensively edematous and hyperemic, with massive hemorrhagic infiltrate surrounding the left superior lobe stab wound. Stomach and proximal ileum (10 cm caudally to the ligament of Treitz) showed transmural coagulative necrosis. Aortic adventitia was necrotic too.

Toxicological screening of blood and urine samples was negative; gastric contents contained a high quantity of concentrated (96%) sulfuric acid with a pH value of < 1.0.

Discussion

Injuries and deaths from exposure to caustic substances are infrequently reported in the forensic pathology literature [16]. Ingestion of caustic substances can be accidental or intentional. Accidental ingestion mostly involves children [17], while intentional contact may be suicidal or as a consequence of a physical assault [18]. Over 25,000 substances are considered capable of causing chemical burns [19]. A surprisingly high percentage of these substances are



Figure 4- *The stomach.*

available and can be easily purchased by the general public. Depending on the country, relevant legislations provide detailed rules about the packaging and labeling of dangerous substances, while purchase restrictions rules are generally inadequate and chemical assault is still a significant world-wide problem [20].

Sulfuric acid is a strong mineral acid that dissociates readily in water to sulfate ions and hydrated protons, and is totally miscible with water. This dissolution/dissociation in water is strongly exothermic and a vigorous reaction occurs when water is added to sulfuric acid. The free hydrogen ion facilitates amide bond hydrolysis, causing protein structures to collapse. When strong acid (pH 2.0) comes into contact with internal visceral tissue, it causes coagulation necrosis, disintegration and/or ulceration of tissue [16]. The primary mechanism of injury due to chemical burns is a result of the direct chemical reaction associated with thermal damage, which further contributes to tissue injury [21].

Sulfuric acid is corrosive to the skin, eyes and mucous membranes. Regardless of the reason for exposure, there are 4 typical injury patterns: cutaneous burns, ocular burns, respiratory compromise from inhalation [22], and ingestion injuries [23].

Once ingested, the fatal amount could be as little as 5-30 mL of the concentrated chemical, but even few drops may be lethal if the acid gains access to the trachea [24]. After acute ingestion of sulfuric acid, a minimum lethal

time of 30 minutes has been reported in literature, with an LT50 (the time in which 50% of persons will die after ingesting a fatal dose of a poison) of 5 hours [25].

In caustic ingestion, fatalities are usually due to severe chemical burns, gastrointestinal necrosis, perforation, hemorrhage and complications including infection [26]. Some typical features of gastrointestinal lesion patterns caused by corrosive acids have been observed [27]. The esophagus squamous epithelium seems to be more resistant to acids than gastric mucosa. As a consequence, esophagus perforation is very rare after the ingestion of strong acids while stomach perforation can occur in 80-90% of cases, greatly increasing the likelihood of death. Alkalis tend to be more viscous than acids and thus reside for a longer period of time in the esophagus, causing more severe lesions at this level than acids do [28]. However, due to their lower viscosity, acids tend to be concentrated at the pyloric end, the gastric area designated for the pooling of the fluids, resulting in massive lesions in this zone [16]. The occurrence of stomach perforation after strong acid ingestion has been correlated with the quantity of the substance and fasting state [29].

Cutaneous burns may present some typical features that can be very useful in the reconstruction of the suicidal act. After ingestion, it is possible that the fluid may leak from the mouth and nostrils onto the exterior of the body, corroding the skin in a pattern which may suggest the posture of the victim while drinking the substance. Cutaneous burns





Figure 5- *The knife embedded in the thorax.*

to the chin, chest and abdomen may suggest that the person was standing or maybe sitting while the fluid was spilling from the mouth, while burns on the cheeks and to the back of the neck may evoke a lying position. If the hands are instinctively brought to the face while spitting or vomiting, they can also present chemical burns [30].

Although rare, aspiration pneumonia can occur during acid ingestion as a consequence of the rapid ingestion of a large volume of acid fluid and of the presence of acid in the mouth prior to swallowing. This event has been shown to greatly increase the likelihood of death [31]. In such cases, a skeptical approach is vital for distinguishing homicide from planned and unplanned complex suicides.

The role of chemical concentration is a further problem in this kind of speculation. As a general rule, toxicological analysis can help to ascertain the role of ingesting chemical substances in the suicidal act [32].

Conclusion

In the present case, the results from the crime scene inspection, external examination and autopsy allowed the forensic investigator to ascertain if death was due to the shock of ingesting sulfuric acid or due to acute anemia following stab wounds to neck and torso. The manner of death was suicide. It was interesting to observe that even after an ETD of 30 hours, the sulfuric acid was still active and severely damaged many instruments during the autopsy.

We hypothesized that the victim planned suicide by sulfuric acid ingestion. Considering her technical knowledge (degree in chemistry), it is possible that she had known the consequences of acid ingestion and had therefore brought two knives to terminate a slow, painful death. In this reconstruction, the case can be classified as a peculiar type of planned complex suicide.

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