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Case report

Virtopsy versus autopsy in unusual case of asphyxia: Case report

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ABSTRACT

We report the case of a 70-year-old woman found dead in her apartment in the South of Italy in February 2011.

The detailed data showed that the victim was affected by familiar-type paranoid schizophrenia. This finding was confirmed by the discovery of antipsychotic and tricyclic antidepressant drugs in the house and the deposition of her psychiatric therapist.

Before the autopsy, a multislice computed tomography (MSCT) scanning of the thoracic and facial maxillo-cervical area was performed that has allowed anatomical identification and diagnosis of a mechanical obstruction as the cause of death. The autopsy has showed the presence of materials obstructing the trachea totally. Histological and toxicological investigations were carried out on the victim. The toxicological investigation has shown the presence of metabolites of tricyclic antidepressants and antipsychotics in the blood and urine. The histology showed the presence of foreign-origin materials (starch fibres) inside the pulmonary alveolus. The cause of death was asphyxia due to obstruction by food-origin material. In this case the radiological data have been compared with the autopsy and toxicological and histological data. The comparison of results has shown that MSCT scanning may aid in identification of occlusion and then in determination of the cause of death. In conclusion, MSCT scanning can be proposed in the cases of suspected asphyxia, as the screening procedure of first instance to produce preliminary information useful to rapidly develop the successive autopsy performance.

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1. Introduction

Asphyxia can be defined as an attack caused by oxygen deficiency (hypoxia) comprising all those conditions and sequences produced by alterations/changes in supplying oxygen and/or in its use in tissues [2]. This deprivation may be partial (hypoxia) or total (anoxia) [4].

Until this day, it has been proved that asphyxias' classification and the definition of various sub-types is not uniform [4]. Certainly, the asphyxial condition is caused by an obstruction of air influx into the respiratory tract. Asphyxial death is caused also by compression of nerves and vessels of the neck. The three mechanical components of the asphyxial phenomenon, in different cases, define suffocation, smothering, hanging, choking (death caused by bolus) and death caused by aspiration of foreign bodies. Asphyxial death can present a suicidal, homicidal or accidental nature.

In this article, we demonstrate the role of radiological investigation in the diagnosis of so-called death by choking [4] due to obstruction of the upper respiratory apparatus by food material. In this form of accidental asphyxia, a foreign body is formed by food which, penetrating into the larynx or bronchial branches, occludes them completely. Retrospective studies have suggested that the main causes of aspiration of tracheobronchial foreign bodies in adults are represented by states of acute intoxication due to alcohol or drugs, trauma with decreased level of consciousness, damaged respiratory apparatus, partial or total edentulism and neurological or psychiatric disorders [3–5]. Furthermore, physical abuse, drug overdose or improperly prepared foods may be a cause of death in elderly patients particularly, so that, even in these cases, the possibility of suffocation or choking must be excluded. In fact, some studies have shown that by carrying out post-mortem MSCT it is possible to exclude or prove the accusation of abuse without performing the autopsy [10].

One of the biggest problems in deaths due to choking is the differential diagnosis between accidental death due to a foreign body in the larynx and natural death due to other cause, such as sudden cardiac death.

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When there is suspicion of asphyxial death, a radiological investigation allows us to visualise the presence of trauma on the anatomical sites affected. In particular, we can highlight the fractures of the hyoid bone or cervical spine, the presence of air embolism in soft tissue and detection of foreign bodies.

The main problem in diagnosis is the deep position of bolus into the pharynx that often makes it undetectable during the external examination. In this article we have reported a case of death by asphyxia due to food obstruction identified through an MSCT scanning, with particular attention to the identification of the origin of the accidental event.

2. Case report

In February 2011, the lifeless body of an elderly woman was found by her sister in her apartment. During the inspection many tricyclic antidepressants and antipsychotic drugs were found that the victim, according to the story of her sister, used long ago to treat a type of familiar-type paranoid schizophrenia.

Inspection of the corpse showed the presence of labial and subungual cyanosis. The hypostasis was demonstrated by deep purple red colour, in posterior seats at supine position, in the absolute phase during which finger pressure is still possible. Rigour mortis was being formed and it was evident only in small joints. The reversal of conjunctivas allowed the visualisation of sub-conjunctival petechiae bilaterally. During the inspection of the oral cavity the presence of material similar to the consistency of bread also found on the floor was noticed.

In turning over the corpse a blood serum material seeped from the oral cavity.

The victim did not have any external injury or signs of active and/or passive defence.

This response, associated with the assessment of sites, has therefore ruled out the homicidal and suicidal hypotheses in the genesis of the death event leant towards the accidental death.

2.1. Data of MSCT scanning

Multislice computed tomography (MSCT) scanning performed before the autopsy highlighted:

- diffused signs of periodontopathy due to residual dental elements in the upper dental arch (Fig. 4);
- the presence of radicular stumps (11°–14°–21°–23°–35°–46°) and widespread signs of trabecular bone resorption especially in the maxillary alveolar region;
- the presence of inhomogeneous hypodensity in the same semi-solid obliterans tomodensitometry extending from the gloctic region until the bronchial carina with involvement of the main bronchial branches except the right upper lobar appearing normo-ventilated (Fig. 8);
- shaded areas of thickening such as frosted glass at the medial and lateral segments of the middle lobe, the upper basal of the right lower lobe and in posterior basal segments of both lower lobes; and
- reduced attenuation bubbles as in pericardial pneumatosis phenomena and signs of intrahepatic aerobilia.

2.2. Findings at autopsy

The buccal cavity of the victim showed a very noticeable impairment of the stomatognathic apparatus. Data collected (Figs. 1–3) in the judiciary inspection addressed the autopsy to an in-depth analysis of the masticatory and respiratory apparatus. In the examined case, the fatal asphyxial event was caused by two components involved in the formation of bolus: salivation and mastication (Figs. 4–5).



Fig. 1. Circumstantial data.



Fig. 2. Bread on the crime scene.



Fig. 3. Loaf of bread on the floor.

These data were compared with data obtained by a post-mortem examination (Figs. 6–9) and dental consultant (Fig. 5), which highlighted a picture of severe periodontal disease with partial edentulous. The present dental formations showed severe degenerative carious-type processes and exposures of radicular and pulp residues with partial exposure of dental cavities.

The analysis of the respiratory system was performed through the removal of the heart–lung block. In fact, at the opening of the trachea (Fig. 9), the oral cavity material was also found in the carinal and bronchial seats that became of pultaceous consistency and occluding the respiratory tract.

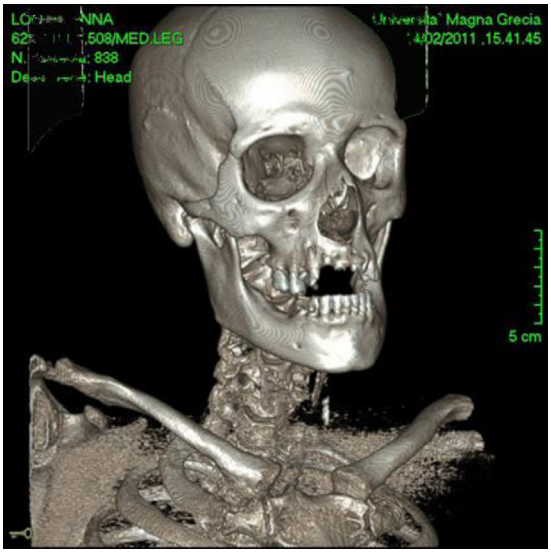


Fig. 4. MSCT signs of periodontopathy.

Therefore, the material found on the floor during the inspection (Fig. 3) was also found within the respiratory tract (trachea and main bronchi). Organs taken during autopsy showed evident signs of diffused visceral congestion. The lung parenchyma appeared increased in volume and the consistency was emphysematous during palpation.

Histology confirmed the presence of natural material (starch fibres) within the pulmonary alveolus. Inspection of the lung and heart parenchyma highlighted small sub-pleural and sub-epicardial petechiae. Therefore, the combination of data collected during the judicial inspection with those acquired after the autopsy allowed us to affirm that the elderly lady's death was caused by



Fig. 5. Partial edentulous.

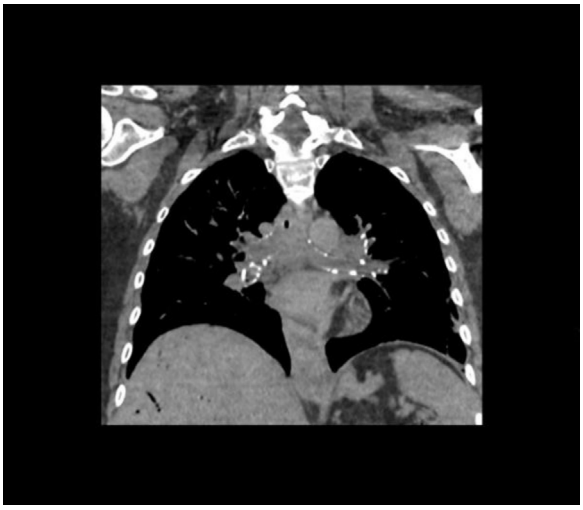


Fig. 6. Signs of respiratory occlusions.

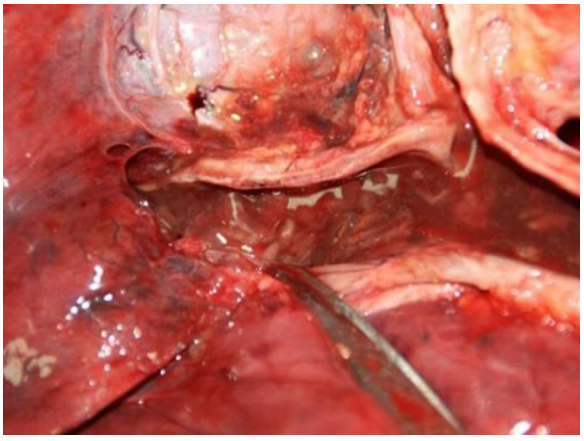


Fig. 7. The opening of the bronchi.

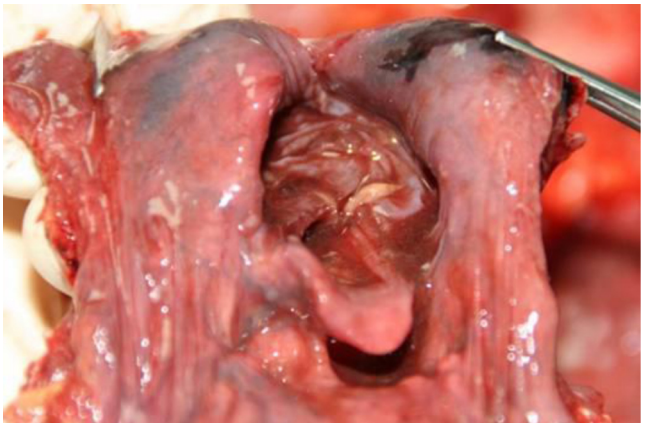


Fig. 8. The opening of the esophagus.

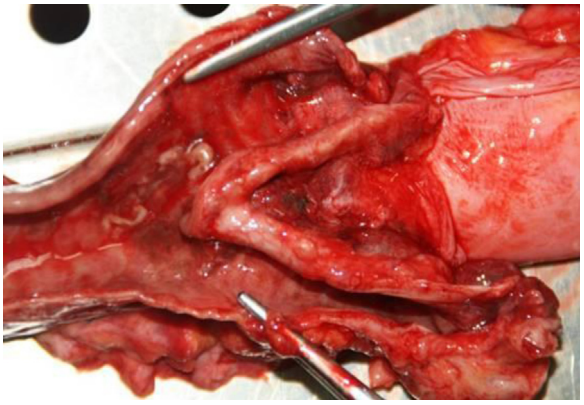


Fig. 9. The opening of the trachea.

acute respiratory insufficiency due to mechanical, violent, accidental asphyxia by bolus obstruction (bread).

2.3. Toxicological investigations

With an automated immunoassay on an ILAB 600 Chemistry Analyzer (Instrumentation Laboratory, Bedford, MA, USA), 2 ml of urine was analysed for a toxicological screening. The screening was negative for: cannabinoids, opiates, cocaine metabolites, benzodiazepines, barbiturates, amphetamines, methadone and ethanol. In agreement with the pharmacological treatment, targeted analyses were conducted on a sample of blood for haloperidol, chlorpromazine, olanzapine, clothiapine, clozapine and valproic acid. The extractions were performed by using Chem Elut extraction procedures for acid and basic substances [18]. Haemolysed blood (2× 1 ml) were treated and loaded onto two Chem Elut columns, one for acidic substances and one for basic substances. Eluates were evaporated and reconstituted with 20 μl of methanol. One microlitre of the methanolic solutions was injected splitless in an HP 5890 Series II Plus GC system combined with a HP 5972 Series mass selective detector (Agilent Technologies, Böblingen, Germany), equipped with a HP-1MS fused silica capillary column of 25 m length, 0.25 mm internal diameter with helium as carrier gas at 1 ml min^{-1}. The inlet temperature was at 280 °C. The ramping time was as follows: 3 min at 85 °C raised by 10 °C min^{-1} to 310 °C. The final temperature was held for 3 min [19,20]. The performed analyses were positive for haloperidol (0.8 ng ml^{-1}), clothiapine (10 ng ml^{-1}) and valproic acid (20 μg ml^{-1}).

3. Discussion

In cases of asphyxia, recognition of the causes directly on the victim body is problematic because of the absence of external signs, internal suggestive injuries or rather respiratory tract obstructions [2]. In the examined case the woman's age, the positive medical history of psychiatric illness in drug treatment and the pathology of stomatognathic system were striking. The data collection procedure was important because it has permitted us to compare the data collected with the literature. In fact, in the literature people with psychiatric illness are mainly at risk for fatal asphyxial events [3].

In addition, deaths from a foreign body in the larynx occur most frequently in middle-aged or elderly people [9]. The prevalence of tracheobronchial foreign bodies' aspiration increases constantly at the sixth life-decade. For this reason, the elderly are at higher risk [3,4]. These age groups are growing in numbers especially in the Western society and the importance of accidental deaths for bolus obstruction may increase. Typically in these types of death, the victim collapses immediately while eating and the cause of death is difficult to interpret in the differential diagnosis with a sudden acute cardiac or coronary impairment. The cause of death is often due to the presence of a bolus in the larynx [9]. Other risk factors identified by some studies about this cause of death include neurological diseases and psychiatric pathologies, old age, poor dentition, local malformations, tumours and alcohol and drug intoxication [1,9]. In some countries, the use of imaging techniques such as CT and magnetic resonance imaging is becoming a routine procedure before the autopsy, or even, in some cases, investigations carried out in place of the autopsy [11,12]. This case highlights the diagnostic value of MSCT in locating a foreign body and anomalies in the larynx without major manipulations that could lead to a bolus movement. The differentiation between neoplasia and a foreign body of soft nature is possible, but it is difficult using only the MSCT scanning. In fact, several literature studies have stressed the importance of magnetic resonance imaging for an easy distinction between soft tissues and soft foreign bodies [13]. Berzlanovich et al. demonstrated that semi-solid food is the cause of a large number of asphyxial cases, especially among the elderly [1]. In our case, the foreign body had a semi-solid nature. The results of toxicological investigation on the victim's biological liquids confirmed the presence of tricyclic antidepressants in biological fluids. Therefore, the cause we have identified as a primary cause in the fatal asphyxial event was attributed to pre-existent pathologies in the victim (edentulism and schizophrenia) that have altered swallowing in different ways. In fact, the use of tricyclic antidepressants and antipsychotics, particularly the atypical chlorine such as olanzapine and clozapine, causes important side effects as xerostomia/dry mouth due to specific antimuscarinic action on the cholinergic system. Both of these tasks, physiological as a rule, were compromised in the victim. In fact, salivation was reduced as a result of antimuscarinic action due to antipsychotic and tricyclic antidepressants drugs, while mastication was compromised as a result of severe periodontal pathology and partial edentulism.

The proper food-bolus formation derives both from an effective mastication and a proper salivation that, in psychiatric patients with pathologies concerning the stomatognathic system, is altered. For this reason, the path of food bolus, when masticatory and salivation conditions do not allow it, can pass through alternatives ways such as respiratory laryngeal and tracheal penetrating into bronchial conduits. In these cases the cause of death is difficult to establish without an autopsy. It has proved that in humans the diagnosis of foreign body aspiration is assigned to the chest radiological examination in the first instance. In the case of negative radiographic examination, the chest MSCT examination (also integrated with the virtual bronchoscopy) is performed. The failure of the MSCT excludes the need for further examinations. Therefore the application of this method seems useful in these cases on the corpse. The limits on a corpse radiographic survey were evaluated by several authors and several suggestions have been proposed. [5] It has been shown that CT is a valuable tool in forensic investigations, particularly in the detection and demonstration of fractures, foreign bodies and air and/or gas (pneumothorax). [6] In general, X-rays are used to locate bullets [7], knife blades [8] or medical implants.

In this case, the MSCT scanning offers a multidimensional visualisation, in radiograms, of the respiratory tract occlusion from the trachea to the bronchial tract. Moreover, another advantage of MSCT is to evaluate the density of foreign objects measured in Hounsfield units [6]; other advantages of this investigation are, presenting clear and objective information to the court as forensic evidence, three-dimensional (3D) documentation of the investigation and quality assurance through digital data filling and transfer [6].

4. Conclusions

The documentation and analysis of post-mortem reports identified by MSCT, a non-invasive method, will lead over time to qualitative improvements in forensic pathology investigations. Apart from its accuracy and three-dimensionality, this method allows us to re-examine the corpse even after some time. In fact, we believe that this virtual approach, non-invasive or minimally invasive, will improve forensic pathology tools in the near future.

The progress and evolution of the radiological sciences, more and more towards the definition of technical parameters necessary to perform a detailed study of human body and its components. The multidisciplinary approach considering the physiological and physiopathological sense and the toxicological investigation contribute with their *humus* to the study and interpretation of

anatomic reports. If radiology is need for a more rapid diagnostic response, the forensic medicine points is need for the verification and interpretation of justice facts. The multidisciplinary approach has as common denominator the final object of the investigation researching procedure.

The methodological operative combination between the different disciplines has begun to define common objectives, especially through the use of methods such as MSCT, which are:

- determination of the cause and modality of death; and
- evaluation of vital signs that depends on the presence of damaged anatomical structures;
- developing a forensic reconstruction based on various reports [14]. Currently MSCT is a method increasingly used for forensic purposes so as to have the potential to enhance today's formal procedures.

Indeed, it is now possible to realise a post-mortem imaging, or 3D virtual autopsy, considering this step as part of the autopsy, through scans of the entire corpse or part of it in order to acquire a set of data to re-investigate with 3D volume-rendering techniques [15].

In our study, the MSCT has proven to be very useful in:

- reporting maxillo-facial area disorders, with particular emphasis on the odontostomatological apparatus;
- evaluation of the presence of an endotracheal foreign body; and
- identification of post-asphyxial lung disorders.

Indeed, this investigation is an observer-independent tool that, through digitisation and filling, even after some time, is always available and repeatable in the scan reconstruction [16,17]. In this case it was important to develop relative toxicological analysis and histological investigation to confirm certain causes of death. In fact the MSCT examination would not allow any specific assessment without performing other investigations. However, it is not possible denying that virtual autopsy can always be performed and currently it remains only a support for forensic medicine practice. In particular, the MSCT scanning can be proposed in the cases of suspected asphyxia, as the screening procedure of first instance to produce preliminary information useful to rapidly develop the successive autopsy performance and to design specific multidisciplinary approaches, but it cannot represent an alternative way to the usual autopsy procedures [14].

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