

Assessing violent mechanical asphyxia in forensic pathology: State-of-the-art and unanswered questions

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Abstract

Mechanical asphyxiation has been a common method used to commit homicide, including femicide, throughout history. A recent report by the United Nations has shed light on the issue of misidentification and concealment of gender-related killings, which makes it difficult to effectively fight against it. Forensic pathologists are frequently asked to examine cases involving suspected asphyxia to determine whether other persons have been involved. Therefore, medicolegal experts must look for signs of occlusion of the oral/nasal orifices, compression of the neck, or specific signs such as the “facie sympathique”. There are situations where the physical signs are not distinctive enough to diagnose asphyxia, especially in cases where the individual has limited ability to resist external compression. In such cases, judicial autopsies should include an anatomical dissection of the neck structures through a layer-by-layer progression. It is important to search for the Amussat’s sign, e.g., as part of a Forensic Clinical Anatomy approach. Additionally, individual anatomical variations, age or artefactual modifications, must be considered for the correct interpretation of findings. Microscopic examinations could aid in the diagnosis by providing additional findings, and several attempts have been made to identify unique markers of asphyxia through various laboratory techniques such as biochemistry, radiology and miRNA studies. However, no single finding or method has been identified as definitive. In the future, biomedical-legal sciences will have to rely on scientific research and the retrospective case series to provide a scientific framework on which to base their hypothesis, giving weight to evidence in the trial.

Key words: asphyxia, autopsy, cadaver, forensic pathology, forensic clinical anatomy

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Introduction

Forensic medicine has seen a growth in subdisciplines, leading to increased scientific contributions in forensic pathology in developed countries.^{1,2} One of the emerging topics is the use of scientific evidence to consistently identify murderers.³ A common historical method for committing homicide, including femicide, is mechanical asphyxiation.^{4–6} The issue of gender-based violence is a global concern and has been discussed at the United Nations General Assembly through a special report analyzing its causes and consequences. The report highlights the emerging issue of misidentification, concealment and underreporting of gender-related killings, which hinders the effective fight against this type of crime.⁷

Classification of asphyxias

Asphyxia is the acute respiratory failure caused by the arrest of pulmonary ventilation following actions that act directly on the respiratory system, preventing the penetration of air into the lungs, and we refer specifically to violent mechanical asphyxiation for our purposes. It is classified into internal and external asphyxia based on the location of the obstruction. Internal asphyxia occurs due to the failure of oxygen to bind to hemoglobin or the inability of hemoglobin to release oxygen to tissues. Notable examples include carbon monoxide poisoning and the increasingly prevalent sodium nitrite poisoning. External asphyxia is defined as the inability of oxygen to reach the alveoli. It can be further classified into several types including environmental asphyxia that results from a lack of oxygen in the inhaled air, impaired chest expansion due to intrinsic pathologies or external compression (also referred to as positional asphyxia), and upper airway obstruction caused by an internal blockage (e.g., obstruction of the oronasal orifices or food blockage) or external compression. External compression asphyxia can present more pronounced autopsy signs, both at the external orifices and the neck. The direct signs of external asphyxia include abrasions or bruises at the external orifices and neck, and rope marks in cases of hanging. Indirect signs include facial congestion and cyanosis, petechiae in the conjunctivae and serous membranes, and dark-blue livor mortis.⁸

Forensic pathologists are frequently requested by judicial authorities to examine cases involving suspected asphyxia. This is aimed to clarify whether other individuals may have played a role in causing the victim's death. While circumstantial evidence collected during a death investigation can offer some insight, it is essential to remember that such evidence is just one factor among many to consider.⁹ Additionally, this evidence can sometimes be misleading if it is the result of tampering with the crime scene or an attempt to conceal the murder. Therefore, medicolegal experts must look for signs of any external/

internal occlusion of the oral/nasal orifices or compression of the neck.^{10,11} Nevertheless, there are only a few rare cases where the physical signs present on the body are not distinctive of an asphyxia diagnosis. In certain situations, individuals who are vulnerable and have limited ability to resist external compression, such as infants, elderly individuals as well as people under the influence of psychoactive substances may become victims of strangulation or suffocation.^{12,13} Also, in infant homicides, or in decomposed bodies, autoptic findings can be of very little help to pathologists.^{14,15} In such cases, external signs may not be evident because only slight compression of the neck or orifices is sufficient to interrupt the oxygen supply to the body. At any rate, to differentiate between homicidal and pretended suicidal, genuine suicidal or accidental asphyxia, it is of utmost importance to conduct a comprehensive examination of the skin, soft tissues, muscles, vessels and other internal structures of the neck.

Autopsy technique and autopsy findings

In suspected asphyxia deaths, the examination will help identify any signs of trauma, fractures, bleeding or modifications that may suggest vitality. In most cases, signs can be observed that replicate the mechanism causing the constriction. A typical sign of hanging is the ligature furrow, which varies in direction and characteristics depending on the type of hanging and the position of the knot and the body.¹⁶ In manual strangulation, marks are often visible at the base of the mouth or neck, or in other areas of the body resulting from the immobilization of the victim. Finally, in ligature strangulation, there are signs that need to be differentiated from those in hanging. In cases of hanging, the anatomical structures of the neck require careful dissection to find even discrete injuries. To this end, the soft tissues of the neck, particularly the neck muscles, need to be dissected under artificial bloodlessness in a layered procedure. In this sense, judicial autopsies for supposed asphyxia should be integrated by anatomical dissection of the neck structures through layer-by-layer progression, according to a Forensic Clinical Anatomy approach.^{17,18} The topographic complexity of the neck region needs an anatomical methodological approach to fully ascertain and evaluate all the findings useful to clarify pathophysiologic mechanisms of injury and to permit medicolegal diagnosis. The context of individual anatomy such as variations, age, disease/surgery-related modifications,¹⁹ as well as the possibility of artefactual modifications, have also to be considered for correct interpretation of findings, as also stressed in Del Balzo et al.²⁰ A particular finding among the others is the unilateral miosis with or without ptosis at the opposite side from the knot, the so-called "facie sympathique".²¹ What is most relevant, the medicolegal diagnosis could benefit from additional findings collected

through microscopic examinations aimed at ascertaining the pathophysiologic chain involved in the mechanism of death, as well as estimating the time of death.⁸ On this point, the literature primarily refers to the presence of hemorrhagic infiltration in skin injuries caused by the means used to induce asphyxia. For instance, vital signs in hanging include the transverse laceration of the intimal layer of carotid arteries, the so-called Amussat's sign, whose vitality could also be checked by the analysis of the glycophorin A.^{8,20,22}

Ongoing research topics, unanswered questions and future perspectives


In most of cases, it can be difficult to distinguish between asphyxia and natural death, often of cardiac origin, when the microscopic pathology is inconclusive. Therefore, the forensic pathologist should examine alternative markers during investigations and, in some cases, consider contextual information. Several attempts have been made to identify unique markers of asphyxia using laboratory techniques such as biochemistry, radiology and miRNA studies,^{15,20,23–25} and the research paper by Del Balzo et al. is aligned with this direction.²⁰ Unfortunately, although many of them can support the hypothesis of asphyxia, no single finding or method has been identified as definitive. Finding future autopsy markers that are not influenced by body decomposition, unlike classic external signs, will be a challenge for forensic pathology, as this remains an unresolved issue to date and is still a topic of ongoing research. The issue related to circumstantial data is still controversial. In fact, it is believed that circumstantial data, also referred to as context information, should be considered by the forensic pathologist during the autopsy.²⁶ Contextual data are very useful in investigative reasoning, whereas criteria are stricter in evaluative reasoning due to the high risk of bias. The forensic pathologist's opinion should be mainly based on forensic pathology evidence, such as the number, location and types of wounds.²⁷ However, especially in cases where findings may be subtle and non-indicative, circumstantial data must be considered and evaluated to formulate a hypothesis. For a correct evaluation of circumstantial data to be incorporated into forensic reasoning, close collaboration between the forensic pathologist performing the scene investigation and autopsy, and the police handling the scene, is crucial for obtaining an accurate multidisciplinary assessment that considers all collected evidence.


In criminal proceedings, forensic pathologists are required to present all the evidence that supports the hypothesis of asphyxia. They must also evaluate their observations against the backdrop of 2 or more alternative hypotheses, as usually performed in medical malpractice

and forensic clinical anatomy.¹⁸ To do this, they need to be in a situation where all the elements that support or refute the hypothesis can be weighed, and this evaluation should not be based solely on their personal experience. Forensic pathology, particularly the study of violent asphyxiations, seems slow to adopt these principles, unlike other medico-legal branches, such as forensic genetics. In the future, biomedical-legal sciences, including forensic pathology, will need to strive through scientific research and the study of retrospective cases to give weight to scientific evidence, providing a logically sound framework on which to base the strength of their hypothesis.

In the context of modern forensic investigations, distinguishing between violent asphyxia death without any external signs of compression and sudden death is an intricate task during a trial. It is especially challenging for forensic pathologists to provide evidence that supports a homicidal dynamic over an accidental one. In some instances, it may be impossible for the pathologist to provide conclusive evidence to the trier-of-fact. As a result, circumstantial data that may fall outside the narrow expertise of a pathologist, often plays a crucial role in trials involving asphyxia. This could prove to be a critical factor. For all these reasons, future scientific research must focus on identifying indicative signs of asphyxia, rather than solely relying on the evaluator's experience.

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References

1. Viel G, Boscolo-Berto R, Cecchi R, Bajanowski T, Vieira ND, Ferrara SD. Bio-medicolegal scientific research in Europe: A country-based analysis. *Int J Legal Med.* 2011;125(5):717–725. doi:10.1007/s00414-011-0576-3
2. Boscolo-Berto R, Viel G, Cecchi R, et al. Journals publishing bio-medicolegal research in Europe. *Int J Legal Med.* 2012;126(1):129–137. doi:10.1007/s00414-011-0620-3
3. Ferrara SD, Bajanowski T, Cecchi R, Boscolo-Berto R, Viel G. Bio-medicolegal scientific research in Europe: A comprehensive bibliometric overview. *Int J Legal Med.* 2011;125(3):393–402. doi:10.1007/s00414-010-0538-1
4. Thomsen AH, Leth PM, Hougen HP, Villesen P. Asphyxia homicides in Denmark 1992–2016. *Int J Legal Med.* 2022;136(6):1773–1780. doi:10.1007/s00414-022-02787-0
5. Fong WL, Pan CH, Lee JCI, Lee TT, Hwa HL. Adult femicide victims in forensic autopsy in Taiwan: A 10-year retrospective study. *Forensic Sci Int.* 2016;266:80–85. doi:10.1016/j.forsciint.2016.05.008
6. Giorgetti A, Fais P, Giovannini E, et al. A 70-year study of femicides at the Forensic Medicine department, University of Bologna (Italy). *Forensic Sci Int.* 2022;333:111210. doi:10.1016/j.forsciint.2022.111210
7. Šimonović D. *Report of the Special Rapporteur on Violence against Women, Its Causes and Consequences on Online Violence against Women and Girls from a Human Rights Perspective.* New York, USA: United Nations (UN); 2018:21. <https://digitallibrary.un.org/record/1641160?v=pdf>.
8. Dettmeyer RB, Verhoff MA, Schütz HF. *Forensic Medicine: Fundamentals and Perspectives.* Berlin–Heidelberg, Germany: Springer Berlin Heidelberg; 2014. doi:10.1007/978-3-642-38818-7
9. Leković A, Živković V, Nikolić S. Subendocardial hemorrhages in a case of crush asphyxia. *J Forensic Leg Med.* 2023;95:102506. doi:10.1016/j.jflm.2023.102506

10. Leković A, Živković V, Nikolić S. Commentary on the “Entrapment within an ottoman storage bed: an unusual accidental asphyxial death”: The complex asphyxiation. *Forensic Sci Med Pathol.* 2022;18(3): 382–384. doi:10.1007/s12024-022-00500-6
11. Cinquetti A, Franchetti G, Fichera G, Girauo C, Viel G, Cecchetto G. Entrapment within an ottoman storage bed: An unusual accidental asphyxial death. *Forensic Sci Med Pathol.* 2022;18(2):176–181. doi:10.1007/s12024-022-00473-6
12. Pelletti G, Garagnani M, Rossi F, Roffi R, Banchini A, Pelotti S. Safe drugs in drug facilitated crimes and acute intoxications in Northern Italy. *Forensic Sci Med Pathol.* 2018;14(4):442–449. doi:10.1007/s12024-018-0010-y
13. Živković V, Leković A, Nikolić S. Hyposphagma, positional asphyxia, and acute intoxication with psychoactive substances. *J Forensic Sci.* 2022;67(6):2492–2496. doi:10.1111/1556-4029.15141
14. Galante N, Blandino A, Disegna M, Franceschetti L, Casali MB. Intentional child and adolescent homicides in Milan (Italy): A 30-year interdisciplinary study. *Leg Med (Tokyo).* 2024;68:102433. doi:10.1016/j.legalmed.2024.102433
15. Giovannini E, Franchetti G, Ridolfi M, et al. An unusual case of corpse concealment driven by emotional distress. *Leg Med (Tokyo).* 2024;67: 102379. doi:10.1016/j.legalmed.2023.102379
16. Leković A, Vukićević A, Nikolić S. Assessing the knot in a noose position by thyrohyoid and cervical spine fracture patterns in suicidal hangings using machine learning algorithms: A new insight into old dilemmas. *Forensic Sci Int.* 2024;357:111973. doi:10.1016/j.forsciint.2024.111973
17. Porzionato A, Macchi V, Stecco C, Loukas M, Tubbs RS, De Caro R. Forensic clinical anatomy: A new field of study with application to medicolegal issues. *Clin Anat.* 2017;30(1):2–5. doi:10.1002/ca.22796
18. Porzionato A, Macchi V, Stecco C, et al. Clinical anatomy and medical malpractice: A narrative review with methodological implications. *Healthcare (Basel).* 2022;10(10):1915. doi:10.3390/healthcare10101915
19. Porzionato A, Macchi V, Mazzarolo C, Morra A, Sanudo J, De Caro R. Symmetrical apophyses on the posterior margins of the thyroid cartilage: A previously undescribed anatomical variation with potential forensic implications. *Am J Forensic Med Pathol.* 2019;40(1):84–88. doi:10.1097/PAF.0000000000000452
20. Del Balzo G, Pelletti G, Raniero D, et al. Forensic value of soft tissue detachments from the hyoid bone in death due to strangulation asphyxia [published online as ahead of print on April 29, 2024]. *Adv Clin Exp Med.* 2024. doi:10.17219/acem/186560
21. Marchetti D, Santoro L, Mercuri G. The “facie sympathique” sign in hanging: Historical background, forensic review, and perspectives. *Forensic Sci Med Pathol.* 2023;20(1):261–267. doi:10.1007/s12024-023-00603-8
22. Crudele L, Graziano D, Graziano, et al. The forensic application of the glycophorin A on the Amussat’s sign with a brief review of the literature. *J Forensic Leg Med.* 2021;82:102228. doi:10.1016/j.jflm.2021.102228
23. Zhang K, Liu R, Tuo Y, et al. Distinguishing asphyxia from sudden cardiac death as the cause of death from the lung tissues of rats and humans using Fourier transform infrared spectroscopy. *ACS Omega.* 2022;7(50):46859–46869. doi:10.1021/acsomega.2c05968
24. Ikematsu K, Takahashi H, Kondo T, Tsuda R, Nakasono I. Temporal expression of immediate early gene mRNA during the supravital reaction in mouse brain and lung after mechanical asphyxiation. *Forensic Sci Int.* 2008;179(2–3):152–156. doi:10.1016/j.forsciint.2008.05.007
25. Scopetti M, Padovano M, Manetti F, et al. Molecular autopsy in asphyxia deaths: Diagnostic perspectives of miRNAs in the evaluation of hypoxia response. *Int J Med Sci.* 2023;20(6):749–753. doi:10.7150/ijms.79539
26. De Boer HH, Fronczek J, Berger CEH, Sjerps M. The logic of forensic pathology opinion. *Int J Legal Med.* 2022;136(4):1027–1036. doi:10.1007/s00414-021-02754-1
27. Irmici M, D’Aleo M, Pelletti G, et al. Homicide or suicide? A probabilistic approach for the evaluation of the manner of death in sharp force fatalities. *J Forensic Sci.* 2024;69(1):205–212. doi:10.1111/1556-4029.15413