

Pulmonary Changes in Asphyxia: An Autopsy and Histopathological Study

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ABSTRACT

Introduction: Asphyxial deaths constitute a significant proportion of medicolegal autopsies and require careful evaluation of both external and internal findings. **Aim:** To analyze the demographic profile, types of asphyxia, and associated pulmonary changes in medicolegal autopsy cases. **Methods:** A prospective study was conducted on 80 cases of asphyxial deaths at Government Medical College, Parbhani. Each case underwent complete autopsy with detailed gross examination of lungs, followed by histopathological analysis using hematoxylin and eosin staining. Data were tabulated and expressed as frequencies and percentages. **Results:** Hanging was the most common type of asphyxia (58.8%), followed by drowning (33.8%). Gross lung findings revealed congestion in 77.5% and edema in 60% of cases. Microscopically, pulmonary congestion (75%) and alveolar edema (67.5%) were the predominant changes, while intra-alveolar hemorrhage (35%), atelectasis (20%), and hyaline membrane formation (7.5%) were less frequent. **Conclusion:** Hanging remains the leading cause of asphyxial death, with pulmonary congestion and edema serving as consistent markers of hypoxic injury. Histopathological examination of lungs provides crucial supportive evidence in confirming asphyxia and strengthens medico-legal interpretation.

Keywords: Asphyxia; Hanging; Drowning

INTRODUCTION

Asphyxia is defined as a condition resulting from interference with oxygen uptake or utilization by the body, ultimately leading to hypoxia and death if prolonged. In forensic medicine, asphyxial deaths constitute a significant proportion of medicolegal autopsies and demand meticulous evaluation to differentiate between accidental, suicidal, and homicidal causes¹.

The mechanisms of asphyxia include mechanical obstruction of the airway, compression of the neck structures, or impairment of oxygen transport at the cellular level². Common forms encountered in forensic practice are hanging, drowning, strangulation, suffocation, and smothering³. Each type presents with characteristic external and internal findings, though overlap often complicates diagnosis.

Autopsy remains the cornerstone in the evaluation of asphyxial deaths. Gross findings such as facial congestion, cyanosis, and petechial hemorrhages, along with internal evidence like pulmonary congestion and edema, provide valuable clues. However, these findings are not always specific, necessitating histopathological examination for confirmation⁴. Microscopic changes in the lungs, including alveolar edema, intra-alveolar hemorrhage, and hyaline membrane formation, serve as important indicators of hypoxic injury and help establish the diagnosis⁵.

The forensic pathologist must also integrate circumstantial evidence, scene investigation, and toxicological analysis with autopsy findings to reach accurate conclusions. This is particularly important in distinguishing suicidal hanging from homicidal

strangulation, or accidental drowning from deliberate submersion⁶.

Recent advances, including postmortem imaging techniques such as CT and MRI, have further enhanced the diagnostic accuracy of asphyxial deaths, though histopathology continues to be indispensable⁷. Given the medico-legal importance, systematic documentation of demographic distribution, type of asphyxia, and pulmonary changes is essential. This study was undertaken to analyze these parameters in a series of 80 medicolegal autopsy cases of asphyxial deaths, with emphasis on both gross and microscopic lung findings.

Aim and Objectives

Aim

To analyze the demographic profile, types of asphyxia, and associated pulmonary changes in medicolegal autopsy cases of asphyxial deaths.

Objectives

- 1. To study the age and sex distribution of asphyxial deaths.
- 2. To categorize cases based on the type of asphyxia.
- 3. To document gross lung findings in asphyxial deaths.
- 4. To evaluate microscopic histopathological changes in lung tissue.

MATERIALS AND METHODS

Study Design and Population

This prospective study was carried out on 80 medicolegal autopsy cases of asphyxial deaths at Government Medical College, Parbhani.

Inclusion Criteria

- 1. All medicolegal autopsy cases where death was attributed to asphyxia.
- 2. Cases with clear circumstantial evidence supporting asphyxial death.
- 3. Cases with identifiable external and internal autopsy findings consistent with asphyxia.

Observation and Result

Table 1: Demographic Profile of Cases

Sr No	Age (Years)	Male n (%)	Female n (%)	Total N (%)
1	20 to 30	8 (66.7%)	4 (33.3%)	12 (15.0%)
2	31 to 40	14 (70.0%)	6 (30.0%)	20 (25.0%)
3	41 to 60	22 (68.8%)	10 (31.2%)	32 (40.0%)
4	>60	12 (75.0%)	4 (25.0%)	16 (20.0%)
Total N (%)		56 (70.0%)	24 (30.0%)	80 (100%)

The study comprised 80 cases, with a predominance of males (70%) compared to females (30%). The largest age group was 41–60 years, accounting for 40% of cases, followed by 31–40 years (25%), >60 years (20%), and 20–30 years (15%).

- 4. Cases where lung tissue samples could be collected for histopathological examination.

Exclusion Criteria

Cases with advanced decomposition, uncertain cause of death, or insufficient evidence to confirm asphyxia were excluded from the study.

Procedure

Each case underwent a complete medicolegal autopsy following standard forensic protocols. The external examination focused on identifying classical signs of asphyxia such as ligature marks, facial congestion, cyanosis, and petechial hemorrhages.

During internal examination, special attention was given to the lungs. Gross findings were carefully documented, including congestion, edema, petechial hemorrhages, overinflation, or normal appearance. Representative lung tissue samples were collected from each case and preserved in 10% formalin.

Histopathological examination was performed using routine hematoxylin and eosin staining. Microscopic changes such as alveolar edema, pulmonary congestion, intra-alveolar hemorrhage, atelectasis, inflammatory infiltrates, and hyaline membrane formation were systematically recorded.

The type of asphyxia was determined based on circumstantial evidence, external findings, and internal examination. Cases were categorized into hanging, drowning, ligature strangulation, throttling, and smothering. Hanging was the most frequent type observed, followed by drowning, while other forms were relatively rare.

Statistical Analysis

All data were compiled and tabulated. Frequencies and percentages were calculated to highlight the distribution of demographic variables, types of asphyxia, gross lung findings, and microscopic histopathological changes. Results were expressed in percentage terms to facilitate comparison and interpretation.

This indicates that middle-aged individuals formed the majority of the study population, with a clear male preponderance across all age categories

Table 2: Type of Asphyxia

Sr No	Type of Asphyxia	Cases (n)	Percentage (%)
1	Hanging	47	58.8 %
2	Drowning	27	33.8 %
3	Ligature Strangulation	4	5.0 %
4	Throttling	1	1.25 %
5	Smothering	1	1.25 %
Total N (%)		80	100 %

Among the 80 cases, hanging was the most frequent type of asphyxia, accounting for 58.8% of cases. Drowning was the second most common, observed in 33.8% of cases. Ligature strangulation was relatively rare (5%), while throttling and smothering were each seen in 1.25% of cases.

Table 3: Gross Lung Findings

Sr No	Finding	Cases (n)	Percentage (%)
1	Congested lungs	62	77.5 %
2	Edematous lungs	48	60.0 %
3	Petechial hemorrhages	36	45.0 %
4	Overinflated lungs	22	27.5 %
5	Normal appearance	12	15.0 %
Total N (%)		80	100 %

Congested lungs were the most common gross finding, present in 77.5% of cases. Edematous lungs were observed in 60% of cases, while petechial hemorrhages were noted in 45%. Overinflated lungs were seen in 27.5% of cases, and 15% of lungs appeared normal.

Table 4: Microscopic Histopathologic Changes

Sr No	Histopathologic Change	Cases (n)	Percentage (%)
1	Alveolar edema	54	67.5 %
2	Pulmonary congestion	60	75.0 %
3	Intra-alveolar hemorrhage	28	35.0 %
4	Atelectasis	16	20.0 %
5	Inflammatory infiltrates	12	15.0 %
6	Hyaline membrane formation	6	7.5 %
Total N (%)		80	100 %

Pulmonary congestion was the most frequent microscopic change, seen in 75% of cases. Alveolar edema was present in 67.5%, while intra-alveolar hemorrhage occurred in 35%. Atelectasis was noted in 20%, inflammatory infiltrates in 15%, and hyaline membrane formation in 7.5%.

Graph 1: Microscopic Histopathologic Changes

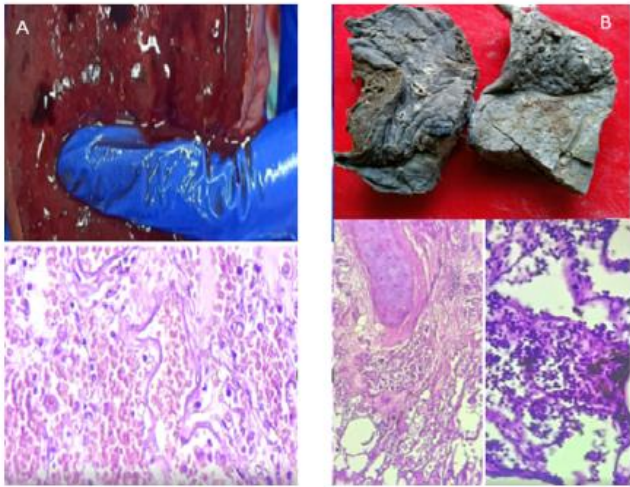
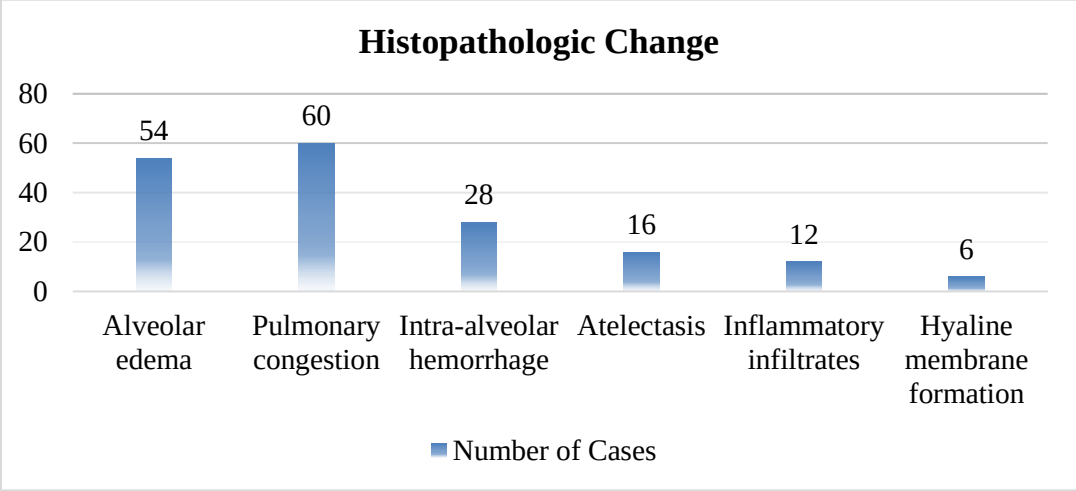


Fig 1: Showing Gross & microscopy of A) Intrapulmonary haemorrhage B) Bronchopneumonia

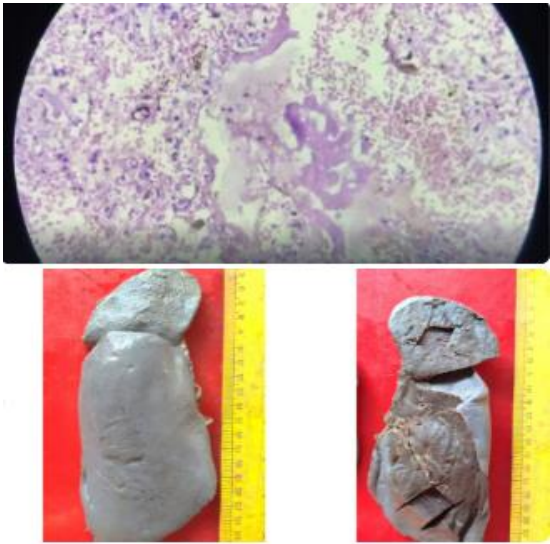


Fig 2: Showing Gross & microscopy of ARDS. Grossly lungs are voluminous boggy, on cut section angry looking. Microscopy: Hyaline membrane on alveolar sac with interstitial and intralveolar oedema, collapsed alveoli and areas of hemorrhage (on 400x)

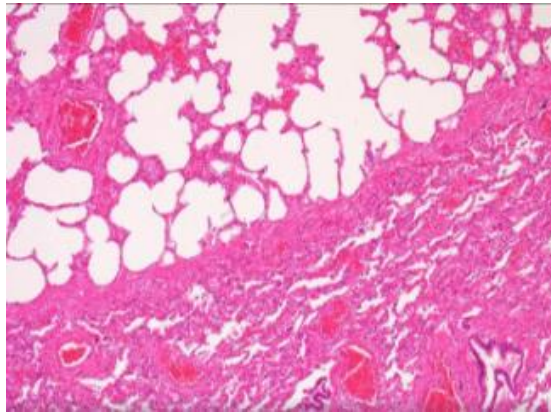


Fig 3: collapsed and compressed alveoli with closely apposed alveolar septa, resulting in marked reduction of alveolar air spaces, consistent with atelectasis.

DISCUSSION

In the present study, hanging was the most common type of asphyxia, accounting for 58.8% of cases, followed by drowning (33.8%). This distribution is comparable to findings reported by Gour et al. at SMS Medical College, Jaipur, where hanging constituted 85% of acute asphyxial deaths, with drowning being the next most frequent cause⁸. The predominance of hanging in both studies underscores its medico-legal importance as the leading method of suicidal asphyxia in India.

Gross lung findings in our study revealed congestion in 77.5% and edema in 60% of cases. These results are consistent with the Jaipur study, which documented interstitial edema and passive congestion in nearly all cases of hanging and drowning⁸. Similarly, Suresh et al. in a drowning-focused study reported pulmonary congestion in 92% and edema in 96% of cases, highlighting the near-universal presence of these changes in asphyxial deaths⁹.

Microscopically, pulmonary congestion (75%) and alveolar edema (67.5%) were the most frequent changes in our series. These findings are corroborated by Harish et al., who studied hanging victims and observed pulmonary edema and alveolar hemorrhage as dominant features, particularly in those who survived for varying periods before death¹⁰. The consistency across studies suggests that congestion and edema are reliable histopathological markers of hypoxic insult in asphyxia.

Intra-alveolar hemorrhage was noted in 35% of our cases, which is slightly lower than the 46% reported in drowning victims by Suresh et al.⁹. This variation may reflect differences in the mechanism of injury, with fluid aspiration in drowning contributing to higher rates of hemorrhage. Atelectasis and hyaline membrane formation were less frequent in our study (20% and 7.5%, respectively), but their presence indicates severe hypoxic damage, findings echoed in other reports of mechanical asphyxia where alveolar collapse and membrane formation were occasionally documented⁵.

Recent studies have also highlighted additional histopathological markers. Camatti et al. demonstrated significantly increased alveolar macrophage counts in asphyxial deaths compared to controls, suggesting a potential supportive diagnostic feature¹¹. While our study did not assess macrophage quantification, the overlap in congestion, edema, and hemorrhage supports the broader consensus that these changes are central to the diagnosis of asphyxia.

STRENGTHS OF THE STUDY

1. The study included 80 medicolegal autopsy cases, providing a meaningful sample for evaluating pulmonary changes associated with asphyxial deaths.
2. Both gross and microscopic lung findings were systematically assessed, allowing correlation between autopsy and histopathological observations.
3. The study evaluated different forms of asphyxia, including hanging, drowning, ligature strangulation, throttling, and smothering.
4. Standard autopsy procedures and routine hematoxylin and eosin staining were used for histopathological assessment.
5. The findings provide supportive forensic evidence regarding the role of pulmonary congestion, edema, hemorrhage, and other hypoxic changes in asphyxial deaths.

LIMITATIONS OF THE STUDY

1. The study was conducted at a single institution, which may limit the generalizability of the findings to other populations and forensic settings.
2. The sample size was relatively limited, particularly for less common forms of asphyxia such as throttling and smothering.
3. The study did not include a non-asphyxial control group for direct comparison of pulmonary histopathological findings.

4. Histopathological assessment was based primarily on routine hematoxylin and eosin staining, without immunohistochemical or molecular markers.
5. Potential confounding factors such as the duration of the terminal event, postmortem interval, comorbid conditions, and toxicological findings were not systematically analyzed.
6. The pulmonary findings are supportive rather than pathognomonic of asphyxia and should therefore be interpreted together with circumstantial, autopsy, and toxicological evidence.

FUTURE DIRECTIONS

Future studies should include larger, multicentric cohorts with appropriate non-asphyxial control groups to improve the diagnostic interpretation of pulmonary changes. Quantitative histopathological assessment, immunohistochemical markers, molecular techniques, and postmortem imaging may further improve the ability to distinguish asphyxial deaths from other causes. Correlation of histopathological findings with toxicological results, postmortem interval, survival interval, and detailed circumstances of death may also help identify more specific diagnostic patterns. Development of standardized histopathological scoring systems for pulmonary changes could further strengthen the forensic utility and reproducibility of these findings.

CONCLUSION

The present study highlights that hanging is the most common cause of asphyxial death, followed by drowning. Pulmonary congestion and alveolar edema emerged as the most consistent gross and microscopic findings, reinforcing their diagnostic value in hypoxic injury. Intra-alveolar hemorrhage, atelectasis, and hyaline membrane formation were less frequent but indicate severe hypoxic damage when present. These findings, in concordance with similar studies, emphasize the importance of systematic autopsy and histopathological examination thereby strengthening medico-legal investigations.

DECLARATIONS

Ethics Approval and Consent to Participate

The study involved medicolegal autopsy cases and was conducted in accordance with institutional and applicable medico-legal procedures. Ethical approval and/or institutional permission was obtained as applicable. As the study used postmortem material, individual consent was not applicable where waived by the competent authority.

Consent for Publication

Not applicable. The study used anonymized postmortem data and histopathological material without personally identifiable information.

Data Availability

The data supporting the findings of this study are available from the corresponding author on reasonable request, subject to institutional and medico-legal restrictions.

Conflict of Interest

The authors declare that they have no conflict of interest.

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The authors received no specific funding for this study.

Authors' Contributions

Dr. Arunkumar Dhondiba Chopwad: Study conception, study design, autopsy/histopathological evaluation, data collection, interpretation of findings, manuscript preparation and critical revision.

Dr. Hrishikesh Deshpande: Forensic evaluation, interpretation of medicolegal findings, data analysis and critical revision of the manuscript.

Dr. Sanket Wagh: Histopathological assessment, data interpretation, literature review and critical revision of the manuscript.

All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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AI Use Disclosure

The authors declare that no generative artificial intelligence tool was used to generate or substantially modify the scientific content, data, analysis, interpretation, or conclusions of this manuscript. Any language or formatting assistance, if used, did not alter the scientific content of the work.

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