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Cause and Manner of Death in Medicolegal Autopsy: A Tertiary Care Centre Study from North India

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ABSTRACT

Context: Medicolegal autopsy results are determined by the pathological examination hence there is a need to check and consolidate all the factors that contribute in the interpretation of histology finding. Lung is vital organ in contributing the certain histologic pattern that can unfold the cause and manner of death.

Aims: To note the role of gross and histopathological examination in ascertaining the cause and manner of death in lung autopsy.

Setting and Design: Study was conducted in department of Pathology with Forensic department collaboration over the period of one year. It's a prospective observational study including 100 medicolegal autopsy cases taken.

Material and Method: Gross examination followed by histopathological examination on hemotyxilin and eosin stained slide of lung tissue were done. Special stains were used wherever required and findings noted. All variable were correlated using Chi-squared test, Fisher's Exact and Kruskal Wallis and strength of association with Kendall's Tau, Chi-squared test, Cramer's V statistical tools.

Results: Majority of cases were in between 20-39 yrs with male predominence. Most common gross finding was congestion followed by consolidation. In histology pulmonary edeme followed by pneumonitis were noted. Most frequent cause of death was brain injury followed by septicemia and manner of death was accidental followed by natural. There was significant assocaition observed between histopathology and age as well as in between gross finding with cause and manner of death.

Conclusion: Gross finding coupled with microscopy can link in the detection of cause and manner of death.

Keywords: Autopsy; Cause of death; Lung, Manner of death and pathology

Key Message: Gross findings in conjunction of histopathology can lead to ascertain the cause and manner of death in majority of medicolegal autopsy cases.

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Introduction

Auopsy has expanded into a multidisciplinary field that may be used to study the evolution of disease, its causative agents, and organisms. It also provides insight into the biological foundation of disease, as evidenced by changes in the architecture of cells and tissues. An autopsy may uncover some natural diseases, the existence of which may raise concerns about the disease's relative role to mortality and its relationship to trauma, employment, criminal activity, etc.[1] A forensic autopsy is carried out in situations involving suspected suicide, murder, accidents, persistent drug or alcohol abuse, mistreatment by medical personnel, unexpected deaths, long post-mortem delays (*i.e.*, body decomposition), or other challenges in identifying the deceased. On an individual basis, it is critical to accurately diagnose the cause of death and any coexisting illnesses.

Precise identification of the cause of death and coexisting illnesses is crucial not only for the individual's family and relatives but also for health care planning and research on a population level.[2] In cases where the cause of death is uncertain, pathological investigation, which includes both gross and histological examination, can help identify the manner and cause of death.[3,4]

The lungs are engaged in all terminal diseases in form of inflammation and neoplastia. In situations of asphyxia, strangulation, drowning, hanging, and aspiration, pathological findings of the lung are particularly significant. Since many Indian facilities rarely take a biopsy unless there are unclear findings on gross inspection, gross findings must be verified by histopathology. When the cause of death is unknown, we are attempting to determine the demography of the disease and the relationship between pathological findings and cause and manner of death.

Material and Method

Aims and Objectives

To evaluate the role of histopathological examination of lung in medicolegal autopsy and to correlate the histopathological findings of lung organ with manner and cause of death.

Study design: This is an prospective observational study was conducted in the Department of Forensic Medicine and Toxicology at AIIMS Rishikesh with collaboration of Department of pathology. Hundred medical-legal cases for autopsy were received in mortuary between March 2022 to March 2023. The autopsy and clinical findings were noted. Representative tissue from macroscopically variable areas of bilateral lungs, collected in 10% neutral buffered formalin in the autopsy room. For histopathological analysis, specimens from all of the medico-legal cases were fixed in a 10% neutral buffered formalin solution. The H&E (haematoxylin and eosin) stain was used to stain sections. Special stains, including Ziehl Neelsen stain for tubercular bacilli, Fite faraco stain for lepra bacilli and sliver stains like Grocotte Methenamine Silver stain along with Periodic Acid Schiff (PAS) for fungal profiles were done wherever required. Gross and microscopic features were studied, and a brief discussion of the incidental and interesting findings were noted. All confidentiality was maintained, and only non-identifiable data of the patient was collected and tabulated for analysis. Additional consent was also taken from deceased relatives for taking histological samples.

Statistical Tools: To ascertain significant correleation between two or more than two groups and variables Chi Squqred Test and Fisher's Exact test along with Kruskal Wallis Test were used. Strength of association between variables were assessed using Cramers V, Kendall Tau.

Inclusion and exclusion criteria:

It included all the medicolegal autopsy cases except:

Previously autopsied cases, police encounter deaths, decomposed body and Unidentified bodies.

A prospective observational study was conducted in Forensic Medicine department and Toxicology, All India Institute of Medical Sciences (AIIMS) Rishikesh. One hundred medico legal cases presented in department of Forensic Medicine and Toxicology (FMT) for autopsy, were taken. After gross inspection and measuring the weight, representative histopathological samples were taken from bilateral lungs kept in 10% neutral buffered formalin and sent to the Department of Pathology at AIIMS Rishikesh, during March 2022 - March 2023 taken. Sections were processed and finally paraffin tissue embedding was done to prepare tissue blocks. Five (5.0) mm thickness sections were cut in microtome and all prepared sections slides were stained with Haematoxylin and Eosin (H&E) stain and mounted and examined microscopically. This is a part of study that was approved by institutional ethics committee vide letter no. AIIMS/IEC/22/16.

Results

Total of hundred cases were included in the study with age ranges from 20 years to 90 years with male predilection. Age group 30-39 years constituted the most cases (27.0%) followed by 20-29 years. Parenchymal hemorrhage and COPD with pneumonitis histopathological types showed the lowest (26.9%) and highest (76.0%) mean age in years. There was no significant difference between the various groups in terms of distribution of Gender (p = 0.595). However, Over all male dominence was noted in the majority of subgroups.

Congestion (33.0%) was the most common gross finding with majority of cases in 20-29 yrs age group followed by consolidation (24.0%) and pulmonary edema (18.0%) both noted in 30-39 yrs age group. However, there was no statistical correlation could be find out between gross findings and age distribution. (p = 0.656). (Fig. 1).

Pulmonary edema (34.0%) was the most common histopathological finding noted followed by pneumonitis (15.0%) both groups presented in 30-39

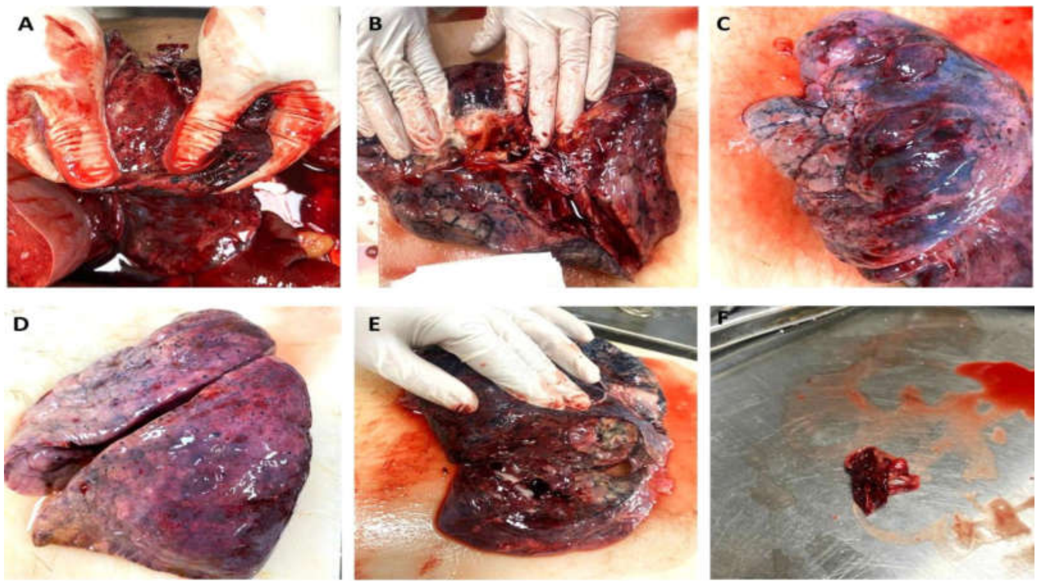

Fig. 1: Gross findings- A) Cut surface is congested. B) Cut surface exudes the fluid (Pulmonary edema). C) Outer surface shows emphysematous bullae. D) Outer surface shows petechial hemorrhagic spots. E) Cut surface shows pleura based cercumscribed tumor. F) Blood clot like pulmonary embolus

yrs age group. Overlap of pneumonitis and pulmonary edeme was noted in 8.0% of cases. Parenchymal hemorrhage and emphysematous change were noted in 6.0% of cases. Focal fibrosis, granuloma and malignant tumor were noted in 5.0% and 3.0% and 4.0% of cases respectively. There was significant association between histopathology and age groups (p=0.033). (Table1) (Fig. 2).

Brain injury (35.0%) was the most common cause of death followed by septicemia (16.0%). Hundred percent cases of lung abscess and pulmonary embolism with pneumonitis had cause of death septicemia and

Table 1: Association of histopathology with age distribution

S. N.	Histopathology	Number	Percentage	Most common age group (Yrs)
1	Pulmonar edema	34	34	30-39
2	Pneumonitis	15	15	30-39
3	Miscellaneous	14	14	40-49
4	Pulmonary edema and Pneumonitis	8	8	30-39, 60-69
5	Emphysema	6	6	40-49
6	Parenchymal hemorrhage	6	6	20-29
7	Fibrosis	5	5	50-59

Table Cont...

8	Tumor	4	4	50-79
9	Granuloma	3	3	20-49
10	Pulmonary embolism and Pneumonitis	2	2	30-49
11	COPD and Pneumonitis	1	1	70-79
12	Lung abscess	1	1	40-49
13	Pneumonitis and Bronchiectasis	1	1	60-69
	Total	**100**	**100**	

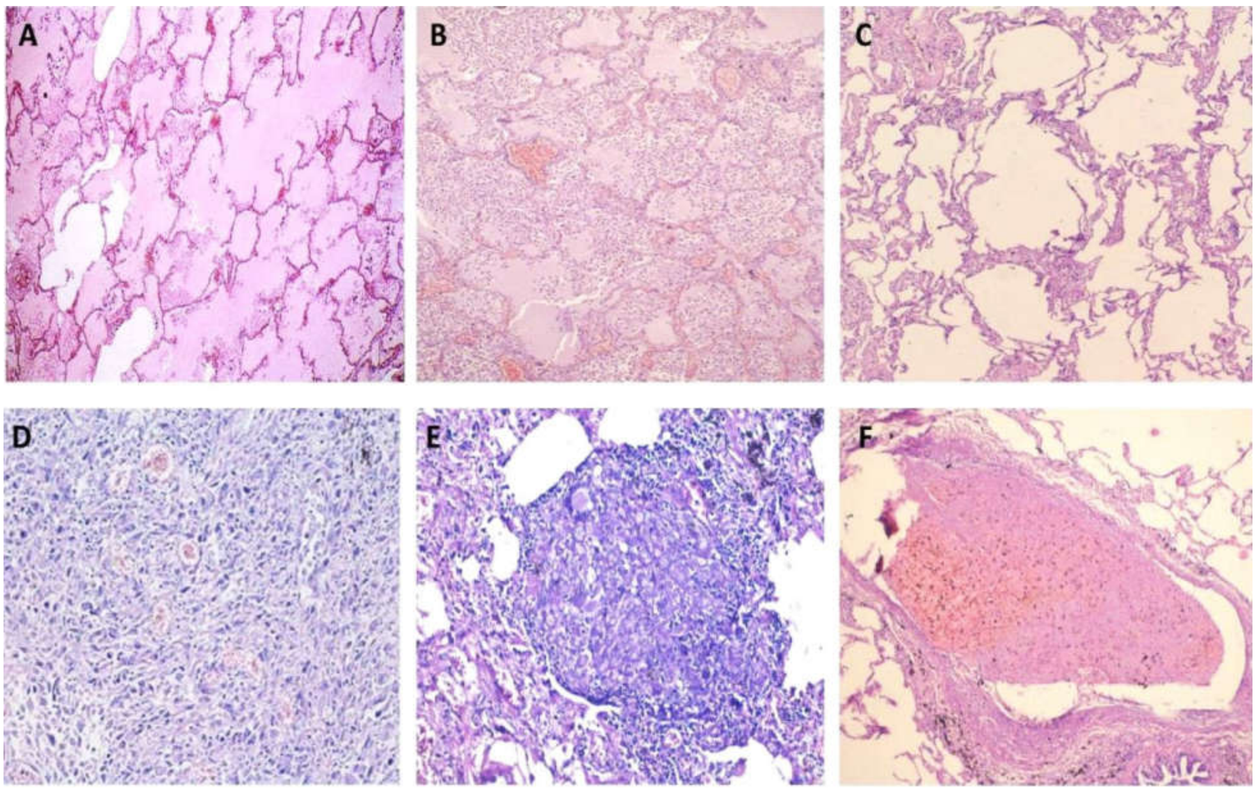

Fig. 2: A) Proteinaceous material in alveoli (Pulmonary edema). (H&E,200X), B) Alveolar spceces and septa infiltrated by neutrophils (Pneumonitis)(H&E,200X), C) Destruction of alveolar septa (Emphysematous change)(H&E,200X), D) Oval to spindled neoplastic cell proliferation in lung tissue (Tumor)(H&E, 200X), E) Aggregates of epithiloid cell (Granuloma)(H&E, 200X), F) Adhered embolus to endothelium. (H&E, 200X)

brain injury respectively. All cases of pneumonitis with bronchiectasis had also coronary artery disease as a cause of death. There was no significant difference between the various groups in terms of distribution of Cause of Death and histology (p = 0.100).

Contrary to that there was statistically significant association between gross findings and cause and manner of death. Brain injury is the most common cause of death in gross types of congestion (42.4%), consolidation (37.5%), pulmonary edema (27.8%) and variable dilated spaces (40.0%). 66.7% of the participants in the group gross of laceration had cause of death was hemorrhagic shock. Cases in the gross group of abscess had the largest proportion of cause of death of septicemia. Grossly lacertaed lung cases had the largest proportion of cause of death from hemorrhagic shock. Pneumonia was the most common cause of death in cases whose gross finding was consolidation. There was a significant difference between the various groups of gross finding and distribution of Cause of Death (p = 0.015). (Table 2). Accidental (67.0%) was the most common manner of death followed by natural (18.0%) and suicidal (14.0%). Pulmonary edema was the most frequent histopathology followed by pneumonitis in both accidental and natural types of manner of death.

Those cases who had gross features of laceration and abscess were having the accidental largest proportion of manner of death. Most of the cases

Table 2: Association of gross finding with cause of death

Cause Of Death	Lung: Gross								
	Congestion	Consolidation	Pulmonary Edema	Variable Dilated Spaces	Petechial Hemorrhages	Adherent To Chest Wall	Laceration	Abscess	Total
Brain Injury	14 (42.4%)	9 (37.5%)	5 (27.8%)	4 (40.0%)	1 (16.7%)	1 (20.0%)	1 (33.3%)	0 (0.0%)	35 (35.0%)
Septicemia	4 (12.1%)	7 (29.2%)	3 (16.7%)	0 (0.0%)	0 (0.0%)	1 (20.0%)	0 (0.0%)	1 (100.0%)	16 (16.0%)
Hemorrhagic Shock	3 (9.1%)	0 (0.0%)	1 (5.6%)	2 (20.0%)	0 (0.0%)	1 (20.0%)	2 (66.7%)	0 (0.0%)	9 (9.0%)
Unclear	3 (9.1%)	2 (8.3%)	2 (11.1%)	2 (20.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (9.0%)
Miscellaneous	2 (6.1%)	1 (4.2%)	2 (11.1%)	2 (20.0%)	0 (0.0%)	1 (20.0%)	0 (0.0%)	0 (0.0%)	8 (8.0%)
Antemortem Hanging	4 (12.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (7.0%)
Poisoning	1 (3.0%)	1 (4.2%)	3 (16.7%)	0 (0.0%)	2 (33.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (7.0%)
Coronary Artery Disease	2 (6.1%)	1 (4.2%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (4.0%)
Pneumonia	0 (0.0%)	3 (12.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (3.0%)
Pulmonary Edema	0 (0.0%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	1 (20.0%)	0 (0.0%)	0 (0.0%)	2 (2.0%)
Total	**33 (100%)**	**24 (100%)**	**18 (100%)**	**10 (100%)**	**6 (100%)**	**5 (100%)**	**3 (100%)**	**1 (100%)**	**100 (100%)**

Table 3: Association of histopathology with gross findings

Gross	Pulmonary edema	Pneumonitis	Miscellaneous	Pneumonits and Pulmonary edema	Emphysema	Parencymal hemorrhae	Fibrosis	Tumor	Granuloma
Congestion	16 (47.1%)	1 (6.7%)	12 (85.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (60.0%)	0 (0.0%)	1 (33.3%)
Consolidation	4 (11.8%)	8 (53.3%)	0 (0.0%)	4 (50.0%)	0 (0.0%)	1 (16.7%)	1 (20.0%)	2 (50.0%)	1 (33.3%)
Pulmonary Edema	10 (29.4%)	4 (26.7%)	1 (7.1%)	2 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Variable Dilated Spaces	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (12.5%)	6 (100.0%)	1 (16.7%)	0 (0.0%)	2 (50.0%)	0 (0.0%)
Petechial Hemorrhages	3 (8.8%)	2 (13.3%)	1 (7.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Adherent To Chest Wall	1 (2.9%)	0 (0.0%)	0 (0.0%)	1 (12.5%)	0 (0.0%)	1 (16.7%)	1 (20.0%)	0 (0.0%)	1 (33.3%)
Laceration	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Abscess	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	**34 (100%)**	**15 (100%)**	**14 (100%)**	**8 (100%)**	**6 (100%)**	**6 (100%)**	**5 (100%)**	**4 (100%)**	**3 (100%)**

with gross finding of pulmonary edema had the pnatural manner of death. Cases with gross features of petechial hemorrhages had the largest proportion of manner of death as Suicidal and cases with gross feature of pulmonary edema had the largest proportion of manner of death, Homicidal.

All (100%) cases of parenchymal hemorrhage and pulmonary embolism with pneumonitis had accidental manner of death. Similarly all cases of pneumonitis with bronchiectasis showed natural manner of death. There was no significant difference between the various groups in terms of distribution of Manner of Death ($\chi 2 = 28.470$, $p = 0.810$). Most common gross finding was congestion (33.0%) and its corresponding tissue section showed pulmonary edema (47.7%) on histology. Second most frequent gross finding was consolidation and it revealed pneumonitis on microscopy (53.3%).

All cases (100.0%) of pneumonitis with bronchiectasis which are the sub group of histopathology had consolidation on gross appearence followed by 85.7% cases of miscellaneous group and fibrosis (60.0%) that exhibited congestion grossly. There was a significant association between the histopathology and gross findings ($p = <0.001$). (Table 3).

Discussion

Most patients that are brought for investigation in medicolegal autopsy have no known medical history. If any morbid anatomical change in tissue is noticed, a histopathological investigation is performed as part of a medicolegal autopsy to determine the cause of death. However, a number of unintentional discoveries from histological tests have been brought to light, and these have shown to be excellent resources for pathologists and forensic experts to learn from. Planning for public health and health services depends on the collection of mortality statistics, which is made possible by histopathological investigation.[5] After death, a thorough physical examination is carried out, and internal organs are visually and histologically inspected in order to determine the reason or manner of death. A forensic professional ascertains the cause of death by comparing the findings of the histopathological study.

Inflammation, infections, occupational diseases, and neoplastic tumours are common manifestations of lung pathology. Even if the lung lesion diagnosis is supported by the clinical history, laboratory tests, and radiographic examination, invasive biopsy for histological evaluation is sometimes necessary for confirmation and determining the prognosis of the lung lesion.[6] Rapid progression of disease and high cost of modern diagnotic techniques compile the practitioner under pressure. Finding the most common causes of death and the frequency of various lung abnormalities is essential for developing a preventive plan for prevention.[1,2]

Pathological examination (macro and microscopic): To examine the remaining parenchyma, it is helpful to make a horizontal cut through each lobe using a large-bladed knife, such as a brain knife, after the airways and veins have been dissected. The lung is laid flat on the dissecting board, medial side facing the board. To prevent accidental harm to the securing hand while slicing, a sponge might be placed over the exterior of the lobe to be cut.

Even in cases when no evident pathology is found, tissue samples ought to be obtained from each lung lobe. By using a technique of cutting certain tissue shapes for a specific spot, it becomes easier to identify where these blocks originated. Prior to processing and sectioning, the tissue blocks must be securely fastened and of the standard size, measuring roughly 3 x 2 x 0.4 cm. Any bulk or regions of interest that are found will require additional blocks to be taken. Recall that if there is surplus tissue, it is preferable to preserve and repair it at the postmortem stage.

Congestion (33.3%) and consolidation (24.0%) were the two most frequent gross findings. In the lung, the average age of congestion was 38.36 ± 14.53. The most prevalent age group, with a male preponderance, was 20–29 years old. In congestion cases, the male to female ratio was 2.3:1, whereas in consolidation cases, it was 11:1.

Pneumonitis (15.0%) was the most frequent histological finding, with pulmonary edoema (34.0%) being the most prevalent age group. The ratio of men to women was 3.25:1. In the lungs, there was a strong correlation between the histological and gross findings. P<0.0012. In our study common histopathological finding is in line with research conducted by Minal G *et al*.[7], P. Arunlatha et al.[8]

According to Pulak Chakma et al.[9], 10.56% of pneumonia patients were identified on histology; this figure is similar to 15.0% in our analysis. This percentage is consistent with findings from other research by Chauhan G et al.,[10] (14.62%), Fang *et al.*, 2004 (18%), and Nichols *et al.*, 2012 (12%). However, in contrast to the results of other studies, Hanmante *et al.*, 2014[22] detected pneumonia in 39%, Sumaya et al., 2020 in 33.9%, and Udayashankar *et al.*, [2] in 41.18% of the study population. General lung tissue inflammation is referred to as pneumonia.[1,2] Chest radiation therapy is one possible cause.[3] Pneumonitis and pneumonia can be differentiated by their respective causes and clinical manifestations. Pneumonia is defined as pneumonitis along with lung tissue consolidation and exudation as a result of microbial infection.[5] Prolonged inflammation, if left untreated, can cause irreversible harm, including lung fibrosis. Pneumonia-related mortality may be largely explained by host characteristics regardless of the significance of the aetiology and treatment. Granuloma frequency 3.0% was consistent with previous researches done by Sangma *et al.*, 2014, 1.68%, Kaur JK *et al.*, 2013, 1.6%, Theegarten *et al.*, 2006, 1.39%, and Pavic *et al.*, 2012, 1.8%. According to research by Theegarten *et al.*, 2006, Pavic *et al.*, 2012, and Sangma MM *et al.*, 2014 males were more susceptible to infection than females. The incidence of pulmonary tuberculosis was found in 6 of the 8 cases, with 2 of those cases occurring in the 60–70 age range. One study by Pulak Chakma et al. found 1.87% of participants had tuberculosis.[9] Emphysematous lesions were noted in 6.0% cases with deceased male only. It was found more commonly in the age group of 40-49 years. This was in accordance with the studies by Amin NS *et al.*, 2017 exhibiting 6.6% of cases with age goup 30-49 year.

Lung cancer is the most frequent cancer globally and the leading cause of cancer-related deaths annually. Its 8–16% 5 year survival rate is largely due to the disease's late onset of symptoms, which is incurable, but it is also partially caused by comorbidities that preclude curative therapy. Five year survival chances for lung cancer are significantly greater (up to 67%) when the disease is discovered early and is treatable with drastic measures such radical radiation and possibly curative surgery. Thus, a key strategy to enhance results should be the accurate identification of lung cancer at this earlier (often asymptomatic) stage of the illness. As an inadvertent finding, four male autopsy cases (4.0%) with lung cancer ranging in age from 30 to 79 years were found. This was similar to research conducted over a 5-year period by P. Khare *et al.*, 2017 and Vaideeswar P *et al.*, 2022, which found that 19.7% of Mumbai, Maharashtra, residents had lung cancer. In neoplastic diseases, autopsies are crucial for accurately identifying the primary cancer sites, evaluating the behaviour of the disease, describing the harmful effects of novel treatment regimens, and determining the actual causes of death. All of these benefits will contribute to local, national, and worldwide research as well as the management of health care.

This study presents a variety of lung abnormalities that were either incidental or the direct cause of mortality and were verified by histopathology. Studying such lung abnormalities through autopsy can help develop preventive measures to lower mortality from lung pathology.

After poisoning, hanging is the second most common means of suicide in India. Suicide by hanging has become more common during the last 30 years, particularly among young individuals. A significant social, psychological, and financial burden is placed on our society by the fact that 71% of suicides in India occur in people under the age of 44. The National Crime Records Bureau study from 2012 states that throughout the decadal periods of 2003–2013, there were, on average, over one lakh suicides in India.

In the current study, 7.0 % cases of hanging were observed. Of the total cases, 57.1% belonged to the 30-39 age bracket. Premortem hanging was the cause of death, and gross findings in the lungs included congestion, petechial haemorrhages, and pulmonary edoema. The findings of this investigation were consistent with those of Chaudhari *et al.*[10] and Vijaykumar L *et al.* 1 Suicidal hanging are happening more frequently every day. Effective and thorough programmes are needed to identify the relevant factors and stop suicide behaviours.

This study showed that macroscopic and histological findings are reliable and together can predict the method and cause of death in a reasonable number of medicolegal autopsy cases. Thus, it is necessary to emphasise both gross and microscopic.

Assessment of the range of gross features and subsequent microscopy are critical skills for a pathologist. Site of tissue taken from the organ determines the outcome. Hence, there is a no scope of overlooking the reprentative site from the organ. Unless until, there is a proper and sound training of forensic residents/doctors Let the pathologist must take the lead in this regard rather than to allow forensic expert to determine the site of tissue taken.

Conclusion

In most medicolegal autopsies, lung gross findings combined with histological characteristics can determine the cause and manner of death. Therefore, it is imperative to enhance the ability to evaluate both gross and histological findings.

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