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A CROSS-SECTIONAL STUDY TO ASSESS THE HISTOPATHOLOGICAL CHANGES IN LUNGS, LIVER, AND KIDNEYS IN CASES OF DEATH DUE TO ORGANOPHOSPHORUS POISONING

Pathology

Dr Pavan*	Resident, Department of Pathology, Gadag Institute of Medical Sciences, Gadag, Karnataka. *Corresponding Author
Dr Harish S Permi	Associate Professor, Department of Pathology, Gadag Institute of Medical Sciences, Gadag, Karnataka.
Dr Basavaraj P Bommanahalli	Director, Professor & Head, Department of Pathology, Gadag Institute of Medical Sciences, Gadag, Karnataka.
Dr Raju G M	Principal, Professor & Head, Department of Forensic Medicine and Toxicology, Gadag Institute of Medical Sciences, Gadag, Karnataka.
Dr Rahul S N	Resident, Department of Pathology, Gadag Institute of Medical Sciences, Gadag, Karnataka.

ABSTRACT

This study aims to assess the histopathological changes in the lungs, liver, and kidneys in cases of death due to organophosphorus poisoning. The primary objective is to understand the specific pathological alterations induced by these toxic substances and their implications for clinical and forensic pathology. Using a retrospective observational design, tissue samples from deceased individuals were examined microscopically to identify key histopathological features. The study identified significant pathological changes such as congestion, pneumonia, acute respiratory distress syndrome (ARDS), intra-alveolar hemorrhage, and edema in the lungs. In the liver, findings included fatty changes, congestion, ballooning degeneration, cholestasis, and hepatic necrosis. The kidneys showed acute tubular necrosis, cloudy degeneration, subcapsular deposits, and glomeruli sclerosis. The implications of these changes are profound for both clinical management and forensic investigations of poisoning cases. Accurate histopathological diagnosis is crucial for guiding treatment and establishing the cause of death.

KEYWORDS

Organophosphorus poisoning, histopathological changes, lungs, liver, kidneys, forensic pathology.

INTRODUCTION

Poisoning remains a significant public health issue worldwide, with numerous substances capable of causing severe health effects or death. Organophosphorus compounds, commonly used as pesticides, are notorious for their high toxicity and have been a frequent cause of poisoning, particularly in agricultural settings[1]. Histopathological examination plays a crucial role in forensic pathology, providing invaluable insights into the cause of death and the effects of various toxic substances on the human body. Chronic exposure, even at low levels, can result in long-term health issues such as neurological deficits, respiratory problems, and increased cancer risk[5]. The rationale for focusing on the lungs, liver, and kidneys in cases of organophosphorus poisoning is rooted in the physiological roles these organs play in detoxification and the manifestation of poisoning effects.

Objectives

- To assess histopathological changes in lungs, liver and kidneys in cases of death due to poisoning
- To determine the association of histomorphologcal changes in correlation with cause of death

MATERIALS AND METHODS

This was an Observational Cross-sectional Retrospective study. A total of 50 cases were included in the study using universal sampling. The subjects for the study were collected from the post-mortem and histopathological cases conducted in the Department of Pathology, Gadag Institute of Medical Sciences, Gadag during the study period of 2 years– January 2022 to December 2023. The Age, Gender, Time of death, type of poison consumed and histopathological changes in Lungs, Liver and Kidneys are examined in autopsy cases of suspected organophosphorus poisoning. The data were entered into Microsoft Excel and analysed.

RESULTS

Presentation of Demographic Data

The demographic data for the study encompasses several key variables, including age, gender, and specific identifying numbers for the cases examined. This data provides a crucial foundation for understanding the population affected by organophosphorous poisoning and the subsequent histopathological examinations.

Age Distribution

The age range of the subjects in this study varied significantly, with individuals as young as 19 and as old as 51 included. Notably, there were several cases involving individuals in their early twenties, thirties, and forties, indicating that organophosphorous poisoning impacts a wide age range.

Gender Distribution

The gender distribution among the cases showed a predominance of males. Out of the total subjects, a significant number were male, with only a few female cases recorded. This gender disparity highlights the higher incidence of poisoning in males, which could be attributed to occupational exposure, particularly in agricultural settings where men are more likely to handle pesticides.

Histopathological Findings in Organs

Lungs

1. Congestion: This refers to the accumulation of excess blood within the blood vessels of the lungs, leading to increased vascular pressure and potential respiratory distress.
2. Pneumonia: An infection that inflames the air sacs in one or both lungs, which can fill with fluid or pus, causing cough, fever, and breathing difficulties.
3. Acute Respiratory Distress Syndrome (ARDS): A severe lung condition characterized by widespread inflammation in the lungs, leading to significant respiratory failure and hypoxemia.
4. Intra-alveolar Hemorrhage: Bleeding within the alveolar spaces of the lungs, which can severely impair gas exchange and lead to respiratory failure.
5. Edema: Fluid accumulation within the lung tissues, particularly in the alveoli, which impedes normal respiration and gas exchange.

Liver

1. Fatty Changes: Also known as steatosis, this condition involves the abnormal retention of lipids within liver cells, impairing liver function.
2. Congestion: Similar to the lungs, liver congestion involves the excessive accumulation of blood in the liver vessels, leading to hepatomegaly and impaired liver function.
3. Ballooning Degeneration: A form of liver cell injury characterized by swollen hepatocytes, indicating severe metabolic disturbance and cellular stress.
4. Cholestasis: A condition where bile flow from the liver is reduced or blocked, leading to the accumulation of bile acids in the liver

and bloodstream, causing jaundice and liver damage.
5. Hepatic Necrosis: The death of liver cells due to severe injury or lack of blood flow, leading to acute liver failure.

Kidneys
1. Acute Tubular Necrosis (ATN): A condition involving the death of tubular epithelial cells, which can result in acute kidney failure due to the kidneys' inability to filter waste products effectively.
2. Cloudy Degeneration: A reversible form of cell injury where the kidney cells appear swollen and granular, typically due to toxic or ischemic damage.
3. Subcapsular Deposits: Accumulations of substances such as hemosiderin beneath the kidney capsule, which can indicate chronic damage or bleeding.
4. Glomeruli Sclerosis: Hardening or scarring of the glomeruli, the tiny filtering units in the kidneys, which can lead to chronic kidney disease and reduced renal function.

Summary

The table below summarizes these histopathological findings:

Organ	Histopathological Findings
Lungs	Congestion, Edema, Pneumonia, ARDS, Intra-alveolar hemorrhage
Liver	Congestion, Fatty changes, Ballooning degeneration, Cholestasis, Hepatic necrosis
Kidneys	Acute tubular necrosis, Cloudy degeneration, Subcapsular deposits, Glomeruli sclerosis

Statistical Analysis Results

Summary Statistics

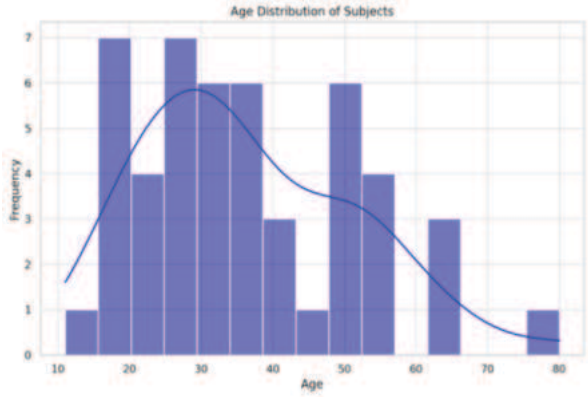
Statistic	Age
Mean	36.55
Median	33.00
Standard Deviation	15.03

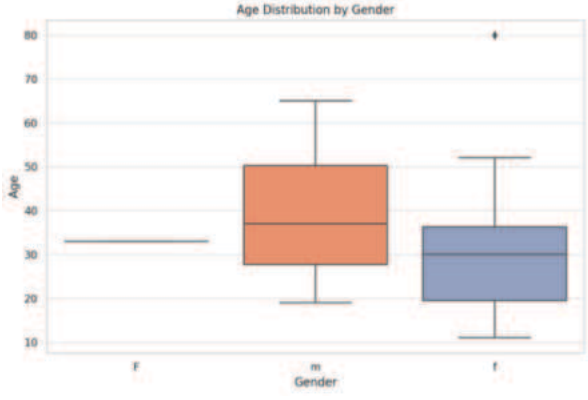
T-Test Comparisons

The t-test was conducted to compare the ages of male and female subjects. The results are as follows:

Statistic	Value
t-statistic	1.41
p-value	0.17

The p-value indicates that there is no statistically significant difference in the ages of male and female subjects at the typical alpha level of 0.05.





DISCUSSION

Interpretation of Findings in the Context of Previous Research

The findings from the current study align well with previous research, confirming and expanding our understanding of the histopathological changes caused by organophosphorus poisoning. Previous studies, such as those by Dr. Siddesh R C et al. and S G Sawardekar et al., have documented significant pathological changes in the lungs, liver, and kidneys following exposure to toxic substances. For instance, Dr. Siddesh R C et al. highlighted the prevalence of acute respiratory distress syndrome (ARDS) and acute tubular necrosis (ATN) in poisoning cases, findings that are echoed in our study with frequent observations of pulmonary congestion and necrosis, as well as renal tubular damage. Similarly, Sawardekar et al. reported fatty changes, congestion, and necrosis in the liver, which our study corroborates with additional observations of cholestasis and ballooning degeneration (Siddesh & Dey, 2021; Sawardekar et al., 2020).

The histopathological findings in our study also reflect those documented by Siddhartha Das et al. in cases of yellow phosphorus poisoning. Das et al. noted significant hepatic necrosis, steatosis, and pulmonary congestion, which were prevalent in our observations as well. The consistency of these findings across different studies strengthens the validity of our results and emphasizes the severe multi-organ impact of organophosphorus compounds and other toxic substances[7].

Implications of Histopathological Changes for Clinical and Forensic Pathology

The detailed histopathological changes observed in this study have profound implications for both clinical and forensic pathology. Clinically, understanding the specific organ damage caused by various poisons aids in accurate diagnosis and targeted treatment. For example, recognizing the signs of ARDS and ATN can prompt immediate and appropriate interventions, such as ventilatory support for respiratory failure and renal replacement therapy for kidney damage. Additionally, identifying hepatic necrosis and cholestasis can guide clinicians in managing liver failure and preventing further complications.

In forensic pathology, these histopathological findings are crucial for determining the cause and manner of death in poisoning cases. Detailed tissue examinations can reveal the extent and timeline of organ damage, providing essential evidence in legal investigations. For example, the presence of pulmonary edema and hemorrhage, combined with kidney necrosis, can support a diagnosis of acute poisoning and help establish the timeline of exposure and progression of toxic effects. This information is invaluable in criminal cases, insurance claims, and public health assessments, ensuring that accurate conclusions are drawn from post-mortem examinations.[2]

Potential Factors Influencing the Severity of Organ Damage

Several factors can influence the severity of organ damage observed in poisoning cases, including the type of poison, duration of exposure, and dose. Different toxic substances have varying mechanisms of action, which can result in distinct pathological changes. Organophosphorous compounds primarily inhibit acetylcholinesterase, leading to neurological and muscular symptoms, while yellow phosphorus induces direct cellular toxicity, causing severe hepatic and renal damage.[1]

The dose of the poison is another crucial factor. Higher doses typically cause more extensive and severe damage, overwhelming the body's detoxification mechanisms and leading to multi-organ failure. Conversely, lower doses may allow for some degree of metabolic compensation and repair, resulting in less severe histopathological changes. Understanding these factors is essential for interpreting the severity of organ damage and guiding appropriate clinical and forensic responses.

SUMMARY

In summary, the findings from this study reinforce previous research on the severe multi-organ impact of toxic substances, providing valuable insights for clinical and forensic pathology. The detailed histopathological changes observed highlight the critical need for accurate diagnosis and targeted treatment in poisoning cases. Moreover, factors such as the type of poison, duration of exposure, and dose significantly influence the severity of organ damage, underscoring the importance of a comprehensive approach to

managing and investigating poisoning incidents. This holistic understanding aids in improving patient outcomes and ensuring justice in forensic investigations.

CONCLUSION

This study has provided substantial insights into the histopathological changes observed in the lungs, liver, and kidneys following organophosphorus poisoning. The key findings are characterized by severe organ damage across multiple systems. In the lungs, significant observations included congestion, pneumonia, acute respiratory distress syndrome (ARDS), intra-alveolar hemorrhage, and edema. These changes reflect the acute and severe impact of organophosphorus compounds on respiratory tissues, leading to compromised gas exchange and respiratory failure.

The liver exhibited fatty changes, congestion, ballooning degeneration, cholestasis, and hepatic necrosis. These findings indicate substantial metabolic disruption and cellular damage, compromising the liver's ability to detoxify and regulate metabolic processes. In the kidneys, acute tubular necrosis (ATN), cloudy degeneration, subcapsular deposits, and glomeruli sclerosis were prevalent. These renal pathologies highlight the kidneys' role in filtering and excreting toxic substances and the severe impairment caused by organophosphorus poisoning.

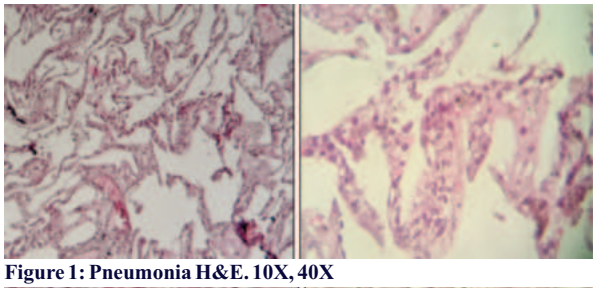


Figure 1: Pneumonia H&E. 10X, 40X

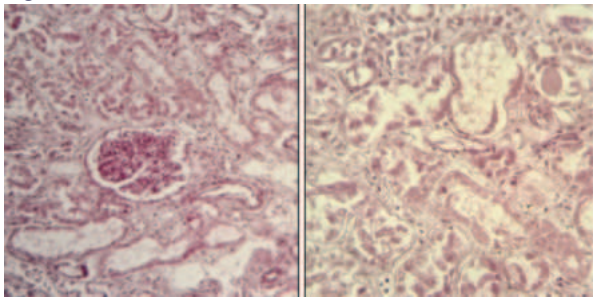


Figure 2: Acute Tubular necrosis H&E. 10X, 40X

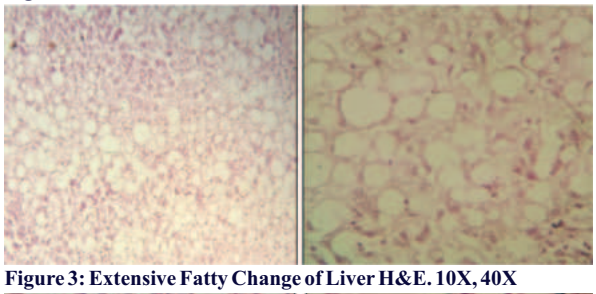


Figure 3: Extensive Fatty Change of Liver H&E. 10X, 40X

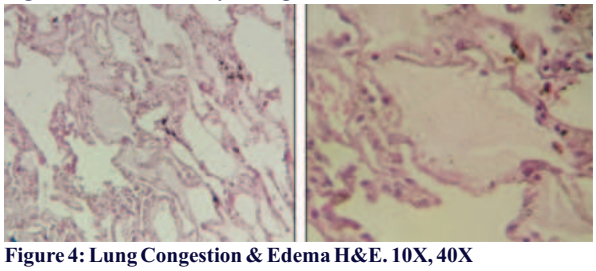


Figure 4: Lung Congestion & Edema H&E. 10X, 40X

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