

Fundus and Pupillary Changes in Organophosphorus Poisoning: An Observational Study in Forensic Toxicology

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Abstract

Background: Organophosphorus (OP) compounds remain a major cause of poisoning in developing countries, contributing significantly to morbidity and mortality. While systemic manifestations are well established, ocular changes particularly pupillary and fundus abnormalities can provide important diagnostic and prognostic clues in forensic and clinical toxicology. This is study to evaluate the spectrum of pupillary and fundus changes in patients with OP poisoning and assess their association with severity of poisoning. **Materials and Methods:** This observational study included 100 patients with confirmed OP poisoning. Demographic data, exposure details, and clinical severity were documented. Detailed ophthalmic examination, including pupillary size, reactivity, and fundus evaluation, was performed. Findings were analyzed descriptively and correlated with severity using the Peradeniya Organophosphorus Poisoning Scale. **Results:** The mean age of participants was 34.7 ± 11.2 years, with a male predominance (58%). Intentional ingestion accounted for two-thirds of cases. Pupillary abnormalities were common, with miosis observed in 72%, mydriasis in 14%, and irregular pupils in 8%. The pupillary light reflex was sluggish in over half of the patients and absent in 16%. Fundus changes were identified in 36% of cases, most frequently retinal hemorrhages (12%) and papilledema (10%), followed by venous congestion (8%) and optic disc pallor (6%). Both pupillary and fundus abnormalities showed a clear correlation with poisoning severity, being most frequent in patients with severe poisoning. **Conclusion:** Pupillary constriction and fundus abnormalities are frequent in OP poisoning and correlate with clinical severity. Their routine assessment may aid early diagnosis and prognostication.

Keywords: Organophosphorus poisoning, pupillary changes, fundus abnormalities, miosis, forensic toxicology, Peradeniya scale.

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INTRODUCTION

Organophosphorus (OP) compounds are extensively used as pesticides, particularly in developing countries such as India, where agriculture remains a dominant occupation. Their easy accessibility, low cost, and high toxicity make them frequent agents of both accidental and intentional poisoning. According to the World Health Organization, pesticide self-poisoning contributes significantly to global suicides, with OP compounds being a leading cause in South and Southeast Asia.^[4] The clinical burden is substantial, ranging from acute cholinergic crisis to delayed neurological complications, and continues to challenge emergency physicians, intensivists, and forensic specialists.^[5]

The pathophysiology of OP poisoning is well established. OP compounds irreversibly inhibit acetylcholinesterase, resulting in accumulation of acetylcholine at muscarinic, nicotinic, and central nervous system receptors. This produces a characteristic cholinergic syndrome, including miosis, excessive secretions, bronchospasm, fasciculations, seizures, and cardiorespiratory failure.^[2,5] Pupillary constriction is often the earliest and most consistent sign, providing a readily observable clinical clue in both diagnostic and prognostic contexts.^[1,2]

In addition to pupillary responses, fundus abnormalities have also been documented, although less consistently studied. Retinal hemorrhages, papilledema, venous

congestion, and optic disc pallor have been reported, particularly in severe cases of poisoning.^[6] These changes may be secondary to systemic hypoxemia, raised intracranial pressure, or direct neurotoxic effects of OP compounds.^[3,6]

Despite the high prevalence of OP poisoning in India, limited studies have systematically examined pupillary and fundus changes in affected patients. Given their non-invasive nature and potential forensic value, ocular findings may provide important adjunctive information in assessing the severity and prognosis of OP poisoning. This study was therefore undertaken to evaluate pupillary and fundus changes in OP poisoning and to explore their association with clinical severity.

MATERIALS AND METHODS

Study Design and Setting: This was an observational cross-sectional study conducted in the Department of Forensic

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Medicine and Toxicology, Government Medical College (GMC) and Government General Hospital (GGH), Suryapet, Telangana. The study was carried out over a period of twelve months, from January 2024 to December 2024.

Study Population: A total of 100 patients with clinically and biochemically confirmed organophosphorus (OP) poisoning were included. All patients presenting to the emergency and toxicology units during the study period and fulfilling the eligibility criteria were enrolled consecutively after obtaining informed consent from the patient or legally authorized representative.

Inclusion Criteria: Patients of either sex, aged >12 years, with history of OP compound exposure (accidental or intentional).

Diagnosis of OP poisoning confirmed by clinical features (cholinergic symptoms, pupillary changes, fasciculations) and treatment history.

Patients admitted within 24 hours of exposure.

Exclusion Criteria: Patients with mixed or unknown poisoning.

History of ocular trauma, pre-existing ocular disease (glaucoma, optic atrophy, diabetic retinopathy), or prior ocular surgery.

Patients with co-morbid neurological conditions likely to affect pupillary reflexes.

Data Collection: Baseline demographic and clinical data were recorded, including age, sex, and mode of exposure. The severity of poisoning was assessed using the

Peradeniya Organophosphorus Poisoning Scale (POPS). Ophthalmic examination was performed by an ophthalmologist and included:

Pupillary assessment: size, symmetry, reactivity to light (normal, sluggish, absent).

Fundus examination: performed using direct ophthalmoscopy after pupil dilation, documenting changes such as retinal hemorrhages, papilledema, venous congestion, and optic disc pallor.

Ethical Considerations: Ethical clearance was obtained from the Institutional Ethics Committee of GMC Suryapet prior to commencement of the study. Written informed consent was obtained from all participants or their attendants.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations between severity of poisoning and ocular findings were assessed using Chi-square test, with a p-value <0.05 considered statistically significant.

RESULTS

A total of 100 patients with organophosphorus poisoning were included in the present study. The mean age of the cohort was 34.7 ± 11.2 years, with a male predominance (58%). Most exposures were intentional (68%), while 32% were accidental [Table 1].

Table 1: Demographic and Clinical Characteristics of Study Population (N = 100)

Variable	Frequency (n)	Percentage (%)
Age (Mean ± SD)	34.7 ± 11.2	—
Gender: Male	58	58.0
Gender: Female	42	42.0
Mode of exposure: Intentional	68	68.0
Mode of exposure: Accidental	32	32.0

Pupillary abnormalities were frequent, with miosis observed in 72% of cases, followed by mydriasis (14%) and irregular pupils (8%). Only 6% of patients had normal pupils. In

addition, the pupillary light reflex was sluggish in 58% and absent in 16% of patients [Table 2].

Table 2: Pupillary Changes in OP Poisoning (N = 100)

Pupillary Finding	Frequency (n)	Percentage (%)
Miosis	72	72.0
Mydriasis	14	14.0
Irregular pupils	8	8.0
Normal pupils	6	6.0
Sluggish light reflex	58	58.0
Absent light reflex	16	16.0

At the end of the study, HbA1c, TC, LDL, TG, SGOT/AST, and SGPT/ALT were significantly lower in group A,

compared to group B [Figure 1].

Table 3: Fundus Changes Observed in OP Poisoning (N = 100)

Pupillary Finding	Frequency (n)	Percentage (%)
Normal fundus	64	64.0
Retinal hemorrhages	12	12.0
Papilledema	10	10.0
Venous congestion	8	8.0
Optic disc pallor	6	6.0

Fundus examination revealed that 64% of patients had normal findings. However, 36% demonstrated abnormalities, which included retinal hemorrhages (12%), papilledema (10%), venous congestion (8%), and optic disc pallor (6%) [Table 3].

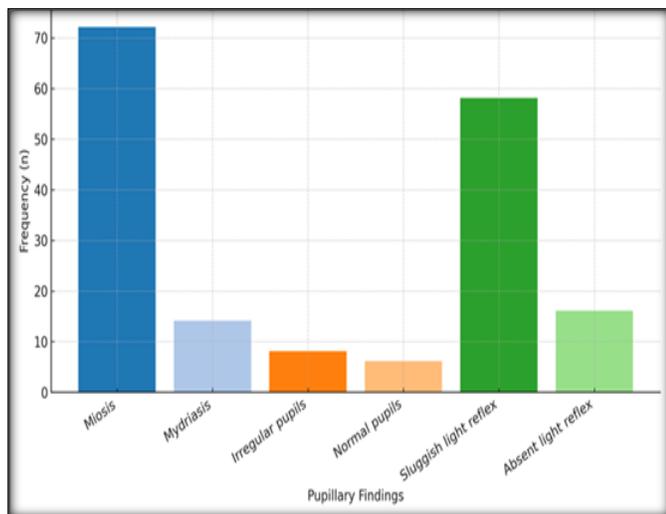


Figure 1: Pupillary Changes in Organophosphorus Poisoning

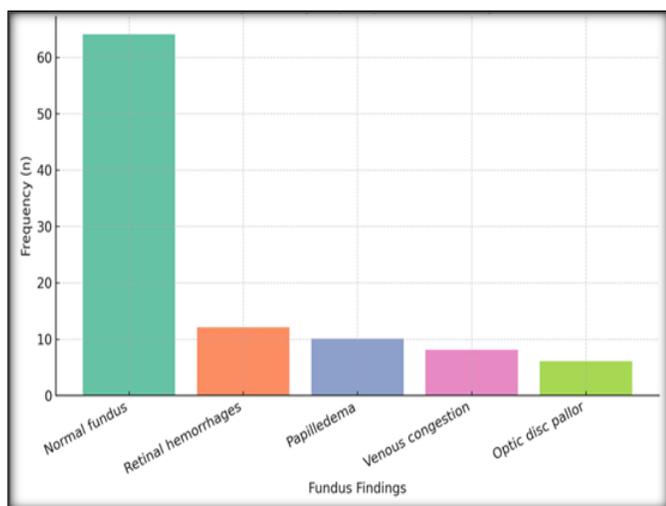


Figure 2: Fundus Changes Observed in OP Poisoning

When compared across severity grades of poisoning, a progressive rise in the frequency of ocular abnormalities was evident. Pupillary abnormalities were noted in 85.7% of severe cases compared with 52.0% of moderate and 40.9% of mild cases. Similarly, fundus changes were observed in 60.7% of severe cases compared with 25.0% of moderate and 13.6% of mild cases [Table 4]. This association suggests that both pupillary and fundus changes correlated with increasing severity of poisoning.

Table 4: Association Between Poisoning Severity and Ocular Findings

Severity of OP Poisoning	Pupillary Abnormalities (%)	Fundus Abnormalities (%)
Mild (n=22)	40.9	13.6
Moderate (n=50)	52.0	25.0
Severe (n=28)	85.7	60.7

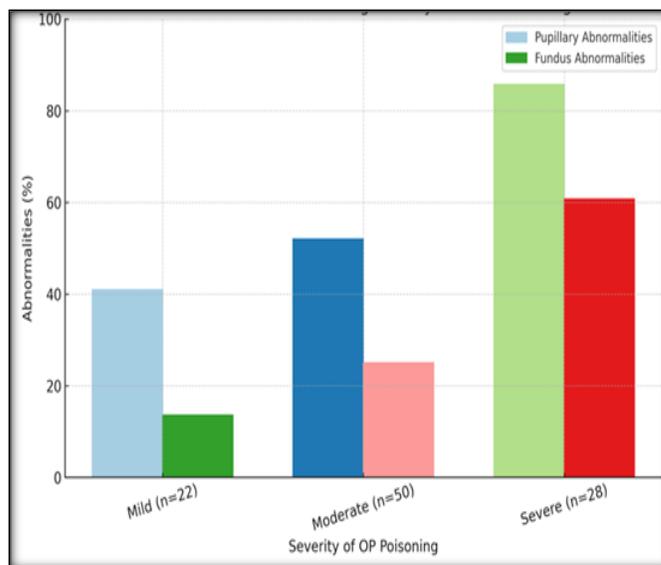


Figure 3: Association Between Poisoning Severity and Ocular Findings

DISCUSSION

In this study pupillary and fundus abnormalities were systematically assessed in 100 patients with organophosphorus (OP) poisoning. Miosis emerged as the predominant pupillary finding, followed by mydriasis and irregular pupils, while more than one-third of patients demonstrated fundus changes, including retinal hemorrhages and papilledema. Importantly, both pupillary and fundus abnormalities were significantly more common in severe cases, underlining their clinical value as markers of toxicity severity.

Our observation of miosis in most patients aligns with the classical cholinergic syndrome and is consistent with recent occupational exposure studies, where significant changes in pupil size were documented among agricultural workers chronically exposed to OP compounds.^[7] Such pupillary changes remain one of the earliest and most reliable indicators of poisoning. At the same time, the occurrence of mydriasis in a minority of cases may reflect sympathetic overactivity, hypoxic injury, or terminal phases of poisoning, phenomena also recognized in toxicological literature.^[9,10]

Fundus abnormalities, though less frequently studied, represent clinically important findings. In the present study, 36% of patients exhibited fundus changes ranging from retinal hemorrhages to papilledema and optic disc pallor. Prior reports have suggested that such abnormalities may arise from systemic hypoxemia, raised intracranial pressure, or microvascular compromise during severe poisoning.^[8] The significant association between fundus changes and poisoning severity in our series parallels earlier observations linking advanced toxicity with higher rates of ocular and neurological complications.^[9]

Ocular motor disturbances, including abnormal eye movements, have also been described in OP poisoning and may accompany pupillary dysfunction, reinforcing the role of ocular assessment in early recognition of severe cases.^[11] Moreover, rare but important systemic complications, such as

pancreatitis, may coexist with ocular findings, broadening the clinical spectrum of OP poisoning.^[12] Experimental studies further demonstrate that organophosphate exposure can induce marked miosis and visual impairment in animal models, which improve with anticholinergic and oxime therapy, highlighting the mechanistic basis for our clinical observations.^[13]

The present findings carry both clinical and forensic significance. Bedside pupillary and fundus examinations are rapid, inexpensive, and non-invasive, making them especially valuable in resource-limited settings where laboratory confirmation may be delayed. Documentation of these ocular changes also provides objective medicolegal evidence in suspected poisoning cases. Our results add to the growing evidence that ocular manifestations correlate with poisoning severity and can serve as practical adjuncts to established clinical scoring systems.

Nonetheless, caution is warranted in interpretation. As noted in previous case reports, delayed or atypical neurological sequelae may occur even when initial clinical and imaging findings are normal.^[14] Examiner expertise and the acute condition of patients may also influence the accuracy of fundus evaluation. Therefore, ocular findings should be integrated with systemic features and biochemical confirmation for comprehensive assessment.

Overall, our study underscores the diagnostic and prognostic relevance of ocular manifestations in OP poisoning. Incorporating routine pupillary and fundus evaluation into toxicological assessment may enhance clinical decision-making, facilitate early identification of severe cases, and strengthen medicolegal documentation.

Limitations

This study was limited by its single-center design and relatively small sample size, which may restrict the generalizability of the findings. Fundus examination was performed using direct ophthalmoscopy, which, although practical, may not detect subtle retinal changes compared to advanced imaging techniques. The acute condition of some patients limited detailed ophthalmic assessment. Long-term ocular outcomes were not evaluated. Despite these limitations, the study provides valuable insights into ocular manifestations in organophosphorus poisoning.

CONCLUSION

Pupillary constriction was the predominant ocular finding in organophosphorus poisoning, while one-third of patients demonstrated fundus abnormalities such as retinal hemorrhages, papilledema, and venous congestion. Both pupillary and fundus changes showed a strong association with the severity of poisoning, being most frequent in severe cases. These easily identifiable, non-invasive markers may serve as useful adjuncts in early diagnosis, prognostication, and forensic evaluation of OP poisoning. Incorporating routine ocular examination into standard toxicological assessment can enhance clinical decision-making and patient outcomes.

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Conflicts of interest

There are no conflicts of interest.

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