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Original Article

Correlation of Creatine Phosphokinase (CPK) Levels with Severity of Organophosphate Poisoning

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ABSTRACT

Objective: To determine the correlation of creatine phosphokinase (CPK) levels with the severity of organophosphate poisoning in assessing the prognosis.

Material and Methods: A cross-sectional study was conducted from January 9, 2025, to July 9, 2025, at the Department of Accident and Emergency, Mayo Hospital, Lahore. A total of 60 patients presenting with organophosphate poisoning were enrolled. The Peradeniya Organophosphate Compound Poisoning Scale (POP) assessed the severity of OP poisoning. Then, blood samples were collected for serum creatine phosphokinase. A comparison of CPK levels between mild to moderate and severe organophosphate poisoning was performed using a paired t-test. To find a correlation between CPK levels and the severity of OP poisoning (POP score), the Pearson correlation coefficient (r) was used.

Results: The mean age was 37.63±13.48 years, with 55.0% of patients being under 40 years old. There were 78.3% males. The mean serum CPK level was 615.95±407.75 (IU/L). Patients with mild to moderate POP scores had a mean CPK level of 515.11 ± 248.65 IU/L, whereas those with severe scores had a significantly higher mean of 1374.33 ± 189.65 IU/L ($p < 0.001$). Pearson correlation analysis revealed a strong positive correlation between POP severity and CPK levels ($r = 0.807$, $p < 0.001$).

Conclusion: Our study concluded that the creatine phosphokinase level is positively correlated with severe organophosphate poisoning, as measured by the POP scale.

Key Words: *Atropine; Creatine phosphokinase; Creatine kinase; Organophosphorus; Organophosphate; Organothiophosphonate Poisonings; Malathion*;

1. INTRODUCTION

The vast majority of patients who are exposed to pesticides are also exposed to organophosphates. Although the first organophosphate insecticide was developed in the mid-1800s, its widespread application did not begin until after World War II. Organophosphates are utilized in the medical, pest control, and military fields as nerve agents.[1,2] There may be an increase in the production of saliva handlebars. It is also associated with diarrhea, nausea, vomiting, tiny pupils, perspiration, muscle tremors, and confusion. The symptoms typically start appearing within minutes, and it may take several weeks to subside completely. [3,4] Due to the widespread application of organophosphate pesticides in the agricultural sector, most cases of organophosphate toxicity are now observed in agrarian workers and farmers.[5]

The three primary routes of exposure are inhalation, consumption, or skin contact with organophosphate pesticides. The intensity of the symptoms is determined by the amount of insecticide ingested, the mode of absorption, and the rate of metabolism. The phosphorylation of the serine hydroxyl group on the acetylcholinesterase (AChE) enzyme is the mechanism by which the organophosphate pesticide renders the enzyme inactive.[6] Following this, an accumulation of acetylcholine occurs, which subsequently leads to excessive stimulation of both nicotinic and muscarinic receptors. Fasciculations and myoclonic jerks are two symptoms that can be brought on by overstimulation of the nicotinic receptors that are located at neuromuscular junctions. The depolarising block will eventually result in flaccid paralysis. Nicotinic receptors can also be present in the adrenal glands, leading to symptoms such as hypertension, sweating, tachycardia, and a leftward shift in the distribution of white blood cells.[7,8]

Assessment of the severity of organophosphate poisoning and its associated prognosis is crucial, and for this purpose, the pseudocholinesterase test is considered a vital tool.[9] However, it is not available easily in Pakistan and is highly costly. For this purpose, an alternative and cheaper test should be sought. In this instance, Research has been conducted to assess the prognostic significance of creatine phosphokinase (CPK) in determining the severity of organophosphate poisoning. In this instance, a study found that serum CPK levels were much higher in patients who died of organophosphate poisoning as compared to those who survived and recovered (1021.56±343.73 vs 32l.l6±l79.l3l).[10] A study recently conducted showed that serum CPK levels were strongly correlated with clinical severity of OP poisoning [r= 0.686].[11] Despite these positive results, serum CPK levels have not yet been made the standard of care for assessing the severity of organophosphate poisoning. This study is therefore conducted to add to the evidence on the prognostic significance of creatine phosphokinase (CPK) levels in determining the seriousness of organophosphate poisoning, which may help make it a cheaper and equally effective prognostic tool that can be used as a standard of care in developing countries, such as Pakistan. So, this study aimed “to determine the correlation of creatine phosphokinase (CPK) levels with the severity of organophosphate poisoning in assessing the prognosis.”

2. METHODOLOGY

Following ethical and synopsis approval from CPSP (CPSP/REU/EMD-2021-066-255; Dated January 8, 2025), a cross-sectional study was conducted from January 9, 2025, to July 9, 2025, using a purposive non-probability sampling method at the Department of Accident and Emergency, Mayo Hospital, Lahore. The sample size was calculated using the Pearson correlation hypothesis testing sample size calculator, with the following parameters: an expected Pearson correlation of 0.686, an α-error of 0.05, and a β-error of 0.10.[11] So, the minimum sample size needed was 60. After informed consent, patients aged 15–65 years of both genders who presented in the emergency department with organophosphate poisoning were enrolled in the study. Patients who underwent CPR before presentation in the hospital had co-morbid conditions like epilepsy, CKD, or a prior

history of myopathy, and patients who received any intramuscular injection within the last 24 hours were excluded from the study. OP was confirmed based on history and clinical findings with signs of constricted pupils, bradycardia, excessive secretions, and rapid breathing. The Peradeniya Organophosphate Compound Poisoning Scale (POP) assessed the severity of OP poisoning. The scale assesses six clinical manifestations of organophosphorus poisoning (miosis, fasciculations, respiratory rate and cyanosis, pulse rate, level of consciousness, and seizures) on a three-point scale (0-2). The severity is graded as Mild: POP score of 0-3; Moderate: POP score of 4-7; and Severe: POP score of 8-11.

After approval of the study proposal and informed consent of the participants, all patients fulfilling the inclusion criteria will be included in the study. Baseline characteristics include age, gender, pupil size, respiratory rate, heart rate, GCS, and any fit episodes were noted. The Peradeniya Organophosphate Compound Poisoning (POP) Scale was documented. After initial resuscitation and stabilization of the patients, the POP scale was used to assess the severity of OP poisoning. Then, blood samples were collected for serum creatine phosphokinase and baseline investigations, aseptically through a peripheral vein without the use of a tourniquet. After that, patients will be treated with an injection of Pralidoxime and an initial dose of atropine per hospital guidelines. All data was recorded in the proforma.

Data were analyzed using SPSS v.26. The numeric variables (Age, duration to achieve atropinization, POP score, Serum CPK levels) were presented as mean ± SD. In contrast, frequency and percentages were used for categorical variables (gender, heart rate, respiratory rate, level of consciousness, occurrence of fits, pupil size, and severity of OP poisoning). A comparison of CPK levels between mild to moderate and severe organophosphate poisoning was performed using a paired t-test. To find a correlation between CPK levels and the severity of OP poisoning (POP score), the Pearson correlation coefficient (r) was used. Data will be stratified by age, gender, and time since poisoning. A post-stratification t-test will be applied, followed by correlation calculations.

3. RESULTS

The mean age was 37.63±13.48 years, with 55.0% of patients being under 40 years old. There were 78.3% males. The average time since poisoning was 280.78 ± 71.42 minutes. Pupil size was pinpointed in 83.3% patients. The heart rate varied, with 40.0% of the patients in the 41-60 bpm range. The respiratory rate was <20 in 43.3% of patients, while 16.7% of patients had cyanosis. Fasciculations were generalized/continuous in 46.7% patients. The conscious level was impaired in 65.0% of patients. Fits were present in 78.3% of patients. The mean serum CPK level was 615.95±407.75 (IU/L), and the mean duration to achieve atropinization was 2.80±1.29 days. The mean POP score was 5.32 ± 2.63, with 80.0% of patients having mild to moderate POP scores and 20.0% having severe POP scores. (Figure. I). Patients with mild to moderate POP scores had a mean CPK level of 515.11 ± 248.65 IU/L, whereas those with severe scores had a significantly higher mean of 1374.33 ± 189.65 IU/L. The t-test revealed a statistically significant difference between the groups ($p < 0.001$). (Table. I). Pearson correlation analysis revealed a strong positive correlation between POP severity and CPK levels ($r = 0.807$, $p < 0.001$). (Figure. II).

Patients under 40 years of age had a higher mean POP score (5.80±2.74) and CPK levels (795.58±488.46 IU/L) than those 40 years of age and above. A significant difference was observed in CPK levels ($p = 0.025$), but not in POP scores ($p = 0.102$). Males had a higher mean POP score

(5.51±2.77) than females (4.62±1.94), but differences were not significant (p=0.280, p=0.283). Those poisoned for <200 minutes had higher scores (6.70±2.75) and CPK levels (834.80±462.77 IU/L), but differences were not significant. Strong positive correlations were observed between POP scores and CPK levels across all stratifications. (p<0.001). (Table. II).

Figure. I. Severity of the POP score among the patients

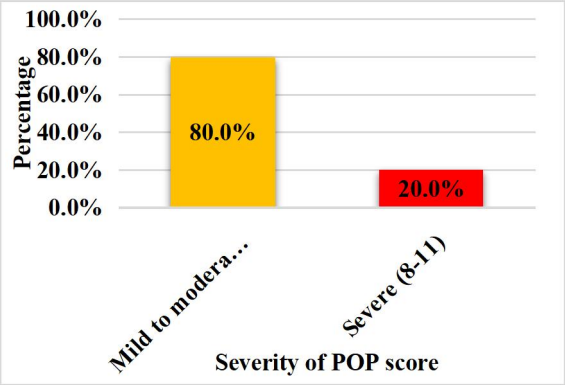

Table. II. Comparison of the severity of the POP score and the CPK Levels

CPK levels (IU/L)	POP Severity Score		Test of sig
	Mild-Mod	**Severe**	
Mean± S.D	515.11±248.65	1374.33±189.65	t=-11.16, d.f=58, p<0.001

Figure. II. Correlation between serum CPK levels and POP score (r=0.807, p<0.001)

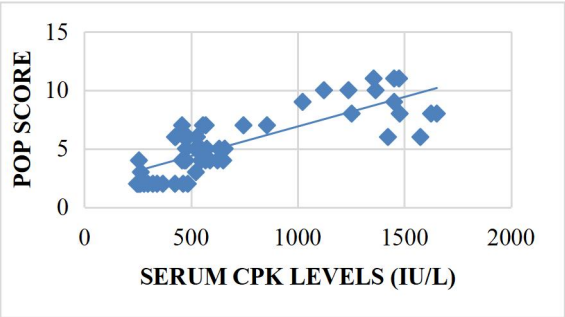

Table. III. Comparison of POP Score and CPK Levels across different stratifications

Stratification	Mean±S.D		Pearson Corr.
	POP score	**CPK levels**	
Age (years)			
<40	5.80±2.74	795.58±488.46	r=0.794, **p<0.001**
≥40	4.70±2.38	544.19±269.34	r=0.859, **p<0.001**
t-test	t=1.65, d.f=58, p=0.102	t=2.29, d.f=58, **p=0.025**	
Gender			
Male	5.51±2.77	4.62±1.94	r=0.815, **p<0.001**
Female	717.79±442.09	575.46±314.86	r=0.704, **p<0.001**
t-test	t=1.08, d.f=58, p=0.280	t=1.08, d.f=58, p=0.283	
Time since poisoning (minutes)			
<200	6.70±2.75	5.04±2.54	r=0.722, **p=0.018**
≥200	834.80±462.77	657.38±408.99	r=0.819, **p<0.001**
t-test	t=1.86, d.f=58, p=0.068	t=1.23, d.f=58, p=0.225	

4. DISCUSSION

In Pakistan, organophosphate poisoning remains a significant clinical and public health concern, particularly due to widespread access to and use of agricultural pesticides.[12] Early assessment of poisoning severity is essential for ensuring safe and effective treatment to prevent complications. In resource-limited emergencies, such as those in Pakistan, cost-effective and simple predictive methods are essential, including serum creatine phosphokinase (CPK) level measurement for evaluating the severity of organophosphate poisoning.[13] Additionally, few studies have utilized the POP (Pesticide Poisoning Outcome Prediction) scale for assessment.[14]

Pertaining to demographic patterns of OP poisoning, the mean age was 37.63±13.48 years, with 55.0% of patients being under 40 years old. There were 78.3% males. The average time since poisoning was 280.78 ± 71.42 minutes. A study conducted in Nepal reported a maximum of OP poisoning cases under 40, with 58.1% of males.[15] Another

study in India reported maximum suicidal intake between 21-30 years, while the majority of non-survivors belong to the 36-60 years age group.[16] This shows the increasing tendency of emotional instability among males with more suicidal attempts. Moreover, males have more access to pesticides, as they are often involved in outdoor activities,[17] especially in rural areas of Pakistan.

The increased CPK levels noted in patients with higher POP scores suggest moderate to severe OP skeletal muscle injury because of sustained cholinergic-induced rho fasciculations and long-term hypoxia. This corroborates the previous studies investigating the rationale of serum CPK concentration as a biochemical marker for the degree of neuromuscular involvement in OP toxicity.[18,19] The strikingly elevated mean CPK concentrations in patients with OP poisoning (1374.33 ± 189.65 IU/L) as opposed to those with mild to moderate scores (515.11 ± 248.65 IU/L) further reinforce its potential prognostic usefulness.

Pearson correlation analysis revealed a positive correlation between POP severity and CPK levels ($r = 0.807$, $p < 0.001$), consistent with previous studies. Rayannavar et al. reported a positive correlation between the POP score and CPK ($r = 0.692$; p-value < 0.001).[20] Bhattacharyya et al reported a positive correlation of CPK (in IU/L) with POP score ($r=0.874$). This study has limitations.[21] The limited sample size from a single center may restrict the generalization. Additionally, serum CPK levels may be affected by confounding factors, such as recent seizures, trauma, or intramuscular injections, which were not adequately controlled in this study. More studies with large sample sizes, multicenter designs, and extended follow-up periods are recommended.

5. CONCLUSION

This research revealed a definitive positive correlation between serum CPK (Creatine Phosphokinase) levels and the degree of organophosphate (OP) poisoning, as evaluated by the Peradeniya OP Poisoning (POP) scale. Patients sustaining severe poisoning demonstrated significantly elevated CPK levels relative to mild and moderate cases. These results indicate that CPK levels may indicate the severity and prognosis of OP poisoning.

CONFLICT OF INTEREST: The authors had no conflict of interest.

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