Original Article

Correlation and prognostic significance of serum amylase, serum lipase, and plasma cholinesterase in acute organophosphorus poisoning

Ajit Dungdung[1], Abhinav Kumar[1], Bindey Kumar[1], Mukul Preetam[1], Ruth K. Tara[1], Md K. Saba[1]

[1]*Department of Medicine, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India*

Abstract

Background: Organophosphorus (OP) are substances that are originally produced by the reaction of alcohols and phosphoric acid. These OP compounds are the main components of herbicides, pesticides, and insecticides. These are easily available in developing country like India; there is lack of awareness about these chemicals which results in high morbidity and mortality. **Aims and Objectives:** To estimate levels of amylase, lipase, plasma cholinesterase in acute OP poisoning. To assess severity of OP poisoning by using plasma cholinesterase levels and correlating it with other two markers. Predicting the severity of acute OP poisoning by using these biochemical markers. **Materials and Methods:** A hospital-based observational study was conducted on 100 subjects who were clinically diagnosed of acute OP poisoning. Subjects of either gender of all age-groups were included in the study. On admission, plasma cholinesterase, serum amylase, and serum lipase were measured. Based on plasma cholinesterase activity at the time of admission, subjects were divided into three groups. Group I-having 20-50% of plasma cholinesterase activity; Group II-10-20% of plasma cholinesterase activity; and Group III <10% of plasma cholinesterase activity. **Results:** Among 100 patients it was seen that serum amylase and serum lipase were negatively correlated with plasma cholinesterase levels and it was statistically significant. It was seen that serum amylase had the highest diagnostic accuracy for assessing severity of poisoning, 10 deaths were there in which 6 had <10% of plasma cholinesterase activity, 8 out of these 10 patients had elevated amylase level. **Conclusion:** OP poisoning is associated with elevated amylase level. Serum amylase, lipase can be used as an additional prognostic indicator along with plasma cholinesterase levels. Serum amylase could be considered as a better predictor of severity than lipase.

Keywords: Amylase, lipase, organophosphorus poisoning, plasma cholinesterase

Introduction

Organophosphorus (OP) are insecticides which have widespread use in agriculture to control weeds, pests, or plants diseases, because of its specific action these OP compounds are useful in crop protection and increased productivity, OP poisoning is one of the major type of poisoning in India.[1] The OP compounds likely to have more adverse effects in developing countries like India, because it is easily available and people are less aware leading to high morbidity and mortality.[2] The OP compounds act by inhibiting acetylcholine esterase enzyme at nerve endings and neuromuscular junction, causing overstimulation of acetylcholine receptors. Signs and symptoms of poisoning are mainly due to muscarinic, nicotinic and central nervous system (CNS) receptor overstimulation.[3] In acute OP poisoning, the severity of poisoning correlates the decrease in pseudocholine esterase activity. Various scoring systems such as Acute Physiology and Chronic Health Evaluation and Simplified

Address for correspondence: Dr. Abhinav Kumar, E5, Nalanda Cottage, Memco More, Dhaiya, Dhanbad - 826 004, Jharkhand, India.
E-mail: drshanki.avi@gmail.com

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Acute Physiology Score are available, but laboratory evaluation plays an important and vital role for confirmation of poisoning, diagnosing the first acute organ damage and assessing the severity of poisoning. In laboratory evaluation of OP poisoning, assessment of plasma cholinesterase is most specific lab test for OP poisoning.[4] OP poisoning is associated with derangement of various biochemicals, among which hyperamylasemia is well documented and may be due to excessive cholinergic stimulation of pancreas. Studies conducted by Matsumiya N *et al.*, and Lee HC have evaluated the prognostic significance of serum amylase in OP poisoning.[5,6] Acute pancreatitis is quite often in OP poisoning and increased serum amylase is less specific and sensitive. Hence, serum lipase estimation may be helpful in patients with increased amylase levels for early diagnosis of pancreatitis.[7] This study was undertaken to know the accuracy of biochemical markers like amylase and lipase as indicators in evaluation of the severity of OP poisoning.

Materials and Methods

This study was conducted after taking ethical clearance from Institutional Ethical Committee, Rajendra Institute of Medical Sciences, Ranchi (Date of Approval 30th November 2018). A longitudinal study was conducted among 100 subjects reported and clinically diagnosed with acute OP poisoning in the emergency unit for a period of 12 months. Based on plasma cholinesterase activity at the time of admission, subjects were divided into three groups. Group I-having 20-50% of plasma cholinesterase activity; Group II-10-20% of plasma cholinesterase activity; and Group III-<10% of plasma cholinesterase activity.

Inclusion criteria

All cases of OP poisoning confirmed by history, circumstantial evidence of poisoning, specific clinical examination, and basic laboratory reports were included in the study.

Exclusion criteria

Patients with history of intake of OP compound mixed with any other poison or alcohol, chronic alcoholism, disorders of salivary gland were excluded from the study.

Sample collection

At the time of admission of patients, after taking informed consent about 2 ml of blood was collected in plain tube under aseptic precautions. Blood was allowed to clot, serum was separated by centrifugation, and used for the analysis of following parameters.

1. Estimation of serum amylase by chromogenic method using dyed amylopectin.[8]
2. Estimation of plasma cholinesterase activity by kinetic method based on hydrolysis of butyrylthiocholine by choline esterase.[8]
3. Estimation of serum lipase by kinetic method using 1-oleoyl-2-3-diacetyl glycerol as substrate.[8]
4. Estimation of serum creatine kinase by kinetic method.[8]

All the parameters were analyzed in Drychemisrty Vitros 250 Johnson and Johnson analyser. During the analysis, regular and routine internal quality checks using Biorad controls was carried out.

After the biochemical analysis, patient were followed-up for clinical outcome like complete recovery, acute respiratory distress syndrome, circulatory failure, CNS complications, renal failure, death due to any of the above-mentioned complications and any other complications.

Statistical analysis

The parameters were tabulated and the mean values and standard deviation (SD) was analyzed using SPSS software. Mean and SD were compared between the groups using one way analysis of variance (ANOVA). All biochemical parameters were correlated with plasma cholinesterase using Pearson's coefficient. Chi-square test was the test of significance for qualitative variables to find the association. Diagnostic accuracy of the biochemical parameter was assessed by calculating the area under the curve in receptor operating curve (ROC).

Results

In the study out of 100 cases 70 (70%) were males and 30 (30%) were females this is similar to study done by Devee Anjana *et al.*,[9] mean age was 30.6 ± 10.1 yrs.

Group I-20-50% of normal plasma cholinesterase activity; Group II-10-20%; and Group III-<10%.

In the study, it was observed that majority 80% (40/50) belonged to Group I who had plasma cholinesterase activity 20-50%, followed by 12% (6/50) of cases in Group II and 8% (4/50) in Group III.

Among 100 subjects, 10 patients died of respiratory failure in which 2 patients belonged to Group I, 2 patients belonged to Group II and 6 patients belonged to Group III.

In Group I, 36 out of 80 patients had elevated amylase levels, 56 had increased lipase, 34 patients who had elevated amylase levels also had elevated lipase level, whereas 2 patients had elevated amylase level with normal lipase level. There were 22 patients who had normal amylase level but elevated lipase level, whereas 22 had normal amylase and lipase level.

In Group II, 10 out of 12 patients had both increased amylase and lipase level, whereas 2 patients had both normal amylase and lipase level.

In Group III, 6 out of 8 had both high levels of amylase and lipase, whereas 2 patients had normal amylase with high lipase level.

Comparison of biochemical parameters between the groups and within the groups was done by ANOVA. Mean plasma

cholinesterase level was 4247.25 ± 1725.25 in Group I, 1175.0 ± 253.83 in Group II and 637.5 ± 65.51 in Group III.

Mean values of serum amylase in Group I was 120.4 ± 82.04, Group II was 256.83 ± 147.96, and Group III was 315.5 ± 213.13.

Mean values of serum lipase was 84.77 ± 49.08 in Group I, 139.66 ± 93.46 in Group II and 193.75 ± 86.35 in Group III.

There was significant statistical significant difference among the groups. It is observed that when there is decrease in plasma cholinesterase level, there is increase in the mean values of amylase and lipase [Table 1].

Plasma cholinesterase was negatively correlated with serum amylase and lipase and it was statistically significant [Table 2].

The association between the severity of OP (based on plasma cholinesterase) and other biochemical parameters showed that there was significant association with severity of OP poisoning with respect to amylase and lipase levels [Table 3].

Association of death with amylase, lipase and cholinesterase level showed that out of 10 patients who died 6 belonged to Group III (<10% of plasma cholinesterase activity), 8 had elevated amylase level, whereas all 10 had elevated lipase level. Plasma cholinesterase had statistically significant relation with death. [Table 4].

ROC to assess the predictor of severity of OP poisoning showed that the area under the curve for serum amylase was 0.783, and for lipase was (0.693) suggesting that amylase was the better predictor of severity between the two [Figure 1].

Discussion

Acute OP poisoning often presents in medical emergency requiring urgent monitoring and treatment in intensive care unit. Management of OP poisoning depends on its clinical severity as well as laboratory evaluation, mechanism of toxicity in OP poisoning is inhibition of cholinesterase. Assessing the level of acetylcholinesterase (AchE) and butyrylcholinesterase (BchE)/ plasma cholinesterase are the screening tools for OP poisoning. Plasma cholinesterase is the most widely used laboratory test for diagnosis and prognosis of OP poisoning as compared to AchE in erythrocytes which is more specific.[10]

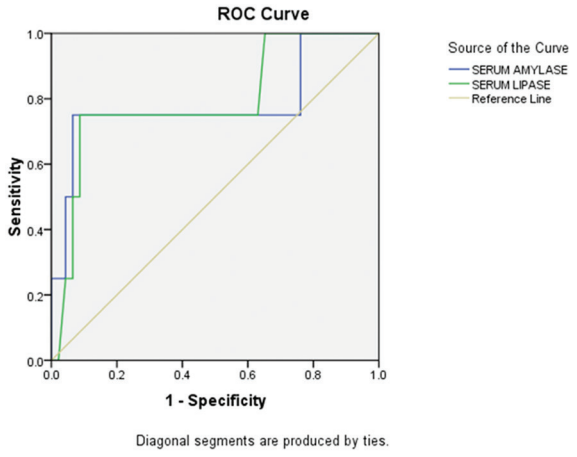

Figure 1: Diagnostic accuracies of Serum Amylase and Lipase in OP poisoning

In this study majority of cases belonged to Group I and major mortality occurred in Group III. Similar results were observed in the studies conducted by Amanvermez R *et al.*[4] and Hundekari IA *et al.*,[11] demonstrating a strong correlation between plasma cholinesterase level and severity of poisoning. A retrospective study was conducted by Manu *et al.* that demonstrated patients with low plasma cholinesterase levels had poor prognosis and mortality with longer stay in intensive care unit and they took long time to be out of mechanical ventilation.[12] One more retrospective study by Yun *et al.*, demonstrated that absence of an increase in serum cholinesterase activity is associated with high mortality and morbidity.[13]

OP poisoning is associated with many lab abnormalities. Among which hyperamylasemia is most often noted in cases of OP poisoning, which may be due to the fact that acute pancreatitis is caused by excessive cholinergic stimulation of pancreas by OP compounds.[14,15] Our study results are similar to the study done by Lin *et al.*, where they found that mean amylase levels were elevated in patients with respiratory support and serum amylase levels predicted ventilator support in OP poisoning.[16,17] Another prospective study done by Singh *et al.*,[18] found that amylase was elevated in 48.95% in patient with fenthion poisoning and serum amylase showed persistent elevation during serial estimation. An important effect of OP or carbamate intoxication is development of acute pancreatitis. Incidence of acute pancreatitis in adults with OP poisoning is approximately 12%.[18] A recent study by Nagabhiru revealed that there was a significant rise in serum amylase level following OP poisoning and they concluded that serum amylase levels can be considered as marker of organophosphorous intoxication.[19] Another study conducted in china by Dong *et al.* revealed a rise in serum amylase in acute OP poisoning with significant *P* value.[20] In this study, mean amylase level was highest in to Group III and showed significant negative correlation with plasma cholinesterase levels.

Lipase was elevated in 56 patients, in which 22 had normal amylase level, all patients in Group III had elevated lipase level. Serum lipase also showed significant negative correlation with plasma cholinesterase.

Diagnostic accuracy of the biochemical parameters show that serum amylase had highest diagnostic accuracy than serum lipase.

Our study is very useful in primary care as it can be used for predicting severity of OP poisoning by measuring serum amylase and lipase level, we can categorize the patient according to the severity so that healthcare giver can be more vigilant regarding their

Table 1: Comparison of biochemical parameters

Parameters	Number	Mean + SD (IU/L)		
		Plasma cholinesterase	Serum amylase	Serum lipase
Group I (20-50%)	80	4247.25±1725.25	120.4±82.04	84.77±49.08
Group II (10-20%)	12	1175.0±253.83	256.83±147.96	139.66±93.46
Group III (<10%)	8	637.5±65.51	315.5±213.13	193.75±86.35
Significance	*F*	17.59	9.839	7.911
	P	0.012	0.013	0.015

Table 2: Correlation of plasma cholinesterase with serum amylase and Lipase

Parameters	Plasma cholinesterase	
	Correlation coefficient	*P*
Serum amylase	-.506	0.011
Serum lipase	-.541	0.014

Table 3: Association of biochemical parameters with severity of poisoning

		Cholinesterase Level			*P*
		Mild group I	Moderate group II	Severe group III	
Amylase level	Normal	44	2	2	0.03
	High	36	10	6	
Lipase level	Normal	24	2	0	0.04
	High	56	10	8	

Table 4: Correlation of serum amylase, lipase and plasma cholinesterase with death

		Outcome		Total	*P*
		Death	Alive		
Amylase	Normal	2	46	48	0.351
	High	8	44	52	
Total		10	90	100	
Lipase	Normal	0	26	26	0.309
	High	10	64	74	
Total		10	90	100	
Cholinesterase Level	MILD	2	78	80	0.001
	MODERATE	2	10	12	
	SEVERE	6	2	8	
Total		10	90	100	

treatment and day to day progression of their symptoms. Patients having raised lipase level should be observed for abdominal pain and proper radiographic investigations, such as ultrasound and computed tomography abdomen should be done to rule out Acute pancreatitis.

Limitations of this study is that biochemical parameters are estimated at the time of admission. Serial measurements of plasma cholinesterase and other biochemical parameters can help to draw better conclusions.

Key message: In this study we conclude that OP poisoning is associated with increased amylase and lipase level. Serum amylase and serum lipase can be used as a prognostic indicator along with plasma cholinesterase levels but Serum amylase can be considered as a better predictor of severity than lipase. However, further studies with larger sample size can be useful in making conclusions.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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