Pre-Interventional Cardiac and ECG Changes in Acute Organophosphate Poisoning Cases Admitted to a Tertiary Hospital in India

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ABSTRACT

Background: Cardiac complications are the less common fatal effect of acute organophosphate poisoning. This study was undertaken to analyze the pre-interventional cardiac and Electrocardiographic (ECG) changes in acute organophosphate poisoning cases.

Materials and Methods: Clinical records of acute organophosphate poisoning patients of age less than 50 years admitted to KLE's Dr. Prabhakar Kore Hospital, Belgaum, Karnataka, from 01-01-2010 to 31-12-2010 were analyzed. Cases of organophosphate poisonings referred from other hospitals, poisoning with multiple agents, patients with history of previous cardiac diseases and coexisting medical conditions were excluded from the study. Poisoning Severity Score was calculated as per International Programme on Chemical Safety and patients were grouped into 3 grades.

Results: In this study, 50 cases of acute organophosphate poisoning (male - 32; female - 18) were analyzed. Sinus tachycardia was present in 45 patients (90%), hypertension in 13 (26%) and hypotension in 12 (24%). Prolonged corrected QT interval was observed in 14 patients (28%), elevated ST segment in 2 (4%), inverted T wave in 13 (26%) and conduction defects in 1 (2%). Among 14 patients with prolonged corrected QT interval, 12 were in grade III and 2 in grade II severity; and, among 13 patients who had inverted T wave, 2 were in grade I, 4 in grade II and 7 in grade III severity. Acidosis, as assessed by blood pH and HCO_3, was observed in 22 patients (44%).

Conclusion: Fatal cardiac complications do occur in acute organophosphate poisoning, which are overlooked at times as the most common complications expected are respiratory complications. Higher incidence of ECG changes in Grade III cases suggests that if the cardiac complications develop, the patient should be immediately transferred to an intensive cardiac care unit.

►*Implication for health policy/practice/research/medical education:* Cardiac and ECG Changes in Acute Organophosphate Poisoning

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1. Introduction:

Incidence of pesticide poisoning is increasing in the developing countries in which agriculture is the main occupation of many people. Widespread and negligent use, not so stringent legislation and the personal problems have made the pesticides as the most commonly encountered substance in human poisoning. Organophosphates are considered as the king of pesticides, because their magnitude of use in agriculture. Organophosphate pesticide self-poisoning is estimated to kill around 2,00,000 people each year, largely in the Asia-Pacific region and the mortality rate varies from 10-20% (1).

Organophosphates are powerful inhibitors of carboxylic esterase enzymes, including acetyl cholinesterase and pseudo cholinesterase. Symptoms of organophosphate poisoning appear in sympathetic and parasympathetic nervous system. Patients develop muscarinic, nicotinic and central nervous system manifestations (2). Literatures say that the most common, or at least the best-recognized, cause of death in patients with acute poisoning is asphyxia, pulmonary oedema complicating the clinical course in many cases. Macroscopic and histological changes were recognized in the respiratory tract at a time when the heart at autopsy was considered minimally affected. Electrocardiographic changes were noticed in such patients early, but only recently has the possible underlying histological myocardial picture been emphasized (3). The present analysis was undertaken to study the pre-interventional cardiac and Electrocardiographic (ECG) changes in patients of acute organophosphate poisoning.

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2. Materials and Methods:

In this study, hospital records of acute organophosphate poisoning cases treated at KLE's Dr. Prabhakar Kore Hospital & MRC, Belgaum, Karnataka, during the period from 01-01-2010 to 31-12-2010 were retrospectively analyzed. This analysis was carried out to evaluate the pre-interventional Cardiac and ECG changes in patients of acute Organophosphate poisoning. Cardiac changes were studied with respect to blood pressure and heart rate; and, ECG changes with respect to rhythm, elevated ST segment, T wave depression and corrected QT interval. These parameters were recorded before administration of atropine, oxime and other therapeutic procedures. Corrected QT (cQT) interval was calculated by Bazett's formula (cQT=QT interval/√RR interval). QT interval is measured from the beginning of the QRS complex to the end of the T wave. cQT is prolonged if it is >450 millisecond in men and >460 millisecond in women (4). Diagnosis of organophosphate poisoning was done based on the clinical features, pseudocholinesterase level and chemical analysis report (Thin Layer Chromatography and UV-Vis Spectrophotometry) from our Poison Detection Centre. Cases of organo-phosphate poisoning referred from other hospitals, poisoning with multiple agents, patients with history of previous cardiac diseases and coexisting medical conditions

and patients aged more than 50 years were excluded from the study. Patients were grouped into grade I, grade II and grade III as per the Poison Severity Score (IPCS PSS) developed by the International Program on Chemical Safety and the European Community, and the European Association of Poisons Centres and Clinical Toxicologists. The highest grade scored in any category is considered as the overall grade.

3. Results:

Data required for the study was available in 50 cases (male - 32; female - 18) out of 57 cases of acute organophosphate poisoning admitted during the study period. As per IPCS poison severity score, 12 patients were in grade I, 4 in grade II and 34 in grade III severity. Sinus tachycardia was present in 45 patients (90%), hypertension in 13 (26%) and hypotension in 12 (24%). Majority of the patients with sinus tachycardia (76%), hypertension (92%) and hypotension (83%) were in Grade III severity (Table 2). Prolonged corrected QT interval was observed in 14 patients (28%), elevated ST segment in 2 (4%), inverted T wave in 13 (26%) and conduction defects in 1 (2%). Among 14 patients with prolonged corrected QT interval, 12 (86%) were in grade III and 2 (14%) in grade II severity; and, among 13 patients who had inverted T wave, 7 (54%) were grade III, 4 (31%) were grade II and 2 (15%) were grade I patients (Table 3). ECG changes were observed in 21 cases of the total 50 cases. Acidosis as assessed by blood pH and HCO_3 was observed in 22 patients (44%).

Table 1: IPCS Poison Severity Score (5)

	Grade 1	Grade 2	Grade 3
Respiratory			
Intubated	No	-	Yes
Neurological			
GCS	14-15	9-13	3-8
Seizures	No	-	Yes
CVS			
Bradycardia (Pulse)	> 50	41-50	≤ 40
Tachycardia (Pulse)	≤ 140	141-180	> 180
Hypotension (Systolic BP)	> 100	81-100	≤ 80

4. Discussion:

Organophosphates are powerful inhibitors for acetyl cholinesterase enzyme. This enzyme hydrolyses acetylcholine [neurotransmitter at pre and postganglionic parasympathetic synapses, sympathetic preganglionic synapses and at neuromuscular junction] into choline and acetic acid after its release and completion of function. Inhibition of acetyl-cholinesterase results in the accumulation of acetylcholine with continued stimulation of local receptors and eventual paralysis of nerve or muscle. Apart from acetylcholinesterase, organophosphates exert powerful inhibitory action over other carboxylic ester hydrolases such as chymotrypsin, butyrylcholinesterase, plasma and hepatic carboxylesterase, paraoxonases, and other non-specific proteases. Clinical features of acute organophosphate poisoning are due to cholinergic excess and CNS effects (6). Three phases of cardiac toxicity has been described due to organophosphate poisoning:

Phase 1: Brief period of increased sympathetic tone

Phase 2: Prolonged period of parasympathetic activity

Phase 3: QT prolongation followed by torsade de pointes ventricular tachycardia and then ventricular fibrillation (7).

In the present study, sinus tachycardia and blood pressure deviation were observed in significant number of patients. Moreover, majority of these were in grade III severity. These observations indicate that cardiac changes are directly related to severity of case. Sinus tachycardia and hypertension are due to the nicotinic

effect, whereas, hypotension is due to muscarinic effect of organophosphates. It

Table 2: Distribution of cases according to heart rate and blood pressure

Grade	No. of Cases	Heart Rate		Blood Pressure		
		Normal	Tachycardia (>100/min)	Normal	Hypertension (Systolic BP: >140 mmHg)	Hypotension (Diastolic BP: <60 mmHg)
I	12	05	07	12	00	00
II	04	00	04	01	01	02
III	34	00	34	12	12	10
Total	**50**	**05**	**45 (90%)**	**25**	**13 (26%)**	**12 (24%)**

Table 3: Distribution of cases according to ECG changes

Grade	No. of Cases	↑ c QT*	↑ ST	↓ T	Ectopic
I	12	00	00	02	00
II	04	02	00	04	00
III	34	12	02	07	01
Total	**50**	**14 (28%)**	**02 (4%)**	**13 (26%)**	**01 (2%)**

*c QT: Corrected QT interval

Table 4: Comparison of cardiac changes in different studies

	Tachycardia	Hypertension	Hypotension
Present Study	90.0%	26%	24%
Yurumez Y *et al* (8)	31.8%	--	--
Karki P *et al* (7)	40.5%	13.5%	10.8%
Lee HJ *et al* (9)	50.0%	--	--
Saadeh AM *et al* (10)	35.0%	22.0%	17.0%
Paul UK *et al* (11)	36.6%	--	--

is mentioned in the literature that in a given case, there may be either tachycardia or bradycardia; hypo - or hypertension. Hypertension can occur in up to 20% cases of acute organophosphate poisoning (6).

In this study, prolonged corrected QT interval was observed in about 1/3rd of patients. Though not in many cases, elevated ST segment and inverted T wave were also seen. ECG changes are more seen in patients of Grade III severity. Literature says that patients in whom the QT interval is prolonged, there is an increased incidence of ventricular arrhythmias and sudden death (12). Malfunction of ion channels leads to an intracellular excess of positively charged ions by way of an inadequate outflow of potassium ions or excess inflow of sodium ions. This intracellular excess of positively charged ions extends ventricular repolarisation and results in QT interval prolongation (4). ST elevation is suggestive of transmural myocardial ischaemia and T wave inversion is of subendocardial myocardial ischemia (14).

Mechanism behind these ECG changes is not clear. These could be due to direct toxic effect of organophosphates on the myocardium or sympathetic & parasympathetic over activity or hypoxemia or acidosis or electrolyte derangements.

Table 5: Comparison of ECG changes in different studies

	↑ cQT	↑ ST	↓ T	Ectopics
Present Study	28.0 %	4.0%	26.0%	02%
Karki P *et al* (7)	37.8%	16.2%	13.5%	5.4%
Yurumez Y *et al* (8)	55.5 %	17.6%	17.6%	00%
Lee HJ *et al* (9)	55.6%	22.2%	22.2%	--
Saadeh AM *et al* (10)	67.0%	24.0%	17.0%	6.0%
Vijayakumar S *et al* (13)	60.0%	40.0%	40.0%	--
Paul UK *et al* (11)	62.6%	25.2%	19.6%	--

Patients of acute organophosphate poisoning with prolonged cQT interval are more likely to develop respiratory failure and have a worse prognosis than patients with normal cQT interval (6). Dalvi CP *et al* found significant reduction in the mortality in cases of organophosphate poisoning at their center from 20% in the pilot study to 4.1% in their present study (3).

5. Conclusion:

Fatal cardiac complications do occur in acute organophosphate poisoning, which are overlooked at times as the most common complications expected are respiratory complications. Continuous monitoring of cardiovascular system changes, more so, ECG changes is to be done even if the patient becomes clinically normal. ECG changes needs to be considered as the indicator of prognosis in acute organophosphate poisoning.

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