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Original Research Article

STUDY ON THE EFFECT OF ECG CHANGES AND ELECTROLYTE ABNORMALITIES IN THE PROGNOSIS OF ORGANOPHOSPHORUS POISONING IN A TERTIARY CARE HOSPITAL: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Aim of the Study: To evaluate the effect of electrocardiographic (ECG) changes and electrolyte abnormalities on the prognosis of patients with acute organophosphorus compound (OPC) poisoning presenting to a tertiary care hospital.

Material and Methods: This prospective observational study was conducted over a period of six months in the Emergency Department of a tertiary care teaching hospital. A total of 180 adult patients with confirmed acute OPC poisoning presenting within 12 hours of exposure were included. All patients underwent clinical evaluation, serial ECG monitoring, and laboratory investigations including serum electrolytes (sodium, potassium, and calcium). ECG parameters including rhythm abnormalities, conduction intervals, and QTc interval were recorded. Patients were followed during hospitalization to assess outcomes such as need for mechanical ventilation, duration of hospital stay, and in-hospital mortality.

Results: ECG abnormalities were observed in 63.3% of patients, with QTc prolongation noted in 22.2%. Electrolyte disturbances were present in 50% of cases, with hypokalemia seen in 30% patients being the most common abnormality. Patients with QTc prolongation had higher rates of arrhythmias, need for mechanical ventilation, and mortality. Hypokalemia was also significantly associated with ventricular arrhythmias and poor clinical outcomes. The overall mortality rate in the study population was 11.7%.

Conclusion: ECG changes, particularly QTc prolongation, and electrolyte abnormalities such as hypokalemia are common in acute OPC poisoning and are important predictors of morbidity and mortality. Early ECG monitoring and prompt correction of electrolyte imbalance may improve prognosis in these patients.

Keywords: Electrocardiography; QTc prolongation; Electrolyte imbalance; Hypokalemia; Prognosis.

INTRODUCTION

Organophosphorus compounds (OPCs) are among the most commonly used agricultural pesticides worldwide and remain an important cause of poisoning in many developing countries. Due to their easy availability and widespread use, OPCs are frequently implicated in cases of accidental as well as intentional poisoning. According to the World Health Organization(WHO), pesticide poisoning is a significant global health problem and contributes substantially to morbidity and mortality in many developing nations.[1] OPC insecticides are commonly used because of their high effectiveness in pest control, but their toxic effects on humans make

them an important cause of poisoning cases presenting to emergency departments.

OPC poisoning occurs primarily due to inhibition of the enzyme acetylcholinesterase, which leads to accumulation of acetylcholine at synapses and neuromuscular junctions. This results in overstimulation of muscarinic, nicotinic, and central nervous system receptors, producing a wide range of clinical manifestations including salivation, lacrimation, bronchospasm, muscle weakness, and altered sensorium.[2,3] In addition to these classical cholinergic symptoms, OPC poisoning can also lead to serious complications affecting the cardiovascular, respiratory, and nervous systems.

Cardiovascular complications are among the most important manifestations of OPC poisoning and may significantly influence patient outcome. Various electrocardiographic (ECG) abnormalities have been reported in patients with acute OPC poisoning, including sinus tachycardia, sinus bradycardia, ST-T changes, QT interval prolongation, and conduction disturbances.[8,10] These ECG changes may occur due to autonomic imbalance, direct toxic effects of OPCs on the myocardium, and electrolyte disturbances. In some cases, severe cardiac complications such as ventricular arrhythmias and myocardial infarction have also been reported.[9,28]

Electrolyte imbalance is another important factor that may contribute to cardiac complications in OPC poisoning. Disturbances such as hypokalemia, hyperkalemia, and hyponatremia may occur due to excessive vomiting, diarrhea, and metabolic disturbances associated with cholinergic crisis. These electrolyte abnormalities can further predispose patients to cardiac arrhythmias and worsen the overall prognosis. Therefore, early recognition and correction of electrolyte imbalance are essential components in the management of OPC poisoning.

The severity of OPC poisoning and its complications can be assessed using clinical scoring systems. In addition, studies have demonstrated that ECG changes and cardiac manifestations may correlate with the severity of poisoning and can serve as useful prognostic indicators.[11,13] Continuous cardiac monitoring is therefore recommended in patients with moderate to severe OPC poisoning to detect early complications.

Despite advances in the management of OPC poisoning, cardiovascular complications remain an important cause of morbidity and mortality. Early identification of ECG changes and electrolyte disturbances may help in predicting prognosis and guiding timely management. Therefore, the present study was undertaken to evaluate the effect of ECG changes and electrolyte imbalance on the prognosis of OPC poisoning patients in a tertiary care hospital.

MATERIALS AND METHODS

This prospective observational study was carried out over a period of six months in the Emergency Department of Government Medical College and Hospital, Miraj, Maharashtra, India, which is a tertiary care teaching hospital. Adult patients aged 18 years or older presenting within 12 hours of confirmed or suspected OPC poisoning were considered for inclusion in the study.

Patients with a definite history of exposure to OPC and clinical features suggestive of poisoning were included. Individuals with chronic exposure to OPC pesticides, those who had received treatment at another healthcare facility before presentation, and patients with known pre-existing cardiac disease, electrolyte imbalance or peripheral neuropathy were excluded.

The study protocol was approved by the Institutional Ethics Committee of Government Medical College and Hospital, Miraj (Reference number GMCM/IEC/C/178/2025 dated 20/05/2025). Written informed consent was obtained from all participants or their legally authorized representatives before enrolment. All procedures were performed in accordance with the ethical principles outlined in the Declaration of Helsinki.

The diagnosis of OPC poisoning was established based on a history of exposure, clinical manifestations consistent with cholinergic toxicity and response to atropine therapy. All patients were treated according to standard management protocols, including administration of atropine, pralidoxime, supportive care and gastric decontamination when indicated. Mechanical ventilation was provided for patients who developed respiratory failure.

A standard ECG was recorded at the time of admission and repeated daily during the first 72 hours of hospitalization. It included assessment of heart rate, rhythm abnormalities, conduction defects and measurement of the corrected QT(QTc) interval. The QTc interval was calculated using Bazett's formula. QTc values greater than 0.41 seconds in males and 0.42 seconds in females were considered prolonged. Any arrhythmias or conduction abnormalities detected during hospitalization were documented.

Serum electrolyte levels including sodium, potassium and calcium were measured at admission and monitored daily for the first three days of hospital stay. Hypokalemia was defined as serum potassium levels below 3.5 mmol/L, hyperkalemia as levels above 5.0 mmol/L, hyponatremia as serum sodium levels below 135 mmol/L and hypocalcemia as serum calcium levels below 8.5 mg/dL.

The primary outcomes assessed in the study were requirement for mechanical ventilation, duration of hospital stay and in-hospital mortality.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using descriptive statistics. Categorical variables were expressed as frequency and percentage, while continuous variables were expressed as mean ± standard deviation (SD). Association between categorial variables was tested using Chi-square test, as appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 180 patients were included in the study. The mean age was 33.4 ± 12.1 years (range: 18–65 years). The majority were male consisting of 108 patients (60%). The most common mode of poisoning was suicidal ingestion in126 patients (70%). The mean time interval between exposure and hospital presentation was 4.8 ± 2.3 hours.

ECG abnormalities were observed in a significant proportion of patients. As shown in table 1 prolonged QTc interval was strongly associated with adverse outcomes. Among patients with prolonged QTc interval, arrhythmias were observed in 12 patients (30%), need for ventilation seen in 24 patients (60%) and mortality seen in 8 patients (20%). Patients with borderline QTc also had higher complication rates compared to the normal QTc interval, indicating a progressive increase in morbidity with increasing QTc duration.

Table 1: Association between QTc Interval and Outcomes in OPC Poisoning

QTc Category	Frequency	Arrhythmias (%)	Ventilation Required (%)	Mean Hospital Stay (days)	Mortality (%)	p-value
Normal (≤0.41/0.42 s)	98 (54.4%)	5 (5.1%)	12 (12.2%)	5.3 ± 2.4	3 (3.1%)	—
Borderline (0.42–0.45 s)	42 (23.3%)	7 (16.7%)	14 (33.3%)	7.4 ± 2.8	4 (9.5%)	0.04
Prolonged (>0.45 s)	40 (22.3%)	12 (30.0%)	24 (60.0%)	9.1 ± 2.7	8 (20.0%)	0.003
Total	180 (100%)	24 (13.3%)	50 (27.8%)	—	15 (8.3%)	—

Values are expressed as mean ± standard deviation. QTc = corrected QT interval; OPC=organophosphorus compound.

Electrolyte abnormalities were present in 50% patients. As shown in Table 2, hypokalemia was the most common electrolyte disturbance seen in 54 patients (30%) and was significantly associated with ventricular arrhythmias which was seen in 15 patients (27.8%) and associated with higher mortality seen in 8 patients (14.8%) (p=0.001). hyperkalemia, hyponatremia and hypocalcemia were less frequent. Hypocalcemia showed significant association with QTc prolongation (p=0.03).

Table 2: Association between Electrolyte Abnormalities and Outcomes (n = 180)

Electrolyte Abnormality	Frequency	Arrhythmias (%)	Ventilation Required (%)	Mortality (%)	p-value
Hypokalemia (<3.5 mmol/L)	54 (30%)	15 (27.8%)	21 (38.9%)	8 (14.8%)	0.001
Hyperkalemia (>5.0 mmol/L)	9 (5%)	2 (22.2%)	4 (44.4%)	2 (22.2%)	0.08
Hyponatremia (<135 mmol/L)	12 (6.7%)	2 (16.7%)	3 (25.0%)	2 (16.7%)	0.21
Hypocalcemia (<8.5 mg/dL)	15 (8.3%)	3 (20.0%)	5 (33.3%)	2 (13.3%)	0.03
No abnormality	90 (50%)	2 (2.4%)	3 (3.1%)	1 (1.2%)	—
Total	180 (100%)	24 (13.3%)	36 (20.0%)	15 (8.3%)	—

Values are expressed as frequency (%) unless otherwise specified.

Both QTc prolongation and electrolyte abnormalities were associated with worse clinical outcomes. As shown in table 3 patient with prolonged QTc interval had higher requirement for mechanical ventilation seen in 24 patients (60%) and increased mortality seen in 8 patients (20%). Similarly patients with hypokalemia showed poorer outcomes, with higher ventilation requirement seen in 21 patients (38.9%) and prolonged hospital stay and increased mortality seen in 8 patient (14.8%).

Table 3: Correlation of ECG and Electrolyte Abnormalities with Outcomes

Abnormality	Ventilation Required (%)	Mean Hospital Stay (days)	Mortality (%)	p-value
Normal QTc (n = 98)	12 (12.2%)	5.3 ± 2.4	3 (3.1%)	—
Borderline QTc (n = 42)	14 (33.3%)	7.4 ± 2.8	4 (9.5%)	0.04
Prolonged QTc (n = 40)	24 (60.0%)	9.1 ± 2.7	8 (20.0%)	0.003
Hypokalemia (n = 54)	21 (38.9%)	8.7 ± 2.9	8 (14.8%)	0.02
No major abnormality (n = 66)	7 (10.6%)	5.2 ± 2.1	1 (1.5%)	—

Values are expressed as mean ± standard deviation. QTc = corrected QT interval.

DISCUSSION

The present study highlights the significant role of ECG abnormalities and electrolyte disturbances in determining the prognosis of patients with acute OPC poisoning. In this study, the majority of patients were young adults with a mean age of 33.4 ± 12.1 years, and males constituted a higher proportion of cases. This demographic pattern is consistent with earlier studies which have reported a higher incidence of OPC poisoning among young adult males, largely attributed to occupational exposure and higher rates of intentional ingestion in this population.[2,21] The predominance of suicidal poisoning observed in the present study also reflects the easy availability of pesticides in agricultural settings, which has been

highlighted as an important contributing factor in previous reports.[1,23]

A key observation in this study was the high prevalence of ECG abnormalities, which were identified in 63.3% of patients. Cardiovascular manifestations in OPC poisoning are well documented and are thought to occur due to autonomic nervous system imbalance, hypoxemia, metabolic disturbances, and the direct toxic effects of organophosphorus compounds on the myocardium.[12] Previous studies have similarly reported various ECG changes such as sinus tachycardia, sinus bradycardia, ST-T wave abnormalities, and conduction defects in patients with acute OPC poisoning.[10,13] The present findings reinforce the importance of routine cardiac monitoring in these patients, as cardiac complications may develop even in the absence of severe initial symptoms.

An important finding of the present study is the strong association between QTc interval prolongation and adverse clinical outcomes. Patients with prolonged QTc intervals demonstrated significantly higher rates of arrhythmias, requirement of mechanical ventilation, prolonged hospital stay, and increased mortality. These findings are consistent with earlier reports that have identified QT interval prolongation as an important marker of severe toxicity in organophosphate poisoning.[9,11] The pathophysiological mechanisms underlying QTc prolongation are likely multifactorial and may involve cholinergic effects on cardiac ion channels, autonomic instability, and myocardial ischemia resulting from hypoxemia or hypotension. The present study further suggests a increase in adverse outcomes from normal to borderline and prolonged QTc intervals, indicating that even borderline prolongation may have prognostic significance.

Electrolyte disturbances were also frequently observed, with hypokalemia being the most common abnormality. The association between hypokalemia and increased incidence of ventricular arrhythmias and mortality in our study suggests that electrolyte imbalance plays an important role in cardiac complications of OPC poisoning. Previous literature has emphasized that electrolyte disturbances can predispose patients to arrhythmias and worsen overall clinical outcomes.[26] In the present study, hypocalcemia was also associated with QTc prolongation, suggesting a possible interaction between electrolyte imbalance and ECG abnormalities in influencing prognosis.

The present study also identified that patients with ECG abnormalities and electrolyte disturbances had a significantly higher requirement for mechanical ventilation and longer duration of hospital stay. Similar observations have been reported in earlier studies where severe OPC poisoning was associated with respiratory failure requiring ventilatory support.[24,26] These findings indicate that cardiovascular and metabolic abnormalities may serve as early indicators of disease severity.

The study provides important evidence supporting the routine use of ECG monitoring and electrolyte assessment in patients with acute OPC poisoning. Early identification of QTc prolongation and correction of electrolyte abnormalities, particularly hypokalemia, may help in reducing complications and improving patient outcomes. However, the findings should be interpreted in light of certain limitations. As this study was conducted in a single tertiary care center, the results may not be fully generalizable to other settings. Further multicenter studies with larger populations may help to better define the prognostic value of these parameters.

CONCLUSION

The findings of the present study indicate that electrocardiographic abnormalities, particularly QTc interval prolongation, and electrolyte disturbances such as hypokalemia are important indicators of adverse clinical outcomes in patients with acute organophosphorus poisoning. Early identification of these abnormalities through routine ECG monitoring and timely correction of electrolyte imbalance may help in identifying high-risk patients and improving overall clinical outcomes.

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Data Availability Statement: The datasets generated during the current study are available from the corresponding author upon reasonable request.

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