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Original research article

Clinical profile of acute organophosphorus compound poisoning and the resultant electroencephalographic changes

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Abstract

Aims/Objectives: Although the Clinical description of central nervous system toxicity during the early phases of acute poisoning has been provided in the existing scientific literature, the electrographic mapping of the alteration in electrical activity of the brain due to poison is rarely available, especially in Indian subcontinent. Moreover, despite the prevalence of organophosphorus compound poisoning (OPC) in this territory, there is a dearth of studies on the electroencephalographic (EEG) changes caused by OPC poisoning. Hence, this study was conducted with the aim to fill this gap in research.
Material and Methods: This observational study was conducted in Jawahar Lal Nehru Medical College, Ajmer, from February 2018 to October 2019. A Total of 100 patients participated in this study. The patients' EEG changes and their correlation with severity and prognosis were examined.
Results: The patients who presented with abnormal EEG changes were found to have a delayed hospitalization of 4.82±1.25 hours compared to the patients presenting with normal EEG results who were found to have a delayed hospitalization of 2.92±1.56 hours. This suggests that delayed hospitalization leads to the delayed removal of OPC poison and poor prognosis. Out of the 100 cases 78 (78%) showed normal background alpha rhythm while, 14 (14%) showed high-amplitude slow waves, and 8 (8%) showed spikes.
Moreover, out of the 6 expired cases, 4 (66.66%) showed abnormal EEG and 2 cases (33.33%) normal EEG. Furthermore, out of the 78 cases with normal EEG, only 2 (2.56%) expired, whereas out of the 22 cases with abnormal EEG, 4 (18.18%) expired.
Conclusion: It was found that abnormal EEG results in poor prognosis hence, it's an important investigation for monitoring OPC poisoning.
Keywords: EEG, mortality, slow wave, alpha rhythm, poisoning, organophosphorus compounds

Introduction

Acute organophosphorus compound (OPC) poisoning is one of the most common forms of poisoning, having reached epidemic proportions in most parts of the world, particularly developing countries, where the medical management of poisoning is lacking, resulting in high fatality rates. Therefore, in a developing country such as India, acute poisoning is a major cause of morbidity and mortality. In medical emergency 10% of admissions are due to poisoning and organophosphorus compound poisoning contributes to nearly 50% of these admissions in India [1].
Although a high rate of mortality was reported in the past, over recent years, mortality has considerably declined due to intensive care [2].
The following three well-defined clinical phases can be observed in a case of classical OPC poisoning:

1. **Acute cholinergic crisis:** This results from the accumulation of acetylcholine at the nerve endings,

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leading to the initial stimulation and eventual exhaustion of the cholinergic synapse. The muscarine effects include diarrhea, lacrimation, salivation, bronchorrhea, bronchospasm, bradycardia, urination, and miosis whereas the nicotinic effects include hypertension and tachycardia. During acute intoxication, the nicotine receptors are activated which leads to muscle paralysis. Moreover, fasciculations, are a reliable sign of Organophosphorus compound poisoning, while the paralysis of respiratory muscles may lead to respiratory failure. Further the effect of severe intoxication on the central nervous system may cause emotional irritability, mental obtundation, cognitive impairment, coma, and convulsions.

2. **Intermediate syndrome:** cranial nerve palsies, proximal muscle weakness, and respiratory muscle weakness are common, symptoms that often require respiratory support. Intermediate syndrome, the best described delayed manifestation, is characterized by paralysis of proximal limb muscles, neck flexors, motor cranial nerves, and respiratory muscles 24-96 hours after poisoning, after the cholinergic phase has settled down, with the weakness lasting for up to 18 days [3,4].
3. **Organophosphate-induced delayed polyneuropathy (OPIDN):** OPIDN sets in after a period of 7-21 days of exposure and causes significant morbidity. Its earliest symptom is paresthesia. Initially the weakness appears in the distal leg muscles, causing foot drop followed by the small muscles of the hands. Later, it may extend proximally and even involve truncal muscles. In OPIDN, deep tendon jerks are absent.

Although previous studies have assessed and investigated the effects of OPC, especially on neuromuscular junction, only a few studies focusing on the EEG changes caused by OPC poisoning are available.

Materials and Methods

Study design

This observational study was conducted in the Department of Medicine, Jawahar Lal Nehru Medical College and associated group of hospitals, Ajmer. Cases were selected from various medical wards. Total 100 patients were included in the study during February 2018 to October 2019. The diagnosis of the nature of poison was based on reliable history provided by the patients, as well as their close relatives or accompanying persons, along with the presentation of remaining poison or the container from which the poison had been consumed and the suggestive clinical profile.

Aims and Objectives

1. To identify the EEG changes in acute organophosphorus compound poisoning.
2. To investigate the clinical profile, morbidity, and mortality of organophosphorus compound poisoning.
3. To explore the relationship between EEG results and the severity and prognosis of acute organophosphorus compound poisoning.

Inclusion criteria

1. The patients of acute organophosphorus compound poisoning who were admitted to the hospital within 24 hrs. of the poisoning.
2. The patients who were over ≥18 years of age.

Exclusion criteria

1. The cases in which either the exact nature of the poison could not be identified based on the aforementioned criteria, or more than one type of poison was consumed.
2. The patients who were on regular doses of hypnotics, sedatives, or anticonvulsant medication.
3. The patients with previous history of central nervous system disorders (such as seizure disorders, cerebrovascular accident, intra cranial space occupying lesions), unconsciousness (the cause of which where could not be finalized), and focal neurological deficits (due to tumor or trauma).
4. The patients who had other neurological diseases such as meningitis and trauma.

Procedure: Every patient selected for the study underwent medicolegal case registration and the collection of gastric content by gastric lavage, where the preservation of the blood sample was ensured. Afterward, a thorough general physical and systemic examination with routine laboratory investigations and EEG was performed on admission (or preferably within 72 hrs. of admission).

At the time of admission, all the patients were subjected to a computerized EEG by using a 32-channel digital EEG machine with a window-based program. Further the universally accepted 10-20 international system of electrode placement was used where each electrode placement on the scalp was performed after a thorough hair wash.

As regards the statistical analysis, chi-squared test was performed for the interpretation of the obtained data.

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Results

Table 1: Clinical features of organophosphorus compound poisoning at the time of admission

Symptoms/Signs	No. of cases
Fasciculations	64
Vomiting	56
Tachypnea	36
Abdominal pain	22
Restlessness	20
Rales	18
Excessive sweating	16
Nausea	16
Frothing from mouth	14
Vertigo	8
Constriction in chest	6
Urinary incontinence	6
Fecal incontinence	6
Burning throat	4
Level of consciousness	
Alert	36
Drowsy	48
Comatose	16
Pupillary response	
Normal	36
Constricted	52
Pin point	12
Plantar reflex	
Flexor	84
Extensor	6
Absent	10

A total of 100 patients were recruited for study, with the mean age of the patients being 28.26 ± 8.96 years. Upon performing EEG, 78 patients showed normal results, whereas 22 patients demonstrated abnormal results. Further the mean duration between poison ingestion and hospitalization was 3.34 ± 1.67 hours. However, in the cases where the EEG results were abnormal, the mean duration was 4.82 ± 1.25 hours, which was significantly higher than the mean duration in the cases where the EEG results were normal (2.92 ± 1.56 hours).

As Table 1 shows the most common symptoms was vomiting, which was reported in 56 cases (56%), followed by abdominal pain in 22 cases (22%), restlessness in 20 cases (20%), excessive sweating in 16 cases (16%), nausea in 16 cases (16%), and frothing from the mouth in 14 cases (14%).

The most common sign of OPC poisoning was fasciculation, which was reported in 64 cases (64%), followed by constricted pupils in 52 cases (52%), drowsiness in 48 cases (48%), tachypnea in 36 (36%), pulmonary rales in 18 cases (18%), and coma in 16 cases (16%).

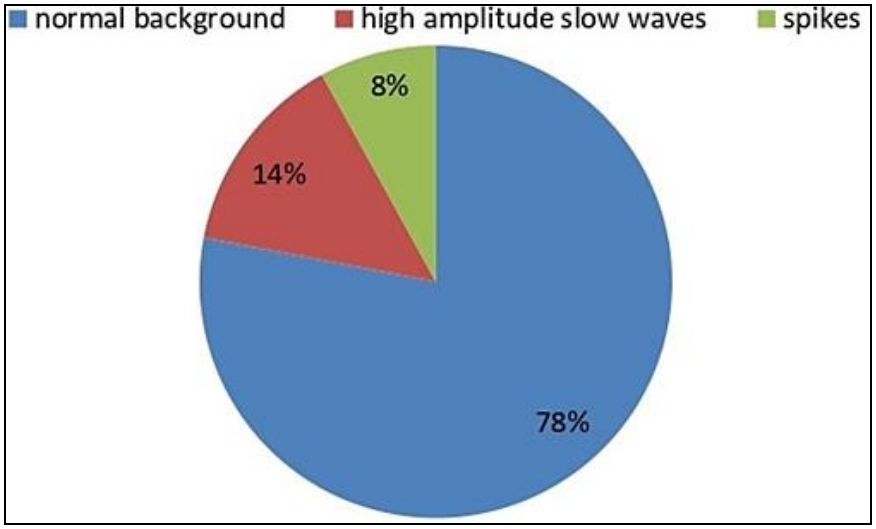

Fig 1: Various EEG changes in acute organophosphorus poisoning

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As figure 1 shows, out of the 100 cases, 78 demonstrated normal background alpha rhythm on the EEG. Out of the 22 cases with abnormal EEG results, 14 (63.64%) presented high-amplitude slow waves on the EEG, whereas 8 cases (36.36%) presented spikes.

Table 2: Correlation between EEG changes and duration of hospital stay

Duration of Hospital Stay	<7 days No. of cases	%	≥7 days No. of cases	%	Total No. of cases	%	Mean ± SD	t Value	p Value
Abnormal EEG	8	36.36	14	63.64	22	22	4.285 + 1.25	5.25	0.0001
Normal EEG	56	71.79	22	28.21	78	78	2.92 + 1.56		
Total	64	64	36	36	100	100			

As Table 2 shows, the patients presenting with EEG changes, were found to have a longer duration of hospital stay than the patients with normal EEG. Therefore, the correlation between EEG changes and the duration of hospital stay was considered clinically significant.

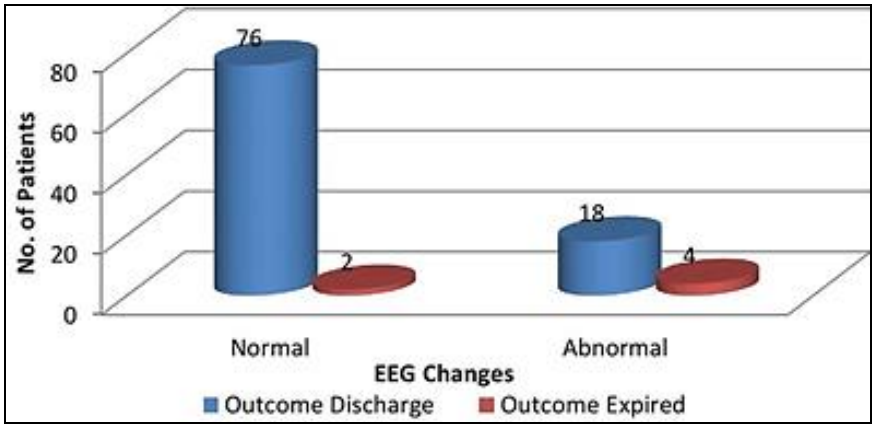

Fig 2: EEG changes and outcome results

As Figure *2* shows, out of the 22 cases with EEG abnormalities, 4 (18.18%) expired, whereas out of the 78 cases without EEG abnormalities, only 2 (2.56%) expired. The total mortality was found to be 6 (6%) out of 100 cases.

Table 3: A comparison between the outcomes and the various EEG changes

S. No.	Various EEG changes	Outcome			Total
		Discharge		Expired	
		<7 days	≥7 days		
1	Normal background alpha rhythm	54	22	2	78
2	High-amplitude slow waves	0	12	2	14
3	Spikes	4	2	2	8
	Total	58	36	6	100

As Table *3* shows, 12 (85.71%) out of 14 cases presenting with high-amplitude slow waves reported a hospital stay of ≥ 7 days, whereas only 2 (25%) out of 8 cases presenting with spikes reported a hospital stay of ≥ 7 days.

Discussion

In India, OPC poisoning is a significant cause of morbidity and mortality. It is also the most common form of poisoning, accounting for 50% of the poisoning-related admissions to the emergency department. Out of the 100 selected patients with acute OPC poisoning, 70 (70%) were between 20 and 40 years of age followed by 18 (18%) in age group < 20 years, the mean age was 28.26 ± 8.96 years which is comparable to study by P. Yuri Gagarin in which two-thirds (66%) of the patients of poisoning were between 21 and 40 years of age [5].

The average delays between admission and consumption of poison were 3.34 ± 1.67 hours in our study. The patients who presented abnormal EEG changes demonstrated a delay of 4.82 ± 1.25 hours in contrast to the patients presenting normal EEG who demonstrated delay of 2.92 ± 1.56 hours. This suggests that delayed hospitalization leads to delayed removal of OPC poison, resulting in EEG changes and a bad prognosis.

Moreover, it was found that fasciculations was most common clinical sign in 64 (64%) patients, whereas vomiting was the most common symptom in 56 (56%) patients. Frothing from mouth was present in 14 (14%) patients, whereas excessive sweating was present in 16 (16%) patients. Moreover, Urinary and

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fecal incontinence were present in 6 (6%) [patients. Further, 16 (16%) patients were in a comatose state at the time of admission, while 48 (48%) patients were drowsy. According to study by A. Goel *et al*., observed that vomiting was the most common symptom in 97.08% patients, followed by altered sensorium in 45.6% [6]. Additionally, it was noted that the most common symptom noted was vomiting (94%), followed by excessive secretions (84%). Seventy percent of the patients presented with breathlessness, while 28% had diarrhea. Altered levels of consciousness and seizures were relatively uncommon and were reported by 22% and 12% of the patients, respectively [7].

This study also demonstrated that out of the 100 cases of acute OPC poisoning, abnormal EEG changes were found in 22 (22%) patients, while 78 (78%) patients presented with normal EEG. Out of the 22 patients with abnormal EEG, 14 (63.64%) had a hospital stay of ≥ 7 days, while 8 (36.36%) had a hospital stay of < 7 days. Further, out of 78 patients with normal EEG, 22 (28.21%) had a hospital stay of ≥ 7 days. This difference in the total duration of hospital stay with regard to EEG change may be due to high doses of OPC poison and delay in hospitalization among patients with abnormal EEG changes. Additionally, 6 (6%) out of 100 patients expired due to poisoning.

Out of the 100 cases, normal background alpha rhythm was observed in 78 (78%) patients while 14 (14%) patients showed high-amplitude slow waves and 8 (8%) patients showed spikes. Out of the 14 patients with high-amplitude slow waves EEG, 12 (85.71%) had a hospital stay of ≥ 7 days, while only 2 (25%) out of 8 patients with spikes had a hospital stay of ≥ 7 days.

Out of the 6 patients who expired, 4 (66.66%) showed abnormal EEG and 2 (33.33%) showed normal EEG. Moreover, out of the 78 patients with normal EEG, only two expired (2.56%), whereas out of 22 patients with abnormal EEG, 4 (18.18%) expired. No comparable data is available regarding this observation.

According to Mangsheety *et al*., faster frequencies, higher voltage, and bursts of slow waves of high voltage at 3 to 6 Hz in EEG in subjects exposed to OPC poison were observed [8]. While Duffy *et al*., showed the EEG in subjects exposed to sarin demonstrated marked slowing of activity with bursts of high voltage, 10 Hz waves in temporofrontal leads [9].

Limitations

As this study was limited to a sample size of 100 patients, further study with a large sample size is needed.

Conclusions

Early hospitalization and quick removal of ingested poison are the most important factors in determining the overall outcome in acute OPC poisoning. Additionally, EEG recording is a useful diagnostic tool in the case of poisoning where the prognosis is to be determined.

The study emphasizes that abnormal EEG results suggest poor prognosis, and early triage and mobilization of all resources may prove advantageous in improving the overall survival.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. Jawaharlal Nehru medical college ethical committee issued approval SSB/2016.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work.

Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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