Cardiac and electrocardiographical manifestations of acute organophosphate poisoning

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ABSTRACT

Introduction: To study the extent, frequency and pathogenesis of the cardiac and electrocardiographical manifestations of acute organophosphate poisoning.

Methods: 37 adult patients admitted over a three-year period with a diagnosis of acute organophosphate or carbamate poisoning were studied prospectively. The clinical features and electrocardiographical finding were recorded.

Results: Cardiac complications developed in 23 patients (62.2 percent). These were: non-cardiogenic pulmonary oedema in eight cases (21.6 percent), electrocardiographical abnormalities including prolonged Q-Tc interval in 14 cases (37.8 percent), ST-T changes in 11 cases (29.7 percent), and conduction defects in two cases (5.4 percent). Sinus tachycardia occurred in 15 patients (40.5 percent) and sinus bradycardia in seven patients (18.9 percent). Hypertension developed in five patients (13.5 percent) and hypotension in four patients (10.8 percent). Five patients (13.5 percent) needed respiratory support because of respiratory depression of which two patients developed intermediate syndrome. Out of 14 patients with prolonged Q-Tc interval, only one had polymorphic ventricular tachycardia of the torsade de pointes type. Two patients died from non-cardiogenic pulmonary oedema and one from ventricular fibrillation, giving a hospital mortality of 8.1 percent.

Conclusion: Cardiac complications usually occur during the first hour after exposure. Hypoxemia, electrolyte derangements and acidosis are major predisposing factors for the development of these complications. Intensive supportive treatment, meticulous respiratory care and administration of atropine in adequate doses very early in the course of the illness will reduce the mortality.

Keywords: carbamate poisoning, cardiotoxicity, electrocardiographical abnormalities, insecticides, organophosphates

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INTRODUCTION

Organophosphorus (OP) compounds are possibly the most widely-used insecticides worldwide. They are utilised in increasing quantities for the control of insects affecting agriculture and homes[1]. OP poisoning is an important preventable public health problem in developing countries. Though accidental poisoning can occur following exposure or inhalation, serious poisoning often follows suicidal ingestion[2]. A high incidence of mortality has been reported in past, and is attributed to delay in diagnosis and improper treatment[3]. Since agriculture is the main occupation in Nepal, OP compounds are widely and easily-available in ordinary shops. They are often stored in an improper manner due to lack of awareness of their hazards. Organophosphorus insecticides amount for more than 75% of all cases of acute poisoning in hospital practice in our part of Nepal[4]. Cardiac complications that often accompany poisoning with these compounds may be serious and are often fatal. These complications are potentially preventable, if they are recognised early and treated adequately.

The extent, frequency, and pathogenesis of the cardiac toxicity from these compounds have not been clearly defined. However, according to a recent report, the mortality rate has declined considerably following intensive management[5]. The current body of knowledge largely consists of limited studies and case reports. Therefore, many physicians may not be fully aware of the complications of OP poisoning. In the present study, we describe our experience with 37 consecutive adult patients who had severe acute intoxication due to OP poisoning and who were admitted to the medical ward of our hospital.

METHODS

Over a period of three years (between January 1995 and December 1997), 39 patients with OP poisoning

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Table I. Distribution of patients by sex and compound ingested.

Compound type	Male	Female	Number (%)
Metacid (Methyl-parathion)	10	13	23 (62.2)
Baygon spray (Propoxur 1% Sichlorvos 0.5% Cytluthrine 0.04%)	3	2	5 (13.5)
Monocrotophos	0	1	1 (2.7)
Malathion	0	1	1 (2.7)
Dichlorovos	1	2	3 (8.1)
Unknown	1	3	4 (10.8)
Total	15	22	37 (100)

Table II. Cardiac manifestations of acute organophosphate poisoning.

Cardiac manifestations	Male	Female	Number (%)
Sinus bradycardia	2	5	7 (18.9)
Sinus tachycardia	9	6	15 (40.5)
Hypertension	3	2	5 (13.5)
Hypotension	3	1	4 (10.8)
Pulmonary oedema (Non-cardiogenic)	4	4	8 (21.6)

Table III. Electrocardiographical manifestations of acute organophosphate poisoning.

ECG abnormalies	Male	Female	Number (%)
ST/T changes			
– Elevated ST segment	3	3	6 (16.2)
– Inverted T waves	3	2	5 (13.5)
Prolonged P-R interval	1	1	2 (5.4)
Atrial fibrillation	1	1	2 (5.4)
Ventricular tachycardia	2	2	4 (10.8)
Extra systole	1	1	2 (5.4)
Prolonged Q-Tc interval	10	4	14 (37.8)

were admitted to the emergency department of B.P.Koirala Institute of Health Sciences (BPKIHS) Teaching Hospital in Dharan, Eastern Nepal. Only 37 were included in the study, as two cases were excluded because of a past history of cardiac disease. Patients were admitted to the general medical ward directly from the emergency department. The diagnosis was based on the definite history of OP ingestion and clinical features. Resources for estimation of blood cholinesterase activity were not available. Therefore, the diagnosis of OP poisoning depended upon: a history or evidence of exposure to OP compounds within the previous 24 hours; characteristic manifestation of organophosphate poisoning, including excessive salivation, miosis and fasciculations; and improvement of the signs and symptoms of OP poisoning after administration of atropine. All these criteria were required to be present in each patient to be included in the study.

The age, sex, cause of ingestion, compound involved, time elapsed between ingestion and admission to the hospital, duration of hospital stay, need for assisted ventilation, cardiac manifestations at the time of presentation, and during the in-hospital stay were recorded. During their hospital stay, electrocardiography (ECG) was carried out once daily on all patients in the general medical ward. Chest radiographs and estimation of serum electrolytes were routinely done on admission to the medical ward. Pulse rate, blood pressure and ECG recordings taken on arrival in the emergency department or in the general medical ward were selected for analysis before the start of atropine treatment. ECG analysis included the rate, rhythm, ST/T abnormalities, conduction defects and measurement of P-R and Q-T intervals. The Q-T interval was corrected (Q-Tc) according to the formula of Bazett[6].

RESULTS

Thirty-seven patients with OP poisoning presented to the emergency department of BPKIHS from January 1995 to December 1997, over a period of three years. The ages of the patients ranged from 15 to 50 years. The mean age was 26.85 years. There was no significant difference in the mean age between males and females. Majority (65%) of the patients were in the 15 to 30 years age group. It is interesting to note that there were 10 patients (27%) under the age of 20 years. Sex distribution and types of compound ingested are listed in Table I. There were 15 (41%) males and 22 (59%) females. The male to female ratio was 1:1.5. Twenty-three patients (62%) were unmarried. Among 37 patients, there were 17 (46%) students, eight (22%) farmers, six (16%) housewives and six (16%) service holders.

The cause of poisoning was suicidal intentions in 33 (89%) patients. In only four (11%) patients was it accidental in nature. Interestingly, in all the 10 patients under the age of 20 years, the ingestion was suicidal in intent. Among the cases of accidental poisoning, three (75%) patients had accidentally ingested the OP compound while in one (25%) patient, it occurred during the course of work. Nine (24%) patients had a history of previous suicidal attempts. The patients presented to us as early as five minutes

to as long as 12 hours after ingestion of the poison. 90% of the patients presented to us within 2 hours after ingestion, with the mean time interval of about 1 hour 10 minutes.

The most commonly-involved organophorphorus compound was Metacid (Methyl-parathion), which was implicated in 23 (62.2%) patients. In four (10.8%) patients, the actual compound could not be identified as the relatives did not bring the poison along with them (Table I). The total amount of atropine administered varied considerably from patient to patient, according to the need. The mean amount of atropine used on day one was 30.6mg (range 20-110mg), while the mean amount of atropine used in the total treatment of the patients was 136.74mg (range 20-600mg). The duration of treatment with atropine was 5.5 days (range 2-20 days).

Cardiac manifestations and electrocardiographical changes that were recorded before the administration of atropine are shown in Tables II and III. Fourteen patients (10 males and four females) had a prolonged Q-Tc interval (0.46 (0.05) seconds), with no significant differences between the male (0.47 seconds) and females (0.46 seconds) (p=0.23). Sinus tachycardia (40.5%) was the most common ECG abnormality, followed by prolongation of the Q-Tc interval (>0.41 seconds in males and >0.42 seconds in females) (37.8%). Elevation of ST segment (>2mm above isoelectric line was seen in six cases (16.2%). This was most striking (>2.5mm) in the antero-lateral precordial leads (V2-V5). The ST segment remained elevated for two to five days but unfortunately, cardiac enzymes could not be done due to non-availability of these facilities in our hospital. T wave inversion was seen in five cases (13.5%) and involved the anterior lead (V1-V3) in two cases, the inferior lead (II, III, aVF) in two cases, and the inferolateral (II, III, aVF, V5, V6) in one case.

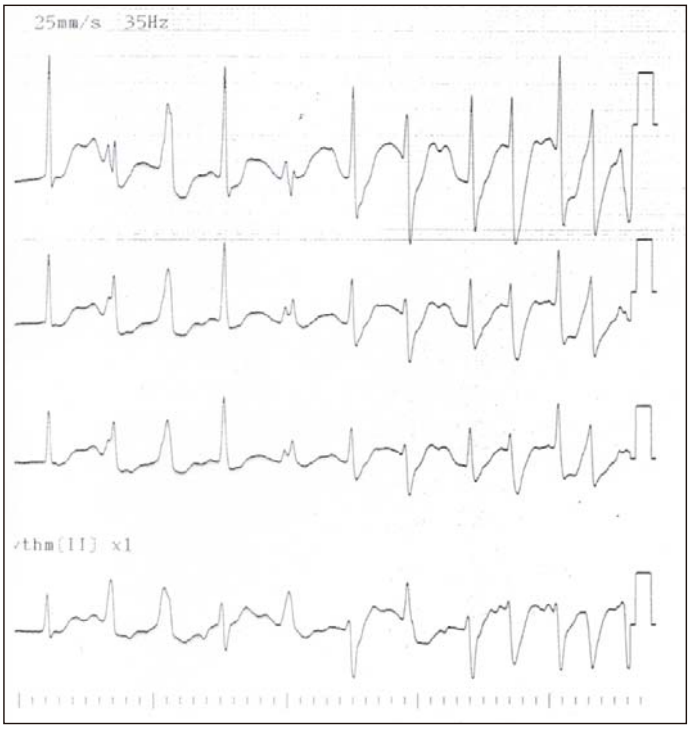

Fig. 1 ECG shows ventricular tachycardia.

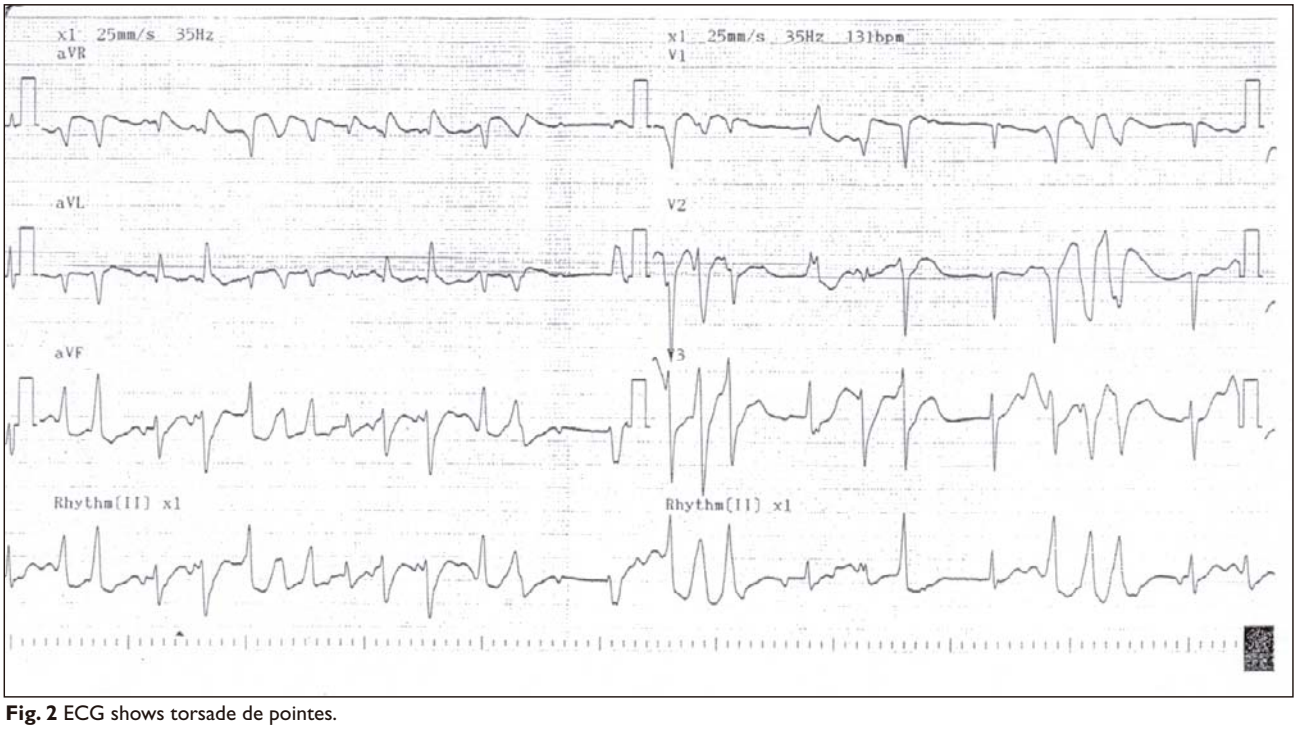

Fig. 2 ECG shows torsade de pointes.

First-degree heart block (P-R interval >0.23 seconds) occurred in two cases (5.4%). No other conduction defect was observed. Atrial fibrillation was seen in two patients, one male and one female, and was present at the time of admission before the start of atropine treatment. Ventricular tachycardia (Fig. 1) was seen in four cases (10.8%) and ventricular premature contractions in two cases (5.4%). Interestingly, one of these four patients with ventricular tachycardia had polymorphic ventricular tachycardia of the torsade de point type (Fig. 2). Of these four cases, three subsided after intravenous lignocaine, and the other one developed ventricular fibrillation leading to death despite other resuscitative measures. This case was a female patient with organophosphate poisoning and without prolonged Q-Tc interval on ECG.

Non-cardiogenic pulmonary oedema, shown on chest radiographs as fluffy infiltrates in the periphery of both lung fields with normal heart size, occurred in eight patients (21.6%). The clinical and radiological signs resolved completely in four patients within 36 hours, with atropine treatment alone. Of these six patients, two patients (16.2%) died despite adequate and appropriate treatment. Two patients developed intermediate syndrome and were kept on mechanical ventilator support.

Hypertension (systolic pressure >140mmHg and/or diastolic pressure >90mmHg) was observed in five cases (13.5%), and hypotension (systolic atrial pressure <80mm of Hg) occurred in four cases (10.8%). The cardiac and electrocardiographical abnormalities all returned to normal before the patients were discharged. Three patients died. The cause of death was cardiac arrhythmia (ventricular fibrillation) in one patient and non-cardiogenic pulmonary oedema in two patients. Interestingly, all the above patients received adequate doses of atropine and pralidoxime.

DISCUSSION

The mechanism by which organophosphates and carbamates induce cardiotoxicity is still uncertain. Ludomirsky et al[7] described three phases of cardiac toxicity after organophosphate poisoning: phase 1, is a brief period of increased sympathetic tone; phase 2, is a prolonged period of parasympathetic activity; and in phase 3, Q-T prolongation is followed by torsade de pointes ventricular tachycardia, and then ventricular fibrillation. Both sympathetic and parasympathetic over-activity have been shown to cause myocardial damage[8,9]. The cardiac toxicity associated with organophosphate and carbamate poisoning is caused by more than one mechanism. Possible mechanisms include sympathetic and parasympathetic over-activity, hypoxemia, acidosis, electrolyte derangements, and a direct toxic effect of the compounds on the myocardium.

Some investigators[7,10] have described a polymorphic ventricular tachycardia of the torsade de pointes type attributed to a prolongation of the Q-Tc interval associated with organophosphate poisoning. In spite of the presence of a prolonged Q-Tc interval in the majority of our patients (37.8%), only one of them had this type of arrhythmia. Administration of atropine in high doses has been implicated in the development of ventricular arrhythmias[11,12]. In our, study there was no such correlation. Lyzhnikov et al[10] and Ludomirshy et al[7] also found no correlation between atropine therapy and ventricular arrhythmias in organophosphate poisoning.

Hypertension and sinus tachycardia, which may be seen in organophosphate and carbamate poisoning, are nicotinic effects, while hypotension and sinus bradycardia are cholinergic manifestations[13]. Although bradycardia is thought to dominate in the early cholonergic phase of the poisoning, sinus tachycardia was a more frequent finding in our study. Others have also made the same observation[14-16]. Some investigators consider the presence of hypertension and sinus tachycardia to be manifestations of severe poisoning[17].

In our study, hypertension was seen in 13.5% and sinus tachycardia in 40.5% of cases. Of these cases, only 13.5% can be considered to have had severe poisoning as indicated by death (8.1%) or the need for assisted ventilation (5.4%). 91% (34/37) of the patients recovered fully and only 8.1% (three cases) died. No chronic sequelae was noted. We believe that the type of poisonous agent (organophosphate versus carbamate), the severity of the poisoning, the stage at which treatment is started, and the presence or absence of intensive care facilities are the main determinant factors for the hospital mortality and similar observations have also been made by others[14].

In conclusion, cardiac complications associated with organophosphate and carbamate poisoning are not fully appreciated by many physicians. Most of them occur during the first few hours after exposure. Hypoxemia, acidosis and electrolyte derangements are major predisposing factors for the development of these complications. Once the condition is recognised, the patient should be immediately transferred to an intensive or coronary care unit where appropriate monitoring and resuscitative facilities are available. Intensive supportive treatment, meticulous respiratory care, and administration of

atropine in adequate doses very early in the course of the illness are the keys to successful management of these cases.

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