

THE STUDY OF CHANGES IN SERUM ELECTROLYTES (Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺) IN ALUMINIUM PHOSPHIDE POISONING PATIENTS- IS THERE ANY CORRELATION WITH MORTALITY OR SURVIVAL

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ABSTRACT

BACKGROUND

Aluminium phosphide (ALP), a solid fumigant pesticide was declared as an ideal fumigant pesticide in 1973 because of its effectiveness, low cost and ease to use. Its toxic effects on humans are due to liberation of toxic phosphine (PH₃) gas on contact of moisture and HCL in stomach after ingestion leading to cellular toxicity and death.

MATERIALS AND METHODS

The present descriptive comparative study comprised of 42 acute aluminium phosphide (ALP) poisoning patients without prior intervention admitted in medical emergency of GSVM Medical College, Kanpur. The details of history and physical examination was recorded, and relevant lab investigations were done. The serum electrolytes were evaluated at the time of admission before any treatment in all the ALP poisoning patients. There were 35 healthy control subjects evaluated for serum electrolytes measurement.

RESULTS

The study of 42 acute ALP poisoning patients showed hyponatraemia in 30% cases, hypokalaemia in 90%, hypocalcaemia and hypomagnesaemia in 75% each and these changes were statistically significant. The 14 patients who expired had decreased serum Na⁺ levels in 21.42% cases and in 78.51% cases were having hypokalaemia, hypocalcaemia and hypomagnesaemia each. In the 28 survived patients, hyponatraemia was seen in 42.85% cases, hypokalaemia in 92.85% cases, hypocalcaemia and hypomagnesaemia in 71.43% cases. There was no statistically significant difference between the serum Na⁺, K⁺ and Ca⁺⁺ values of expired and survived patients. However, serum Mg⁺⁺ level was higher in expired patients than the survived patients, but it was less than the control subjects.

CONCLUSION

In the study, various significant electrolytes changes were found in the ALP poisoning patients. But as evident from the study, there is no correlation between serum electrolytes levels and mortality or survival of ALP poisoning patients.

KEY WORDS

Aluminium Phosphide Poisoning (ALP), Serum Electrolytes Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺, Phosphine (PH₃) Gas.

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BACKGROUND

Aluminium phosphide (ALP) is a solid fumigant pesticide used to prevent moles and vermines in granaries. In India it is marketed as tablets of quickphos, celphos, alphos, phostoxin and also in the form of powder in sachets. Each tablet weighing 30 gm containing 56% active ingredients and 44% as (NH₄)₂ CO₃. The tablet when comes in contact with HCL of stomach or moisture of grains has the capacity to release 1gm of phosphine (PH₃) gas. Due to its easy availability in the market or accessibility at home and being lethal, this agent is being used as a sure suicidal method to end the life of oneself. In India the first case of ALP poisoning was reported in 1981, since then the incidence of this poisoning is increasing steadily mainly in the Northern states of India and has almost

reached to the epidemic proportions. It is common in post-harvesting season and in rural areas. The clinical features after ALP ingestion includes nausea, vomiting, burning epigastrium, excessive thirst, diarrhoea, hypotension or shock, brady or tachycardia, arrhythmias, myocardial ischaemia or conduction defects, myocarditis, pericarditis and acute CHF, cough, dyspnoea, crackles, type I (ARDS) or type II respiratory failure, acute hepatic failure, acute renal failure, anxiety and unusual cry and restlessness, convulsions, stupor and coma may occur terminally. According to one theory, the PH₃ absorbed by the gastrointestinal tract and hamper the respiratory mechanism of mitochondria in the cell and ultimately death of the cell. Another hypothesis say that there is increased level of free radicals leading to lipid peroxidation and changes in the fluidity of cell membrane. It may lead to alterations in permeability of cell membrane (Na⁺, K⁺, Ca⁺⁺ and Mg⁺⁺) with other ions and leading to cell death. There are conflicting reports of serum electrolytes changes in ALP poisoning patients and their possible role in mortality. In and around Kanpur city, the incidence of ALP poisoning is very common and mortality rate is also high. Therefore, it was considered worthwhile to conduct a study with the following aims-

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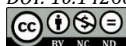
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- To study the levels of serum Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺ in ALP poisoning patients.
- If there is any relationship between serum Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺ levels and mortality or survival of the ALP poisoning patients.

MATERIALS AND METHODS

The present descriptive comparative study comprised of 42 acute ALP poisoning patients admitted in the Medicine Emergency of GSVM Medical College, Kanpur. Sample size is taken as per our convenience. These were those patients who came directly to the emergency without any prior intervention anywhere. 35 healthy control subjects were also enrolled for the measurement of serum electrolytes in them. Criteria for selection of patients for this study based on the history given by the patients and their relatives and no prior intervention before admission to the emergency.

The serum Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺ levels were measured at the time of admission. Other investigations like CBC, ESR, blood sugar, liver function tests, renal function tests and ECG were also done. The patients were treated by gastric lavage with KMnO₄ (1: 10000 dilution) and slurry of 100 gm activated charcoal orally. Intravenous fluids (5% DNS and Ringer's lactate) intravenous magnesium sulphate 1.0 gm stat then 1.0 gm every hourly for 2 consecutive hours, then 1.0 to 1.5 gm every 6 hours in 5% DNS. Inotropic support was given if needed and other supportive treatment as required. All the patients were followed till the expiry or discharge from the hospital. Data was compiled using Microsoft Excel and analysed using SPSS 20.0 Software. Categorical variables were analysed using percentages and Chi-square test. Quantitative variables were analysed using mean, standard deviation and student's "t" tests. Two-tailed p-value less than 0.05 was considered significant.

RESULTS

In all the 42 patients under study showed normal Haemogram values. Liver function, Renal function and Random blood sugar levels were found to be within normal limits. The serum electrolytes were measured in 35 healthy individuals. The calculated normal ranges (mean \pm 2 SD) for serum electrolytes were used in the present study, which are comparable to reference values (Table 1). Therefore, the cut-off values to consider hyponatraemia, hypokalaemia, hypocalcaemia and hypomagnesaemia the values < 134.1 mEq/L, < 4.20 mEq/L, < 9.0 mg/dL and < 2.3 mg/dL will be considered respectively in this study. Similarly, for hypernatraemia, hyperkalaemia, hypercalcaemia and hypermagnesaemia, the values > 145.9 mg/L, > 4.8 mEq/L, > 10.6 mg/dL and > 2.9 mg/dL will be considered the cut-off point respectively.

In overall statistical analysis of 42 patients at the time of admission there were highly significant hyponatraemia, hypokalaemia, hypocalcaemia and hypomagnesaemia (Table 2). Out of 42 patients 14 patients expired during study and in these patients 78.57% patients were having hypokalaemia, hypocalcaemia and hypomagnesaemia each and hyponatraemia was present in only 3 patients (21.42%) (Table 3). Among the 28 survived patients at the time of admission, 42.85% patients were hyponatraemic, hypokalaemia was present in 92.85% patients, hypocalcaemia and hypomagnesaemia was present in

71.43% patients each (Table 3). The serum electrolytes (Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺) values of 14 expired patients and 28 survived patients at the time of admission were compared. There was no significant difference found in serum Na⁺, K⁺, Ca⁺⁺ values in both the expired and survived patients. However, serum magnesium (Mg⁺⁺) level was higher in expired patients than the survived patients, but it was less than the control subjects (Table 4).

Variables	Na ⁺ (mEq/L)	K ⁺ (mEq/L)	Ca ⁺⁺ (mg/dL)	Mg ⁺⁺ (mg/dL)
Range	141 – 144	3.9 – 4.9	9.0-9.8	2.0-2.8
Mean	140.5	4.50	9.80	2.6
\pm SD	\pm 2.70	\pm 0.15	+0.40	+0.15
Calculated Range (Mean \pm 2SD)	134.1 – 145.9	4.20 – 4.80	9.0-10.6	2.3-2.9

Table 1. Serum Electrolytes Levels in 35 Normal Healthy Control Subjects

The above table of control subject shows the serum Na⁺, Serum K⁺, serum Ca⁺⁺ and serum Mg⁺ values comparable to the normal reference values of serum electrolytes (Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺) in healthy people.

Variables	Healthy Control Subjects (35)		ALP Poisoning Patients (42)		P value
	Mean	SD	Mean	SD	
Serum Na ⁺ (mEq/L)	140.5	2.7	135.1	3.5	<0.0001
Serum K ⁺ (mEq/L)	4.5	0.15	3.8	0.42	<0.0001
Serum Ca ⁺⁺ (mg/dL)	9.8	0.40	9.0	0.35	<0.0001
Serum Mg ⁺⁺ (mg/dL)	2.6	0.15	2.0	0.30	<0.0001

Table 2. Comparison of Serum Electrolytes Level in Healthy Control Subjects and ALP Poisoning Patients

The above table shows that there is highly significant hyponatraemia, hypokalaemia, hypocalcaemia and hypomagnesaemia in ALP poisoning patients in comparison to healthy control subjects.

Variables	Expired Patients (14)	Survived Patients (28)	P value
	No. of Cases	No. of Cases	
Serum Na ⁺ level (< 134 mEq/L)	3 (21.42%)	12 (42.85%)	0.171
Serum K ⁺ level (< 4.2 mEq/L)	11 (78.57%)	26 (92.85%)	0.177
Serum Ca ⁺⁺ level (< 9.0 mg/dL)	11 (78.57%)	20 (71.43%)	0.619
Serum Mg ⁺⁺ level (< 2.3 mg/dL)	11 (78.57%)	20 (71.43%)	0.619

Table 3. Serum Electrolytes changes in Expired and Survived ALP Poisoning Patients at the Time of Admission

The above table shows hyponatraemia in 21.42%, hypokalaemia in 78.57%, hypocalcaemia in 78.57% and hypomagnesaemia in 78.57% of expired ALP poisoning patients. Among the survived ALP poisoning patients, there is hyponatraemia in 42.85%, hypokalaemia in 92.85%, hypocalcaemia in 71.43% and hypomagnesaemia also in 71.43% patients. On comparison of both the groups

statistically, the changes are found to be insignificant (p value less than 0.05).

Variables	Survived Patients (28)		Expired Patients (14)		P value
	Mean	SD	Mean	SD	
Serum Na ⁺ level (mEq/L)	131.8	4.5	131.2	5.5	0.7198
Serum K ⁺ level (mEq/L)	3.24	1.4	3.8	0.8	0.2041
Serum Ca ⁺⁺ level (mg/dL)	8.6	2.6	9.9	1.2	0.1074
Serum Mg ⁺⁺ level (mg/dL)	1.9	0.8	2.5	0.6	0.0255*

Table 4. Comparison of Serum Electrolytes Values at the Time of Admission between all Survived and Expired Patients

* 'p' value < 0.05 was considered significant.

The above table shows that there is no statistical difference in serum Na⁺, K⁺ and Ca⁺⁺ values between survived and expired ALP poisoning patients. However, serum Mg⁺⁺ level was higher in expired patients than the survived patients, but it was less than that of control subjects.

DISCUSSION

In our study, ALP poisoning patients were having statistically highly significant hyponatraemia, hypokalaemia, hypocalcaemia and hypomagnesaemia (p < 0.0001) at the time of admission as comparison to the various serum electrolyte levels in healthy controls. One study of ALP poisoning patients reported significant hypomagnesaemia in cases having evidence of acute cardiotoxicity and shock, while patients with normal magnesium levels did not present with cardiotoxicity or shock.¹ Both hypo and hypermagnesaemia was detected during the acute phase of ALP poisoning by another study.² Shock was also found in patients of ALP poisoning with hypermagnesaemia.³ The serum K⁺ levels were also found to be raised in 2/3 cases of ALP poisoning in one of the study.⁴ While in the present study, none of the ALP poisoning patients was having hyperkalaemia. There were no significant changes found in serum electrolytes in 50 patients of ALP poisoning study by some researchers.⁵ According to one study, there was hypomagnesaemia in 16.18% patients of ALP poisoning,⁶ while in our study there was hypomagnesaemia in 75% cases. A study was also conducted in the South West of Iran, which found hyponatraemia in 8.7% and hypokalaemia in 21.7% cases of ALP poisoning.⁷ While in our study hyponatraemia was found in 30% cases and hypokalaemia in 90% ALP poisoning patients. The cause of these variable observations of serum electrolytes level in ALP poisoning is difficult to answer and requires estimation of these serum electrolytes level in a larger study.

In the present study of 42 cases of ALP poisoning, 14 patients expired within hours to 3 days. In these 14 expired patients, on day 1 before treatment 78.57% patients were

having hypokalaemia, hypocalcaemia and hypomagnesaemia each, and 31.42% had hyponatraemia. While 28 patients who survived had hyponatraemia in 42.85% cases, hypokalaemia in 92.8% cases, hypocalcaemia and hypomagnesaemia in 71.4% cases each at the time of admission. On statistical analysis there was no difference between serum electrolytes values of expired and survived ALP poisoning patients. Therefore, it is clear that there is no correlation between serum electrolytes values and mortality or survival of the ALP poisoning patients.

CONCLUSION

ALP poisoning is an important cause of suicidal mortality in general population. The overall mortality rate was 30.33% in ALP poisoning patients according to our study. There is significant hyponatraemia, hypokalaemia, hypocalcaemia and hypomagnesaemia in ALP poisoning patients. But there was no correlation between serum Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺ levels and mortality or survival in ALP poisoning patients, because there were significant serum electrolytes Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺ disturbances present also in those patients who survived and there was no statistical difference in serum Na⁺, K⁺ and Ca⁺⁺ Mg⁺⁺ values of both the expired and survived ALP poisoning patients. However, serum Mg⁺⁺ level was higher in expired patients than the survived patients, but it was less than that in control subjects. So, we conclude that there might be other causes of mortality in ALP poisoning patients and require more elaborate studies and research.

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