Indian Internet Journal of Forensic Medicine & Toxicology
Vol. 9, No.3, July-September 2011, 55-58

Original Article

Changes in Serum Magnesium levels in cases of Aluminium Phosphide Poisoning

Dr. Janani[1]*, Dr. Shiv Kochar[2], Dr. Neelima Hemkar[3]

[1]Assistant Professor, Department of Forensic Medicine, NIMS, Jaipur
[2]Professor and Head, Department of Forensic Medicine and Toxicology, SMS Hospital, Jaipur
[3]Assistant Professor, Department of Biochemistry, SMS Hospital, Jaipur

*e-mail id: janyraj@gmail.com

ABSTRACT

Aluminium Phosphide (ALP) is widely used in India as a fumigant to protect stored grains from pests and rodents. It is marketed in India as 3 gms tablets under several brand names such as Celphos, Phostek, Quickphos, Alphos, Phostoxin, and so on. ALP has the advantage of being cheap, efficacious, easy to use and freely available in the market. The incidence of poisoning has been steadily increasing and it is now the commonest poisoning method used in northern and central regions of the country. The toxic principle of ALP Phosphine causes hypoxia at the cellular level and causes death by multi-system failure. The effects of ALP on serum magnesium and the role of Intravenous magnesium sulphate as an antidote has been a topic of much debate. The present study was conducted with the aim of analysing the serum magnesium changes in cases of ALP poisoning.

Keywords: Aluminium phosphide, Celphos, Serum magnesium, Magnesium sulphate

INTRODUCTION

ALP has the advantage of being cheap, efficacious, easy to use and freely available in the market. ALP has been used as a pesticide since 1940. The incidence of poisoning has been steadily increasing and it is now the commonest poisoning method used in northern and central regions of the country. ALP is a lethal poison and the lack of a specific antidote is a big lacuna in the management of its poisoning. Development of Aluminium Phosphide as a source of Phosphine gas for fumigation was pioneered by the German company Degesch. Aluminium Phosphide was first registered as a pesticide in the U.S. in 1958 by Hollywood Termite Control Company, Inc. Aluminium Phosphide (ALP) is widely used in India as a fumigant to protect stored grains from pests and rodents. The effects of ALP on serum magnesium and the role of Intravenous magnesium sulphate as an antidote has been a topic of much debate. The present study was undertaken with the objective to study the derangements in serum magnesium Levels by Atomic Absorption Spectrophotometer in cases of Aluminium Phosphide Poisoning.

MATERIALS AND METHODS

The present study was conducted at SMS Hospital Jaipur, which is a tertiary care hospital. 89 cases of Aluminium Phosphide (ALP) poisoning admitted in the medical wards, through the Accidental Emergency were studied during the study period; from 9-10th September,2011. Further confirmation of the diagnosis was done by the silver nitrate filter paper test. Blood was systematically collected at the time shortly after admission prior to starting any fluid therapy. The sample collected was centrifuged and the clear serum obtained was refrigerated till processing. The samples were processed in Atomic Absorption Spectrophotometer- Element AS AAS 4141A as per standard protocol. Data thus obtained were recorded in the form of master chart in microsoft excel and subjected to computer aided analysis. Results thus obtained were tabulated and charts prepared. The means of the quantitative data were compared using “t- test.”

DISCUSSION

The magnesium levels were analysed in serum samples by Atomic Absorption Spectrophotometry in patients who had not received magnesium sulphate injection as a part of treatment. Patients who were referred from peripheral hospitals were not analysed since magnesium sulphate treatment was started in most of the hospitals as soon as a positive history of ALP ingestion was elicited. Such patients were excluded from the study. Only patients who were directly brought to SMS Hospital or who were referred from peripheral hospitals without starting any intravenous medications as stated by relatives were included in this study, to study the serum magnesium derangements in the toxidrome of ALP poisoning itself without being altered by iatrogenic interventions. 38 such patients were assessed in the current study.

The serum magnesium levels were raised than the higher end of the range 1.8mg/dl-2.4mg/dl in 22 patients. They varied from 2.858 mg/dl to 5.9 mg/dl. The Serum Magnesium was low in 6 patients ranging from 0.134 mg/dl to 1.576 mg/dl. The rest of the patients had serum levels ranging from 1.845 mg/dl to 2.373 mg/dl, falling in the normal range. The average serum Mg in patients who died was 3.86 ± 1.81 and 1.95 ± 0.17 in those who survived. The difference between the serum magnesium levels of patients who died and those who survived was statistically significant as the P value is less than 0.001. The mean serum magnesium of the entire study population was high (3.46 ± 1.79) when compared to the control population (2.0042 ± 0.163) which was also statistically significant ($P<0.001$).

The mean serum magnesium levels of patients who had consumed up to 3 grams of ALP (1Tablet) was less than those who had consumed 4 to 6 grams (2 Tablets) of the poison. But the difference was not statistically significant (P=0.08). Similarly a difference was observed between those who had consumed 4 to 6 grams of poison to those who had consumed more than 6 grams (more than 2 tablets or a sachet) of poison. This was also statistically insignificant with a P value of 0.35. However, the difference between the serum magnesium of those who had consumed up to 3 grams and those who had consumed more than 6 grams was statistically significant (P=0.002).

The serum magnesium levels of patients who had consumed fresh unexposed tablets were high as compared to those who had consumed old, exposed tablets. This difference was statistically significant (P=0.024).

The limitation of the study was that, as soon as the patients give history of Aluminium Phosphide poisoning, Intravenous MgSO4 injection is started even in the absence of Cardio toxicity and shock. Hence, follow up of serum magnesium levels could not be done, since magnesium levels will be elevated due to iatrogenic medications.

Serum magnesium levels have always been controversial in cases of ALP poisoning. Jain S.M. et al [2] (1985) reported that the cellular and subcellular toxic effects produced by ALP could be due to disturbances produced by ALP in permeability to Na, K, Mg, Ca and other ions giving rise to changes in transmembrane action potentials brought on by focal myocardial necrosis. He thereby tried Magnesium, which has well known membrane stabilising effect in such situations. The findings of the present study are in acceptance to Singh R.B.et al [4] (1989) who reported that the mean serum magnesium levels was much higher after 12- 24 hours of ingestion compared to 6-12 hours after ingestion, which further decreases after 48 hours, as the serum magnesium is excreted out. Hypermagnesemia (>2.5mEq/L) was present in 13 cases. He further observed that serum magnesium is usually on the higher side of normal and can increase up to 3-4mEq/L depending on the tissue damage. He also reported that magnesium infusions had been found to reduce complications and mortality in patients with acute myocardial infarction, despite the presence of hypermagnesemia.

This is against the findings of Chugh SN et al [1] (1994), who reported hypomagnesaemia in ALP poisoning and suggested to rapidly increase the serum magnesium levels by intravenous magnesium sulphate injections, to bring down the mortality. They further mentioned that hypomagnesaemia was not due to vomiting, but due to cardio toxicity of ALP. The possible explanation of low magnesium in their cases were, either rapid diffusion of magnesium into bones, its binding lipids or its rapid excretion through the kidneys. They however agreed that in early stages, magnesium levels could be high.

Siwach S.B. et al [5] (1995) studied the tissue magnesium content in 30 non survivors of ALP poisoning and compared with similar age and gender matched controls. They studied magnesium in brain, heart, kidney, liver and lung using Atomic absorption spectrophotometer and found that tissue Mg levels were not significantly different (P=NS) when compared to control and patients who were not given magnesium sulphate as part of treatment.

It was in the year 1988 onwards that some workers reported usefulness of Magnesium Sulphate (MgSO4) injection in treatment of Aluminium Phosphide poisoning. It is quite possible that there may be comparatively large number of patients in the group treated with MgSO4 injection who might have had consumed a relatively small dose or may be exposed to tablets or might have vomited out instantaneously.

However, despite the fact, that we have observed hypermagnesemia in our study, we recommend the use of magnesium sulphate injection in treatment of ALP poisoning due to the following reasons.

Magnesium is a divalent cation (Mg++) in the body and is known for its versatile action starting from the womb. Zwillger reported its anti-arrhythmic properties in 1935, but only later, its cardiac actions had been considered. Biochemically, it activates hundreds of enzyme systems in the body which are usually involved in the energy metabolism. It is regarded as the natural physiological calcium antagonist due to its properties such as, chelating ATP, assisting in DNA and RNA protein synthesis, regulating calcium access in to the cell and influencing calcium mediated release of transmitter substances. Magnesium sulphate injection is available as 2 ml ampoules containing 25% solution.

It has beneficiary actions over almost every system of human body. It crosses blood brain barrier, reverses cerebral vasospasm and acts as an anti convulsant. At the peripheral nervous system level, it reduces muscle fasciculations and the release of potassium, at higher levels causes ganglionic blockade. It causes bronchodilation and renal vasodilation. Magnesium has direct effect on blood vessels causing vasodilation. Hypomagnesaemia increases and hypermagnesemia decreases the vascular tome. It reduces catecholamine release. It exerts actions over the cardiovascular system due to its influence on K+ and Ca++ channels. When intracellular magnesium is depleted, the K+ channels lose their selectivity and allow more K+ to pass out of the cell. Alterations in magnesium concentration would cause derangements in action potential leading to depolarisation. All these in turn will affect the cardiac rhythm. Magnesium is effective in severe ventricular arrhythmias, digitalis toxicity, hypokalemia, alcoholism, diabetes mellitus, myocardial infarction and is the drug of choice in Torsades-de pointes (a rare complex type of cardiac arrhythmia). It may protect against bupivacaine induced arrhythmias. In intact subjects, Mg++ causes slight increase in heart rate. It can be regarded as cardiovascular drug due to its anti-arrhythmic and calcium antagonistic properties with minimal myocardial depression.

Magnesium which was widely used in the labour rooms and obstetric wards has crossed barriers and entered operating rooms, coronary and intensive care units. As it caused much flutter in experimental and clinical literature, it was called as ION OF THE DECADE.[3]

Table 1: Outcome Wise Distribution of Serum Magnesium Levels

SERUM MAGNESIUM	OUTCOME			TOTAL
	ABSCONDED	DISCHARGED	EXPIRED	
MEAN ± Sd	1.87 ± 0.16 (n=5)	2.08 ± 0.12 (n=3)	3.86±.81 (n=30)	3.46 ± 1.79 (n=38)

Table 2: Relationship of Amount of Alp With Serum Magnesium

AMOUNT OF ALP	SERUM MAGNESIUM	NUMBER OF CASES
UPTO 3 Grams	2.03 ± 1.23	6
4 to 6 Grams	3.91 ± 1.78	5
MORE THAN 6 Grams	4.77 ± 1.12	6
UNKNOWN	3.39 ± 1.8	21
TOTAL	3.46 ± 1.79	38

Table 3: Relationship Between Nature of Alp And Serum Magnesium

NATURE OF ALP	MEAN SERUM MAGNESIUM	NUMBER OF CASES
FRESH, UNEXPOSED	3.69 ± 2	9
OLD, EXPOSED	2.63 ± 2.39	8
UNKNOWN	3.67 ± 1.85	21
TOTAL	3.46 ± 1.79	38

P=0.024

RECOMMENDATIONS

Despite the hypermagnesemia observed in the present study, we still advocate and to continue use of MgSO4 therapy in case of ALP poisoning. Most of the cases of ALP are presenting with ARDS and require assisted mechanical ventilation. Magnesium is beneficial due to its broncho-dilator effect and also aids in faster weaning from mechanical ventilation. It may help in terminal stage of hypoxemic convulsion and as a cerebro-protective agent in case of cerebral ischemia produced by histotoxic and stagnant hypoxia as a part of toxidrome of ALP.

Therefore, MgSO4 should always be made available in the resuscitation trays of Emergency and casualty departments even at the Primary Health Centre levels.

REFERENCES

1. Chugh SN, Kumar P, Aggarwal HK, Sharma A, Mahajan SK, Malhotra KC. Efficacy of Magnesium Sulphate in Aluminium phosphide poisoning- comparison of two different dose schedules *JAPI*, 1994.Vol42(5) 373-375.
2. Jain SM, Bharani A, Sepaha GC, Sanghvi VC, Raman PG. Electrocardiographic changes in Aluminium Phosphide poisoning *JAPI*, 1985; 33: 406-9.
3. Rao SM. Magnesium- ion of the decade, Clin Proc *NIMS*, 1974, 9(2), 4-6.
4. Singh RB, Rastogi SS, Singh DS. Cardiovascular manifestations of Aluminium phosphide intoxication *JAPI*, 1989, Vol 37 (9) 590-192.
5. Siwach SB, Dua A, Sharma R, Sharma D, Mehla RK. Tissue Magnesium content and histopathologial changes in Non – survivors of Aluminium phosphide poisoning *JAPI*, 1995, Vol 43(10)676-678.