Vol-4, Issue-9 PP. 256-260 ISSN: 2394-5788

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

ALUMINUM PHOSPHIDE POISONING - CASE STUDY

Ali Th. Khlaif
Iraq
pharmalith@gmail.com

ABSTRACT

Aluminum phosphide (AlP) is a cheap, effective and commonly used pesticide. It is one of the fatal pesticides. It liberates lethal phosphine gas when it comes in contact either with atmospheric moisture or with hydrochloric acid in the stomach. The mechanism of toxicity includes cellular hypoxia due to the effect on mitochondria, inhibition of cytochrome C oxidase and formation of highly reactive hydroxyl radicals. The signs and symptoms are nonspecific and instantaneous. The toxicity of AlP particularly affects the cardiac and vascular tissues, which manifest as profound and refractory hypotension, congestive heart failure and electrocardiographic abnormalities. The diagnosis of AlP usually depends on clinical suspicion or history, but can be made easily by the simple silver nitrate test on gastric content or on breath. Due to no known specific antidote, management remains primarily supportive care. Early arrival, resuscitation, diagnosis, decrease the exposure of poison (by gastric lavage with KMnO4 or sodium bicarbonate), intensive monitoring and supportive therapy may result in good outcome.

Keywords : Aluminum phosphide, phosphine, sodium bicarbonate, arrhythmias, magnesium sulfate.

1. INTRODUCTION

Aluminum phosphide is highly effective insecticide and rodenticide. Acute toxicity can occur due to ingestion of products containing aluminum phosphide or by inhalation of phosphine gas generated during its use (Anand, 2011). Aluminum phosphide poisoning is lethal with mortality rate about 70 %. The mechanism of toxicity occur by (Proudfoot, 2009) :

a) Inhibition of cytochrome c oxidase.
b) It rapidly perturbs mitochondrial morphology, inhibits oxidative respiration by 70%, and causes a severe drop in mitochondrial membrane potential.
c) It can interact with hydrogen peroxide forming reactive hydroxyl radical leading to lipid peroxidation
d) It inhibits peroxidase and catalase

There is no specific antidote for aluminum phosphide toxicity and the key to treatment lies in rapid decontamination and institution of resuscitative measures. The specified fatal dose in human is 0.15 - 0.5 gm. Moisture in the air mixes with phosphide and release phosphine (hydrogen phosphide, phosphorus trihydride, PH3) which is the active as pesticide and toxic compound. After contact with an acid, phosphine is released even more vigorous (Hackenberg, 1972).

There is a short interval between ingestion and appearance of systemic toxic features because of rapid and easy absorption of phosphine gas (Stewart, et al, 2003, Chan, et al, 1983)

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

2. CLINICAL FEATURES

The early symptoms include nausea, vomiting, retrosternal and epigastric pain, dyspnea, anxious, agitation with garlic odor (Popp, et al, 2002). Shock and peripheral circulatory failure are also early signs of toxicity. Mortality can occur within 12 to 24 h of ingestion (Singh, et al, 1991).

2.1 Cardiac toxicity

Cardiac toxicity includes circulatory failure (Alter, et al, 2001), hypotension (Bayazit, et al, 2000), and ECG abnormalities (ST and T-wave changes) (Kalra, et al, 1991).

2.2 Respiratory toxicity

Tachypnea, dyspnea, crepitations, and rhonchi were present on examination in 192 out of 418 cases (46%) of phosphide poisoning (Chugh, et al, 1991). Pulmonary edema is common but it is not always clear whether it is cardiogenic or non-cardiogenic in etiology. It tends to develop 4 – 48 h after ingestion and the finding of a reduced arterial pressure of O2 without an increase in pulmonary artery wedge pressure, suggested it was non-cardiogenic (Kalra, et al, 1991).

2.3 Gastrointestinal toxicity

Hematemesis (Gupta, et al, 2000), corrosive lesions of the esophagus and stomach (Madan, et al, 2006, Tiwari, et al, 2003), vomiting, epigastric pain, severe gastric erosions, duodenal erosions, esophageal strictures (Darbari, et al, 2007). Dysphagia may be apparent as soon as 3 or 4 days after ingestion of aluminium phosphide (Madan, et al, 2006, Darbari, et al, 2007) but is more usual about 2 weeks later.

2.4 Hepatic toxicity

Transient elevations of alanine aminotransferase and aspartate aminotransferase activities are not infrequent after ingestion of metal phosphides (Frangides & Pneumatikos, 2002) but jaundice secondary to liver damage is much less common (Chugh, et al, 1998). Acute hepatic failure and encephalopathy was considered to be the cause of death in one man (Chittora, et al, 1994), while a 12 - year old girl died from a combination of acute hepatic failure and encephalopathy with renal failure (Bayazit, et al, 2000).

2.5 Electrolyte and metabolic abnormalities

Hypokalemia, metabolic acidosis, mixed metabolic acidosis and respiratory alkalosis, and acute renal failure are reported frequently. Also, hypoglycemia and hypomagnesemia have been reported in several studies (Dueñas, et al, 1999). Hypokalemia is common soon after ingestion of metal phosphides and is probably secondary to vomiting, though catecholamine release could also contribute. Hyperglycemia (Abder - Rahman, 1999) appears to be rare. A study by Singh et al, demonstrated that serum magnesium concentrations were increased, possibly secondary to release from damaged cardiac myocytes and hepatocytes (Singh, et al, 1991; Singh, et al, 1990). In another study by Chugh et al, found that patients poisoned with aluminium phosphide suffering from shock and cardiotoxicity (Chugh, et al, 1991)

3. DIAGNOSIS

A positive history of ingestion is the basis of diagnosis in most cases. The presence of typical clinical features, garlicky odour from the mouth and highly variable arrhythmias in a young patient with shock and no previous history of cardiac disease points towards aluminium phosphide poisoning.

The risk of aluminium phosphide poisoning reduced in the following conditions :

a) When the patient uses the expired one
b) When aluminum phosphide is dissolved in water before use
c) When the patient experiences immediate vomiting

Confirmation can be done by the Silver Nitrate Test (Chugh, et al, 1989). In this test, 5 ml of gastric aspirate and 15 ml of water are put in a flask and the mouth of the flask is covered by filter paper impregnated with silver nitrate. The flask is heated at 50 C for 15 to 20 min. If phosphine is present the filter paper turns black. For performing the test on exhaled air, the silver nitrate impregnated filter paper is placed on the mouth of the patient and the patient is asked to breath through it for 15-20 minutes, blackening of the paper indicates the presence of phosphine in breath. The sensitivity of the test is 100%.

4. LABORATORY INVESTIGATIONS

Laboratory evaluation is often performed to assess the prognosis. Leucopenia indicates severe toxicity. Increased aspartate aminotransferase or alanine aminotransferase and metabolic acidosis indicate moderate to severe poisoning. Electrolyte analysis shows decreased magnesium while potassium may be increased or decreased (Chugh, et al, 1990). Electrocardiogram shows various

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

manifestations of cardiac injury (ST depression or elevation, bundle branch block, ventricular tachycardia, ventricular fibrillation) (Jain, et al, 1985; Katira, et al, 1990; Siwach, et al, 1998; Singh, et al, 1989).

5. MANAGEMENT

5.1 Decontamination

Gastric lavage is probably best avoided after ingestion of phosphides as it might increase the rate of disintegration of the pesticide and increase toxicity (Maitai, et al, 2002). Gastric lavage must be done with potassium permanganate (1:10,000) to reduce absorption of phosphine. Permanganate oxidizes PH3 to form non-toxic phosphate. This is followed by a slurry of activated charcoal (approximately 100 gm) given through a nasogastric tube.

5.2 Supportive care

The most important factor is resuscitation of shock and institution of supportive measures as soon as possible. Intravenous access should be established and 2- 3 litres of normal saline are administered within the first 8-12 hr (Siwach, et al, 1997). Low dose dopamine (4-6 µg/kg/min) is given to keep systolic blood pressure > 90 mm Hg. The use of high doses of glucagon may benefit in the treatment of aluminum phosphide poisoning; the likely mechanism of action is the increase of cAMP in the myocardium, effectively bypassing the β-adrenergic second messenger system. Oxygen is given for hypoxia. Acute respiratory distress syndrome requires intensive care monitoring and mechanical ventilation. The blood glucose concentration should be measured in every case and hypoglycemia corrected if found.

5.3 Magnesium supplementation

Magnesium administration appeared to terminate atrial fibrillation in many cases of aluminum poisoning (Chugh, et al, 1989) and supra ventricular tachycardia and ventricular tachycardia (Chugh, et al, 1991). On the other hand, magnesium sulphate 3 g given intravenously over 30 min did not abolish very frequent ventricular ectopic beats and bigeminy though it restored a normal magnesium concentration (Dueñas, et al, 1999). Only a few studies have attempted to assess the value of magnesium sulphate in large groups of patients and their results are conflicting. In a study, 50 patients after aluminium phosphide ingestion were given high doses of magnesium and the result compared with the control group that was not treated. The result showed (42%) of those given supplemental magnesium survived compared with (40%) not so treated.

6. CASE STUDY

A 55 yr-old female presented to the ED with repeated vomiting and disturbed level of consciousness, BP 140 / 70, PR 63, SPO2 95%. Her past medical history include hypertension and ischemic heart disease (IHD), she was on captopril 25 mg twice daily. After taking history of poisoning, her son said that " she attempted to suicide by ingestion of an unknown amount of an old unlabeled rodenticide in her possession after a problem happened with my father ". After 2 hours of admission, she became comatose and hypotensive where BP became 100 / 60, oxygen saturation was reduced to 85 %. ECG findings were : ventricular ectopic with atrial fibrillation. After a call of the physician and in response to the situation, a team of our poison control center (PCC) went to the hospital to get the rodenticide itself for analysis and evaluates her clinical situation. Analysis was done to the granules of the unknown rodenticide, the results revealed liberation of phosphine gas during silver nitrate test.

As a PCC, we took an action for decontamination and treatment of this patient to prevent any poor progression in her clinical condition. 2 L of Potassium permanganate 0.1 % solution was prepared for gastric lavage followed by 50 gm in 400 ml of water activated charcoal irrespective of exposure time in order to increase her saving possibility. After these decontamination measures, her conscious level improved and oxygen saturation became about 90 %; but ventricular ectopic and atrial fibrillation are still present.

To prevent any worsening in cardiac effects, we suggested to administer Mg - sulfate IV. She became conscious, oriented after 2 doses of 2 gm Mg - sulfate IV and considered as clinically stable except for AF which still present after 24 hours of treatment with Mg - sulfate. Physicians of CCU were phone called our PCC to inquire whether they continue Mg - sulfate or not; we instruct them to continue Mg - sulfate IV as 6 gm / day administered by infusion for at least 5 days. AF unresolved for 3 days despite using of continuous IV Mg - sulfate; but she is clinically well and stable. At the 4th day AF was resolved and she became completely stable and transported from CCU to the general wards in the women's floor of medicine.

7. DISCUSSION

Aluminum phosphide toxicity is less common than zinc phosphide toxicity in our society in Nasyriah city. Many cases include those with suicidal attempt especially in women and many cases of children with incidental exposure. Unfortunately, most those with

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

aluminum phosphide toxicity received by our poison control center were died, the fatal dose was 1 tablet for one case and 4 tablets for the other. Both are admitted later after exposure, more than 6 hrs. of taking the tablets; while in this 55 - yr old case, admission was after 2 hours of exposure; this made the decontamination measures active and saved her life. In such cases, gastric lavage with 5 % sodium bicarbonate or 0.1 % potassium permanganate solution must be done immediately after exposure to prevent the release of phosphine gas in the stomach because once it is released; phosphine gas will be absorbed rapidly and causing free radical formation leading to lipid peroxidation ending with end organ damage and there is no specific antidote for phosphide (Bogle RG et al, 2006).
Aluminum phosphide can cause arrhythmias of any type. In our case for study, ventricular ectopic and atrial fibrillation were occurred and magnesium sulfate IV used for treatment. Magnesium sulfate given as 4 gm bolus dose initially when AF occurred, then 6 gm per day given as IV infusion for 5 days and this is identical to the dose remembered in many studies such as Mohan G et al, 2011.

8. CONCLUSION

Aluminum phosphide is considered one of the fatal pesticides. Later activities will not improve patient state because of phosphine absorption in considerable amounts to the blood circulation and exert its toxic effects, besides; no specific antidote is present for this phosphine gas. Early decontamination measures will be able in high percentage to save patient life due to prevention or decreasing absorption of this gas to the circulation. Magnesium sulfate used to treat cardiac effects caused by phosphine gas and not considered as specific antidote and it is effective in this field.

REFERENCES

[1] Abder-Rahman H. Effect of aluminium phosphide on blood glucose level. Vet Hum Toxicol 1999; 41: 31–32.
[2] Alter P, Grimm W, Maisch B. Lethal heart failure caused by aluminium phosphide poisoning. Intensive Care Med 2001; 27: 327.
[3] Anand R, Binukumar B. K, Kiran D. G. Aluminum phosphide poisoning an unsolved riddle: J. Appl. Tox. 2011; 31: 499 - 505
[4] Alex T. Proudfoot. Aluminium and zinc phosphide poisoning: J. Clinic. Tox. 2009; 47: 89 - 100
[5] Bayazit AK, Noyan A, Anarat A. A child with hepatic and renal failure caused by aluminum phosphide. Nephron 2000; 86: 517.
[6] Bogle RG, Theron P, Brooks P, Dargan PI, Redhead J. Aluminium phosphide poisoning. Emerg Med J 2006; 23: e03.
[7] Chan LT, Crowley RJ, Delliou D, Geyer R. Phosphine analysis in post mortem specimens following ingestion of aluminium phosphide. J Anal Toxicol 1983; 7: 165–167.
[8] Chittora MD, Meena SR, Gupta DK, Bhargava S. Acute hepatic failure in aluminium phosphide poisoning. J Assoc Physicians India 1994; 42: 924.
[9] Chugh SN, Chugh K, Ram S, Malhotra KC. Electrocardiographic abnormalities in aluminium phosphide poisoning with special reference to its incidence, pathogenesis, mortality and histopathology. J Indian Med Assoc 1991; 89: 32–35.
[10] Chugh SN, Aggarwal HK, Mahajan SK. Zinc phosphide intoxication symptoms: analysis of 20 cases. Int J Clin Pharmacol Ther 1998; 36: 406–407.
[11] Chugh SN, Ram S, Chugh K, Malhotra KC. Spot diagnosis of aluminium phosphide ingestion: an application of a simple test. J Assoc Physicians India 1989; 37: 219-20.
[12] Chugh SN, Juggal KL, Sharma A, Arora B, Malhotra KC. Magnesium levels in aluminium phosphide poisoning [Abstract]. J Assoc Physicians India 1990; 38: 32.
[13] Darbari A, Kumar A, Chandra G, Tandon S. Tracheo-oesophageal fistula with oesophageal stricture due to aluminium phosphide (Celphos tablet) poisoning. J Chest Dis Allied Sci 2007; 49: 241–242.
[14] Dueñas A, Pérez-Castrillon JL, Cobos MA, Herreros V. Treatment of the cardiovascular manifestations of phosphine poisoning with trimetazidine, a new antiischemic drug. Am J Emerg Med 1999; 17: 219–220.
[15] Frangides CY, Pneumatikos IA. Persistent severe hypoglycemia in acute zinc phosphide poisoning. Intensive Care Med 2002; 28: 223.
[16] Gupta V, Singh J, Doodan SS, Bali SK. Multisystem organ failure (MSOF) in aluminium phosphide (ALP) poisoning. JK Pract 2000; 7: 287–288.

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

[17] Hackenberg U. Chronic ingestion by rats of standard diet treated with aluminum phosphide. Toxicol Appl Pharmacol 1972; 23: 147-58.
[18] Jain SM, Bharani A, Sepaha GC, Sanghvi VC, Raman PG. Electrocardiographic changes in aluminium phosphide (ALP) poisoning [Case reports]. J Assoc Physicians India 1985; 33: 406-9.
[19] Kalra GS, Anand IS, Jit I et al. Aluminium phosphide poisoning: haemodynamic observations. Indian Heart J 1991; 43: 175–178.
[20] Katira R, Elhence GP, Mehrotra ML et al. A study of aluminium phosphide (Aluminium phosphide poisoning) poisoning with special reference to electrocardiographic changes. J Assoc Physicians India 1990; 38: 471–473.
[21] Madan K, Chalamalasetty SB, Sharma M, Makharia G. Corrosive-like strictures caused by ingestion of aluminium phosphide. Natl Med J India 2006; 19: 313–314.
[22] Maitai CK, Njoroge DK, Abuga KO et al. Investigation of possible antidotal effects of activated charcoal, sodium bicarbonate, hydrogen peroxide and potassium permanganate in zinc phosphide poisoning. East Central Afr J Pharm Sci 2002; 5: 38–41.
[23] Mohan Gurjar, Arvind K Baronia, Afzal Azim, Kalpana Sharma. Managing aluminum phosphide poisonings. J Emerg Trauma Shock 2011; 4: 378–384.
[24] Popp W, Mentfewitz J, Gotz R, Voshaar T. Phosphine poisoning in a German office. Lancet 2002; 359: 1574.
[25] Singh RB, Saharia RB, Sharma VK. Can aluminium phosphide poisoning cause hypermagnesaemia? A study of 121 patients. Magnes Trace Elem 1990; 9: 212–218.
[26] Singh RB, Singh RG, Singh U. Hypermagnesemia following aluminum phosphide poisoning. Int J Clin Pharmacol Ther Toxicol 1991; 29: 82–85.
[27] Singh RB, Rastogi SS, Singh DS. Cardiovascular manifestations of aluminium phosphide intoxication. J Assoc Physicians India 1989; 37: 590–592.
[28] Siwach SB, Jagdish, Katyal VK, Dhall A, Bhardwaj G. Prognostic indices in aluminium phosphide poisoning observations on acidosis & central venous pressure. J Assoc Physicians India 1997;45: 693-5.
[29] Siwach SB, Singh H, Jagdish, Katyal VK, Bhardwaj G. Cardiac arrhythmias in aluminium phosphide poisoning studied by on continuous holter and cardioscopic monitoring. J Assoc Physicians India 1998; 46: 598-601.
[30] Stewart A, Whiteside C, Tyler-Jones C et al. Phosphine suicide. Chemical Incident Rep 2003; 27: 23–26.
[31] Tiwari J, Lahoti B, Dubey K et al. Tracheo-oesophageal fistula – an unusual complication following celphos poisoning. Indian J Surg 2003; 65: 442–444.