

Review Article

Aluminium phosphide poisoning in children -challenges in diagnosis and management

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Abstract: Metal phosphides in general and aluminium phosphide in particular are potent insecticides and rodenticides. These are commercially used for protection of crops during storage, as well as during transportation. They are highly toxic substances and its poisoning is a common pediatric emergency leading to mortality and morbidity in children. Thousand of innocent children are poisoned accidentally every year throughout the world mainly due to their innovative and exploratory nature and mouthing tendency. Following the ingestion of metal phosphide, phosphine gas is generated which is rapidly absorbed throughout the gastrointestinal tract, reaches the blood stream and causes multisystemic involvement. We tried to review the various aspects of toxicity associated with aluminium phosphides, including clinical presentation specially unusual presentation, diagnostic and management challenges and poor prognostic indices. The presentation varies from GIT manifestation to shock, cardiac arrhythmias, renal failure, metabolic acidosis and rare presentation pleural effusion, ascites, pericarditis, acute respiratory distress (ARDS). Diagnosis is based on clinical suspicion, history of ingestion, clinical manifestations with garlic or decaying fish odour, unexplained shock. A range of chemical tests and analytical methods may be used for the analysis of sample like silver nitrate impregnated paper test on the gastric fluid of patients, a reliable and sensitive method to detect phosphine. In management role of magnesium sulphate (MgSO₄) in reducing the cardiac arrhythmias and mortality is well documented.

Keywords: Aluminium phosphide poisoning, garlic odour, silver nitrate test, magnesium sulphate

INTRODUCTION

WHO reports estimate poisoning as one of the most common causes of increased morbidity and mortality rate world-wide. Various agents such as pesticides, drugs have been used for intentional and accidental poisoning in different countries. In the Indian scenario, pesticides are the most commonly used poisoning agent and a most common pediatric emergency leading to mortality and morbidity in children. Thousand of innocent children are poisoned accidentally every year throughout the world mainly due to their innovative and exploratory nature and mouthing tendency [1-4]. Metal phosphides is highly fatal as it elicits extreme toxic effects and no suitable antidote is available. Aluminium Phosphide (ALP) is most commonly used solid fumigant and ideal pesticide since 1940s as it is cheap, most efficacious and easy to use and freely available on the counter in India (as Alphos, Celphos, Quickphos, Phostek, Phosfume and Synfume)) in form of chalky white or brown 3 gm.

tablets containing 56% of ALP and 44% of ammonium carbonate [5-7].

FATAL DOSE AND PERIOD

The fatal dose after ingestion is 150 mg -500 mg for a 70 Kg person and fatal period is 1 to 96 hours, the average being 28 hours [8-11].

Popp et al suggested that death may occur after a 30 minute exposure to 290 to 600 ppm, and serious effects may develop after exposure to 7 ppm for several hours. As the compound is reported to hold lethal and delayed effects, therefore, an observational period of 72 hours is recommended to enable identification and management the complication [12-13].

EPIDEMIOLOGY IN INDIA

Aluminium phosphide (ALP) poisoning has emerged as a common cause of accidental poisoning in children with mortality ranging from 37-100% [8]. A retrospective analysis of poisoning calls received by

NPIC(National poisons information centre) showed a total of 2,720 cases during 3 years period(1999-2002).36.6% cases were pediatrics poisoning, out of these agricultural pesticide poisoning were 9.1%.. Accidental cases were most common(79.7%), <6 years were most vulnerable group, although intentional attempts also found among 12-16 years(20.2%).Among all cases of agriculture pesticides poisoning the aluminium phosphide cases were (29.67%),which was a huge figure [14]. Another studies reported dramatic increase in the number of poisoning cases and deaths caused by ALP ingestion, in India. In fact, it is the most common cause of poisoning in sub-urban and rural parts of Northern India [9,10,15,16]

PATHOGENESIS OF TOXIC EFFECTS

On coming into contact with water or moisture or OH radical of air or hydrochloric acid 3 gm. tablet of ALP liberates 1 gm. of phosphine or phosphorus hydrogen. Phosphine is a colorless gas with fishy or garlic odour. It is removed with half life of 5-24 hours [17-19].

Following the ingestion of metal phosphide, phosphine gas is generated which is rapidly absorbed throughout the gastrointestinal tract, reaches the blood stream and distributed to vital organs. Phosphine disturb the permeability for Na⁺, K⁺, Mg and inhibits the electron transport resulting from preferential inhibition of cytochrome oxidase leading to respiratory chain inhibition which leads to cellular hypoxia and small vessel injury which is further potentiated by cardio toxicity due to anoxic myocardial damage and shock [20,21,22,23].

CLINICAL SIGNS AND SYMPTOMS

Clinical signs and symptoms vary from common presentation to some unusual presentations. It depends on various factors like amount ingested and duration after the ingestion.The most common reported signs and symptoms in case of aluminium phosphide poisoning are a characteristic garlic-like odour breath, gastrointestinal symptoms in the form of nausea and vomiting, gastrointestinal hemorrhages other are hemodynamic instability, shock which results in congestive cardiac failure, cardiac arrhythmia and acute renal failure, metabolic acidosis, acute respiratory failure [23-29]. There are some unusual presentation of ALP poisoning has been reported, which make the diagnosis and management difficult, especially when sample of ingested substance or container is not available. Involvement of Central Nervous System and Muscular system has been reported ,which present as headache, dizziness, diplopia, paraesthesias, ataxia, altered sensorium, restlessness, intention tremors, convulsion, hypoxic encephalopathy, coma and delayed hemorrhagic stroke. Muscle pain, severe muscle weakness [30,31].

Exudative pleural effusion and ascites are rare clinical presentation. This delayed complication of pleural effusion and ascites is some time associated with or without pericardial effusion and Acute Respiratory Distress Syndrome(ARDS). The secondary form of capillary leak syndrome caused by phosphine is an attractive hypothesis to explain this complication [32-35]. Other unusual complication includes renal tubular necrosis, respiratory alkalosis, acute respiratory arrest, hepatitis, bleeding diathesis due to DIC and hypoglycemia or hyperglycemia due to endocrine involvement [28,36-40].

POOR PROGNOSTIC SIGNS

During treatment of ALP poisoning one should be alert for the poor prognostic signs. Ingestion of ALP in fatal dose and Ingestion of “unexposed tablets” of ALP is associated with a greater risk and fatal outcome as these tablets retain their potency, time lapsed after ingestion ,lack of vomiting after ingestion correlates with mortality. Intractable shock, metabolic acidosis, severe hypoxia, electrolyte disturbances, hyperglycemia, arrhythmias, oliguria or acute renal failure, haemolysis, coma and DIC, are bad prognostic signs. Louriz *et al.* in a study on 49 patients demonstrated hepatic dysfunction as a risk factor of poor prognosis [9,41,42,43].

DIAGNOSIS

Diagnosis is based on clinical suspicion, inhalational exposure or history of ingestion of ALP, corroborated by seeing the tablets of ALP or its empty container left in the house, clinical manifestations with garlic or decaying fish odour, unexplained shock [25,44].

A range of chemical tests and analytical methods may be used for the analysis of sample/s in case of phosphide poisoning.

1. Silver nitrate test

Diagnosis of phosphide poisoning can be confirmed by detecting the phosphine gas in samples. Chugh *et al* described the use of silver nitrate impregnated paper test on the gastric fluid of patients in cases of aluminium phosphide poisoning. It is a simple, reliable and sensitive method to detect phosphine [35,45].

2. Ammonium molybdate test-

This test has been recommended for the detection of phosphorus and phosphides in the stomach contents and non-biological materials in the event of poisoning cases. For this test to be conducted; a small amount of minced tissues (10 g) or other biological material suspected to contain phosphide is taken into a steam distillation flask, mixed with an equal amount of water and then acidified with dilute sulfuric acid, followed by steam distillation. The distillate is collected in an ice cold receiver containing 5 ml of 1% silver nitrate solution by dipping the adapter into the silver

nitrate solution. In the presence of the phosphide, the silver nitrate solution turns black. 5 ml of concentrated nitric acid is added to this black precipitated material and boiled till the solution becomes practically colorless. Then 5 ml of ammonium molybdate solution is added and heated for 1 min. Appearance of canary yellow precipitates confirms the presence of phosphide [46,47,48].

TREATMENT

1. Decrease the absorption of phosphine

Milk, fats or saline emetics should not be given orally. After ingestion, effectiveness of gut decontamination to reduce the absorption of unabsorbed poison is primarily dependent on the duration of exposure of poison and is useful if it is done within 1–2 h. Gut decontamination should not be performed if the patient has an unprotected airway without endotracheal intubation. Potassium permanganate (1:10,000) is used for gastric lavage through a nasogastric tube as it oxidises phosphine to nontoxic phosphate. This can be followed by approximately 100 g (1 g/kg) of activated charcoal to reduce absorption if the patient arrives within 1 h after ingestion of a large amount of poison. There are insufficient data to support the routine use of activated charcoal in AIP poisoning as phosphine gas is rapidly absorbed through the gut [49].

1. Role of MgSO₄

The conventional anti arrhythmic drugs-digoxin and xylocaine are not effective and cardioversion is not attempted due to diffuse myocarditis. The role of magnesium sulfate as a potential therapy in AIP poisoning to decrease the likelihood of a fatal outcome has been described in many studies. It corrects cardiac arrhythmias by modulating sympathetic, parasympathetic and slow channel kinetics and acts as a cell membrane stabilization factor, but the exact mechanism is still unclear as this is a weak anti arrhythmic. Magnesium sulfate also has an anti-peroxidant effect and it combats free radical stress due to phosphine. MgSO₄ is effective in first 24 hours in dose of 1 gm. IV stat after dissolving in 100 ml of 5% dextrose and 1 gm. every hour for next 3 hours and then 1 gm. every 6 hours for 5-7 days in continuous IV infusion in 5% dextrose. Mg²⁺ level should be maintained at less than toxic levels of 10 meq/l. The magnesium level achieved with said dosage schedule is 2.00 to 3.1 meq/l. [50-54].

2) Role of steroid-

In ALP poisoning low Blood cortisol level has been reported because of adrenal insufficiency which is responsible for hypotension and tachycardia. Severity of illness depends on level of cortical insufficiency. It defines a role for corticosteroids therapy in management of ALP poisoning, particularly if it does not respond to conventional treatments [55].

CONCLUSION

Aluminium phosphide is a frequently used solid grain fumigant because of its highly potent characteristic, cost effectiveness and easy availability. The high mortality in ALP poisoning is due to rapid toxic effect on all the vital organs and lack of antidote.

The commonest clinical presentation is GIT manifestation and cardiac involvement in the form of shock and arrhythmia but delayed complication of pleural effusion and ascites with or without pericardial effusion and ARDS should be kept in mind as unusual presentation. Diagnosis is done by history, garlic odour with refractory shock. Diagnosis can be confirmed by detecting the phosphine gas in sample by the use of silver nitrate impregnated paper test on the gastric fluid of patient. It is a simple, reliable and sensitive method to detect phosphine. There is definite role of MgSO₄ and corticosteroids therapy in management of ALP poisoning, particularly if it does not respond to conventional treatments

Because the main cause of pediatric poisoning are ignorance and negligence, many deaths and disabling outcomes could very easily be prevented if more attention were given to implementing preventive measures at home like caging of tablets in plastic packs with holes and spikes. So increased public awareness of risks could reduce the occurrence of accidental pediatric poisoning. Early diagnosis, intensive monitoring and supportive management may result in good outcome.

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