Case Report

Successful management of aluminium phosphide poisoning using intravenous lipid emulsion: Report of two cases

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Abstract

Aluminum phosphide (ALP) is a cheap, easily available agricultural pesticide which causes lethal poisoning by liberation of phosphine and inhibition of cytochrome c oxidase thereby leading to cellular hypoxia. Although there is no known specific antidote, clinical trials are still going on. We present here two cases of ALP poisoning who were successfully managed by treatment with lipid emulsion and intravenous magnesium sulfate.

Keywords: Aluminum phosphide, lipid emulsions, magnesium sulfate

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Introduction

Aluminum phosphide (ALP) is a fumigant widely used in agricultural as well as in nonagricultural field.[1] In India, it is available in tablet form as celphos and quickphos or as pellets or granules.[2] It is commonly misused for suicidal purpose.[1] The tablets are green, brown, or gray with chemical composition of 56% ALP and 44% aluminum carbonate which is added to prevent self-ignition of phosphine (PH_3) on contact with moisture or hydrochloric acid in stomach.[1] PH_3 inhibits mitochondrial cytochrome c oxidase thereby inhibiting cellular O_2 utilization, inducing cellular damage by lipid peroxidation, direct toxic effect on cardiac myocytes, and adrenal gland with circulatory collapse.[3-7]

Case Reports

We present here two cases of suicidal ALP poisoning successfully treated in our institute.

Case 1

A 40-year-old female presented to emergency department with alleged history of consumption of one tablet of celphos (3 g) in the morning. The time interval between consumption of poison and presentation to hospital was approximately 1 h. On arrival, the patient was conscious, irritable with pulse rate of 100/min, blood pressure (BP) of 80/60 mm Hg, respiratory rate of 30/min and temperature of 98°F [Table 1]. Per abdominal examination revealed tenderness. Arterial blood gas (ABG) findings on room air were PaO_2 82.6, $PaCO_2$ 19.6, pH 7.326, HCO_3 9.9 with base excess-4, and oxygen saturation of 97%. Intravenous (IV) access was secured and resuscitated with 1 L of Ringer's lactate. The patient was given gastric lavage and was shifted to Intensive Care Unit (ICU) for further management.

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Routine investigation revealed hemoglobin of 11 g/dl, blood sugar of 96 mg/dl, total leukocyte count (TLC) of 10,000/mm^3, platelet count of 1.09 L/mm^3, blood urea of 20 mg/dl, serum creatinine of 0.6 mg/dl, serum sodium of 138 milliequivalent/L, and serum potassium of 4.6 milliequivalent/L. Coagulation profile, liver function test (LFT), chest X-ray, and electrocardiogram (ECG) were within normal limits. The patient was started on intralipid emulsion 20% at 10 ml/h and gradually tapered with monitoring of serum triglyceride level. Time interval between ingestion of poison and starting of lipid emulsion was 12 h. She also received IV magnesium sulfate ($MgSO_4$) 1 g over 20 min followed by 1 g/h for first 24 h and then 1 g every 6 h. Close monitoring of vitals and serum magnesium level [Graph 1] was performed.

She improved clinically on day 5 and intralipid and $MgSO_4$ were stopped. The patient did not require any ionotropic and ventilatory support during ICU stay. She was discharged on 9th day in a stable condition.

Table 1: Monitoring of vitals in patient 1

Day	Morning			Evening		
	Heart rate	Blood pressure	Respiratory rate	Heart rate	Blood pressure	Respiratory rate
1				103	98/70	28
2	98	100/65	28	98	102/60	26
3	90	109/67	26	88	110/66	23
4	84	110/78	20	86	108/73	19
5	85	1126/80	18	Patient was discharged		

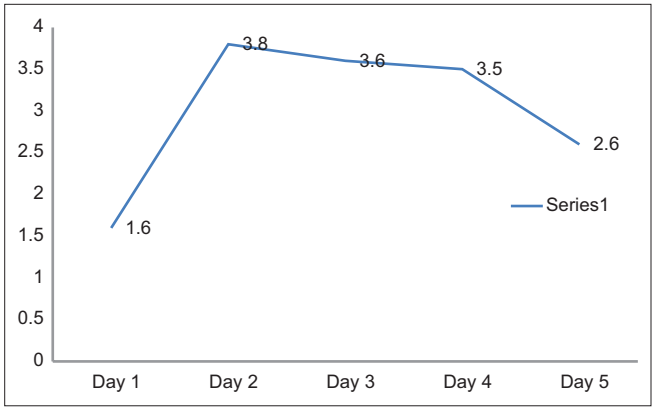
Table 2: Monitoring of vitals in patient 2

Day	Morning			Evening		
	Heart rate	Blood pressure	Respiratory rate	Heart rate	Blood pressure	Respiratory rate
1				132	78/55	28
2	118	80/60	28	108	99/60	22
3	124	99/59	22	115	110/66	21
4	116	101/63	20	117	103/70	18
5	109	106/73	19	104	110/70	18
6	92	100/72	16	88	106/74	18

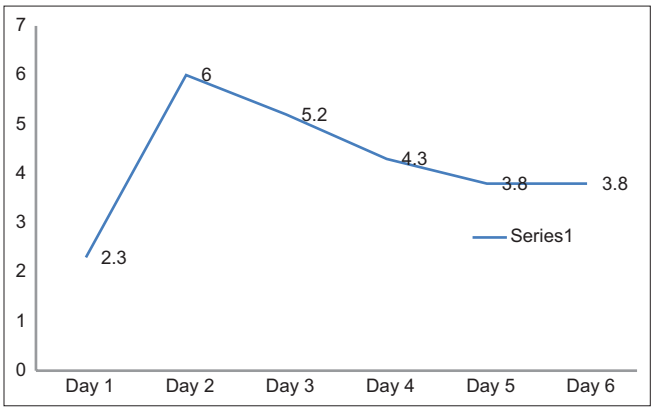
Case 2

A 30-year-old male presented to the emergency department with alleged history of consumption of one tablet of celphos in the morning. He was brought to the hospital within 1½ h of ingestion with complaint of nausea. His Glasgow coma scale was E3V4M5, heart rate was 132 beats/min, BP was 85/55 mm Hg [Table 2], peripheral pulse was feeble, skin was cold and clammy, respiratory rate was 34/min, and saturation was 93% on room air. Cardiovascular examination revealed tachycardia whereas central nervous system examination revealed mild dilated pupil reactive to light on both sides. IV access was secured and he was initially resuscitated with 1 L of IV Ringer's lactate. Gastric lavage was performed with normal saline and the patient was shifted to ICU on oxygen mask. ABG of the patient revealed severe metabolic acidosis (pH 7.081, $PaCO_2$ 14.2, PaO_2 97.7, SaO_2 95.6%, and HCO_3 4.0) which was corrected. Other routine investigations were within normal limits (hemoglobin 13.8 g/dl, TLC 13,500/mm^3, platelet 1.93 L/mm^3, blood urea 27 mg/dl, serum creatinine 1.5 mg/dl, serum sodium 143 milliequivalent/L, and serum potassium 4.1 milliequivalent/L). LFT, ECG, and chest X-ray were within normal limits. During the course of ICU stay, the patient received intralipid emulsion 20% at 10 ml/h and later tapered with monitoring of serum triglyceride. Time interval between ingestion of poison and starting of lipid emulsion was 10 h. Infusion of $MgSO_4$ started at 1 g/h for the first 24 h then tapered to 1 g every 6 hourly. Serum magnesium [Graph 2] was closely monitored.

He also received ionotropes titrated according to BP and stopped on day 5 of ICU stay. The patient showed clinical improvement and was finally discharged on 10th day in a stable condition.



Graph 1: Serum magnesium level (mg/ml) in first patient



Graph 2: Serum magnesium level (mg/ml) in second patient

Discussion

Aluminum phosphide poisoning may lead to multi-organ dysfunction. Presentation varies depending on variables such as doses, exposure route, and time interval between exposure and treatment initiation.[8] Diagnosis is based on history, garlic breath, and silver nitrate test on gastric aspirate.[9,10] It may lead to hypoglycemia, hyperglycemia, hypomagnesemia, or hypermagnesemia, although exact pathogenesis is unclear till date.[9-11]

Management is primarily supportive and involves initial evaluation, resuscitation along with strict monitoring of vitals and laboratory parameters. Previously published literature suggests potassium permanganate ($KMnO_4$) for gastric lavage as it oxidizes PH_3 to nontoxic phosphate.[12] However, Nasri Nasrabadi and Marashi described that PH_3 is a hard nucleophile and free radicals from resolution of $KMnO_4$ do not interact with each other.[13] Mirakbari described that $KMnO_4$ is an oxidizing agent and reduced to manganese dioxide and KOH by an exothermic reaction posing health hazard to patient as well as attending physician.[14] Bajwa *et al*. and Shadnia *et al*. in their studies proposed coconut oil for gastric lavage proposing that formation of protective layer around damaged gastric mucosa prevents PH_3 gas absorption. It also dilutes the gastric acid inhibiting the breakdown of phosphide.[15,16] We used intralipid emulsion in both cases based on "lipid sink" theory which relies on the fact that toxin with lipid soluble property can be sequestered within the lipid emulsion thereby reducing its effect site concentration and toxicity.[17] PH_3 is phosphorus trihydride and solubility of phosphorus can also effect PH_3. Solubilities of phosphorus are as follows: In water: 1 part/300,000 parts water; in absolute alcohol: 1 g/400 mL; in absolute ether: 1 g/102 mL; in $CHCl_3$: 1 g/40 mL; in benzene: 1 g/35 mL; and in CS_2: 1 g/0.8 mL. One gram phosphorus dissolves in 80 ml olive oil, 60 ml oil of turpentine, and about 100 mL of almond oil.[18] Hence, we thought PH_3 might also have lipid soluble property and used IV lipid emulsion to counter its effects. Hypomagnesemia is known to cause arrhythmia in ALP poisoning, and rationale of using $MgSO_4$ is its membrane stabilizing and antiperoxidant effect.[19] Rationale behind use of soda bicarbonate for moderate to severe acidosis is based on many studies mentioning it as a prognostic indicator of aluminum phosphide poisoning.[20] Moreover, drug ionization in acidic environment may reduce lipophilicity preventing maximal potential sequestration to circulating lipid particle.[21] However, there is literature against the use of sodium bicarbonate to treat metabolic acidosis in ALP poisoning. Marashi and Nasri-Nasrabadi proposed use of hydroxyethyl starch in ALP poisoning with induced shock and arterial pH > 7 to resolve symptoms of shock and increase arterial pH without the use of sodium bicarbonate.[22] Furthermore, Cooper *et al*.[23] reported no beneficial hemodynamic effect of sodium bicarbonate in patients with severe lactic acidosis. Other treatment modalities described are intravenous methylene blue for methemoglobinemia, N-acetylcysteine, digoxin, hyperbaric oxygen, trimetazidine, and boric acid.[20,24]

Conclusion

We propose the use of IV lipid emulsion for ALP poisoning. To the best of our knowledge, this is the first case report citing the use of IV lipid emulsion to treat ALP poisoning. Both of our cases had positive outcome with the use of IV lipid emulsion with an aim of dissolving the circulatory PH_3 gas which has diffused through the gastric barrier. It has an extra edge over coconut oil as it targets absorbed poison which will be helpful for cases coming late for the treatment. However, large multi-centric trial will be needed to find out whether IV lipid emulsion can be used alone or in combination with coconut oil gastric lavage with other available modalities for successful management of ALP poisoning.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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