Case Report

Hot charcoal vomitus in aluminum phosphide poisoning - A case report of internal thermal reaction in aluminum phosphide poisoning and review of literature

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ABSTRACT

Aluminium phosphide (ALP) poisoning is a commonly encountered poisoning in emergency departments in most developing countries. Many papers have revealed metabolic derangements in this poisoning and also examined contributing factors leading to death, but only few have reported physical damage. Some case reports have described a complication that has been frequently termed 'ignition'. The exact mechanism of this phenomenon has not been fully elucidated. An exothermic reaction during therapeutic administration of chemicals may contribute to this problem, but the incidence has occurred in the absence of treatment or drug administration. Here, we report a 34-year-old woman with ALP poisoning who presented with hot charcoal vomitus, a sign of internal thermal event, leading to the thermal burning of the patient's face and internal damage resulting in death. We reviewed all reported cases with similar complication to demonstrate varied characteristics of patients and to propose the possible mechanisms leading to this event.

Key words: Aluminium phosphide poisoning, ignition, physical damage, thermal injury

INTRODUCTION

Aluminium phosphide (ALP) is an effective solid pesticide commonly used for preserving grain. It is a commonly encountered poisoning in developing countries including Iran and India and has drawn worldwide attention since it is considered as a life-threatening condition without an efficient antidote.[1] While studies are going on to develop an effective antidote, some chemicals are used to help patients to recover from this poisoning.[1] Predictive factors have been elucidated to determine which patient would have better or worse condition.[2] Authors of related case reports have tried to attribute it to ignition of highly flammable phosphine gas. If this is true, there should be a source of commencement of thermal reaction; in some cases this has been suggested to originate from the friction during nasogastric tube insertion or negative pressure induced by suctioning. We are presenting a case of ALP poisoning that appeared as internal ignition with hot charcoal vomitus. The literature was reviewed for all case reports of internal ignition in ALP poisoning.

CASE REPORT

A 34-year-old woman was brought to the emergency department with alleged history of taking ALP tablets. Her relatives revealed the aluminium canister of ALP tablets and alleged she had taken 2 tablets 30 min before. On arrival, she was drowsy and was not responding to verbal commands. Her body was cold and hypotonic, and her skin was pale with mottling. Her vital signs were as follows: Pulse rate 110/min regular, blood pressure 70/52 mm Hg, respiratory rate 20/min, shallow and body temperature, 36.1°C. On emergency investigations, the electrocardiogram showed sinus tachycardia, pulse oximetry showed O_2 saturation of 91% on room air and arterial blood

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gas analysis demonstrated metabolic acidosis with pH of 7.1. Presentation of ALP tablets by the family and symptoms of patient favoured diagnosis of ALP poisoning. The patient was instantly attended to; intubation was carried out, and a nasogastric tube was inserted. Normal saline was administered by infusion intravenously. After gastric washing with sodium bicarbonate, gastric lavage was performed using potassium permanganate (1:10,000) and then activated charcoal (100 g) was administered. Shortly afterwards, she vomited hot charcoal filled with small bubbles covered with white smoke that led to thermal burning of the left side of the her face. A simultaneous cough splashed some vomit on the personnel's clothes. She was immediately transferred to an isolated room and underwent infusion of calcium gluconate and magnesium sulphate. The patient's situation progressively deteriorated. Sensorium decreased and apnoea occured necessitating resuscitation and mechanical ventilation. At 3 h after emergency department admission, the patient had cardiac arrest and died.

DISCUSSION

Using Google Scholar, PubMed and Scopus databases, the terms' ignition, thermal injury, exothermic reaction and physical damage were searched under 'ALP' category. Six cases of thermal injury in ALP poisoning were found in five papers that had been published in the literature during 2007–2012.[3-7] A summary of case reports along with the present report is shown in Table 1. In the case reports mentioned, the mechanisms of ignition are diverse and implicate the poison's byproducts, patient and environment factors as contributing factors.

ALP is not flammable. However, it reacts readily with water and acids to produce hydrogen phosphide (phosphine) and a small amount of diphosphine. Phosphine imposes its toxicity with inhibition of cytochrome oxidase that leads to metabolic disturbances and internal organ damages.[1] Methaemoglobinemia and haemolysis,[8] acute pancreatitis,[9] oesophagobronchial fistula[10] and polyserositis[11] are regarded as uncommon

Table 1: Summary of seven case reports of thermal injury events in aluminium phosphide poisoning

References	Gender/ age	Presenting symptom	Place of event	Term used	NGT insertion before event	Chemical administration before event	Suggested mechanism	Outcome	Autopsy findings
Mirakbari (present case)	Female, 34	Hot vomitus	Emergency department	Exothermic reaction	Yes	Yes	Chemical interaction	Death	Not available
Akinci *et al.*[3]	Female, 19	Blue coloured gas emission with gunpowder sound	Emergency department	Explosion	Yes	No	The friction of NGT + negative pressure + highly flammable gas phosphine and diphosphine gas	Death	Not available
Wahab *et al.*[4]	Female, 26	Bluish flames	Emergency department	Self-ignition	Yes	No	Large amount of phosphine produced + the heat + negative pressure	Death	Not available
Shadnia and Soltaninejad[5]	Female, 22	Flame	Emergency department	Spontaneous ignition	Yes	No	Spontaneously flammable diphosphine and phosphine reacting with air oxygen	Death	Available*
Shadnia and Soltaninejad[5]	Male, 57	Flame	Emergency department	Spontaneous ignition	Yes	No	As above	Death	Available*
Yadav *et al.*[6]	Male, 55	Explosive sound with a flash and flame	Found dead in a park	Spontaneous ignition	No	No	Autoignitable diphosphine gas + high atmospheric temperature	Death	Available**
Rai *et al.*[7]	Male, 56	Flames with sparkling of fumes	Emergency department	Spontaneous ignition	Yes	No	Not declared	Death	Not available

*Burning of the left side of the face of the first patient and the hair of the second patient. In both internal examination revealed congestion, inflammation, microvascularisation, hydropic degeneration of hepatocytes, mononuclear infiltration, haemorrhage and sinusoidal clusters of polymorphonuclear leucocytes of the live, **Singeing of hair along with clothing in situ showing blackening, congestion of all organs with oedematous lungs, gastric mucosa sloughing with slight submucosal haemorrhage at the greater curvature, thinned out stomach wall with obliteration of mucosal rugosities. NGT – Nasogastric tube

complications of ALP poisoning. Internal ignition and thermal injury following ALP poisoning is another interesting and unusual complication that may complicate the patient's condition and may be a hazard to the medical personnel.[12,13]

Phosphine and diphosphine may ignite spontaneously at air concentrations above the lower explosive (flammable) limit (LEL) of 1.8% v/v.[14,15] Phosphine causes corrosion and may induce an exothermic reaction at higher temperatures, especially above 30°C.[15] When phosphine burns, it produces a dense white cloud of 'phosphorus pentoxide', a severe respiratory tract irritant. ALP is incompatible with oxidising agents, which means it induces adverse reactions.[15] Potassium permanganate is recommended in ALP poisoning to convert phosphine to phosphate,[1] but it is an oxidising agent and when in contact with organic matter, it is reduced to manganese dioxide and the very corrosive potassium hydroxide.[16-18] This reaction is also exothermic and may have contributed in increasing injury as well as the occurrence of ignition events.[18] Soltaninejad *et al*. suggest that permanganate-induced toxicity occurs when saturated solution is ingested and not the diluted solution (1:10,000) that is used in decontamination of the patient, but the dilution is usually not supervised in emergency departments and the exothermic reaction may occur even in the diluted form.[18,19] Even though it is suggested that negative pressure during gastric suctioning may contribute to ignition, practically, negative pressures are designed for an exhaust ventilation system in gas cabinets relative to surrounding areas for safety purposes and have not been documented to act as starting points of ignition.[20] An event is reported outside the hospital where ignition happened in the absence of therapeutic interventions.[6]

Phosphine, diphosphine and its by-products may impose a threat to the health personnel that would need preventive measures, even evacuation.[12] Physical damage is rare in this poisoning and has frequently been reported in the case of ignition.[6] Thermal injury further increases damage and is an additional risk to medical personnel. The reason why the combustion injury is rarely reported in spite of multiple cases of ALP poisoning is not clear. This event may occur internally without external manifestations in many instances.

CONCLUSION

ALP poisoning warrants aggressive management, and emergency departments need to be prepared adequately to handle the patients. The occurrence of ignition with the release of phosphine from ALP poisoned patients can affect not just the patient but also pose a health hazard to emergency physicians and medical staff. The mechanism of the ignition is still not well-understood and may vary from patient to patient.

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Conflicts of interest

There are no conflicts of interest.

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