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Case Report

N-ACETYLCYSTEINE, A BOON FOR YELLOW PHOSPHORUS-INDUCED ACUTE LIVER FAILURE? A CASE REPORT

AASHIQ AHAMED SHUKKOOR[1], NIMMY ELIZABETH GEORGE[1], SARAVANAN THANGAVELU[2]*

[1]Department of Cardiology, PSG Institute of Medical Science and Research, Coimbatore, Tamil Nadu, India. [2]Department of General Medicine, PSG Institute of Medical Science and Research, Coimbatore, Tamil Nadu, India. Email: dr_saravanan12@yahoo.co.in

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ABSTRACT

Rat killer, in the form of a paste, is a commonly used rodenticide in India. It contains 3% yellow phosphorus, which is a local and a systemic toxin that damages all tissues it contacts. The lethal dose of yellow phosphorus is about 1 mg/kg of body weight. We present a case report of a 30-year-old female patient with an alleged history of intake of 30 g rat killer paste mixed with one glass juice with suicidal intent. She presented with clinical features of acute liver failure (ALF) and was treated with N-acetylcysteine (NAC) infusion with other supportive therapy and recovered completely within 13 days. Poisoning with yellow phosphorus needs to be studied in the aspect of treatment, due to the lack of any specific antidote. The patient factors that help in the recovery also need to be investigated. Although highly lethal, the recovery of ALF due to yellow phosphorus-containing rodenticide is possible. Early intravenous administration of NAC, which acts as glutathione substitute, anti-inflammatory agent, and anti-oxidant could contribute to complete resolution of ALF in yellow phosphorus poisoning.

Keywords: Yellow phosphorus, Poisoning, Acute liver failure.

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INTRODUCTION

Poisoning is a major problem worldwide. Intentional and accidental ingestions of toxins in humans lead to high mortality and morbidity rates. Yellow phosphorus is a well-known hepatotoxic agent commonly found in fireworks, ammunition, agricultural dung and it is ubiquitously present in rodenticides. It is available as both paste and powder form in the open market in India, with concentrations varying from 2% to 5%. The lethal dose of yellow phosphorus is 1 mg/kg of body weight, and ingestion of amounts >780 mg is almost invariably followed by death [1,2]. It is a protoplasmic poison, which spontaneously combusts in air and causes multi-organ failure when ingested. The quantity of yellow phosphorus consumed, lack of specific antidote, and time lapse in treatment affects the outcome of poisoning. Very few case reports of yellow phosphorus poisoning have been reported worldwide. Here is one such rare case report of successful management of a 30-year-old female patient who consumed a substantial amount of yellow phosphorus in the form of rodenticide paste which is 18 times of the lethal dose.

CASE REPORT

A 30-year-old female patient, a housewife of weight 50 kg, with no medical or medication history was brought to the emergency department with complaints of loose stools (2 episodes), vomiting (7 episodes), and mild giddiness. The initial presentation of the patient depicted gastroenteritis. On personal interview of the patient, it was revealed that she consumed two packets of 15 g rodenticide paste-containing yellow phosphorus (3%), 11 hours before admission with suicidal intent.

On initial examination, she was conscious, oriented, had paled, and was psychologically depressed. There were no bleeding manifestations, jaundice, or other signs of liver failure. Laboratory investigations showed normal biochemical parameters. Electrocardiogram was within the normal limits. Ultrasonography of the abdomen showed fatty liver. She was treated with supportive measures such as intravenous pantoprazole 40 mg and intravenous ondansetron 4 mg. N-acetylcysteine (NAC) infusion was started within 1 hour of admission, and the patient was shifted to the intermediate care unit (Tables 1 and 2).

From day 2, the patient experienced a clinical deterioration with mild abdominal pain and vomiting. It was followed by two episodes of vomiting, fatigue, abdominal pain, and nausea on day 3. On day 4, she had generalized body tiredness, myalgia, and disturbed sleep due to nausea. On day 5, she experienced mild nausea. On day 6, she had 1 episode of vomiting and was shifted to the ward. On these days, her laboratory investigations showed deranged liver enzymes (Table 3).

From day 7 to day 13, the patient was asymptomatic and improved clinically. She was discharged from hospital on day 14 after 1 day of observation. The discharge medications consisted of tablet pantoprazole 40 mg O.D, tablet ursodeoxycholic acid 300 mg B.D, tablet rifaximin 550 mg B.D, tablet L-adenosyl L-methionine 200 mg BD, and syrup lactulose 20 ml TID, which was continued till review.

The patient was reviewed on the 7th day from hospital discharge, her laboratory investigations showed improvement in the liver enzymes. On the second review, the laboratory investigations were normal and the patient had completely recovered (Table 4).

DISCUSSION

Sporadic cases of ingestion of toxins on a suicidal intent are common in developing countries [3]. Our patient allegedly ingested 900 mg of yellow phosphorus in the form of a paste which is highly lethal. Orally ingested yellow phosphorus is rapidly absorbed through the gastrointestinal tract. About 69%–73% of the total ingested dose concentrates in the liver after remaining in the gut for a few hours [4].

The features of yellow phosphorus poisoning are classically divided into three stages. The first stage involves gastrointestinal irritation and shock. Features begin within minutes of ingestion, but may be delayed in some cases. Symptoms involve nausea, vomiting, diarrhea, and abdominal pain [5-7]. Our patient developed several episodes of vomiting, diarrhea, and giddiness within 11 h of ingestion.

The second stage is quiescent or asymptomatic period, which lasts for 24–74 h [8]. The patient is mistaken to be improving and is most likely to get discharged prematurely. The patient was asymptomatic and was clinically stable for 24 h after initial supportive therapy.

The third stage involves a clinical deterioration with fulminant hepatic failure, which may progress to multi-organ failure. This stage involves high rates of mortality, and death usually occurs in 4–8 days [9]. From day 2, our patient's biochemical and clinical parameters deteriorated. She was at increased risk of fulminant hepatic failure but recovered by day 13 due to prompt treatment with NAC.

The current report is in line with other reports that it is difficult to manage yellow phosphorus poisoning due to multiple factors. First due to the property of yellow phosphorus itself, that it gets rapidly absorbed and remains stable for long periods in the gut because of higher water content and low oxygen tension [10]. Second, because there are no diagnostic tests to detect or antidote available to treat yellow phosphorus poisoning. Finally, treatment of yellow phosphorus is complicated due to symptomatic improvement in stage 2.

Mechanism of toxicity of yellow phosphorus is by the production of phosphoric acid, which produces an exothermic reaction and causes direct tissue damage due to the production of free radicals. NAC, which is an antioxidant and hepatoprotectant, acts as a glutathione precursor by donating sulfhydryl groups [11]. It also improves mitochondrial energy metabolism [12]. It acts as a scavenger of oxygen free radicals and it replenishes the glutathione stores. It is found to have a good prognosis in patients with yellow phosphorus poisoning when administered early [13,14]. The patient's liver enzymes were highly elevated. The outcome of the patient after 10 days of NAC administration was excellent; highlighting the importance NAC in nonacetaminophen-related liver failure.

Table 1: Core therapy of NAC

Day	NAC dose
Day 1	NAC 10.5 g in 200 ml 5% dextrose over 1 h NAC 3.5 g in 500 ml 5% dextrose over 4 h NAC 7 g in 1000 ml 5% dextrose over 16 h
Day 2 to Day 10	NAC 3 g in 500 ml 5% dextrose over 4 h (2 doses per day)

NAC: N-acetylcysteine

CONCLUSION

Our case report highlights the importance of history taking of patients brought to emergency care. Yellow phosphorus poisoning requires more than just primary care. Early improvement in symptoms should not be mistaken as a resolution to the clinical problem. Instead, the patient has to be periodically monitored for clinical and biochemical parameters for at least 5 days before premature discharge from the hospital. Prompt use of NAC within the first 12 h of poisoning has been

Table 2: Supportive medications administered during the hospital stay

Drugs	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13
Vit K 10 mg intravenous Q24H	✓	✓	✓	✓	✓								
Piperacillin-tazobactam 4.5 g intravenous Q6H					✓	✓	✓	✓	✓	✓	✓		
Tablet L-adenosyl L-methionine 200 mg Oral Q12H			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tablet ursodeoxycholic acid 300 mg Oral Q12H				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Syrup lactulose 20 ml oral Q12H			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Capsule rifaximin 550 mg–400 mg-550 mg oral Q8H				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3: Abnormal laboratory parameters of the patient during the hospital stay

Laboratory parameters	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 13
Direct bilirubin (mg/dl) ref: (0.0–0.2)	0.2	0.3	1.9	2.1	4.7	6.1	5.9			4.5	2
Indirect bilirubin (mg/dl) ref : (0.2–0.8)	0.4	0.5	0.5	0.9	1	0.9	0.3			0.2	0.4
Serum glutamic oxaloacetic transaminase (U/L) ref: (5–41)	17	93	652	555	460	324	333	364		219	146
Serum glutamic pyruvic transaminase (U/L) ref: (5–38)	19	263	2047	1758	1071	534	375	638		102	102
Alkaline phosphatase (U/L) ref: (40–129)	81	81	114	138	157					167	147
Platelet ($\times 10^3/\mu L$) ref: (150–400)	171	166		139		120	71		74		
Prothrombin time (s) ref: (11–15)	17.8	27.8		29.4		16	13	13.8			
Lactate (mmol/L) ref: (0.4–2.2)	0.9		2.7		4.1	3.1	3.7			2.9	3
Ammonia (mcg/dl) ref: (15–45)	20				22						22

Table 4: Comparison of laboratory parameters on review after discharge from the hospital

Laboratory parameters	First review (after 1 week)	Second review (after 1 month)
Direct bilirubin (mg/dl) ref: (0.0–0.2)	1.1	0.3
Indirect bilirubin (mg/dl) ref: (0.2–0.8)	0.4	0.7
Serum glutamic oxaloacetic transaminase (U/L) ref: (5–41)	63	37
Serum glutamic pyruvic transaminase (U/L) ref: (5–38)	41	23
Alkaline phosphatase (U/L) ref: (40–129)	124	123
Lactate (mmol/L) ref: (0.4–2.2)	2.7	2.1
Prothrombin time (s) ref: (11–15)	12.6	12.6
Platelet ($\times 10^3/\mu L$) ref: (150–400)	100	350

found to be beneficial. Due to high mortality rates, restriction of use and appropriate disposal procedures of yellow phosphorus-containing rodenticide should be developed.

AUTHORS' CONTRIBUTION

Aashiq Ahamed Shukkoor: Informed consent, maintaining patients file and master file of project, drafting final report, submission to IHEC, publication.

Nimmy Elizabeth George: Informed consent, maintaining patients file and master file of project, drafting final report, submission to IHEC, publication.

Saravanan Thangavelu: Concept, design, laboratory investigations, laboratory report interpretation, treatment decision, patient evaluation, examination of patients on follow-up, publication.

CONFLICT OF INTEREST

The authors have none to declare.

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