

Hemoperfusion in white phosphorus poisoning, case report.

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Abstract

Introduction: White phosphorus is commonly used in pyrotechnic products. When ingested, it can cause gastrointestinal, hepatic, and renal alterations, circulatory collapse, and neurotoxicity. There is no antidote, and a treatment option may be hemoperfusion, which is why the management of this case is presented.

Clinical case: A 26-year-old man ingested 100 mg of white phosphorus in the form of 5 pyrotechnic pills (1.41 mg/kg) 5 hours previously. The physical examination revealed arterial hypertension 158/92 mm Hg; the rest of the examination was regular. Hemoglobin 17.8 g/dl, cholinesterase 13216 U/L, ketonuria 150 mg/dl, and toxicology were negative for amphetamines, barbiturates, benzodiazepines, cocaine, marijuana, methadone, methamphetamines, opiates, and antidepressants.

Management: Gastric lavage was performed with 10% sodium bicarbonate (20 ampoules) plus 1000 ml of 0.9% sodium chloride. He was hydrated with 0.9% saline solution (100 ml/hour), 40 mg omeprazole intravenously, and acetylcysteine via continuous infusion. Vascular access was achieved, and the patient underwent four sessions of hemoperfusion (Jafron HA230 activated carbon) every 12 hours for 3 hours.

Evolution: In the third year, there was an increase in TGP of 1002 U/l, and the INR was 4.56. Severe acute hepatitis was diagnosed without encephalopathy or acute liver failure. Four additional sessions of hemoperfusion were performed, and the patients simultaneously received vitamin K and acetylcysteine. On the 6th day, the TGP decreased to 128 U/L, and the INR normalized. He was discharged in good condition.

Conclusion: Hemoperfusion for eight sessions prevented liver failure and mortality in this patient with severe white phosphorus poisoning.

Keywords

Phosphorus, liver failure, hemoperfusion, poisoning, intoxication, case report.

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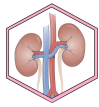
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Hemoperfusion is an extracorporeal technique characterized by the passage of blood through a cartridge or column containing fixed adsorbent particles with varied adsorption properties [1].

Toxins with molecular weights between 100 and 40,000 daltons bind to the particles and are eliminated as the blood leaves the column; this binding is carried out by physical adsorption, the affinity of which is governed by molecular size and lipophilicity through hydrophobic interactions, van der Waals interactions, hydrogen bonds or ionic attraction; in this way, higher-molecular-weight solutes are adsorbed less efficiently [1].

There are two main types of adsorbent particles: activated carbon and resins (such as hydrocarbon polymers and polystyrene). Charcoal has a greater affinity for water-soluble molecules, while resins have a greater affinity for fat-soluble molecules [1].

In our country, there is growing evidence of cases of white phosphorus poisoning, as confirmed by a retrospective study with 590 cases of this type of poisoning after 19 years of follow-up; the age ranges vary between 2 and 70 years, with a mean of 18.27 years. Female sex was more common (68%), and 98.6% of the patients attempted suicide, with between 1 and 70 tablets (0.3-21 g) being consumed [2].

The objective of the present study was to present therapeutic management with hemoperfusion in a patient with poisoning.

Case

Clinical history

The male patient was 26 years old and Hispanic, with no previous clinical or surgical history. Concerning toxic habits, he had a history of ingesting alcohol once a week until he became drunk for one year and using *Cannabis sativa* occasionally for several years. The patient came to the emergency room asymptomatic due to voluntary ingestion of white phosphorus in the form of tablets (imps-“diablillos”) for 5 hours (approximately 100 mg, 1.41 mg/kg) 5 hours before his arrival, with family problems as the apparent cause.

Physical exam

Upon physical examination, the patient was found to have the following vital signs: blood pressure 158/92 mm Hg, heart rate 97 beats/minute, respiratory rate 21 breaths/minute, and temperature 36.1 degrees Celsius. The patient had a patent airway, no signs of hypoperfusion or shock, and no neurological alterations, with physical examination showing no evidence of alterations.

Laboratory:

Initial laboratory tests revealed the following results: hemoglobin 17.75 g/dl, hematocrit 55.25%, cholinesterase 13216 U/L, elemental and microscopic urine presence of ketones 150 mg/dl, and toxicological negative results for amphetamines, barbiturates, benzodiazepines, cocaine, marijuana, methadone, methamphetamines, opiates, and antidepressants.

Driving

In the emergency department, gastric lavage was performed with 10% sodium bicarbonate (20 ampoules) plus 1000 ml of 0.9% sodium chloride because potassium permanganate or activated carbon was unavailable. Extensive hydration with crystalloid was indicated at 100 ml/hour with 0.9% saline solution, gastric protection with intravenous omeprazole 40 mg, and acetylcysteine in continuous infusion as liver protection.

The patient was evaluated by a nephrology specialist, who determined the start of adsorbent therapy through hemoperfusion (Jafron HA-activated carbon 230); a temporary high-flow catheter was placed at the right jugular level under ultrasound guidance, and four sessions were scheduled, one every 12 hours lasting 3 hours, with an extracorporeal flow of 200 ml/min and a QD of 500 ml/min, without complications.

Evolution

During his hospitalization in the clinical area, the patient maintained stable hemodynamics without signs of fluid overload or encephalopathy. From the third day of hospitalization, there was a progressive increase in liver enzymes and prolongation of clotting times (Table 1), indicating severe acute hepatitis; due to the absence of encephalopathy, the patient did not meet the criteria for acute liver failure. He again received four additional sessions of hemoperfusion. Simultaneously, vitamin K and acetylcysteine are received. On the sixth day, there was an improvement in liver function tests and normalization of clotting times. Due to good clinical progress and laboratory parameters, the high-flow catheter was removed, and it was decided that discharge would continue to follow up on an outpatient basis.

The most relevant laboratory parameters and their evolution during the patient's hospitalization are described below (Table 1).

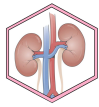
Discussion

Technological advances in extracorporeal purification techniques, especially cartridges or adsorption columns, have allowed more efficient management of patients requiring them.

Additionally, knowing the mechanisms of adsorption as a complement to diffusion and convection and its adverse effects made it easier to determine which types of patients benefit most from this therapy despite the need for more consensus.

A patient requires hemoperfusion therapy in cases such as severe poisoning (due to drugs, chemicals, or natural toxins), acute or chronic liver diseases, and chronic kidney disease in the context of improving the removal of medium toxins and pruritus [3]. In the case of sepsis, hemoperfusion plays a complex role since it is selectively indicated for the removal of endotoxins and nonselectively for the removal of cytokines and interleukins [3].

In the case of white phosphorus poisoning, the toxic dose reported by most of the literature in adults is 0.2 to 1.4 mg/kg, and its treatment has classically been managed with gastric lavage,



hydration, and diuretics to increase its elimination, N acetylcysteine, and enemas [4].

Among the most severe symptoms of white phosphorus poisoning are hepatitis with increased transaminase and bilirubin levels, encephalopathy, increased clotting times, and dysrhythmias [4].

Symptoms progress through phases: phase I, characterized by gastrointestinal symptoms; phase II (1 to 3 days), characterized by a quiescent stage with mild gastrointestinal symptoms; and phase III (more than three days), characterized by severe organic toxicity [4].

Phases I and II are potentially reversible if action is taken promptly; for this reason, clinical treatment yields good results in these phases but not in the last one, which is less effective and even irreversible [4].

For this reason, extracorporeal therapy, such as hemodialysis and hemoperfusion, can increase effectiveness, allowing patients to recover favorably even if they are in phase III. Although hemoperfusion therapies are preferred for paraquat poisoning and combination with hemodialysis is indicated if hydro electrolyte or acid-base alterations occur [3], this indication could be extrapolated in patients with white phosphorus poisoning.

White phosphorus (P₄) is an inorganic chemical component of 30.9 daltons that is used in the manufacture of rodenticides, fireworks, weapons, and fertilizers, so when considering extracorporeal therapy, it can be removed efficiently and quickly with hemoperfusion cartridges [4, 5].

It can react spontaneously with air-forming phosphoric pentoxide (P₄O₁₀), which in turn comes into contact with the water-forming phosphoric acid known for the burns it produces due to its corrosive

characteristics. In this way, the molecular weight increases, so hemoperfusion therapy is more efficient than hemodialysis for this type of poisoning [4, 5].

Hemoperfusion uses dialysis blood transfer lines and a conventional dialysis machine, and the cartridge or column generally contains between 100 and 300 g of activated carbon or 300 to 650 g of resin. In our case, a Jafro HA 230 cartridge was used for coal. Vascular access, such as a tunneled or nontunneled central venous hemodialysis catheter, is also required for most patients [1].

It requires anticoagulation, which is performed with systemic heparin or regional citrate. Priming and flushing of the devices are accomplished with normal saline [1].

The minimum recommended blood flow for adequate efficacy is approximately 300 ml/min [1].

Intermittent hemoperfusion is generally performed for approximately four hours, and longer treatment times are unlikely to additionally remove the toxicant due to cartridge saturation [1].

Repeat treatments may be necessary once the drug is redistributed from tissues to plasma following its elimination from the plasma compartment (i.e., "rebound"). This is associated with increased signs of drug toxicity, such as neurological dysfunction or coma [1].

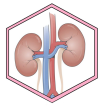
For the prescription of hemoperfusion in our patient, a Jafro HA230 carbon cartridge was used in a conventional hemodialysis machine for 3 hours at a flow rate of 250 ml/h.

Not reaching the recommended prescription values allowed us to have a better outcome since the patient was in phase I of poisoning, clearly with liver damage after having ingested 100 mg of organophosphate, corresponding to 1.4 mg/kg per autolytic attempt.

Table 1. Evolution of laboratory tests.

Laboratory	Day 0	*Day 3	Day	Day 5	Day 6	Day 7	Day 9	Day 10	Day 11
Leukocytes (u/ul)	7050			5070	4210	4330	5520		
Hemoglobin (g/dl)	17.75			14.64	13.3	13.75	14.1		
Platelets (u/ul)	252000			86000	72000	103000	141000		
TP (Seconds)	fifteen		fifty	27		12.8		fifteen	
TTP (Seconds)	29		74	46		26		29	
INR	1.15		4.56	2.6		0.96		1.15	
Glucose (mg/dl)	71			78	76				83
Urea (mg/dl)	12.84	19.26		17.12	10.7			19	23.54
Creatinine (mg/dl)	1.04	0.83		0.76	0.74			0.84	0.9
AST (U/L)	13	285	527	1002	201	128			69
ALT (U/L)	13	105	239	546	270	235			183

* Start of hemoperfusion therapy



In this way, clinical treatment plus hemoperfusion allowed the patient to recover satisfactorily on the eighth day after hospitalization, shortening the hospitalization time and preventing damage to other organs.

Conclusions

Poisoning by different chemical substances and, in this case, by white phosphorus represents a public health problem in our country, so more work should be done in the preventive field with an appropriate mental health program. In the case of acute white phosphorus poisoning, hemoperfusion with charcoal cartridges and the use of a conventional dialysis machine has become another ally for clinical treatment, so understanding its physiology, mechanism, and prescription is essential for nephrologists and doctors who are treating these patients.

Patient perspective

The patient was interviewed on multiple occasions, and on each of them, he appeared cooperative and with hope of recovery despite having attempted his life. He was psychologically treated for impulse control and for suffering from depression. The patient observed the treatment as part of the healing process without experiencing extreme discomfort from placing the hemoperfusion catheter or the treatment.

Abbreviations

QD; Dialysate flow.

Supplementary information

The supplementary materials have yet to be provided.

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Contributions of authors

María José Pinos Cedeño: conceptualization, data curation, formal analysis, Research, Methodology, Resources.
Sebastián Guacho Guacho: conceptualization, data curation, formal analysis, research
Anthony Rosero Portilla: conceptualization, data curation, formal analysis, and research.
Santiago Silva Tobar Project administration, Resources, Software, Writing – original draft.

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Availability of data or materials

The datasets generated and analyzed during the current study are not publicly available but can be shared with an academic request.

Statements

Ethics committee approval and consent to participate

Clinical cases are not needed. Consent for participation was obtained from the patient.

Consent for publication

Consent for publication was obtained from the patient.

Conflicts of interest

The authors declare no conflicts of interest.

Author information

Does not apply.



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