

Intentional ricin intoxication: A case report and review of the literature

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Abstract

Background: Ricin is considered one of the most potent toxins worldwide. Several case-reports of intentional ricin intoxication have been described. Symptoms are mainly gastro-intestinal and may lead to hypovolemia and organ failure.

Case: A 34-year-old man visited the emergency department of our hospital with an attempted suicide by ingestion of 15 castor seeds which were chewed upon, along with consumption of 4 or 5 units of alcohol. He was admitted for observation. Several hours after ingestion, the patient developed nausea and vomited several times. He was discharged after 24 hours of observation.

Conclusion: In the past 40 years 18 cases of intentional ricin intoxication have been described. Five of them had lethal outcome. There appears to be a correlation between the time of intoxication and risk of death. Therefore, clinicians should start therapy immediately when intoxication with ricin is suspected.

Keywords

Ricin; Nausea; Toxins; Organ failure.

Introduction

Ricin is considered one of the most potent toxins worldwide. It is obtained from the seeds of the castor oil plant, *Ricinus communis*. Ricin intoxication in humans and animals has been described since 100 years or more [1]. Nevertheless, symptomatic ricin intoxication is rare and has been described previously in scientific case reports [2,3]. Recently, a review was published which described 50 intoxications with ricin, of which 12% had a fatal outcome. The homicide of the Bulgarian journalist Georgi Markov in London 1978, also known as the “umbrella murder”, probably is the most infamous intentional intoxication with

ricin [4]. Intoxication with ricin can cause a wide spectrum of symptoms, but the toxin itself can hardly be detected in serum because of rapid intracellular absorption. Diagnosing a ricin intoxication and timely recognition of clinical symptoms can therefore be a challenge. Since ricin can easily be obtained from the internet or garden centers, timely recognition by physicians is crucial.

Case Presentation

A 34-year-old man with a medical history of depression and an attempted suicide visited the emergency department of our hospital with an attempted suicide by ingestion of 15 castor seeds which were chewed upon, along with consumption of 4 or 5 units of alcohol. The castor seeds were ingested approximately 7 hours before presentation at the emergency department. Several hours after ingestion he developed nausea and vomited several times.

We observed patient with a blood pressure of 137/87 mmHg and a mild tachycardia of 106 beats per minute with mild shortness of breath. Other physical examination was normal. There were no signs of dehydration or hypovolemia. Additional laboratory tests showed no abnormalities besides a slightly elevated creatinine kinase of 197 (table 1). The patient was admitted for observation and the laboratory tests for electrolytes and liver enzymes were continued every 4 hours. In the absence of further physical complaints, stable blood results and after psychiatric consultation, the patient was discharged from the hospital after 24 hours of observation.

Background

Ricin is a potent toxin that can be obtained from the seeds of the Castor bean plant (*Ricinus communis*). The castor bean is related to the Euphorbiaceae, a family of plants known for their tox-albumin [5]. Tox-albumins are toxic plant proteins which inhibit protein synthesis. The castor plant does not have an European origin, but castor seeds are easily available at garden centers and on the internet. Castor seeds are used to produce castor or so-called wonder oil. After producing wonder oil from the castor seed, ricin is left in the bean pulp. When processed under high temperatures, ricin remains inactive [6,7]. Castor oil has a history for its use as a laxative and for the management of infection and inflammation [1,8]. Nowadays, castor oil is still used for paints, ink, lubricating and cosmetic products [1].

Our patient bought the castor seeds on the internet and made an exact calculation of how many seeds he would need to ingest in order to obtain a lethal effect. The amount of ricin in one castor bean is approximately 1-5% of the seed its total weight. Considering one castor seed weights a 100 milligram, the amount of ricin in one seed would be 1-5 milligram [7,9]. The lethal dose in oral ingestion has been estimated to be 1 to 20 mg/kg of bodyweight [7,10]. Ricin can be administered by inhalation, injection or ingestion. In the case of ingestion, it is essential that the seeds are chewed upon in order to release the toxin in the stomach and small intestine.

Table 1: Laboratory test results, approximately 7 hours after ingestion of the castor seeds.

Test	Result	Test	Result
Creatinine (Cr) mg/dl	0.77	Alanine transaminase U/L	20
Sodium (Na) mmol/L	145	LDH U/L	173
Potassium(K) mmol/L	3,9	AF U/L	77
Bicarbonate mmol/L	25	gGT U/L	21
Calcium (Ca) mg/dl	9.3	CK U/L	↑197
Phosphate mmol/L	0,88	CRP mg/L	<0,5
Magnesium mmol/L	0,9	Glucose mg/dl	90
Bilirubine U/L	8	Albumine mmol/L	48
Aspartate transaminase U/L	27		

Pathophysiology

Ricin is a protein with a molecular weight of about 64 kilodalton, roughly equivalent to albumin. It consists of two polypeptide chains: the A-chain and B-chain. After ingestion of ricin, the B-chain binds to the glycoproteins and glycolipids expressed on the surface of intestinal epithelial cells and facilitates the intracellular uptake of ricin [7,9-11]. Intracellular uptake of ricin is facilitated by transportation of the ricin A-chain into the endoplasmic reticulum by the Golgi apparatus. Once intracellular, the presence of the ricin A chain leads to apoptosis in several ways. First, it infiltrates ribosomes and attaches to ribosomal ribonucleic acid (rRNA) where it inhibits protein synthesis, causing cell death. Secondly, it causes direct cell membrane damage and cell membrane dysfunction. It also induces several apoptotic pathways through a yet unknown mechanism and through the release of cytokines causing an inflammatory response. One ricin molecule is able to inactivate 1500 ribosomes per minute [7,10,11].

Clinical Symptoms

The clinical presentation of an intoxication with ricin may be variable. This probably depends on how the toxin was ingested or administered and on the amount of ricin absorbed by the patient [9,10]. Research in mice has shown that, when injected or inhaled, the lethal dose of ricin is approximately a 1000-fold less than the lethal dose in case of ingestion [7]. In order to cause symptoms, castor seeds must be masticated to release the ricin toxin. Symptoms can occur from up to 15 minutes to 20 hours after ingestion [2]. Clinical symptoms include oropharyngeal irritation, nausea, vomiting, abdominal pain followed by persistent vomiting, diarrhea (with or without blood loss) leading to hypovolemia, dehydration and renal and liver dysfunction. Other symptoms described are fatigue, fever, tachypnea, muscular pain, urticaria, tachycardia, cough and paresthesia of the extremities. In mild cases, patients recovered within 24 hours. In severe cases, death occurred within 10-72 hour after ingestion due to hypovolemic shock, capillary leakage and multiple organ failure [2,7]. Postmortem analysis of ricin intoxication victims has shown elevated levels of ricin in liver, kidneys and spleen [12].

Table 2: Summary of intentional intoxications with ricin between 1983 and 2022.

Publication year	Author	Amount of castor seeds/ ricin poison	Route of Administration	Fatal	Time between intoxication and hospital admission (hours)	Symptoms
1983	Kopferschmitt et al [13]	30 castor seeds, some of them were masticated.	Ingestion	no	17	Gastro-intestinal and hemodynamic
1986	Wedin et al [14]	unknown amount, masticated.	Ingestion	no	9.5	Gastro-intestinal
2009	Coopman et al[6]	10 ml self-made acetone extract of castor seeds.	Intravenous and subcutaneously	yes	24	Gastro-intestinal hemodynamic and multi-organ failure
2011	Ferguson et al [15]	8 crushed castor seeds	Ingestion	no	9	Gastro-intestinal
2012	Hamelin et al [16]	6 masticated castor seeds.	Ingestion	no	9	Gastro-intestinal
2013	Grimshaw et al [17]	40 masticated castor seeds	Ingestion	no	5	Gastro-intestinal
2013	Roen et al [18]	unknown	Intravenous and ingestion	yes	4	Gastro-intestinal, hemodynamic, multi-organ failure
2014	Hoizey et al [19]	20 seeds and an injection with an extraction of castor seeds and trimipramine	Ingestion and intravenous injection	no	3	Gastro-intestinal
2016	de Haan et al [20]	15 crushed seeds	Ingestion	no	24	Gastro-intestinal and respiratory
2017	Lopez Nunez et al [9]	200 castor seeds mixed with juice in a blender.	Ingestion	no	8	Gastro-intestinal
2018	Tournoud et al [22]	20 castor seeds	Ingestion	no	2	Gastro-intestinal and metabolic
2019	Aggerwal et al [21]	unknown	Intramuscular	Yes	— *	Gastro-intestinal, multi-organ failure
2019	Verougstraete et al[23]	unkown	intravenous	yes	5.5	Gastro-intestinal, hemodynamic multi-organ failure
2020	Stankova et al [12]	2 ml of 13 crushed castor seeds in a aqueous solution	Intravenous	yes	96**	Gastro-intestinal, respiratory
2021	Bucaretschi et al [24]	3 ml castor seed extract	Intramuscular and subcutaneously	no	1	Metabolic, hemodynamic, multi-organ failure
2021	Levefer et al [25]	50 castor seeds, swallowed with benzodiazepines, some of them were masticated.	Ingestion	no	48	Gastro-intestinal and metabolic
2022	Dibbits et al [26]	16 masticated castor seeds	Ingestion	no	27	Gastro-intestinal
2022	Koning et al	25 castor seeds	Ingestion	No	7	Gastro-intestinal

* The patient was admitted between 15-24 hours after intoxication.

** The patient was admitted 1 hour after intoxication, but went home on his own request, after the fourth day he came back to the hospital and died due to ricin intoxication.

Treatment

Treatment consists mainly of supporting vital functions, in particular administration of intravenous fluids and the management of electrolytes. There is no antidote or specific treatment for ricin intoxication. Since most symptoms are gastrointestinal, gastric lavage followed by active charcoal has been suggested when the presentation of intoxication is early, to prevent further gastrointestinal absorption [10]. Dialysis is not beneficial due to the large molecular weight of the ricin molecule and its rapid intracellular absorption after ingestion [2]. It is important to start treatment immediately when ricin intoxication is suspected to limit mortality. Abbes et al. studied 50 cases of ricin intoxication in which the mean time between ingestion and hospital admission was 14 hours for patients who recovered of ricin intoxication and 27 hours for patients who died due to intoxication with ricin [2].

Methods

Many of previously described cases of ricin intoxication were unintentional, e.g. due to confusion of the intoxicant with other seeds, curiosity or accidents with self-medication [2]. Deliberate intoxication with ricin is rarer. We performed a literature search using MEDLINE/Pubmed and google scholar for intentional ricin intoxications specifically. We used combinations of the search terms “castor seed”, “castor bean”, “ricin”, “poisoning”, “ricin intoxication”, “human” and “case report”. We included only articles in English or French.

Results

Abbes et al have performed a literature search from 1980 till 2021 and found 50 cases of ricin intoxication of which 13 intentional ricin intoxications. We found eighteen cases of intentional ricin intoxication. Eleven of them intoxicated themselves by ingestion. In all cases the seeds were crushed or masticated. Five patients injected themselves intravenously, intramuscularly or subcutaneously with ricin. Two patients ingested the castor seeds and simultaneously injected themselves intravenously. Five cases had a lethal outcome. In described cases with oral route of administration, the outcome was never lethal. Mean time between intoxication and admission in the hospital was 17.6 hours in all cases (median=9). Mean time between intoxication and admission in the hospital in the cases with a lethal outcome was 32 hours (median=14.8) and 13 hours (median=9) in the non-lethal cases. Although there appeared to be a major difference between the two means, a non-parametric Man Whitney U test did not show a significant difference between the time of intoxication and hospital admission for lethal and non-lethal cases respectively.

Discussion

Ricin intoxication is relatively rare among patients who attempt suicide. Although a lethal outcome depends on the amount of ricin administered [7], correlation between the amount of castor seeds and

lethality was not confirmed in this review of the literature. The present review observed a non-significant difference between lethality and the time between intoxication and admission to the hospital as was also seen by Abbes et al. [2]. In their study, mean time between ingestion and hospital admission was 14 hours for patients who recovered of ricin intoxication and 27 hours for patient who had a lethal outcome due to ricin intoxication [2].

Conclusion

Clinicians should be aware of the possibility of ricin intoxication because of the wide spectrum of symptoms and the potential lethal outcome. Supportive treatment must start immediately when intoxication with ricin is suspected.

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