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Toxic optic neuropathy due to methanol: About two cases

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Abstract

Ingesting methanol voluntarily or accidentally can result in irreversible optic neuropathy or death. This report discusses two patients admitted to the Hassan II University Hospital Center in Fes after methanol intoxication. Both patients experienced gastrointestinal and neurological symptoms, including severe metabolic acidosis. Despite undergoing treatments like hemodialysis, they suffered permanent visual impairment. While methanol-induced optic neuropathy is less frequent nowadays, complete recovery without long-term effects has only been observed in cases of mild poisoning and early treatment. This study emphasizes the importance of early diagnosis and tailored treatment to minimize the severe consequences of methanol poisoning.

Keywords: Methanol; Intoxication; Sequelae; Optic neuropathy; Diagnosis

1. Introduction

Methanol, a commonly used industrial solvent, is among the leading causes of toxic optic neuropathy. Cases of methanol poisoning represent a serious problem due to the high mortality rate and the frequency of health after-effects among those who survive. [1-2]. Over the last few years, several countries have reported incidents of collective poisoning linked to methanol. In the Moroccan context, methanol intoxication is mainly associated with the consumption of adulterated contraband alcohol, sold at low prices. We present two cases of methanol poisoning received at the Hassan II University Hospital in Fez, in which the evolution was marked by irreversible blindness following acute exposure.

2. Observations

2.1. Observation 1

A 56-year-old patient, chronic drug addict and alcoholic for 36 years, residing in Immouzar Mermoucha, was admitted to the emergency room following collective and voluntary consumption of methanol during an evening with friends (1 liter of artisanal alcohol purchased in a drugstore). This situation led to the death of his three friends after a period in intensive care due to severe methanol poisoning. On admission, the patient was conscious but confused, presenting with visual fog, characteristic breath, and digestive symptoms of abdominal pain, nausea, and vomiting. His condition was stable on the hemodynamic and respiratory level, with an enlargement of the support polygon.

On ophthalmological examination, the pupils were in bilateral unreactive mydriasis. Fundus examination revealed the presence of bilateral papilledema, preserved ocular motility, without ptosis, strabismus deviation or damage to other cranial pairs. No obvious motor or sensory deficits were observed, and there were no signs of head trauma or seizures. The patient's vital parameters were as follows: blood pressure at 140/80 mmHg, heart rate at 90 beats/min, oxygen

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saturation at 96% on room air and preserved diuresis. Initial biological analyzes revealed leukocytosis, blood sugar at 1.2g/L, ethanolemia by enzymatic method of 0 g/L, hemoglobin at 17g/dL, Creatine phosphokinase (CPK): 294UI/L, CPK mb at 10 N, normal platelet count, ionogram and good kidney function. Gasometry revealed organic metabolic acidosis with a high anion gap with hydrogen potential (PH) < 7.2, partial pressure of carbon dioxide (paCO2) < 15 mmHg in relation to his hyperventilation, a level of bicarbonates [HCO-3] < 20 mmol/L, hyperlactacidemia (6mmol/L), serum sodium and serum potassium correct. The patient was hospitalized in intensive care and received a basic ration, vascular filling, *IPP*®, *Lovenox*®, glycemic control/4 hours, and three hemodialysis sessions in order to eliminate the toxic. Monitoring involved hemodynamic, biological (gazometry, blood sugar, blood ionogram) and neurological monitoring. The evolution was complicated by an irreversible toxic optic neuropathy with sudden onset, in the absence of specific antidotal treatment at the hospital level.

2.2. Observation 2

This is a 34-year-old patient, admitted to the emergency room, victim of a knife attack with a frontal point of impact resulting in a 3cm frontal wound. The history of the illness dates back 2 days when the patient took a product containing methanol (undetermined quantity) causing him a sudden decline in bilateral visual acuity, hence his transfer for treatment.

On admission, the patient was in a drunken state, hemodynamically and respiratory stable, complained of abdominal pain with vomiting. He benefited from gastric lavage with good clinical improvement. The biological assessment showed a correct serum sodium and potassium level, a blood sugar level of 1.7g/l, a hemoglobin of 15g/l, a leukocytosis, and a normal platelet level with a correct renal assessment, transaminases (GOT at 150 UI/L and GPT at 82UI/L). Gasometry revealed organic metabolic acidosis with a high anion gap with PH <7.1, paCO2 at 20 mmHg, [HCO-3] <20 mmol/L with an increased lactate level (5mmol/L). The action to be taken was to hospitalize the patient, carry out a hemodialysis session, suture the frontal wound and refer the patient to the ophthalmology department in order to manage his reduced visual acuity. Unfortunately, the methanol level measurement was not available in our hospital, as was the antidotic treatment.

3. Discussion

Cases of methanol poisoning are uncommon in usual clinical practice. Over the years, several countries including Estonia in 2001, Turkey in 2011, the Czech Republic in 2012, Russia in Krasnoyarsk in 2015 and Morocco in 2017 have reported cases of collective poisoning due to the consumption of beverages. containing methyl alcohol [3].

Adulterated alcohol and methylated spirits contain varying concentrations of methanol (methyl alcohol) as a replacement for ethanol. Methanol, also known as "wood spirit," is a component found in many solvents, as well as various commercial products such as paints, liquid makeup removers, and fuels. It is also used as a raw material in the synthesis industry [4].

Methanol is a colorless, volatile liquid with a sweet taste and a rather pleasant odor. It is commonly used as a solvent, fuel and raw material in various industries such as the production of varnishes, paints, dyes, antifreeze, etc. It is also present in very small quantities in certain fruit and vegetable juices. In our context, its misuse in alcohol intoxication represents a worrying situation. Although rare, methanol poisoning can be potentially serious, occurring intentionally or accidentally following ingestion, inhalation or dermal penetration of pure methanol or mixed with other substances. The mechanism of toxicity seems to be linked to the inhibition of the activity of mitochondrial cytochrome oxidase, thus leading to a reduction in the synthesis of ATP (adenosine triphosphate) leading to hypoxia. In contrast, an important indicator of mortality in cases of acute methanol poisoning is severe metabolic acidosis [5-6]. The most severely poisoned patients, characterized by metabolic acidosis on admission, had the highest rate of axonal loss. Concerning our patients, the metabolic acidosis was severe which agrees well with the optical damage observed in them. After a constant latency period, which can extend from 12 to 24 hours, symptoms such as headache, vomiting, abdominal pain, anorexia and weakness appear [7]. Alterations in consciousness are possible, accompanied by hyperventilation indicating metabolic acidosis. Acidosis is characterized by a decrease in pH below 7.38, according to the acid-base balance equation: $pH = \{\alpha [HCO_3-] \div pCO_2\}$. This decrease can result either from a reduction in bicarbonates or an increase in pCO2. When the decrease in pH is attributable to a drop in bicarbonates, it is called metabolic acidosis. The anion gap represents a key indicator in guiding the diagnosis of metabolic acidoses, requiring careful analysis in conjunction with other clinical and biological information. The common formula for the anion gap (TA) is: (Na+ + K+) - (Cl- + HCO3-), with a normal TA value between 12 and 16 mmol/L. It makes it possible to distinguish two main categories of metabolic acidosis, with normal or elevated anion gap. That with an organic or high anion gap results from endogenous acid overload, such as lactic acidosis or other causes, or from exogenous acid overload. This latter situation

is frequently observed during poisonings, involving various toxic agents such as acidifiers (ammonium chloride, arginine chloride), alcohols (methanol, ethanol), glycols (ethylene glycol), salicylates, and nalidixic acid. Methanol toxicity arises from its metabolites, which exhibit neurotoxic properties and cause metabolic acidosis. Formic acid, the main metabolite responsible for this toxicity, acts as a potentially damaging functional toxicant. Lethal oral doses are estimated at approximately 30 to 60 ml. It is a serious poisoning that generally requires hospitalization in intensive care. Despite current treatments, mortality rates are between 26% and 50%, and survivors are generally subject to neurological and visual aftereffects [8]. According to studies, the prevalence of long-term visual sequelae of toxic optic neuropathy caused by exposure to methanol is 40% [9-10]. Ophthalmological manifestations manifest later with papilledema, alterations in color vision and a reduction in visual acuity linked to optic neuritis. [11]. These symptoms can progress to permanent blindness. It is important to note that early and reversible retinal damage does not predict the subsequent appearance of irreversible optic neuropathy. The presence of reactive mydriasis as well as a profound decline in visual acuity are poor prognostic factors and reflect the severity of the poisoning. The results of the electrophysiological examination, performed early, are significantly linked to the risk of irreversible eye damage. One study mentioned that patients who developed visual after-effects had a higher frequency of visual disturbances on admission and coma ($p < 0.05$) [10]. Retinal ganglion cells and optic nerve axons are the main targets of the neurotoxic effects of formic acid [12-13] ; However, chronic changes in the visual system after methanol exposure have not been studied. One reason for this is the loss of contact with survivors after they leave the hospital. [14], and this was the case for our patient.

In sporadic case reports and small retrospective serial studies, it has been shown that partial recovery and progression of visual loss can be observed six to nine months after discharge [9,15,16]. A cross-sectional study was carried out in the Czech Republic in 2012, which aimed to analyze the frequency and nature of long-term visual sequelae resulting from acute methanol poisoning based on data from the widespread methanol epidemic; 50 patients with confirmed methanol poisoning were included: 14% were released with diagnosed visual after-effects, while 12% were released with both visual and central nervous system after-effects. During subsequent follow-up examinations, 40% of patients showed long-term visual sequelae, including 8% who were blind [4,10]. These data agree well with the ocular damage observed in our patients, thus the appearance of papilledema results from the reduction of axonal flow, dependent on energy, leading to axonal stasis [4].

The positive diagnosis of methanol poisoning is based on several clues, notably the notion of methanol ingestion, the initial manifestation of clinical signs which could suggest ethyl poisoning, the presence of metabolic acidosis characterized by low pH, reduced alkaline reserve and low pCO_2, increased anion gap accompanied by an osmolar gap, as well as blood measurement of formic acid and methanol. The prognosis of poisoning is closely related to the earliness of specific treatment, the severity of metabolic acidosis, as well as the presence of coma or convulsions at the time of admission. Acidosis with a pH below 7 is an unfavorable prognosis criterion, with high mortality reaching 89% in a series of 50 patients. The extent of visual aftereffects is directly proportional to the duration of acidosis [17]. Several factors contribute to the assessment of the severity of methanol poisoning, notably the ingestion of a quantity exceeding 40 ml, the therapeutic period which exceeds 10 hours, the degree of metabolic acidosis, characterized by a pCO_2 lower than 10 mmol/L and a blood formate level greater than 0.5 g/L.

Treatment of methanol poisoning generally aims to prevent the conversion of methanol to its toxic metabolites by administering ethanol or 4-methylpyrasole (4-MP). Ethanol is administered by infusion to achieve blood ethanol levels of approximately 150 mg/dL. To date, there is no evidence of the effectiveness of intravenous corticosteroids; however, cases of improvement in visual function with the use of prednisone at doses of 1 mg/kg/day for one month and vitamin B1 intramuscularly at 100 mg/day have been described [8]. Both patients presented to the emergency room within two days and did not receive antidotal treatment. The absence of antidotal treatment and the delay in treatment may explain the appearance of the complications that occurred in them. However, according to one study, no link was identified between visual aftereffects and the type of antidote administered, the mode of hemodialysis or folate substitution. There appeared to be benefits associated with prehospital administration of ethanol; patients who received this intervention had a 90% reduction in the risk of having abnormal nerve fiber tomography (RNFL) results (OR: 0.10 (95% CI: 0.02-0.52); $p < 0.01$) [10].

The course of this poisoning depends on the degree of acidosis and the time between exposure and the start of specific treatmentOur patients developed severe metabolic acidosis, and given that methanol is dialyzable, the decision was made to transfer them to the hemodialysis room. A right femoral catheter was installed, and they underwent a purification session. The effectiveness of this treatment depends on the properties of methanol, such as its low molecular weight, limited volume of distribution (0.6 L/kg), and lack of protein binding [4]. It should be noted that indications for hemodialysis include visual disturbances, renal failure, severe metabolic acidosis, ingestion of more than

40 ml of pure methanol, persistent electrolyte disturbances despite adequate treatment, and a blood methanol concentration exceeding 500 mg/L.

4. Conclusion

Methanol poisoning is a rare, serious condition where the vital and functional prognosis depends on the speed of medical intervention. The progression of methanol poisoning depends on the level of acidosis and the time interval between exposure and the start of specific treatment. We must always think about the long term visual after-effects and monitoring of poisoned patients is therefore essential. In-depth analyzes carried out before release and during subsequent follow-ups will likely highlight increased morbidity following methanol poisoning in general.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no links of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Rostrup M, Edwards JK, Abukalish M, Ezzabi M, Some D, Ritter H, et al. The Methanol Poisoning Outbreaks in Libya 2013 and Kenya 2014. PLoS One. 2016;11(3):e0152676.

[2] Hovda KE, Hunderi OH, Tafjord AB, Dunlop O, Rudberg N, Jacobsen D. Methanol outbreak in Norway 2002-2004: epidemiology, clinical features and prognostic signs. J Intern Med. août 2005;258(2):181-90.

[3] Mégarbane B, Brahmi N, Baud F. Acute poisoning by toxic glycols and alcohols: diagnosis and treatment. Resuscitation. 1 juin 2001;10(4):426-34.

[4] N. Rhalem, Gh. Jalal, R. Soulaymani. Methanol intoxication.

[5] Zakharov S, Navrátil T, Pelclova D. Analysis of serum anion gap and osmolal gap in diagnosis and prognosis of acute methanol poisoning: clinical study in 86 patients. Monatsh Chem. 1 mai 2015;146(5):787-94.

[6] Paasma R, Hovda KE, Hassanian-Moghaddam H, Brahmi N, Afshari R, Sandvik L, et al. Risk factors related to poor outcome after methanol poisoning and the relation between outcome and antidotes--a multicenter study. Clin Toxicol (Phila). nov 2012;50(9):823-31.

[7] Ellenhorn MJ, Barceloux DG. Medical Toxicology: Diagnosis and Treatment of Human Poisoning. Elsevier; 1988. 1634 p.

[8] Gómez Perera S, Rodríguez Talavera I, Tapia Quijada HE, Guerrero-Mártir M, Díaz de Aguilar Osona M, Falcón Roca R. Secondary visual loss due to inhalation and cutaneous poisoning by methanol and toluene. Presentation of a clinical case. Arch Soc Esp Oftalmol (Engl Ed). mai 2020;95(5):231-5.

[9] Desai T, Sudhalkar A, Vyas U, Khamar B. Methanol poisoning: predictors of visual outcomes. JAMA Ophthalmol 2013;131(3):358-364.

[10] Zakharov S, Pelclova D, Diblik P, et al. Long-term visual damage after acute methanol poisonings: Longitudinal cross-sectional study in 50 patients. Clin Toxicol 2015;53(9):884-892.

[11] Onder F, Ilker S, Kansu T, Tatar T, Kural G. Acute blindness and putaminal necrosis in methanol intoxication. Int Ophthalmol. 1999 1998;22(2):81-4.

[12] Yu DY, Cringle SJ. Oxygen distribution and consumption within the retina in vascularised and avascular retinas and in animal models of retinal disease. Prog Retin Eye Res. mars 2001;20(2):175-208.

[13] Carelli V, Ross-Cisneros FN, Sadun AA. Mitochondrial dysfunction as a cause of optic neuropathies. Prog Retin Eye Res. janv 2004;23(1):53-89.

[14] Paasma R, Hovda KE, Jacobsen D. Methanol poisoning and long term sequelae – a six years follow-up after a large methanol outbreak. BMC Clin Pharmacol. 27 mars 2009;9:5.

[15] Sanaei-Zadeh H, Zamani N, Shadnia S. Outcomes of visual disturbances after methanol poisoning. Clin Toxicol (Phila). févr 2011;49(2):102-7.

[16] Zhao XJ, Lu L, Li M, Yang H. Ophthalmic findings in two cases of methanol optic neuropathy with relapsed vision disturbance. Int J Ophthalmol. 18 avr 2015;8(2):427-9.

[17] Liu JJ, Daya MR, Carrasquillo O, Kales SN. Prognostic Factors in Patients with Methanol Poisoning. Journal of Toxicology: Clinical Toxicology. 1 janv 1998;36(3):175-81.