Chronic methanol toxicity through topical and inhalational routes presenting as vision loss and restricted diffusion of the optic nerves on MRI: A case report and literature review

Christianne V. Mojica,⁎ Esteban A. Pasola, Mercedes L. Dizon, Wenceslao A. Kiat Jr., Timothy Reynold U. Lim, Jacqueline C. Dominguez, Vincent V. Valencio, Bernardo Joaquin P. Túano

A R T I C L E   I N F O

Keywords:
Methanol
Chronic intoxication
Vision loss
Bilateral optic nerve restricted diffusion

A B S T R A C T

Methanol intoxication can cause irreversible neurologic sequelae if unrecognized and untreated. Ingestion is the most common form of toxicity; however, dermal and inhalational exposures likewise occur but are documented rarely. While acute intoxication is commonly encountered, chronic exposure to methanol should also be highlighted. We report a case of a 57-year-old female presenting in the emergency room with progressive dyspnea, metabolic acidosis with high anion gap, and metabolic encephalopathy. After emergency hemodialysis, the patient complained of vision loss on both eyes. Initial non-contrast cranial magnetic resonance imaging (MRI) revealed restricted diffusion of the intraorbital segment of both optic nerves. A thorough history revealed that she was applying a clear colorless liquid bought online all over her body for alleged pruritus for more than a year. The syndrome of metabolic acidosis with high anion gap, metabolic encephalopathy, vision loss, and laboratory findings led us to suspect a diagnosis of chronic methanol poisoning with an acute component. The liquid in question was sent for chemical analysis and result showed that it consisted of 95.5% Methanol. This case highlights the need for high index of clinical suspicion for methanol toxicity in the absence of oral consumption, the complications of chronic form of methanol intoxication, and the uncommon radiologic finding seen in diffusion-weighted imaging (DWI).

1. Introduction

Methanol is a clear and colorless chemical that can usually be seen in household cleaning products, antifreeze, varnishes, and fuel [1,2]. Methanol intoxication is a significant cause of neurologic morbidity and mortality if it is unrecognized and left untreated. Acute methanol toxicity may present with mild symptoms such as headache, altered mentation, blurring of vision, abdominal pain, and vomiting. However, in more severe cases, patients may develop blindness, severe metabolic acidosis, and coma [1]. Intake of adulterated alcoholic beverages is the primary cause of poisoning outbreaks of this substance [2]. Although ingestion is the most commonly implicated route of toxicity, methanol can be absorbed by inhalation and dermal exposure and these serve as uncommon routes of acute and chronic intoxication. Studies on chronic exposure to methanol particularly through dermal and inhalational routes are all the more rare and seen only on limited case reports. Chronic methanol toxicity can have neurologic sequelae such as vision loss that can potentially be irreversible. Vision loss is brought about by the affinity of the toxic metabolite of methanol, formic acid, to the optic pathway [1]. As such, methanol toxicity is an important differential diagnosis in unexplained vision loss. On cranial MR imaging, the most characteristic imaging feature of methanol poisoning is bilateral symmetric basal ganglia necrosis [3–7].

We present a case of chronic exposure to methanol through dermal and inhalational routes manifesting as shortness of breath, vision loss, and altered sensorium. This patient did not present with the typical
supratentorial findings of methanol toxicity on initial cranial imaging.

2. Case report

The patient is a 57-year old female, right-handed, who presented with one-week history of cough and progressive shortness of breath few hours before arrival to the emergency room (ER). In the ER, her blood pressure was 130/100 mmHg. She was tachycardic at 140 beats per minute with new-onset atrial fibrillation. She was tachypneic with a respiratory rate of 28 cycles per minute and with an oxygen saturation of only 82% at room air. She was afebrile at 36.5 degrees Celsius. She was agitated and inconsistently followed commands. Arterial blood gases revealed severe metabolic acidosis with a pH of 6.898, carbon dioxide of 20.5, oxygen of 261.6, bicarbonate of 4, and oxygen saturation 99.4% with a high anion gap of 20. The patient was intubated, started on amiodarone and bicarbonate drip, and was sedated with dexmedetomidine. The initial assessment at the ER level was thyroid storm. However, the laboratory findings were consistent with only subclinical hyperthyroidism. A red flag noted in the patient's history was the chronic intake of multiple supplements mostly consisting of herbal extracts. Intoxication with any of these drugs was then considered.

The patient was admitted in the intensive care unit and underwent emergency hemodialysis for the metabolic acidosis with high anion gap. The patient was seen with spontaneous eye opening despite the sedation, with no regard, and without following commands. Her pupils were 4 mm non-reactive to light. She had normal fundoscopic examination with roving eyes movements. There was no focal sensorimotor deficit or meningeal sign. When the sedation was titrated down, she communicated through writing “Darkness” and “Why can’t I see?”. At this time, test for visual acuity revealed hand movement at 6 in. on both eyes. Cranial MRI with angiography revealed restricted diffusion involving the intraorbital segment of both optic nerves (Fig. 1A) and confluent white matter hyperintensity in the central pons on fluid attenuation inversion recovery sequence (FLAIR) (Fig. 1B). Considering toxic optic neuropathy, careful pharmacologic review of the herbal supplements taken by the patient and their possible interaction was done but results were not consistent with her signs and symptoms. Unfortunately, no blood sample for any drug or toxic metabolite was collected prior to hemodialysis. Blood and urine heavy metal analysis done after hemodialysis including mercury, lead, and cadmium eventually turned out to be negative. The patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.

When the patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.

When the patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.

When the patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.

When the patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.

When the patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.

When the patient's sensorium improved, she was able to report 3-month history of persistent painless darkening of the entire field of vision. On further investigation, the patient disclosed that for the past year, she had been applying clear, odorless liquid on her entire body for months. Methanol was isolated on blood examination. He was leathargic and atactic but had normal ophthalmologic exam and was not in coma. The patient was started on Dexamethasone 5 mg IV every 8 h.
spirit to massage her head a few days prior. This report postulated that
the high permeability and rich vasculature of the scalp could have
readily led to the absorption of methanol [15]. Our patient applied
methanol on her scalp and skin of her entire body daily for a year.
Interestingly, she did not present with severe symptoms early on. Cu-
taneous absorption of methanol is a
affected by many factors. It has been
reported that the condition, hydration, temperature, and other char-
acteristics of the skin can influence the rate at which methanol is ab-
sorbed [16].

Recently, methanol was highlighted as an occupational hazard
through chronic inhalational and dermal exposure in factories in Asia.
In South Korea, two factory workers developed blurring of vision after
4 months of being exposed to machines that used methanol to cool
down cellular phone parts. No protective devices were used at work
exposing the workers to vapor, skin contact, and even eye contact with
the fluid [17]. Eight Chinese patients were also reported to have acute
vision loss from chronic inhalation of methanol in the workplace. Some
patients were exposed for as long as 5 years before developing acute
symptoms. It was postulated that the toxic metabolites of methanol
could have been accumulating over the years and that acute symptom
onset was the result of these metabolites finally reaching the toxic dose
[18]. In the same way, our patient presented with vision loss in a
background of chronic exposure to methanol through dermal and in-
halational routes. The patient applied this solvent throughout her skin
and scalp for a year and was exposed to the vapor of this substance
upon its application. There was no prior oral intake of methanol or any
alcohol-based product. Our patient also had a 3-month history of visual
disturbance prior to acute vision loss that was similar to the experience
of 3 out of the 8 subjects in China who were exposed to methanol
chronically [18]. This underscores that persistent exposure to methanol
can present with acute and severely debilitating symptoms on top of
probable slowly progressive findings. Such cases warrant further doc-
cumentation and investigation.

4. Conclusion

We present an uncommon case of vision loss in the background of
chronic exposure to methanol through dermal and inhalational routes.
Methanol was isolated late in the course of this patient. As such, this
case highlights the need for high index of suspicion for methanol in the
presence of vision loss and severe metabolic acidosis with high anion
gap despite lacking history of toxic ingestion. This case adds to the
increasing number of reports of methanol intoxication from vapor and
skin contact. The symptoms and course of the patient were similar to
those seen in toxic ingestion of methanol. The DWI findings particularly
in the optic nerves can be seen in the background of chronic exposure to
this substance. History of methanol exposure should therefore be eli-
cited when faced with characteristic clinical findings of vision loss and
metabolic acidosis with high anion gap and radiologic finding of re-
stricted diffusion of the optic nerves and confluent hyperintense signal

Fig. 1. Cranial MRI. Axial DWI (A) and FLAIR (B, C) images during admission show restricted diffusion in the intraorbital segment of both optic nerves (arrows) and confluent hyperintense signal in the central pons. Follow-up DWI (D) and FLAIR (E, F) images after two months show resolution of the restricted diffusion in the optic nerves and less confluent signal abnormality in the pons with interval demonstration of hyperintense foci in the bilateral cerebral subcortical white matter.
in the central pons. These imaging findings may be hypothesized as unusual imaging features and further case documentation is warranted.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

None declared.

Acknowledgements

We like to thank Dr. Wohldorf, Dr. Yano-Simbulan, Dr. Samson, and Dr. Hawson, for their significant help in managing the case.

References

[1] D.G. Barceloux, G.R. Bond, E.P. Krenzelok, H. Cooper, J.A. Vale, American academy of clinical toxicology practice guidelines on the treatment of methanol poisoning, Clin. Toxicol. 40 (2002) 415–446.
[2] World Health Organization, Information Note Methanol Poisoning Outbreaks, https://www.who.int/environmental_health_emergencies/poisoning/methanol_information.pdf, (2014).
[3] M. Blanco, R. Canado, F. Vázquez, J.M. Pumar, CT and MR imaging findings in methanol intoxication, Am. J. Neuroradiol. 27 (2006) 452–454.
[4] M. Azeemuddin, R. Naqi, MRI findings in methanol intoxication: a report of three cases, J. Pak. Med. Assoc. 62 (2012) 1099–1101.
[5] S.M. Elkhamary, D.M. Fahmy, A. Galvez-Ruiz, N. Aghzar, T.M. Bosley, Spectrum of MRI findings in 58 patients with methanol intoxication: long-term visual and neurological correlation, Egypt. J. Radiol. Nuclear Med. 47 (2016) 1049–1055.
[6] V.S. Yedavalli, P.S. Chowdhry, V. Bachchav, A. Patil, et al., Potent Potables: examining acute and chronic CT and MR imaging patterns of ethanol and methanol poisoning, Neurographics 8 (2018) 244–253.
[7] A.M. De Oliveira, M.V. Paulino, A.P.P. Vieira, A.M. McKinney, A.F. da Rocha, G.T. dos Santos, et al., Imaging patterns of toxic and metabolic brain disorders, Radiographics 39 (2019) 1672–1695.
[8] A. Tanrivermis Sayit, K. Aslan, M. Elmali, I. Gunogor, Methanol-induced toxic optic neuropathy with diffusion weighted MRI findings, Catan. Ocul. Tissiol. 35 (2016) 337–340.
[9] F. Gala, Magnetic resonance imaging of optic nerve, Indian J. Radiol. Imaging 25 (2015) 421–426.
[10] H.P. Gau, C.J. Wallace, R.N. Auer, T.C. Fong, MR findings in methanol intoxication, Am J Neuroradiol 16 (1995) 1783–1786.
[11] F. Karayel, A.A. Turan, A. Sav, I. Pakis, E.U. Akyildiz, G. Ersoy, Methanol intoxication: pathological changes of central nervous system (17 cases), Am. J. Forensic Med. Pathol. 31 (2010) 34–36.
[12] M.J. McCormick, E. Mogabgab, S.L. Adams, Methanol poisoning as a result of inhalational solvent abuse, Ann. Emerg. Med. 19 (1990) 639–642.
[13] A. Downie, T.M. Khattab, M.I. Malik, I.N. Samara, A case of percutaneous industrial methanol toxicity, Occup. Med. 42 (1992) 47–49.
[14] C.R. Beaton, C. Meyer, Accidental transdermal methanol poisoning presenting to a regional emergency department, Can. J. Emerg. Med. 21 (2019) 435–437.
[15] D. Soysal, O. Yersal Kabayegit, S. Yilmaz, E. Tatar, T. Ozatli, B. Yildiz, et al., Transdermal methanol intoxication: a case report, Ata Anaesthesiol. Scand. 51 (2007) 779–780.
[16] S.A. Batterman, A. Franzblau, Time-resolved cutaneous absorption and permeation rates of methanol in human volunteers, Int. Arch. Occup. Environ. Health 70 (1997) 341–351.
[17] J. Ryu, K.H. Lim, D.R. Ryu, H.W. Lee, J.Y. Yun, S.W. Kim, et al., Two cases of methyl alcohol intoxication by sub-chronic inhalation and dermal exposure during aluminum CNC cutting in a small-sized subcontracted factory, Ann. Occup. Environ. Med. 28 (2016) 65.
[18] Z. Ma, H. Jiang, J. Wang, Clinical analysis of severe visual loss caused by inhalational methanol poisoning in a chronic process with acute onset: a retrospective clinical analysis, BMC Ophthalmol. 19 (2019) 124.