Case Report

Transverse myelitis-like presentation of methanol intoxication: A case report and review of the literature

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Context: Methanol is the simplest member of alcohol family. However, it is an extremely toxic substance to humans upon exposure with severe and detrimental effects that range from visual loss to death. Spinal cord involvement in methanol intoxication is a rare occurrence.

Findings: In this article, we are reporting a case of methanol intoxication with extensive spinal cord involvement possibly due to necrosis. A literature review yielded only two cases of spinal cord involvement due to methanol intoxication. Our article is the first to discuss the spinal cord involvement specifically including interesting neuroimaging features.

Conclusion/Clinical Relevance: We recommend performing MRI of the cervicothoracic spine in every methanol intoxication case to exclude both asymptomatic and symptomatic cases of spinal cord involvement.

Keywords: Methanol intoxication, Spinal cord, Putaminal necrosis, Putaminal hemorrhage, Metabolic acidosis, Transverse myelitis

Introduction

Methanol, CH₃OH, is a clear, colorless, volatile liquid with a distinct odor that tastes the same as ethanol. It is also referred to as methyl alcohol or wood alcohol and is widely used in commercial and industrial setting. It is found as a component of many paint removals, varnishes, shellacs, windshield washing fluid, model airplane fuel, and antifreeze. It is also found as a solvent in some brands of colognes and perfumes, and contaminated whiskey. Poisoning with methanol may be accidental, due to a suicide attempt, or used by drinkers as a substitute for ethanol.¹ In this article, we are reporting a case of methanol intoxication with extensive spinal cord involvement possibly due to necrosis. A literature review yielded only two cases of spinal cord involvement due to methanol intoxication. Our article is the first to discuss the spinal cord involvement specifically including interesting neuroimaging features.

Case report

A previously healthy 27-year-old salesman presented to the emergency department with nausea, fatigue, and feeling unwell. His symptoms progressed quickly, and few hours later he developed quadriplegia, had dyspnea, cyanosis, and confusion. His condition deteriorated with development of cardiac arrest. After cardiopulmonary resuscitation (CPR), the patient revived, was intubated, mechanically ventilated, and sedated. His pupils were small, pinpoint, and not reactive to light. The rest of his brainstem functions and reflexes were normal. He was hypotonic with exaggerated reflexes and bilateral upgoing toes. The rest of the systemic examinations was unremarkable including skin and eye examinations. Initial brain computed tomography (CT) of the brain was normal. In the emergency, he received naloxone, atropine, intravenous (IV) fluids, empirical antibacterial and antiviral treatment, and thiamine. His blood tests showed metabolic acidosis with a pH 6.79 and anion gap of 32 mmol/L. Apart from low bicarbonate level, the rest of other electrolytes and lactic acid levels were normal. Serum and urine

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analysis for toxicology detected methanol at a concentration of 10 ng/ml with negative results for other substances. Although there was no history of drug, alcohol, or methanol abuse, the emergency physician suspected methanol intoxication due to the age of the patient, the patient's job as a salesman in a shop selling perfumes, and the clinical presentation of high anion gap metabolic acidosis. Aquaporin 4 serology and connective tissue screen including rheumatoid factor, antinuclear antibody (ANA), anti-double stranded DNA (anti-dsDNA), cytoplasmic antineutrophil cytoplasmic antibodies (C-ANCA), perinuclear antineutrophil cytoplasmic antibodies (P-ANCA), and antibodies for Sjogren's syndrome were unremarkable. Magnetic resonance imaging (MRI) of the brain revealed abnormal signal intensity involving both cortical and subcortical regions of the frontal and occipital lobes bilaterally. In addition, involvement of the basal ganglia, specifically the putamen bilaterally, was observed. These abnormalities were iso to hypointense on T1-weighted and hyperintense signals on T2-weighted images. (Fig. 1) MRI of the spinal cord showed swollen cord with abnormal signal intensity along the cervical and thoracic segments. These abnormalities were iso to hypointense on T1-weighted and hyperintense signals on T2-weighted images with faint enhancement post-gadolinium infusion. Diffusion images showed

high signal intensity suggesting possible vascular etiology. (Figs. 2 and 3) Lumbar puncture showed normal opening pressure and cerebrospinal fluid (CSF) analysis including negative oligoclonal band. Electroencephalogram (EEG) showed diffuse slowing with no epileptiform discharges noticed. Unfortunately, despite aggressive correction of acid-base imbalance and restoration of hemodynamic and cardiac functions, the patient's level of consciousness did not improve, and he was left with persistent vegetative state. Treatment modalities used included IV bicarbonate infusion and hemodialysis.

Discussion

Methanol is well absorbed in the gastrointestinal tract with peak levels attained in 30–90 minutes and serum half-life ranges from 14–20 hours. Methanol volume of distribution is 0.6–0.7 L/Kg, primarily eliminated by hepatic metabolism with only 2–5% being renally excreted. Toxicity comes from the formation of formaldehyde and formic acid through hepatic alcohol dehydrogenase. The accumulation of formic acid triggers the onset of symptoms while formaldehyde inhibits mitochondrial respiration leading to tissue hypoxia and lactate formation.² Viscera typically shows petechial hemorrhages and edema while the brain shows petechial hemorrhages, cerebral hemorrhages, brain edema, necrosis, and atrophy.³

Figure 1 MRI of the brain showing abnormal symmetrical high signal intensities in the putamen and head of caudate nucleus. The images are FLAIR (A,B,C,D) and T2-weighted images (E,F,G,H).

Figure 2 MRI of the cervical spine and cervicomedullary junction showing high signal intensity and diffuse cord lesion with edema on T2-weighted images (A and B) and FLAIR images (C and D).

The pathological changes in the retina are attributed to retinal metabolism of methanol with formaldehyde production, which may lead to optic papillitis and retinal edema. Retinal glial cells and the retrolaminar optic nerve may be the first target. It has, therefore, been suggested that inhibitors of aldehyde dehydrogenase could be therapeutic. This means that administration of ethanol or other drugs such as fomepizole to block the first step of the toxic metabolic pathway both in the retina and liver is beneficial with unchanged toxin being excreted in the urine.⁴

The clinical features of methanol intoxication usually start 12–24 hours following methanol ingestion. Latent period corresponds to the previously mentioned time period in which methanol is converted by alcohol dehydrogenase in the liver to formic acid. Early manifestations include inebriation, nausea, vomiting, abdominal pain, dizziness, headache, and weakness. Late manifestations

(after 24 hours of ingestion) are due to the toxic effect of formic acid on brain, eyes, and other systems. These include seizures, blurred vision, light flashes, central scotomas, blindness, high anion gap metabolic acidosis, and death. Respiratory arrest is often the terminal symptom at 6–36 hours after intoxication. Extrapyraxidal manifestations are typical neurological sequelae in patients who survive the intoxication. These include dystonia and parkinsonism.⁵

Brain injury in methanol intoxication is characterized by involvement of basal ganglia and subcortical regions bilaterally. The typical appearance of bilateral putaminal necrosis has been described as a characteristic finding for methanol intoxication but can be seen in other diseases such as Wilson's disease, Kearns-Sayre syndrome, and Leigh disease. The basis for the selective vulnerability of the putamen is due to its high metabolic demand and location in an end zone of vascular

Figure 3 Axial images of the spine at the cervical spine and the cervicomedullary junction region showing high signal intensity on T2-weighted images (A and B), FLAIR (C and D), and DWI (E and F).

perfusion.⁶ The imaging findings of methanol intoxication include bilateral putaminal hemorrhagic necrosis, cerebral and intraventricular hemorrhage, cerebellar necrosis, and diffuse cerebral edema. These characteristic changes can be visualized on both CT and MRI. Hemorrhage is reported in approximately 7–14% of cases and is associated with poor prognosis. CT changes typically include bilateral putaminal hyperdensities (petechial hemorrhages) or hypodensities (due to edema alone) with surrounding poorly delineated

edema in the subcortical white matter regions. Cystic necrosis of the affected areas may be seen in the chronic stage. MRI typically shows T1 hyperintensities because of the presence of hemorrhage with T2 hyperintensity of the lateral putamen which could extend into the pallidum, corona radiata, and the centrum semiovale. Other described features include edema and necrosis of hippocampi, cerebellum, and subcortical white matter, mainly in the frontal and occipital lobes with sparing of the subcortical U-fibers. The presence of

cytotoxic edema is suggested by the restricted diffusion. The lesions are characterized by a non-specific contrast enhancement pattern which varies from no enhancement to rim and strong enhancement patterns.⁷

Treatment of methanol intoxication is directed towards decreasing the metabolism of methanol into formic acid, removing both parents and toxic metabolites from the blood, and correcting metabolic acidosis. To decrease the metabolism of methanol to formic acid, we can inhibit the enzyme alcohol dehydrogenase using either intravenous ethanol or the specific antidote fomepizole. To remove both parents and toxic metabolites from the blood and correct the metabolic acidosis, we can perform hemodialysis and give sodium bicarbonate infusion. Hemodialysis is usually continued until plasma level falls below the toxic levels and metabolic acidosis is corrected.⁸

Spinal cord involvement in methanol intoxication is a rare occurrence. It was documented only twice in the literature. The first case was reported by McLean *et al.*⁹ who described a case of descending degeneration through the lateral columns, with swelling of the anterior horn cells of the spinal cord on histopathology. The other case was reported by Anderson *et al.*¹⁰ who reported a case of methanol intoxication with possible spinal cord involvement documented only clinically by the presence of sensory level and other signs of thoracic myelopathy. There was no radiological or histopathological documentation. The mechanism of spinal cord involvement in methanol intoxication is unknown. We speculate that it has a similar vulnerability as the putamen due to both high metabolic demand and vascular vulnerability. Supporting this hypothesis, the involvement of the upper half of the spinal cord (cervical and thoracic) as compared to the lower half (lumbar and sacral). More clinicoradiological and autopsy studies should be done to evaluate the exact mechanism of the spinal cord involvement.

Conclusion

Methanol intoxication is a serious and dangerous medical condition that requires high index of suspicion and prompt treatment. Involvement of the spinal cord with methanol intoxication is extremely rare and can present with a picture similar to transverse myelitis or myelopathy. MRI is the modality of choice in the diagnosis and could show swollen cord with abnormal signal

intensity along the cervical and thoracic segments. The exact mechanism of spinal cord involvement remains unknown, but we believe it is due the high metabolic demand and vascular vulnerability of cervical and thoracic segments of the spinal cord similar to the putamen. We recommend performing MRI of the cervicthoracic spine in every methanol intoxication case to exclude asymptomatic and symptomatic cases of spinal cord involvement. More scientific studies with autopsies are needed to understand the mechanism of spinal cord involvement well.

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References

- 1 Takao H, Doi I, Watanabe T. Serial diffusion-weighted magnetic resonance imaging in methanol intoxication. *J Comput Assist Tomogr* 2006;30(5):742–4.
- 2 Kruse JA. Methanol and ethylene glycol intoxication. *Crit Care Clin* 2012;28(4):661–711.
- 3 Moharamzadeh P, Rahmani F, Pouraghaei M, Ebrahimi Bakhtavar H, Mohammadzadeh Abachi E. Epidural Hematoma Following Hemodialysis in a Methanol Poisoned Patient; a Case Report. *Emerg (Tehran)* 2014;2(1):48–9.
- 4 Galvez-ruiz A, Elkhamary SM, Asghar N, Bosley TM. Visual and neurologic sequelae of methanol poisoning in Saudi Arabia. *Saudi Med J* 2015;36(5):568–74.
- 5 Andresen H, Schmoldt H, Matschke J, Flachskampf FA, Turk EE. Fatal methanol intoxication with different survival times—morphological findings and postmortem methanol distribution. *Forensic Sci Int* 2008;179(2–3):206–10.
- 6 Gadodia A, Singhal B, Sharma R. Methanol intoxication causing putaminal necrosis. *J Emerg Trauma Shock* 2011;4(2):300–1.
- 7 Geibprasert S, Gallucci M, Krings T. Alcohol-induced changes in the brain as assessed by MRI and CT. *Eur Radiol* 2010;20(6):1492–501.
- 8 Nazir S, Melnick S, Ansari S, Kanneh HT. Mind the gap: a case of severe methanol intoxication. *BMJ Case Rep* 2016. doi:10.1136/bcr-2015-214272
- 9 McLean DR, Jacobs H, Mielke BW. Methanol poisoning: a clinical and pathological study. *Ann Neurol* 1980;8(2):161–7.
- 10 Anderson TJ, Shuaib A, Becker WJ. Neurologic sequelae of methanol poisoning. *CMAJ* 1987;136(11):1177–9.