



# Severe Methanol Intoxication due to Spirit Consumption and Magnetic Resonance Imaging Findings

## *İspirto Tüketimine Bağlı Ciddi Metanol Zehirlenmesi ve Manyetik Rezonans Görüntü Bulguları*

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CASE REPORT  
OLGU SUNUMU

ABSTRACT  
ÖZET

Acute methanol intoxication may result in a wide range of damage to the central nervous system. Most patients are typically admitted to the hospital for several days after methanol ingestion, presenting with visual disruptions, severe acidosis, or both. Rapid diagnosis and treatment are necessary to prevent death and to minimize the neurological sequelae. We want to emphasize the importance of specific MRI findings in a patient, who had drunk a bottle of beer and 70 mL of spirits, and was admitted to hospital after 20 hours, with severe metabolic acidosis and loss of consciousness. A methanol assay was unavailable.

Akut metanol zehirlenmesi santral sinir sisteminde geniş hasara yol açabilir. Bir çok hasta metanol alımından birkaç gün sonra görmeyle ilgili şikayetler, ciddi asidoz veya her iki şikayetle birlikte baş vurur. Nörolojik hasarı azaltmak ve ölümü önlemek için hızlı tanı koyup erken tedavi gereklidir. Alkol ile birlikte 70 mL ispirto içtikten 20 saat sonra bilinç kaybı ve ciddi metabolik asidoz tablosu ile gelen ve kan metanol düzeyi bakılamayan bir hastanın tanısında spesifik MRI bulgularının önemini vurgulamak istedik.

**Key words:** Hemodialysis, magnetic resonance imaging, methanol, intoxication,

**Anahtar kelimeler:** Hemodiyaliz, manyetik rezonans görüntüleme, metanol, zehirlenme

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### Introduction

Methanol has a molecular weight of 32 g/mol. It is freely miscible with water, ethanol, and many organic solvents. Methanol is water-soluble and easily crosses the blood-brain barrier (1).

Methanol poisoning has a rare incidence, however, it presents with a high morbidity and mortality. Generally, it is encountered after an attempted suicide or an accidental intake. Methanol poisoning affects the optic nerve and central nervous system, particularly the basal ganglia, potentially leading to visual impairment, blindness, dizziness, seizures, and coma (2, 3). Patients present with symptoms such as blindness, motor dysfunction, rigidity, hypokinesia, and other Parkinson-like signs (2, 4). In this study, we aimed to underscore the importance of MRI findings in a patient that presented with late signs of serious intoxication in whom we were unable to evaluate serum methanol and ethanol levels.

### Case Report

A 32-year-old unconscious man was admitted to the Emergency Department because of vomiting and severe metabolic acidosis with an arterial pH of 6.79 (normal range 7.35-7.45). The anion gap was 32 mmol/L (8-16 mmol/L), whereas HCO<sub>3</sub><sup>-</sup> was 3 mmol/L (22-26 mmol/L), lactate was 1.6 mmol/L (0.5-1.5 mmol/L), glucose was 360 mg/dL (74-106 mg/dL), Ca<sup>++</sup> was 7.6 mg/dL (8.3-10.6 mg/dL), and K<sup>+</sup> was 6 mmol/L (3.5-5.5 mol/L) Na<sup>+</sup>, Cl<sup>-</sup>, AST, ALT, BUN, Cr, CPK, ALP, GGT, amylase, and urine ketone values were normal.

The Glasgow Coma Scale (GCS) was found to be 4 (E1V1M2). Both pupils were fixed and 4 mm in size. The initial blood pressure (BP) was 110/70 mmHg with a regular heart rate of 90 beats/min. The electrocardiogram was normal. The body temperature was 38°C. The respiration rate was 35/min, but shallow. According to information from the patient's relatives, he had drunk a glass of beer and 70 mL of spirits approximately 20 hours prior; he had no symptoms initially, but lost consciousness with nausea and vomiting in the previous hour. Immediately, the patient was intubated and central venous access was obtained in the emergency department; 100 mL of 43% ethyl alcohol was administered via a nasogastric tube. The blood methanol and ethanol levels could not be measured because of technical limitations and oral ethanol delivery was stopped. The patient was transferred to the Intensive Care Unit wherein hemodialysis was promptly initiated. The patient received fluid replacement therapy in order to achieve a central venous pressure of 8-10 mmHg, along with a multivitamin preparation. Hemodialysis was continued until reaching normal blood gas values, which took 4 hours. During the dialysis, from the second hour to the third hour,

acidosis showed a tendency toward normal values (arterial pH: 7.25 to 7.36);  $P_aCO_2$  changed from 20 mmHg to 24 mmHg;  $P_aO_2$  remained constant (95 mmHg); the  $HCO_3^-$  level increased from 8.6 mmol/L to 12.4 mmol/L and the lactate level decreased from 4 mmol/L to 3.2 mmol/L. During the third hour of hemodialysis, systolic and diastolic blood pressures were measured as 60 mmHg and 40 mmHg and the radial pulse rate was measured as 150 beats/min. Then, after hypotension was successfully treated with volume supplementation (5-10 mL/kg/h of normal saline), a dopamine (10-20  $\mu$ g/kg/min) and dobutamine (5  $\mu$ g/kg/min) infusion was initiated to keep the mean arterial pressure above 60 mmHg. 8.4% sodium bicarbonate was given intravenously as necessary to keep arterial pH above 7.25.

During the treatment, the patient received two hemodialysis sessions with an interval of 12 hours because of acidosis in blood gases. The patient's body temperature rose to around 40°C. The body temperature did not decrease despite prolonged exposure to cold application and medical treatment. The initial physical examination of the patient revealed fixed pupils and thereafter nystagmus developed. Fundus examination of the patient by the Ophthalmology Department showed no abnormal findings.

A cranial magnetic resonance imaging (MRI) study was performed 24 hours after spirit consumption. The MRI scan showed diffusion restriction on bilateral cerebellar hemispheres (Figure 1, 2) and diffuse cerebral edema, along with bilateral putaminal and thalamic lesions appearing hyperintense on T1- and T2-weighted images, (Figure 3, 4) which were suggestive of hemorrhagic infarction. No abnormal signal was identified in the optic nerves. Although the hemodynamic parameters improved, the patient remained unresponsive and unconscious. After 48 hours, the patient developed ventricular tachycardia. Since he did not respond to 300 mg amio-

darone, cardioversion was applied and a sinus rhythm was established. He showed no acidosis at 72 hours and his hemodynamic parameters were normal. Platelets, 63000/mm<sup>3</sup>; PTZ, 19.3 s; aPTT, 26.1 s; INR, 1.7. He had no hemorrhage. The dopamine and dobutamine infusion was discontinued on the fourth day of hospitalization. The GCS score of the patient did not change but blood gas values as well as hemodynamic and laboratory parameters followed a stable course. However, the patient developed cardiac arrest because of sudden hypotension and bradycardia 108 hours after hospitalization. He did not respond to resuscitation attempts and died.

## Discussion

The core reason behind the pathology of methanol intoxication is known to be associated not with methanol itself, but with its toxic metabolites generated by the oxidation process (1). Methanol is oxidized to formaldehyde by alcohol dehydrogenase, while formaldehyde is converted to formic acid, a major toxic metabolite, by formaldehyde dehydrogenase. Eventually, formic acid hinders ATP synthesis by inhibiting mitochondrial enzyme cytochrome C oxidase (5, 6). In vitro and in vivo studies on the rodent cerebral cortex and retina have shown reduced intracellular ATP concentration (known to cause deficiency in mitochondrial oxidative metabolism) and cytotoxic impact (induced by formic acid) in cerebral neurons, optic nerve cells, and retinal cells (7, 8).

Methanol is rapidly absorbed after oral intake and 1-2 mL/kg methanol may lead to death, while even smaller amounts of methanol, as little as 0.1 mL/kg, have been reported to cause blindness and death as well (1). As the mean half life of absorption following oral intake is 5 minutes, depending on the stomach being empty or full, peak absorption may take 30-60 minutes and elimination half life varies between 12-20 hours (9).

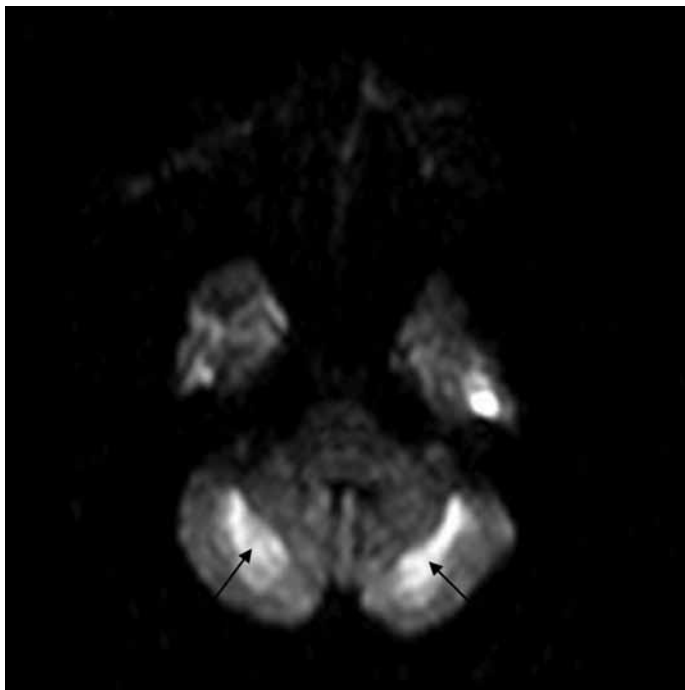


Figure 1. Axial diffusion weighted image showing high signal intensity in the cerebellar hemispheres bilaterally and ADC map

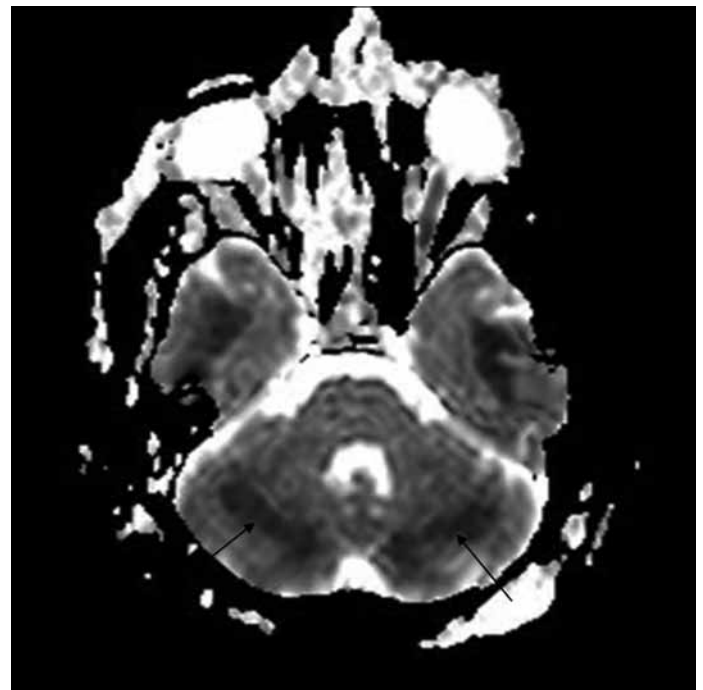


Figure 2. Axial diffusion weighted image showing low signal intensity in the cerebellar hemispheres bilaterally and ADC map

Clinical symptoms of methanol poisoning may occur during three stages: early, latent, and late. During the early stage, patients demonstrate moderate and temporary euphoria, dizziness, and drowsiness. The latent stage may last 6-30 hours during which the methanol metabolism takes place and patients experience no perception impairment. However, patients in the late stage present with heavier acidosis, accumulation of toxic metabolites, and serious systemic toxicity (1).

In cases of serious toxicity, a Parkinson-like extrapyramidal syndrome characterized by rigidity, bradykinesia, mild tremor, mask-like face expression, lethargy, and mild dementia can be observed, while coma and convulsions have been reported to suggest brain edema (1). Ocular symptoms strongly vary and include blurry vision, central scotoma, impaired light reflex, photophobia, visual field defects, and total blindness. Severe metabolic acidosis, increased formic acid level, bradycardia, cardiovascular shock, anuria, and seizures or coma at presentation are recognized as signs of poor prognosis. Respiratory failure or sudden respiratory arrest is the most common cause of death in methanol poisoning (10).

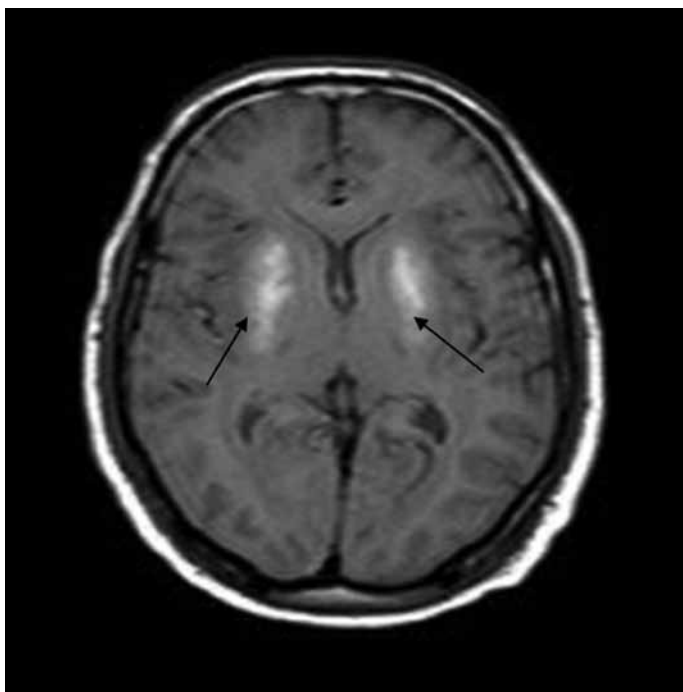
In light of the medical history and clinical signs on admission, we can say that our patient was brought to the hospital at the late stage. Initial examination revealed fixed and dilated pupils; however, following hemodialysis, pupils were normal, the light reflex was positive, and nystagmus was present. Nonetheless, no pathology associated with the optic nerve was detected upon ocular examination and MRI.

In cases suspected of methanol poisoning, blood methanol and ethanol levels should be measured along with taking the medical history. However, this may not be possible in all patients. When the methanol level cannot be evaluated, computed tomography (CT) and MRI findings may assist in reaching a diagnosis (11). Patients who survive for more than 24 hours show characteristic CT find-

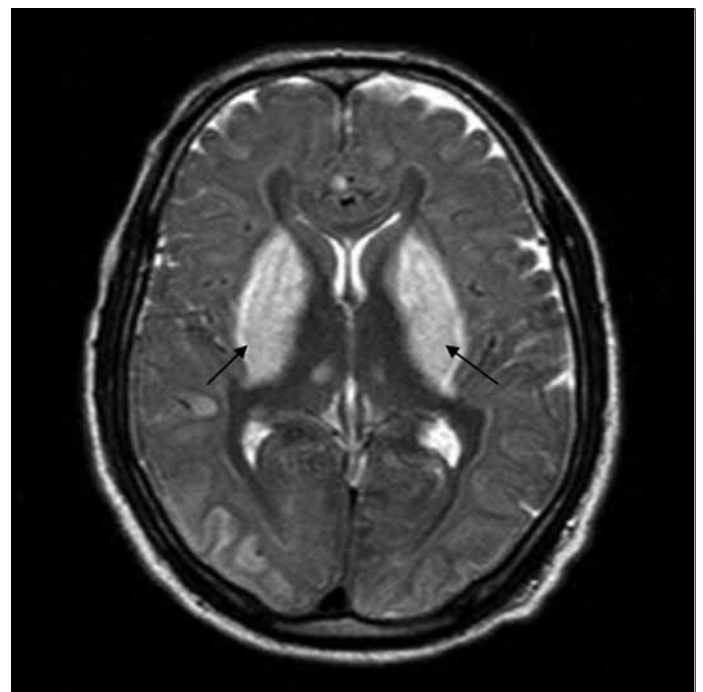
ings of bilateral low attenuation lesions in the putamina and cerebral deep white matter (12, 13).

Characteristic clinicopathologic symptoms of methanol poisoning have been reported to be optic neuropathy and bilateral hemorrhagic or non-hemorrhagic necrosis (14). Deep and peripheral white matter lesions have also been reported in the literature, with some reports mentioning sparing of the subcortical white matter (15-17). In addition, there may be bilateral hemorrhagic and diffuse subcortical necrosis in the putamen and caudate nucleus, and bilateral symmetric necrosis in the pontine tegmentum and optic nerves, all of which are recognized as predictors of poor prognosis (18). Moreover, bilateral putaminal necrosis is not specific to methanol poisoning and it has been shown to be present in other diseases such as Wilson's disease, Leigh's disease, Kearns-Sayre syndrome, and striatal degeneration of Leber's optic atrophy (2).

In addition to these pathologies, carbon monoxide inhalation and hypoxic injuries such as near drowning should be considered in the differential diagnosis. Nonetheless, the specific target of toxicity is the globus pallidus in carbon monoxide, where as it is the globus pallidus, caudate nucleus, and other gray nuclei in hypoxic/anoxic damage (14). There are various theories about the etiology of intracranial hemorrhage in methanol poisoning. Phang et al. (19) noted that applying hemodialysis in methanol intoxication might lead to intracranial hemorrhage. Keklikoglu et al. (20) found hemorrhagic lesions on CT images obtained prior to the application of hemodialysis and reported that these lesions could be associated with hypotension, hypoxia, or the direct impact of formic acid. Since the medical history of our patient informed us that he had drunk spirits, we were able to rule out the other pathologies. Moreover, the CNS lesions were believed to be associated with methanol, because heparin had not been delivered during hemodialysis.



**Figure 3.** Turbo spin-echo T1 weighted axial image shows abnormal high signal intensity in the putamen bilaterally



**Figure 4.** Turbo spin-echo T2 weighted axial image shows abnormal high signal intensity in the putamen bilaterally

The mechanism of cytotoxicity of methanol is well-understood, however, its predilection for deep white matter, retrolaminar optic nerves and putamina is unclear. Partially, the distribution pattern appears to have a relationship with the blood supply, because all the aforementioned body parts are watershed areas (5). Therefore, these areas are subjected to greater tissue hypoxia and an increased likelihood of infarction. Poor venous drainage of the putamen has also been proposed as a possible factor (21).

## Conclusion

Early diagnosis of methanol poisoning may improve the prognosis during the acute phase. In this case report, we presented a patient in whom MRI played an important role in establishing a diagnosis which initially appeared to be difficult due to the unavailability of a methanol assay.

## Conflict of Interest

No conflict of interest was declared by the author.

**Peer-review:** Externally peer-reviewed.

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Authors' contributions:** Conceived and designed the experiments or case: AB, AE, AA. Examination and follow-up of the patient: AB, AE, AA, HD, RA, MU. Analyzed the data: AB, AE, AA, HD. Wrote the paper: AB. All authors read and approved the final manuscript.

## Çıkar çatışması

Yazarlar herhangi bir çıkar çatışması bildirmemişlerdir.

**Hakem değerlendirmesi:** Bağımsız hakemlerce değerlendirilmiştir.

**Hasta Onamı:** Yazılı hasta onamı bu çalışmaya katılan hastalardan alınmıştır.

**Yazar katkıları:** Çalışma fikrinin tasarlanması: AB, AE, AA. Hastanın muayenesi ve takibi: AB, AE, AA, HD, RA, MU. Verilerin analizi: AB, AE, AA, HD. Yazının hazırlanması: AB. Tüm yazarlar yazının son halini okumuş ve onaylamıştır.

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