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Case Report

Methanol poisoning is not easily differentiated from diabetic ketoacidosis in a patient with diabetes mellitus type 2: a case report

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Abstract: Patients with methanol poisoning commonly present with normal blood glucose and negative for ketone bodies, whereas hyperglycemia and ketone positive conditions are associated with diabetes. We describe a case that matched the criteria for diabetic ketoacidosis and was treated according to the relevant guidelines and protocol. Although the acidosis was corrected quickly, the patient experienced a progressive decline in visual acuity. Review of the patient's medical records revealed a history of drinking self-prepared alcoholic drinks containing a high concentration of methanol. Methanol poisoning can present with symptoms of diabetic ketoacidosis in diabetes patients. Awareness of the condition and signs along with a detailed review of the patients' history can aid the differential diagnosis.

Keywords: Methanol poisoning, diabetic ketoacidosis, diabetes mellitus, differential diagnosis

Introduction

Methanol is a colorless, transparent, flammable, volatile, slightly ethanol-flavored liquid that is easily soluble in water. Methanol poisoning in humans can occur following absorption in the respiratory tract, digestive tract and skin. Methanol and its metabolic intermediates, formic acid/methanoic acid has serious toxic effects to the body, resulting in metabolic acidosis, visual impairment, and neurological symptoms [1]. Thus, although rare, methanol poisoning is a serious medical problem.

Diabetic ketoacidosis (DKA) is a complication of diabetes that is usually not difficult to diagnose. When a diabetes patient presents with severe hyperglycemia, ketonuria, and high anion gap (AG) metabolic acidosis, the presumptive diagnosis is DKA. However, DKA should be differentiated from other causes of metabolic acidosis [2]. The following case report describes a patient with methanol poisoning, which presented with high AG acidosis in the early stage. Because both types of acidosis are characterized by high AG metabolic acidosis, it is easy to assume DKA while ignoring the possible presence of methanol intoxication until the time of disease progression with an atypical presentation. This case warns us not to neglect the possible existence of other problems in patients with obvious diseases.

Case presentation

A 53-year-old man was brought to the emergency department of Jilin University First Hospital due to complaints of blurred vision and fatigue lasting for 2 days and worsening on the second day. The patient had been diagnosed with diabetes 6 years previously. Blood sugar control had been poor in the previous 4 days due to poor diet control, and the patient's fasting blood glucose, as self-tested using a portable blood sugar monitoring device, had fluctuated around 13-15 mmol/L. Two days previously, the patient had felt tired with limb pain and blurred vision. He could not recognize the words and images displayed on a television screen but could see objects around him. The patient also had symptoms of nausea and vomiting, and the vomit was the stomach contents with-

Table 1. Standard laboratory test results of the patient on presentation

Blood gas test	pH	7.14
	pCO_2	10 mmHg
	pO_2	143 mmHg*
	Potassium	4.8 mmol/L
	Sodium	132 mmol/L
	AB	3.4 mmol/L
	BEecf	-25.6 mmol/L
	BE	-22.6 mmo1/L
	AG	32.5 mmol/L
Routine urinalysis	RBC count	62.4 cells/μl
	Ketone body	+
	Glucose	++++
Liver function	A	37 g/L
	γ-GCT	88.9 U/L
Renal function	Cr	150.2 μmol/L
	CO_2CP	6.1 mmol/L
Diabetes control	FBG	15.38 mmol/L
	HbA1c	9.5%

pCO_2: partial pressure of CO_2; pO_2: partial pressure of oxygen. *oxygen inhalation 3 L/min with a nasal catheter; AB: actual bicarbonate; BEecf: base excess in extra cellular fluid; BE: base excess; AG: anion gap (normal range: 12-14 mmol/L); RBC: red blood cell; A: blood albumin (reference: 40-55 g/L); γ-GCT: γ-glutamyl transpeptidase (reference: 10-60 U/L); Cr: serum creatinine (reference: 58-110 μmol/L); CO_2CP: carbon dioxide combing power (reference: 22-30 mmol/L); FBG: fasting blood glucose (normal range: 3.9-6.1 mmol/L); HbA1c: glycated hemoglobin (normal range: < 7%).

out coffee ground vomitus. These symptoms worsened the day before the patient presented in the emergency department. The patient went to the hospital once he had extremely poor vision and began to experience dyspnea. The patient also had an 8-year history of hypertension, with a blood pressure reaching 180/110 mmHg, and amlodipine 5 mg was taken orally per day. The patient's records also revealed a 10-year history of chronic bronchitis, a 30-year history of smoking about 10 cigarettes per day, and a 10-year history of alcohol drinking of about 100-130 mL per day. No diabetes mellitus positive family history was found.

On physical examination, the patient was conscious and active on arrival. He had a body temperature of 36.5°C, heart rate of 88 beats/min, respiratory rate of 23 breaths/min, and blood pressure of 100/60 mmHg. He was well developed and moderately nourished with a body mass index (BMI) of 26.6 kg/m^2. The skin and sclera were not stained yellow. Eye ball movement was normal. The right eye visual acuity was -5.25 index/20 cm and left eye -4.75 index/20 cm. The pupils were round, equal sized with a diameter of approximately, and normally reactive to light. Multiple aneurysms could be seen in both eyes by fundus examination. The trachea was in midline. The thyroid was not enlarged. No abnormal breath or heart sound was heard in auscultation. No abdominal positive sign was found. The standard laboratory test results were normal (**Table 1**).

The results of additional tests were as follows. Carotid artery ultrasound revealed multiple plaques in bilateral carotid arteries. Echocardiography showed that the cardiac chambers were of normal size, regional wall motion was normal, left ventricular diastolic function was reduced, and mild aortic regurgitation was present. Pulmonary computed tomography (CT) indicated bronchitis combined with a slight possibility of inflammation in both lungs. Cranial CT showed a low-density area in pons and the possibility of lacunar infarction. Cranial magnetic resonance imaging (MRI) revealed a subacute lacunar infarction in the right basal ganglia, multiple lacunar infarctions, an ischemic focus in the brain, and pons softening. No abnormalities were found on the electrocardiogram and transcranial Doppler ultrasound. On measurement of the flash visual-evoked potential (FVEP), there was no exact waveform in the right eye, and the p2 peak in the left eye was slightly delayed.

The patient was transferred to the Department of Endocrine & Metabolic Disease 2 days after admission. After active treatment, the patient's blood sugar was controlled between 7-12 mmol/L, the test for ketone bodies in the urine was negative, and metabolic acidosis was corrected. Nevertheless, the patient's visual impairment continued to progress, and he was no longer able to perceive light. On eye examination, there was no light perception in either eye. The right pupil was 5.0 mm in diameter, and the direct and indirect pupillary light reflexes had disappeared. The left pupil was 4.0 mm in diameter, and the direct pupillary light reflex was slow and partial; the indirect pupillary light reflex was absent. Dilated fundus examination showed an obscure boundary of the optic papilla as well as venous tortuosity and dilatation in both eyes. We asked the patient for a more

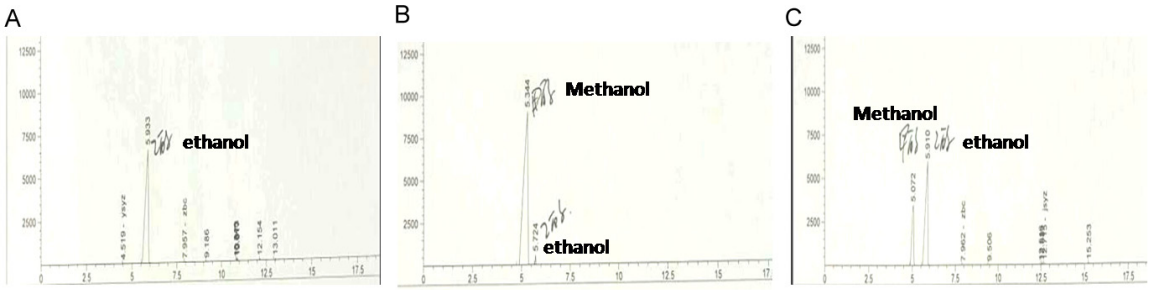

Figure 1. High-performance liquid chromatography/mass spectrometry results for the contents: (A) Alcoholic beverage that the patient purchased from the market; (B) Alcoholic beverage provided by a friend of the patient; (C) Alcoholic beverage that the patient drank prior to presentation, prepared by mixing the alcohols shown in (A and B).

detailed history. He reported that he had previously consumed commercial alcoholic beverages, but in the past 1 week before becoming ill, he had mixed the purchased alcohol with alcohol made by a friend. High-performance liquid chromatography/mass spectrometry analysis of the friend's alcohol showed a high concentration of methanol (**Figure 1**). Considering this findings with the clinical symptoms of the patient; we believed that the diagnosis should be severe metabolic acidosis and optic nerve injury caused by chronic methanol poisoning, rather than DKA. The patient was then given the following treatment: correction of fluid loss, acidosis, electrolyte disturbance, and hypoglycemia along with oxygen therapy, glucocorticoid, nutritional support, and protection of the optic nerve. After these treatments, the patient's vital signs were stable, and his vital organ function was protected. However, the blindness was not improved. We recommended that the patient continue to receive nutritional support for the optic nerve or hyperbaric oxygen therapy after discharge, along with regular visits to the ophthalmology department.

Discussion

The present case initially seemed to be a typical case of DKA, because the patient had all the expected clinical manifestations, including hyperglycemia, acidosis, and ketonuria. These superficial DKA symptoms and signs as well as his long history of diabetes may prompt this misdiagnosis at first sight.

In addition, upon admission, the patient denied consuming methanol or any other special substance. When the treatment obviously relieved the acidosis, but his eyesight continued to seriously deteriorate, we considered that the patient might have methanol poisoning, which was verified through a second history inquiry and laboratory tests.

Metabolic acidosis is the most common disorder of acid-base balance and is characterized by primary HCO_3^- reduction and decreased pH caused by an increase in extracellular fluid H^+ or loss of HCO_3^-. In the clinical judgement of metabolic acidosis, AG values are important. According to different AG values, metabolic acidosis can be divided into a high AG normal chlorine type and a normal AG high chlorine type. In general, high AG metabolic acidosis caused by excessive endogenous acid is more common in the clinic [3]. Methanol poisoning also results in increased AG. Methanol is metabolized by alcohol dehydrogenase to formaldehyde and then transformed to formic acid by aldehyde dehydrogenase [4]. Because formic acid is an acid substance, the AG of patients with acute methanol poisoning is increased; therefore, the clinical manifestation is a high AG normal blood chlorine metabolic acidosis.

The toxicity of formic acid is related to its inhibition of cytochrome oxidase at the end of the electron transport chain in mitochondria. Accumulation of formic acid can cause damage to the retina and optic nerve, resulting in changes in the histological morphology and function of the tissues and ultimately leading to blindness [5]. The organ most sensitive to methanol's toxicity is the optic nerve, as confirmed by both animal experiments and a large-scale clinical epidemiological survey in Cuba, although the mechanism is still not completely clear [6]. Previous studies also showed that the degree of acidosis caused by methanol poisoning is positively correlated with the risk of permanent blindness in patients [7]. Residual visual distur-

bance due to toxic optic neuropathy has been shown to recover partially, and in some cases fully, in survivors of methanol intoxication [8]. Unfortunately, our patient in this case did not experience visual recovery.

The lesson of this report is that although it is to be hoped that methanol consumption is uncommon, it should be recognized as a condition that can mimic DKA. For suspected cases, clinicians should perform a thorough history inquiry regarding potential exposure sources. Early recognition and treatment is essential for the management of methanol intoxication and minimization of morbidity and mortality. Particularly for diabetes patient with metabolic ketoacidosis, if the patient shows an atypical response to treatment, intoxication should be considered immediately. A toxicological scan should be made, and great care must be taken to prevent the corresponding complications.

Disclosure of conflict of interest

None.

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