CASE REPORT

Two Cases of Ethylene Glycol Poisoning Treated Successfully with Haemodialysis

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Abstract

Introduction: Ethylene glycol is an organic toxic compound found in many household items including radiator coolants and brake oil. Toxic effects of ethylene glycol are due to its metabolites glycolic acid and oxalic acid which cause potentially fatal metabolic acidosis and renal failure. Here we discuss two cases of ethylene glycol poisoning with literature review on pathophysiology, clues in diagnosis and therapy.
Case presentations: First case is of a teenage girl presenting with unexplained persistent drowsiness. She went on to develop acidotic breathing and anuria. Unexplained metabolic acidosis and acute kidney injury inclined us towards ethylene glycol poisoning. On further questioning, she confirmed taking radiator coolant 5 hours before admission.
The second case is of a young automobile serviceman who presented with unexplained markedly reduced level of consciousness. He had high anion gap metabolic acidosis, calcium oxalate crystals in urine and basal ganglia hypodensities in non-contrast CT. He later developed acute kidney injury. Ethylene glycol poisoning was suspected which was later confirmed when the patient regained consciousness.
Both patients responded well to haemodialysis and recovered without complications.
Discussion: Ethylene glycol is an easily accessible toxic compound that can be used as a suicidal agent. High anion gap metabolic acidosis, acute kidney injury, calcium oxalate crystalluria and altered sensorium are highly suggestive.
Conclusions: A high degree of suspicion is needed for early diagnosis. Haemodialysis can be used effectively to remove the toxic metabolites and treat the renal impairment. Early recognition will save lives without long term renal or neurologic complications.

Keywords: Acute Kidney Injury; Ethylene Glycol; Haemodialysis; Metabolic Acidosis

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INTRODUCTION

Pure ethylene glycol is a colourless, odourless sweet tasting fluid. It is viscous and has a low freezing point and high boiling point; properties that make it useful as a radiator coolant and brake oil. It is also found as a solvent in window and other household cleaners. Sweet taste of ethylene glycol leads to unintentional ingestion in children and pets and makes suicidal ingestion less discomforting (1, 2).

Literature survey revealed no published cases of ethylene glycol poisoning in Sri Lanka. Case reports published elsewhere revealed high mortality if diagnosis and appropriate therapy is delayed (2, 3). Central nervous system depression, high anion gap metabolic acidosis, high osmolar gap, acute kidney injury, calcium oxalate crystals in urine and basal ganglia, thalamic and brainstem hypodensities on plain CT are clinical clues that are well described in ethylene glycol poisoning (1, 3-5). Early initiation of haemodialysis even in the absence of specific antidote is lifesaving (6).

CASE PRESENTATION

Case report 1

A 16-year-old girl presented to us with a history of syncope followed by drowsiness for 4 hours. She had complained of a headache and subsequently fainted while walking and was briefly unconscious. Despite of regaining consciousness, she remained drowsy. She was seen by a general practitioner who found her vitals to be normal. Her capillary blood glucose was 122 mg/dL. She was admitted to hospital in the evening of the same day as she remained drowsy. On admission, she was afebrile with a pulse rate of 100 bpm and blood pressure of 130/70 mmHg. She had no premorbid conditions. History elicited by the admitting medical officer was unremarkable. Her fundi were normal and GCS was 13/15. She had no focal neurological signs.

ECG and non-contrast computed tomography of brain were normal. A diagnosis of vasovagal syncope was made, however, her hypersomnolance was unusual.

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The following day she was noted to be increasingly drowsy with GCS of 10/15. She had rapid deep breathing pattern which alerted to possible acidosis. There was a reduction of urine output. Arterial blood gas analysis confirmed severe metabolic acidosis with a pH of 7.08, HCO_3^- of 3 mmol/L and pCO_2 of 8 mmHg. Lactate level was 13.9 mmol/L. Capillary blood glucose was 174 mg/dL and urine ketone bodies were negative. Serum sodium was 143 mmol/L and serum potassium was 6.2 mmol/L. Serum creatinine was 220 µmol/L.

Unexplained metabolic acidosis and acute kidney injury pointed towards a possibility of ethylene glycol poisoning and on further probing she revealed that she had ingested 100 ml of radiator coolant 5 hours before admission. Her acidosis was treated with intravenous 8.4% $NaHCO_3$ and urgent haemodialysis was performed. Intravenous thiamine and pyridoxine was administered. Her renal failure and level of consciousness gradually improved and at the time of discharge 4 days after admission she was asymptomatic and her creatinine was normal.

Case report 2

A 19-year-old automobile serviceman was admitted with reduced level of consciousness. No preceding history was available. His GCS on admission was 5/15. He had rapid deep breathing with clear lungs on auscultation. His pulse rate was 116/min and blood pressure was 160/100 mmHg. Pupils were equally reactive to light and fundi were normal. No focal neurological signs were present.

Arterial blood gas analysis revealed pH of 6.9, pCO_2 of 6 mmHg and HCO_3 of 3 mmol/L. His serum sodium was 140 mmol/L, serum potassium was 6 mmol/L and serum chloride was 108 mmol/L. His calculated anion gap was high at 35 mmol/L. His serum creatinine was 196 µmol/L and urine analysis showed proteinuria, microscopic haematuria and calcium oxalate crystals. Non-contrast CT of brain showed hypodensities of both basal ganglia.

The patient was electively intubated and transferred to intensive care unit. Ethylene glycol poisoning was suspected given his presentation and easy access to brake oil and radiator coolant. He was started on haemodialysis and there was gradual improvement in acidosis and renal impairment. He remained comatose until about the tenth day after which his level of consciousness improved. When he regained consciousness, he admitted to taking 100 ml of DOT3 brake oil approximately 24 hours prior to admission.

DISCUSSION

We have presented two cases of ethylene glycol poisoning. First patient presented early and the diagnosis was clear as the patient admitted ingesting radiator coolant. Second patient presented late. The diagnosis was confirmed retrospectively as the patient was unconscious on admission. However, both patients responded well to treatment with haemodialysis with good outcome.

Easy accessibility and bland nature of ethylene glycol favours high dose ingestion. Although the minimum lethal dose is considered 1-1.5 ml/Kg (around 100 ml in an adult) based on case reports, higher doses of poisoning can be treated with early intervention (7, 8).

It is rapidly absorbed from the gastrointestinal tract and reaches peak concentrations within 1-4 hours (2, 7, 9, 10). Therefore, gastric lavage is of no use unless performed within one hour [3]. Eighty per cent of ethylene glycol is converted to glycoaldehyde via liver alcohol dehydrogenase enzyme [10]. This oxidation utilizes NAD. Twenty per cent is excreted unchanged in the urine (9, 10)

Glycoaldehyde undergoes further oxidation to glycolic acid via aldehyde dehydrogenase (1, 2, 7). Glycolic acid is further converted to glyoxylate. However, the latter conversion is slow leading to the accumulation of glycolic acid (9). Glyoxylate metabolites inhibit the krebs cycle leading to anaerobic metabolism and lactic acid production. Oxidation of NADH to NAD also leads to the production of lactic acid (7). Hence, high lactate levels are observed as in the first case. Glycolic acid and to a lesser extent lactic acid account for the high anion gap metabolic acidosis (2, 7, 9).

Oxalate is an end product of glyoxylate metabolism. Oxalate chelates with calcium to produce calcium oxalate crystals which are excreted via the kidney (1, 2, 9). This leads to tubular damage and hypocalcemia. Presence of calcium oxalate crystals in urine is suggestive of ethylene glycol poisoning. Calcium oxalate also gets deposited in the brain, heart and lungs (2, 4).

The clinical presentation of ethylene glycol toxicity is described in three stages as neurological, cardiopulmonary and renal (9). These stages are not always seen sequentially and depend on the degree of toxicity.

Inebriation without ethanol smell can occur as early as 30 minutes after ingestion as direct CNS effect of ethylene glycol (2). It is characterised by ataxia, slurred speech, nausea, vomiting and syncope as was the presentation in our first case (5). Within 4-12 hours, hypersomnolence, disorientation and drowsiness set in (2). Coma can persist for days subsequent to acidosis, cerebral oedema and hypoxia as in the second case. Neurological examination may be normal, however, severe toxicity can cause hypotonia, hyporeflexia and delayed cranial neuropathies (1, 11]). Normal fundal examination helps to differentiate from methanol poisoning in which papilloedema is seen (2). Hypocalcemia can lead to tetany, seizures and myocardial dysfunction (7, 9). Cardiopulmonary effects can present in severe toxicity within 12-24 hours of ingestion (7). Unexplained tachycardia which was seen in both these cases is a feature. Hypertension followed by hypotension, congestive cardiac failure, cardiac dilatation and acute respiratory distress syndrome are described (1, 2, 7, 9). The exact pathogenesis is not known.

Acute kidney injury occurs within 24-72 hours of ingestion and leads to oliguria or anuria. The renal toxicity is in part due to the tubular damage caused by glycolate metabolites and partly secondary to oxaluria (12). The proximal tubules undergo dilatation and tubular epithelium undergoes atrophy (3). It is usually reversible. Flank pain and haematuria can occur (9).

Clues on suspecting ethylene glycol toxicity include CNS depression, high anion gap metabolic acidosis with high lactates and acute kidney injury which was seen in both of our patients. High osmolar gap is suggestive but the absence does not exclude ethylene glycol poisoning (9). Calcium oxalate

crystalluria is also characteristic but is seen only in 50% in early presentation (2). Cerebral oedema and hypodensities of basal ganglia, thalami and brain stem are described on plain CT as a result of ischeamia (4, 12, 13).

Fomepizole is an FDA approved antidote which inhibits alcohol dehydrogenase (4). Metabolic acidosis with a pH<7.3, HCO_3<20 mmol/L or presence of urinary calcium oxalate and high osmolar gap (>10 mosm/L) with high clinical suspicion are indications for its use (3). Although safe to use, it is highly expensive. Intravenous pharmacological grade ethanol can be used as a competitive inhibitor of alcohol dehydrogenase and is effective up to 6 hours from ingestion (7, 9). In the absence of pharmacological grade ethanol, an alcoholic spirit diluted to twenty per cent can be administered orally. Alternate pathway of glyoxylate metabolism leads to the production of glycine which requires pyridoxine and thiamine as co-factors (1, 7). Supplementation with intravenous thiamine and pyridoxine prevents their depletion and helps to reduce the amount of oxalate produced.

Haemodialysis removes ethylene glycol and its metabolite, glycolate. It also corrects acidosis, uraemia and hyperkalemia. Haemodialysis is indicated in severe metabolic acidosis (pH<7.3), acute kidney injury, high dose ingestion (ethylene glycol concentration greater than 50 mg/dL) and poor response to antidote (3). Haemodialysis eliminates ethylene glycol more rapidly compared to fomepizole. Peritoneal dialysis is less effective than haemodialysis.

Fomepizole and pharmacological grade ethanol are not available in Sri Lanka. Oral administration of ethanol requires intensive monitoring of vitals, blood glucose level, electrolytes and ethanol levels which are not feasible in many instances. However, haemodialysis is available in many tertiary care hospitals in Sri Lanka and it can be used effectively for ethylene glycol poisoning as the sole therapy as seen in our cases.

CONCLUSION

These cases illustrate the challenges of managing an unknown poisoning in a resource poor setting. A high degree of suspicion and rational utilization of available resources are often rewarding as in these cases.

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