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CASE REPORT

Acute Sodium Chlorite Poisoning Associated with Renal Failure

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ABSTRACT

A 25-year-old Chinese male presented with generalized cyanosis and respiratory distress. The patient was known to have ingested 10 g of sodium chlorite in a suicide attempt. Methemoglobinemia was found and intravenous methylene blue was given repeatedly. However, the therapy could not prevent an acute hemolytic crisis. Methemoglobinemia remained profound (43.1%) and disseminated intravascular coagulation ensued. He was put on CAVHD to correct the fluid overload and probably to remove the active metabolites of the chlorite. After 24 h, the methemoglobin was reduced to 16.9%. However, the development of acute renal failure further complicated the clinical course. Percutaneous renal biopsy suggested a picture of acute tubulointerstitial nephropathy. In addition, hemodialysis was continued for 4 weeks. After 3 months, renal function normalized. To our knowledge, there has been no clinical report of human intoxication with sodium chlorite.

INTRODUCTION

Sodium chlorite is a strong oxidizing agent used commercially as bleaching agent for textiles and paper pulp. It is also used in the preparation of chlorine dioxide and in water purification. In the past, cases of similar powerful oxidizer intoxication—such as nitrates, quinones (1), chlorates (2, 3)—have been described but this has been infrequent. Methemoglobinemia is an important initial presentation and the clinical course is usually

complicated by massive intravascular hemolysis and acute renal failure. To our knowledge, there has been no clinical report of human intoxication with sodium chlorite. We report here a case who presented with methemoglobinemia and acute reversible renal failure after ingestion of sodium chlorite in a suicide attempt.

CASE REPORT

A 25-year-old Chinese male patient was brought to the emergency room because of conscious disturbance and generalized cyanosis. For the past 4 years he had suffered from repeated seizure attacks and was put on anticonvulsant therapy. However, in recent months, seizure attacks became increasing frequent despite therapy and he became extremely depressed.

On February 16, 1992, he drank a teacup of disinfectant containing 10 g sodium chlorite dissolved in 100 mL of water in an attempted suicide. Within a few minutes, he experienced episodes of abdominal cramps. Nausea and vomiting ensued. Later, he appeared very irritable and confused. Generalized cyanosis occurred and he was sent to our hospital within 30 min.

At the emergency room, the patient was promptly intubated. An arterial blood gas was sent and thorough gastric decontamination was done. Generalized cyanosis persisted despite hyperbaric oxygen therapy, and methemoglobin was 59%. Repeated doses of methylene blue amounting to 250 mg were given intravenously. After the initial management, improved conscious state was found. Still, profound respiratory failure was noted and he was sent to MICU.

On admission, the patient remained deeply cyanotic and afebrile. The heart rate was 148 per min and regular, and respiratory rate was 26 breaths per min. The blood pressure was 94/40 mm Hg. The lungs, the heart, and the abdomen were physically normal at that time. Initial laboratory data revealed hemoglobin 17.6 g/dL, white blood cells 62,300 cells/mm^3, platelets 31,700/mm^3, sodium 138 mmol/L, potassium 10.5 mmol/L, chloride 111 mmol/L, BUN 7.14 mmol/L, urea, Cr 123.8 μmol/L, alkaline phosphate 88 U/L, amylase 870 U/L, and glucose 9.88 mmol/L. Urine was of brown color and contained 2+ protein and 3+ blood. Microscopic examination of urine revealed 8–12 red blood cells and 2–4 white blood cells. There were no ghost cells in the early blood film.

Unfortunately, the methemoglobin remained elevated, viz. 43.1% despite 5 additional vials of intravenous methylene blue. Apparently treatment with methylene failed to prevent a massive hemolysis and disseminated intravascular coagulation. The hemoglobin concentration had fallen to 7.1 g/100 mL and the platelet count to 30,000/cmm^3. Coagulation profile gave results which were consistent with a state of disseminated intravascular coagulation, viz. prothrombin time 15.4 min (control 11.4 min); thrombin time 29.4 min (control 16 min); activated prothrombin time 67.4 min(control 31.4 min), FDP $>$ 40 μg/mL and a positive 3P test. However no transfusion of blood products was given. Due to persistent methemoglobinemia and hemodynamic instability, he was put on continuous arteriovenous hemofiltration in an attempt to remove the unreacted chlorite. After 12 h the methemoglobin level fell to 21.1%, and over the next 12 h it dropped to 16.9%. Concomitantly, cyanosis improved. During the following days, severe respiratory failure resulting from both pulmonary edema and hemorrhage developed. Cardiac arrest was noted and he was successfully resuscitated. During this period, *E. coli* septicemia was found and gentamicin with cephalothin was given for 4 days. Ceftriaxone was continued for one additional week.

Over the ensuing days, acute renal failure and fluid overload supervened. On March 20, renal ultrasound study disclosed the kidneys were normally sized and configurated. A percutaneous renal biopsy was performed and microscopic examination revealed an acute tubulointerstitial changes with infiltration of lymphocytes. Severe interstitial edema and moderately damage of the tubules with hemorrhage and necrosis were also described (Fig. 1). By immunohistochemistry, no IgG,

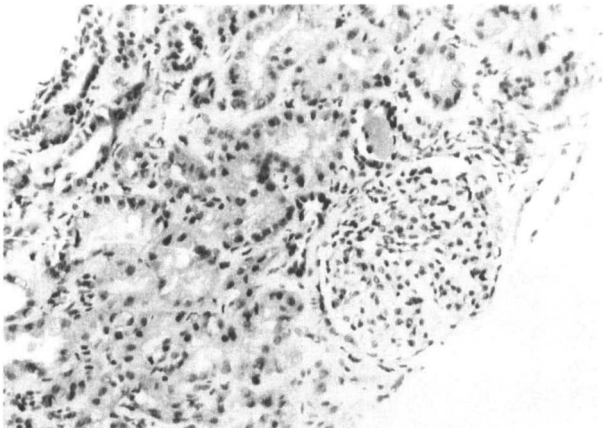

Figure 1 Photomicrograph of a renal biopsy specimen, demonstrating interstitial infiltration with round cells and interstitial edema. The glomeruli are normal.

IgA, IgM, complement C3, C4, or Clq deposits were seen. Electron microscopic examination showed a picture of focally collapsed loops with focal fusion of processes. No thrombi or broken RBCs were found (Fig. 2). Due to persistent azotemia, he received hemodialysis for an additional 4 weeks. In addition, a course of steroids was given. Thereafter, progressive improvement of his clinical status was noted and he was discharged about 2 months after admission.

When last seen in April 28, 1992, the patient had made a complete recovery. Serum creatinine had fallen to 150.28 μmol/L and the 24-h urine collection showed 0.3 g protein and a creatinine clearance of 65.7 cc/min. In addition, recovery of glucose-6-phosphatase dehydrogenase activity was noted.

DISCUSSION

Sodium chlorite occurs as colorless, odorless, and slightly hygroscopic crystals or flakes that readily dissolve in water. It is a powerful oxidizer that is used extensively as a bleaching agent and in water purification. To our knowledge, our current case is the first report to describe the clinical and pathologic pictures of sodium chlorite poisoning. The information available on the impact of chlorite ingestion in man is therefore severely limited.

In 1964 Musil et al. (4) first associated oral chlorite ingestion with methemoglobin formation. Thereafter, several authors (5–7) suggested that chlorite could induced hemolytic anemia and suppressed glutathione levels in animals. At high levels of chlorite ingestion, the possibility of renal toxicity has recently been described (7).

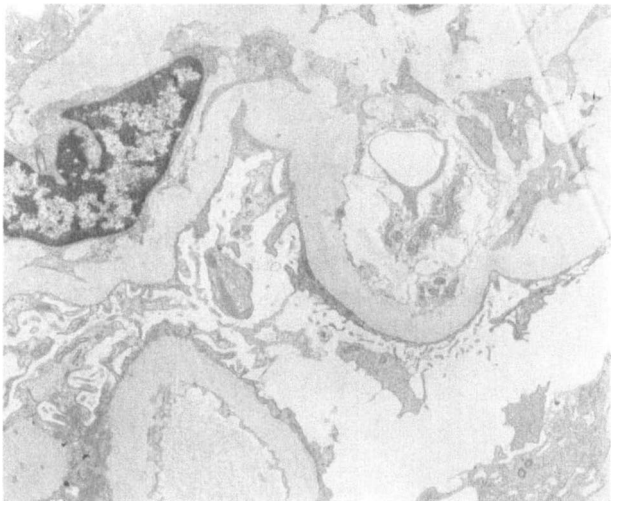

Figure 2 Electron micrograph shows no significant change in a glomerulus. ×5000.

When cells and organs are exposed to oxidant stress, several different antioxidant defense mechanisms exist to prevent or limit the extent of injury. Of particular importance is the glutathione redox cycle. Normally reduced glutathione (GSH) detoxifies the oxidants but there is a limit to the oxidant stress a cell or tissue can handle. As a consequence, virtually each major class of biological molecules—including amino acids and proteins, lipids and membranes, DNA, and extracellular matrixes such as basement membranes—are targets of oxidant injury. When normal red cells are exposed to excess oxidant drugs or toxins such as sodium chlorite, the hemoglobin undergoes oxidation to the functionless methemoglobin. Besides, oxidative crosslinking of spectrin and lipid peroxidation may cause membrane damage. This ultimately leads to direct intravascular hemolysis.

The initial symptoms of chlorite poisoning such as nausea, vomiting, and abdominal pain probably relate to the irritant effect of the chlorite ion on the gastrointestinal mucosa. Upon absorption, hemoglobin is rapidly oxidized to methemoglobin which later impairs its ability to transport oxygen. Cyanosis becomes clinically manifest when the proportion of methemoglobin exceeds 10%. Similar to chlorate poisoning (2), the formation of methemoglobin is reversible only in the early phase and when the degree of oxidation is less than 70% (2). In the case of severe intoxication, treatment with methylene blue usually failed. In our case, the administration of continuous arteriovenous hemodiafiltration (CAVHD) successfully corrected the fluid overload, reduced the methemoglobin level, and reversed the cyanotic state. In addition, exposure to the red cells to the excessive oxidant effects will lead eventually to intravascular hemolysis. Massive products of hemolysis causes saturation or perhaps blockade of the reticuloendothelial system. As a result, reduced clearance of fibrin degradation products and activated clotting factors aggravate the coagulation disorder, precipitating disseminated intravascular coagulation.

Reversible renal failure attributed to acute interstitial nephritis complicated the course and necessitated prolonged dialytic therapy. Oxidant injury probably can be implicated in the pathogenesis of this renal injury. Many drugs and chemicals alike induce oxidant stress either directly or after conversion to redox cycling agents. Pre-

sumbly strong oxidants such as chlorite deplete the glutathione and other reducing equivalents in the renal tubular and interstitial cells. This disruption of the antioxidant defense mechanisms may accentuate oxidant injury, precipitating a tubulointerstitial pattern of renal disease. In addition, it has been reported that oxidants such as sodium chlorate may also cause intense renal vasoconstriction and subsequent tubular damage (3). The renal histological demonstration of extensive lymphocyte infiltration and diffuse edematous change in the interstitium in our case strongly support our notion of renal injury. In the absence of other offending factors for renal failure, acute reversible interstitial nephritis in our case can probably be attributed to sodium chlorite poisoning. However, its mechanism needs further confirmation and clarification. However, it is undeniable that methemoglobinuria in combination with massive hemolysis, disseminated intravascular coagulation, and acidosis may cause acute tubular degenerative changes and thus contribute to the impairment of renal function.

In summary, sodium chlorite is a strong oxidant and may lead to methemoglobinemia, hemolytic anemia, and disseminated intravascular coagulation. Reversible renal failure attributed to acute interstitial nephritis may complicate the course and necessitate prolonged dialytic therapy. Early recognition of ingestion is important, since treatment with intravenous methylene blue, gastric decontamination, and dialysis or CAVHD may prevent severe toxicity and promote earlier recovery.

Key Words: Acute renal failure; Methemoglobinemia; Sodium chlorite.

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