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A case of acute inhalation injury caused by premeditated chlorine gas exposure

Takuma Katano, Hiroto Murao, Toshio Kato, Akihito Kubo & Satoru Ito

Department of Respiratory Medicine and Allergology, Aichi Medical University, Nagakute, Japan.

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Correspondence
Takuma Katano, Department of Respiratory Medicine and Allergology, Aichi Medical University, 1-1 Yazako-Karimata, Nagakute 480-1195, Aichi, Japan.
E-mail: katano.takuma.843@mail.aichi-med-u.ac.jp

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Abstract

Chlorine is a toxic gas that causes severe inhalation injury. We report the case of a 43-year-old woman who inhaled chlorine gas generated by mixing household bleach and vinegar. She was referred to our hospital because she had developed respiratory failure. Chest computed tomography (CT) showed diffuse ground-glass opacity and the tree-in-bud pattern. We diagnosed acute inhalation injury compatible with that due to chlorine gas exposure. Six days after admission, her respiratory symptoms and abnormal CT findings fully resolved without the use of bronchodilators or corticosteroids. This is the first report of a patient with acute inhalation injury caused by intentional chlorine gas exposure. It is considered that chlorine gas reached her respiratory tract and induced widespread injury from bronchioles to alveoli.

Introduction

Chlorine is one of the most common substances that cause inhalation injury. Exposure to toxic levels of chlorine gas usually occurs secondary to household, occupational, or environmental accidents [1]. Here, we describe a case of acute inhalation injury caused by chlorine gas exposure.

Case Report

A 43-year-old woman with a history of intellectual disability was referred to Aichi Medical University Hospital with respiratory failure and sustained dyspnoea. She had no previous history of smoking or respiratory disorders. She told us that in the early morning of the day before admission, she had mixed rice vinegar and household bleach containing sodium hypochlorite in a plastic bag. Then, she inhaled the gas generated from the mixture several times. Soon after inhalation of the gas, she felt pain from the pharynx to the chest and experienced dyspnoea with wheezing and coughing and stopped inhaling. One day after the gas inhalation, she visited an outpatient clinic close to her house due to sustained dyspnoea and was referred to our hospital for admission. On admission, her peripheral artery oxygen saturation (SpO_2) was 92% with 1 L/min oxygen via nasal cannula. Physical examination revealed bilateral lung crackles but no wheeze. Chest computed tomography (CT) showed bilateral diffuse ground-glass opacity (GGO), ill-defined centrilobular nodules, and centrilobular nodules with the tree-in-bud pattern (Fig. 1). The peripheral white blood cell count (9700/μL) and serum C-reactive protein level (0.36 mg/dL) were slightly high. Images of a flexible bronchoscope showed injured and oedematous surfaces of the large airways. Bronchoalveolar lavage was performed from the posterior segmental bronchus of the upper lobe of her right lung. A cell count of the bronchoalveolar lavage fluid (BALF) revealed 62.5% macrophages, 27.0% neutrophils, 9.0% lymphocytes, and 1.5% eosinophils. The total BALF cell count was 3.8 × 106/mL. No bacteria or fungus was isolated from cultures of BALF. We diagnosed acute inhalation injury due to chlorine gas exposure. She received ceftriaxone for five days to prevent secondary bacterial pneumonia. Her respiratory symptoms gradually improved without the use of bronchodilators or corticosteroids. Three days after admission, her SpO_2 was 97% without supplemental oxygen. Six days after admission, follow-up chest CT was almost normal (Fig. 2) and she was discharged.

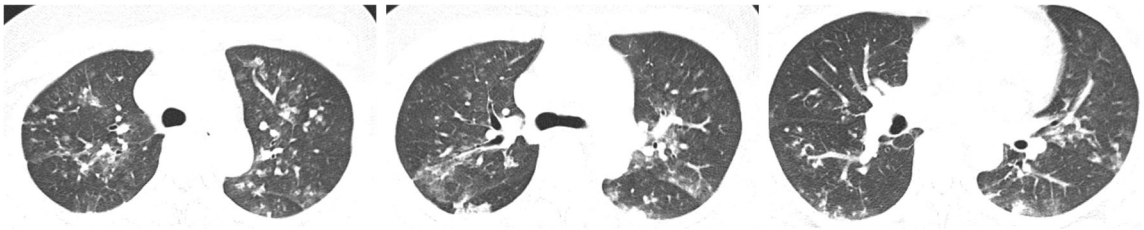

Figure 1. Images of chest computed tomography (CT) on admission. Ill-defined centrilobular nodules with interlobular septal thickening in both upper lobes (left), bilateral diffuse ground-glass opacity in both upper lobes (middle), and centrilobular nodules with tree-in-bud pattern in the lower lobe of the right lung (right) are shown.

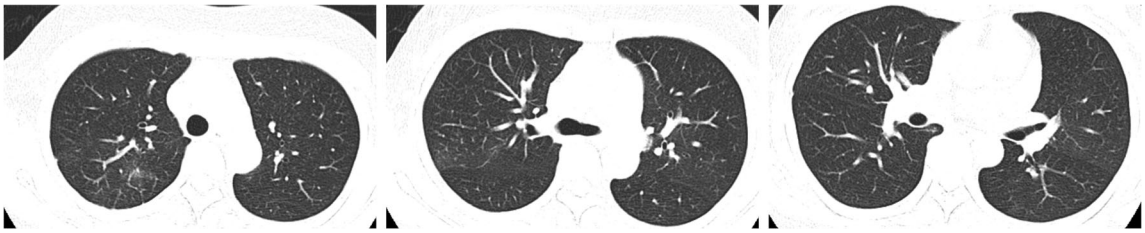

Figure 2. Images of chest computed tomography (CT) six days after admission.

Discussion

Most previous literature has described inhalation of chlorine gas that happened in accidental conditions such as in a swimming pool, household chemical exposure, and industrial accidents [2,3]. Historically, chlorine gas was used as a chemical weapon during the First World War [2]. The household bleach used in our present case contained sodium hypochlorite, sodium hydroxide, and a surfactant. When sodium hypochlorite is mixed with an acid such as acetic acid, a component of the vinegar used in the present case, chlorine gas is generated. To our knowledge, this is the first report of clinical and radiological manifestations in a patient with acute inhalation injury caused by intended chlorine gas exposure.

The site of inhalation injury due to toxic fumes or gases depends on the solubility and physicochemical properties of the substance, and less soluble gases tend to form centrilobular lesions while more soluble gases tend to form extensive GGO on chest CT [4]. The solubility of chlorine is indeterminate and can potentially affect the entire respiratory tract [5]. There have been few reports on CT findings of acute inhalation injury due to chlorine gas [4]. Interestingly, the chest CT findings of the present case on admission showed various findings that reflect both airway (tree-in-bud pattern) and parenchymal (GGO) abnormalities (Fig. 1). The toxicity of chlorine gas depends on the amount, length of exposure, and concentration of the chlorine [2,3,5]. Exposure to high concentrations of chlorine gas can be fatal which can cause severe respiratory diseases including lung oedema, acute respiratory distress syndrome, and toxic pneumonitis [2,3,5]. In this case, the patient inhaled gas directly into the airways and there was evidence of pulmonary injury from large airways to the alveoli and parenchyma. Nevertheless, both respiratory symptoms and abnormal CT findings completely resolved without developing severe respiratory failure or lung injury. This may be because the concentration of chlorine gas generated by a mixture of household bleach with acetic acid, a weak acid, is lower than that with strong acids such as hydrochloric acid.

The significance of clinical biomarkers of acute chlorine inhalation has not been established [3]. In our case, the ratio of BALF neutrophils (27.0%) was increased without evidence of bacterial infection, suggesting that chlorine inhalation caused acute toxic injury to the lungs and airways. BALF findings might be beneficial for management of this disease. Further exploration of useful biomarkers would be important [3].

There is no specific treatment for acute inhalation injuries caused by chlorine gas [1–3,5]. Therefore, the management is mainly supportive. Bronchodilators are appropriate for patients with bronchospasm or wheezing [2,3,5]. Although possible benefits of treatment with corticosteroids have been proposed, the use of inhaled or systemic corticosteroid is still controversial [3,5]. In the

present case, the patient recovered without the use of bronchodilators or corticosteroids.

We experienced a rare case of acute inhalation injury due to chlorine gas with various chest CT manifestations and BALF neutrophilia. It is considered that disease severity was determined by the duration and concentration of inhaled chlorine gas.

Disclosure Statement

Appropriate written informed consent was obtained for publication of this case report and accompanying images.

Acknowledgment

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