CASE REPORT

Bronchiolitis obliterans organizing pneumonia following nitric acid fume exposure

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Abstract We describe a patient with clinical, radiological and pathological features of bronchiolitis obliterans organizing pneumonia. Investigation showed that this was likely to have been a delayed consequence of inhalation of nitric acid fumes (containing nitrogen dioxide) after a fire. This case shows that thorough investigation of the aetiology is important not only in clinical management but also in ensuring patients benefit from appropriate work injury compensation.

Key words Bronchiolitis obliterans organizing pneumonia; nitric acid; nitrogen dioxide; toxic inhalation.

Introduction

The clinical course, pathophysiology and management of lung injury caused by nitrogen dioxide inhalation are seldom documented and believed to be under-reported [1]. Several diseases can lead to bronchiolitis obliterans organizing pneumonia (BOOP), and other known causes include post-infection, drugs, radiotherapy, organ transplantation, connective tissue disorder and environmental exposure [2]. We report an unusual case of BOOP, which we believe was the delayed consequence of inhaling nitrogen dioxide released from a nitric acid fire.

Case report

A previously healthy 50-year-old Chinese male was referred to the respiratory physician because of cough and exertional dyspnoea lasting more than a month. He was a non-smoker and worked as a storekeeper, normally with no direct exposure to chemicals. His general practitioner had treated him with clarithromycin, followed by moxifloxacin, for chest infection, but his symptoms had persisted. Medical examination revealed no significant findings except for crackles in both lung bases. His arterial oxygen saturation at rest while breathing room air was 98%. His full blood count, erythrocyte sedimentation rate and C-reactive protein were normal. The chest X-ray showed atelectasis and airspace shadowing at both lower zones. He was given a 5 day course of 20 mg prednisolone but on review a month later, his symptoms and chest X-ray had not improved. Pulmonary function testing showed a restrictive ventilatory pattern with decreased forced expiratory volume in 1 s and forced vital capacity and a diffusing capacity of 71%. His anti-nuclear antibodies, indirect fluorescent antibody (ANA-IFA) was normal and HIV test was negative. A high-resolution computerized tomography (HRCT) scan of the chest showed interlobular septal and intralobular interstitial thickening with minimal scarring in both lung bases. Minimal peribronchial thickening with early traction bronchiectasis was also noted. A video-assisted thoracoscopy with open lung biopsy was performed to establish a definitive diagnosis. At operation, there were copious secretions and fibrotic changes seen in both lower lobes. The rest of the lungs were normal. Histological examination of the right lower lobe tissue wedge showed patchy areas of fibroblastic plugs in the respiratory bronchioles and alveolar ducts. There were also proteinaceous exudates and foamy macrophages in the alveolar airspaces with chronic inflammation composed of lymphocytes and plasma cells in the alveolar septa. There was no evidence of granulomatous inflammation or malignancy. Reticulin and Mallory trichome stains did not show significant fibrosis. The Gomori methenamine silver stain for fungi was negative. Congo red stain shows no amyloid deposition. Acid-fast bacillus smear and tuberculosis culture...
were negative. The histological picture was consistent with BOOP (Figures 1 and 2).

As no cause could be found to explain these findings, further enquiry was made about his occupational history. He revealed that a few days before his cough developed, there was a small fire in his work area, which was extinguished by firemen. He then spent about 4 hours alone in the room checking and cleaning up the burnt debris without donning any personal protective equipment. There was smoke and burnt smell but he had no symptoms at the time. A check with the fire department showed that the firemen, who had worn self-contained breathing apparatus, were well. Their investigations showed that bottles of concentrated nitric acid were burnt in the fire. No other chemicals were kept in the room. The patient was started on daily dose of 60 mg prednisolone for 8 months. This was reduced to 5 mg daily for another month when his symptoms and carbon monoxide diffusing capacity (DLCO) improved and his chest X-ray cleared. His lung function also returned to normal. He was awarded work injury compensation on the basis that his lung damage was caused by nitrous fumes emitted during the fire at his workplace. He remained asymptomatic during 5 years of follow-up. His effort tolerance improved and his DLCO reached 101%. His HRCT thorax still showed scarring and bronchiectatic changes.
in both lower lobes, but the ground-glass changes seen previously had disappeared.

**Discussion**

In this patient, we suspect that lung injury resulted from unprotected inhalation of nitrogen dioxide emitted from the heated nitric acid. Nitric acid decomposes completely at high temperatures to give nitrogen dioxide, water and oxygen [3]:

\[ 2\text{HNO}_3 \leftrightarrow 2\text{NO}_2 + \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 \]

Nitrogen dioxide causes minimal to mild irritation of the upper airways as it is water insoluble. Concentrations of 50–150 ppm may produce only mild to moderate irritant symptoms, allowing people to remain in the offending environment for prolonged periods. The clinical effects depend on the concentration and duration of exposure [4]. This could explain why our patient did not experience any irritation or acute symptoms. The extinguished fire probably emitted low levels of nitrogen dioxide such that he did not suffer from conditions associated with high level exposures, such as laryngospasm, bronchospasm or pulmonary oedema. Nitrogen dioxide is known to cause delayed bronchiolitis obliterans, believed to be the result of oxidant injury to terminal bronchioles and alveoli [4]. A review of nitrogen dioxide inhalation cases where bronchiolitis obliterans were reported showed that they belong to the constrictive type, which is unresponsive to steroids, with poor prognostic outcome [5,6].

We are uncertain if there have been previous cases of BOOP due to nitrogen dioxide inhalation as most earlier reported cases, including those of silo filler’s disease, did not have a histopathological diagnosis [7,8]. BOOP is a term first coined in 1985 by Epler [9]. If biopsies had been conducted in earlier reported cases, they might have been classified as general bronchiolitis, organizing diffuse alveolar damage or idiopathic pulmonary fibrosis. While the BOOP pattern seen may simply be a reparative phase of fibrosis, the histopathological features of the lung biopsy and good response to steroid treatment with no subsequent relapse support a diagnosis of BOOP in this case [10].

**Key points**

- Physicians need to be aware of the possibility of delayed lung damage from inhalation of thermal decomposition products.
- A detailed occupational history needs to be obtained when patients present with persistent respiratory symptoms and signs that fail to respond to conventional treatment.
- Open lung biopsy can be important in providing definitive diagnosis, prognostication and management of such cases.

**Conflicts of interest**

None declared.

**References**