Interstitial Pneumonitis after Cadmium Exposure: Is it Reversible?

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Abstract

Introduction: Cadmium fume generation, during silver-cadmium alloy formation, is a common occurrence in the silver industry. It can involve various organ systems but its toxic effects have not been widely reported.

Case Presentation: A silver merchant developed respiratory distress and substernal pain after a single exposure to cadmium fumes generated during silver-cadmium alloy formation. Chest X-ray revealed bilateral ground glass haze and computed tomography (CT) also revealed changes suggestive of interstitial pneumonia. Bronchoalveolar lavage was suggestive of increase in the number of polymorphonuclear neutrophils. Forced vital capacity (FVC) showed a restrictive pattern. Oral prednisolone was initiated on the third day of the illness. FVC repeated at the fourth week showed improvement with return of FVC towards normal. The chest CT scan repeated after six weeks showed complete resolution with no residual fibrosis.

Conclusion: Even a single brief episode of cadmium fume exposure can cause rapid onset of pneumonitis. Steroids when started early in course of illness were temporally associated with a good clinical outcome. Definite studies are however required to establish the role of steroids in cadmium fume induced interstitial pneumonitis.

Abbreviations

ECG: Electrocardiography; HRCT: High Resolution Computed Tomography; 2D-ECHO: Two Dimensional Echocardiography; SGOT: Serum Glutamic Oxaloacetic Transaminase; SGPT: Serum Glutamic Pyruvic Transaminase

Introduction

Cadmium is a white colored metal with usage in many industries. It is used in making an alloy with silver to improve the malleability of silver. It is preferred over other metals because it can be mixed with silver without changing its color. India is one of the leading consumers of silver and millions of people who work in the silver industry are at risk of developing cadmium toxicity. During the process of alloy formation, cadmium fumes are generated which when inhaled can cause acute and chronic toxic effects on various organ systems including nose, throat, lungs, kidneys, liver, hematopoietic and nervous system and can be carcinogenic [1,2]. We report a patient with cadmium toxicity that developed rapid onset of pulmonary damage in the form of interstitial pneumonitis after a single exposure to cadmium fumes in a closed space. Appropriate patient consent was taken and approval from ethics committee was also obtained.

Case Presentation

A 35 years aged male, non smoker, silver merchant by occupation, resident of Jaipur, Rajasthan was admitted in the hospital with complaints of respiratory distress. Two days earlier he had been involved in preparation of silver-cadmium alloy. During the process he was exposed to cadmium fumes. He had never been exposed to cadmium fumes to the best of his knowledge. The procedure involved heating of silver and cadmium to a temperature of 1200 C in an open furnace with subsequent generation of yellow cadmium fumes. Only two metals, silver and cadmium were used during the procedure in a ratio of 4:1 respectively. The procedure was carried out in a closed room
Spirometry values (FEV₁ and FVC) as a percentage of predicted normal values on subsequent days after exposure to cadmium fumes.

<table>
<thead>
<tr>
<th>Number of days from exposure</th>
<th>FEV₁ Liters (Percent Predicted)</th>
<th>FVC Liters (Percent Predicted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted 3.8 L</td>
<td>Predicted 4.7 L</td>
<td></td>
</tr>
<tr>
<td>6 Days</td>
<td>0.9L (23.6%)</td>
<td>1.5L (32%)</td>
</tr>
<tr>
<td>8 Days</td>
<td>1L (26.3%)</td>
<td>1.8L (38%)</td>
</tr>
<tr>
<td>10 Days</td>
<td>1.76L (46%)</td>
<td>2.26L (48%)</td>
</tr>
<tr>
<td>13 Days</td>
<td>2.09L (55%)</td>
<td>2.31L (49%)</td>
</tr>
<tr>
<td>30 Days</td>
<td>3.23L (85%)</td>
<td>3.49L (74%)</td>
</tr>
<tr>
<td>45 Days</td>
<td>3.5L (92%)</td>
<td>3.9L (83%)</td>
</tr>
</tbody>
</table>

After careful history elicitation and chest CT evaluation a diagnosis of cadmium induced pneumonitis was made. The history of exposure to cadmium fumes, onset of symptoms two and a half hours after exposure, chest CT findings suggestive of interstitial pneumonitis and raised cadmium levels in the blood were clues to the diagnosis. He was given oral antibiotics (C. amoxicillin + clavulanic acid 625 mg thrice a day) and oral prednisolone. Prednisolone was given in the dose of 20 mg once daily in the morning for one month. With initiation of oral steroids, there was reduction in respiratory rate from 32/min on the 1st day to 25/min on the 2nd day and finally stabilized to 15-18 /minutes from the 4th day onwards. Clinical symptoms improved gradually and patient started normal daily activities by the 14th day. Patient was unable to perform spirometry initially, however, repeat testing done on the 6th day of illness demonstrated restrictive ventilatory defect with a forced vital capacity (FVC) of 1.5L (32% of the predicted for age and height) Subsequently he showed improvement in FVC and on day 45 it had increased to 3.9L (83% of the predicted for age and height as shown in Table 1 & Figure 3).

Blood leukocyte counts, blood urea and liver enzymes returned to normal levels on the seventh day. Antibiotics were stopped after microbiological yield was negative. The oral steroids were tapered after the initial one month with doses of 10mg once daily for five days, 5 mg once daily for the next five days and 5mg on alternate days for next five days before completely stopping them (total duration of steroid administration– 6 weeks). Repeat HRCT done after one and a half month of the episode of cadmium exposure showed resolution of all acute inflammatory reaction, with no evidence of residual fibrosis or ground-glass opacity (Figure 4).

Results and Discussion

Cadmium toxicity has been previously mentioned in literature but this case is unique because of the rapidity of onset of interstitial pneumonitis after a single brief exposure to cadmium fumes and without any window or exhaust and without any use of any personal protective by the subject. He completed the procedure in half an hour. Two and half hours later, the patient developed chest discomfort in the form of sub-ternal pain and difficulty in breathing. His distress progressively increased to the extent that the patient was unable to walk even a few steps. There was no history of fever, chills, headache, myalgia, metallic taste in mouth and hemoptysis. The patient did not give previous history of hospitalization or any major illness in the past. There was no history of exposure to pigeon dust or contaminated organic material. He took analgesics and bronchodilators by the local doctor but got no relief. The patient was admitted to the hospital on the third day. Clinical examination revealed that the respiratory rate was 32 breaths per minute, blood pressure was 130/80 mm of Hg, pulse rate was 102 beats per min and fine inspiratory crepitations were heard on auscultation in bilateral basal lung fields. Routine blood investigations were normal except that the total leukocyte count was 15730 cells/mm³ (normal range - 4000-11000 cells/mm³), serum urea, blood creatinine was 1.0 mg/dl (normal range – 0.5-1 mg/dl), SGOT was 240 U/l and SGPT was 400 U/l (normal range – 0-42 U/l). Arterial blood gas analysis on admission (at room air) was as follows: pH = 7.442, PaO₂ = 85 mm of Hg, PaCO₂ = 46.9 mm of Hg, HCO₃⁻ = 32.3 mEq and SpO₂ = 96.7%. Blood culture, urine culture and sputum examination were normal. Chest radiograph showed ground glass haze in bilateral lower lung zones (Figure 1). Electrocardiography (ECG) and two dimensional echocardiography (2D ECHO) were normal. High resolution computerized tomography (HRCT) scan of thorax was done on the day of admission and it revealed ground-glass haziness with subpleural plate like atelectasis in the peripheral aspects of both lower lobes, lingular segments of left upper lobe and right middle lobe (Figure 2). The tracheobronchial tree was normal on inspection during flexible bronchoscopy. Bronchoalveolar lavage (BAL) was composed of 63% neutrophils and 24% lymphocytes. There were no prismatic crystals in the BAL fluid. Blood cadmium levels assessed by atomic absorption spectrometry on the 4th day of illness were 0.99 µg/liter (normal levels of cadmium are less than 0.5 µg/liter in blood).

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the resolution of clinical symptoms and radiological shadows after a short course of steroids.

Acute exposure to moderate concentrations [200-500 µg/m³] of cadmium fumes can cause the symptoms of fume fever characterized by metallic taste, fever, malaise, joint pains, cough, sore throat, chest tightness and fatigue. The fume fever develops 4-8 hours after exposure [3,4] and lasts for two to three days. However, very intense exposure can cause pulmonary edema and pneumonitis [5]. Deaths due to respiratory failure have also been reported [6]. Persistent impairment in respiratory functions has been reported following acute and brief exposure to cadmium fumes [7]. Pulmonary fibrosis in a survivor of single exposure to cadmium fumes has also been reported [8]. The onset of illness in our patient was within two and a half hours of exposure (more rapid than metal fume fever). He worked only for thirty minutes and did not report any fever, myalgias, metallic taste in mouth and joint pains which are classical symptoms of metal fume fever. The patient did not use any personal protective equipment and the windows of the room were also closed, therefore exposure proved more intense.

Acute hypersensitivity pneumonitis is another differential diagnosis in which the patient presents with sudden onset of dyspnea, fever, myalgias, arthralgias and cough, 2-9 hours after exposure to contaminated organic matter [9]. In the above mentioned case there was no history of exposure to any organic material. Also there was strong temporal association of the symptoms with cadmium fume exposure.

Cadmium exposure has been known to cause liver damage [10] which explains the raised enzymes in our patient. But, the primary organ of damage was however, the lung.

Small case series have been reported regarding the role of steroids in preventing permanent damage with variable results. Seidal et al. [6] had reported a patient with cadmium induced pulmonary toxicity who died despite receiving steroids. However, the steroids were initiated very late in the course of illness in their case (after ten days of exposure). Our patient developed similar symptoms after cadmium fume exposure but the steroids were initiated sooner (third day).

Improvement in symptoms of the patient could be attributed to the normal return of lung functions after cessation of exposure to cadmium fumes. Chan et al. [11] had previously studied that impairment in respiratory functions due to cadmium dust exposure, was partly reversible if exposure was terminated. However they had studied a healthy cohort of factory workers exposed to cadmium dust, who had reduced respiratory functions and no clinical symptoms of respiratory insult. Our case was unique because he had symptoms of respiratory distress and radiological evidence of interstitial pneumonitis. The resolution of symptoms and improvement in lung functions was much faster with steroids than the resolution in the cohort of Chan et al. [11]. Thus, steroids are temporally associated with faster resolution of symptoms of interstitial pneumonitis.

The case report highlights the risk of cadmium toxicity even after a single exposure and good outcome with early start of steroids. The role of steroids in treatment of cases of acute cadmium fume exposure still needs to be researched.

References