Acute lung reaction due to zinc inhalation

J-L. Malo*, J. Malo*, A. Cartier*, J. Dolovich**


ABSTRACT: A 27-yr-old man began work at a company that produces concrete pipes in April 1987. The pipes are linked with rings covered with zinc. In September 1987, he was transferred to a new job in the same plant where he had to heat zinc wires and shoot the heated zinc in powder form onto the iron rings. He had no past personal nor family atopic history. Two weeks after beginning his new job, he experienced an episode of chills with muscle aches and dyspnoea at the end of a working day. The fever persisted until the next day, at which time he saw a physician. A chest radiograph revealed diffuse interstitial shadows. He was off work for 10 days. His symptomatology disappeared and his chest radiograph cleared. He went back to work and experienced a similar episode. He remained away from work for one month; after which specific inhalation challenges were performed. On a control day, there were no significant changes in forced expiratory volume in one second (FEV1), forced vital capacity (FVC), or buccal temperature. Two white blood counts (WBC) showed 8,400 and 8,500 white cells. He was exposed to his usual work environment for one hour on two consecutive days. On both occasions, there were significant falls in FEV1 (16% and 20%) and FVC (10% and 11%), occurring 4–6 h after exposure. Buccal temperature reached 38.1 and 38.7°C on the two occasions, and WBC were 17,000 and 15,900 at the end of each day. Precipitins were negative and specific IgG antibodies could not be detected. In conclusion, this report shows that zinc can cause an acute lung reaction, which seems different from "metal fume fever" for which functional or radiological changes have not been reported.

"Metal fume fever" is a self-limiting condition characterized by fever and general symptoms of malaise that occur after welding metal [1–3]. The mechanism of the reaction is unknown. In this report, we describe a subject who presented symptoms typical of this condition who furthermore showed evidence of functional and radiological lung involvement.

Case report

A 27-yr-old man began work at a company that produces concrete pipes in April 1987. The pipes are linked with rings covered with zinc. In September 1987, he was transferred to a new job in the same plant where he had to heat zinc wires and shoot the heated zinc in powder form onto iron rings. He had no past personal nor family atopic history. Two weeks after beginning his new job, he experienced an episode of chills with muscle aches and dyspnoea at the end of a working day. The fever persisted until the next day at which time he saw a physician. A chest radiograph revealed diffuse interstitial shadows (fig. 1). He was off work for 10 days. His symptomatology disappeared and his chest radiograph cleared. He went back to work and experienced a similar episode. He remained away from work for one month; after which specific inhalation challenges were performed. On a control day, there were no significant changes in forced expiratory volume in one second (FEV1), forced vital capacity (FVC), or buccal temperature. Two white blood counts (WBC) showed 8,400 and 8,500 white cells. He was exposed to his usual work environment for one hour on two consecutive days. On both occasions, there were significant falls in FEV1 (16% and 20%) and FVC (10% and 11%), occurring 4–6 h after exposure. Buccal temperature reached 38.1 and 38.7°C on the two occasions, and WBC were 17,000 and 15,900 at the end of each day. Precipitins were negative and specific IgG antibodies could not be detected. In conclusion, this report shows that zinc can cause an acute lung reaction, which seems different from "metal fume fever" for which functional or radiological changes have not been reported.
for 10 days. His symptomatology disappeared and his chest radiograph cleared (fig. 1). When he returned to work, he experienced a similar episode on the first day of re-exposure. He remained away from work for one month after which specific inhalation challenges were carried out.

Specific inhalation tests

These tests were performed in the following way: on the control day, spirometry including forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC) was performed in accordance with proposed standards [4] in the hospital laboratory. Baseline FEV₁, FVC and the FEV₁/FVC ratio were normal (105% predicted, 113% predicted and 98% predicted, respectively) [5]. Spirometry and buccal temperature was assessed hourly for 7 h; there were no significant changes throughout the day (figs 2–4). White blood counts showed 8,400 and 8,500 polymorphonuclears (60% and 58% neutrophils respectively) at the beginning and at the end of the control day. The concentration of methacholine causing a 20% change in FEV₁ was assessed using a standardized procedure; no significant bronchial hyperresponsiveness (PC₂₀ >128 mg·ml⁻¹) was demonstrated [6]. On the next two consecutive days, he was exposed to his usual work environment for one hour. On both occasions, there were significant falls in FEV₁ (maximum of 16% and 20%) and FVC (maximum of 10% and 11%), occurring 4–6 h after exposure (figs. 2–3). Buccal temperature reached 38.1°C and 38.7°C on the two occasions (fig. 4), and white blood counts were 17,000 and 15,900 white cells respectively (84% neutrophils on each occasion). The subject experienced malaise and general muscle ache on both occasions. His PC₂₀, assessed at the end of the second day of active challenges, was still within the normal range (PC₂₀=74 mg·ml⁻¹).

Immunological tests

Standard double diffusion in agar for precipitins was performed using the subject’s serum and zinc sulphate at 6 different concentrations (10⁻¹–10⁻⁴ mg·ml⁻¹). These tests were negative.

A micro-Elisa technique with zinc sulphate in phosphate buffered saline (PBS) and zinc sulphate in human serum albumin (HSA) at 3 different concentrations (10⁻²–10⁻⁴ mg·ml⁻¹) was used to test for specific IgG antibodies. As shown in table 1, the results were not significantly different from those for two control, non-exposed individuals.
Diseases and conditions due to zinc fume exposure have been described, probably because they were not systematically sought after. Elevated levels of zinc in the serum [12] and zinc and copper in the urine [13] have been documented. Farrell recently presented an interesting case of angioedema and urticaria after zinc fume exposure [14]. That subject also reported metal fume fever. Prospective assessment of individuals who solder with hard metals should be performed in order to establish the frequency of the condition. Further studies using bronchoalveolar lavage and/or lung biopsies are also needed to investigate the mechanism of the reaction.

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References


Table 1. - MicroELISA for specific IgG antibodies to zinc

<table>
<thead>
<tr>
<th>subject</th>
<th>control control control subject subject subject no. 1 no. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc sulphate in PBS</td>
<td>1 mg·ml⁻¹</td>
</tr>
<tr>
<td></td>
<td>0.1 mg·ml⁻¹</td>
</tr>
<tr>
<td></td>
<td>0.01 mg·ml⁻¹</td>
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</table>

Zinc sulphate in HSA

| | 1 mg·ml⁻¹ | 0.302 | 0.293 | 0.397 |
| 1 mg·ml⁻¹ | 0.311 | 0.351 | 0.406 |
| | 0.379 | 0.334 | 0.336 |

PBS: phosphate buffered saline; HSA: human serum albumin.
Une réaction aigue pulmonaire chez l'inhalation de zinc.

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RÉSUMÉ: Un ouvrier de 27 ans commença à travailler en avril 1987 pour une compagnie fabriquant des tuyaux en ciment. Ces tuyaux sont reliés avec des anneaux faits de zinc. En septembre 1987, il fut muté à un nouveau poste de travail où il avait à chauffer des fils de zinc et à propulser le zinc chaud et sous forme de poudre sur les anneaux métalliques. Il n'avait aucune histoire antérieure, familiale ou personnelle, d'atopie. Deux semaines après avoir entrepris ce type de travail, il souffrit d'un épisode de fièvre avec douleurs musculaires et dyspnée à la fin d'un jour au travail. La fièvre persista le lendemain, ce qui l'emménna à consulter. À ce moment, une radiographie pulmonaire montra des infiltrats diffus de type interstitiel. Il s'absenta de son travail durant 10 jours. Ses symptômes disparurent et la radiographie pulmonaire devint normale. Il retourna au travail et souffrit d'un épisode semblable. Il fut mis en congé de travail durant un mois et des tests de provocation bronchique spécifique furent effectués. Lors d'une journée témoin de non exposition, il n'y eut aucun changement significatif du VEMS, de la capacité vitale forcée (CVF) et de la température buccale. Deux numérations globulaires montrèrent 8400 et 8500 polymorphonucléaires. Il travailla durant une heure lors des deux journées suivantes consécutives. Lors de ces deux journées, le VEMS chuta de 16% et 20% et la CVF de 10% et 11%. Ces changements furent maximaux 4 à 6 heures après la fin de 38,7°C l'exposition. La température buccale atteignit 38,1°C et 38,7°C et la formule sanguine montra 17,000 et 15,900 polymorphonucléaires respectivement à la fin de chaque journée. On n'a pu déceler de précipitines dans le sang circulant ni d'augmentation des IgG spécifiques contre le sulfate de zinc. Nous concluons que le zinc peut causer une réaction aigue pulmonaire. Cette réaction semble différente de celles décrite sous le vocable "metal fume fever" puisque des changements fonctionnels ou radiologiques n'ont pas été décrits dans cette condition.