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Allergenic cross-reactivity between nickel and chromium salts in electroplating-induced asthma

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To the editor

Allergic contact dermatitis from nickel and chromium is a common condition. However, exposure to chromium and nickel salts during electroplating is a rare cause of occupational asthma.^{[1](#) [6](#)} Specific IgE antibodies to these metals have occasionally been reported in patients with work-related asthma.^{[1](#) [2](#) [6](#)} We describe the case of a patient whose symptoms at work suggested asthma caused by nickel sulfate (NiSO₄) and chromium potassium sulfate (CrK(SO₄)₂). The diagnosis was confirmed by specific inhalation challenge (SIC) tests.

A 36-year-old man, an ex-smoker, developed work-related asthma symptoms 2 years after he started working in a metal plating factory. During electroplating, he was exposed to nickel sulfate, potassium dichromate, gold, silver, and some acid compounds. He reported dyspnea and wheezing that developed shortly after he was exposed to chromium dust and worsened after he finished his work shift.

Results of physical examination and chest radiography disclosed no significant

abnormalities. Blood cell counts were within normal limits. Spirometry revealed a forced vital capacity (FVC) of 6.22 L (119% of predicted), an FEV₁ of 3.99 L (97% of predicted), and an FEV₁/FVC ratio of 64%. The value obtained in a methacholine inhalation test at baseline (4 weeks after a sick leave) was 0.40 mg/mL (methacholine PC₂₀ values of less than 16 mg/mL were considered to reflect significant bronchial hyperresponsiveness).

Skin prick tests elicited an immediate wheal reaction (4 × 4 mm) with both nickel sulfate and potassium dichromate at a concentration of 10 mg/mL, whereas skin test results with common aeroallergens were negative. Results of patch tests with nickel sulfate and potassium dichromate were negative. Skin prick test results with these metallic salts were negative in 5 atopic patients. SIC tests were performed according to the tidal breathing method⁷ through use of a De Vilbiss model 646 nebulizer (Somerset, Pa). SIC with NiSO₄ at 5 mg/mL induced a dual asthmatic response (the maximum fall in FEV₁ from baseline during the early asthmatic response was 23%). A dual asthmatic response was also obtained with potassium dichromate at 25 mg/mL (the maximum fall in FEV₁ during the early response was 49%). The methacholine inhalation test was repeated 24 hours after SIC; nickel sulfate and potassium dichromate yielded PC₂₀ values of 0.15 and 0.098 mg/mL, respectively. The result of a bronchial challenge test with potassium dichromate at 25 mg/mL in an asthmatic control subject was negative.

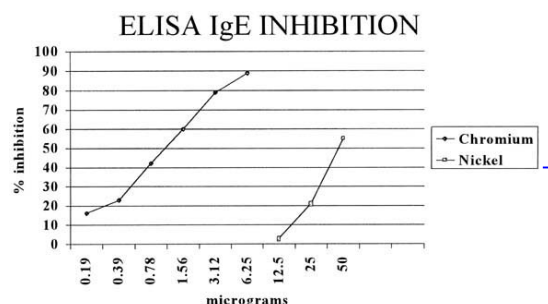
Specific IgE to nickel and chromium salts was determined by direct ELISA and allergenic cross-reactivity by ELISA inhibitions. NiSO₄ and CrK(SO₄)₂ were conjugated with human serum albumin (HSA) at a metal-HSA ratio of 1:10 by weight and dialyzed against distilled water at pH 7.⁶ Positive ELISA results of 0.460 and 0.911 optical densities (ODs) were obtained against NiSO₄-HSA and CrK(SO₄)₂-HSA conjugates, respectively, whereas control sera had a mean value of 0.029 ± 0.039 OD. ELISA inhibitions using CrK(SO₄)₂ as solid phase showed that 1 µg of CrK(SO₄)₂-HSA and 47 µg of NiSO₄-HSA conjugates caused 50% inhibition (Fig 1).

Differential cell counts in induced sputum at baseline showed 40% macrophages, 35% neutrophils, 15% eosinophils, and 10% bronchial epithelial cells. Six months after the patient left the workplace, he was symptom-free; his methacholine PC₂₀ value was 0.125 mg/mL, and induce sputum revealed 55% macrophages, 38% neutrophils, 2% eosinophils, and 5% bronchial epithelial cells.

This patient developed occupational asthma that was caused by nickel and chromium salts, with evidence of an IgE-dependent mechanism and eosinophilic bronchial inflammation. Nevertheless, cell-mediated hypersensitivity might also play a role in chromium and nickel salts-induced asthma.⁵ Type I hypersensitivity to both nickel and chromium has been previously described in electroplating workers,^{1 6} suggesting that cross-reactivity might exist; to the best of our knowledge, however, this is the first report to demonstrate allergenic

cross-reactivity between NiSO_4 and $\text{CrK}(\text{SO}_4)_2$ in a patient with metal-induced asthma.

Fig. 1. ELISA inhibition assay using $\text{CrK}(\text{SO}_4)_2$



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