

Letter to the Editor

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Occupational Asthma due to Welding Fumes From Stellite

To the Editor: Welding is associated with respiratory effects such as metal fume fever, chronic bronchitis, lung function abnormalities, and occupational asthma (OA).¹ Previous studies have described OA in workers exposed to welding fumes from stainless steel^{2,3} and aluminum.⁴

Stellite is a metal alloy with both cobalt and chromium.⁵ The amount of cobalt is usually about 60% and of chromium about 30%. It also contains tungsten and a small amount of carbon. Stellite alloys are resistant to corrosion and also retain their hardness at elevated temperatures. They are used in wear-related applications such as in the manufacture of components of gas turbine and jet engines, and in cutting tools. Previously, respiratory symptoms including cough, dyspnea, and wheezing have been described in saw filers exposed to stellite,⁶ and in workers maintaining hard metal and stellite blades.⁷ However, to the best of our knowledge, OA associated with exposure to welding fumes from stellite has not been described. We report here on such a worker.

A 42-year-old man, working since age 18 for the same employer manufacturing machines for the pulp and paper industry, had tasks including cutting mild or stainless steel for his first 6 years. Thereafter, he worked as a machinist; the material used was mild or stainless steel, and he also used metal working fluids. Very near his workplace, welding on stellite took place, but he himself did not take part. The patient had a history of

perennial rhinitis, and had smoked for 4 years in his youth. He had been examined in a local central hospital for dyspnea 15 years before the examinations at the Finnish Institute of Occupational Health (FIOH), where bronchial asthma was diagnosed and asthma medication started.

During one year prior to examinations at the FIOH, the patient had started to experience worsening of his asthma symptoms. This worsening was clearly related to exposure to stellite welding fumes, and his use of short-acting inhaled bronchodilating medication was therefore increased. Before this, his asthma has been in good balance with moderate use of regular inhaled budesonide combined with sodium chromoglycate. Because of asthma exacerbation, the patient contacted his occupational health physician, and workplace peak expiratory flow (PEF) monitoring was scheduled. The results were suggestive of OA: PEF values were 540–620 L/min when he was not in his workplace or when he was not exposed to welding fumes from stellite; on one working day with stellite welding, his PEF value fell to 480 L/min, but rose after short-acting bronchodilating medication to 590 L/min. The patient was referred to FIOH for further examination.

At the FIOH, auscultation of his chest was normal. Total serum immunoglobulin (Ig)E was 281 kU/L. Spirometry was normal, but the histamine challenge test revealed mild bronchial hyperresponsiveness (PD₁₅ 1.20 mg). His diurnal PEF and forced expiratory volume in 1 second (FEV₁) values were within normal limits. Skin prick tests for common

allergens showed allergy to pollens of grass, mugwort, alder, and dandelion, to epithelia of cow, and to *Pityrosporum ovale*, but for metals they were negative.⁸ The concentrations of the tested metals in water solutions were nickel sulfate 10 mg NiSO₄/mL, potassium dichromate 1 mg Cr⁶⁺/mL, chromium chloride 1 mg Cr³⁺/mL, and cobalt chloride 1 mg Co²⁺/mL.³

Diagnosis of OA was made according to the European guidelines.⁹ Bronchial challenge tests were performed in a special welding exposure chamber. The referent test was by a diluent (ALK-Abello A/S, Copenhagen, Denmark). Cobalt and chromium challenge tests comprised solutions of cobalt chloride (0.1–10 mg Co²⁺/mL) and potassium dichromate (0.01–1 mg Cr⁶⁺/mL). Stellite welding was done by welding (30 minutes) on mild steel with a special stellite electrode (Soudostel HR21, Soudometal SA, Belgium), which consisted of about 65% cobalt, 28% chromium, 4.5% molybdenum, 2.5% nickel, and 0.25% carbon. After challenge tests, the patient was followed up for 24 hours. Lung function measurements (FEV₁ and PEF) were done with a portable, pocket-size spirometer (One Flow, STI MEDICAL, Saint-Romans, France). A drop of 20% in PEF or FEV₁ was regarded as significant compared with both starting level and control test. Clinical symptoms and lung auscultation findings were also recorded.

In our patient, the referent inhalation challenge test did not indicate any adverse reactions, nor did the tests with both cobalt and chromium solutions. Welding mild steel with the specific electrode for stellite, however, caused an immediate asthmatic reaction, with a 21% drop in PEF measurements, and a suggestive delayed reaction, with a 15% drop. FEV₁ values did not show a significant drop (maximal drop was –10% immediately). In association with the significant PEF drop, lung auscultation revealed wheezing in forced expiration. To confirm the diagnosis of

OA, a workplace challenge test with PEF monitoring was performed. This showed a variation in PEF values of 560–630 L/min without exposure to stellite welding fumes, but after a 3-hour work exposure to stellite welding, PEF values dropped to 480 L/min and returned to the starting level in 19 hours.

Based on work-related respiratory symptoms, occupational exposure, suggestive workplace PEF monitoring, positive findings in the specific welding challenge test, and the positive workplace challenge test, the diagnosis was OA. Avoidance of working near stellite welding was recommended, and regular inhaled budesonide medication was continued, with salbutamol on demand.

Our patient's asthmatic reaction was specifically related to stellite welding, since specific challenge tests with either cobalt or chromium solutions did not indicate any adverse reactions. The rationale for first performing challenge tests to chromium and cobalt solutions was that these metals might have been responsible, because stellite contains them and because these agents have earlier been associated with OA.^{10,11} In line with this, we used a diluent as a referent challenge. Because these active challenge tests did not indicate any adverse reactions and the patient's OA was clearly associated with stellite welding fumes, we performed this challenge test, as well, using welding on mild steel with a special stellite electrode. This was reasonable, because most of the welding fumes are generated from the electrode, with the welded material playing a minor role.

In our patient, the pathophysiological mechanism responsible for the

induction of OA remains unknown. Although some studies concerning OA related to metals have proposed an IgE-mediated mechanism, skin reactivity to metal salts has not been consistently demonstrated in subjects with OA caused by these agents.¹² Our patient showed no immediate skin reactivity to chromium or cobalt in skin-prick tests, and the specific challenge tests with these metal solutions did not indicate any adverse reactions. Tungsten was not skin prick tested. The literature has one case study reporting tungsten-induced OA with positive scratch test to this metal; in that case, however, the diagnosis of OA was based only on symptoms, with no lung function examinations or specific challenge tests.¹³ Unfortunately, we could not determine the concentrations of the welding aerosols during specific challenge tests to possibly further elucidate the pathophysiological mechanism.

In conclusion, exposure to welding fumes from stellite should be included among etiological factors capable of inducing OA. Where there is doubt about the diagnosis, specific challenge tests remain the only method to confirm OA caused by welding fumes at an individual level.

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