

CONTACT POINT

Occupational allergic contact dermatitis caused by cobalt in machine oil

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Cobalt is used in the creation of hard metal alloys, because of its ability to bind tungsten and carbon.¹ This allows for increased resistance to wear, which is essential for mechanical parts exposed to heavy strain.² Occupational allergic cobalt dermatitis has traditionally been observed in metal, construction and pottery workers following direct skin contact with cobalt ions from alloys, paint, porcelain, cement, and leather.^{3,4} We present a case of severe allergic contact dermatitis caused by occupational exposure to machine oil that was contaminated with cobalt residues.

CASE REPORT

A non-atopic and non-pierced 24-year-old man was referred with acute dermatitis. He worked as a marine engineer on a container ship, and had no previous medical history, especially not concerning metal or leather contact dermatitis. While at work on the ship in the Far East, he acutely developed severe oozing dermatitis located on the dorsa of the hands (Figure 1), forearms, and lateral aspects of the thighs. Skin changes occurred following routine cleaning of a centrifuge, which was separated into different components. In this process, the patient was heavily exposed to warm oil from the centrifuge on the affected body parts. He explained that he kept moist cloths for cleaning different engine parts in his pockets, exposing his thighs to the same oil.

He was patch tested with the European baseline series, the Gentofte Hospital extended test series, and 2 different oils provided by the patient, that is, "Veritas 800 Marine 20,30" and "BoB 300". The oils had both been used for various machines in the engine room. Both were diluted 50% in olive oil, put in Finn Chambers, and occluded for 2 days. Patch test were read on day (D) 2, D4 and D7

according to the ESCD recommendations.⁵ On D4, there was a +++ reaction to cobalt chloride 1% pet. (Figure S1), a + reaction to 1 of the oils, namely Veritas 800 Marine 20,30, and a ?+ reaction to BoB 300. Although the manufacturer claimed that neither oil contained cobalt, the patient's history, the clinical presentation and the result of the patch testing gave a strong suspicion of cobalt contamination.

The cobalt spot test gave a negative result, as did further analyses with 2 different X-ray fluorescence devices. However, inductively coupled plasma mass spectrometry (ICPMS) detected cobalt in both samples. Briefly, subsamples of ~0.1 g were digested with concentrated nitric acid in a microwave oven (Multiwave 3000; Anton Paar, Graz, Austria) at ~200°C. The digests were diluted with 2% nitric acid, and the content of cobalt (m/z 59) was determined by the use of ICPMS (iCAPq; ThermoFisher Scientific, Bremen, Germany), with external calibration with internal standardization (Rhodium at m/z



FIGURE 1 Severe oozing dermatitis on the dorsum of the hand

103). The cobalt concentrations in the 2 oils were, respectively, 2.7 ppm (BoB 300) and 2.4 ppm (Veritas 800 Marine 20,30).

DISCUSSION

Our case suggests that cobalt sensitization and dermatitis occurred following exposure to low concentrations of cobalt residues in machine oil. To establish the cobalt elicitation threshold, Allenby and Basketter⁶ carried out serial dilution tests with cobalt chloride on 9 patients sensitized to cobalt. The minimum elicitation threshold on normal skin was 1000 ppm. However, when the skin was pretreated with surfactant, this was lowered to 10 ppm cobalt chloride, corresponding to 2.3 ppm cobalt. Fischer et al⁷ found that concentrations of 30.8 to 259 ppm cobalt chloride will elicit a positive patch test reaction in 10% of cobalt-allergic patients, and that 1% of patients will react to 1.96 to 24.4 ppm. However, the study was based on the patch testing of already sensitized patients, so the results may not be entirely applicable to real-life exposures, in which the elicitation threshold may be lower. Fischer et al previously observed that higher allergen concentrations were needed to produce a skin reaction in patch testing than in the repeated open application test.⁸

Our patient suffered from severe dermatitis following exposure to oils with cobalt concentrations of 2.4 and 2.7 ppm, which are within the range that 1% of cobalt-sensitized patients will react to in an experimental setting.⁷ A low elicitation threshold corresponds well to the strong patch test reaction observed (+++). Furthermore, it is likely that the amount of cobalt in the oils varied; hence, the amount in the oil samples may have been different from the amount of cobalt that was present when the dermatitis occurred. In the present case, the machine oils may have acted as a surfactant, disturbing the skin barrier and thus facilitating the skin absorption of cobalt. The ability of some oils to enhance transdermal penetration has been previously described.^{9,10} This may have been even more pronounced because of the humid and hot working conditions that our patient was exposed to. It is unclear why the patient reacted more strongly to the oil with the lowest concentration of cobalt, but this could be explained by the chemical properties of the oil.

Cobalt is increasingly being recognized as an independent sensitizer,¹¹ but exposure is often difficult to establish. In a large Danish cohort of dermatitis patients, only 1 in 4 positive patch test reactions to cobalt were judged to be of clinical relevance.¹² In several studies, the presence of cobalt in metalworking fluids have been investigated. Cobalt has been detected at concentrations of ~300 ppm and up to 550 ppm in metalworking fluids used for the processing of hard metal containing cobalt.^{13,14} Although other possibly important occupational sources have been identified,¹⁵ the increasing number of solitary patch test reactions to cobalt calls for a continuous search for as yet unidentified sources of exposure. Our case adds to the growing list of cobalt exposures, and further emphasizes the importance of perseverance when searching for the source of exposure.

Conflicts of interest

J. Thyssen receives royalties from Smarthealth for annual net sales of the cobalt spot test.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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