Allergic Contact Dermatitis Caused by Metals in Blackboard Chalk: A Case Report

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Periorbital dermatitis has an incidence of 3.9–4.8% (1). It is most commonly caused by contact allergy (54%) (direct contact 44% or airborne contact 10.2%), irritant contact dermatitis (CD) (9.1%) and atopic dermatitis (25%) (1). Metals are reported among the main causes of airborne allergic CD, in particular in occupational settings (2). We report here an unusual case of periorbital airborne allergic CD together with direct allergic CD of the hands in a teacher. It was found to be due to metals in the powder of blackboard chalk.

CASE REPORT

A 40-year-old atopic female primary school teacher reported an itching and bilateral erythematous-oedematous periorbital dermatitis she had had for 6 months. A fissured pulpitis involving bilaterally the distal apex of the thumbs (in particular on the right hand) and the second finger of the right hand was also present.

Her medical history revealed previous dermatitis at the sites of contact with jewellery.

Patch tests were performed with the Italian standard (Società Italiana di Dermatologia Allergologica Professionale e Ambientale-SIDAPA) series. Test allergens were applied to the upper back for 48 h using Haye's test Chambers® (Haye's Service AJ Alphen aan den Rijn, The Netherlands) and evaluated after 48 and 72 h. A positive reaction to *Myroxylon pereirae* resin 25% pet (–D2/+D3), nickel sulphate 5% pet (+++D2/+++D3), and cobalt chloride 1% pet (+D2/++D3) was observed.

As the patient denied having used cosmetics over the previous month and associated the start of the dermatitis with the beginning of the school year, we hypothesized an allergic CD caused by blackboard chalk powder.

Six different colours of blackboard chalks used by the patient at school were analysed for their metal content. After pulverization and microwave acid digestion, graphite furnace atomic absorption spectroscopy was performed. Each sample was analysed twice and the mean values of metal content calculated. The results confirmed the presence of nickel and cobalt (Table I).

Patch tests with the powder of the chalks, tested as is, performed on the healthy skin of the patient's back, showed a weak positive reaction to red chalk (+D2/+D3) and a doubtful reaction to white, yellow and green chalks. No reactions were observed in 5 healthy controls.

The use of vinyl gloves improved the patient's hand dermatitis, while her eyelid eczema healed during the summer holidays.

Table I. *Chemical analysis of the metal content of the patient's blackboard chalks*

	Metal content (μg/g ± 0.10)				
Colour of chalk	Chromium[a]	Nickel[b]	Cobalt[c]	Lead[d]	Patch test results
Yellow	2.98	<0.53	0.73	16.1	Doubtful
Violet	2.47	<0.53	0.65	14.9	Not performed
White (brand 1)	2.03	2.30	<0.32	<0.79	Doubtful
Green	2.37	1.03	0.87	14.5	Doubtful
White (brand 2)	2.75	2.72	0.99	<0.79	Doubtful
Red	2.23	0.82	0.36	14.9	+D2/+D3
Orange	2.18	<0.53	0.51	15.4	Not performed

Detection limit; μg/g = ppm [a]0.63 μg/g, [b]0.53 μg/g, [c]0.32 μg/g, [d]0.79 μg/g.

DISCUSSION

The nickel elicitation threshold on healthy skin in adults is 5–10 ppm; a concentration of 0.5 ppm has been found to be sufficient to trigger CD on irritated skin (3–5). For cobalt, the minimum elicitation concentration is approximately 2 ppm (5). On the basis of these data, scientific literature proposes a value for nickel and cobalt lower than 5 ppm as "good manufacturing practice", while the "target" amount to minimize the risk of sensitization in particularly sensitive subjects should be as low as 1 ppm (5, 6).

In our case the level of nickel in the chalks was lower than 5 ppm, but higher than 1 ppm, and therefore sufficient to elicit CD on irritated skin. In particular, the level of nickel in coloured chalks was less than 1 ppm, but approximately 2 ppm in white ones, which were the most used.

It is notable that the white chalks were composed mainly of calcium carbonate, while the coloured chalks were composed of calcium sulphate. As calcium carbonate is more alkali than calcium sulphate, it may have facilitated the penetration of allergens, inducing irritant CD and decreasing elicitation threshold.

Unexpectedly high levels of lead were found in the chalks, in particular in the coloured ones.

Few cases regarding CD among professionals due to nickel in blackboard chalks have been reported in the literature (7, 8); these cases concerned teachers with allergic contact eczema of the hands due to direct contact with blackboard chalks, but without airborne exposure.

A further case of allergic CD involving the hands and face in a college lecturer has been described due to azo pigment sensitivity in coloured blackboard chalk (9).

Other non-metallic components of chalk were associated not only with delayed allergic reactions, but also with immediate ones. In particular, a case of con-

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tact urticaria due to carboxymethylcellulose (CMC) in white chalk has been reported in a student (10). During open testing the patient developed stronger urticarial reactions with powdered chalk than with pure CMC. In that case a "compound allergy" due to chemical modifications of CMC in the chalk was hypothesized.

In our case, despite the doubtful results of patch testing with the patient's own materials, the negative patch test results with the powder of the chalks in the healthy controls, the chemical analysis and the positive stop-restart test confirmed the diagnosis of allergic CD.

Considering the chronic and intense exposure to blackboard chalk and the accumulation of powder in the eyelid crease, we conclude that the amount of nickel contained in the chalks in this case may have been sufficient to cause both professional direct eczema of the hands and airborne periorbital dermatitis.

The authors declare no conflicts of interest.

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