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Foot dermatitis caused by didecyltrimethylammonium chloride in a shoe refresher spray

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The quaternary ammonium compound didecyltrimethylammonium chloride (DDAC; CAS no. 7173-51-5) is used in various water-based products for its bactericidal, virucidal and fungicidal properties. Cases of both allergic contact dermatitis (1–3) and immediate-type reactions (4, 5) caused by DDAC when present as an ingredient in detergents/disinfectants have previously been reported. In this report, we present a case of foot dermatitis associated with contact allergy to DDAC.

Case Report

A 64-year-old retired woman, who had previously worked as a saleswoman of shoes, had a history of atopic dermatitis and chronic hand eczema. She consulted a dermatologist because of dermatitis on the dorsal aspects of the feet, spreading to the lower legs, which were swollen, and to the arms. She was treated with potent topical corticosteroids, compression stockings, and UVB on the feet. All of the dermatitis healed, except on the feet. The patient was then referred to our department for suspected allergic contact dermatitis. She had used shoes made of textile on a vacation, and suffered from severe oozing dermatitis on the feet after wearing these. According to a label, the textile shoes contained a “microbe shield”. Moreover, before using both textile shoes and leather shoes, she sprayed them on the insides with a ‘refreshing spray’ (Ecco Shoe Refresher; Ecco Sko A/S, Bredebro, Denmark). There was

Table 1. Positive reactions at initial patch testing

Substance/product	Concentration	Strength of reaction (D3/D7)
Swedish baseline series		
Potassium dichromate	0.5% pet.	+++ / +++
Cobalt chloride	0.5% pet.	++ / –
Fragrance mix II	14% pet.	+ / ++
Additional substances		
Cocamidopropyl betaine	1% aq.	+
Own products		
Ecco Shoe Refresher	10% aq.	++ / +++
	5% aq.	++ [†]
	2.5% aq.	++ [†]
	1.3% aq.	++ [†]

*Tested on D7 of initial test; reading performed on D10 (i.e. D3).

[†]Tested on D3 of initial test; reading performed on D7 (i.e. D4).

no further information available concerning any of these products.

Patch testing was performed with the Swedish baseline series, and the department’s extended baseline and shoe series. Additionally, the patient was tested with the shoe refresher, 10% in aq. The test chambers were removed by the patient after 48 hrs. When the tests were read on D3, positive reactions were observed to potassium dichromate, cobalt chloride, fragrance mix II, and the shoe refresher (Table 1). Supplementary patch testing was performed with the shoe refresher further diluted to 5.0%, 2.5% and 1.3% in aq. The patient reacted to all dilutions of the shoe refresher. After the D3 reading, we contacted the manufacturer, who agreed to send us samples of the ingredients of the shoe refresher, one being cocamidopropyl betaine. The patient was therefore tested with cocamidopropyl betaine, and showed a + reaction (Table 1).

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Table 2. Patch test results at supplementary patch testing; the tests were read once on D3 or D4

Substance/product	Concentration (%)	Strength of reaction
Ecco Shoe Refresher	2.0	+
	1.0	+
	0.50	+
	0.25	+
	0.13	+
	≤ 0.013	–
	0.13 a.b.	+
Raw material sample 1	2.0	+
	0.20	–
Raw material sample 2	0.20	+
	0.020	+
	0.0020	+
	≤ 0.00020	–
	0.020 a.b.	+
Didecyltrimethylammonium chloride	0.080	+
	0.0080	+
	≤ 0.00080	–
	0.0080 a.b.	+

All material tested in aq., except where indicated otherwise:
a.b., acidic buffer solution.

Later, we received two samples of the raw materials used in the product. Sample 1 contained a mixture of cocamidopropyl betaine and ethoxylated alcohols (C12–C15), and sample 2 contained a mixture of DDAC and ethylene glycol. The patient was then tested with dilutions of samples 1 and 2, DDAC, and the shoe refresher at even lower concentrations (Table 2). As the aqueous solutions of the shoe refresher, sample 2 and DDAC all had pH values of ~9, even at low concentrations, dilutions of these were also prepared in an acidic buffer solution (6). Positive reactions were observed for sample 1, sample 2, the shoe refresher and DDAC when diluted in aq. Positive reactions were also observed for all preparations diluted in the buffer solution (Table 2). Twenty controls were patch tested with the shoe refresher 0.25% in aq., sample 2 0.02% in aq., and DDAC 0.0080% in aq. All controls were negative.

The patient was advised not to use shoes made of chromium-tanned leather. However, the patient was seen during summer, and was at that time only wearing textile shoes. She stopped treating her textile shoes with the shoe refresher. When she was followed up at the department, the dermatitis on the feet had healed without further use of topical corticosteroids. She agreed to be patch tested with a hand antiseptic used at our department that contained DDAC. The patient showed + reactions to the antiseptic tested 'as is', wet/wet diluted to 10% aq., and evaporated (dry) 'as is'.

Discussion

The patient's foot eczema could have been caused by several factors, both endogenous and exogenous. On patch testing, the patient showed allergic reactions to chromium, cocamidopropyl betaine, and DDAC, which she may have been exposed to through her footwear. As the patient developed dermatitis both when wearing textile shoes and when wearing leather shoes, which were both treated with the shoe refresher, it is likely that the main culprit was the shoe refresher. This is also supported by the fact that the dermatitis healed when the patient stopped treating her shoes, including the currently worn textile shoes, with the shoe refresher. Unfortunately, we were not able to obtain any information on the content of the "microbe shield" used in one pair of textile shoes, but the patient had used the spray from Ecco in most of her shoes, regardless of material.

According to information printed on the bottle of the shoe refresher, it is "uniquely formulated to kill odour and prevent its return". The customers are instructed to apply the spray evenly to the inside of the footwear, and to allow the spray to dry before using the footwear. During the investigation, the patient was also patch tested with a piece of fabric that had been sprayed with the shoe refresher 1 day before it was tested. The reaction was scored as negative, but there were signs of erythema and papules at the edges of the test area. Presumably, the patient's shoes were sprayed more often than just once, which might have increased the concentration of DDAC.

DDAC has irritant properties, and was therefore tested in a relatively low concentration. The absence of reactions to the shoe refresher, sample 2 and DDAC in 20 controls supports the interpretation that the reaction observed in the patient was of an allergic nature. As no irritant reactions were observed, buffering of the DDAC-containing preparations does not seem to be necessary.

DDAC is used as a detergent/disinfectant in hospitals, as an algicide in swimming pools, as a fungicide, and against termites in wood (7). In previous reports on contact dermatitis and contact urticaria caused by DDAC, the patients have been exposed to DDAC in disinfectants and detergents used at hospitals (1–5). Our patient also reacted to a hand antiseptic containing DDAC, although she had not previously been in contact with this kind of product.

This case report shows that DDAC may be a cause of allergic, and probably also irritant, contact dermatitis on the feet, and that DDAC is an important test substance when allergic reactions to footwear are suspected. However, if the patient has a history of immediate-type reactions, an open test on the arm should be considered before any patch tests are performed.

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