

Allergic contact dermatitis associated with reactive dyes in a dark garment: a case report

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In this study, we present a case of a patient who has not been occupationally exposed to reactive dyes, but did present with a dermatitis from wearing a dark cotton garment. The patient experienced reactivation of his dermatitis when rewearing a new unwashed dark T-shirt made of 100% cotton (in fact, the patient reported that it had to be washed at least 3 times before the skin reaction disappeared). He presented positive patch tests to 6 reactive dyes from Chemotechnique[®] textile series. The clothing could not be proved as the true cause of the dermatitis, but resolution occurred upon removal of the suspected garment. This suggests that contact allergy to the reactive dyes (he did not react to any other dyes and his garment was a natural fabric) was likely responsible. With this report, we would like to emphasize that reactive dyes, as a class, should be considered as potential allergens, both occupationally and from non-occupational exposure such as garments. If garments containing reactive dyes are not properly rinsed in the manufacturing process, we believe that excess of dye can be retained that may cause allergic contact dermatitis (ACD). As the reactive dyes and their hydrolysis products are very water-soluble, they can be easily washed off to prevent ACD.

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Allergies to textiles are likely underdiagnosed (1). This may be due to under reporting by the patient, the difficulty in associating a dermatitis with textiles and the different clinical presentations of a textile allergy (1–4), for which sweating and friction are the activating or aggravating factors (2, 5). Dyes are the first, and resin finishes are the second major causes of textile dermatitis: their presence is dependent on the textile fabric composition (2, 5, 6). Chemicals such as metals, lubricants, fragrances, biocides and UV absorbers may be other potential textile allergens (2, 5). The challenge is first to recognize the skin manifestation as putative textile allergy and then identifying the allergen and its clinical relevance. The chemicals used are not declared, nor are the resin finishes or the dyes, only the composition of the fibre, if greater than 5%, is identified on the label of the garment or textile (2). Based on textile fibre composition (if correct!) and texture of the material, it is possible to deduce the dye classes that may be employed (2, 6).

Disperse dyes, of which 32 have been documented (7), are the main culprits in causing

textile dermatitis. They are used on synthetic fibres such as polyesters, acetates, triacetates and nylon or on a combination of fabrics (5, 8). Once a dye has been identified as an allergen, its presence in the textile may not be evident as the dyeing process to obtain a colour is usually achieved by combining many different dyes. Thus avoidance of blue textiles is irrelevant, as blue will be used in black, violet and other coloured textiles. Other classes, i.e. acid dyes, reactive dyes and direct dyes, have rarely been described as the cause of allergic contact dermatitis (ACD). Reactive dyes are used on natural fibres (cotton, linen and wool) and polyamides and have only been reported as occupational allergens (9–11). They have caused type I mediated allergic reactions such as asthma, rhinitis and urticaria (9, 10) and also type IV hypersensitivity reactions or ACD (9, 10). In both of these reactions, the mechanism of allergic sensitization remains unclear. In type I, IgE-mediated response, it is postulated that the dye reacts with human serum albumin (HAS), creating a reactive-HAS complex acting as antigen (12). So far, 14

different reactive dyes have been documented as being allergenic through skin contact (7, 9–12). The prevalence of reactive dye contact allergy is 0–0.3% based on 2 main articles published by Manzini et al. (12, 13), who looked at a large population group. Reactive dyes have, however, been dismissed as a cause of 'garment dermatitis' (dermatitis caused by a dye from clothing worn by the patient) due, in principle, to the chemistry of the dyeing process (7, 8): they are considered non-allergenic once they have dyed the textile, because of the covalent bond that forms between the fibre and the dye molecule (8, 14). Reactive dyes are made of 2 parts, the chromophore, which can be an azoic, anthraquinone or phthalocyanine group, and the reactive portion, which covalently binds to the fibre (protein, cellulose or polyamide) (Fig. 1). The reactive portion of the textile fibre can be an amino, hydroxyl or sulfhydryl group (8). We report, in this study, on 3 cases of garment dermatitis due to reactive dyes, the most recent of whom is described in detail.

Materials and Methods

A 30-year-old mechanic consulted us in March 2004 because of axillary and neck dermatitis that had been present for approximately 1 year. He gave a history of intolerance to perfumes and deodorant, nickel, and to the dark cotton T-shirts (furnished by his workplace) that he had to wear during working hours. He mentioned that the T-shirts had to be washed at least 3 times before he could wear them without having itch or erythema developing. On examination, he presented with a papular eczematous eruption involving his neck, axillae and lower back. The patient had already suspected his T-shirt, deodorant and shampoo, which he had already eliminated. However, as he wished to prove that his T-shirt was the cause of his dermatitis, upon rewearing a new unwashed T-shirt (marked 100% cotton on

label), he developed a flare-up of his dermatitis, which was observed in our clinic. The patient had a positive family history of hay fever and a personal history of eczema in childhood. Patch testing was performed with the European standard series and the Chemotechnique[®], Malmö, Sweden, textile series administered with Vander Bend[®] patch-test chambers (Vander Bend[®], Brielle, the Netherlands) applied to the back with Micropore[®] (Healthcare 3M, Borken, Germany) and fixed with Mefix[®] (Mölnlycke, Göteborg, Sweden). The results have been summarized in Table 1. The reaction to his T-shirt (applied with saline as is) was doubtful. He reacted to fragrance mix and hydroxyisohexyl-3-cyclohexene carboxaldehyde (Lyrall[®], Malmö, Sweden), which was deemed relevant to his deodorant and perfume intolerance. Furthermore, methyl(chloro)isothiazolone was found to be present in his shampoo and his reaction to nickel had a past relevance. The T-shirt was subject to chemical analysis. A comparison of UV-spectra (200–700) obtained from a solution of reactive black 5 and from the extract from the T-shirt indicated the presence of reactive black 5 in the extract. The spectrum from the extract also showed other absorption maxima indicating the presence of other dyes. Paper chromatography with water as the eluent showed the presence of a black as well as an orange and a blue dye in the extract (chemical analysis by Erik Zimmerson, University Hospital, Malmö, Sweden).

In the patient database from Leuven, Belgium (16 786 patients tested since 1978), we were able to retrieve 2 other patients (Table 1), who had a history suggestive of textile dermatitis and who had reacted to reactive dyes. The clothing could not be proved as the true cause of the dermatitis, but resolution occurred upon removal of the suspected garments. This suggests that allergy to the reactive dyes was likely responsible, as these patients did not react to disperse dyes and their clothing was of natural fabric.

Discussion

Reactive dyes entered the market in 1956 (15) and represent the last discovery in the chemistry of colour dyes (16): they are used in textiles, as well as in artist's shop, home dyeing, leather dyeing and tie-dyeing (8, 9). The reactive colour dyes comprise approximately 13% of the world market compared with 18% for the disperse dyes (16). The literature on reactive dyes has focused on occupational exposure, whereas disperse dyes have been the centre of attention as the main culprits of textile or garment dermatitis; other

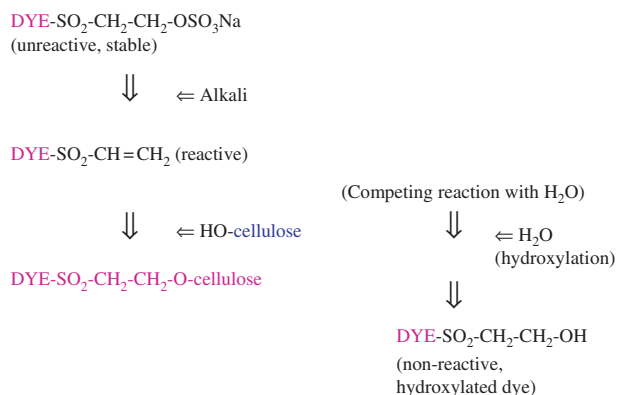


Fig. 1. Chemistry of vinyl sulphone group reaction with cotton fibre (15).

Table 1. Summary of clinical data and patch test result in patients reacting to reactive dyes

Patient Age/sex	Clinical presentation	Occupation/hobby	Reactive dye allergen	D2	D4	Area of skin involved	Atopic history	Other positive allergens	D2	D4	Diagnostic significance
30/male (March 2004)	Papular eczema	Mechanic	Reactive orange 107	2+	2+	Neck	Personal and familial	Fragrance mix Lyrat [®] Methyl(chloro)-isothiazolinone Nickel T-shirt as is	–	1+ 1+ 2+ 2+ +?	3× washing the black cotton garment brought resolution of dermatitis Flare-up of dermatitis with re-wearing his suspected T-shirt
			Reactive black 5	2+	2+	Axilla					
			Reactive blue 21	2+	2+	Lower back					
			Reactive red 228	1+	2+						
			Reactive violet 5	1+	2+						
52/male (May 2003)	Papular eczema	Administrative work/cycling with dark sport pants and T-shirt	Reactive blue 238	1+	1+		Familial	Wool alcohols PPD	1+	2+ 2+ 2+ 2+ 2+	During patch testing, the axillae and arms presented with flare-up of dermatitis
			Reactive black 5	–	1+	Buttocks					
						Axilla					
						Forearms					
						Hips					
13/male (Jan 2000)	Nummular eczema	Sports Football	Reactive blue 21	–	1+	Inner thighs	Personal and familial	Wool alcohols	–	1+	Nummular eczema resolved with avoidance of sports wear
			Acid red 118	–	1+	Dorsum foot/lower leg					
			Basic red 46	–	1+	Buttocks/lower back/abdomen					
				–	1+	Wrist/fingers					
						Eyelids					

dye classes have taken a position outside the spotlight (17–20). Manzini et al. (12) studied 1813 consecutive patients and tested with 12 reactive dyes: they found 18 who had positive reactions to reactive dyes, 17 of which had non-occupational exposure, 5 of whom who described intolerance to certain wool garments (worsening of itch with wool) and only 1 had worsening of dermatitis with dark cotton, as well as wool. In their study, they found 2 positive tests to patient's own textile, but they summarize that no absolute clinical correlation could be confirmed. Having a reaction to a dye does not confirm an allergic reaction to a garment; the dermatitis and allergen must be correlated with the suspected textile by means of proper examination (2). Testing a piece of clothing (tested as is in saline or water or pre-soaked >48 h), challenge test (stop and wear again) and extraction of the textile dye with ethanol or acetone are useful ways to prove clinical relevance when investigating textile dermatitis (2, 5). However, because there is no standard for testing a piece of clothing ('swatch' patch test), a negative 'swatch' patch test does not necessarily mean that the fabric is free of allergen (21). Another important test is the colour fastness, which is a measure of the ability of a textile to retain its dye (6). On our patient's own T-shirt, we were able to demonstrate 'bleeding' of the colour onto a white cotton gauze (wet and dry) after rubbing (the colour rubbed off showing grey discolouration of the gauze). The chemical analysis further supports residual reactive dyes in the T-shirt. The residual colours in the T-shirt from chemical analysis correlate well with the positive patch tests; identification of reactive black 5 was obtained by means of UV spectra (orange and blue colours were showed by paper chromatography).

The problem is that so little is known about the dye allergen that it could be a metabolite of the dye molecule or even impurities of the dye; the allergen may not even be coloured as was showed by thin layer chromatography (TLC) of the reactive black by Estlander, who tested 10 different coloured spots extracted from the reactive black and did not obtain an allergic reaction (9).

Neither the mechanism nor the group involved in the allergy to reactive dye is known. Our patient no. 1 reacted to dyes sharing a common reactive group, i.e. the vinyl sulphonyl group, whereas the chromophore was different (Table 2). This is similar to Estlander's (9) observation in her group of patients that tested positively to more than 1 reactive dye: 2 of 5 patients were allergic to dyes that had the same reactive group, 1 patient reacting to the vinyl sulphonyl group, the other to the chlorotriazinyl group, while the chromophores were different. However, not all the structures of the reactive dyes tested are known. Along with Estlander (9), we found it also very difficult to obtain the chemical formula or any useful information on the dyes, which makes research and postulations all the more complicated.

With this report, we emphasize that reactive dyes as a class should be considered as potential, but rare allergens, both occupationally and from garments. If the textile containing reactive dyes is not properly rinsed during its fabrication, excess of dye may be retained and may cause ACD. As the reactive dyes and their hydrolysis products are very water-soluble, any excess can be easily washed off to prevent ACD (Motschi, personal communication, September 2004).

Conclusions

We recognize that the reactive dye groups are rarely involved in ACD; however, the possibility of residual reactive dyes remaining in the garment, due to improper processing or rinsing, should not be overlooked. As mentioned previously, the fabric composition gives a clue into which dye has been used (6): the synthetic fibres (polyesters, acetates, triacetates, nylon or combination of fabric) receive disperse dyes; the natural fibres (100% cotton, rayon (viscose), wool, silk, linen, cotton/spandex and polyamides) are routinely dyed with reactive dyes. We recommend that textiles made of natural fibres and polyamides, especially dark clothing, should be washed at least 2–3 times before wearing. This procedure

Table 2. Comparison of reactive groups and chromophore in the reactive dyes to which patient no. 1 did and did not react (15)

Reactive dye with positive reaction	Chromophore class	Reactive group	Reactive dye that tested negative	Chromophore class	Reactive group
Reactive orange 107	Monoazo	Not known	Reactive red 123	Monoazo	Not known
Reactive red 228	Azo	Not known	Reactive red 238	Azo	Not known
Reactive blue 21	Phthalocyanine	Vinyl sulphonyl			
Reactive blue 238	Not known	Vinyl sulphonyl			
Reactive black 5	Disazo	Vinyl sulphonyl			
Reactive violet 5	Monoazo	Vinyl sulphonyl			

could prevent ACD even if the patient is allergic to the reactive dyes, as their presence after washing should be negligible.

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