

High frequency of simultaneous sensitivity to Disperse Orange 3 in patients with positive patch tests to para-phenylenediamine

ANTHONY T.-J. GOON¹, NICOLA J. GILMOUR², DAVID A. BASKETTER², IAN R. WHITE¹, RICHARD J. G. RYCROFT¹
AND JOHN P. MCFADDEN¹

¹St John's Institute of Dermatology, St Thomas' Hospital, London, ²SEAC, Unilever, Sharnbrook, Bedfordshire, UK

Cross-sensitization between para-phenylenediamine (PPD) and Disperse Orange 3 (DO3), among other textile dyes, has frequently been reported. We evaluated the frequency of simultaneous patch test reactions to PPD and a range of textile dyes. Retrospectively, we studied 128 patients who were patch test positive to PPD and who had also been tested to textile dyes. The dyes that most commonly also reacted were DO3 (46.1%) followed by Disperse Yellow 3 (21.9%). 80% of 55 patients who had a ++ or stronger reaction to PPD also reacted to DO3. Dyes that were least likely also to react were Bismarck Brown (0%), Naphthol AS (1.06%), Disperse Yellow 9 (1.06%), Disperse Blue 3 (1.56%) and Disperse Red 11 (2.13%). We interpreted the simultaneous patch test reactions to PPD and DO3 as due either to cross-sensitivity proper, or to metabolic conversion of textile dyes in the skin to PPD.

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Disperse dyes are well-known causes of allergic contact dermatitis. They are chemically either azo or anthraquinone dyes. In addition to colouring synthetic fibres, azo compounds have been used in hair dyes, fur dyes, leather processing, printer's ink and photographic products. Allergic contact dermatitis from azo dyes may be due to the dye itself or to its metabolic products (1). Some of the metabolic intermediates formed are similar to para-phenylenediamine (PPD) or its metabolites, and this may lead to cross-sensitization between PPD and certain azo dyes (1). Cross-sensitization between PPD and Disperse Orange 3 (DO3) in particular has been reported many times, sometimes with a very high concordance rate. In this study, we evaluated the frequency of simultaneous patch test reactions to PPD and a range of textile dyes.

Methods

Retrospectively, we have studied 128 patients who were patch test positive to PPD and who were also patch tested to textile dyes. In this

group the clinical presentation was a dermatitis where textiles were suspected as the cause.

The textile dye allergens were obtained from Chemotechnique Diagnostics AB, Malmö, Sweden. Patch tests were applied for 2 days with Finn Chambers on Scanpor tape (Epitest, Tuusula, Finland) and readings were made at day (D) 2 and D4, following international guidelines.

All patients were patch test positive to PPD, which was present in the standard series (PPD base 1% petrolatum). There have been 3 textile dyes series used over the years. 33 patients had been tested to an earlier series that comprised 16 dye allergens, while 61 patients were tested with a later dyes series that had 10 allergens and 29 patients had been tested to an abbreviated dyes series of only 4 allergens. In 5 patients, we could not determine which series had been used.

Results

The frequency of PPD-positive patients with simultaneous textile dye sensitization is shown in decreasing order of frequency in Table 1.

Table 1. Percentage of PPD-positive patients with simultaneous textile dye sensitization, in decreasing order of frequency

Dye	No. tested	No. positive	% positive
Disperse Orange 3	128	58	46.1
Disperse Yellow 3	128	28	21.9
Disperse Black 1	33	7	21.2
4-Aminophenol	94	15	16.0
Disperse Black 2	33	5	15.2
Disperse Red 1	128	17	13.3
Serilene Yellow Brown	33	4	12.1
Disperse Red 17	61	6	11.5
Serisol Blue 3	33	3	9.09
Disperse Blue 7	33	2	6.06
Disperse Blue 35	33	2	6.06
Disperse Blue 1	61	2	3.28
Disperse Yellow 4	33	1	3.03
Disperse Yellow 39	33	1	3.03
Disperse Red 11	94	1	2.13
Disperse Blue 3	128	2	1.56
Disperse Yellow 9	94	1	1.06
Naphthol AS	94	1	1.06
Bismarck Brown	33	0	0

The dyes that most commonly reacted were DO3 (46.1%) followed by Disperse Yellow 3 (21.9%). Dyes that were least likely to react were Bismarck Brown (0%), Naphthol AS (1.06%), Disperse Yellow 9 (1.06%), Disperse Blue 3 (1.56%) and Disperse Red 11 (2.13%).

In 102 of these patients, the strength of the reaction to PPD was documented. Of these, 44 (80.0%) of the 55 patients who had ++ or stronger reactions to PPD had also reacted to DO3.

Discussion

A high degree of cross-sensitivity between DO3 and PPD was first reported in 1990, 6 out of 6 patients positive to PPD also reacting to DO3 (2). In 1992, Doooms-Goossens reported that, while all of 5 patients allergic to DO3 reacted to p-aminobenzene, only 2 such patients reacted to PPD (3). However, 2 out of the 3 who did not react to PPD had reacted to black rubber mix. In 1996, Nakagawa et al. reported that positive reactions to DO3 were observed in 14 out of 17 (83.3%) patients primarily sensitized to PPD and with no history of textile dermatitis (4). This was attributed to cross-sensitivity between DO3 and PPD.

In a 1997 study of 236 azo-dye-sensitive subjects, Seidenari et al. reported that cosensitization to PPD was present in 66% of subjects sensitized to DO3 (1). In the same study, out of 84 subjects with hand dermatitis, 36 out of 43 (83.7%) DO3-positive patients were sensitized to PPD. Furthermore, monosensitization to DO3 was rare, occurring in only 3 cases out of 109 positive subjects. From this study population also, 20 had been clearly reported to have intolerance to hair dyes:

all of them were sensitized to PPD and DO3. The authors concluded that, in many DO3-sensitive subjects, sensitization seemed to be acquired from hair dyes, and might represent cross-sensitivity. Disperse dyes of the azo type have been reported to cross-react with para-amino compounds and to cause group sensitizations (2, 3). On the whole, 35% of azo-dye-sensitive subjects react to PPD.

Nakagawa et al. (4) classified azo dyes into 4 groups. DO3 belongs to the PPD group. DO3 is degraded to PPD and nitroaniline in the skin (5). The similarity in molecular structure between PPD (Fig. 1) and DO3 (Fig. 2) may support a high frequency of cross-sensitivity. However, the more likely explanation may be that this dye is susceptible to the action of azo-reductase enzymes in the skin (6). These will break the dye at the azo bond, leaving a molecule of free PPD. Similarities can also be seen between PPD and the other dyes that frequently react in PPD-sensitive subjects, i.e. Disperse Yellow 3, Disperse Black 1, 4-aminophenol and Disperse Red 1, which also have an azo bond and may be metabolized to yield PPD. On the other hand, the dyes least likely to cross-react with PPD are nonazo dyes and cannot be broken down to yield PPD.

In PPD-sensitive individuals, we suggest substitution of PPD and dyes that cross-react with PPD with other dyes of similar colour, but with different molecular structure, shown to be less reactive in PPD-sensitive skin. From our data, a

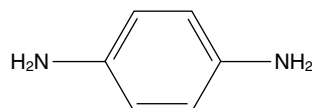
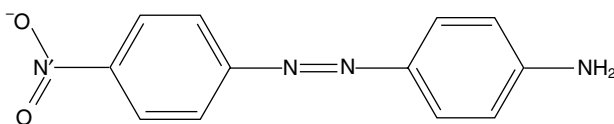
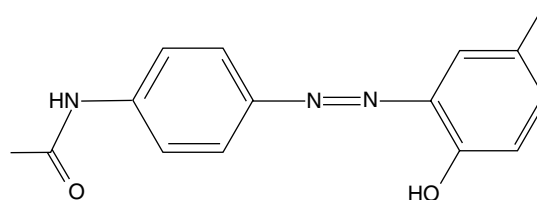


Fig. 1. Para-phenylenediamine.

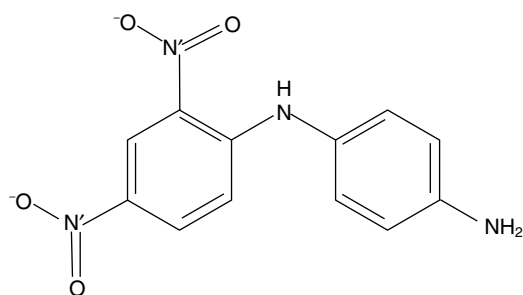


Disperse Orange 3

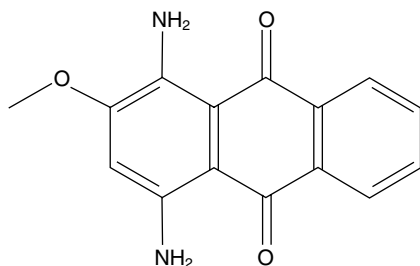


Disperse Yellow 3

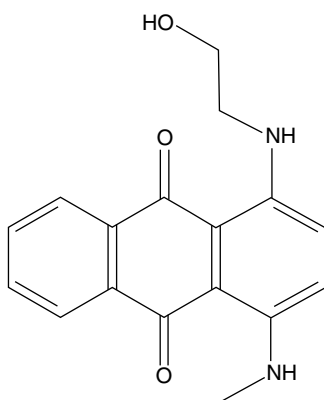
Fig. 2. Dyes most frequently cross-reacting with PPD.



Disperse Yellow 9



Disperse Red 11



Disperse Blue 3

combination of Disperse Yellow 9 (benzenedia-mine), Disperse Red 11 (anthraquinone) and Disperse Blue 3 (anthraquinone) (Fig. 3), if they could be mixed into a suitable black dye, could be a viable alternative black permanent hair dye for PPD-sensitive individuals. It is noted that other workers are considering similar strategies, which it is hoped in the longer term might also assist in the development of a wider range of less-sensitizing hair dye products (7).

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Address:

Dr Anthony Goon
National Skin Centre
1 Mandalay Road
Singapore 308205
Tel: + 65 62534455
Fax: + 65 62533225
e-mail: agtj_2000@yahoo.com

Fig. 3. Dyes that are unlikely to cross-react with PPD.