

Allergy to 3-nitro-*p*-hydroxyethylaminophenol and 4-amino-3-nitrophenol in a hair dye

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Contact allergy to 3-nitro-*p*-hydroxyethylaminophenol in a hair dye is described for the first time. *p*-Phenylenediamine is the most common screening allergen when allergic contact dermatitis is suspected, but sometimes the allergen is not sufficient for diagnosing allergic contact dermatitis to hair dyes. A 50-year-old woman developed a severe scalp dermatitis and developed vesicular hand eczema for the first time in her life. Patch testing was performed with the European Standard Series. The patch testing was supplemented with a local series of cosmetic allergens and the hairdresser's series. At the initial patch testing, there was a + reaction to nickel and a +? to PPD at days 3 and 7. Further, she reacted with a +? to her own hair collected at day 3 after the hair dying which elicited the dermatitis reaction. Open exposure to the product, which had initiated the dermatitis, was negative both before and after the allergic reaction to the product. None of the screening chemicals in the hairdresser's series gave a definite positive reaction. Only by patch testing with the individual hair dye product ingredients, the patient's reactions were explained. The patient gave a positive patch test to 4-amino-3-nitrophenol and 3-nitro-*p*-hydroxyethylaminophenol at days 3–4 reading.

Keywords: allergic contact dermatitis; 4-amino-3-nitrophenol; cosmetics; hair colouring; hair dyes; 3-nitro-*p*-hydroxyethylaminophenol; patch test; *p*-phenylenediamine. © Blackwell Munksgaard, 2005.

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Introduction

p-Phenylenediamine (PPD) has been used as screening agent for hair dye contact allergy and to a lesser degree textile dyes allergy in the European Standard Series. Evaluations based on the exposure from consecutively patch-tested patients generally confirm that PPD is an acceptable screening agent for hair dye allergy (1). By advertising, the Danish Consumer Organization recently collected 55 cases with severe, sometimes oedematous hair dye reactions (2). Since then, the Department of Dermatology, Gentofte Hospital in Denmark has received hair dye reactions based on consumer complaints. This has given an insight into a more complex picture of the hair dye reactions. The following case story represents a patient reacting to hitherto unknown hair dye allergens.

Case Report

A 50-year-old woman with nickel allergy for 30 years and no history of exposure to temporary

tattoos and no chronic dermatitis is described. She had her hair dyed for the first time in 2001 at a hairdresser without any side effects. At home, in late 2002, she wanted to dye her hair with a non-permanent hair dye and made the recommended pre-exposure test without any reaction within 1 day. Then she dyed her hair, following the recommendations carefully by the help of her husband. After 1 day, she developed a scalp dermatitis with severe itching which spread to her face, neck and upper part of the thorax. As a further complication, the patient developed vesicular hand eczema for the first time in her life. Treatment with systemic and topical steroids was giving for months, leading to gradually clearing of the dermatitis.

Patch testing was performed in several sequences in 2002 and 2004 (Table 1). Patch testing was performed with the European Standard Series (Hermal[®]) using Finn chambers[®] and Scanpore tape. The patch testing was supplemented with a local series of cosmetic allergens and the hairdresser's series. Results of relevant hair

Table 1. Exposure and reaction to 2 hair dyes in a patient who has only coloured her hair twice over life time

Screening substances for hair dye allergy (INCI name)	Patch test concentration	Exposure		Outcome of patch testing 2002–2004		
		December 2001 Product I	October 2002 Product II	Day 2	Days 3–4	Day 7
Toluene-2,5-diamine sulfate	1% pet.	+	–	–	–	–
<i>m</i> -Aminophenol	1% pet.	+	–	–	–	–
2-Amino-4-hydroxyethylamino-amisole sulfate*	1% aqua.	+	–	–	–	–
1-Hydroxyethyl-4,5-diamino pyrazole sulfate*	1% pet.	+	–	–	–	–
4-Amino-2-hydroxy toluene*	1% pet.	+	–	–	–	–
Resorcinol	2% pet.	+	–	–	–	–
4-Amino-3-nitrophenol*	1% pet.	–	+	+	++	Not done
3-Nitro- <i>p</i> -hydroxyethyl aminophenol*	1% pet.	–	+	+	+	Not done
HC yellow 6*	1% pet.	–	+	–	–	Not done
<i>p</i> -Phenylenediamine	1% pet.	–	–	–	+	+
2-Nitro- <i>p</i> -phenylene diamine	1% pet.	–	–	–	–	–
<i>p</i> -Aminophenol	1% pet.	–	–	–	–	–
Own coloured hair	As is	–	+	–	+	–

*The substances were supplied from the hair dye producer. The purity of the substances is not known.

dye allergens are summarized in Table 1. At the initial patch testing, there was a + reaction to nickel and a weak positive reaction (+?) to PPD at days 3 and 7. Further, she reacted with a +? to her own hair collected at day 3 after the hair dying in 2002, which elicited the dermatitis reaction. Open exposure to the product, which had initiated the dermatitis, was negative both before (arm exposure at home) and after (back exposure at dermatological clinic) the allergic reaction to the product. The exposure to hair dyes from 2 different products is summarized in Table 1. None of the screening chemicals in the hair-dresser's series or the local series of cosmetic allergens gave a definite positive reaction. Only by patch testing with the individual hair dye ingredients (provided for individual patch testing by the producer), the patient's reactions were explained. The patient gave a positive patch test to 4-amino-3-nitrophenol and 3-nitro-*p*-hydroxyethylaminophenol at day 3–4 reading (Fig. 1).

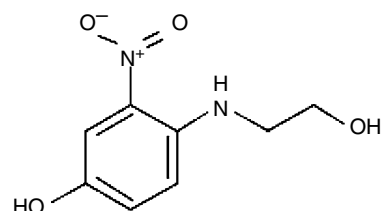
Discussion

Contact allergy is described to 2 frequently used hair dye chemicals

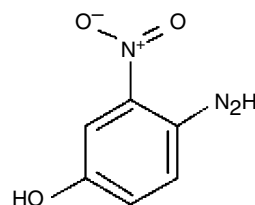
3-Nitro-*p*-hydroxyethylaminophenol is described for the first time and 4-amino-3-nitrophenol for the second time (3). Søstved and coworker (4) published a list of the 229 hair dyes in current use on the European market in 2002 and ranked them according to sensitizing potential using the topological substructural molecular descriptors (TOPS-MODE) quantitative structure-activity

relationships (QSAR) model supplemented by local lymph node assay and human data. The authors made a list of 28 high-volume substances, which are predicted as strong or moderate sensitizers. Their sensitization potency might be higher, lower or similar to the sensitizing potency of PPD (4).

3-Nitro-*p*-hydroxyethylaminophenol



4-Amino-3-nitrophenol



p-Phenylenediamine

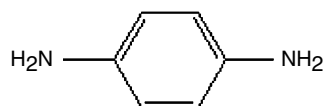


Fig. 1. Molecule structures of 3 hair dye substances.

Both hair dye chemicals, which gave reaction in the actual patient, are represented on this list of 28 high volume substances. It is important to note that allergy to these substances was not picked up by the current screening series.

A recent epidemiological study in Denmark based on the questionnaire methods indicates that eczematous or oedematous hair dye reactions affects 5.3% of the population dying their hair (5). General population-based patch test studies within the same geographical region shows that reactivity to PPD is far below these figures (6).

These observations are significant and suggest that the current screening tray for hair dye allergy employing first and foremost PPD supplemented with toluene-2,5-diamine, 3-aminophenol, 4-aminophenol and resorcinol is insufficient in an unknown number of allergic hair dye reactions in the population.

Work is currently ongoing to establish a new screening patch test series for hair dyes currently in high-volume use in Europe and evaluate it in consecutive patients. Only in this way, the true frequency can be estimated and real value of PPD as a screening agent re-evaluated.

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