

Severe allergic hair dye reactions in 8 children

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Serious adverse skin reactions to permanent hair dyes and temporary black tattoos have been reported. As temporary tattoos have become fashionable among adolescents, the risk profile for *p*-phenylenediamine (PPD) sensitization of the population has changed simultaneously with an increasing use of hair dyes in this age group. This investigation reports PPD sensitization in children with regard to cause of sensitization, clinical presentation and consequences. Clinical history and patch test results for consecutive children below 16 years of age with suspected hair dye allergic reactions and positive patch tests to PPD were collected over 2 years in 2 Danish dermatology clinics. 8 children aged 12–15 years were collected, and they all reacted to several hair dye ingredients. 5 of the patients were hospitalized, 1 in the intensive care unit. 6 of the patients gave a history of prior reaction to temporary black tattoos. These children showed simultaneous positive patch reactions to *N*-isopropyl-*N*-phenyl-*p*-phenylenediamine and local anaesthetics, while such reaction patterns were not seen in children with hair dye reactions only. The clinical consequences of these reactions are unknown. A re-evaluation of the risk assessment/risk management for hair dyes is required.

Key words: 4-amino-*m*-cresol; allergic contact dermatitis; benzocaine; black henna tattoo; children; cosmetics; Disperse orange 3; hair colouring; hair dyes; Hydroquinone; IPPD; *m*-aminophenol; *N*-*p*-phenylenediamine; *p*-amino-*m*-cresol; *p*-aminophenol; patch test; *p*-phenylenediamine; semipermanent tattoo; toluene-2, 5-diamine; youngsters. © Blackwell Munksgaard, 2006.

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The median age of first hair dying in a Danish Population is 16 years for both men and women (1). Permanent hair dyes contain strong contact allergens, such as *p*-phenylenediamine (PPD) and related substances (2, 3), but other groups of hair dye ingredients also have a significant potential to cause allergic reactions (4). Severe allergic reactions to hair dyes have been reported by 1.4% of women and 1.3% of men dying their hair (1). In some cases, the patient develops severe angioedema-like reactions necessitating intensive care treatment (5).

PPD is also used on an illegal basis in semipermanent tattoos, also called black henna tattoos, in order to obtain a darker colour and a faster drying time than natural henna can provide. The content of PPD in semipermanent tattoo ink has been reported to vary between 0.43 and 15.7% (6–8). This form of exposure also causes allergic reactions, which are usually localized (9), but puts the individual at risk of adverse reactions if hair dying with PPD and related substances later.

This investigation reports PPD-sensitization in children below 16 years of age with regard to cause of sensitization, clinical presentation and consequences.

Materials and Methods

Children aged 16 years or younger seen at 2 dermatological departments associated with the National Allergy Research Centre in 2003 and 2004 and showing a positive patch tests to PPD were included. The medical history (Table 1) as well as patch test results with European Standard Series and additional dye-related ingredients were recorded. Details of the patch test materials are in Table 2. In one case, testing was performed with 4-amino-*m*-cresol 1% supplied from the hair dye producer (KPSS GmbH, Darmstadt Germany); the purity of it is unknown.

The patch tests were performed according to the International Contact Dermatitis Research Group recommendations at the upper back, occlusion time was 2 days, and readings were performed at D3/4 and D7 (10).

Results

8 children aged between 12 years and 15 years were referred to the clinics because of a suspected allergic reaction to a hair dye product. 5 of them had been admitted to hospital, and all had

Table 1. Hair dye dermatitis and temporary black tattoo dermatitis in children: sex, age, exposure, symptoms and medication

No.	Sex/age	Hair dye exposure	Symptom description and onset after exposure to hair dye	Previous reaction to temporary tattoo	Admission to hospital and medication
1	M/12	LIVE, permanent black colour, Schwartzkopf. Home colouring	D1: oedema of ears, eczema. D2-4: facial oedema. Severe symptoms lasted for 1 week	Temporary black tattoo in the past with subsequent skin reaction	Admission to hospital for 2 days. Topical and systemic corticosteroids
2	F/14	Red dark color at a hairdresser	D2: oedema of the forehead. Still eczema on D10	When 11 years old, temporary black tattoo in Thailand with subsequent skin reaction	Topical corticosteroids and antibiotic
3	F/15	Evolution 564 R. Alfa-Parf Srl, Milano. Coloured at a hairdresser	D1: eczema, oedema of forehead, eyes and face. Symptoms lasted for 2 weeks	When 13 years old, temporary black tattoo in Thailand with subsequent skin reaction	Admitted to hospital. Systemic anti-histamine and corticosteroids
4	M/14	Garnier, Nutrisse, Natea, (2,10 Bilberry) L'Oréal. Home colouring	D3: severe facial and neck oedema. Symptoms lasted for 1 week	When 13 years old, temporary black tattoo in Egypt with subsequent skin reaction	Acute admission to hospital, intensive care unit. Corticosteroids and anti-histamine
5	M/12	Garnier, Nutrisse, Natea, (2,10 Bilberry) L'Oréal. Home colouring	D2: eczema and severe oedema in face. 13 days after application: symptoms lasted for 2 weeks.	None	Topical corticosteroids
6	M/15	Garnier Nutrisse Natea (Blue black) L'Oréal. Home colouring	D1: fainting. Severe oedema of the face and eyes completely closed	When 11 years old, temporary black tattoo in Turkey with subsequent skin reaction	D3. Admission to hospital for 4 days. Systemic and local corticosteroids. Systemic antibiotic.
7	F/14	L'Oréal New Casting 37 Mangue. Home colouring	D2: oedema of forehead and face. Oozing scalp dermatitis, and she cut off all her hair.	When 8 years old, temporary black tattoo in Thailand with subsequent skin reaction	Systemic corticosteroids
8	F/15	Wella Koleston Perfect and Wella Magma Lightning Colour. Coloured at a hairdresser.	D1: redness and scaling. D10: oedema and oozing dermatitis on scalp and ears. D18: depigmentation on truncus and infiltrated eczema on the scalp	None	Admission to hospital for 5 days. Systemic antibiotic. Topical corticosteroids

Table 2. Hair dye and black henna temporary tattoo dermatitis in children. Maximum patch test reaction from D3/4 and D5–7

Patient no.	PPD	DO3	TDA	pAP	Hydro-quinone	Black rubber	mAP	N-PPD	Caine
1 ^b	+++	+++	+++	++	+	++	++	++	++
2 ^f	++	++	++	++	++	++	++	++	+
3 ^e	+++	NT	++	++	++	+	+	++	+
4 ^c	+++	+++	+++	+++	+++	++	Neg.	++	Neg.
5	++ ^a	+++	++ ^a	++	++	Neg.	++	+? ^a	Neg.
6 ^d	++ ^a	+++	++ ^a	+? ^a	Neg.	++	+? ^a	Neg. ^a	+?
7	++ ^g	NT	Neg.	++	Neg.	Neg.	++	Neg.	+?
8	++	+	+	+?	Neg.	Neg.	+?	Neg.	Neg.

Neg., negative; NT, not tested; +?, doubtful positive reaction.

p-phenylenediamine (PPD); Disperse Orange 3 (DO3); toluene-2, 5-diamine (TDA); *p*-aminophenol (pAP); *m*-aminophenol (mAP); *N*-*p*-phenylenediamine (N-PPD).

All the substances were 1% in petrolatum (pet.). Black rubber is *N*-isopropyl-*N*-phenyl-*p*-phenylenediamine 0.1% pet. from Hermal or black rubber-mix from TRUE[®] TEST. Caine is Caine mix from TRUE test or benzocaine 5% from Hermal. 4-amino-*m*-cresol 1% was supplied from the hair dye producer KPSS GmbH, Darmstadt, Germany, the purity is not known.

The patch test materials were from Hermal, Germany; Chemotecnique Diagnostics AB, Sweden or TRUE[®] TEST, Mekos, Denmark.

The patch test reading followed the ICDRG recommendations.

^a30 min open application.

^b+ Sesquiterpenelactone-mix 1%, ++ pyrogallol 1%, +++ *p*-aminoazobenzene 0.25%, ++ 4-amino-*m*-cresol.

^cFragrance mix positive in TRUE test negative in Finn chamber[®]. *p*-aminoazobenzene 0.25% +++, pyrogallol positive.

^d+++ aminoazobenzene 0.25%.

^e+ Thiuram mix 1%, doubtful to resorcinol.

^f+ Thiuram mix 1%, ++ Disperse blue 124, hydrogen peroxide ++, pyrogallol ++, ++ aminoazobenzene, ++ hydrogen peroxide 3% aq.

^g 0.1% PPD.

received medical treatment. In 5 cases, home colouring was performed, and in 3 cases, hair dying was performed by a hairdresser. The brand and colour of the product used was available in 7 of 8 cases. (Table 1). 6 of the youngsters had a history of a skin reaction to a temporary tattoo, while 2 had reactions to hair dyes only.

At patch testing, almost all of the children gave a reaction to PPD as well as the hair dye ingredients toluene-2,5-diamine, *m*-aminophenol or *p*-aminophenol. 5 of the 6 children with previous reactions to temporary tattoos had reactions to the black rubber chemical *N*-isopropyl-*N*-phenyl-*p*-phenylenediamine (IPPD) and 3 children to local anaesthetics (Fig. 1, Tables 1 and 2), without any history of prior exposure to these chemicals. The 2 children (no. 5 and no. 8) with no prior temporary tattooing only gave allergic reaction to hair dye ingredients and did not react allergic to IPPD or local anaesthetics. In 1 patient (no 1), the hair dye ingredient *p*-amino-*m*-cresol was tested, as it was contained in the hair dye causing the reaction, and it gave a strong-positive reaction. Contact allergy to this substance to our knowledge have never been reported before.

Discussion

The 8 children with severe allergic reactions to hair dyes diagnosed within 2 years in 2 hospital clinics that on a yearly basis see about 5% of the suspected contact dermatitis patients in Denmark

suggest that this problem of PPD allergy among children is more frequent than reflected by the actual number of cases.

Furthermore, it is estimated that only 10% to 30% of those with a severe reaction to cosmetics such as hair dyes will be seen by a doctor and even fewer by a dermatologist (1, 11, 12). On a European level, this suggests that severe allergic reactions to hair dyes in children may be a considerable problem.

6 of the 8 children had a history of prior reactions to a temporary tattoo, which probably contained the black dye PPD. Temporary tattoos have become fashionable (13) as also is dying hair at an increasingly younger age (1, 14). This means that the risk profile of the population using hair dyes is changing, and producers of legal consumer products, such as hair dyes, will have to take this into consideration. While the primary reaction to temporary tattoos is a minor event in the medical context, these children may become severely ill from dying their hair. However, severe allergic reactions to hair dyes is seen also in children without any prior history of temporary tattoo use.

The current cases of contact allergy in children to hair dyes were selected based on patch test reactions to PPD. PPD is described as cross-reacting to the hair dyes toluene-2,5-diamine, *p*-aminophenol, 2-nitro-PPD (15) and to disperse orange 3 (16). The severe clinical reactions may be caused by the multiple PPD-related

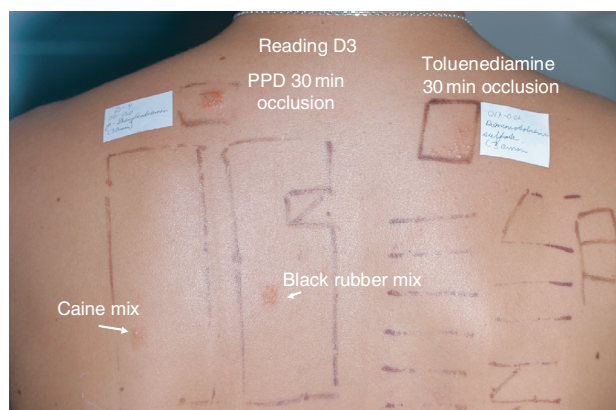


Fig. 1. *p*-phenylenediamine (PPD) allergic patient with cross-reactivity to caine mix and black rubber mix (with kind permission of Frosch, P. Textbook of Contact Dermatitis, 4th edition 2006, ©Springer-Verlag, Berlin, Heidelberg).

cross-reacting allergens present in commercial dyes. As many of these chemicals are potent allergens, synergistic immunological reactions may be the result (17) and unpredictable severe clinical reactions among the consumers the consequence.

PPD has also been described to cross-react with the black rubber chemical family, including IPPD (18). As regard to local anaesthetics, little evidence is published of cross-sensitization; however, this seem to occur, as 5 of our 6 children, who had had a temporary tattoo, gave positive or doubtful reactions to TRUE[®] test caine mix or benzocaine. Contamination of the tattoo ink with other chemicals cannot be ruled out, but it is unlikely, because the tattoos were performed at resorts in different parts of the world. The tendency to react to other chemically related substances may also reflect the degree of sensitivity of the individual. The practical consequences of the individual as regard to use of local anaesthetics in the future is unknown.

Exposure to semipermanent tattoos containing PPD mimics, an experimental model, showing the effect of continuous exposure to PPD in relatively high concentrations. In hair dying, the maximum allowed quantity of PPD is 6% before oxidation (19). The producers recommend that the hair dye is applied to the skin for 24–48 hr as a pretest before hair dying in order to identify the already sensitized consumer (20). This may be comparable to semipermanent tattooing. Under the hair dying process, the exposure to the chemicals is short, around 30–45 min, but repeated exposures have in some contexts been shown to be of equal or greater significance than just duration of exposure (21, 22).

One can only speculate on the future consequences of these excessive exposures to potent allergens starting at an early age and continuing

in many cases intermittently for life. A re-evaluation of the risk assessment and risk management before marketing of hair dyes is required.

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