

## Results of Hairdressing Series Patch Test in Patients with Allergic Contact Dermatitis to Para-phenylenediamine; Are there any Safe Alternatives?

Dear Editor,

Exposure to hair-dye is the most frequent route of sensitization to para-phenylenediamine (PPD), a common contact allergen (1). Patients allergic to PPD often worry about the use of hairdressings and usually ask about safe alternative agents and the use of other hairdressing materials such as permanent wave agents, shampoos, and bleaching agents. However, there have been no studies on this issue.

The aim of the present study was to investigate the positivity of hair-related allergens and identify safe alternatives.

We conducted a prospective patch test study using the hairdressing series (Chemotechnique Diagnostics<sup>®</sup>, Vellinge, Sweden) in patients allergic to PPD and control subjects. The control group was defined as subjects who had no history of allergic contact dermatitis (ACD) to hair dye and negative reaction to PPD. Volunteers in the experimental group were recruited from patients who were previously diagnosed with PPD-induced ACD using a TRUE test<sup>®</sup> and clinical relevance, but hairdressers and barbers at high risk of being exposed to hairdressing materials were excluded. The study protocol was approved by the local ethical committee, and informed consent was obtained from all volunteers (PNUH IRB No. F2010004).

We tested 24 patients allergic to PPD and 21 control group subjects; 20 of the former and 19 of the latter completed the study. A summary of the study results is shown in Table 1. Eleven patients from the experimental group (55.0%) were positive for more than one allergen other than PPD, while only 2 from the control group (11.1%) were positive ( $P < 0.05$ ). Para-toluenediamine sulfate (15.0%), 3-aminophenol (10.0%), and nickel-sulfate hexahydrate

(10.0%) were common allergens, which is consistent with the findings of other studies that investigated hairdressing allergens (2). The rates of positive reaction for each allergen showed a higher frequency than in the control group.

Previous studies reported that people allergic to PPD were also positive for other hair-related allergens (2-4). We thus suggest that people who are allergic to PPD should be cautious in using hairdressing materials and recommend performing patch tests to identify safe agents.

Based on these results, although the positive rates were not statistically significant, patients in our case should also be cautiously tested with other hair-dye components. We also tentatively hypothesize that getting a permanent wave is safer than a hair-dye in patients allergic to PPD, because all study patients showed negative reaction to permanent wave components.

Although our study was too small in number to generalize the results, it is a unique study on PPD-induced ACD in patients from the general population examining the positivity of each allergen in the hairdressing series. Furthermore, while most studies on the topic were of retrospective design, our study was a prospectively designed study. The patients allergic to PPD were advised to perform hairdressing series patch test and to use other hairdressing materials with care, such as bleaching agents, shampoos, and especially hair-dye components other than PPD, due to cross-reaction. Moreover, we expect this study could be an important preliminary study offering clinical data on cross-reaction with PPD and other hair-dye components.

**Table 1.** Demographics and rates of patch test reaction to each allergen in 20 patients with allergic contact dermatitis due to para-phenylenediamine (PPD) and another 18 control subjects

	Allergic reaction, N (%)†		p-value*	Uses of allergen
	Patients allergic to PPD (N=20)	Controls (N=18)		
<b>Gender, M:F</b>	10:10	9:9		
<b>Age, mean ± Standard Deviation</b>	51.4±8.5	31.8±4.0		
<b>Positive for more than one allergen</b>	20 (100.0)	2 (11.1)	<0.001	
<b>Positive reaction for allergen other than PPD</b>	11 (55.0%)	2 (11.1)	0.006	
<b>Antidandruff agents</b>				
Captan	0	0	-	-
Zinc pyrithione	1 (5.0%)	0	1.000	-
<b>Bleaching agent</b>				
Hydrogen peroxide	0	0	-	Antiseptic and bleaching agent
Ammonium persulfate	1 (5.0%)	0	1.000	Bleaching and deodorizing agent
Hydroquinone	1 (5.0%)	0	1.000	Bleaching agent
<b>Hair-dye components</b>				
para-phenylenediamine base	20 (100.0)	0	<0.001	Black dye
para-toluenediamine sulfate	3 (15.0%)	0	0.232	Dye intermediate
2-Nitro-4-phenylenediamine	1 (5.0%)	0	1.000	Brown or reddish brown dye
3-Aminophenol	2 (10.0%)	0	0.488	Color additive
4-Aminophenol	0	0	-	Color additive
<b>Metals</b>				
Nickel-sulfate hexahydrate	2 (10.0%)	1 (5.6%)	1.000	-
Cobalt(II) chloride hexahydrate	0	0	-	-
<b>Permanent wave components</b>				
Ammonium thioglycolate	0	1 (5.6%)	0.474	-
Glyceryl monothioglycolate	0	0	-	-
<b>Preservatives, antimicrobials, antiseptics</b>				
4-Chloro-3,5-xyleneol	0	1 (5.6%)	0.474	Antiseptic
Resorcinol	1 (5.0%)	0	1.000	Antiseptic and disinfectant
4-Chloro-3-cresol	0	0	-	Disinfectant
Formaldehyde	1 (5.0%)	0	1.000	Preservative
Methylisothiazolinone	0	0	-	Preservative
2-Bromo-2-nitropropane-1,3-diol	0	0	-	Preservative
2-Chloroacetamide	0	0	-	Preservative
Imidazolidinyl urea	0	0	-	Preservative
Quaternium-15	0	0	-	Preservative
2,5-Diazolidinylurea	0	0	-	Preservative
Lauryl Glucoside	0	0	-	Surfactant
Cocamidopropylbetaine	0	0	-	Surfactant and thickener
Balsam Peru	0	0	-	Fragrance

† The interpretation of the patch test; based on ICDRG guideline

• A P value &lt;0.05 was considered statistically significant; Fisher's exact test.

**References:**

- Jenkins D, Chow ET. Allergic contact dermatitis to para-phenylenediamine. *Australas J Dermatol.* 2015;56:40-3.
- Basketter DA, English J. Cross-reactions among hair dye allergens. *Cutan Ocul Toxicol.* 2009;28:104-6.

3. Scheman A, Cha C, Bhinder M. Alternative hair-dye products for persons allergic to para-phenylenediamine. *Dermatitis*. 2011;22;189-92.
4. Xie Z, Hayakawa R, Sugiura M, Kojima H, Konishi H, Ichihara G, *et al.* Experimental study on skin sensitization potencies and cross-reactivities of hair-dye-related chemicals in guinea pigs. *Contact Dermatitis*. 2000;42;270-5.

**Min-Young Park<sup>1</sup>, Won-Jeong Kim<sup>1</sup>, Hoon-Soo Kim<sup>1</sup>, Byung-Soo Kim<sup>1,2</sup>, Moon-Bum Kim<sup>1,2</sup>, Hyun-Chang Ko<sup>1,3</sup>**

<sup>1</sup>*Department of Dermatology, School of Medicine, Pusan National University, Pusan, Korea*

<sup>2</sup>*Biomedical Research Institute, Pusan National University Hospital, Pusan, Korea*

<sup>3</sup>*Research Institute for Convergence of Biomedical Science and Technology, Pusan National University Yangsan Hospital, Yangsan, Korea*

**Corresponding author:**

Prof. Hyun-Chang Ko, MD

Department of Dermatology, School of Medicine,  
Pusan National University

20 Geumo-ro, Mulgeum-eup, Yangsan-si,  
Gyeongsangnam-do

Korea, 602-739

*hcko@pusan.ac.kr*

Received: July 11, 2016

Accepted: November 5, 2017

