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**2-methoxymethyl-para-phenylenediamine containing hair dye as a less allergenic
alternative for para-phenylenediamine allergic individuals**

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ME-PPD Research Letter

Para-phenylenediamine (PPD) is the most common allergen specifically associated with allergic contact dermatitis to hair-dyes.¹ The prevalence of positive PPD patch tests is approximately 6.2% in North America and 4% in both Europe and Asia.¹

Allergy to hair dye is an important health concern due to continued usage by patients for personal and social purposes, despite obvious allergy. Many hair dyes are advertised as “non-allergenic” or “PPD free.” However, these products typically contain cross reactive chemicals such as toluene-2,5-diamine sulfate (TDS), to which almost 50% of PPD-allergic patients are also allergic.¹ Because of this well-known cross reactivity, dermatologists generally recommend discontinuing the use of permanent hair dye to PPD allergic patients. Patients, however, are frequently unwilling to follow this advice and choose to continue dying their hair and accept the itching and rash that follows.

Four recent publications have analyzed the recently formulated less-allergenic PPD derivative, 2-methoxymethyl-PPD (ME-PPD).^{2,3,4,5} ME-PPD has been shown to attenuate the innate and adaptive immune responses triggered by PPD and TDS, while maintaining an equivalent hair coloring performance.³

The decreased allergenic potential of ME-PPD has been postulated to be secondary to its methoxymethyl side chain. As ME-PPD based hair dye encounters the surrounding epidermis/dermis, this side chain inhibits binding to the CD86 co-stimulatory marker on antigen presenting cells that is necessary for T-cell activation.³ In PPD-allergic patients, ME-PPD has been shown to create a hapten complex which is poorly recognized by PPD-specific T-cells. The concentration of ME-PPD necessary to induce a local lymph node immune response is reported as 3-4%, as opposed to 0-1% for the more allergenic PPD.⁴ Zahir et al performed open testing

with ME-PPD in 20 patients known to be allergic to PPD and found that all 6 patients with a 1+ reaction to PPD tested negative to ME-PPD. 6 out of 7 patients with 2+ reactions to PPD tested negative to ME-PPD and 1 had a +/- reaction. Of the 7 patients with 3+ reactions to PPD, 2 tested negative to ME-PPD, 1 had a +/- reaction, 2 had 1+ reactions, and 2 had 2+ reactions.²

Existing literature and marketing materials promote ME-PPD as a way to avoid becoming allergic to hair dye, but the crucial unanswered question is if it can be used in the “real world” as an alternative dye by individuals who are already allergic to PPD. We present three cases to demonstrate that it is, in fact, a viable alternative for individuals already allergic to PPD (Table 1).

In Summary, ME-PPD appears to be a relatively safe permanent hair dye for PPD-allergic patients. We still recommend avoidance of all permanent hair dye to PPD allergic patients, but if they are going to continue dying despite our advice, we recommend ME-PPD based dye. We inform them that they may still react to it, but that at a minimum the reaction will be expected to be much less severe than their prior reactions to PPD based dyes.

Table 1: ME-PPD Patient Cases and Demographics

	Age	Gender	Years Dyeing	Duration of clinical reactions to dying hair	Patch Test to PPD	Reaction to dyeing with ME-PPD based dye
Patient 1	62	F	40 years	8 months	3+	No
Patient 2	69	F	20 years	4 months	3+	No
Patient 3	49	F	15 years	6 months	2+	No

Abbreviations and Acronyms

Para-phenylenediamine: PPD

2-methoxymethyl-Para-phenylenediamine: ME-PPD

Toluene-2,5-diamine sulfate: TDS

Table Legend

Table 1: ME-PPD Patient Cases and Demographics

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