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Allergic Contact Dermatitis to Hair Dye Ingredients

Summary

Since the end of the 19th century it has been possible to colour hair using so-called permanent hair dyes based on para-substituted aromatic amines combined with couplers and oxidizing agents. Allergic contact dermatitis caused by hair dyes has long been known as a risk for hairdressers and consumers. The frequency and severity of such reactions in the Danish population was unknown and initiated the investigation reported in the two first studies. The **first** study is a nationwide consumer complaint-based study made by advertising for persons who had experienced adverse reactions to hair dyes. Using a Danish consumer organisation, 55 persons with hair dye contact dermatitis were recruited within 16 months. The study revealed that adverse reactions to hair dyes were often severe, were frequently unreported to the health care system, and if persons were seen by a doctor, they were often misdiagnosed. The **second** study is an epidemiological investigation including a representative random sample of 4,000 persons of the Danish adult population invited to take part in an interview investigation. Adverse skin reactions to hair dye were reported in 5.3% of the respondents. 15.6% of those with symptoms had been in contact with health care services after a hair dye reaction.

For many years, *p*-phenylenediamine (PPD) has been included in the standard patch test series as the main indicator of contact allergy to hair dyes. However, many other dye ingredients are used and a **third** study was undertaken to evaluate if some of these would be relevant as a supplement to the current diagnostic testing. Furthermore such a study could indicate if less sensitizing dyes could substitute the aromatic amines. The third study covered a quantitative structure-activity relationship (QSAR) analysis based on local lymph node assay (LLNA) data and topological substructural molecular descriptors (TOPS-MODE). The objectives were to rank hair dye ingredients according to their predicted sensitization potency and to suggest a hair dye patch test series. 229 substances were identified by their chemical structure; the majority (75%) were predicted to be strong/moderate sensitizers and this group covered the 8 most used hair dye ingredients. A new patch test series consisting of 28 dye ingredients was suggested. Since most of the used hair dyes are sensitizers, it may be necessary to reduce the content of dye allergen to a concentration where it is tolerable for allergic patients. Subsequently, the **fourth** study was planned as a patch test dose response investigation of PPD thresholds and regional differences. 15 patients with a former positive patch test reaction to PPD were included. A patch test with a serial dilution of PPD in petrolatum was applied. The thresholds value for 10% of the patch-tested persons (ED_{10}) on the back was 38 ppm *p*-phenylenediamine. There were no statistically significant differences in responses between testing behind the ears, on the back and on the arms.

In summary, 1) among consumers, hair dyes can cause severe allergic reactions that may be misdiagnosed in the health care system, 2) in a general population-based sample, 5.3% reported adverse skin reactions to hair dyes, 3) the most used hair dye ingredients are predicted to be strong/moderate sensitizers, and 4) the threshold value for PPD in 10% of the patch tested persons (ED_{10}) is 38 ppm.