

Allergic contact dermatitis to paraphenylenediamine

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Here are two cases of allergic contact dermatitis to a chemical found in many permanent hair dyes, in temporary henna tattoos and in some inks.

Case histories

Contact allergy to permanent hair dye

A 32-year-old man presented with a marked angioedematous reaction on his face, ears, scalp and neck that had started six hours after having blonde tips applied to his dark hair by a hairdresser (Figure 1). There was no involvement of the respiratory tract. He had had no reaction three years ago when he had the same hair dye applied. There was no history to suggest prior food allergy, and he was on no medications.

He was given promethazine 50 mg intravenously, then 25 mg orally three times daily as well as prednisolone 50 mg daily on a reducing dose regimen over seven days. The skin swelling settled by the fourth day and did not recur when medication was stopped.

The man recalled having a paint-on tattoo applied while holidaying in Bali one year previously. He had developed an itchy blistering rash at the site, which had settled by the time he returned home. He gave no prior history of atopy or of other allergies.

Subsequent patch testing showed a marked 3+ (out of a possible score of 3) delayed reaction to paraphenylenediamine (PPD) 1% in petrolatum and 2+ reactions to the related chemicals, 2-nitro-paraphenylenediamine and diaminotoluene sulfate (Figure 2).

Contact allergy to temporary henna tattoo

A 42-year-old Polynesian woman had a temporary henna tattoo applied to her forearms and legs by a tattooist. That evening vesicular dermatitis developed on the tattooed skin (Figure 3). She had previously used hair dyes and thought they had made her neck a bit itchy. At presentation, she gave no prior history of atopy or other allergies.



Figure 1. Marked angioedematous reaction on the face following blonde hair dying.



Figure 2. Results of skin patch testing showing a 3+ reaction to paraphenylenediamine (PPD) 1% in petrolatum (left) and 2+ reactions to 2-nitro-paraphenylenediamine and diaminotoluene sulfate (right).

The woman was treated with prednisolone 50 mg daily on a reducing dose regimen for seven days, thrice daily soaks with 5% aluminium acetate solution and twice daily mometasone furoate cream. The dermatitis settled in eight days.

A diagnosis of contact allergy probably to PPD in the tattoo paint was made, but the woman declined patch testing.

Comment

PPD is a common contact allergen, most often causing delayed (or type IV) hypersensitivity reactions. The allergy is confirmed by patch testing (a test for delayed-type hypersensitivity reactions). The allergen is present in all standard patch test series. It is a particularly common allergen in hairdressers, in whom it causes dermatitis of the hands and forearms. Dermatitis in the hairdressers' clients usually occurs on the scalp, face or neck. Studies

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from patch test clinics show reaction rates to PPD of 4 to 7% (compared with about 14% for each of the most common allergens: nickel and fragrance mix). PPD has also been reported to cause immediate (or type 1) hypersensitivity reactions. I have seen a number of patients who develop angioedema-like reactions to PPD but who are positive on patch testing; however, I have not skin prick tested patients to PPD (the test for type 1 reactions).

Hair dyes

It is estimated that more than 50% of women in the industrialised world use hair dyes, which are also being used more often by men. Safe commercial hair colouring based on PPD was invented in France in 1909 by a company that later became L'Oreal. PPD is used in permanent (oxidative) hair dyes, a common method of hair dying in both salons and commercial home hair dye kits.

Various dyeing chemicals are used in permanent hair dyes, including PPD and 2,5-toluenediamine (which cross reacts with PPD). The process of permanent hair dying involves the production of colourless quinone-diamines, whose small molecular size allows easy penetration

through the hair cuticle. Addition of other coupler chemicals and oxidation with hydrogen peroxide produce large coloured molecules that cannot diffuse out of the hair cortex. The hydrogen peroxide used in these dyes bleaches natural

melanins from the hair, so these dyes can be used to lighten dark hair. Once the dyeing reactions are complete, the chemicals in the hair are no longer allergenic.

Semipermanent dyes comprise smaller coloured molecules that diffuse into the hair shaft. Unlike permanent dyes, there is no chemical reaction producing larger molecules, so they can slowly diffuse out of the hair shaft. These dyes wash out of the hair shaft after six to eight washes. There is also no oxidation step, so the dyeing process cannot lighten natural colour. However, some of the dyes used, including 2-nitro-phenylenediamine and some disperse dyes, cross react with PPD. The complex chemistry and potential cross reactions make it advisable that patients who are allergic to PPD avoid both permanent and semi-permanent type hair dyes.

Temporary hair dyes use coloured polymers that coat the hair and easily wash off. They do not cross react with

PPD (nor do metallic lead-based dyes such as Grecian Formula or true natural henna dyes).

Henna tattoos

Increasingly, temporary henna (black henna or Mehndi) tattoos are being reported as causes of contact dermatitis. These tattoos are applied as a paste, which is rubbed off to reveal the tattoo; the tattoo lasts for three to four weeks. They are applied by some tattoo artists, but can also be bought as a do-it-yourself kit with stencils. They are popular because they are cheap, painless and carry no infection risk. Henna is a plant that has been used for thousands of years to dye the hair and skin. Its leaves contain lawsone, a dye with a high affinity to keratin.

Contact dermatitis to natural henna is rare. PPD is added to henna as it both speeds the taking of the dye to the skin and darkens the henna from a reddish brown to ebony-black. There is a substantial risk of sensitisation to the PPD as it is often present in a high concentration in the henna mix and is applied under a plastic wrap to intensify the colour. To speed the dyeing process, other substances may also be added, such as essential oils of eucalyptus, cloves, lavender and lemon, all of which can also cause contact allergy. Reactions to PPD in henna tattoos are often strong and prone to cause post-inflammatory pigmentation, which is slow to clear. Often the henna tattoo reaction is the sensitising event leading to later problems from hair dyes.

Other sources of PPD

PPD can also be found in some inks, such as those used in stamp pads and in fur and leather dyes. These inks are not allergenic once they have dried.

PPD cross reactions

People with allergies to PPD should be aware that this chemical may also cross react with:



Figure 3. Vesicular dermatitis on the forearms after application of a temporary henna tattoo.

- antioxidant chemicals – for example, isopropyl phenylenediamine used in the manufacture of ‘black rubbers’ such as tyres and tubes, belts, grips and shoe soles
- benzocaine, used as a topical anaesthetic to treat painful haemorrhoids, sunburns or mouth ulcers.

More uncommonly, PPD cross reacts with:

- butesin picrate, a local anaesthetic that is used to treat burn pain
- para-aminobenzoic acid (PABA), a sunscreen (octyl PABA is present in some lip balms)
- azo-based, disperse-type, textile dyes used to dye synthetic fabrics
- some chemicals used for photographic developing or as hardeners for epoxy resins
- some oral drugs, including

procainamide and sulfa drugs (sulfonamides, sulfonamide drugs and sulfa-based diuretics such as thiazides and frusemide); however, these are rarely a problem.

Summary

PPD allergic contact dermatitis is quite common and potentially severe. Patients should be advised never to have temporary henna tattoos. Knowledge of substances that PPD may cross react with is also useful for patients. **MT**

Further reading

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DECLARATION OF INTEREST: None.