Allergic contact dermatitis to substitute hair dyes in a patient allergic to para-phenylenediamine: pure henna, black tea and indigo powder

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Acknowledgements

We thank Dr Jennifer Cahill for her kind assistance with this report.

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/ajd.12454](https://doi.org/10.1111/ajd.12454)

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Received Date : 17-Nov-2015

Accepted Date : 08-Jan-2016

Article type : Case Report

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Abstract

We report a case of a 50-year-old lady with allergic contact dermatitis (ACD) to para-phenylenediamine (PPD), who in her quest to find a substitute hair dye, subsequently reacted to a number of plant-based hair dyes, including pure henna, black tea and indigo powder respectively. While these substances all contain tannins, testing to possible constituents tannic acid and gallic acid was negative.

Key words: allergic contact dermatitis, tannin, henna, indigo, tea, para-phenylenediamine, hair dye, patch testing, scalp, allergy

Introduction

Allergic contact dermatitis (ACD) to hair dyes is commonly caused by para-phenylenediamine (PPD) and related chemicals. We report a case of ACD to pure henna, black tea and indigo powder, all used as alternative hair dyes by a patient allergic to PPD, who was desperate to dye her hair.

Case Report

A 50-year-old woman presented with a 3 year history of pruritic, eczematous eruptions involving her scalp, face, neck and ears after self-applying hair dyes. Her first eruption occurred 24 hours after the application of Schwarzkopf Colour creme™ (Henkel AG & Co, Dusseldorf, Germany). This article is protected by copyright. All rights reserved

Germany). She developed a severe acute eczematous eruption over her scalp, face, ears and neck associated with periorbital swelling and was admitted to hospital for 4 days (Figure 1). She was treated with prednisolone 37.5mg daily weaning over 3 weeks, topical 0.1% methylprednisolone aceponate fatty ointment (Advantan^{TM}) and 1% hydrocortisone ointment (Sigmacort^{TM}). A skin swab cultured methicillin sensitive staphylococcus aureus and she was treated with IV cephazolin followed by oral cephalexin. She ceased using Schwarzkopf^{TM} products and subsequently applied Godrej Nupur Natural Henna^{TM} (Aura Cosmetics Pvt Ltd, India). In order to achieve a darker hair colour, she experimented with mixing the henna into a paste, then adding various warm black teas: Lipton^{TM} black tea (Unilever PLC/N.V. London, UK), Twinings^{TM} black tea (Twinings & Co, Victoria, Australia) and Organic Healthy Moonlight Black Tea^{TM} leaves (China). After 2 hours, she applied this henna and tea mixture to her scalp, but after each application, she developed a scalp and face reaction. She then tried a different brand of henna, Nature Shop^{TM} Organic henna and then Nature Shop^{TM} Organic Indigo Powder (NSW, Australia) but developed similar skin reactions.

She had a personal and family history of hay fever. She did not report any reactions when drinking black tea, but experienced a generalised pruritic eruption within 15 minutes of consuming wine or beer, but not black tea.

She was patch tested at the Skin and Cancer Foundation Inc., Victoria using AllergEAZE Chambers (SmartPractice^{TM} Canada) applied to her upper back. Patches were removed and reactions assessed at 48 hours (day 2) and at 96 hours (day 4) according to the International Contact Dermatitis Research Group guidelines. Positive reactions were classified as relevant, past relevance or unknown relevance. She was patch tested to the Australian Baseline Series, cosmetic series, hair chemical series, selected fragrances and 19 of her own products.

Our patient developed reactions (Table 1) to PPD (1% in petrolatum), ammonium thioglycolate (2.5% in aqua), ammonium persulfate (2.5% in petrolatum), 4-aminophenol (1% in petrolatum) and hydrogen peroxide (3% in aqua). She also reacted to her Schwarzkopf colour creme^{TM} tested at 5% in aqua and her Godrej Nupur Natural Henna^{TM} tested at 0.01% in aqua, which was the concentration she had used.

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Schwarzkopf colour creme^{TM} contains PPD and is used with a developer containing hydrogen peroxide. Ammonium thioglycolate was present in her Wella^{TM} Perm (Procter & Gamble Co.) but she had not used this for over 10 years, so the reaction was not thought to be relevant. None of her products were known to contain aminophenol or ammonium persulfate. Aminophenol may cross-react with PPD. These reactions were therefore classed as contact allergy rather than ACD.

On further patch testing, she developed reactions to Lipton^{TM} black tea and Organic Healthy Moonlight Black Tea^{TM} (Table 1), both tested at 5% in aqua. She also reacted to Nature Shop^{TM} Organic Indigo Powder and Nature Shop^{TM} Organic henna, both tested at 0.01% in aqua (10mg in 100mL) as used by the patient. Ten consecutive patients patch tested with the same concentrations of Godrej Nupur Natural Henna^{TM}, Nature Shop^{TM} Organic Indigo Powder and Lipton^{TM} black tea had no reactions.

As pure henna, black tea and indigo powder are all known to contain natural tannins, with gallic acid and tannic acid being possible common constituents, our patient and 10 controls were additionally tested to gallic acid in petrolatum (10%, 5%, 1%) and aqua (1%) (CAS 149-91-7, Sigma Aldrich, Castle Hill, NSW) and tannic acid in petrolatum and aqua (10%, 1%) (CAS 1401-55-4, Chem-Supply, Gillman, SA). However all tests were negative.

Our patient was diagnosed with ACD to her henna samples (Godrej Nupur Natural Henna^{TM} and Nature Shop^{TM} Organic henna), black tea and indigo powder as well as ACD to PPD and hydrogen peroxide. She was also diagnosed with contact allergy to ammonium thioglycolate, aminophenol and ammonium persulphate.

Discussion

This case demonstrates the pitfalls of hair dyeing. ACD to hair dye causes scalp and neck dermatitis in consumers and occupational hand dermatitis in hairdressers. PPD is a common allergen and was found to cause 15.4% of cases of ACD to hair cosmetics, followed by p-toluenediamine (PTD) 13.9%, p-aminophenol 7.2% and to a lesser degree pyrogallol, m-

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aminophenol, ammonium persulfate, glycerol monothioglycolate, cocamidopropyl betaine and hydroquinone (each accounting for less than 5%).¹ PPD is known to cross react with similar aromatic amines p-toluenediamine, p- and m-aminophenol so even when patients do not react to PTD, there are concerns about its use.² To avoid exposure to PPD and yet keep dyeing their hair, patients often source dye alternatives: henna is commonly used. However we have not previously observed the use of indigo powder or black tea as substitute hair dyes.

Henna preparations such as “black henna” and “neutral henna” often contain undisclosed PPD to improve the fixation and darken the stain. Such preparations have also contributed to many temporary tattoo reactions.³ Pure henna, also known as “natural henna” from the plant *Lawsonia inermis*, contains lawsone (2 hydroxy 1,4 naphthoquinone) which is a red brown dye. There are a few reported cases of ACD to pure henna.^{3,4,5} Although we cannot exclude the fact that our patient's henna preparations were contaminated with PPD, as she reacted to two different 'organic' preparations of henna, we think her reaction was likely to be caused by henna itself.

Indigo powder contains the dye indigotin from the plant *Indigofera tinctoria*. Indigo treated with sulfuric acid produces indigo carmine (also called indigotine) and is administered intravenously for medical procedures and is known to cause acute allergic systemic reactions, which may be due to the sulfa component rather than the indigo.⁶ We have not found any reported cases of ACD to untreated indigo. ACD to black tea has similarly not been reported.

Pure henna, indigo powder, tea, beer and wine are all known to contain tannins. Following the principle enunciated by William of Ockham,⁷ we considered the possibility that there was a common ingredient in all substances to which our patient reacted. Henna leaves have been demonstrated to contain 11% tannin⁸ while black tea may contain up to 15% tannin, which is higher than green tea (3%) because of fermentation during production.⁹ Indigo has a reported tannin content in the order of 3.5%¹⁰ and wine and beer contain 7-11% tannins.¹¹ Tannins are found in many plants and known for their astringent taste. They are thought to deter herbivorous predators and are chemically large complex polyphenolic molecules, unlike PPD.¹² Tannin content varies with plant genotype and its developmental stage.¹² There are few

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reports in the literature of ACD caused by tannins. Obi *et al.* described a case of ACD from tannins in guava tea.¹³ Tannins have also been reported to cause ACD in 2 patients with perianal eczema applying a topical haemorrhoidal cream containing tannin¹⁴ and in a patient with hand eczema who applied synthetic tannin (Tannosynt liquid).¹⁵ The allergens in tannins have not been clearly defined: we considered both tannic acid and gallic acid but testing to these agents was negative in our case. There may be another chemical, as yet unidentified, responsible for these reactions.

In conclusion, our patient's quest to find an alternative to PPD hair dye led her unluckily to experience ACD from multiple sources. We suspected that tannins may be a cause for her multiple reactions, but this has yet to be proven. In the meantime, she has chosen to put up with temporary scalp discomfort from using natural henna, rather than give up hair dyeing completely.

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Table 1. Patient's patch test results

Allergen	Day 2	Day 4	Relevance
4 phenylenediamine base 1% pet	++	++	R
Ammonium thioglycolate 2.5% aq	+/-	+	U
Ammonium persulfate 2.5% pet	+/-	+	U
4-aminophenol 1% pet	Neg	+	U
Hydrogen peroxide 3% aq	+/-	+	R
Schwarzkopf colour cream ^{TM} 5% aq	+	+	R
Godrej Nupur Natural Henna ^{TM} 0.01% aq	Neg	+	R
Nature Shop ^{TM} Organic henna 0.01% aq	Neg	+	R
Nature Shop ^{TM} Organic indigo powder 0.01% aq	++	+	R
Lipton ^{TM} black tea 5% aq	+	+	R
Organic Healthy Moonlight Black Tea ^{TM} 5% aq	+	+	R
Gallic acid 10%, 5% and 1% pet, 1% aq	Neg	Neg	U
Tannic acid 10%, 1% pet & aq	Neg	Neg	U

R= relevant reaction, U= unknown relevance

Figure 1. Allergic contact dermatitis on face, ear and neck.

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Title:

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Date:

2016-08-01

Citation:

Swan, B. C., Tam, M. M., Higgins, C. L. & Nixon, R. L. (2016). Allergic contact dermatitis to substitute hair dyes in a patient allergic to para-phenylenediamine: Pure henna, black tea and indigo powder. AUSTRALASIAN JOURNAL OF DERMATOLOGY, 57 (3), pp.219-221. <https://doi.org/10.1111/ajd.12454>.

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