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Original Research Article

A STUDY OF HAIR DYE CONTACT DERMATITIS - ITS CLINICAL PRESENTATIONS AND ALLERGENS

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ABSTRACT

Background: Hair dye products are popular for cosmetic enhancement and are a common cause of allergic contact dermatitis (ACD), mainly due to para-phenylenediamine (PPD) exposure. This study aimed to investigate the epidemiological pattern, clinical presentation, and causative allergens of contact dermatitis due to hair dye. **Materials and Methods:** This prospective study included 43 patients at Madras Medical College, Chennai, from June 2017 to May 2018. Patients underwent detailed clinical history and examination to assess symptoms, exposure, and lesion characteristics. Patch testing was performed using the Indian Standard Series with Finn chambers, and results were interpreted per ICDRG guidelines. Allergic and irritant reactions were carefully differentiated. Patients received counselling on allergen avoidance, protective measures and appropriate treatment. **Result:** The mean age was 58.5 ± 7 years, with 70.5% males and 79.5% urban residents. Most patients were in the 41-50 years age group (45.5%). Most patients (93.2%) had no prior history of contact dermatitis; however, 52.3% of them presented with chronic skin lesions. The most common clinical pattern was localised contact dermatitis with face and neck involvement (47.7%). Approximately 38.7% of patients reported itching post-application, while 4.5% had lesions or pigmentation. Patch test positivity was high (88.6%), with PPD being the most common allergen (91.7% in women, 86.7% in men), followed by fragrance mix (23.8%), colophony, benzocaine, and parthenium (7–10%). **Conclusion:** Hair dye contact dermatitis predominantly affects middle-aged men, involving the scalp and facial regions. PPD is the leading sensitiser, and patch testing plays an important role in diagnosis. Early allergen identification can guide effective prevention and management.

INTRODUCTION

The use of hair dyes has increased significantly across all age groups and sexes in recent years. Hair dyes were primarily used by older individuals to mask grey hair, but they are now mainly applied by younger populations and professionals such as beauticians and hairdressers for enhancement and experimentation with their style.[1] While these products offer cosmetic value, their widespread use has led to a rising incidence of allergic contact dermatitis.[2]

Hair dyes can induce two types of contact dermatitis: irritant and allergic. Irritant contact dermatitis (ICD) is a non-immunological inflammatory response resulting from direct chemical damage to the skin barrier. It is characterised by localised inflammation, dryness, fissuring, and sometimes vesiculation without prior sensitisation.[3] Allergic contact dermatitis (ACD) is more frequently reported and represents a type IV delayed hypersensitivity reaction. It reveals when the immune system reacts to allergens that are previously encountered, leading to symptoms such as pruritus, erythema, vesicles, scaling, and hyperpigmentation.[4] Clinical presentation ranges from localised dermatitis involving the scalp and face to broader patterns such as airborne contact dermatitis, especially in men who use hair dye on the beard and moustache.[3] They are rarely presented with complications like angioedema or generalised eruptions, or even chemical leukoderma due to pigment loss in the affected areas.[5]

The most commonly associated allergen in hair dye ACD is para-phenylenediamine (PPD), an aromatic amine that plays a central role in the oxidative hair

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dye formulations. Its low molecular weight, high protein-binding affinity, and excellent skin penetration make it a potent sensitiser.6 PPD is also used in several non-cosmetic products, such as textiles, leather, and henna tattoos. Structurally, it resembles several compounds, leading to cross-reactions with para-aminobenzoic acid (PABA), sulphonamides, ester anaesthetics, para-aminosalicylic acid, thiazides, and azo dyes.[7] Due to its high sensitisation potential, PPD is used as a key allergen in patch test screening panels.[8]

Studies report a median prevalence of 4.3% in Asia, 4% in Europe, and 6.2% in North America.[9] A fourfold increase in sensitisation to PPD over the last decade has also been observed, which can be due to increasing cosmetic and occupational exposure.[10] In India, this issue is complicated by a sharp rise in usage among younger individuals, including teenagers exposed to temporary black henna tattoos containing PPD adulterants.[1] Studies indicate a prevalence of 80% of contact dermatitis among hairdressers and cosmetic workers.[11]

Patch testing remains the gold standard diagnostic tool for identifying ACD. It works by reproducing the hypersensitivity response in a controlled manner using standardised allergens.[12] In India, the Indian Standard Battery is widely used for patch testing, and includes PPD as a primary screening allergen.[2] Proper techniques, allergen concentration, and timing are essential to minimise false readings and distinguish between allergic and irritant reactions.[12] Given the growing incidence of hair dye-related dermatitis and its impact on quality of life and occupation, this study aimed to evaluate the epidemiological profile, clinical presentations, and allergen patterns in patients with hair dye–induced contact dermatitis using standardised patch testing as a diagnostic tool.

MATERIALS AND METHODS

This prospective study was conducted on 44 patients at the Department of Occupational and Contact Dermatitis, Madras Medical College, Chennai, between June 2017 and May 2018. Before initiating the study, it was approved by the Institutional Ethics Committee. Written informed consent was obtained from the parents before patient enrolment.

Inclusion Criteria

Patients aged > 18 years who attended or were referred to the occupational and contact dermatoses OPD with a clinical suspicion of contact dermatitis due to hair dye were included.

Exclusion Criteria

Patients aged < 18 years, pregnant women, those with active dermatitis, and those receiving steroid treatment were excluded.

Methods

Each patient underwent a face-to-face interview, and a detailed case history was recorded, including age, sex, duration and course of the disease, occupation (e.g. domestic worker, food handler, farmer, or construction worker), type of work, residential address, educational status, age at first use of hair dye, type of hair dye used, frequency and quantity of use, reaction post-application, medical history, and prior treatments.

Clinical examination was performed to exclude differential diagnoses such as psoriasis, lichen planus, and dermatophytosis, with assistance from a senior, experienced dermatologist. Symptoms such as itching, burning sensation, and watery discharge were noted, along with lesion morphology (e.g. vesicles, oozing, scaling, crusting, hyperkeratosis, and discoid lesions) and sites of involvement. A history of endogenous (e.g. atopy) and exogenous (e.g. hair dye use) risk factors was also recorded.

All patients underwent patch testing using the Indian Standard Series kit approved by the Contact and Occupational Dermatoses Forum of India, which included 20 allergens. The test was conducted on the upper back using Finn chambers with non-irritant, non-occlusive tape. Approximately 5 mm of solid antigen or 15 µL (0.1 mL) of liquid antigen was applied to aluminium discs. Two strips containing allergens were adhered to the skin, with the allergen positions marked using indelible ink and the patch corners marked to monitor displacement. Patients were instructed to avoid bathing, strenuous activity, and UV exposure during the test period. After 48 h, the patches were removed, and the patients were observed for one hour to allow pressure-induced erythema to subside. Allergen locations were re-marked, and reactions were interpreted according to the International Contact Dermatitis Research Group (ICDRG) scoring system.

Responses were graded as: negative (-), doubtful, faint erythema only (?+), weak positive reaction: palpable erythema, infiltration, and papules (+), strong positive reaction: erythema, infiltration, papules, and vesicles (++), extreme positive reaction: intense erythema, infiltration, and coalescing vesicles (+++), irritant reaction (IR), or not tested (NT). Allergic reactions were distinguished from irritant responses by the presence of itching, infiltration, and extension beyond the patch margins. Patients were counselled on allergen avoidance, advised on regular emollient use, and given occupation-appropriate protective measures, such as glove use. Treatment was administered based on the severity of the disease. Data were analysed and presented as frequencies and percentages.

RESULTS

The majority of patients were between 41 and 50 years of age (45.5%), followed by those aged 51–60 years (36.4%) and 31–40 years (18.2%). Males were predominant (70.5%), and most patients were from urban areas (79.5%). Regarding occupation, skilled workers (29.5%) and housewives (20.5%) formed the largest groups, followed by clerks/shop owners

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(18.2%) and unskilled labourers (18.2%). Educationally, nearly half of the patients were graduates or diploma holders (45.5%), while 20.5% had secondary school education. A minority had education up to middle school (15.9%) or higher secondary/postgraduate levels (13.6%), and only a few had primary education (4.5%) (Table 1).

Table 1: Demographic details

		Frequency (%)
Age group in years	31–40	8 (18.2%)
	41–50	20 (45.5%)
	51–60	16 (36.4%)
Gender	Male	31 (70.5%)
	Female	13 (29.5%)
Locality	Urban	35 (79.5%)
	Rural	9 (20.5%)
Occupation	Skilled	13 (29.5%)
	Housewife	9 (20.5%)
	Clerk/Shop owner	8 (18.2%)
	Unskilled	8 (18.2%)
	Semi-skilled	4 (9.1%)
	Prof/Semi-prof	2 (4.6%)
Education	Graduate/Diploma	20 (45.5%)
	Secondary school	9 (20.5%)
	Middle school	7 (15.9%)
	Higher secondary/Postgraduate	6 (13.6%)
	Education: Primary	2 (4.5%)

Most patients had no history of contact dermatitis (93.2%), and many reported a duration of contact dermatitis of < 1 month (56.8%). Regarding hair dye usage, nearly half (47.7%) had been using dye for 1–5 years, and 22.7% had used it for < 1 year. The most common frequency of application was monthly (40.9%), followed by once every 1-3 weeks. The most common quantities of dye used per application were 25-30 ml and 15-20 ml (47.7% and 40.9%, respectively). While 56.8% of patients experienced no adverse reactions, 38.7% developed itching, and 4.5% reported lesions or pigmentation changes. Godrej was the most frequently used hair dye brand (47.8%), followed by Black Rose (27.3%) and Indica (18.2%) (Table 2).

Table 2: Clinical history and dye usage patterns

		Frequency (%)
Previous Contact Dermatitis	Absent	41 (93.2%)
	Present	3 (6.8%)
Duration of contact dermatitis	< 1 month	25 (56.8%)
	1 month – 1 year	14 (31.8%)
	> 1 year	5 (11.4%)
Duration of dye use in years	1–5	21 (47.7%)
	< 1	10 (22.7%)
	6–10	9 (20.5%)
	>10	4 (9.1%)
Dye Use	Once a month	18 (40.9%)
	Once in 2 months	10 (22.7%)
	Once in 3 months	5 (11.4%)
	Once in 1 to 3 weeks	11 (25.0%)
Quantity of dye used	25-30 ml	21 (47.7%)
	15-20 ml	18 (40.9%)
	≤10ml	5 (11.4%)
Reaction	No Reaction	25 (56.8%)
	Itching	17 (38.7%)
	Raised lesion/Pain/Darkening	2 (4.5%)
Dye brand	Black henna	4 (9.1%)
	Black rose	12 (27.3%)
	Godrej	21 (47.8%)
	Garnier	3 (6.8%)
	Indica	8 (18.2%)
	Super Vasmol	3 (6.8%)
	V care	1 (2.3%)

A history of atopy was present in 15.9% of patients, and over half (52.3%) had chronic skin lesions, with 25% presenting with acute or subacute forms and 22.7% showing no lesions at examination. The most common clinical pattern was localised contact dermatitis involving both the scalp and face/neck (47.7%), followed by isolated scalp involvement (22.7%) and face/neck involvement (18.2%). A

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smaller group (11.4%) exhibited airborne contact dermatitis (ABCD) and other miscellaneous patterns. Regarding comorbidities, 75% of the patients had no associated conditions. Diabetes mellitus was the most common comorbidity (15.9%), followed by hypertension and various dermatological or neurological conditions, each affecting 2.3% of patients. Morphologically, the most frequent lesions were hyperpigmented papules (25%) and hyperpigmented/scaly plaques or patches (20.5%). Lichenification (13.6%), crusting/erosions (9.1%), and other pigmentary or inflammatory changes were also noted. Approximately 22.7% of patients had no visible skin lesions at the time of evaluation (Table 3).

Table 3: Clinical features and comorbidities

		Frequency (%)
History of atopy	Absent	37 (84.1%)
	Present	7 (15.9%)
Type of skin lesion	Chronic	23 (52.3%)
	Acute/Subacute	11 (25.0%)
	No skin lesion	10 (22.7%)
Clinical pattern of skin lesion	Localised contact dermatitis + Face (beard, periorbital) and neck involvement	21 (47.7%)
	Localised contact dermatitis (scalp and scalp margins) only	10 (22.7%)
	Face/Neck only	8 (18.2%)
	ABCD/hands and feet/Miscellaneous	5 (11.4%)
Comorbidities	Diabetes mellitus	7 (15.9%)
	Hypertension	2 (4.6%)
	Cataract	1 (2.3%)
	Hypertrophic LP/Prurigo nodularis	1 (2.3%)
	Trigeminal neuralgia	1 (2.3%)
	Pityriasis capitis	1 (2.3%)
	Facial melanosis	1 (2.3%)
	Acanthosis Nigricans	1 (2.3%)
	No comorbidities	33 (75.0%)
Morphology of skin lesions	No skin lesion	10 (22.7%)
	Multiple skin-coloured papules with or without erythema	3 (6.8%)
	Hyper-pigmented macules	5 (11.4%)
	Hyper-pigmented papules	11 (25.0%)
	Hyperpigmented/scaly plaques ± erythema	9 (20.5%)
	Urticarial plaque	1 (2.3%)
	Crusted erosions/oozing/Fissuring	4 (9.1%)
	Hyperpigmented patch	9 (20.5%)
	Depigmented macules/papules/Leukoderma	1 (2.3%)
	Hypo-pigmented patch	2 (4.6%)
	Seborrheic melanosis	1 (2.3%)
	Angioedema	1 (2.3%)
	Lichenification/lichenified plaques	6 (13.6%)

Patch testing revealed a high positivity rate, with 88.6% of patients showing allergic reactions, 6.8% showing negative results, and 4.6% not returning for follow-up. PPD was the most frequent allergen, with over half of the tested patients demonstrating a positive response; 40.5% showed a 1+ reaction, 11.9% had a 2+ reaction, and 33.3% exhibited pigmentation. Other notable allergens included fragrance mix (23.8% positive), colophony, benzocaine, and epoxy resin, each with approximately 7.1% positivity. Patch test reactivity to parthenium was observed in 10% of patients. Mercaptothiazide showed only one clear positive result, although three results were doubtful. Additional allergens, such as nickel and potassium bichromate, had a 7.1% positivity rate. Other sensitisers with lower frequencies included nitrofurazone, balsam of Peru, black rubber mix (4.8% each), and agents such as neomycin, cobalt sulfate, and paraben mix (2.4% each) (Table 4).

Table 4: Patch test results – overall and specific allergens

		Frequency (%)
Patch Test	Positive	39 (88.6%)
	Negative	3 (6.8%)
	Reading not taken (Patient not returned)	2 (4.6%)
Patch test for Para-phenylenediamine (PPD)	Negative	5 (11.9%)
	1+	17 (40.5%)
	2+	5 (11.9%)
	Pigmentation	14 (33.3%)
	Pigmentation and 1 +	1 (2.4%)
Patch test for parthenium	Negative	38 (90.5%)
	1+	3 (7.1%)
	3+	1 (2.4%)
Patch test for Benzocaine	Negative	38 (90.5%)

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		1+	3 (7.1%)
		Doubtful	1 (2.4%)
Patch test for Colophony		Negative	38 (90.5%)
		1+	3 (7.1%)
		Doubtful	1 (2.4%)
Patch test for fragrance mix		Negative	32 (76.2%)
		1+	10 (23.8%)
Patch test for Epoxy resin		Negative	37 (88.1%)
		1+	3 (7.1%)
		Doubtful	2 (4.8%)
Patch test for mercaptothiazide		Negative	38 (90.5%)
		1+	1 (2.4%)
		Doubtful	3 (7.1%)
Patch test Antigen	Nickel	1+	3 (7.1%)
	Nitrofurazone	1+	2 (4.8%)
	Chlorocresol	1+	1 (2.4%)
	Neomycin	Doubtful	1 (2.4%)
		1+	1 (2.4%)
	Cobalt sulfate	1+	1 (2.4%)
	Balsam of Pern	1+	2 (4.8%)
	Black rubber Mix	1+	2 (4.8%)
	Paraben mix	1+	1 (2.4%)
	Potassium bichromate	1+	3 (7.1%)

PPD was the most common allergen in both sexes, with slightly higher positivity in females (91.7% vs. 86.7%). Fragrance mix sensitivity was similar in both groups (25% vs. 23.3%). Males showed more reactivity to epoxy resin (16.7% vs. 0%), colophony (13.3% vs. 0%), and potassium bichromate (10% vs. 0%). Nickel and mercaptothiazole reactions were more frequent in women than in men (16.6% vs. 3.3% and 16.6% vs. 6.7%, respectively). Other allergens, such as benzocaine, neomycin, and nitrofurazone, showed comparable sensitisation between the sexes. Black rubber mix, chlorocresol, paraben mix, and cobalt sulphate reactions were observed in only a few men (Table 5).

Table 5: Patch test results by gender

Allergen	Female	Male
PPD	11 (91.7%)	26 (86.7%)
Fragrance Mix	3 (25%)	7 (23.3%)
Epoxy Resin	0	5 (16.7%)
Parthenium	1 (8.3%)	3 (10%)
Benzocaine	1 (8.3%)	3 (10%)
Colophony	0	4 (13.3%)
Mercaptothiazide	2 (16.6%)	2 (6.7%)
Potassium bichromate	0	3 (10%)
Nickel	2 (16.6%)	1 (3.3%)
Neomycin	1 (8.3%)	1 (3.3%)
Nitrofurazone	1 (8.3%)	1 (3.3%)
Balsam of Peru	1 (8.3%)	1 (3.3%)
Black rubber Mix	0	2 (6.7%)
Chlorocresol	0	1 (3.3%)
Paraben Mix	0	1 (3.3%)
Cobalt sulphate	0	1 (3.3%)

DISCUSSION

Hair dye contact dermatitis is a growing dermatological concern associated with the increasing cosmetic use of hair dyes across diverse populations. This study aimed to evaluate the epidemiological trends, clinical patterns, and allergen profiles of patients with hair dye–induced contact dermatitis using patch testing as a diagnostic tool. The mean age of the patients was 48.5 ± 7.02 years, with the majority (63%) aged between 31 and 50. This age distribution is comparable to the findings of Lee et al., who reported a mean age of 58.7 ± 9.6 years in their study evaluating the safety of 15 commercial hair dye products.13 Sajid et al. analysed 400 patients with suspected contact allergy to hair dye and reported that the majority of patients (52.5%) were aged between 31 to 50 years.[14] In contrast, a younger population was noted by Tomar et al., with a mean age of 27.5 years, while Sadagopan et al. found 42% of their patients to be between 26-40 years.[15,16]

In our study, the majority of patients were males (70%), which aligns with the findings of Gupta et al., who reported 58% male and 42% female patients.[2] Similarly, Sharma et al. documented 59% males, but in contrast, Lee et al. reported a female predominance (56.5%).[17,13] These variations might reflect regional or cultural differences in hair dye use among the genders.

In our study, over half of the patients were graduates or postgraduates, 30% were skilled workers, and 20% were housewives. Similarly, Gupta et al. found that

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57% of males were skilled workers and 91% of females were housewives.[2] Tomar et al. noted that 46% of patients were students, highlighting occupational diversity in affected populations.[15] The duration of dermatitis was less than a month for most patients in our study, similar to findings by Tomar et al., where 68% had symptoms for less than a year.[15] Gupta et al. reported that 33% were affected for more than a year.[2]

In our study, hair dye usage patterns revealed that nearly 70% had been using dye for 1-5 years. Gupta et al. reported that 14% of their patients used dye for less than a month, 52% for 1 month to 1 year, and 21% for more than 3 years.[2] Similarly, Lee et al. reported that among their contact dermatitis patients, 33.3% had dyed their hair for 1 to 5 years, 17.8% for 5 to 10 years, 31.1% for >10 years, and only 2.2% used it for the first time.[18]

The clinical patterns in our study showed chronic lesions in more than half of the patients. The most common distribution was both the scalp and face/neck (48%), followed by localised scalp-only dermatitis (22.7%). Similar distributions were observed by Gupta et al., who reported scalp margin involvement most frequently, followed by face, neck, and hands.[2] Rozas et al. emphasised that scalp, face, neck, eyes and hands are common sites that are at higher risks of contact dermatitis.[19]

Morphologically, hyperpigmented papules were the most frequent lesions, followed by hyperpigmented patches and plaques. Less common presentations included lichenified plaques, crusted erosions, and depigmented or urticarial lesions. Tomar et al. noted similar findings with the face, scalp, and forehead being frequently involved.[15] Sharma et al. found ABCD, hands, and feet involvement to be common.[17] Patch testing in our study showed a high positivity rate (88.6%). Similarly, Puri et al. analysed 50 patients and reported a high positive rate of 84% for the patch test.[20] In contrast, Jindal et al. found 50% positivity, and Gupta et al. reported 67.5%.[21,2]

In our study, the most common allergen was PPD, with approximately 88% positivity; 40.5% showed a 1+ reaction, 11.9% showed a 2+ reaction, and one-third developed pigmentation. These findings are consistent with those of Lee et al., where 100% of the patients were PPD positive, and 60.9% showed a 1+ reaction.[13] Similarly, Gupta et al. reported PPD as the most common allergen.[2] Tomar et al. found fragrance mix to be the leading sensitiser (27.2%), followed by PPD (21.2%) and parabens (9%).[15] After PPD, the most common allergens were fragrance mix (24%), parthenium (9.5%), benzocaine, colophony, epoxy resin, nickel, and potassium dichromate (each 7.1%). These results are supported by Lee et al., who reported nickel, fragrance mix, and potassium dichromate as significant allergens.[13]

Sharma et al. reported nickel sulphate (31%), parthenium (26%), and fragrance mix (11%) among the top sensitisers.[17] Gupta et al. and Sadagopan et al. also identified potassium dichromate, parthenium, and other occupational allergens as important sensitisers in their respective cohorts.[2,16]

Patients with hair dye contact dermatitis predominantly presented with chronic lesions affecting both the scalp and the face/neck. Most patients had prolonged dye exposure, with a significant proportion showing strong sensitisation to PPD and other allergens on patch testing. Larger multicentre studies with extended follow-up are recommended to better understand sensitisation dynamics, guide preventive strategies, and refine allergen screening protocols in high-risk populations.

Limitations

This study was limited by its single-centre design, short follow-up period, and relatively small sample size, which may affect the generalisability of the findings.

CONCLUSION

Hair dye contact dermatitis was most prevalent among middle-aged urban males, the majority of whom had used hair dye for 1–5 years. Clinically, chronic lesions with scalp and face/neck involvement were the most common. Patch testing revealed a high positivity rate, with PPD as the predominant allergen, followed by fragrance mix and other occupational and cosmetic agents. These findings emphasise the need for early diagnosis through patch testing and targeted counselling to prevent recurrence and complications. Broader community education on the safe use of dyes and awareness of allergen content are also necessary.

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