A Clinical and Dermoscopic Study of Pigmentary Changes in Hair Dye Users and Its Correlation with Patch Testing – A Hospital based Cross Sectional Study

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***Abstract*:**

Hair dyes contain various allergens which have the potential to cause allergic/irritant contact dermatitis. In the following study, non-invasive diagnostic modalities like dermoscopy and patch testing has been done to evaluate the pigmentary changes in hair dye users.

Methodology: This cross-sectional study was implemented at a tertiary care hospital in South India. The consented participants were interviewed using a standardized questionnaire followed by a dermoscopic examination of the lesion was done using dermlite DL4 (3rd generation) and patch testing with a hair dye series.

Results: The majority of the patients were in their mid-forties with a slight male preponderance. Fifty-three percent of the participants gave a history of usage of hair dye for more than 5 years and 58.1% used hair dyes more than once in a month. The most common sites affected were the forehead and temple (40.2%). The most common dermoscopic finding was black dots and globules (45.3%). Of the 105 patients who were patch-tested, 96 patients (91.4%) had a positive reaction to single or multiple hair-dye allergens. Sixty-four patients (60.95%) were allergic to PPD 1% and a majority of the patients (85.7%) showed 1+ reaction according to ICDRG grading. Patch testing along with dermoscopic examination had a high negative predictive value of 85.7%.

Conclusion: Most of the patients presented to hospital only after the pigmentation was more visible and bothersome after prolonged periods of usage of hair-dyes. There is paucity of studies showing the various dermoscopic patterns observed with pigmentation caused by hair dyes which have been described in this study. Patch testing with hairdresser series can be advised to patients before usage of hair dyes to avoid pigmentation and other side effects.

***Keywords*:** allergens, Dermoscopy, pigmentary, preponderance, prolonged.

Introduction:

Hair dyes are generally used to conceal the grey and white hairs or to break the monotony of looks in young adults. They are considered a sign of attraction. Hair dyes contain various allergens which have the potential to cause allergic/irritant contact dermatitis. The mean age of first-time hair dye use was 27 years according to an Indian study.[1] Forty-two percent of respondents reported adverse events following the use of hairdye[1]. Hairdressers are especially at an increased risk in addition to their customers and people who use hair coloring agents at home. They are exposed to continuous lower levels of allergens and frequent wet work which may lead to skin reactions of an irritant and/or allergic nature[2]. Patch testing is a commonly used diagnostic modality for diagnosing hair dye allergy.

Various studies have been done in past to study the trends of hair dye and it's adverse effects among which pigmentation was a common side effect observed. Patients were patch tested with the commercially available hair dye they have been using, or a specific patch test series was used with few common allergens. However, patients can be allergic to a single or multiple allergens present in the dyes. We can therefore identify the precise allergen they are allergic to by patch-testing them using a particular patch test series. With this background, the objectives ascertained was to identify the clinical and dermoscopic features of

pigmentary changes in hair dye users and to correlate the findings with patch testing.

MATERIALS AND METHODS:

Study setting:

Patients with pigmentary changes due to hair dye usage attending the Dermatology Out Patient Department in Sri Manakula Vinayagar Medical College and Hospital, Puducherry were included in the study.

Study design:

A hospital-based cross-sectional study was conducted in a tertiary health care setup of Sri Manakula Vinayagar Medical College and Hospital at Kalitheerthalkuppam in Puducherry.

Study participants:

All consenting patients above 18 years of age using permanent/ semi-permanent hair dyes with pigmentary changes due to hair dye usage were included. Pregnant and lactating women, patients with pigmentation due to other causes were excluded.

Sample size:

Considering the prevalence of positive patch test among hair dye users to be 67.5% based on previous study done by Gupta M et al[3] and with absolute precision of 8.5% at confidence interval 95%, the required sample size for the present study was estimated to be 117 using Open Epi version 3.

Study duration:

The duration of the study was for a period of 18 months from Jan 2023 to June 2024 after ethical committee clearance.

Data collection procedure:

After obtaining consent from the participants for the study, they were interviewed using a questionnaire on socio-demographic details, chief complaints, duration of disease, duration of treatment and family history. General examination and examination of scalp, face, trunk, upper and lower limbs was done on the study participants. Then dermoscopic examination of the lesion was done using dermlite DL4 (3rd generation). Patch testing was done in consenting individuals.

Standardized questionnaire and interview by the same investigator was done to minimize interviewer bias.

Analysis plan:

Data was entered in Epi - Info software version 7.2.2.6 and using IBM SPSS Statistics version

20. Frequency and percentage was obtained for the independent variables. Mean and standard

deviation were calculated for duration of symptoms and treatment. Mean (SD) or Interquartile

range was calculated for dependent variables. To assess the significance of association between

dependant and independent variables, multivariate analysis was used.

Implications of the study:

The implication of this study is to identify the clinical and dermoscopic features of the pigmentary changes in patients using hair dye. Positive patch test in such patients indicates allergy to component(s) of hair dye. Such patients were advised to avoid using hair dye containing the sensitising allergen.

Ethical consideration:

EC Number - EC/55/2022. After getting informed consent from the patient, dermoscopic visualisation of pigmentary changes was done using Dermlite DL4 dermoscope and analysed. Patients with findings were patch tested. No invasive procedure was done on patients in this study.

Reporting of study guidelines:

The study was conducted according to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE).

Results:

The study was conducted in population of 117. The mean age of the patients was 44.6 years. There were 54 females, making up 46.2% of the total, and 63 males, comprising 53.8%. The table outlines the frequencies of the nature of illness within the sample population. The majority, 86 individuals (73.5%), have used a single hair dye product and 90 individuals (76.9%) preferred black coloured dyes. Majority (53%) of the individuals have been using hair dye for more than 5 years and 68 (58.1%), use hair dye more than once a month. The most

frequently affected sites were forehead and temple (40.2%) followed by ears (21.4%). Ninety individuals (77.8%), experienced a persistent nature of illness.

Table showing presenting complaints of participants

Chief complaints		**n**	**% (N - 117)**
Asymptomatic Hyperpigmentation	Localised (limited to one anatomical site	10	8.5
	Diffuse (involving more than one anatomical site)	53	45.2
	Hyperpigmentation with itching	37	31.6
	Asymptomatic Pigmentation (Localized)	11	9.4
	Depigmentation with itching	2	1.7
	Diffuse hyperpigmentation along with few hyperpigmented raised lesion	2	1.7
	Only localised hyperpigmented raised lesion	1	0.8
	Swelling of face with Pigmentation	1	0.8

Table showing dermoscopy findings:

Frequencies of Dermoscopic finding			
Dermoscopic finding	**Counts**	**% of Total**	**Cumulative %**
Dots & globules	48	45.3 %	45.3 %
Enhanced perifollicular network	9	8.5 %	53.8 %
Structureless Pattern	17	16.0 %	69.8 %
Arcuate pattern	7	6.6 %	76.4 %
Accentuation of reticular pigment network	9	8.5 %	84.9 %
Pseudo network	1	0.9 %	85.8 %
Loss of pigment network	6	5.7 %	91.5 %
Homogenous areas	9	8.5 %	100.0 %

Table showing association of dermoscopy with patch test:

Dependent: Patch test		**Negative**	**Positive**	**OR (univariable)**	**OR (multivariable)**
Dermoscopic finding	Dots & globules	20 (41.7)	28 (58.3)	-	-
	Structureless Pattern	11 (64.7)	6 (35.3)	0.39 (0.12-1.20, p=0.108)	0.39 (0.12-1.20, p=0.108)
	Homogenous areas	4 (44.4)	5 (55.6)	0.89 (0.21-4.00, p=0.877)	0.89 (0.21-4.00, p=0.877)
	Pseudo network	1 (100.0)	0 (0.0)	0.00 (NA-Inf, p=0.996)	0.00 (NA-Inf, p=0.996)

	Accentuation of reticular pigment network	1 (11.1)	8 (88.9)	5.71 (0.94-110.37, p=0.113)	5.71 (0.94-110.37, p=0.113)
	Arcuate pattern	6 (85.7)	1 (14.3)	0.12 (0.01-0.77, p=0.057)	0.12 (0.01-0.77, p=0.057)
	Enhanced perifollicular network	0 (0.0)	5 (100.0)	30389151.66 (0.00-NA, p=0.992)	30389151.66 (0.00-NA, p=0.992)
	Loss of pigment network	1 (20.0)	4 (80.0)	2.86 (0.39-58.16, p=0.364)	2.86 (0.39-58.16, p=0.364)
	Enhanced perifollicular network	1 (25.0)	3 (75.0)	2.14 (0.25-45.07, p=0.522)	2.14 (0.25-45.07, p=0.522)

Table showing diagnostic power of Patch test with dermoscopy

	Ratios
Sensitivity	23.1 %
Specificity	57.7 %
Accuracy	53.8 %
Prevalence	11.1 %
Positive Predictive Value	6.4 %
Negative Predictive Value	85.7 %
Post-test Disease Probability	6.4 %
Post-test Health Probability	85.7 %
Positive Likelihood Ratio	0.545
Negative Likelihood Ratio	1.33

Out of the total, 12 patients were not willing to undergo the patch test. Among those who were tested, 105 patients had positive results. Of these, 79 patients tested positive for a single allergen, while 17 patients tested positive for multiple allergens. This indicates a significant portion of the tested population exhibited allergic reactions, with most reacting to just one allergen, while a smaller subset showed sensitivity to multiple allergens. Among those tested, 9 patients had negative results, indicating no allergic reaction. There were no cases with a doubtful reaction. The majority of positive reactions were mild, with 90 patients exhibiting a 1+ reaction. Additionally, 6 patients had a moderate 2+ reaction. There were no instances of a strong positive 3+ reaction. This data suggests that while positive reactions to the patch test were common, they were predominantly mild in severity.

Table showing positivity to allergens in patch test:

Allergen	No	%
Hydroxyethyl-p-phenylenediamine sulphate 2 %	9	8.57%
4 amino 2 - hydroxytoluene 1 %	8	7.62%
P - phenylendiamine (PPD) 1 %	64	60.95%
P - aminophenol 1 %	21	20.00%
P-chloro-m-cresol 1% %	0	0%
M - aminophenol 1 %	4	3.81%
Hydroxyquinone 1%	4	3.81%
2-methyl resorcinol %	0	0.00%
Resorcinol 1 %	1	0.95 %
Toluene2,5 - diamine sulfate 1	12	11.43%

Discussion:

Hair dye induced pigmentary dermatitis is a condition characterized by discolouration and inflammation caused by sensitivity to hair dye products. This cross-sectional study shows mean age of the patients to be 44 +/- 7.21 years. Slight male preponderance was noted with a male-to-female ratio of 1.16:1. The usage of hair dyes were more common in urban population probably due to the peer pressure observed more in these population than rural areas.

Most of the patients (73.5%) used a single hair dye product and most (76.9%) preferred black colour dyes. 77.8% of the patients had a persistent course whereas few (22.2%) had exacerbations predominantly at the time of usage of the hair dye.

Fifty-three percentage of the participants gave a history of usage of hair dye for more than 5 years and 58.1% used hair dyes more than once in a month, indicating that prolonged and more frequent usage of dye leads to more clinically apparent pigmentary changes.

The most common sites affected were forehead and temple (40.2%) which was similar to studies conducted by Ju Hee Han et al. and Erin M. Warshaw et al.[4,5] The second common sites affected were ears (21.4%).

Dermoscopy is a non-invasive tool which can be used for diagnosis of various dermatological conditions. Of the 117 patients in our study, the most common dermoscopic finding was black dots and globules (45.3%), followed by structureless pattern (17%).

Based on the dermoscopic features observed in our study, the following types of pigmentation can occur in a patient with hair dye usage[6]:

i.Lichen planus pigmentosus-like pigmentation
i.Pigment contact dermatitis like pigmentation
i.Melasma-like pigmentation
⁄.Erythema dyschromicum perstans-like pigmentation
⁄.Nevus like pigmentation
i.Matural hyperpigmentation like pigmentation
i.Seborrheic melanosis-like pigmentation
i.Vitiligo like pigmentation

However, some studies have reported association of hair dye usage with some of the pigmentary disorders like lichen planus pigmentosus and pigment contact dermatitis.[4,7,8]

There are studies that have done patch testing for hair dye allergy previously where they have commonly used the standard patch-test series which mainly contains only PPD. In our study, a more specific hairdresser series has been used.

Of the 105 patients who were patch-tested, 96 patients (91.4%) had a positive reaction to single or multiple hair-dye allergens. Most of the patients (79 patients – 75.2 %) were allergic to a single allergen. Sixty-four patients (60.95%) were allergic to PPD 1% followed by p-aminophenol 1% (21 patients – 20%) and toluene 2,5 diamine (12 patients – 11.43 %). Few patients also showed positivity to other allergens like hydroxyethyl-p-phenylenediamine sulphate 2 %, 4 amino 2 - hydroxytoluene 1 %, Hydroxyquinone 1%, m-aminophenol 1% and resorcinol %. None of the patients were found allergic to p-chloro-m-cresol 1% and 2-methyl resorcinol %.

Most of the patients (85.7%) showed 1+ reaction according to ICDRG grading.

Patch testing along with dermoscopic examination had a high negative predictive value of 85.7%, indicating that the possibility of hair dye allergy can be ruled out and other diagnoses can be considered if both are negative.

The dye allergy is unique in the pattern and manifestation. Establishing the allergen is important as it plays a very important role in treatment and further avoidance of allergen.

The normal CODFI series used in diagnosing contact dermatitis has only few allergens. Our hair dresser series has a wider spectrum and very useful in diagnosing rare allergens which are not present in CODFI series.

In our study, it is interesting to note that only 60% were allergic to PPD. Others were allergic to other components of hair-dye. This is an interesting finding as it helps us to isolate and avoid allergens.

STUDY	EPIDEMIOLOGICAL DATA	CLINICAL DATA	PATCH TEST
Mrinal Gupta et al.[3] (80 patients)	71% patients - older than 40 years	• Duration of dermatitis - varied from one year. • Most common site involved - scalp and/or scalp margins.	• Fifty-four patients - positive patch tests for PPD. • Eight patients – positive patch tests for other agents also like fragrance mixtures, thiuram mixtures, paraben mixtures.
Meghana V et al.[7] (120 patients)	83 – male patients 37 - female patients Mean age - 47 years +/- 10 years	• Majority of the patients had a moderate level of pigmentation • Lateral forehead and ear spiral was most commonly affected sites (106, 88.3%)	
Bishnoi A et al.[9] (108 patients)	21 men and 87 women with a mean age of 40.3 +/- 12.2 years (range 13–68 years)	Ninety (83.3%) patients reported using hair dyes, of whom 41 (45.5%) complained of mild, occasional itching after hair dye application.	• Thirty-nine (36.1%) patients - found to show a positive patch/photo-patch test. • Fourteen patients - delayed hyperpigmentation developed on positive patch-test sites - at 1 month. • Self-products showed more positivity than commercial series.
Ju Hee Han et al.[10] (105 patients)	31 (29.5%) were male and 74 (70.5%) were female. The average age was 52.9 years 75% of the patients were more than 50 years of age.	Clinical symptoms observed included itching, stinging, dryness, and burning or tingling. Itching was the most commonly observed symptom in - 75 patients	105 patients - positive result on PPD, 61 patients - positive for multiple antigens. Nickel - 37 patients (most common). Cobalt chloride – 22 patients Potassium dichromate - 18 patients Mercury aminochloride -11 patients Thiuram mix – 9 patients

		Stinging sensation - 9 patients Dryness – 2 patients Burning/tingling sensation - 1 patient Clinical signs: Erythematous macules and patches - 56.2% of the patients Scaling - 8.6% of the patients Erythematous papules and plaques - 7.6% of the patients Oozing - 6.7% of the patients Combined skin problems – was observed in 52 patients Most commonly affected site Face (57.1%) Scalp - (36.2%), Neck - (34.3%), Trunk - (29.5%), Hand - (21.0%) Upper extremities - (20.0%). 68 (64.8%) - contact dermatitis only on direct contact site such as the face, scalp or neck. 37 patients (35.2%) - at both a direct and an indirect contact site.	Formaldehyde – 9 patients Fragrance mix – 8 patients Peru balsam – 7 patients Paraben mix – 7 patients Others: “Imidazolidinyl urea, neomycin sulfate, colophony, thimerosal, mercapto mix, quanterium-15, lanolin alcohol, captan, 2-mercaptobenzothiazole, tixocortol-21-pivalate” Forty-four patients (41.9%) showed a weak positive result, 44 patients (41.9%) showed a strong positive result and 17 patients (16.2%) showed an extreme positive result in the patch test with PPD.

Hyun-Joo Lee et al.[11] (27 patients)			20 (87.0%) patients had a positive patch test reaction to at least one product. Four (26.7%) hair dyes contained para-phenylenediamine, 10 (66.7%) of 15 contained m-aminophenol and seven (46.7%) contained toluene-2,5-diamine sulfate.
Erin M. Warshaw et al.[12] (38,775 individuals)	Most were women (84.2%), 40 years old (75.6%)	Anatomic sites involved included: Face (36.6%), Hands (24.9%), Scattered-generalized (18.9%) Occupational cases - also involved hands and arms	PPD patch testing done Most reactions were 2+/3+

Strengths of the study:

1. Specific hair dresser series was used
2. Various dermoscopic patterns observed with usage of hair dyes have been described

Limitations of the study:

1. Histopathological examination was not done
2. Some of the allergens were not patch tested due to unavailability

Conclusion:

There is a rampant increase in usage of hair-dyes among general population. Most of the patients presented to hospital only after the pigmentation was more visible and bothersome after prolonged periods of usage of hair-dyes. There is paucity of studies showing the various dermoscopic patterns observed with pigmentation caused by hair-dyes which have been described in this study. Patch testing with hair dresser series can be advised to patients before usage of hair-dyes to avoid pigmentation and other side effects. This helps in identifying the allergen.

1. The allergic contact dermatitis is most common and well studied side effect of hair dye. But the pigmentary contact dermatitis seen in hair dye users is mostly neglected and not well studied. This study proves that this pattern of pigmentation in hair dye users is unique.

References:

1. Patel D, Narayana S, Krishnaswamy B. Trends in use of hair dye: a cross-sectional study. Int J Trichology 2013; 5:140-3.
2. Symanzik C, Johansen JD, Weinert P, Babić Ž, Hallmann S, Havmose MS, Kezic S, Macan M, Macan J, Strahwald J, Turk R, van der Molen HF, John SM, Uter W. Differences between hairdressers and consumers in skin exposure to hair cosmetic products: A review. Contact Dermatitis. 2022 May;86(5):333-343.
3. Gupta M, Mahajan VK, Mehta KS, Chauhan PS. Hair dye dermatitis and p-phenylenediamine contact sensitivity: A preliminary report. Indian Dermatol Online J 2015;6:241–5

4. Sharma VK, Gupta V, Pahadiya P, Vedi KK, Arava S, Ramam M. Dermoscopy and patch testing in patients with lichen planus pigmentosus on face: A cross-sectional observational study in fifty Indian patients.Ind J Dermatol Venereol Leprol 2017;83:656–62
5. Han JH, Lee HJ, Bang CH, Lee JH, Park YM, Lee JY. P-Phenylenediamine Hair Dye Allergy and Its Clinical Characteristics. Ann Dermatol. 2018 Jun;30(3):316-321.
6. Vinay K, Ankad B. Dermatoscopic features of pigmentary diseases in ethnic skin. Indian Dermatology Online Journal. 2021;12(1):24.
7. Meghana V, Gopinath H, Karthikeyan K, Venugopal V. Face and Neck Pigmentary Alterations in Hair Dye Users: A Cross-sectional Study from South India. Indian Dermatol Online J. 2020 Sep 19;11(5):760-765.
8. Shenoi SD, Rao R. Pigmented contact dermatitis. Ind J Dermatol Venereol Leprol. 2007;73:285–7.
9. Bishnoi, A., Vinay, K., Arshdeep, Parsad, D., Handa, S., Saikia, U.N. and Sendhil Kumaran, M. (2019), Contact sensitization to hair colours in acquired dermal macular hyperpigmentation: results from a patch and photo-patch test study of 108 patients. J Eur Acad Dermatol Venereol, 33: 1349-1357.
10. Han JH, Lee HJ, Bang CH, Lee JH, Park YM, Lee JY. P-Phenylenediamine Hair Dye Allergy and Its Clinical Characteristics. Ann Dermatol. 2018 Jun;30(3):316-321.
11. Lee HJ, Kim WJ, Kim JY, Kim HS, Kim BS, Kim MB, Ko HC.Patch tests with commercial hair dye products in patients with allergic contact dermatitis to para-phenylenediamine. Indian J Dermatol Venereol Leprol 2016;82:645-650.
12. Warshaw EM, Kullberg SA, Atwater AR, DeKoven JG, Silverberg JI, Belsito DV, Fowler JF Jr, Fransway AF, DeLeo VA, Maibach HI, Zug KA, Reeder MJ, Taylor JS, Sasseville D, Pratt MD. Currently relevant p-phenylenediamine patch test reactions associated with hair dye and nonscalp anatomic areas: Retrospective cross-sectional analysis of North American Contact Dermatitis Group data, 2001 to 2016. J Am Acad Dermatol. 2021 Mar;84(3):e175-e177.