Effects Of Chemical Treatments On The Hair Shaft And Scalp – A Clinico Epidemological Study

Shiva Saadhvi[1], Rajashekar Talari Srinivas[1], Suresh Kumar Kuppuswamy[1], Hanumanthayya Keloji[1], Vaishnavi Bindumalyam Venkatesh[1], Madhu Kiran Chandrashekar[1].

[1]Department of Dermatology Venereology and Leprosy, Sri Devaraj Urs Medical College, Kolar, Karnataka, India
[1]mshivasaadhvi@gmail.com; [2]yeshits@rediffmail.com; [3]s

***Corresponding Author:** Dr. Rajashekar Talari Srinivas
*Department of Dermatology Venereology and Leprosy, Sri Devaraj Urs Medical College, Kolar, Karnataka, India.Phone: (+91) 9448316136, Email: yeshits@rediffmail.com

KEYWORDS

Hair Straightening

Hair colouring

Perming

ABSTRACT

Background: The medulla, cortex, and cuticle are the three keratin-containing layers that make up the hair shaft. Cysteine residues are abundant in keratin proteins. Tightly bound disulphide bridges and other connections like Van der Waals, hydrogen, and salt bonds allow adjacent keratin chains to link.

Progressive or permanent chemical straightening, hair perming, or colouring can alter the shape and form of the hair shaft. In general, hair straightening affects the cuticles, hydrogen bonding, and the cortical amino acid tyrosine. It straightens hair by changing the shape of the disulphide bridges and creating a polymerised structure in the hair shaft, rather than breaking them.

The substances used in oxidative (permanent) and non-oxidative (semi-permanent and temporary) hair colourants differ greatly. As a result, different hair dyes have distinct ways of being manipulated. While permanent hair perming transforms straight hair into curly hair by breaking and reconstructing the hair disulphide bond, permanent hair dyes bleach and add a new colour to hair by penetrating tiny dye precursors into the cortex and then oxidising them.

Methodology: A Clinico-epidemiological study conducted to determine the efficacy of chemical treatments like hair straightening, colouring and perming of hair on the hair shaft and scalp on a total 114 subjects. They were evaluated based on detailed history and examination, including the type of chemical treatment, duration of the treatment and any adverse effects present over the hair scalp and shaft during or post the chemical treatment. The hair scalp and shaft was examined both clinically and dermoscopically. The side effects noted, clinical photographs were taken using Iphone 14 Pro max.
Statistical analysis- by co-guide software.
Results: In our study total of 116 participants, the most common chemical treatment undergone was hair colouring which was about 48.7% followed by hair straightening (39.8%) and perming in 12.4%. Females were more prevalent in our study constituting about 58.6%. All the chemical treatments had their own side effects, but dryness and hair fall were prevalent among all three groups. Dermoscopy changes like perifollicular scaling and black dots were most commonly seen in patients who had undergone hair straightening, whereas pigment deposition was seen more in patients who had coloured their hair and red dots were more seen in patients who permed their hair.
Conclusions: This analysis underscores the complex interactions between chemical hair treatments and their effects on the hair shaft and scalp. While these treatments offer aesthetic benefits, they can significantly impact hair integrity and scalp health, emphasizing the need for cautious application and proper aftercare. Enhanced understanding through clinical and dermoscopic evaluations allows for informed decisions regarding hair treatment practices, encouraging an approach that balances aesthetic desires with health considerations

INTRODUCTION

The human pursuit of beauty and self-expression has led to the widespread adoption of various hair treatments, creating a substantial market for products designed to alter hair appearance. Chemical treatments—namely hair straightening, colouring, and perming—occupy significant niches within

this industry. Each of these methods utilizes chemical agents to bring about changes in the hair's texture, colour, or shape, allowing individuals to achieve their desired look.[1]

However, these aesthetic benefits often accompany potential drawbacks. Chemical treatments can lead to structural damage to the hair shaft and impact scalp health. The chemicals used can weaken the hair, stripping it of its natural strength and moisture. Over time, repeated procedures can leave the hair brittle, more susceptible to damage, and potentially lead to scalp complications such as irritation or allergic reactions.[1]

This study reviews each treatment method in detail, utilizing clinical observations and dermoscopic evaluations. The blend of these approaches facilitates a holistic understanding of the chemical effects on hair and scalp. Clinically, the focus is on the visible and tactile changes to the hair and scalp condition. Meanwhile, dermoscopy—a magnification technique used primarily in dermatology for examining skin and hair microstructures—provides in-depth insights into the finer details of hair and scalp morphology.

MATERIALS AND METHODS

Study Design

It is a Clinico epidemiological study conducted to determine the efficacy of chemical treatments like hair straightening, colouring and perming of hair on the hair shaft and scalp.

Patient Selection

In this Clinico epidemiological study, Any patient with history of chemical treatment of their hair like straightening, colouring or perming within the span of 1 year attending the Department of Dermatology, Venereology and Leprosy in RL Jalappa Hospital and Research Centre were evaluated based on detailed history and examination, including the type of chemical treatment ,duration of the treatment and any adverse effects present over the hair scalp and shaft during or post the chemical treatment. The hair scalp and shaft examined both clinically and dermascopically. The side effects noted, serial photographs at baseline (first visit), 3 months and 6 months were taken using Iphone 14 Pro max. Patients less than 18 years of age and those who refused to give consent were excluded from the study. The institutional ethical committee approved the study (Reference No: SDUAHER/KLR/R&D/CEC/S/P00/2/2024-25), and before clinical examination and photographs, written informed consent was taken from all patients with their signatures. All patients fulfilling the inclusion criteria were assessed for the same.

STATISTICAL ANALYSIS

Based on survey of previous literature for an outcome variable on higher frequency of hair straitening in treated group in comparison with control, with minimum difference of 12% improvement (JN Hatsbatch…) table to attain significance at type I error (α error) of at least 5%, Type II error(β error) at 10% and keeping statistical power above 90%, the sample size of 114 is adequate for single group assessment clinical study after adjusting for, non responders and withdrawals

Statistical methods

Chi-Square test, Fisher exact test, student t test or any other suitable method at the time of data analysis

RESULTS

Out of total, 58.4% were females and 41.6% were males

Distribution according to Type of Treatment

The most common type of treatment was hair colouring (47.8%) followed by straightening (39.8%) and perming (12.4%)

Table 1:Distribution according to history

History	Frequency	Percentage
Dryness	100	88.5 %
Itching	80	70.8 %
hair fall	100	88.5 %

The higher prevalence of dryness and hair fall (88.5%) suggests that these are the dominant concerns in the patient history, with itching (70.8%) also affecting a significant portion of the group.

Table 2: Distribution according to clinical examination

Clinical examination	Frequency	Percentage
Eczema	36	31.9 %
Alopecia	40	35.4 %
Cicatricial alopecia	10	8.8 %
Breakage	44	38.9 %

Out of total, 36 (31.9%) were observed with eczema, 40 (35.4%) had alopecia, 26 (23.0%) exhibited colour changes in their skin or hair,10 (8.8%) was diagnosed with cicatricial alopecia and 44 (38.9%) presented with hair breakage. Overall, hair breakage and alopecia are the most common clinical findings in this group, followed by eczema and colour change, with cicatricial alopecia being the least common.

Table 3: Distribution according to Dermoscopy finding

Dermoscopy	Frequency	Percentage
Yellow area	24	21.2 %
Black dot	22	19.5 %
Perifollicular scaling	47	41.6 %
Perifollicular erythema	18	15.9%
empty areas	17	15.0 %
pigment changes	23	20.4%
Dilated blood vessels	14	12.4 %

Perifollicular scaling (41.6%) is the most prevalent finding, followed by yellow areas (21.2%), pigment changes (20.4%) and black dots (19.5%). These dermoscopic features provide insights into the underlying conditions affecting the scalp and hair.

Table 4: Association of reaction with study variables

		Type of reaction			Test statistic	P value
		Hair colouring (n=54)	Perming (n=14)	Straightening (n=45)		
Gender	Female	22(19.5)	13(11.5)	31(27.4)	15.812	0.0001*
	Male	32(28.3)	1(0.9)	14(12.4)		
History						
Dryness	Positive	47(41.6)	12(10.6)	41(36.3)	0.522	0.770
	Negative	7(6.2)	2(1.8)	4(3.5)		
Itching	Positive	47(41.6)	11(9.7)	22(19.5)	17.744	0.0001*

	Negative	7(6.2)	3(2.7)	23(20.4)		
hair fall	Positive	48(42.5)	11(9.7)	41(36.3)	1.665	0.463
	Negative	6(5.3)	3(2.7)	4(3.5)		
Clinical examination						
Eczema	Positive	23(20.4)	5(4.4)	8(7.1)	7.072	0.029*
	Negative	31(27.4)	9(8.0)	37(32.7)		
Alopecia	Positive	6(5.3)	10(8.8)	24(21.4)	28.207	0.0001*
	Negative	48(42.5)	4(3.5)	21(18.6)		
Colour change	Positive	14(12.4)	3(2.7)	9(8.0)	0.509	0.861
	Negative	40(35.4)	11(9.7)	36(31.9)		
Cicatricial alopecia	Positive	1(0.9)	1(0.9)	8(7.1)	7.779	0.017*
	Negative	53(46.9)	13(11.5)	37(32.7)		
Breakage	Positive	13(11.5)	6(5.3)	25(22.1)	10.335	0.006*
	Negative	41(36.3)	8(7.1)	20(17.7)		
Dermascopy						
Yellow area	Positive	11(9.7)	3(2.7)	10(8.8)	0.051	0.975
	Negative	43(38.1)	11(9.7)	35(31.0)		
Black dot	Positive	0	0	22(19.5)	41.282	0.0001*
	Negative	54(47.8)	14(12.4)	23(20.4)		
Perifollicular scaling	Positive	19(16.8)	5(4.4)	23(20.4)	2.790	0.281
	Negative	35(31.0)	9(8.0)	22(19.5)		
Perifollicular erythema	Positive	0	6(5.3)	12(10.6)	21.686	0.0001*
	Negative	54(47.8)	8(5.3)	33(29.2)		
empty areas	Positive	0	0	17(15.0)	30.238	0.0001*
	Negative	54(47.8)	14(12.4)	28(24.8)		
pigment changes	Positive	22(19.5)	0	1(0.9)	26.548	0.0001*
	Negative	32(28.3)	14(12.4)	44(38.90		
Dilated blood vessels	Positive	6(5.3)	0	8(7.1)	3.264	0.195
	Negative	48(42.5)	14(12.4)	37(32.7)		

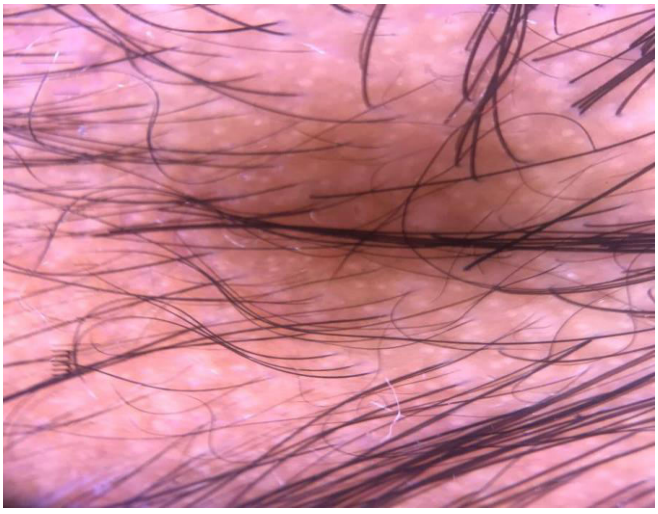
SERIAL PHOTOGRAPHS OF A PATIENT WHO UNDERWENT PERMANENT HAIR COLOURING- SHOWING PROGRESSIVE THINNING OF THE HAIR

AT FIRST VISIT

AT 3 MONTHS

AT 6 MONTHS

DERMOSCOPIC PICTURE DEPICTING PIGMENTORY CHANGE ON A PATIENT WHO RECEIVED CHEMICAL HAIR COLOURING



SERIAL PHOTOGRAPHS OF A PATIENT WHO UNDERWENT CHEMICAL HAIR PERMING SHOWING INCREASED HAIR FALL

AT BASELINE

AT 3 MONTHS

AT 6 MONTHS

DERMOSCOPIC PICTURE DEPICTING PERIFOLLICULAR SCALING ON A PATIENT WHO RECEIVED CHEMICAL HAIR PERMING

SERIAL PHOTOGRAPHS OF A PATIENT WHO UNDERWENT CHEMICAL HAIR STARIGHTENING SHOWING INCREASES FRIZZINESS OF HAIR

AT BASELINE

AT 3 MONTHS

AT 6 MONTHS

DERMOSCOPIC PICTURE DEPICTING WHITE DOTS ON A PATIENT WHO RECEIVED CHEMICAL HAIR STRAIGHTENING

DISCUSSION

Chemical treatments such as hair straightening, colouring, and perming are popular cosmetic procedures aimed at altering hair appearance to enhance aesthetic appeal. Despite their popularity, these treatments entail various chemical processes that can potentially impair hair shaft integrity and scalp health. This study focuses on evaluating these impacts both clinically and dermoscopically, offering a dual perspective that combines visual examination and magnified skin analysis. Understanding these effects can inform safer hair care practices and highlight potential risks associated with frequent chemical exposure.

In our study out of total 114 subjects, 58.4% were females and 41.6% were males. The most common type of chemical treatment done by our study subjects was hair colouring (47.8%) followed by straightening (39.8%) and least being perming (12.4%).
Hair straightening is typically achieved through treatments that break the hair's natural disulfide bonds, allowing it to reform in a straight configuration. Common straightening products contain chemicals such as formaldehyde, ammonium thioglycolate, or sodium hydroxide.[2]
On hair shaft Clinically, hair that has undergone chemical straightening appears smoother but is often more prone to breakage. The chemicals alter the fiber structure, leading to a reduction in tensile strength. Hair may become dry, lack elasticity, and be more susceptible to split ends.[3]In this study most common side effects noted were increased hair loss which was seen in almost all patients, followed by dryness in 41 patients (95%) and itching in about 23 patients(51%) which was similar to a study conducted by Shetty et al where the most common side effects noted was dryness in about 90% of patients followed by hairloss.[4]
The application of strong chemicals near the scalp can lead to potential irritation. Some individuals experience redness, itching, or in extreme cases, chemical burns. Scalp hydrolipidic film might also be disrupted, which impacts skin barrier function.[5]
Under dermoscopy, the cuticle layer appears damaged, with possible areas of thinning or stripped sections, depending on the treatment's harshness. This observation highlights the vulnerability of the hair to further mechanical stress or environmental damage post-treatment. The most common finding noted with hair straightening were perifollicular scaling, black dots due to remnants of hair shaft and empty hair follicles in about 22 (48%) ,21 (46%) and 17 (31%) patients respectively which was not similar to the study conducted by Kaliyadan et al, where yellow areas indicated an early change due to straightening.
Scalp resolution sowed some rare findings like dilation of blood vessels due to irritation in about 8 (17%) patients, yellow dots in 10 (22%) patients and one patient noted pigmentary change.

Colour treatments involve either depositing or removing pigment in the hair shaft. This is done through oxidative dyes, bleaching agents, or non-oxidative temporary colours. Coloured hair often becomes less smooth, feeling coarser to the touch due to the lifted cuticle scales required for colour penetration. The use of hydrogen peroxide in bleach can remove natural pigments and moisture from the hair, exacerbating dryness and increasing porosity. The scalp can react to colouring agents, especially if they contain high levels of ammonia or bleaching agents. Most common Symptoms noted in our study were dryness, itching and hair fall seen in about 87%, 87% and 88% respectively. Palaniappan et al conducted a study where dermatological adverse effects of hair dye use was studied which sowed similar results as our study, where the most common effects were itching, hair loss and pigment changes.[7] Clinically due to irritation caused by the dyes ,23 patients developed eczematous changes, and 15 patients developed colour change due to the bleaching agents and aggravation of alopecia was seen in 6 patients which was similar to a study by Neetu et al.

The dermoscopic evaluation might showed pigmentation changes, with colour particles embedded in the hair shaft. Continual dying exacerbated cuticle damage, with more pronounced fragmentation observed in bleached hair.[8]Sensitive scalps also showed signs of redness around hair follicles due to inflammation, and scaling can occur in response to irritant substances. In our study the most prominent changes in seen were perifollicular scaling in 38% of patients and 37% patients had pigmentary changes.

Perming treatments chemically alter hair structure, enabling curly or wavy formations. It fundamentally changes the cystine content in the hair to achieve desired curls or waves. Chemically permed hair often appears frizzy with increased fragility. The structural changes make it prone to mechanical damage like brushing or environmental factors such as humidity. Over time, this could

lead to significant weakening of the hair shaft. If applied carelessly, perm solutions can lead to scalp discomfort, manifesting as itching or irritation. The chemicals can also affect scalp pH balance, potentially disrupting natural oil production and barrier function.[9,10] About 80 % of the patients had dryness and 73% of the patients observed itching and hairfall,33% of the patient noticed eczematous changes secondary to permingthat were similar in a study conducted by Barreto et al in which permanent hair waving was studied, where dryness, alopecia and eczematous changes were most common.[11]

When observed dermoscopically, permed hair shows irregular surface textures with micro-fissures in the cuticle. This aberration increases the hair's susceptibility to external damage and further chemical treatment adversities. [12] Scalp observation can revealerythema in 40% of the subjectsand desquamation in 33% due to chemical exposure.

The higher prevalence of dryness and hair fall (88.5%) suggests that these are the dominant concerns in the patient history, with itching (70.8%) also affecting a significant portion of the subjects in all groups.

Out of total, 36 (31.9%) were observed with eczema, 40 (35.4%) had alopecia, 26 (23.0%) exhibited colour changes in their skin or hair,10 (8.8%) was diagnosed with cicatricial alopecia and 44 (38.9%) presented with hair breakage. Overall, hair breakage and alopecia are the most common clinical findings in all group, followed by eczema and colour change, with cicatricial alopecia being the least common.

Perifollicular scaling (41.6%) is the most prevalent finding, followed by yellow areas (21.2%), pigment changes (20.4%) and black dots (19.5%). These Dermoscopic features provide insights into the underlying conditions affecting the scalp and hair

CONCLUSION

This analysis underscores the complex interactions between chemical hair treatments and their effects on the hair shaft and scalp. While these treatments offer aesthetic benefits, they can significantly impact hair integrity and scalp health, emphasizing the need for cautious application and proper aftercare. Enhanced understanding through clinical and dermoscopic evaluations allows for informed decisions regarding hair treatment practices, encouraging an approach that balances aesthetic desires with health considerations.

Protective measures and treatments, such as conditioning and use of hair masks, can mitigate some harmful effects. Future research direction includes developing products that offer aesthetic benefits with fewer adverse outcomes and exploring innovative solutions for repairing chemically treated hair.

Given the prevalence of these treatments, it is crucial to disseminate information about potential risks and safe practices, promoting informed choices among consumers and professionals alike.

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