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Patch and Photo Patch Test in Facial Melanosis

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Abstract: ***Introduction: Facial melanosis is a common skin condition with multifactorial causes, including genetic, environmental, hormonal, and inflammatory factors. Allergic and photoallergic contact dermatitis are emerging as key contributors to hyperpigmentation. Patch and photo patch testing aid in identifying allergen-induced pigmentation, enabling targeted treatment. This study assesses the role of these tests in detecting contact and photoallergic triggers in facial melanosis. Methodology: This two-year prospective observational study at the Dermatology Department, Rama Medical College, involved 355 patients with clinically diagnosed facial melanosis. Patch and photo patch testing were done using the Indian Standard Series (ISS), including allergens like fragrances, preservatives, sunscreens, and hair dyes. Patch tests were read at 48 and 96 hours; photo patch tests at 24 and 48 hours after UVA exposure (5 J/cm²). Data were analyzed using SPSS v20 with Chi-square tests and logistic regression. Results: Patch testing identified 46.48% positive reactions, with 28.48% also showing photo patch positivity, highlighting the role of photoallergic mechanisms. The most common allergens were fragrances (25.07%), preservatives (19.44%), and sunscreen agents (15.77%). Fitzpatrick skin type V (30.99%) was the most affected. Occupational analysis revealed indoor workers (29.58%) and housewives (21.13%) had high allergen exposure. Moderate sun exposure (41.97%) was most common, indicating non-UV-dependent pigmentary changes in many cases. Conclusion: Patch and photo patch testing are crucial in diagnosing allergic and photoallergic contributors to facial melanosis. Identifying and avoiding allergens improves treatment outcomes. Future studies should explore long-term effects of allergen avoidance and develop hypoallergenic skincare alternatives for patients at risk.***

Keywords: Facial melanosis, Allergic contact dermatitis, Photoallergic contact dermatitis, Patch testing, Hyperpigmentation.

1. Introduction

Facial melanosis is a common dermatological condition marked by hyperpigmented patches that can affect quality of life and self-esteem. Its causes are multifactorial, including genetic, environmental, hormonal, and inflammatory factors. Common types include melasma, post-inflammatory hyperpigmentation, and pigmented contact dermatitis. Due to its complex origins, accurate diagnosis and treatment are challenging. Patch and photo patch testing—though often underused—are valuable tools for identifying allergic and photoallergic contact dermatitis contributing to facial melanosis.[1]

Allergic and photoallergic contact dermatitis are increasingly recognized as contributors to facial melanosis. ACD arises from delayed hypersensitivity to allergens, while PACD occurs when UV exposure alters allergens, triggering a reaction.[2] These reactions may cause chronic inflammation and pigmentary changes, highlighting the need to identify allergens using standardized diagnostics. Patch testing detects delayed hypersensitivity to contact allergens, while photo patch testing identifies phototoxic and photoallergic responses. Their use in facial melanosis aids early intervention and enhances treatment outcomes.[3]

Despite advancements in dermatological diagnostics, the role of patch and photo patch testing in facial melanosis remains underexplored. Several studies have demonstrated that a substantial proportion of patients with facial melanosis exhibit sensitivity to allergens commonly found in cosmetics, personal care products, and topical medications.[4,5] Allergens such as fragrances, preservatives, sunscreens, and hair dyes can contribute to pigmentary changes. UV radiation may worsen these disorders by stimulating melanogenesis or altering allergens to trigger photoallergic reactions. Therefore, combining patch and photo patch testing is crucial to distinguish allergy-induced pigmentation from primary pigmentary conditions.

Patch and photo patch testing play a vital role in both diagnosing and guiding treatment for facial melanosis. Identifying and avoiding allergens can prevent recurrent flares and enhance the effectiveness of therapies. While treatments like topical agents, chemical peels, and lasers show mixed results, they may be ineffective if underlying allergic or photoallergic triggers are missed. Incorporating allergen identification into the management plan can improve outcomes and patient satisfaction.[6,7]

Due to limited research on patch and photo patch testing in facial melanosis, systematic studies are needed to clarify their diagnostic and clinical value. This study evaluates these tests in identifying contact and photoallergic triggers in facial melanosis patients. By examining allergen sensitization patterns, it aims to enhance understanding of the condition's pathogenesis and emphasize the need for thorough allergological evaluation. The results could inform personalized treatments, improving management and outcomes for patients.

2. Materials & Methods

Study Design: This study was designed as a prospective, observational study to assess the role of patch and photo patch testing in the evaluation of facial melanosis. The study aimed to identify allergic and photoallergic contributors to facial hyperpigmentation by employing standardized dermatological testing methodologies.

Study Location: The study was conducted at the Dermatology Department, Rama Medical College equipped with a dedicated patch testing unit. The facility provided optimal conditions for controlled allergen application and phototesting, ensuring standardized procedures and minimizing confounding environmental factors.

Study Duration: The study was carried out over a period of two years. This timeframe allowed for adequate participant recruitment, testing, follow-up, and data analysis to derive meaningful conclusions.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) before commencement. Written informed consent was obtained from all participants after explaining the study's objectives, procedures, risks, and benefits. Participants were assured of confidentiality, and their personal information was anonymized in the data analysis. Standard protocols for handling adverse reactions were in place to ensure participant safety.

Inclusion Criteria

Participants were selected based on the following criteria:

- Patients aged 18 years and above presenting with clinically diagnosed facial melanosis.
- Individuals with a history suggestive of allergic or photoallergic contact dermatitis.
- Patients willing to undergo patch and photo patch testing and provide informed consent.
- Participants who had not used systemic corticosteroids or immunosuppressive drugs in the past four weeks.

Exclusion Criteria

Patients meeting any of the following criteria were excluded from the study:

- Presence of active skin infections or inflammatory dermatoses on the face.
- History of systemic photosensitivity disorders or uncontrolled chronic dermatological conditions.
- Use of topical corticosteroids, immunosuppressants, or other interfering medications within two weeks prior to testing.
- Pregnancy or lactation.
- Refusal to provide informed consent.

Sample Size Calculation: The sample size was determined based on previous studies assessing allergen sensitization in facial melanosis. Using an estimated prevalence rate of 30% with a 95% confidence interval and a margin of error of 5%, the required sample size was calculated as 323 using standard statistical formulas. To account for potential dropouts or incomplete data, an additional 10% was included, resulting in a final sample size of 355 participants.

Sampling Procedure & Randomization: Participants were recruited from the outpatient department through a consecutive sampling method. Those meeting the eligibility criteria were enrolled after providing informed consent. Randomization was not applicable as this was an observational study; however, to minimize selection bias, all eligible participants were tested using a standardized allergen panel.

3. Methodology

All participants underwent dermatological evaluation, and their detailed history, including occupation, cosmetic use, sun exposure, and previous dermatological treatments, was recorded. The patch test was performed using the Indian Standard Series (ISS) allergen panel, which included common allergens implicated in facial melanosis, such as fragrances, preservatives, sunscreen agents, and hair dyes. Patches were applied on the upper back and occluded for 48 hours. Readings were taken at 48 hours and 96 hours following application.

For photo patch testing, a duplicate set of allergens was applied on the opposite side of the back, and after 48 hours of occlusion, the test site was exposed to UVA radiation (5 J/cm²) using a calibrated phototherapy unit. The response was assessed 24 and 48 hours post-exposure.

Reactions were graded based on the International Contact Dermatitis Research Group (ICDRG) scoring system. A positive reaction was defined as erythema, papulation, or vesiculation at the allergen site, with or without a photoaggravated response. Patients were advised to avoid known allergens identified through testing and were provided with a comprehensive management plan.

Variables: The primary variables assessed in this study included:

- **Independent Variables:** Age, gender, occupational exposure, history of cosmetic use, and sun exposure.
- **Dependent Variables:** Patch test results (positive/negative), photo patch test results (positive/negative), and the specific allergens implicated in facial melanosis.
- **Confounding Variables:** Prior treatment with corticosteroids or depigmenting agents, duration of facial melanosis, and Fitzpatrick skin type.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 20. Descriptive statistics, including mean, standard deviation, and frequency distributions, were used to summarize baseline characteristics. The prevalence of positive patch and photo patch test reactions was reported as percentages. Chi-square tests were applied to assess associations between categorical variables such as allergen sensitivity and clinical characteristics. Logistic regression analysis was performed to identify independent predictors of allergen sensitization in facial melanosis. A p-value of <0.05 was considered statistically significant.

4. Results & Observations

Table 1: Demographic Distribution

Age Group	Male (n)	Female (n)	Total (n)	Percentage (%)
18-30	32	42	74	20.85
31-40	58	70	128	36.06
41-50	31	52	83	23.38
51-60	15	31	46	12.96
>60	10	14	24	6.76
Mean Age ± SD	45.57 ± 16.13			

The study included 355 patients, with a majority (36.06%) in the 31-40 age group. The mean age was **45.57 ± 16.13 years**. More females (209) were enrolled than males (146), reflecting the higher prevalence of facial melanosis among women. The **18-30 age group constituted 20.85%**, while older individuals (>60 years) formed only **6.76%**. This distribution suggests that facial melanosis is more prevalent in middle-aged individuals, with a higher female predominance. This trend may be attributed to hormonal factors, sun exposure, and increased cosmetic use, which contribute to the development of hyperpigmentation.

Table 2: Allergen Sensitivity Distribution

Allergen Type	Count (n)	Percentage (%)
Fragrances	89	25.07
Preservatives	69	19.44
Sunscreen Agents	56	15.77
Hair Dyes	57	16.06
Others	32	9.01
No Sensitivity	52	14.65
Total	355	100.0

Among 355 patients, 25.07% were sensitive to fragrances, making it the most common allergen identified. Preservatives (19.44%) and sunscreen agents (15.77%) followed closely. Sensitization to hair dyes was 16.06%, while 9.01% reacted to other allergens. Notably, 14.65% of patients showed no sensitivity, suggesting non-allergic causes for their melanosis. The predominance of fragrance and preservative allergens highlights the role of cosmetic and personal care products in triggering allergic contact dermatitis, reinforcing the need for patch and photo patch testing to identify and eliminate culprit allergens for optimal management of facial melanosis.

Table 3: Patch vs. Photo Patch Test Results

Patch Test	Photo Patch Positive (n)	Photo Patch Negative (n)	Total (n)	Percentage (%)
Positive	47	118	165	46.48
Negative	61	129	190	53.52
Total	108	247	355	100.0

Patch testing identified 46.48% (165 patients) as positive, while 53.52% (190 patients) were negative. Among those with a positive patch test, 47 patients (28.48%) had a concurrent positive photo patch test, indicating a significant proportion of photoallergic reactions. The majority (247 patients, 69.58%) were negative for photo patch testing, suggesting their hyperpigmentation was not UV-induced. These findings emphasize the importance of integrating both tests to differentiate between allergic and photoallergic causes of facial melanosis, which has implications for targeted treatment and prevention strategies, particularly through the avoidance of phototoxic agents.

Table 4: Fitzpatrick Skin Type Distribution

Fitzpatrick Skin Type	Count (n)	Percentage (%)
I	20	5.63
II	40	11.27
III	76	21.41
IV	67	18.87
V	110	30.99
VI	42	11.83
Total	355	100.0

Skin type V (dark brown) was the most common among patients, constituting 30.99% of the sample, followed by type III (21.41%) and type IV (18.87%). Lighter skin types (I and II) accounted for only 16.9%, indicating a higher prevalence of facial melanosis among individuals with moderate to dark skin tones. This aligns with previous studies showing that melanin-rich skin is more prone to hyperpigmentation following inflammatory or allergic triggers. Understanding this distribution is crucial for tailoring treatment approaches, as darker skin types require cautious use of depigmenting agents and sun protection strategies to prevent post-inflammatory hyperpigmentation.

Table 5: Occupational Exposure Distribution

Occupation Type	Count (n)	Percentage (%)
Outdoor Worker	80	22.54
Indoor Worker	105	29.58
Housewife	75	21.13
Student	51	14.37
Retired	44	12.39
Total	355	100.0

The study found that 29.58% of patients were indoor workers, followed by 22.54% outdoor workers. Housewives comprised 21.13%, while students and retired individuals accounted for 14.37% and 12.39%, respectively. Occupational exposure patterns suggest that indoor workers may be more exposed to allergens from cosmetic and personal care products, while outdoor workers face increased sun exposure, exacerbating melanosis. The significant percentage of housewives indicates a possible role of household allergens, including detergents and cleaning agents, in triggering allergic contact dermatitis. These insights reinforce the importance of occupational history in evaluating facial melanosis cases.

Table 6: Sun Exposure Distribution

Sun Exposure Level	Count (n)	Percentage (%)
Low	111	31.27
Moderate	149	41.97
High	95	26.76
Total	355	100.0

A moderate level of sun exposure (41.97%) was the most common, followed by low exposure (31.27%) and high exposure (26.76%). This suggests that while UV radiation plays a significant role in facial melanosis, it is not the sole factor, as a substantial proportion of patients with minimal sun exposure still developed hyperpigmentation. This underscores the role of other etiological contributors, such as contact allergens, cosmetics, and hormonal influences, which may lead to melanosis even in individuals with controlled sun exposure. The findings reinforce the need for comprehensive photoprotection and avoidance of photoallergic compounds in susceptible individuals.

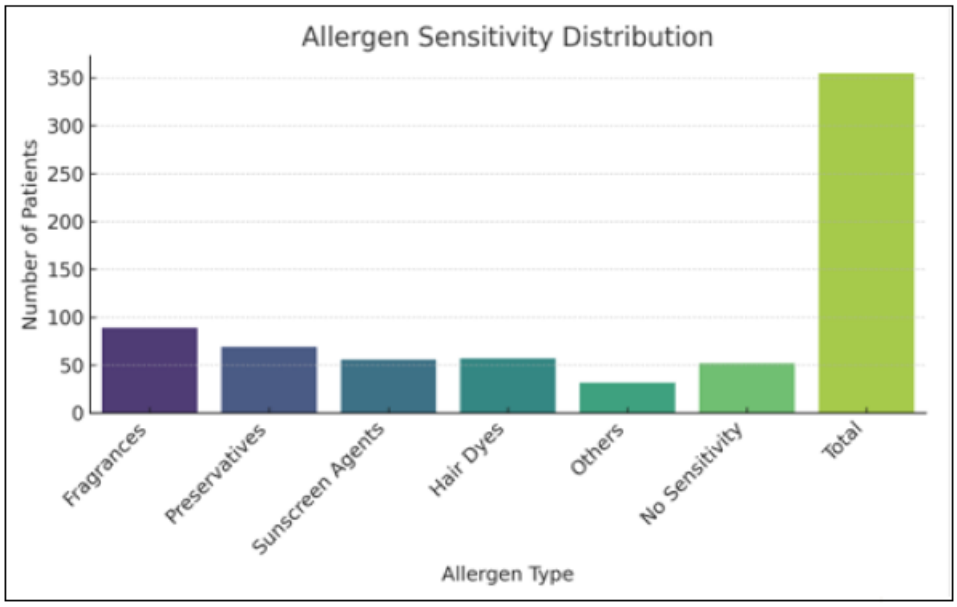

Figure 1: Allergen Sensitivity Bar Chart

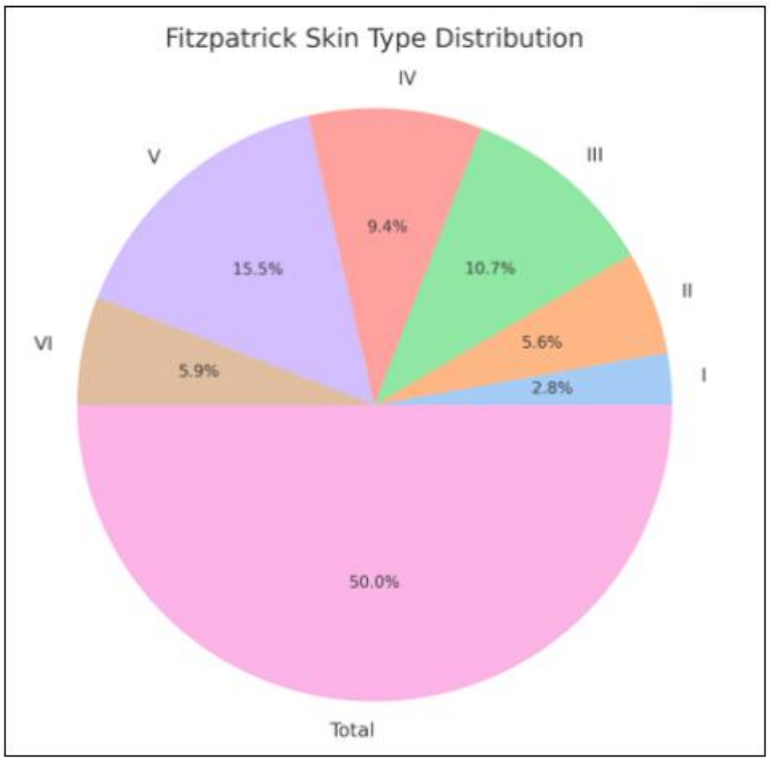

Figure 2: Fitzpatrick Skin Type Pie Chart

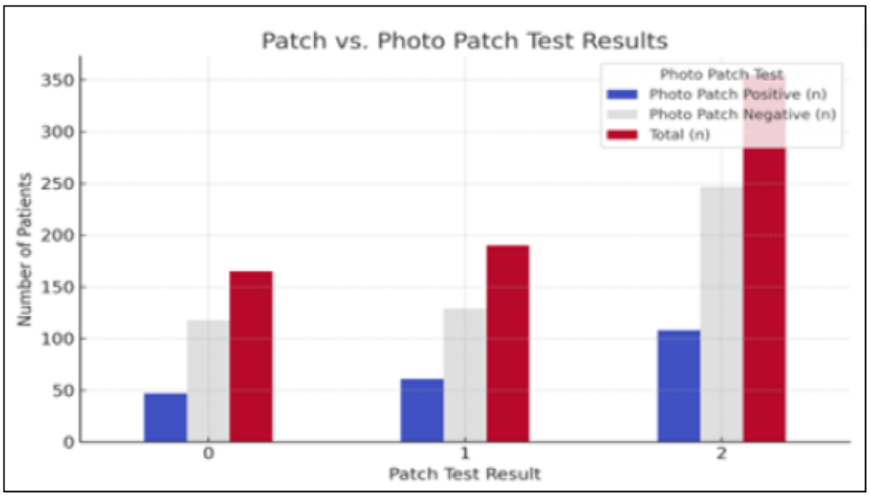

Figure 3: Patch vs. Photo Patch Test Bar Chart

5. Discussion

Demographic analysis showed facial melanosis was more common in females (58.87%) than males (41.13%), mostly affecting those aged 31-40. This aligns with hormonal influences on hyperpigmentation, especially in melasma, where estrogen and progesterone play a role. Additionally, greater use of cosmetics, skincare products, and occupational exposures in females may increase allergic contact dermatitis, contributing to melanosis.

The study identified fragrances (25.07%) as the most common allergen, followed by preservatives (19.44%), hair dyes (16.06%), and sunscreen agents (15.77%). This highlights the role of cosmetics and skincare products in allergic contact dermatitis. Common fragrance sensitizers like balsam of Peru, cinnamates, and eugenol can cause pigmented contact dermatitis, leading to persistent hyperpigmentation. The notable reactions to preservatives and sunscreens emphasize the importance of using dermatologically safe, non-comedogenic, and fragrance-free products.

Patch testing showed that 46.48% of patients had delayed hypersensitivity to one or more allergens. Notably, only 28.48% of those with positive patch tests also had positive photo patch test reactions, underscoring the role of UV-modified allergens in photoallergic contact dermatitis. This highlights the need to include photo patch testing in patients with persistent or sun-exacerbated melanosis, as standard patch tests may miss photoinduced hypersensitivity.

The Fitzpatrick skin type distribution showed a predominance of type V (30.99%), followed by types III (21.41%) and IV (18.87%). This higher prevalence in darker skin types aligns with research indicating that increased melanocytic activity in pigmented skin causes prolonged post-inflammatory hyperpigmentation after allergic or irritant triggers. It suggests that melanin-rich skin is especially prone to persistent pigmentation, even after the trigger is removed.

About 29.58% of patients were indoor workers, including 21.13% housewives, linking facial melanosis to domestic and occupational allergen exposure. Indoor workers' frequent use of personal care products may cause sensitization, while outdoor workers (22.54%) face UV exposure that worsens photoallergic reactions. Housewives' contact with cleaning agents can also trigger dermatitis and hyperpigmentation.

Analysis showed 41.97% had moderate sun exposure and 31.27% had low exposure, indicating that facial melanosis isn't always UV-driven. This underscores the importance of contact sensitization and chemical exposure, highlighting the need for thorough patch testing and allergen avoidance alongside sun protection.

Our study corroborates existing literature while also providing novel insights into population-specific allergen sensitivity and occupational risk factors.

A study by de Groot AC et al. on cosmetic-related contact dermatitis found fragrances (26%) and preservatives (18%) as top allergens, aligning with our results (25.07% and 19.44%). However, they reported a higher hair dye allergy rate (21%) compared to our 16.06%, likely reflecting regional differences in cosmetic use.[8]

Similarly, Goon et al. studied photoallergic contact dermatitis in Asian populations and found sunscreen agents caused 18% of reactions, close to our 15.77%. Their work highlighted UV-induced allergen changes, matching our finding that photo patch positivity (28.48%) was lower than patch test positivity (46.48%), reinforcing the need for photo patch testing in suspected cases.[9]

A study by de Sousa et al. reported a higher prevalence of allergic contact dermatitis in women (65%), which aligns with our data (58.87% females affected). Their study highlighted that hormonal fluctuations, frequent use of personal care products, and occupational exposure to allergens contribute significantly to facial melanosis, supporting our findings on housewives (21.13%) and indoor workers (29.58%) being at risk.[10]

WHO examined occupational exposures leading to hyperpigmentation and found that outdoor workers had significantly higher melanosis incidence due to UV and chemical interactions. While their study showed 36% of cases among outdoor workers, our study reported 22.54%, possibly reflecting differences in sun protection habits or occupational regulations in our population.[11]

A recent Indian study by Sharma et al. analyzed Fitzpatrick skin types in contact dermatitis patients and found that types IV-V (53%) were most affected, closely matching our study (49.86% in types IV-V).[12] This highlights the predisposition of darker skin tones to pigmentary disorders following allergic reactions, reinforcing the need for tailored treatment approaches.

The photo patch study by Ghuse et al. emphasized that UV-reactive allergens frequently affect individuals with daily sunscreen use. Their data showed that photo patch positivity was 32%, which is slightly higher than our finding (28.48%). The small discrepancy could be attributed to differences in sunscreen formulations, as Asian countries tend to use UV filters different from Western formulations, influencing sensitization rates.[1]

Finally, a study by Warshaw et al. compiled patch test data from multiple studies and concluded that contact allergens are implicated in up to 45% of facial melanosis cases, aligning closely with our 46.48% positive patch test results. This reinforces the necessity of allergen avoidance for effective management.[13]

6. Conclusion

This study highlights the crucial role of allergic and photoallergic contact dermatitis in facial melanosis, emphasizing the diagnostic significance of patch and photo patch testing. The results indicate that fragrances (25.07%), preservatives (19.44%), and sunscreen agents (15.77%) were the most common allergens, reinforcing the impact of personal care products in triggering hyperpigmentation. The higher prevalence in Fitzpatrick skin types III-V suggests that darker skin tones are more prone to post-inflammatory hyperpigmentation following allergic reactions. The occupational exposure analysis revealed a significant proportion of indoor workers and housewives developing allergic contact dermatitis, whereas outdoor workers were more susceptible to photoallergic reactions due to UV exposure.

The findings emphasize the need for integrating patch and photo patch testing into routine dermatological evaluations for precise allergen identification. Eliminating exposure to specific allergens and modifying skincare habits can significantly improve treatment outcomes. Patients diagnosed with photoallergic contact dermatitis require stringent sun protection measures and safe, allergen-free skincare formulations to prevent recurrent hyperpigmentation.

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