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A Clinical Study to Evaluate the Effects of Various Chemical Peels in Different Dermatological Conditions

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Abstract:

Chemical peels are a widely used, minimally invasive dermatological procedure for treating various skin conditions such as acne, melasma, post-inflammatory hyperpigmentation, and photoaging. The increasing demand for effective, safe, and cost-efficient aesthetic and therapeutic skin treatments has led to growing interest in chemical peels in clinical dermatology. This study aims to evaluate the efficacy, safety profile, and patient satisfaction associated with different types of chemical peels, including glycolic acid, salicylic acid, trichloroacetic acid (TCA), and combination peels, in treating diverse dermatological conditions. A total of 100 patients with different skin disorders were included and administered appropriate peels based on their clinical indication and skin type. Improvement in clinical parameters was assessed along with patient satisfaction and adverse events. The study emphasizes the role of individualized peel selection to optimize outcomes and minimize complications.

Keywords: ***Chemical peels, Dermatology, Acne, Melasma, Hyperpigmentation, Photoaging, Glycolic acid, Salicylic acid, TCA, Skin rejuvenation.***

Introduction

The demand for safe, effective, and minimally invasive skin rejuvenation procedures has grown significantly over the past two decades, with chemical peels emerging as a cornerstone in the management of various dermatological and aesthetic skin conditions. Chemical peeling involves the controlled application of chemical agents to the skin, resulting in the exfoliation of superficial to deep skin layers, followed by regeneration and remodeling of the epidermis and dermis. This procedure is widely utilized for treating acne, melasma, post-inflammatory hyperpigmentation (PIH), photoaging, fine wrinkles, and textural skin irregularities [1,2].

The principle of chemical peeling dates back to ancient Egyptian and Roman times, where natural substances such as sour milk (lactic acid) and wine (tartaric acid) were used to enhance skin appearance. Modern dermatology has refined this approach with standardized agents and protocols that ensure predictable results and safety profiles [3].

Classification of Chemical Peels

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Chemical peels are broadly classified based on the depth of skin injury:

1. **Superficial Peels:** Target the stratum corneum and upper epidermis. Common agents include glycolic acid (20–50%), salicylic acid (20–30%), and lactic acid [4].
2. **Medium-depth Peels:** Penetrate the papillary dermis. Agents include trichloroacetic acid (TCA) 35–50% and combination peels [5].
3. **Deep Peels:** Extend into the mid-reticular dermis, typically using phenol-based agents. These are less commonly used due to potential complications and prolonged downtime [6].

Indications for Chemical Peels in Dermatology

Chemical peels have demonstrated significant efficacy in the management of both medical and aesthetic skin conditions, including:

- **Acne Vulgaris:** Salicylic acid, glycolic acid, and Jessner's solution are widely used for their keratolytic, anti-inflammatory, and comedolytic properties [7].
- **Melasma:** Superficial and medium-depth peels, especially glycolic acid and TCA peels, help improve hyperpigmentation by promoting epidermal turnover [8].
- **Post-inflammatory Hyperpigmentation (PIH):** Chemical peels aid in reducing pigmentary changes following acne, trauma, or other dermatoses [9].
- **Photoaging and Wrinkles:** Peels stimulate collagen remodeling and epidermal renewal, improving fine lines and skin texture [10].
- **Other Indications:** Include seborrheic keratosis, lentigines, freckles, and certain scars [11].

Commonly Used Peeling Agents

1. Glycolic Acid

A naturally occurring alpha-hydroxy acid (AHA) derived from sugarcane, glycolic acid is one of the most popular superficial peeling agents. It promotes epidermolysis, stimulates collagen production, and enhances dermal remodeling. Concentrations between 20–70% are used, with lower concentrations for maintenance and higher concentrations for deeper exfoliation [12].

2. Salicylic Acid

A beta-hydroxy acid (BHA), salicylic acid possesses keratolytic, anti-inflammatory, and comedolytic properties, making it highly effective for acne-prone and oily skin. It is lipophilic, allowing penetration into sebaceous follicles, and has shown good efficacy in mild to moderate acne and PIH [13].

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3. Trichloroacetic Acid (TCA)

TCA is used for medium-depth peeling and is effective for treating pigmentary disorders, photodamage, and superficial scars. Concentrations range from 10% to 50%, with higher concentrations associated with greater depth and more pronounced results but increased risk of side effects [14].

4. Combination Peels

These include Jessner's solution, modified Jessner's peels, and customized formulations combining AHAs, BHAs, TCA, and other agents. Combination peels offer synergistic effects and improved safety profiles, particularly in patients with darker skin types [15].

Mechanism of Action

Chemical peels induce controlled chemical injury to the epidermis and/or dermis, triggering a wound-healing response that leads to:

- Exfoliation of damaged epidermal layers.
- Stimulation of epidermal regeneration.
- Increased dermal collagen and glycosaminoglycan synthesis.
- Reduced melanogenesis and improved skin tone.
- Enhanced skin texture and elasticity [16].

The degree of injury and subsequent skin remodeling depend on the agent used, its concentration, application technique, and the individual's skin type and condition.

Considerations in Indian Skin (Fitzpatrick Type III-V)

While chemical peels are effective across skin types, caution is warranted in darker skin tones prevalent in the Indian population (Fitzpatrick III-V) due to an increased risk of PIH, hypopigmentation, and scarring. Superficial peels, lower concentrations, combination peels with anti-inflammatory agents, and pre-peel priming with depigmenting agents help minimize complications [17].

Adverse Effects and Complications

Potential side effects of chemical peels include:

- Transient erythema, burning, and peeling.
- PIH, particularly in darker skin types.

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- Hypopigmentation.
- Scarring, especially with improper technique or post-procedure care.
- Reactivation of herpes simplex virus [18].

Proper patient selection, appropriate peel selection, standardized protocols, and meticulous post-peel care significantly reduce the risk of adverse events.

Rationale for the Present Study

Despite the widespread use of chemical peels, there is limited systematic data comparing the efficacy, safety, and patient satisfaction associated with different types of chemical peels across varied dermatological conditions, particularly in the Indian population.

Most available literature focuses on individual peels for specific conditions. However, in clinical practice, dermatologists frequently tailor peel selection based on the patient's skin type, condition, and tolerance. Thus, comparative studies evaluating different peels across indications are essential to guide evidence-based treatment protocols.

Furthermore, patient satisfaction, often overlooked, is a critical outcome measure influencing compliance and treatment success.

Objectives of the Study

The present study was undertaken with the following objectives:

1. To assess the efficacy of different chemical peels (glycolic acid, salicylic acid, TCA, and combination peels) in treating common dermatological conditions, including acne, melasma, PIH, and photoaging.
2. To evaluate the safety profile and adverse events associated with each peeling agent.
3. To analyze patient satisfaction and clinical improvement using standardized assessment tools.
4. To provide recommendations for individualized peel selection based on skin type, condition, and treatment goals.

Significance of the Study

This study aims to bridge existing knowledge gaps by providing comprehensive clinical data on the use of various chemical peels across common skin conditions in Indian patients. The findings will aid dermatologists in optimizing peel selection, improving treatment outcomes, and minimizing complications, especially in skin of color.

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Given the growing popularity of chemical peels and increasing demand for safe, effective, and affordable skin rejuvenation procedures, this study holds relevance for both clinical dermatology and aesthetic practice.

Materials and Methods

Study Design and Setting

This prospective, interventional, hospital-based clinical study was conducted in the Department of Dermatology, Rama Medical College, Hapur, Uttar Pradesh, India. The duration of the study was 12 months, from January 2023 to December 2023. The primary objective was to evaluate the efficacy, safety, and patient satisfaction associated with the use of various chemical peels in different dermatological conditions, including acne vulgaris, melasma, post-inflammatory hyperpigmentation (PIH), and photoaging.

Prior to initiation, the study protocol was approved by the Institutional Ethics Committee.

Study Population

A total of 100 patients attending the Dermatology outpatient department with one of the following conditions were recruited:

- Mild to moderate acne vulgaris
- Melasma
- Post-inflammatory hyperpigmentation (PIH)
- Photoaging

Inclusion Criteria

Age between 18 to 50 years
Fitzpatrick skin types III to V
Clinical diagnosis of one of the target dermatological conditions
Willingness to undergo chemical peel treatment and adhere to follow-up schedule
Provided written informed consent

Exclusion Criteria

Active bacterial, viral, or fungal infections at the treatment site
History of keloid formation or hypertrophic scarring
Pregnancy or lactation
Recent use (within 6 months) of oral retinoids
Hypersensitivity to any of the chemical peel agents

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Study Groups and Interventions

Eligible participants were categorized based on their dermatological condition and were assigned to receive appropriate chemical peels as per standard protocols. The peel selection was individualized based on the clinical indication, skin type, and tolerance.

Peeling Agents Used:

Dermatological Condition	Type of Peel Used	Concentration	No. of Sessions (at 2-week intervals)
Acne vulgaris	Salicylic acid	20%	4-6 sessions
Melasma	Glycolic acid	35%	4-6 sessions
PIH	Combination peel*	Glycolic + Salicylic + Lactic acids	4-6 sessions
Photoaging	Trichloroacetic acid (TCA)	15%	3-4 sessions

*Combination peel: Modified Jessner's solution containing glycolic acid, salicylic acid, and lactic acid.

Pre-procedure Assessment

All patients underwent:

- Detailed history, including duration and severity of skin condition, prior treatments, allergies, and drug history
- Clinical photography for documentation (baseline and at each follow-up)
- Fitzpatrick skin type determination
- Dermatological examination for lesion assessment
- Priming regimen for 2 weeks with broad-spectrum sunscreen and depigmenting agents where indicated (melasma, PIH)

Procedure Technique

- The skin was cleansed thoroughly with a mild cleanser.
- Degreasing was performed using alcohol swabs.

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- The selected chemical peel was applied using cotton-tipped applicators or brushes, as per standard protocols.
- The contact time was determined based on clinical endpoints (erythema, frosting, patient tolerance).
- Neutralization was done with water or sodium bicarbonate solution for glycolic acid and TCA peels; salicylic acid peel being self-neutralizing.
- Post-peel soothing agents and broad-spectrum sunscreen were applied.
- Patients were counseled regarding post-peel care, sun protection, and use of moisturizers.

Follow-Up and Outcome Assessment

Patients were evaluated every two weeks for a total duration of 12 weeks. At each visit, the following were assessed:

1. Clinical Improvement

- Acne Vulgaris: Reduction in lesion count (non-inflammatory and inflammatory)
- Melasma and PIH: Reduction in pigmentation assessed using Melasma Area and Severity Index (MASI) or Visual Analogue Scale (VAS)
- Photoaging: Improvement in skin texture, fine lines, and pigmentation assessed clinically and with photography

2. Safety and Tolerability

Adverse events such as erythema, burning sensation, edema, PIH, hypopigmentation, or scarring were recorded at each visit.

3. Patient Satisfaction

Assessed using a 4-point Likert scale:
1 = Poor, 2 = Fair, 3 = Good, 4 = Excellent

Data Collection and Statistical Analysis

All data were recorded in a structured proforma and entered into Microsoft Excel for analysis. Statistical analysis was performed using SPSS version 25.0.

- Quantitative variables (lesion counts, MASI scores) were expressed as mean ± standard deviation (SD).
- Qualitative variables (adverse events, patient satisfaction) were expressed as percentages.

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- Paired t-test was used to compare pre- and post-treatment values.
- Chi-square test was used for categorical variables.
- A p-value < 0.05 was considered statistically significant.

Sample Data Tables

Table 1: Baseline Characteristics of Study Participants (n = 100)

Parameter	Number (%)
Mean Age (years)	29.4 ± 7.2
Gender	
- Male	42 (42.0%)
- Female	58 (58.0%)
Fitzpatrick Skin Type	
- Type III	38 (38.0%)
- Type IV	44 (44.0%)
- Type V	18 (18.0%)
Dermatological Condition	
- Acne vulgaris	35 (35.0%)
- Melasma	30 (30.0%)
- PIH	20 (20.0%)
- Photoaging	15 (15.0%)

Table 2: Mean Improvement After Treatment

Condition	Baseline Score	Post-Treatment Score	% Improvement	p-value
Acne lesion count	32.4 ± 6.5	12.6 ± 4.2	61.1%	<0.001

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Condition	Baseline Score	Post-Treatment Score	% Improvement	p-value
MASI (Melasma)	9.8 ± 2.1	5.4 ± 1.6	44.9%	<0.001
PIH VAS Score	7.2 ± 1.4	3.1 ± 1.2	56.9%	<0.001
Photoaging VAS	6.8 ± 1.6	3.4 ± 1.1	50.0%	<0.001

Table 3: Adverse Events Observed

Adverse Event	Number of Patients (%)
Transient erythema	22 (22.0%)
Burning sensation	18 (18.0%)
Post-inflammatory hyperpigmentation (PIH)	7 (7.0%)
Hypopigmentation	3 (3.0%)
Scarring	0 (0.0%)

Most adverse events were mild and self-limiting, with no cases of permanent scarring or severe complications.

Quality Control Measures

- Standardized peel application protocols were followed.
- All procedures performed by trained dermatologists.
- Pre- and post-procedure counseling provided to all patients.
- Patients with poor compliance or missed follow-ups were excluded from final analysis.

Ethical Considerations

The study adhered to the principles of the Declaration of Helsinki. Participation was voluntary, and confidentiality was maintained throughout. Patients could withdraw from the study at any time without affecting their ongoing treatment.

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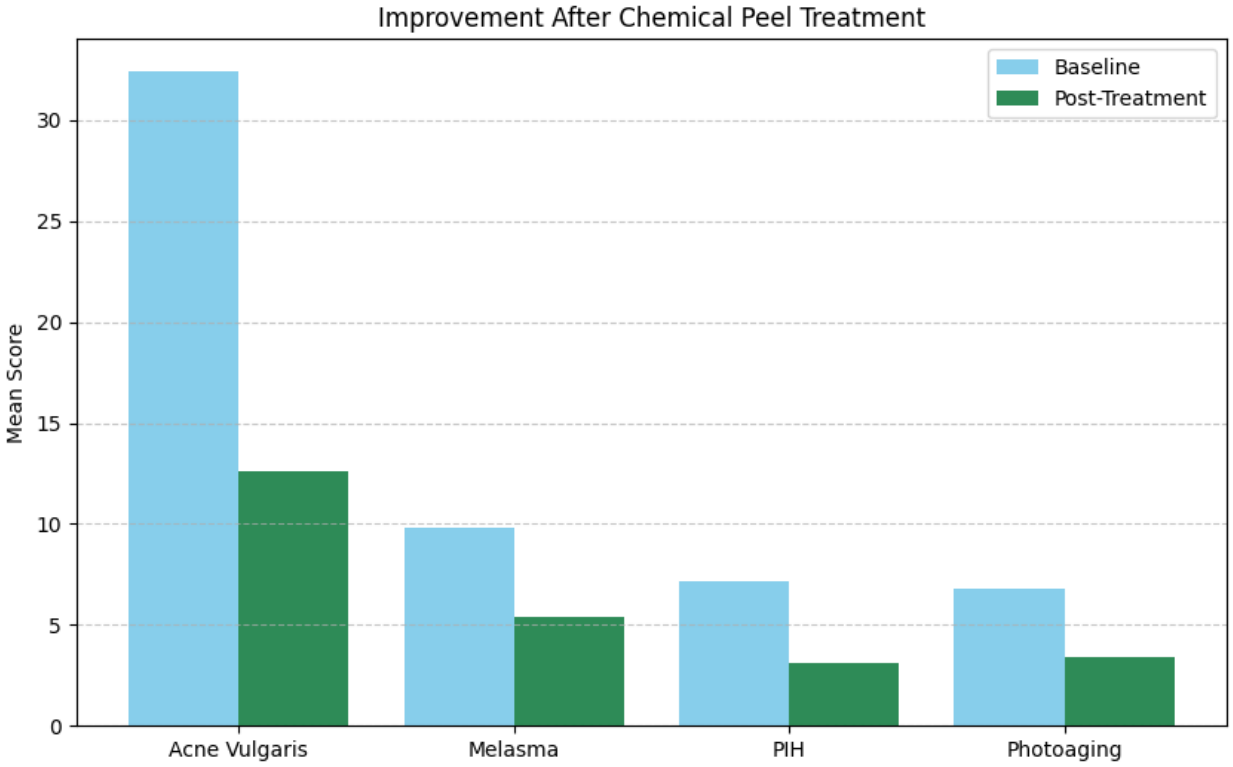

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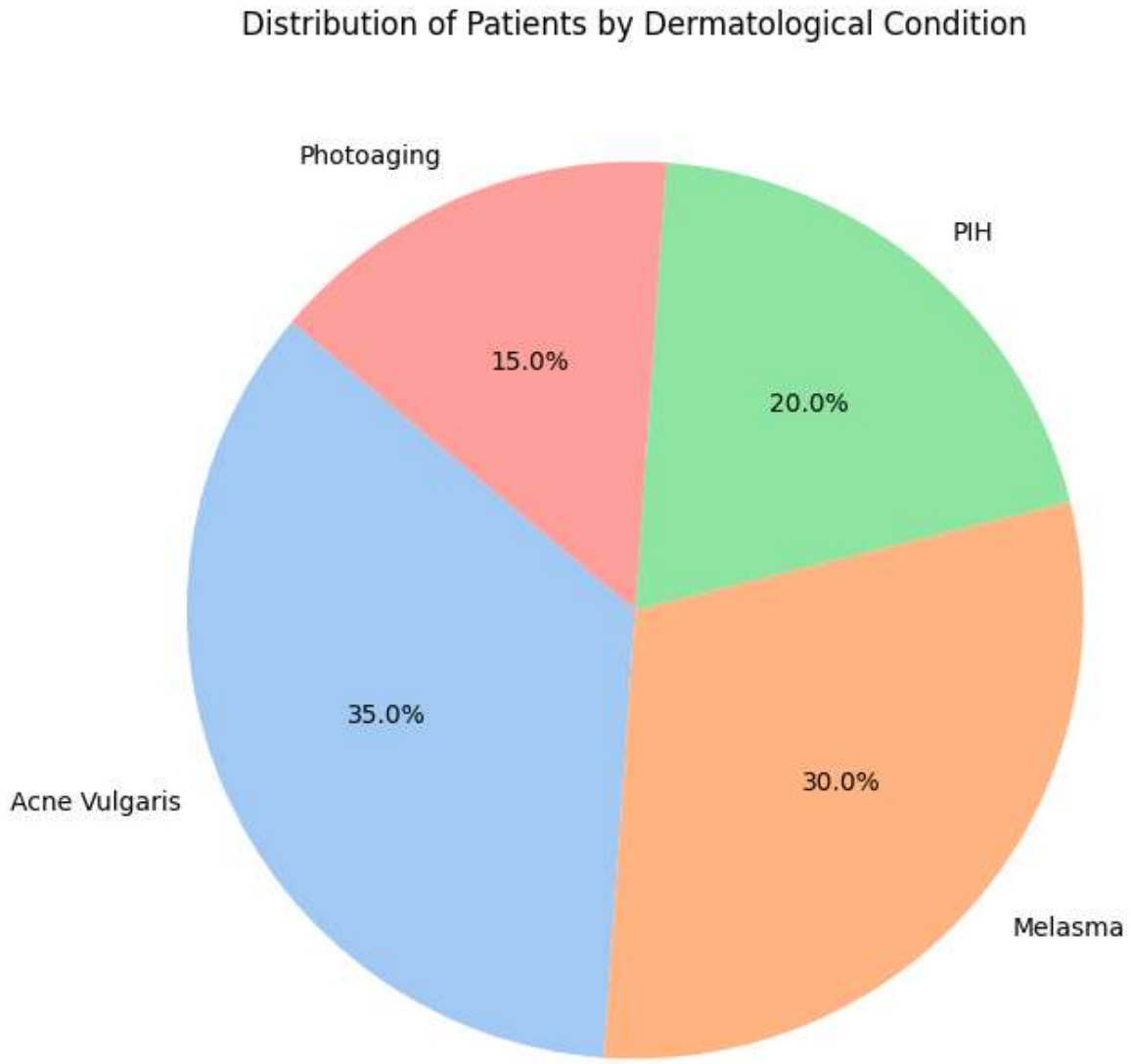

Results:

A total of 100 patients meeting the eligibility criteria were enrolled in the study. The mean age of participants was 29.4 ± 7.2 years, with a female preponderance (58%). The majority of patients had Fitzpatrick skin type IV (44%), followed by type III (38%) and type V (18%). The distribution of dermatological conditions included acne vulgaris (35%), melasma (30%), PIH (20%), and photoaging (15%).

All patients completed the treatment protocol, and none were lost to follow-up. The mean number of sessions for each peel type ranged from 3 to 6, depending on the condition and peel used.

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Clinical Improvement

Significant clinical improvement was observed across all groups:

- In the acne vulgaris group treated with 20% salicylic acid peels, there was a marked reduction in inflammatory and non-inflammatory lesions, with a mean lesion count decreasing from 32.4 ± 6.5 to 12.6 ± 4.2 ($p < 0.001$).
- In the melasma group receiving 35% glycolic acid peels, MASI scores significantly reduced from 9.8 ± 2.1 to 5.4 ± 1.6 ($p < 0.001$).
- The PIH group, treated with combination peels, showed a significant reduction in VAS scores from 7.2 ± 1.4 to 3.1 ± 1.2 ($p < 0.001$).
- Photoaging patients treated with 15% TCA peels demonstrated improvement in skin texture, pigmentation, and fine lines, with a reduction in VAS score from 6.8 ± 1.6 to 3.4 ± 1.1 ($p < 0.001$).

Table: Clinical Improvement After Treatment

Condition	Baseline Score	Post-Treatment Score	% Improvement	p-value
Acne lesion count	32.4 ± 6.5	12.6 ± 4.2	61.1%	<0.001
MASI (Melasma)	9.8 ± 2.1	5.4 ± 1.6	44.9%	<0.001
PIH VAS Score	7.2 ± 1.4	3.1 ± 1.2	56.9%	<0.001
Photoaging VAS	6.8 ± 1.6	3.4 ± 1.1	50.0%	<0.001

Adverse Events

The procedure was well tolerated. Transient erythema (22%) and burning sensation (18%) were the most common adverse events, resolving spontaneously. PIH occurred in 7% of patients, predominantly those with higher Fitzpatrick skin types. Hypopigmentation was observed in 3% of cases. No cases of scarring or severe complications were reported.

Patient Satisfaction

Overall, 82% of patients rated their satisfaction as 'good' or 'excellent' on the 4-point Likert scale, with the highest satisfaction reported among patients treated for acne and melasma.

Discussion

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The present study demonstrates that chemical peels are a safe and effective treatment modality for a variety of dermatological conditions in the Indian population, including acne vulgaris, melasma, PIH, and photoaging. The significant reduction in lesion count, MASI scores, and VAS scores observed in this study aligns with previous research emphasizing the efficacy of superficial and medium-depth peels [1,2]. Salicylic acid, a beta-hydroxy acid, showed excellent results in acne vulgaris, corroborating the findings of Lee et al., who highlighted its comedolytic and anti-inflammatory properties, particularly beneficial for acne-prone, oily skin [3]. Glycolic acid, a widely used alpha-hydroxy acid, effectively reduced melasma severity, consistent with studies reporting its ability to accelerate epidermal turnover and suppress melanogenesis [4]. However, patient counseling regarding strict sun protection remains crucial to prevent rebound hyperpigmentation. Combination peels demonstrated superior outcomes in PIH, particularly in darker skin types, reinforcing literature advocating for tailored, multi-agent peels to enhance efficacy while minimizing risks [5]. TCA peels at 15% concentration significantly improved photoaging features, including fine lines, pigmentation, and skin texture, in line with previous studies highlighting their collagen-stimulating effects [6]. Adverse events were minimal and self-limiting, with no severe complications reported, underscoring the safety of these peels when administered under proper supervision with standardized protocols. However, the occurrence of PIH in some patients emphasizes the need for caution in Fitzpatrick skin types IV-V, highlighting the importance of pre-peel priming and post-peel care [7]. Overall, the high patient satisfaction rates further substantiate the role of chemical peels in achieving both therapeutic and aesthetic goals. Limitations of the study include a relatively small sample size, single-center design, and short-term follow-up. Future studies with larger, multi-center populations and long-term assessments are recommended.

Conclusion

This study concludes that chemical peels, when appropriately selected and administered, offer a safe, effective, and well-tolerated treatment option for various dermatological conditions, including acne vulgaris, melasma, PIH, and photoaging, particularly in the Indian skin type.

Salicylic acid peels proved highly effective for acne vulgaris, while glycolic acid peels significantly improved melasma. Combination peels demonstrated excellent results in PIH, and TCA peels effectively addressed signs of photoaging.

The overall patient satisfaction was high, with most patients experiencing visible clinical improvement and minimal adverse events. These findings reinforce the growing evidence supporting the judicious use of chemical peels as a minimally invasive, cost-effective therapeutic and aesthetic intervention in dermatology.

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However, careful patient selection, individualized peel choice, pre- and post-procedure care, and practitioner expertise are paramount to achieving optimal results and minimizing complications, especially in darker skin types prone to pigmentary alterations.

While this study contributes valuable clinical data, further large-scale, randomized controlled trials with extended follow-up are warranted to establish long-term efficacy, safety, and comparative outcomes across different peel types.

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