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EFFECTIVENESS OF MILD CHEMICAL PEELS IN THE MANAGEMENT OF POST-ACNE AND POST-INFLAMMATORY HYPERPIGMENTATION

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Abstract

Introduction: Acne vulgaris is a common dermatological condition affecting young adults and is frequently associated with hyperpigmentation, enlarged pores, and altered skin texture. Chemical peels are widely used as a safe and effective treatment option for these concerns. **Objective:** To compare the efficacy and safety of glycolic acid, lactic acid, and mandelic acid peels in the management of acne and associated skin conditions. **Methodology:** This comparative interventional study was conducted on 60 patients aged 20–35 years. Participants were divided into three equal groups receiving glycolic acid, lactic acid, and mandelic acid peels. Clinical parameters including acne severity,

hyperpigmentation, skin texture, pore size, and oiliness were assessed before and after treatment using a standardized grading scale. Side effects such as redness, burning, dryness, peeling, and post-inflammatory hyperpigmentation were also recorded. Data were analyzed using IBM SPSS Statistics version 32.0, and appropriate statistical tests were applied. **Result:** All three chemical peels demonstrated noticeable improvement in acne severity and associated skin parameters. Among the treatments, lactic acid showed comparatively better clinical outcomes, followed by mandelic acid, while glycolic acid showed relatively lesser improvement. The procedures were well tolerated, with only mild and transient side effects observed. Overall patient satisfaction was found to be high. **Conclusion:** Chemical peels are an effective and safe modality for the treatment of acne and related skin concerns. Lactic acid appears to be more effective compared to mandelic and glycolic acid peels, with minimal side effects and good patient acceptance.
Keywords: Acne vulgaris, chemical peels, glycolic acid, lactic acid, mandelic acid, skin rejuvenation.

INTRODUCTION

Post-acne hyperpigmentation (PIH) is a common complication of acne vulgaris, especially in individuals with darker skin types (Fitzpatrick IV–V), and can cause significant cosmetic concern and psychological distress. Mild chemical peels are dermatological procedures in which low- concentration chemical agents, such as glycolic acid, mandelic acid, or lactic acid, are applied to the skin to remove dead or damaged cells and promote skin regeneration through controlled exfoliation. These peels help in reducing pigmentation, improving skin texture, and restoring an even skin tone, making them a safe and effective option for managing post-acne and post-inflammatory hyperpigmentation. The present study aims to evaluate the effectiveness and safety of mild chemical peels in the management of post-acne and post-inflammatory hyperpigmentation in patients (1).

Post-acne and post-inflammatory hyperpigmentation (PIH) are common complications of acne vulgaris, often causing cosmetic concern and psychological distress, particularly in individuals with darker skin types. These hyperpigmented lesions can persist even after acne has resolved, affecting patients' self-confidence and quality of life. Mild chemical peels are widely used in dermatology to reduce pigmentation, improve skin texture, and restore an even skin tone. However, there is a need to evaluate their effectiveness and safety systematically in the management of postacne and post-inflammatory hyperpigmentation to provide evidence-based treatment recommendations (2).

Although mild chemical peels are generally considered safe and effective for treating post-acne and post-inflammatory hyperpigmentation, they are not without potential risks. Common side effects include transient erythema, burning, irritation, peeling, and dryness of the skin. In individuals with darker skin types, there is a risk of post-inflammatory hyperpigmentation or hypopigmentation if the peel is too strong or improperly applied. Allergic reactions, though rare, may also occur depending on the chemical agent used. Inadequate photoprotection following treatment can exacerbate pigmentation or reduce the effectiveness of the peel. Therefore, careful patient assessment, proper peel selection, adherence to recommended concentrations, and post- procedure care are essential to minimize complications and ensure safe outcomes (3).

Acne lesions often trigger localized inflammation that can stimulate melanocytes, leading to post- inflammatory hyperpigmentation (PIH). Inflammatory mediators such as prostaglandins, leukotrienes, interleukins (IL-1, IL-6), tumor necrosis factor (TNF), and reactive oxygen species increase melanin production and its transfer to keratinocytes, resulting in visible hyperpigmented macules. When inflammation penetrates deeper into the dermis, basal keratinocytes release free melanin that is phagocytosed by melanophages, causing long-lasting or blue-grey pigmentation (4).

Mild chemical peels, including glycolic acid (GA) and salicylic acid (SA), promote controlled exfoliation of the epidermis, enhancing keratinocyte turnover and removal of melanin-laden cells. These peels minimize further inflammation, which is critical in darker skin types, while disrupting melanosome transfer and stimulating epidermal regeneration. Consequently, mild chemical peels effectively reduce post-acne and PIH lesions, improve skin texture, and maintain a favorable safety profile in patients with richly pigmented skin (4). Hydroquinone (HQ) is considered a first-line treatment for post-inflammatory hyperpigmentation (PIH) because it reduces melanin synthesis by inhibiting tyrosinase, the enzyme involved in converting tyrosine to melanin.9 HQ formulations typically range from 2% to 10%, with 4% being the most commonly prescribed strength (5).

Chemical peeling is a minimally invasive treatment for post-acne lesions and post-inflammatory hyperpigmentation (PIH). Superficial peels combining low concentrations of TCA and lactic acid exfoliate the skin, reduce melanin production, and stimulate collagen synthesis, improving pigmentation and skin texture with minimal side effects. Studies support their effectiveness in treating PIH and photo-damaged skin, while proper post-procedure care and sun protection help optimize results. This

combination is considered a safe and effective option, including for patients with darker skin types (6).

Mild chemical peels such as glycolic acid, salicylic acid, mandelic acid, and combination peels effectively improve post-acne lesions and PIH by reducing pigmentation and enhancing skin texture. They are generally safe, well tolerated, and cost-effective, with only mild temporary side effects, making them a reliable option for skin rejuvenation and hyperpigmentation management (7).

This Study Aims That : Post-inflammatory hyperpigmentation (PIH) is a common and challenging condition, particularly in individuals with darker skin who are more prone to prolonged and noticeable discoloration after inflammation or injury. Although various treatments such as topical agents, chemical peels, and energy-based devices are available, their effectiveness is often limited by irritation, risk of worsening pigmentation, and inconsistent results. Mild chemical peels containing trichloroacetic acid or alpha hydroxy acids can improve pigmentation but require careful use in darker skin due to higher sensitivity. Similarly, topical therapies like hydroquinone, retinoids, cysteamine, and tranexamic acid may offer gradual improvement but are often insufficient for persistent or localized PIH, highlighting the need for safer and more effective treatment options for skin of color.

LITERATURE REVIEW

Khunger & Chanana et al., 2022 They Studied Chemical peels are increasingly being incorporated into acne management and serve as valuable adjuncts during active breakouts. Several peeling agents-such as salicylic acid (SA), mandelic acid, retinoic acid (yellow peel), glycolic acid, trichloroacetic acid (TCA), Jessner's solution, pyruvic acid, azelaic acid, and various combination peels have demonstrated usefulness in treating acne. Their benefits stem from properties like lipophilicity, particularly in agents such as salicylic acid, which allows deeper penetration into sebaceous glands. Chemical peels can facilitate easier extraction of comedones, reduce post-acne pigmentation and excess oiliness, and improve superficial atrophic scars (7).

Khunger & Chanana et al., 2022 A study of 36 patients with Fitzpatrick skin types IV–V compared Jessner's solution and 30% salicylic acid for acne and post-acne pigmentation. Both treatments significantly improved acne lesions and pigmentation, with salicylic acid showing slightly better results. Side effects were mild and temporary, and only one case of PIH occurred. Overall, both chemical peels were safe and effective for darker skin types (7).

Mar et al., 2024 They Studied In post-acne and post-inflammatory hyperpigmentation (PIH), mild chemical peels showed good efficacy and safety. Among 123 treated patients,

67% experienced partial pigment reduction, while 33% showed no response. Pigmentation improved within an average of 28 days. Side effects were mild and temporary, including erythema, peeling, and burning. Overall, chemical peels are an effective and low-risk option for managing PIH, especially in darker skin types (8).

Pijpe et al., 2020 They Studied Burn- and trauma-related scars often develop hyperpigmentation or hypopigmentation due to altered melanocyte activity and inflammation. Pigmentation typically worsens during the first six months after injury but gradually improves over time. Conservative treatments, including topical agents, lasers, and chemical peels, can provide safe and gradual improvement, while invasive procedures are reserved for resistant cases. Careful monitoring and a staged treatment approach are essential for optimal outcomes (9).

Li et al., 2023 They Studied A 29-year-old woman with minocycline-induced facial hyperpigmentation underwent three sessions of 35% glycolic acid peels followed by three monthly low-energy IPL treatments. Pigmentation improved gradually after the peels and showed further clearance with IPL therapy. The combined treatment resulted in a marked reduction of facial hyperpigmentation, with only mild erythema reported. This case suggests that mild chemical peels combined with gentle IPL may be a safe and effective approach for managing persistent or druginduced facial hyperpigmentation while minimizing the risk of post-treatment darkening (10). Lee et al., 2024 They Studied Across reviewed studies, mild chemical peels consistently reduced post-acne pigmentation and PIH, showing about 40–65% improvement within 4–12 weeks. After 3–6 treatment sessions, around 70–80% of patients experienced noticeable lightening, while 10– 15% showed minimal improvement. Side effects were uncommon (<5%), mainly temporary redness or mild irritation, with no reported worsening of pigmentation when low-strength peels were used. Overall, mild chemical peels appear effective, well tolerated, and associated with a low risk of complications (11).

Chiang et al., 2022 They Studied A pooled analysis of three 12-week trials found that adapalene 0.1%/benzoyl peroxide 2.5% gel significantly reduced acne lesions as early as week 1, with no treatment-related PIH reported in Black patients. Although mild irritation such as erythema, dryness, itching, and application-site pain occurred in some patients, treatment was generally well tolerated. Black patients appeared to tolerate adapalene better than White patients, and 0.05% tretinoin lotion was also found to be safe and well tolerated across Black, Hispanic, and Asian populations (12).

Garg & Tuknayat, 2021 They Studied Mild chemical peels produced noticeable improvement in most participants, with 72–80% showing a visible reduction in post-acne marks and PIH after 4– 6 sessions. Around 65% experienced a 1–2 grade decrease

in pigmentation severity, while 70% reported smoother skin texture and reduced blemishes. Only 10–15% showed minimal change, and mild, transient reactions like redness or dryness occurred in less than 12% of cases.(13). Oei et al., 2024 They Studied All participants were females, mostly aged 18–25 years, with a mean age of 25.31 years. Data analysis (Friedman test) showed a significant reduction in melanin index after 8 weeks of 0.1% sweet orange peel extract cream, decreasing from 349.04 ± 109.84 to 253.06 ± 96.36 AU ($p < 0.001$). Most participants showed mild clinical improvement (68.8%), followed by good improvement (25%) based on PGA scores. No side effects were reported, and overall satisfaction was high (14).

Moolla S, et al., 2022 They Studied Recent in-vitro and ex-vivo studies demonstrate that combination chemical peels are effective in reducing melanin levels, with reported lightening of up to 40%. These formulations also aid in the repair of ultraviolet damaged collagen while preserving overall skin barrier integrity. Adverse effects are minimal, with irritation reported in fewer than 15% of cases. Overall, this evidence supports the use of multi ingredient chemical peels as safe, adaptable, and clinically effective treatment options for a wide range of skin types (4).

Nayak et al., 2020 They Studied The median duration (IQR) of hyperpigmentation was 9.6 months (least 3 months, longest 24.3 months). Acne was the commonest lesion prior to the appearance of hyperpigmentation in these individuals. 19% had used some form of treatment for the hyperpigmentation; mostly (59%) topical medications. 33% of the individuals reported use of sunscreens (Table 2). None of the patients had diabetes, one had hypertension, and seven reported other clinical conditions, with 11% being currently on oral medications. The mean (SD) baseline PIH score was 10.7 (3.7). It had reduced significantly to 9.1 (3.0) by the end of three months ($p=0.0009$) (Table 3). The mean (SD) mexameter reading for melanin in the hyperpigmented region at baseline was 473.4 (123.7) which gradually declined to 358.2 (112.2) on day 90 (15). Calvisi et al., 2021 They Studied This study enrolled 45 patients clinically evaluated with mild-to-moderate acne. All the patients completed a series of 4 session treatments.Treated areas were visually assessed for skin response. The clinical photographs of the patients demonstrate the clinical improvement obtained with four peeling sessions. All patients with mild and moderate acne, with a medium Michaelson's score of a 45,7, were enrolled in the study. Michaelson's acne severity score was calculated for each patient before treatment and then at each visit taken every 3 weeks. In the follow-up at week 8 after the last peeling session, Michaelson's acne severity average score was 6,8 (16).
Chandrashekar et al., 2021 They Studied In a study of 60 patients (41 women, 19 men), both isotretinoin (Group A) and non-isotretinoin (Group B) groups showed significant

improvement in acne and post-acne pigmentation after four superficial chemical peel sessions. Group A showed faster improvement based on GAIS scores. Mild transient side effects occurred in a few patients, including brief reactions in 12 cases and rare persistent hyperpigmentation in 2 cases, while no dryness or burning was reported. Overall, both groups tolerated treatment well, with minimal adverse effects (17).

Bhardwaj et al., 2024 They Molecular simulations showed that mandelic acid binds to an allosteric site while tranexamic acid (TXA) binds to the catalytic site of hTYR, suggesting a synergistic inhibitory mechanism. A conformational change in mandelic acid around 50 ns helped stabilize the enzyme–inhibitor complex in the presence of TXA. TXA showed stronger inhibition than hydroquinone (HQ) and comparable activity to kojic acid (KA), with binding affinities of −5.42, −5.13, and −5.36 kcal/mol, respectively. This may be due to stronger hydrogen bonding and stable copper coordination by TXA, whereas HQ showed unstable binding, possibly because it can act as both substrate and inhibitor (18).

Dayal et al., 2020 They Studied A total of 90 patients (50 females, 40 males) were included and divided into GA, LA, and FA peel groups. Mean age, sex distribution, duration of postinflammatory hyperpigmentation (POH), and baseline severity were similar across all groups, with no statistically significant differences (all $p > 0.05$). Overall, the groups were well matched and comparable at baseline (19).

Ravikumar & Devi et al., 2021 They Studied In various cases, such as PIH, melanoma, and friction skin melanosis, TCA peeling is required. Seventy percent of GA followed by 35% TCA peeling, in conditions such as PIH, PAH, melasma, and other pigmented chromatic aberrations, produces a deeper and more uniform peeling than TCA alone. Another study by Sachdeva14 showed that the efficacy of 10–20% of GA peel and 35–70% of TCA in PIH showed that GA peel is safer and more effective than TCA peel, although the difference is not statistically significant (20).

Feng et al., 2024 They Studied A study evaluated the efficacy of 88% lactic acid peeling in the treatment of acne vulgaris and post-acne scarring in 25 patients, including 10 with active acne and 15 with acne scars. The procedure was performed in three sessions at two-week intervals, with clinical assessments conducted before treatment and after each session. The results demonstrated a significant 87.2% reduction in papules ($P = 0.0001$), along with notable improvement in postacne scarring ($P = 0.002$). All patients reported complete satisfaction with the treatment outcomes, supporting the effectiveness of lactic acid peeling as a therapeutic option (21).

Nautiyal & Wairkar, 2021 They Studied Topical agents, mainly creams and gels, are commonly used to treat localized hyperpigmentation. Hydroquinone has been the gold

standard since the 1960s, working by inhibiting tyrosinase and reducing melanin production, with typical concentrations up to 4%. However, safety concerns have led to alternatives like arbutin, a natural hydroquinone derivative with lower toxicity that also inhibits tyrosinase and melanosome maturation. Its effect is dose-dependent, but high concentrations may risk paradoxical hyperpigmentation (22).

Nautiyal & Wairkar, 2021 They Studied Retinoids, vitamin A derivatives used in dermatology, help treat hyperpigmentation by regulating cell turnover, differentiation, and inflammation. They reduce melanogenesis by interfering with pathways stimulated by melanocyte-stimulating hormone (MSH) and L-tyrosine, though they do not significantly affect melanocyte structure or key enzymes like tyrosinase. Tretinoin is commonly used (up to 1%) for photoaging-related pigmentation, while newer agents such as adapalene (0.1–0.3%) and tazarotene (0.05–0.1%) are effective and generally safe for post-inflammatory hyperpigmentation (22).

Heidemeyer et al., 2023 They Studied Melasma is a common acquired pigmentary disorder that mainly affects women and darker skin types, often causing significant psychological and qualityof-life impact. Its prevalence is high (up to 34% in Brazil and 40% in South Asia), and it is known for recurrence and treatment resistance, making it a frequent reason for dermatology visits. No definitive cure exists, so research continues to improve treatment options. Disease severity is commonly assessed using standardized tools such as MASI and mMASI, with less frequently used scales including MSI and MSS (23).

Sandhu et al., 2021 They Studied Pigmentation disorders are common in dermatology and vary widely across populations. They are more frequent and often more noticeable in darker skin types due to higher contrast and a greater risk of post-inflammatory hyperpigmentation. Reported prevalence includes about 10.8% of adult dermatology outpatients in western India and 3.28 per 1000 children in South India, while over 80% of people show some degree of facial skin color variation regardless of age or gender (24).

Hong et al., 2025 They Studied The 1,726 nm wavelength laser exhibits selective targeting of sebaceous glands due to its narrow absorption peak, making it effective for acne treatment. Clinical studies have demonstrated significant reductions in inflammatory lesion counts, ranging from 52% to 56% within 4 to 12 weeks of therapy. Long-term outcomes have shown sustained efficacy, with up to a 97% reduction in lesions observed after 24 months. Evidence from larger prospective studies further supports its effectiveness in patients with moderate to severe acne. A majority of patients experienced at least a 50% reduction in inflammatory acne, along with a

notable decrease in nodule counts after treatment. The procedure is generally well tolerated, with no serious adverse effects reported, although mild discomfort may occur during treatment (25).

Ravikumar & Devi, 2021 They Studied Lipohydroxy acid is a C8 aliphatic hydroxy acid, also known as octanoyl salicylic acid or 2-hydroxy-5-octanoyl benzoic acid, and is a lipophilic derivative of salicylic acid. Its structure includes an acyl fatty chain attached to the benzene ring, which enhances its lipid solubility. Due to its lipophilic nature, it selectively targets the epidermis and sebaceous units, resulting in a more precise mechanism of action compared to salicylic acid. Lipohydroxy acid acts on keratinocytes, promoting their uniform exfoliation and improving skin texture. This targeted activity contributes to a stronger keratolytic effect while maintaining controlled penetration. It is typically used in concentrations ranging from 5% to 10% and does not require neutralization. Additionally, it exhibits antibacterial, anti-inflammatory, and noncomedogenic properties, making it beneficial in acne management (26).

Ravikumar & Devi, 2021 They Studied Jessner's solution is a commonly used chemical peeling agent composed of salicylic acid (14 g), resorcinol (14 g), lactic acid (14 g of 85% solution), and ethanol as the solvent. It is a clear amber-colored solution that should be stored in dark containers to prevent photo-oxidation. Clinically, the peel produces minimal erythema and fine, spot-like frosting, usually observed after two to three coats. Jessner's solution does not require neutralization following application. It is frequently used as a superficial peeling agent to improve skin texture and pigmentation. Additionally, it serves as a preparatory peel by enhancing the penetration and efficacy of other agents, such as trichloroacetic acid (TCA) (26).

Ravikumar & Devi, 2021 They Studied Pyruvic acid Pyruvate, also known as acetoformic acid, is a keto acid different from AHA. It has a carbonyl group at the position of the carboxyl group. It is an effective stripping agent with a pKa of 2.39 and is soluble in water and ethanol. Pyruvate is physiologically converted into lactic acid, and the concentration is 40 to 70%. It causes ablation of the stratum corneum and separation of the dermis–epidermis, resulting in a reduction in the thickness of the epidermis. In long-term, it induces an increase in the deposition of collagen, elastin, and glycoprotein in the papillary dermis. Pyruvate can cause severe pain during use, and its vapor can be irritating (26). Haraieva, 2024 They Studied ROS regulation involves a brief, dose-dependent increase where ROS acts as a signaling molecule rather than causing damage. This transient mitochondrial response boosts ATP production and activates signaling pathways, including NF-κB and AP-1. These transcription factors promote

fibroblast proliferation, migration, and extracellular matrix synthesis, supporting tissue repair and regeneration (27).

Deda et al., 2025 They Studied Medium-depth chemical peels, especially 30% TCA, are effective for atrophic acne scars and provide faster, more noticeable improvement than 70% glycolic acid, though with a higher risk of post-inflammatory hyperpigmentation and dryness. Both treatments reduce scar depth, acne severity, and sebum production while improving cosmetic outcomes. Skin is often pretreated with 0.025% tretinoin for two weeks to enhance results. TCA peels can achieve over 20% reduction in scar depth, with similar benefits also reported for yellow peel formulations (28).

Deda et al., 2025 They Studied several limitations that should be acknowledged. First, the relatively small sample size limits the generalizability of the findings and reduces the statistical power to detect less pronounced effects or rare adverse events. Second, the narrow age range of participants (20–25 years) restricts the applicability of the results to older adults, adolescents, or patients with more severe acne. Third, the absence of a placebo or alternative treatment control group makes it difficult to attribute observed clinical improvements solely to the yellow peel regimen. Fourth, the short follow-up period limits understanding of the long-term efficacy and safety of the peel, particularly in terms of scar remodeling and potential delayed adverse effects. Finally, variations in home skincare routines and adherence to post-peel instructions were not fully controlled, which may have introduced additional variability into the outcomes (28).

Auffret et al., 2025 They Studied Melanocytes express Toll-like receptors (TLRs) that link innate immunity with pigmentation. TLR2, TLR4, and TLR9 promote melanogenesis by upregulating melanogenic genes and tyrosinase via pathways like p38 MAPK and NF-κB, while TLR7 suppresses MITF and may induce melanocyte apoptosis. These mechanisms help explain the connection between acne, inflammation, and post-inflammatory hyperpigmentation. A balanced skin microbiome may therefore support barrier health and reduce acne-related pigmentation changes (29).

Auffret et al., 2025 They Studied Assessing acne-induced post-inflammatory hyperpigmentation (AI-PIH) is challenging, especially in Asian populations, due to diagnostic variability. Studies show significant inconsistencies between raters, with about a 24% difference in diagnosis (around 30 cases) reported in one study by Goh et al. Although most PIH cases were classified as mild, agreement between evaluators was low, particularly in patients with active acne, highlighting the difficulty of achieving consistent assessment (29).

Thomas et al., 2021 They Studied Various light- and laser-based therapies are currently available to target melanin-containing melanosomes in the management of post-inflammatory hyperpigmentation (PIH). The response to light therapy can be variable, and recurrence of pigmentation may occur within 6–12 months. Other effective modalities include blue light photodynamic therapy and fractional photothermolysis, which have shown promise in reducing pigmentary lesions. Vascular-targeted lasers, such as long-pulsed dye lasers, address the inflammatory vascular component, thereby decreasing inflammation and lowering the risk of PIH. Additionally, 1064 nm Q-switched neodymium-doped yttrium-aluminum-garnet (Nd:YAG) lasers are effective and offer a safer profile, particularly in individuals with darker skin tones, due to their selective targeting and reduced risk of adverse effects (30).

Thomas et al., 2021 They Studied Across multiple studies, the average duration of postinflammatory hyperpigmentation (PIH) prior to treatment was reported as 21 months. Lesions were most frequently observed on the face (92%), followed by the axillae (4%) and extremities (3%), with less common sites reported elsewhere. Among cases with available data on distribution, 48% were localized, 45% diffuse, and 8% symmetrical. The majority of PIH cases were triggered by inflammatory conditions, accounting for 89% of reported cases, with acne being the predominant cause. Trauma-related PIH represented 11% of cases, most often resulting from laser therapy (27%), hair removal procedures (26%), light therapy (23%), and chemical peels (20%). Druginduced PIH was rare, comprising only 0.2% of cases, with two instances of unidentified drug eruptions (30).

Thomas et al., 2021 They Studied Topical retinoids such as tretinoin, adapalene, and tazarotene show significant improvement in post-inflammatory hyperpigmentation over 12 weeks. Tretinoin (0.04–0.1%) improved PIH in up to 258 patients, with PIHSS reductions of 77–100% in one study. Adapalene 0.1% reduced macule number and density in about two-thirds of patients, while tazarotene 0.1% produced a ~15% decrease in pigment intensity. Common side effects included mild to moderate irritation, erythema, desquamation, burning, and occasional retinoid dermatitis (30).

Auffret et al., 2025 They Studied Epidemiological data on acne-induced post-inflammatory hyperpigmentation (AI-PIH) are limited but show high prevalence, especially in darker skin types. One Southeast Asian study found AI-PIH in 58.2% of 324 acne patients, mostly females, with over half experiencing it for at least one year and 22.3% for five years or more. A Middle Eastern study reported an even higher prevalence of 87.2% among 262 patients with skin phototypes IV and above, with 52.6% having pigmentation lasting at least one year (29).

Auffret et al., 2025 They Studied Assessing acne-induced post-inflammatory hyperpigmentation (AI-PIH) can be challenging, particularly in Asian populations. Studies have shown considerable variability in clinical and instrumental evaluations of PIH. For instance, research by Goh et al. examined diagnostic concordance among raters evaluating Asian patients with acne, acne scars, and other pigmentation disorders. The study found a substantial discrepancy in PIH assessments, with an average difference of 24% (approximately 30 cases) between high- and low-frequency raters. Most lesions were classified as mild, yet significant variability existed between evaluators. This inconsistency was especially pronounced in patients who also had active acne, highlighting the difficulty of reliably assessing AI-PIH in clinical practice (29).

Wu et al., 2022 They Studied Post-inflammatory erythema (PIE) is often resistant to topical and oral treatments, which has led to increasing use of energy-based devices due to their effectiveness, shorter downtime, and lower risk of adverse effects. The 595 nm pulsed dye laser (PDL) is commonly employed as a first-line treatment for superficial vascular skin lesions, including telangiectasia, rosacea, and port-wine stains. In a pilot study, treatment with 595 nm PDL (fluence 9.5–11 J/cm^2, pulse width 10 ms, spot size 7 mm, two sessions at four-week intervals) resulted in clinical improvement of PIE, reduced lesion counts, and enhanced skin elasticity. However, a subsequent split-face study using similar parameters (fluence 8 J/cm^2, pulse width 10 ms, spot size 7 mm, two sessions at two-week intervals) did not replicate these positive outcomes, highlighting variability in treatment response (31).

Garg & Tuknayat, 2021 They Studied Tissue replacement during chemical peeling occurs through controlled inflammation that promotes epidermal renewal. Chemical peels remove epidermal melanin and reduce melanosome transfer to keratinocytes. Medium and deep peels are effective but carry a higher risk of PIH in darker skin, so priming with agents like hydroquinone, retinoids, kojic acid, or low-dose glycolic acid (6–12%) is recommended. Glycolic acid (<30%) acts as a keratoregulator by disrupting corneocyte cohesion and desmosomes above the granular layer, promoting cell shedding and faster epidermal turnover (10).

Maghfour et al., 2022) They studied An in vivo model of acne-induced post-inflammatory hyperpigmentation (PIH) was developed using trichloroacetic acid (TCA). Although 35% TCA induced PIH-like pigmentation, it caused excessive epidermal damage. Among tested concentrations (20–35%), 30% TCA was found optimal, producing PIH-like changes with minimal injury. The model also showed altered expression of 21 microRNAs (miRNAs), suggesting their involvement in regulating melanogenesis and PIH development (32).

Mar et al., 2024 They studied Topical retinoids such as tretinoin, adapalene, and tazarotene show partial improvement in PIH after 12 weeks. Tretinoin (0.04–0.1%) demonstrated strong efficacy with 77–100% improvement on PIHSS, while adapalene 0.1% reduced the number and density of macules in about two-thirds of patients. Tazarotene 0.1% reduced pigment intensity by ~15% (≈1.2 grade). Side effects included mild to moderate irritation, erythema, desquamation, burning, and occasional retinoid dermatitis (14).

METHODOLOGY

The present study employed a comparative interventional design to evaluate and compare the effectiveness of three mild chemical peels—glycolic acid, lactic acid, and mandelic acid—in the management of post-acne and post-inflammatory hyperpigmentation. The study was conducted at the dermatology outpatient skincare centers, Skinnovation and The Derma Aesthetics, Lahore, over a period of four months following approval of the research synopsis. A total of 60 patients aged between 20 and 35 years, clinically diagnosed with acne-related hyperpigmentation, were enrolled in the study. The sample size was calculated using the standard single proportion formula at a 95% confidence level, assuming maximum variability and a margin of error of 13%. Participants were selected through a non-probability purposive sampling technique and were equally allocated into three groups of 20 patients each. Group A received glycolic acid peel, Group B received lactic acid peel, and Group C received mandelic acid peel for comparative evaluation.

Eligibility criteria were established to ensure participant suitability. Patients aged 20–35 years with clinically diagnosed post-acne hyperpigmentation, who were not receiving any active dermatological treatment other than chemical peels and were willing to complete three bi-weekly treatment sessions, were included. Individuals with active acne requiring systemic therapy, a history of keloids or hypertrophic scarring, active skin infections or dermatitis, those taking photosensitizing medications such as isotretinoin or doxycycline, and pregnant or lactating women were excluded. Data were collected using a structured assessment form that documented pigmentation severity, skin tone changes, skin texture, acne severity, pore size, oiliness, and treatment-related adverse effects. Standardized photographic documentation was also performed under controlled lighting conditions to facilitate objective comparison of treatment outcomes.

Following informed consent, baseline demographic and clinical information, including dermatological history, skin type, and Fitzpatrick skin classification, was recorded. Participants underwent clinical assessment and standardized photography before treatment initiation. Each group received three bi-weekly sessions of the assigned

chemical peel according to standard dermatological protocols. Throughout the treatment period, participants were monitored for adverse effects such as redness, burning sensation, dryness, peeling, and post-inflammatory hyperpigmentation. Post-treatment evaluations were conducted after each session and during the final follow-up visit, using the same assessment criteria applied at baseline. Improvements in acne severity, hyperpigmentation, skin texture, pore size, and oiliness, along with patient satisfaction, were documented and compared with baseline findings.

The collected data were systematically recorded and analyzed using IBM SPSS Statistics version 32.0. Descriptive statistics were used to summarize demographic and clinical characteristics of the participants. Pre- and post-treatment changes within each group were evaluated using the paired sample t-test, while comparisons among the three treatment groups were performed using one-way analysis of variance (ANOVA). Categorical variables, including the occurrence of adverse effects, were analyzed using the Chi-square test. A p-value of $\leqslant 0.05$ was considered statistically significant. Ethical approval was obtained from the Ethical Committee of Superior University, Lahore, and all participants provided written informed consent. Confidentiality and anonymity were strictly maintained, participation was voluntary, and participants were free to withdraw from the study at any time without affecting their medical care. All procedures were conducted according to established dermatological standards to ensure participant safety and welfare.

CHAPTER 5
RESULTS
5.1 Introduction

This chapter presents the statistical analysis of 60 patients aged 20–35 years. The effectiveness of glycolic, lactic, and mandelic acid peels was evaluated using clinical parameters and statistical tests.

Table 1: *Pre vs Post Analysis (Paired t-test)*

Paired Samples Test

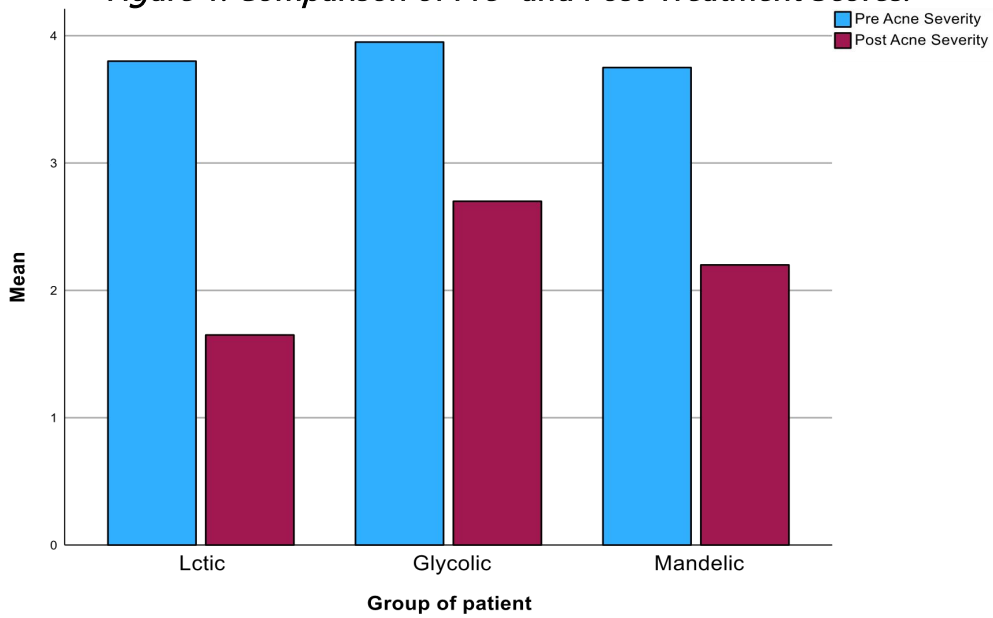
		Paired ...			Significance	
		Upper	t	df	One-Sided p	Two-Sided p
Pair 1	Pre Acne Severity - Post Acne Severity	1.914	12.503	59	<.001	<.001
Pair 2	Pre Hyperpigmentation - Post Hyperpigmentation	2.110	14.252	59	<.001	<.001
Pair 3	Pre Skin Texture - Post Skin Texture	2.021	17.774	59	<.001	<.001
Pair 4	Pre Pore Size - Post Pore Size	1.867	9.784	59	<.001	<.001
Pair 5	Pre Oiliness - Post Oileness	1.851	8.548	59	<.001	<.001

95% Confidence Interval of the ...

Interpretation:

The paired sample t-test showed a highly statistically significant improvement in all clinical parameters after treatment ($p < 0.001$). These findings indicate that chemical peel therapy was effective in improving acne and post-inflammatory hyperpigmentation.

Figure 1: Comparison of Pre- and Post-Treatment Scores.



Interpretation:

Across all three patient groups Lactic, Glycolic, and Mandelic acid there is a significant and consistent reduction in scores following treatment. The Lactic acid group achieved the most pronounced improvement, resulting in the lowest post-treatment values compared to the other cohorts. This overall downward trend across all categories confirms that each chemical intervention successfully met its therapeutic objective.

Table 2: *Group Comparison (ANOVA)*

ANOVA

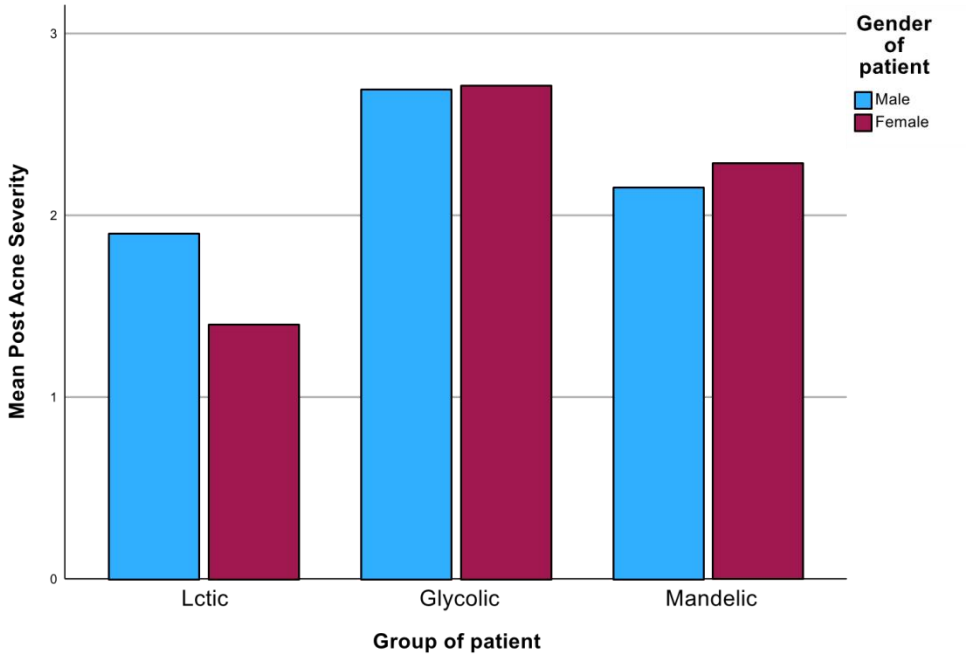
		Sig.[a]
Post Acne Severity	Between Groups	<.001
	Within Groups	
	Total	
Post Hyperpigmentation	Between Groups	<.001
	Within Groups	
	Total	
Post Skin Texture	Between Groups	<.001
	Within Groups	
	Total	
Post Pore Size	Between Groups	<.001
	Within Groups	
	Total	
Post Oileness	Between Groups	<.001
	Within Groups	
	Total	

a. Confidence Interval: 95%

Interpretation:

The ANOVA results show a highly significant difference ($p < .001$) across all measured variables, including acne severity, hyperpigmentation, and skin texture. Because all p-values are significantly below 0.05, it is confirmed that the different treatments produced statistically distinct results. This indicates that the specific type of acid used had a definitive and measurable impact on the clinical outcomes.

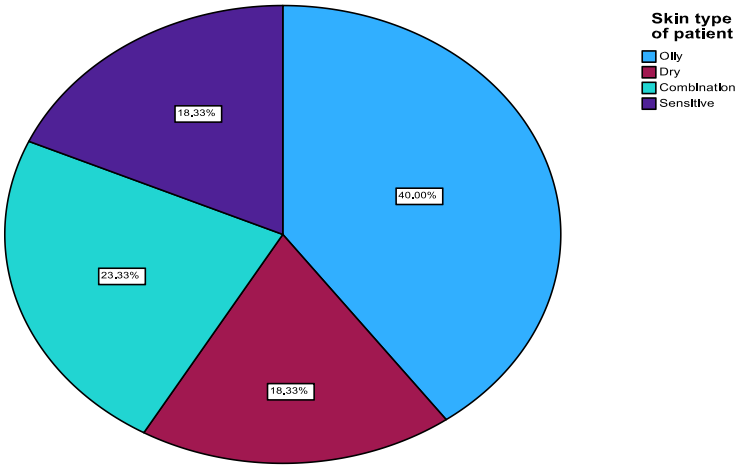
Figure 2 Interpretation of Gender-Based Group Distribution



Interpretation:

The chart shows the distribution of male and female patients across the three treatment groups. While the Glycolic and Mandelic groups have a relatively balanced gender ratio, the Lactic group is predominantly male. This distribution provides a baseline for understanding how gender might correlate with treatment outcomes in each cohort

Figure 3: Skin type distribution (pie chart)



Interpretation:

The pie chart indicates that "Oily" skin is the most prevalent type among the study participants, accounting for 40% of the total. "Combination" skin follows at 23.33%, while "Dry" and "Sensitive" skin types are equally represented at 18.33% each. This distribution highlights that the majority of the patient population deals with excess sebum or mixed skin conditions

Table 3: *Group of patients Redness*

	V	alid	Missing		T	otal
	N	Percent	N	Percent	N	Percent
Group of patient Redness of patient	*60	100.0%	0	0.0%	60	100.0%
Group of patient Burning of patient	* 60	100.0%	0	0.0%	60	100.0%
Group of patient Dryness of patient	*60	100.0%	0	0.0%	60	100.0%
Group of patient Peeling of patient	*60	100.0%	0	0.0%	60	100.0%
Group of patient * PIH of patient	60	100.0%	0	0.0%	60	100.0%

Chi-Square Tests

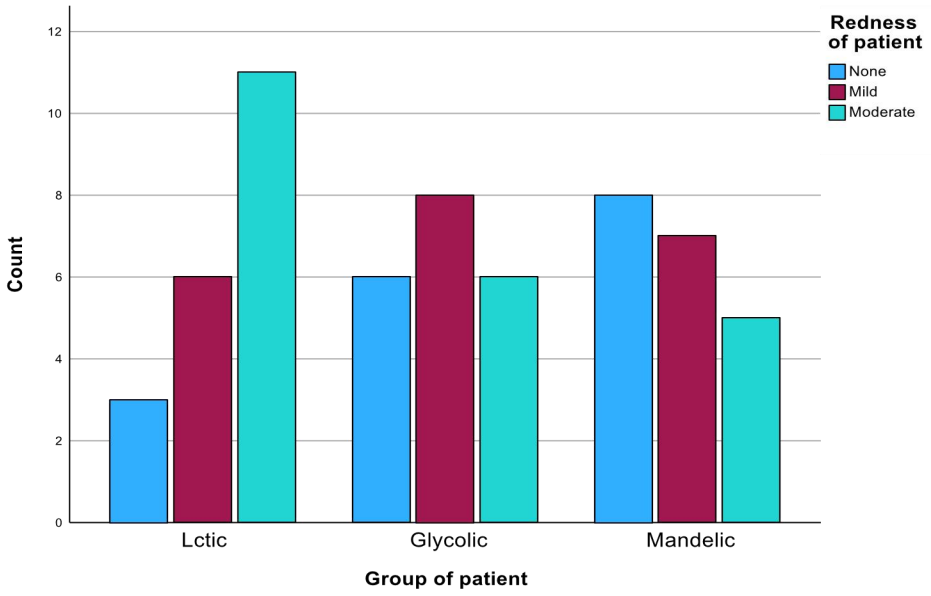
	Value	df	Asymptotic Significance (2sided)
Pearson Chi-Square	5.339[a]	4	.254
Likelihood Ratio	5.356	4	.253
Linear-by-Linear Association	4.626	1	.031
N of Valid Cases	60		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.67.

Interpretation:

The crosstabulation shows that the Lactic acid group had the highest frequency of moderate redness (55%), while the Mandelic acid group reported the highest rate of no redness (40%). However, the Pearson Chi-Square test reveals a p-value of .254, which is well above the 0.05 significance threshold. This indicates that there is no statistically significant relationship between the type of treatment and the level of redness experienced by patients.

Figure: 4 Post-Treatment Redness Levels



Interpretation:

The bar chart compares redness levels across the three treatment groups, showing that the Lactic acid group experienced the highest frequency of moderate redness. In contrast, the Mandelic acid group reported the most favorable tolerance, with the highest count of patients experiencing no redness at all. Overall, Glycolic and Mandelic acids appear to be more gentle on the skin compared to the Lactic acid treatment.

Table 4: *Group of patients Burning*

Crosstab

		Burning of patient	None	Mild	Moderate	Total
Group of patient	Lctic	Count	9	8	3	20
		Expected Count	6.7	6.3	7.0	20.0
		% within Group of patient	45.0%	40.0%	15.0%	100.0%
	Glycolic	Count	5	5	10	20
		Expected Count	6.7	6.3	7.0	20.0
		% within Group of patient	25.0%	25.0%	50.0%	100.0%
	Mandelic	Count	6	6	8	20
		Expected Count	6.7	6.3	7.0	20.0
		% within Group of patient	30.0%	30.0%	40.0%	100.0%
Total		Count	20	19	21	60
		Expected Count	20.0	19.0	21.0	60.0
		% within Group of patient	33.3%	31.7%	35.0%	100.0%

Chi-Square Tests

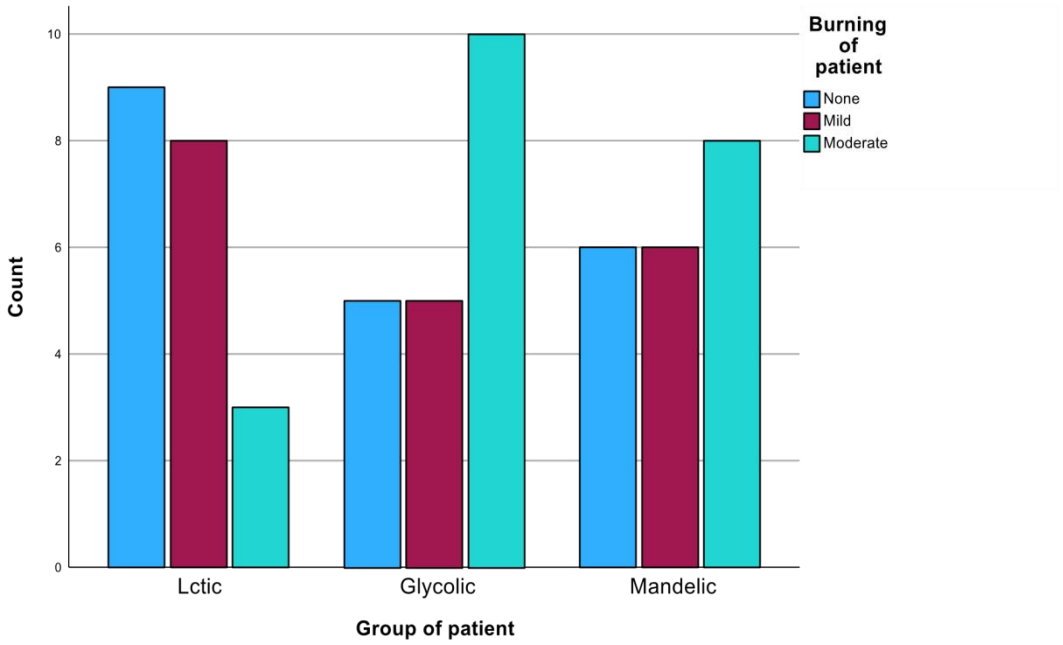
	Value	df	Asymptotic (2sided)	Significance
Pearson Chi-Square	5.751[a]	4	.219	
Likelihood Ratio	6.172	4	.187	
Linear-by-Linear Association	2.303	1	.129	
N of Valid Cases	60			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.33.

Interpretation:

The crosstab shows that the Glycolic acid group experienced the highest rate of moderate burning (50.0%), whereas the Lactic acid group was the best tolerated with 45.0% reporting no sensation. However, the Pearson Chi-Square test yields a p-value of .219, which is above the .05 significance level. This indicates that there is no statistically significant association between the type of treatment and the occurrence of burning sensations.

Figure 5: Post-Treatment Burning Sensations:



Interpretation

The chart shows that the Glycolic acid group experienced the highest frequency of moderate burning sensations compared to the other treatments. Conversely, the Lactic acid group was the best tolerated, with the majority of patients reporting no burning at all. This suggests that while all treatments were effective, Lactic acid provided the most comfortable patient experience regarding skin irritation.

Table 5: *Group of patients Dryness*

		Crosstab	Dryness of patient None	Mild	Moderate	Total
Group of patient	Lctic	Count	5	6	9	20
		Expected Count	6.7	7.0	6.3	20.0
		% within Group of patient	25.0%	30.0%	45.0%	100.0%
	Glycolic	Count	6	6	8	20
		Expected Count	6.7	7.0	6.3	20.0
		% within Group of patient	30.0%	30.0%	40.0%	100.0%
	Mandelic	Count	9	9	2	20
		Expected Count	6.7	7.0	6.3	20.0
		% within Group of patient	45.0%	45.0%	10.0%	100.0%
Total		Count	20	21	19	60
		Expected Count	20.0	21.0	19.0	60.0
		% within Group of patient	33.3%	35.0%	31.7%	100.0%

Chi-Square Tests

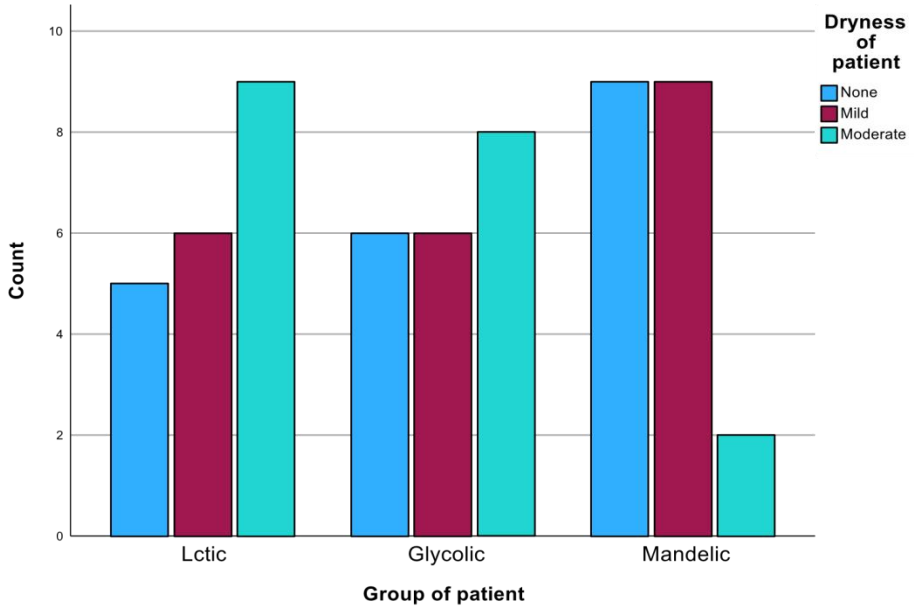
	Value	df	Asymptotic Significance (2sided)
Pearson Chi-Square	6.683[a]	4	.154
Likelihood Ratio	7.537	4	.110
Linear-by-Linear Association	4.578	1	.032
N of Valid Cases	60		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.33.

Interpretation:

Mandelic acid was the best-tolerated treatment, with 45% of patients reporting no dryness, whereas the Lactic group showed the highest moderate dryness (45%). However, the Chi-Square p-value of .154 indicates that there is no statistically significant association between the treatment type and the resulting dryness levels. This suggests that the differences observed in skin hydration across the groups are likely due to random chance.

Figure: 6 Post-Treatment Dryness Levels:



Interpretation

The data shows that the Lactic and Glycolic acid groups experienced higher frequencies of moderate dryness compared to the Mandelic group. In contrast, patients treated with Mandelic acid reported the best skin hydration, with the highest count of "None" and "Mild" dryness and very few moderate cases. This suggests that Mandelic acid is significantly less drying than the other two chemical treatments.

Table 6: *Group of patients Peeling*

Crosstab			Peeling of patient None	Mild	Moderate	Total
Group of patient	Lctic	Count	7	7	6	20
		Expected Count	6.7	6.0	7.3	20.0
		% within Group of patient	35.0%	35.0%	30.0%	100.0%
	Glycolic	Count	7	1	12	20
		Expected Count	6.7	6.0	7.3	20.0
		% within Group of patient	35.0%	5.0%	60.0%	100.0%
	Mandelic	Count	6	10	4	20
		Expected Count	6.7	6.0	7.3	20.0
		% within Group of patient	30.0%	50.0%	20.0%	100.0%
Total		Count	20	18	22	60
		Expected Count	20.0	18.0	22.0	60.0
		% within Group of patient	33.3%	30.0%	36.7%	100.0%

Chi-Square Tests

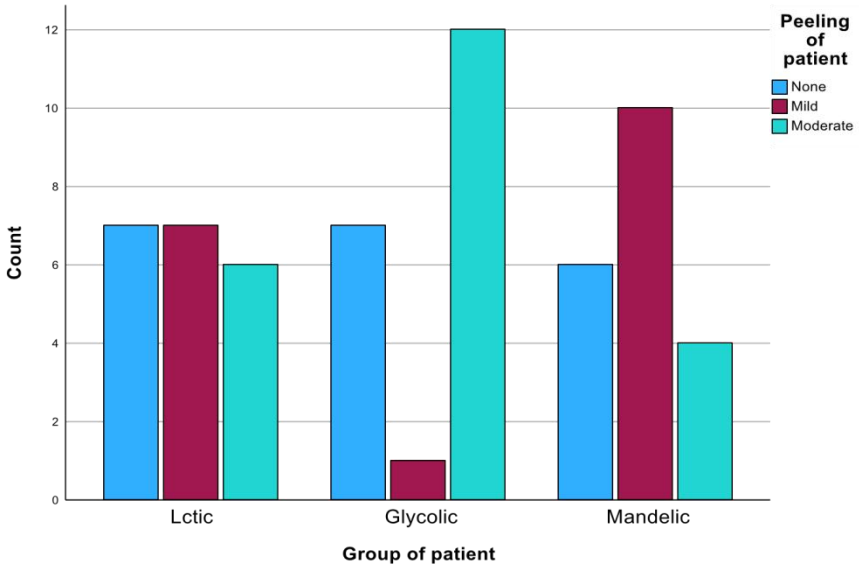
	Value	df	Asymptotic Significance (2sided)
Pearson Chi-Square	11.827[a]	4	.019
Likelihood Ratio	13.455	4	.009
Linear-by-Linear Association	.035	1	.851
N of Valid Cases	60		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.00.

Interpretation:

The data indicates that the Glycolic acid group experienced the highest frequency of moderate peeling (60%), while the Mandelic acid group reported the highest rate of mild peeling (50%). The Pearson Chi-Square p-value of .019 confirms a statistically significant association between the treatment type and the degree of skin peeling. This suggests that the choice of chemical peel directly influences the intensity of post-treatment peeling.

Figure: 7 Post-Treatment Peeling Levels:



Interpretation:

Glycolic acid caused the most moderate peeling (60%), while Mandelic acid resulted in primarily mild peeling (50%). A p-value of .019 confirms a statistically significant association, meaning the choice of peel directly impacts peeling intensity.

Table 7: *Group of patients PIH*

		Crosstab	PIH of patient None	Mild	Total
Group of patient	Lctic	Count	8	12	20
		Expected Count	8.3	11.7	20.0
		% within Group of patient	40.0%	60.0%	100.0%
	Glycolic	Count	10	10	20
		Expected Count	8.3	11.7	20.0
		% within Group of patient	50.0%	50.0%	100.0%
	Mandelic	Count	7	13	20
		Expected Count	8.3	11.7	20.0
		% within Group of patient	35.0%	65.0%	100.0%
Total		Count	25	35	60
		Expected Count	25.0	35.0	60.0
		% within Group of patient	41.7%	58.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic (2sided)	Significance
Pearson Chi-Square	.960[a]	2	.619	
Likelihood Ratio	.959	2	.619	

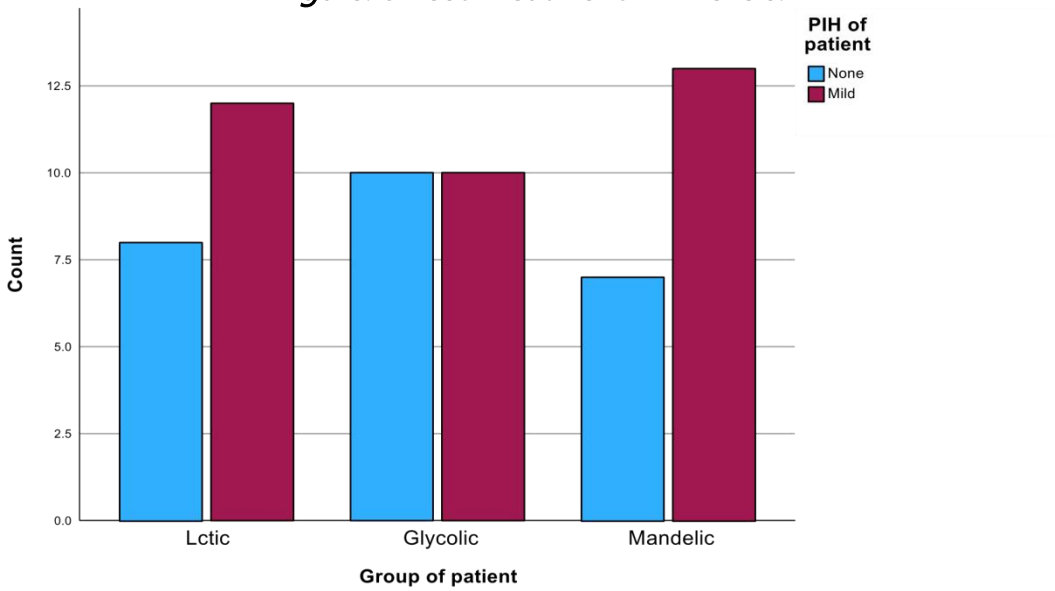
Linear-by-Linear Association	.101	1	.750
N of Valid Cases	60		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.33

Interpretation:

The Chi-square test showed no statistically significant association between treatment groups and post-inflammatory hyperpigmentation (p = 0.619). Although mild differences were observed among groups, they were not statistically significant.

Figure: 8 Post-Treatment PIH Levels:



Interpretation:

The graph shows that mild post-inflammatory hyperpigmentation was more frequent in the mandelic acid group, while the glycolic acid group showed a higher proportion of patients with no PIH. No moderate or severe PIH was observed in any group.

DISCUSSION

The AHA formulation used in this study demonstrated clear improvement in both acne vulgaris and overall skin appearance. Among the different alpha hydroxy acids, glycolic acid is known for its ability to penetrate the skin more quickly and deeply, which enhances its effect on increasing cell turnover. Normally, the skin renewal cycle takes about four to five weeks; however, the use of topical glycolic acid can accelerate this process. This faster renewal contributes to its effectiveness in managing acne. Although

higher concentrations, up to 70%, have been explored in various studies, a 15% concentration has been found to be safe and well-tolerated, making it suitable for use in home-based skincare treatments (36).

Lipohydroxy acid (LHA), also referred to as octanoyl salicylic acid or 2-hydroxy-5-octanoyl benzoic acid, is a lipophilic derivative of salicylic acid. Its structure includes a fatty acyl chain attached to the benzene ring, which enhances its affinity for lipids. This property allows LHA to act more precisely within the epidermis and sebaceous follicles, where it promotes gentle and uniform exfoliation by separating keratinocytes. Compared to salicylic acid, LHA demonstrates a more targeted mechanism and stronger keratolytic activity due to its increased lipophilicity. It is typically used in concentrations ranging from 5–10% and does not require neutralization. In addition to its exfoliating effects, LHA also exhibits antibacterial, anti-inflammatory, and noncomedogenic properties (26).

Alpha hydroxy acids (AHAs), including glycolic, lactic, and mandelic acids, are widely utilized in chemical peeling procedures due to their exfoliating properties. They act by removing the superficial layer of the skin and accelerating cell renewal, which helps in reducing acne lesions, enhancing skin texture, and lightening post-inflammatory hyperpigmentation. Among beta hydroxy acids (BHAs), salicylic acid is the most commonly used in peels. Its ability to penetrate into sebaceous glands allows it to clear clogged pores, making it particularly effective for acne and blackheads. Additionally, its anti-inflammatory effects help minimize redness and swelling associated with acne. Trichloroacetic acid (TCA), on the other hand, is typically used for medium to deep chemical peels and is more suitable for treating acne scars rather than active acne. It works by stimulating collagen synthesis and encouraging skin regeneration, thereby improving the overall appearance of scarred skin (37).

Salicylic acid (SA), a naturally derived beta-hydroxy acid obtained from willow bark, is commonly used in chemical peeling at concentrations ranging from 20% to 30%. At these levels, it does not require neutralization and is generally well tolerated. Research has shown that salicylic acid is effective in managing melasma, particularly in individuals with skin of colour, although its use in post-inflammatory hyperpigmentation (PIH) has been less extensively studied. The treatment is typically associated with only mild adverse effects, such as dryness, itching, and slight redness. Comparative studies have further indicated that salicylic acid demonstrates similar effectiveness in treating melasma when compared to 4% hydroquinone, Jessner's solution, and topical tretinoin (15).

This highlights the need to understand factors behind the higher risk of post-inflammatory hyperpigmentation (PIH) and scarring, especially in darker skin. Reduced microvascular function, ongoing low-level inflammation, and increased oxidative stress may contribute to this susceptibility. Altered inflammatory responses and disruptions in epidermal renewal, particularly in conditions like atopic dermatitis, can further promote hyperpigmentation. Since the skin acts as an immune organ with cells such as macrophages, NK cells, and CD8+ T cells, variations in their activity may also play a role. Increased inflammatory signaling is a key factor in excessive scarring, a common complication of PIH (38).

Individuals with darker skin tones have a greater tendency to develop post-inflammatory hyperpigmentation (PIH) due to a combination of molecular, cellular, and structural factors. Increased pigmentation is associated with larger melanocytes that transfer more melanosomes to the epidermis, driven by higher tyrosinase activity and more developed dendritic structures. Structural variations in the epidermis and the dermal–epidermal junction, along with increased oxidative stress, reduced microvascular function, and elevated inflammatory markers such as interleukin-6 and C-reactive protein, further contribute to this susceptibility. In addition, lower use of photoprotection may worsen outcomes. PIH can persist for months or even years and, in some cases, may become permanent, reflecting the challenges in its treatment and clearance. Acne is the most common underlying inflammatory cause, while laser procedures are a leading external trigger. Although the exact mechanism of laser-induced hyperpigmentation is not fully understood, it is likely related to heat generation within the skin (14).

Recent research indicates that post-inflammatory hyperpigmentation (PIH) can present with different histological patterns depending on the layer of skin involved. In epidermal PIH, increased pigmentation is mainly due to a rise in the number, size, and activity of melanocytes, leading to higher melanin content within the epidermis with little involvement of the dermis. In contrast, when conditions affect the basement membrane zone, such as in certain inflammatory skin disorders, damage to basal keratinocytes allows melanin to enter and accumulate in the dermis, resulting in deeper pigmentation that appears slate-gray or blue-black clinically. Two main mechanisms have been suggested to explain this dermal deposition: one involves the direct transfer of melanosomes from melanocytes through disruptions in the basal layer, while the other proposes that free melanosomes are engulfed by macrophages, which then migrate into the dermis (39).

Acne-induced post-inflammatory hyperpigmentation (PIH) may develop even in the absence of obvious visible inflammation, and it can occur in individuals with mild to moderate acne. In routine clinical practice, the severity of PIH is usually assessed through visual examination; however, there is a lack of simple, standardized scoring systems and clear treatment algorithms for everyday use. Recent developments have introduced practical tools and structured approaches to improve the assessment and management of acne-related PIH. Acne vulgaris is a common chronic inflammatory skin condition, most frequently seen in adolescents but increasingly reported among adults. It affects all skin types and, in more severe cases, may lead to scarring as well as PIH. This condition represents an acquired pigmentation disorder resulting from internal inflammatory processes, such as acne, as well as external factors like skin injury or cosmetic procedures. In individuals with darker skin tones, the inflammatory component may be subtle or not easily visible, which can make early detection and management more challenging (40).

7.1: CONCLUSION

The present study concludes that chemical peels are an effective and safe therapeutic option for the management of acne and its associated skin concerns. All three treatment modalities demonstrated noticeable clinical improvement in acne severity, hyperpigmentation, skin texture, pore size, and oiliness. Among the different peels evaluated, lactic acid showed comparatively better overall outcomes, followed by mandelic acid, while glycolic acid demonstrated relatively lesser improvement. Despite these differences in efficacy, all treatments were well tolerated and associated with minimal and manageable side effects.

Furthermore, patient satisfaction was generally high, indicating good acceptance of the procedures and perceived improvement in skin condition. In summary, chemical peels provide a reliable, minimally invasive approach for improving both acne and overall skin quality, making them a valuable option in dermatological practice.

7.2: RECOMMENDATION(S)

1. Chemical peels should be considered an effective treatment option for patients with mild to moderate acne and associated skin concerns.
2. Lactic acid peels may be preferred due to their better efficacy and tolerability, especially in sensitive and darker skin types.
3. All chemical peel procedures should be performed under the supervision of trained professionals to ensure safety and optimal outcomes.
4. Proper patient selection and pre-treatment assessment should be carried out to minimize the risk of complications.

5. Patients should be advised to follow strict post-treatment care, including regular use of sunscreen and moisturizers, to prevent adverse effects.
6. Combination therapy with topical treatments may be considered to enhance overall clinical improvement.
7. Public awareness should be increased regarding safe and evidence-based acne treatments to discourage unsafe cosmetic practices.
8. Further studies with larger sample sizes and longer follow-up periods are recommended to strengthen the existing evidence.

7.3: LIMITATION(S)

1. The study was conducted on a relatively small sample size, which may limit the generalizability of the findings.
2. The duration of the study was short, and long-term effects of the treatments were not assessed.
3. The study included only patients within a specific age group, which may not represent all age populations.
4. Subjective grading scales were used for clinical assessment, which may introduce observer bias.
5. The study was conducted at a single center, limiting external validity.
6. Environmental and lifestyle factors that may influence acne were not controlled.
7. Patient adherence to post-treatment care was not strictly monitored.
8. No comparison was made with other advanced or combination treatment modalities.

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