

Comparison of Efficacy of Intense Pulsed Light (IPL) versus 50% Glycolic Acid Peel in the Treatment of Melasma

Rabia Naveed^{1*}, Kehkshan Tahir², Muhammad Omer Altaf³, Khaula Tahir³, Munazza Riaz³, Aitizam Waheed³

¹Department of Dermatology, Rahbar Medical and Dental College Lahore.

²Department of Dermatology, Fatima Jinnah Medical University/ Sir Ganga Ram Hospital, Lahore.

³Department of Dermatology, Lahore General Hospital, Lahore.

Abstract

Background Melasma is an acquired disorder of hyperpigmentation that results from the hyperactivity of melanocytes in the epidermis. Despite different treatment modalities available for melasma, recurrence is a big problem. Intense Pulsed light and Glycolic acid peel are two effective treatment therapies for melasma and there is a lack of local study in this regard.

Objective To compare the efficacy of Intense pulsed light versus 50% glycolic acid peel in the treatment of melasma.

Methods This study was conducted on 92 patients through nonprobability consecutive sampling. The patients were randomly divided into two groups. Group A was treated with Intense Pulsed Light therapy using cut-off filter of 570nm using fluence of 26-33 J/cm² and Group B was treated with Glycolic acid peel (50%), at 3-week interval for a total of four sessions at baseline, 3rd, 6th and 9th week. Efficacy was evaluated at the end of the treatment at 12th week and a $\geq 50\%$ reduction in mMASI score from baseline mMASI score was termed as efficacious.

Results In this study, the mean age of patients was 38.14 years, 77 (83.7%) patients were female, and 15 (16.3%) patients were male. In group A, efficacy was achieved in 26 (56.5%) patients, and in group B, efficacy was achieved in 13 (28.2%) patients ($P < .05$).

Conclusion We concluded that Intense pulsed light therapy is a more efficacious treatment modality as compared to glycolic acid peel in the treatment of melasma.

Keywords Melasma; Intense pulsed light therapy; Glycolic acid peel; mMASI.

Citation: Naveed R, Tahir K, Altaf MO, Tahir K, Riaz M, Waheed A. Comparison of Efficacy of Intense Pulsed Light (IPL) versus 50% Glycolic Acid Peel in the Treatment of Melasma. *J Pak Assoc Dermatol.* 2026;36(2):223-229.

Doi: <https://doi.org/10.66344/jpad.v36i2.3429>

Article
Received on
13.02.2026

Revised on
19.05.2026
10.06.2029

Accepted on
11.06.2026

Published on
30.06.2026

Introduction

Melasma is a common acquired skin condition in which dark brown patches appear on the face, especially on sun-exposed areas such as the cheeks,

forehead, and upper lip.^{1,2} It occurs more frequently in women of reproductive age and in individuals with darker skin types.³ The worldwide prevalence ranges from 0.25 to 4%.²

The condition develops due to increased activity of melanocytes in the epidermis.³ Ultraviolet radiation is considered one of the strongest triggering factors. Hormonal influences, pregnancy, and the use of oral contraceptive pills also contribute to its

Address for correspondence

Dr. Rabia Naveed, Senior Registrar,
Department of Dermatology,
Rahbar Medical & Dental College Lahore.
Email: rabianaveed917@gmail.com

development.⁴ Although melasma does not cause physical harm, it can significantly affect a patient's quality of life by causing emotional and social distress.³

Standard treatment usually includes strict photoprotection with broad-spectrum sunscreen along with topical depigmenting agents such as hydroquinone, retinoids, and azelaic acid.⁵ However, some patients show inadequate response or develop adverse effects. In such cases, procedural therapies including chemical peels, lasers, and light-based treatments are considered.⁶ Despite multiple therapeutic options, management remains challenging due to frequent recurrence and incomplete understanding of its pathogenesis.¹

Intense pulsed light (IPL) is a light-based therapy that targets melanin in the skin. It emits high-intensity, polychromatic light within a specific wavelength range and works on the principle of selective photothermolysis.^{7,8} Studies have reported encouraging outcomes with IPL in patients with melasma.⁹

Glycolic acid peel is one of the most commonly used alpha-hydroxy acid peels in melasma management.^{2,10} It produces controlled exfoliation of the epidermis followed by regeneration, leading to gradual reduction in pigmentation.² Previous studies have shown favorable responses with 50% glycolic acid peel in melasma patients.^{8,10}

Melasma is frequently observed in our local population and continues to pose therapeutic challenges due to recurrence and variable treatment response. To the best of our knowledge, comparative local data evaluating the efficacy of IPL versus 50% glycolic acid peel are scarce to date. Therefore, this study was conducted to compare the effectiveness of these two modalities in the treatment of melasma in our clinical setting.

Methods

This comparative interventional study was

conducted at the Dermatology Department, Lahore General Hospital from January 26 to July 26, 2022. The hospital's ethics committee approved the study under Research No. 00-109-21, dated December 12, 2021. Sample size of 92 cases was calculated using OpenEpi version 3.01 (available at www.openepi.com) with 95% confidence level, 5% margin of error and taking expected efficacy as 30% in Glycolic acid peel group and 55.5% in IPL therapy group. Patients were divided in Group A and B (46 cases each) using lottery method.

Males and females aged 15-45 years and Fitzpatrick skin types III-V who had melasma of any type, duration, and severity were included in the study.

Pregnant or breastfeeding women, individuals who had been taking any melasma treatment in the last 3 months, individuals taking medicines that are known to sensitize the skin e.g. doxycycline, individuals taking hormonal treatment such as birth control in the past year, individuals with any skin conditions, such as acne and eczema, and those who are allergic to the treatments used were not included.

After study approval and patient enrollment, written informed consent was obtained from each participant after explaining the study details clearly.

Patients in Group A were treated with IPL and underwent session once every 3 weeks for 4 sessions (at 0, 3rd, 6th, 9th week). At every treatment, the affected area was treated with a colorless cooling gel and IPL treatment was applied with cut-off filter of 570nm and fluence of 26 to 33 J/cm². In Group B, patients received a 50% glycolic acid peel at the same interval, with one session every 3 weeks for four sessions at baseline, 3rd, 6th, and 9th weeks. Before each session, participants washed their face with water and allowed the skin to dry. Plain Vaseline was applied at sensitive area i.e. around eyes and mouth. The peeling solution was applied to the affected area using a gauze piece. Patients were then observed for 3-5 minutes for the development of erythema, burning, or itching. Once erythema

appeared over the treated area, the peel was neutralized with normal saline.

After each session, SPF-30 sunscreen was applied to patients in both groups and were advised to follow appropriate photoprotection measures.

Both groups were assessed during follow-up visits at the 3rd, 6th and 9th weeks, and at the end of treatment at the 12th week. Clinical observations were recorded, and photographs were taken at each visit. The mMASI score was calculated at baseline, during follow-up, and at the end of treatment. Treatment efficacy was assessed at the 12th week, and a reduction of $\geq 50\%$ in the mMASI score from baseline was considered efficacious.

Data were analysed using SPSS version 24.0. Quantitative variables, such as age, duration of disease, and mMASI score, were reported as mean and standard deviation. Qualitative variables, including gender, site of lesion, and treatment efficacy, were presented as frequencies and percentages. The paired sample t-test was used to compare baseline and post-treatment mMASI scores within each group, while the independent sample t-test was applied to compare the mean change in mMASI score between the two groups. p-values for continuous variables (age and mean disease duration) were calculated using the independent samples t-test. Categorical variables, including gender, duration of disease, severity of disease, and treatment efficacy, were compared between groups using the chi-square test. A P-value of $\leq .05$ was considered statistically significant.

Result

A total of 92 patients with melasma were recruited in this study who were randomized into two groups of 46 patients. Group A received IPL treatment, while Group B was treated with 50% glycolic acid peel. There were no drop-outs or missed treatment sessions in both groups.

The clinicodemographic characteristics were

Table 1 Clinico-demographic data.

	Group A (n=46)	Group B (n=46)	P-value
Age (years)	37.54 ±4.24	38.74±4.19	.18
Gender n(%)			
Male	08 (17%)	07 (15%)	.78
Female	38 (83%)	39 (85%)	
Duration of Melasma (mean)	13.07±2.48 months	14.48±2.81 months	.11
Duration of melasma n(%)			
< 12 months	32 (70%)	29 (63%)	.51
> 12 months	14 (30%)	17 (37%)	
Severity of disease n(%)			
Mild	06 (13%)	05 (11%)	.88
Moderate	26 (56%)	25 (54%)	
Severe	14 (31%)	16 (35%)	

comparable between the two groups, with no statistically significant difference observed at baseline (**Table 1**). The average age of the patients was about 38, and ranged from 28 to 45 years. The mean age was 37.54±4.24 years in Group A and 38.74±4.19 years in Group B. Most patients in both groups belonged to the 31-45 years age group. In Group A, 43 patients (93.5%) were aged 31-45 years, while 3 patients (6.5%) were aged 15-30 years. Similarly, in Group B, 44 patients (95.6%) were in the 31-45 years age group, and 2 patients (4.4%) were aged 15-30 years. The overall study population was mostly female (77, 83.7%) and only 15 male (16.3%) (**Table 1**).

The study participants had lesions of melasma located at different sites of the face. In group A, forehead was the most commonly affected area, that is, involving 26 (57%) patients, followed by the chin (11% of cases), left cheek (11% of cases) and right cheek (8% of cases). Forehead involvement was also the most common seen in Group B (24 patients, 52%). In 11 patients the left cheek and chin were involved (24% of each) (**Figure 1**).

The mean duration of disease was 13.07±2.48 months in Group A and 14.48±2.81 months in Group B. Regarding disease severity, most patients in both groups had moderate melasma. In Group A, 6 patients (13%) had mild, 26 patients (56%) had moderate, and 14 patients (31%) had severe

Table 2 Comparison of mMASI scores and mean change between groups. (n=92)

Group	Baseline mMASI (Mean±SD)	Post-treatment mMASI (Mean±SD)	Intragroup p-value	Mean Change in mMASI (Mean±SD)	Intergroup P-value
Group A	16.39±1.693	8.13±4.020	<.001	8.13±2.65	.001
Group B	16.26±1.324	9.98±3.448	<.001	6.17±2.03	

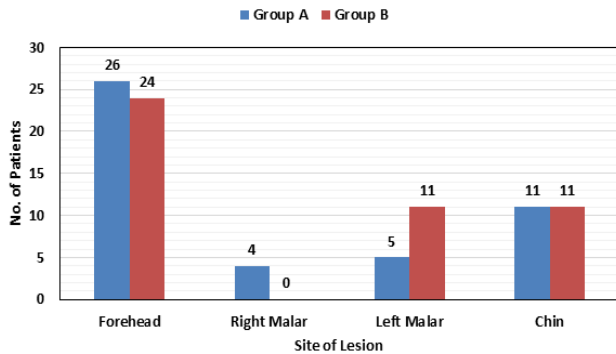


Figure 1 Frequency distribution according to site.

melasma. Similarly, in Group B, 5 patients (11%) had mild, 25 patients (54%) had moderate, and 16 patients (35%) had severe melasma (**Table 1**).

The mean mMASI score at baseline was similar between the two groups: 16.39 ± 1.693 in Group A and 16.26±1.324 in Group B, and both groups improved after treatment: 8.13±4.020 in Group A and 9.98±3.448 in Group B (**Table 2**). There was a greater mean reduction in mMASI score for Group A than Group B (8.13±2.65 vs. 6.17±2.03, $P < .05$), with a mean difference of 1.96 points (95% CI: 0.98-2.94) and a large effect size (Cohen’s $d=0.83$) (**Table 2**). Treatment efficacy was also higher among patients treated with IPL. The difference between the two groups was statistically significant ($P < .05$) with a higher percentage of good improvement in Group A (26 patients, 56.5%) than in Group B (13 patients, 28.2%) (RR=2.00; 95% CI: 1.18-3.38) (**Table 3**).

Subgroup analysis showed that patients aged above 30 years had better treatment response in Group A than in Group B (58.1% vs. 29.5%, $P < .05$).

Table 3 Comparison of efficacy (n= 92).

Efficacy	Group		P-value
	A n(%)	B n(%)	
Yes	26 (56.5%)	13 (28.2%)	.006
No	20 (43.47%)	33 (71.73%)	

Table 4 Stratification of data.

Groups	Efficacy	Group A	Group B	P-value
<i>Age (years)</i>				
≤ 30	Yes	1 (33%)	0 (0%)	.782
	No	2 (67%)	2 (100%)	
>30	Yes	25 (58%)	13 (30%)	.007
	No	18 (42%)	31 (70%)	
<i>Gender</i>				
Male	Yes	5 (62%)	2 (29%)	.121
	No	3 (38%)	5 (71%)	
Female	Yes	21 (55%)	11 (28%)	.016
	No	17 (45%)	28 (72%)	
<i>Duration of lesions (months)</i>				
≤12	Yes	20 (63%)	11 (38%)	.005
	No	12 (37%)	18 (62%)	
>12	Yes	6 (42%)	2 (12%)	.339
	No	8 (58%)	15 (88%)	
<i>Severity of disease</i>				
Mild	Yes	3 (50%)	1 (20%)	.093
	No	3 (50%)	4 (80%)	
Moderate	Yes	14 (54%)	9 (36%)	.119
	No	12 (46%)	16 (64%)	
Severe	Yes	9 (64%)	3 (18%)	.001
	No	5 (36%)	13 (82%)	

Among females, efficacy was seen in 55.2% of patients in Group A and 28.2% of patients in Group B, ($P < .05$). Patients with severe melasma responded better to IPL, with improvement seen in 64.2% of Group A compared to 18.7% of Group B ($P < .05$); similarly, patients with a disease duration of less than 12 months responded better to IPL than Group B (62.5% vs. 38%, $P < .05$) (**Table 4**).

Discussion

Melasma is a chronic, acquired hyperpigmentation disorder affecting sun-exposed facial areas, with a strong predilection for women of reproductive age and darker skin phototypes.^{16,17} Its multifactorial pathogenesis-involving UV radiation, hormonal influences, genetic susceptibility, and dermal micro-environmental changes-renders it prone to relapse, making effective procedural options a persistent

clinical need.¹⁸

The mean age in our cohort (38.14 years, predominantly 31-45 years) is consistent with Achar and Rathi¹² (mean 33.45 years) and Desale *et al.*¹³ (20-46 years); the slightly older mean in our series reflects tertiary-centre referral patterns, where patients typically present after failed topical therapy. Female predominance (83.7%) aligns with the hormonal basis of melanocyte hyperactivity seen across comparable series. Forehead was the most affected site in both groups (57% vs. 52%), mirroring centrofacial predominance (54.44%) reported by Achar and Rathi,¹² consistent with the higher density of hormonally responsive melanocytes in sun-exposed central facial areas among Fitzpatrick types III-V.

The primary finding-IPL superior to 50% glycolic acid peel in efficacy (56.5% vs. 28.2%, $P<.05$) and mean mMASI reduction (8.13 ± 2.65 vs. 6.17 ± 2.03 , $P<.05$) aligns with IPL's mechanism: polychromatic light delivered through a 570 nm filter induces selective photothermolysis, disrupting melanosomes at both epidermal and superficial dermal levels simultaneously.⁷ Glycolic acid peel works purely through epidermal exfoliation and keratinocyte turnover, limiting its reach in patients with dermal or mixed melanin- a common presentation in phototypes III-V. Our IPL rate aligns with Zoccali *et al.*¹⁵ who achieved good-to-excellent responses in 76.5% using a 550 nm filter over five sessions (versus our four); the higher response there likely reflects more sessions and longer inter-session intervals. Naheed *et al.*¹¹ reported a comparable mMASI reduction (14.22 ± 5.32 to 7.41 ± 3.5) with four IPL sessions in a Pakistani cohort, supporting regional applicability. Desale *et al.*¹³ reported higher glycolic acid peel efficacy (66.38%) than IPL (63.33%), likely because they employed step-up concentrations with pre-peel priming (retinoids, sunscreen)- a protocol known to enhance penetration and reduce post-inflammatory hyperpigmentation risk; whereas no priming was used in our study. Their variable IPL filter settings versus our fixed

570 nm protocol and the predominantly Fitzpatrick type IV-V phenotype of our cohort (in whom peels carry higher PIH risk) further explain the divergence.

Subgroup analysis revealed three clinically important patterns. Female patients responded significantly better to IPL (55.2% vs. 28.2%, $P<.05$), consistent with oestrogen and progesterone directly upregulating melanogenic pathways and producing a more photosensitive pigmentary apparatus that responds more robustly to selective photothermolysis.¹⁹ Patients with severe melasma showed the strongest IPL advantage (64.2% vs. 18.7%, $P<.05$): severe disease commonly involves both epidermal and dermal melanin components, and glycolic acid peel's superficial exfoliative action is inherently restricted in such cases, whereas IPL's polychromatic output targets multiple tissue depths in a single session. Finally, patients with disease duration under 12 months responded better to IPL (62.5% vs. 38%, $P<.05$), consistent with Desale *et al.*¹³ who similarly observed superior outcomes with shorter disease duration. Early melasma is predominantly epidermal, with melanin more amenable to photothermolytic disruption; longstanding lesions accumulate deeper dermal melanophages deposition that neither modality reaches effectively.

Conclusion

IPL therapy is significantly more efficacious than 50% glycolic acid peel in treating melasma over a 12-week course, with superior mMASI score reduction and overall treatment response. IPL is particularly effective in melasma as its multi-depth photo-thermolytic mechanism confers a distinct advantage over superficial chemical exfoliation. These findings are clinically relevant in the South Asian context, where melasma in Fitzpatrick phototypes III-IV is prevalent and comparative procedural data remain limited. Future studies should incorporate longer follow-up to assess durability of response and evaluate IPL-based

combination regimens to optimize outcomes in this challenging condition.

Limitations Several limitations of this study merit acknowledgement. First, the post-treatment follow-up was confined to 12 weeks, which is insufficient to assess durability of response or recurrence rates- a particularly relevant concern in melasma. Second, the study was conducted at a single centre, and the range of IPL devices available varies considerably across institutions, limiting direct cross-device generalisability. Third, neither blinded outcome assessment nor a sham-control arm was included, which introduces the possibility of observer bias in clinical photography review.

Strengths To the best of our knowledge, this is the first randomised comparative study evaluating IPL against 50% glycolic acid peel for melasma in a Pakistani population, directly addressing a significant gap in regional evidence

Declaration of patient consent Authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship None.

Conflict of interest No conflict of interest.

Author's contribution

RN: Substantial contribution to conception and design, acquisition, acquisition analysis and interpretation of data and has been involved in manuscript writing.

KaT: Substantial contribution to conception and design and critical review of the manuscript.

MOA: Substantial contribution to acquisition of data, manuscript writing.

KhT,MR: Substantial contribution to analysis and interpretation of data and critical review of the manuscript.

AW: Substantial contribution to acquisition of data, critical review of the manuscript.

Every author has given final approval of the manuscript version to be published and agreed to be accountable for all aspects of the work.

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