Original Article

Comparative Study of 15% TCA Peel Versus 35% Glycolic Acid Peel for the Treatment of Melasma: A Randomised Controlled Trial

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Abstract

Background: Melasma is a common acquired hypermelanosis with significant cosmetic and psychosocial impact. Chemical peels are widely used as adjunctive treatment modalities. The aim is to evaluate the safety and effectiveness of 35% glycolic acid (GA) and 15% trichloroacetic acid (TCA) peels for melasma patients. **Material and Methods:** Settings and Design: Single-centre, randomized controlled trial conducted in the Department of Dermatology, Teerthanker Mahaveer Medical College and Research Centre, Moradabad. A total of 108 patients with melasma refractory to first-line therapy were randomized into two groups: Group B (n = 54) received 35% glycolic acid peel, while Group A received 15% TCA peel. Patients underwent three peeling sessions at four-week intervals following a two-week priming period with 4% hydroquinone. The Melasma Area and Severity Index (MASI) and dermoscopic examination were used for clinical evaluation at baseline, four, and eight weeks. Statistical Analysis Used: The Chi-square test, Student's t-test, and descriptive statistics were used. Statistical significance was defined as a p-value of less than 0.05. **Results:** The MASI scores for both groups significantly decreased from baseline to eight weeks. The mean MASI dropped from 23.90±6.16 to 16.35±5.59 in the GA group and from 23.85±6.01 to 16.20±5.05 in the TCA group. The differences between the groups were not statistically significant (p=0.885). Adverse effects and improvements in dermoscopy were similar in both groups. **Conclusion:** There is no discernible difference in the safety and effectiveness of 15% TCA peel and 35% glycolic acid peel as melasma treatments.

Keywords: Melasma, Trichloroacetic Acid, Glycolic Acid, Chemical Peel, MASI, Dermoscopy, Randomised Controlled Trial.

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Introduction

Melasma is a chronic acquired hyperpigmentary disorder that commonly affects individuals with darker skin phototypes and has a substantial psychosocial impact. Chemical peels such as glycolic acid and trichloroacetic acid (TCA) are widely used as adjunctive therapies, and previous studies have demonstrated their efficacy and safety in the management of melasma.[1-6] Dermoscopy has emerged as a useful non-invasive tool for evaluating treatment response.[4] In order to compare 15% TCA peel with 35% glycolic acid peel in melasma patients, this randomized controlled experiment assessed changes in MASI scores, dermoscopic characteristics, and side effects associated with the treatment.

Materials and Methods

Trial Design: This study used a 1:1 allocation ratio and was a prospective, parallel-group, randomized controlled experiment. A 15% trichloroacetic acid (TCA) peel (Group A) or a 35% glycolic acid (GA) peel (Group B) were given to participants at random. No important changes were made to the study methodology, eligibility criteria, interventions, or outcome measures after trial commencement.

Participants: Inclusion criteria were patients clinically diagnosed with melasma not responding to first-line therapy and willing to provide informed consent. Exclusion criteria included pregnancy, lactation, open wounds, active bacterial or viral infections, herpes simplex, viral warts, molluscum contagiosum, history of photosensitive drug or oral contraceptive use, abnormal scarring, atrophic skin, isotretinoin use within the previous six months, and hypersensitivity to TCA or glycolic acid.

Settings and Locations: The study was carried out at the Teerthanker Mahaveer Medical College and Research Center's Department of Dermatology, Venereology, and Leprology in Moradabad, Uttar Pradesh, India. The Dermatology Outpatient Department was the source of the participants. The trial was registered under the registration number CTRI/2025/01/079337 with the Clinical Trials Registry–India (CTRI).

Interventions: All participants underwent a two-week priming phase with topical 4% hydroquinone cream. Thereafter, Group A

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received 15% TCA peel, and Group B received 35% glycolic acid peel. Chemical peels were applied under standardized conditions at four-week intervals for a maximum of three sessions or until satisfactory clearance of lesions. Participants were advised strict photoprotection throughout the study period.

Outcomes

Primary and Secondary Outcome Measures

The Melasma Area and Severity Index (MASI) score change from baseline to eight weeks was the main end measure. MASI scores were evaluated in the beginning, 4 weeks, and 8 weeks. Secondary outcome measures included dermoscopic improvement in pigmentation patterns and assessment of adverse effects such as erythema, burning, dryness, acneiform eruptions, and post-inflammatory hyperpigmentation.

No changes were made to the predefined outcome measures after commencement of the trial.

Sample Size

Sample Size Determination: The sample size was calculated using means and standard deviations derived from previous studies, assuming a 95% confidence interval and 80% study power. The calculated sample size was 49 participants per group. After accounting for an anticipated 10% loss to follow-up, a total sample size of 108 participants (54 per group) was included.

Interim Analyses and Stopping Guidelines: No interim analyses or predefined stopping guidelines were planned or implemented during the study.

Randomisation Sequence Generation: Method Used to Generate the Random Allocation Sequence

A computer-generated random allocation sequence was used to assign participants to either the TCA or glycolic acid group.

Type of Randomisation: Simple randomisation with a 1:1 allocation ratio was employed.

Allocation Concealment Mechanism Allocation Concealment: Sequentially numbered, opaque, sealed materials were used to hide the allocation order envelopes that were only opened following the enrollment of participants.

Implementation: An investigator who was not involved in outcome evaluation created the random allocation sequence. The lead investigator recruited eligible individuals and used the hidden allocation procedure to assign them to interventions.

Blinding: Due to the nature of the interventions, participants and treating physicians were not blinded. Outcome assessment was performed using objective MASI scoring and dermoscopic evaluation.

Similarity of Interventions: Both interventions involved standardised chemical peeling procedures performed at identical intervals and follow-up schedules.

Statistical Methods: Statistical Methods for Primary and Secondary Outcomes

Qualitative factors were displayed as percentages and frequencies, whereas quantitative values were given as mean ± standard deviation. For comparing continuous variables between groups, the student's t-test was employed; for categorical variables, the Chi-square test was employed. Statistical significance was defined as a p-value of less than 0.05.

Additional Analyses: No subgroup analyses, adjusted analyses, or exploratory analyses were prespecified or performed.

Results

Participant Flow: A total of 108 patients with melasma fulfilling the eligibility criteria were enrolled and randomised in a 1:1 ratio into two groups. Fifty-four participants were allocated to Group A (15% TCA peel) and 54 participants to Group B (35% glycolic acid peel). All randomised participants received the allocated intervention and completed the scheduled follow-up assessments. The final analysis of the primary outcome included all 108 individuals. [Figure 1]

Losses and Exclusions: No participants were lost to follow-up or excluded after randomization. Therefore, outcome data were available for all randomised participants.

Recruitment: Recruitment and Follow-up

Participant recruitment and follow-up were conducted during the 18-month study period following approval from the Institutional Ethics Committee and registration with CTRI (CTRI/2025/01/079337). Each participant was followed for 8 weeks after initiation of treatment.

Trial Completion: The trial was completed as planned after achieving the required sample size and follow-up period. No premature termination or stopping criteria were applied.

Baseline Data

Baseline Characteristics: The two group's baseline clinical and demographic traits were similar. The majority of participants were females (88.9% in Group A and 87.0% in Group B). Mean age of onset was 29.5 ± 5.7 years in Group A and 28.0 ± 5.2 years in Group B (p=0.149).

Centro facial melasma was the most common clinical pattern (61.1% vs 64.8%), while epidermal melasma was the predominant dermoscopic subtype (44.4% vs 38.9%). Baseline MASI scores were comparable between groups (23.85 ± 6.01 vs 23.90 ± 6.16; p=0.962). [Table 1]

Numbers Analysed: All analyses were performed according to the original treatment allocation. Fifty-four participants in each group (n=108) were included in the primary and secondary outcome analyses.

Outcomes and Estimation Primary Outcome: The primary outcome was the change in MASI score over 8 weeks.

In Group A (15% TCA peel), the mean MASI score decreased from 23.85 ± 6.01 at baseline to 20.05 ± 5.14 at 4 weeks and 16.20 ± 5.05 at 8 weeks.

In Group B (35% glycolic acid peel), mean MASI score decreased from 23.90 ± 6.16 at baseline to 20.17 ± 5.69 at 4 weeks and 16.35 ± 5.59 at 8 weeks. [Table 2]

Intergroup comparison demonstrated no statistically significant difference at baseline (p=0.962), 4 weeks (p=0.915), or 8 weeks (p=0.885), indicating comparable efficacy of both peeling agents.

Secondary Outcomes: Dermoscopic evaluation showed both groups' gradual improvement. At eight weeks, 75.9% of patients in the TCA group and 66.7% of individuals in the glycolic acid group had no discernible dermoscopic abnormalities. There was no statistically significant difference between the groups (p=0.389). [Table 3]

Binary Outcomes: No binary efficacy outcomes were predefined. Therefore, absolute and relative effect sizes were not calculated.

Ancillary Analyses: Subgroup analyses based on age, sex, Fitzpatrick skin type, pattern of melanosis, site of involvement, triggering factors, and associated dermatological or medical conditions revealed no significant differences between treatment groups. No adjusted analyses were performed.

All analyses were prespecified and exploratory analyses were not undertaken.

Adverse Events: Both treatments were well received. Dryness, a slight burning feeling, and temporary erythema were the most frequent side effects. In Group A, dryness occurred in 33.3%, mild burning in 27.8%, transient erythema in 25.9%, acneiform eruptions in 5.6%, and post-inflammatory hyperpigmentation in 7.4% of participants. In Group B, dryness occurred in 37.0%, transient erythema in 31.5%, mild burning in 22.2%, acneiform eruptions in 5.6%, and post-inflammatory hyperpigmentation in 3.7% of participants. No statistically significant difference in adverse effects was observed between groups (p=0.845). There were no reports of Ochronosis, depigmentation, or significant adverse effects. [Table 4]

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants

Variable	Group A (15% TCA) n=54	Group B (35% Glycolic Acid) n=54	p-value
Age (years), Mean ± SD	34.3 ± 7.1	33.8 ± 6.8	NS
Gender			
Female, n (%)	48 (88.9)	47 (87.0)	NS
Male, n (%)	6 (11.1)	7 (13.0)	NS
Fitzpatrick skin type			NS
Type III, n (%)	Comparable	Comparable	
Type IV, n (%)	Comparable	Comparable	
Type V, n (%)	Comparable	Comparable	
Clinical pattern of melasma			NS
Centrofacial, n (%)	33 (61.1)	35 (64.8)	
Malar, n (%)	18 (33.3)	16 (29.6)	
Mandibular, n (%)	3 (5.6)	3 (5.6)	
Dermoscopic subtype			NS
Epidermal	24 (44.4)	21 (38.9)	
Mixed	20 (37.0)	24 (44.4)	
Dermal	10 (18.5)	9 (16.7)	
Associated dermatological conditions			0.891
Acne vulgaris/Post-acne pigmentation	14 (25.9)	10 (18.5)	
Freckles/Lentigines	10 (18.5)	9 (16.7)	
Periorbital hyperpigmentation	9 (16.7)	11 (20.4)	
Seborrheic dermatitis	6 (11.1)	7 (13.0)	
No associated dermatological condition	15 (27.8)	17 (31.5)	
Associated medical conditions			0.999
Anemia	10 (18.5)	10 (18.5)	
Diabetes mellitus	4 (7.4)	4 (7.4)	
Hypertension	7 (13.0)	6 (11.1)	
Polycystic ovarian syndrome	7 (13.0)	7 (13.0)	
No associated medical condition	26 (48.1)	27 (50.0)	
Baseline MASI Score, Mean ± SD	23.85 ± 6.01	23.90 ± 6.16	0.962

Abbreviations: TCA = Trichloroacetic Acid; MASI = Melasma Area and Severity Index; SD = Standard Deviation; NS = Not Statistically Significant.

Table 2: Comparison of MASI Scores Between TCA 15% and Glycolic Acid 35%

Time Point	TCA 15% (n=54) Mean ± SD	Glycolic Acid 35% (n=54) Mean ± SD	p-value
Baseline (0 weeks)	23.85 ± 6.01	23.90 ± 6.16	0.962
4 weeks	20.05 ± 5.14	20.17 ± 5.69	0.915
8 weeks	16.20 ± 5.05	16.35 ± 5.59	0.885

Abbreviations: MASI = Melasma Area and Severity Index; TCA = Trichloroacetic Acid; SD= Standard Deviation; n = Sample size.

Table 3: Dermoscopic Outcomes in TCA 15% and Glycolic Acid 35% Groups

Dermoscopic Feature	Baseline n (%)	4 Weeks n (%)	8 Weeks n (%)
TCA Group (n=54)			
Nil	0	21 (38.9)	41 (75.9)
Granules/Dots	10 (18.5)	6 (11.1)	2 (3.7)
Perifollicular Pattern	8 (14.8)	4 (7.4)	2 (3.7)
Reticuloglobular Pattern	22 (40.7)	14 (25.9)	8 (14.8)
Telangiectasia	3 (5.6)	1 (1.9)	0
Unpatterned Pigmentation	11 (20.4)	8 (14.8)	1 (1.9)
Glycolic Acid Group (n=54)			

Nil	0	22 (40.7)	36 (66.7)
Granules/Dots	10 (18.5)	4 (7.4)	1 (1.9)
Perifollicular Pattern	9 (16.7)	6 (11.1)	3 (5.6)
Reticuloglobular Pattern	22 (40.7)	13 (24.1)	7 (13.0)
Telangiectasia	5 (9.3)	2 (3.7)	1 (1.9)
Unpatterned Pigmentation	8 (14.8)	7 (13.0)	6 (11.1)

Abbreviations: TCA, trichloroacetic acid; n, number of participants. Data are presented as n (%)

Table 4: Adverse Effects Following Chemical Peels

Adverse Effect	TCA 15% n (%)	Glycolic Acid 35% n (%)	p-value
Acneiform Eruptions	3 (5.6)	3 (5.6)	
Dryness	18 (33.3)	20 (37.0)	
Mild Burning	15 (27.8)	12 (22.2)	
Post-inflammatory Hyperpigmentation	4 (7.4)	2 (3.7)	
Transient Erythema	14 (25.9)	17 (31.5)	
Overall comparison			0.845

Abbreviations: TCA, trichloroacetic acid; n, number of participants; PIH, post-inflammatory hyperpigmentation (if abbreviated in the manuscript). Data are presented as n (%).

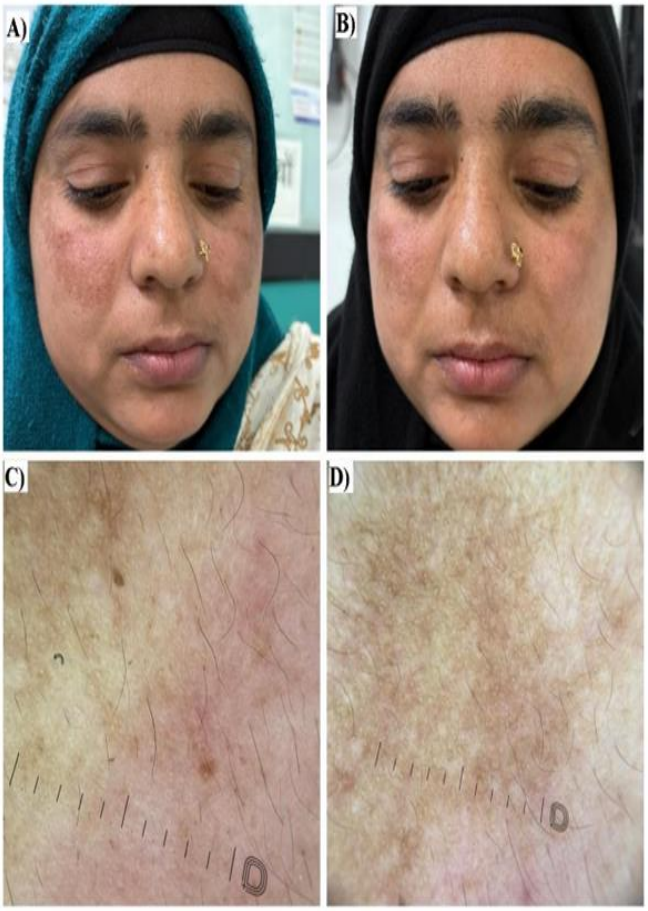

Figure 1: Clinical and dermoscopic photographs demonstrating the therapeutic response to 35% glycolic acid after 8 weeks. (A) Baseline clinical photograph (0 weeks) showing bilateral facial hyperpigmentation. (B) Clinical photograph obtained after 8 weeks of treatment with 35% glycolic acid, demonstrating visible reduction in pigmentation and improvement in overall skin tone. (C) Baseline dermoscopic image (0 weeks) showing a prominent brown pseudonetwork with increased pigment density and heterogeneous pigmentation. (D) Dermoscopic image after 8 weeks of 35% glycolic acid treatment, demonstrating reduction in the brown pseudonetwork, decreased pigment density, and improved pigment homogeneity, consistent with clinical improvement.

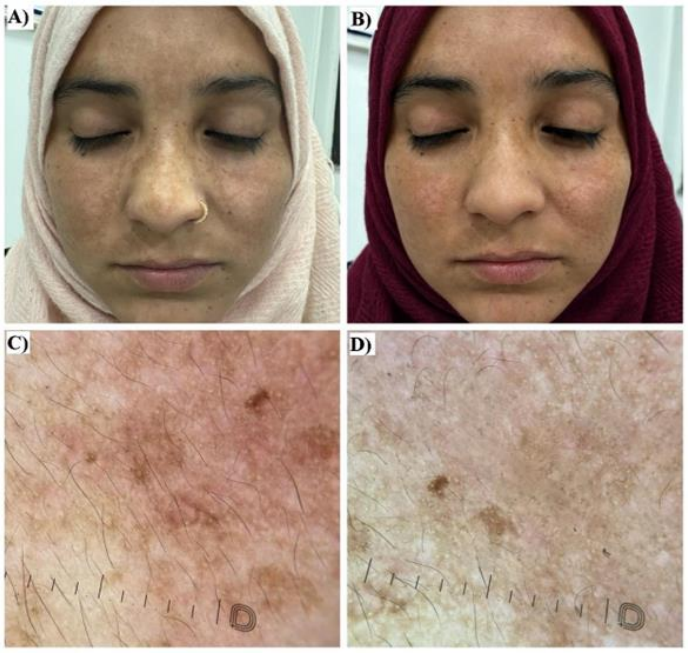

Figure 2: Clinical and dermoscopic response to 15% trichloroacetic acid (TCA) after 8 weeks. (A) Baseline clinical photograph (0 weeks). (B) Clinical photograph after 8 weeks of 15% TCA treatment, showing improvement in facial hyperpigmentation. (C) Baseline dermoscopic image demonstrating a prominent brown pseudonetwork with increased pigment density. (D) Dermoscopic image after 8 weeks showing reduction in the brown pseudonetwork, decreased pigment density, and improved pigment homogeneity.

Discussion

Due to its chronic and recurrent character, melasma is a frequent acquired hyperpigmentary condition that severely impairs quality of life and is still difficult to treat. Chemical peels are widely used as adjunctive treatment modalities to enhance the efficacy of topical depigmenting agents. The current randomized controlled experiment examined the safety and effectiveness of 35% glycolic acid (GA) peel and 15% trichloroacetic acid (TCA) peel in melasma patients.

Both treatment groups demonstrated clinically significant improvement in MASI scores over the study period. For both the

TCA group and the glycolic acid group, the mean MASI score dropped from 23.85 ± 6.01 to 16.20 ± 5.05 and 23.90 ± 6.16 to 16.35 ± 5.59, respectively. However, the difference between the two treatment modalities was not statistically significant, indicating comparable efficacy of both peels in reducing melasma severity.

These results are in line with those of Javed et al., who found that both 35% glycolic acid and 15% TCA peels significantly improved melasma without causing a statistically significant difference between the treatment groups.[1]

Prabhakaran et al. showed similar outcomes, showing that TCA and glycolic acid peels were equally effective in treating epidermal melasma.[2] The comparable therapeutic effects of 15% TCA and 35% glycolic acid peels in diseases of hyperpigmentation are supported by Bharati et al.'s findings of equivalent efficacy and safety profiles, despite the study being undertaken in a separate pigmentary disorder.[3]

Dermoscopic assessment in the present study demonstrated progressive reduction in pigmentary abnormalities in both treatment groups. By the end of the study, a substantial proportion of patients showed resolution of dermoscopic features such as reticuloglobular pigmentation, perifollicular pigmentation, and granules/dots. The findings of Abdel Hay et al., who emphasized the usefulness of dermoscopy as an objective method for tracking pigmentary changes and therapy response in melasma, are consistent with these data.[4] Similarly, Sahu and Dayal reported significant clinical and dermoscopic improvement in melasma following superficial chemical peels in patients with skin of color.[5]

Both treatments were well received. Dryness, temporary erythema, and a little burning feeling were the most common side effects. These adverse events were mild,

self-limiting, and did not necessitate treatment discontinuation. No serious adverse effects were observed during the study period. These findings are consistent with previous studies that have demonstrated favourable safety profiles of both glycolic acid and TCA peels when administered under appropriate supervision.[2,5] Furthermore, Lorenzo-Ríos et al. recently confirmed the safety and efficacy of TCA peels in melasma, reporting satisfactory clinical outcomes with minimal adverse effects in a split-face randomised trial.[6]

Limitations: There are a number of limitations to this study. First, the study population's representativeness may be limited because it was carried out at a single tertiary care facility. Second, evaluation of long-term efficacy, recurrence rates, and response durability was not possible due to the eight-week follow-up time. Third, purposive sampling may have introduced selection bias. In addition, participants and investigators were not blinded because of the visible nature of the interventions, creating the possibility of performance and assessment bias. Treatment outcomes were evaluated using clinical MASI scores and dermoscopic findings without histopathological correlation. Finally, subgroup analyses according to melasma subtype and long-term outcome assessments were not performed.

Generalisability: Despite these limitations, the findings of the present study apply to patients with melasma attending dermatology outpatient clinics, particularly those with Fitzpatrick skin types III–V commonly encountered in the Indian population. The treatment protocols employed are simple, cost-effective, and easily reproducible in routine clinical practice. As a result, the findings might apply to comparable medical environments where superficial chemical peels are employed as supplemental treatments for melasma.[5]

Conclusion

The present randomised controlled trial demonstrated that both 15% TCA peel and 35% glycolic acid peel produced significant clinical and dermoscopic improvement in melasma. No statistically significant difference was observed between the two modalities with respect to efficacy or safety. The benefits of treatment were achieved with only mild and transient adverse effects. These findings are consistent with previous comparative studies and support the use of either peeling agent as an effective adjunctive treatment option for melasma.[1–3] Consequently, the choice between the two modalities may be guided by physician preference, patient characteristics, availability, and cost considerations. Larger multicentric randomised controlled trials with longer follow-up periods are warranted to evaluate long-term efficacy, recurrence rates, patient-reported outcomes, and sustained safety.[6]

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Conflicts of interest

There are no conflicts of interest.

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