e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2026; 17(1); 100-105

Original Research Article

An Analytical Comparative Study to Evaluate the Efficacy and Safety of Fractional CO_2 Laser versus Dermaroller Therapy in the Treatment of Post-Acne Atrophic Scars

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Received: 25-10-2025 / Revised: 23-11-2025 / Accepted: 26-12-2025

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Conflict of interest: Nil

Abstract:

Background: Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit and is frequently followed by permanent scarring, particularly after inflammatory lesions. Post-acne atrophic scars pose a therapeutic challenge due to their variable morphology and depth. Fractional carbon dioxide (CO_2) laser resurfacing and microneedling using dermarollers are commonly employed modalities aimed at collagen remodelling and scar improvement.

Aim: To compare the efficacy and safety of fractional CO_2 laser resurfacing and dermaroller therapy in the management of post-acne atrophic scars.

Materials and Methods: This prospective, analytical, comparative study was conducted on 100 patients with moderate to severe post-acne atrophic scars. Patients were randomly divided into two groups of 50 each. Group A was treated with fractional CO_2 laser resurfacing, while Group B received dermaroller therapy. Six treatment sessions were performed at four-week intervals. Treatment response was evaluated using Goodman and Baron's quantitative global acne scarring grading system and a 5-point visual analogue scale. Adverse effects were documented.

Results: Both treatment modalities showed statistically significant improvement in acne scar scores from baseline. Dermaroller therapy demonstrated comparable efficacy with a slightly higher proportion of very good responses, whereas fractional CO_2 laser therapy showed a higher incidence of post-inflammatory hyperpigmentation. Pain was more frequently reported with dermaroller therapy, while erythema was universal but transient in both groups.

Conclusion: Fractional CO_2 laser resurfacing and dermaroller therapy are both effective and safe for the treatment of post-acne atrophic scars. Dermaroller therapy offers comparable clinical improvement with fewer pigmentary adverse effects, making it a suitable alternative, especially in darker skin types.

Keywords: Post-acne scars, Fractional CO_2 laser, Dermaroller, Microneedling, Atrophic scars.

DOI: 10.25258/Ijpqa.17.1.17

Introduction

Acne vulgaris is one of the most common dermatological conditions, affecting nearly 80–85% of adolescents and young adults. [1] Although active acne lesions may resolve, a significant proportion of patients develop permanent scarring that may persist throughout life. Post-acne scars arise from an imbalance between collagen degradation and synthesis during the wound-healing process following inflammatory acne lesions. [2]

Acne scars are broadly classified into atrophic, hypertrophic, and keloidal scars. Among these, atrophic scars are the most prevalent and are further categorised into ice-pick, boxcar, and rolling scars based on morphology and depth. [3] These scars result from dermal matrix destruction secondary to intense and prolonged inflammation within the pilosebaceous unit. [4]

The presence of acne scars significantly impacts patients' quality of life, leading to psychological distress, reduced self-esteem, and social withdrawal. [5] Therefore, effective management of acne scars is not merely cosmetic but also therapeutic from a psychosocial perspective.

Multiple treatment modalities have been employed for post-acne atrophic scars, including chemical peels, subcision, punch techniques, dermabrasion, lasers, and microneedling. [3] Fractional carbon dioxide (CO_2) laser resurfacing induces controlled thermal injury, stimulating neocollagenesis and dermal remodelling, while microneedling produces mechanical micro-injuries that activate the wound-healing cascade with minimal epidermal damage. [6-8]

This study was undertaken to compare the efficacy and safety of fractional CO_2 laser resurfacing and dermaroller therapy in patients with post-acne atrophic scars.

Materials and Methods

Study Design: This was a prospective, analytical, comparative study conducted in the Department of Dermatology, Varun Arjun Medical College & Rohilkhand Hospital, Shahjahanpur, Uttar Pradesh, after approval from the Institutional Ethics Committee (Ref. No. IEC/VAMC-DER/001/JULY 2024).

Participants: A total of 100 patients with moderate to severe post-acne atrophic scars were enrolled after obtaining written informed consent.

Inclusion Criteria:

- Age between 18 and 45 years
- Goodman and Baron grade II and III atrophic acne scars
- Stable acne with no active inflammatory lesions

Exclusion Criteria:

- Pregnancy and lactation
- Keloidal tendency
- Active acne or infection
- History of recent procedural treatment
- Photosensitizing drug intake

Treatment Protocol: All patients enrolled in the study were advised to discontinue any topical retinoids, exfoliating agents, or cosmetic procedures at least two weeks before initiation of the treatment. Standardised digital photographs were taken at baseline under uniform lighting conditions and identical camera settings. Patients were randomly allocated to two treatment groups using a simple randomisation method.

Group A: Fractional CO_2 Laser Resurfacing: Fractional carbon dioxide laser resurfacing was performed using a fractional CO_2 laser system under strict aseptic precautions. Before the procedure, the treatment area was cleansed thoroughly with normal saline solution followed by povidone-iodine solution. A topical anaesthetic cream containing lignocaine and prilocaine was applied under occlusion for 45–60 minutes and subsequently removed.

Laser parameters were selected based on the severity of the scar, the patient's skin type, and their tolerance. Energy settings ranged between low and moderate fluence, with pulse duration and density adjusted to achieve uniform coverage of the scarred area. The laser was applied in a fractional mode, producing microscopic thermal treatment zones while leaving intervening areas of intact skin to facilitate rapid healing.

Single to multiple passes were performed, depending on the scar depth, to ensure minimal overlap and avoid excessive thermal damage. Immediate post-procedure endpoints included uniform erythema and mild oedema of the treated area. Ice packs were applied immediately after the procedure to reduce discomfort.

Post-procedure care included application of a topical emollient and broad-spectrum sunscreen. Patients were advised to avoid sun exposure, strenuous activity, and application of cosmetic products for at least 48 hours. Sessions were repeated at four-week intervals for a total of six sessions.

Group B: Dermaroller (Microneedling) Therapy: Dermaroller therapy was performed using a sterile dermaroller device with a needle length selected according to scar depth. The treatment area was cleansed with normal saline and povidone-iodine solution. Topical anaesthesia using lignocaine-prilocaine cream was applied under occlusion for 45–60 minutes and removed before the procedure.

The dermaroller was rolled over the scarred area in vertical, horizontal, and diagonal directions with uniform pressure until pinpoint bleeding was observed, which was considered the procedural endpoint. Care was taken to ensure uniform coverage of all scarred areas without excessive trauma.Following the procedure, the treated area was gently cleansed with saline, and a soothing emollient was applied. Patients were instructed to avoid washing the treated area for 24 hours and to use broad-spectrum sunscreen during the treatment period.

Dermaroller sessions were performed at four-week intervals, with a total of six sessions administered to each patient.

Post-procedure Care and Follow-up: All patients in both groups were advised to use a broad-spectrum sunscreen regularly throughout the study period. Oral analgesics were prescribed if required. Patients were instructed to report immediately in case of excessive pain, infection, blistering, or pigmentary changes. Patients were followed up every four weeks. At each visit, a clinical

evaluation was performed, and adverse effects, including erythema, pain, itching, scarring, and post-inflammatory hyperpigmentation, were recorded. Serial photographs were taken to document treatment response.

Assessment of Treatment Response: An objective assessment of acne scars was conducted using Goodman and Baron's quantitative global acne scarring grading system, a validated and widely accepted tool for assessing acne scars. [9] Subjective improvement was evaluated using a 5-point visual analogue scale, as used in previous acne scar studies. [10] Appropriate treatment modalities**.**

Table 1: Global acne scarring classification (modified Goodman and Baron grading system)

Clirincal Description	Clinical Description	Number of Lesions (1-20)	Number of Lesions (>20)
Milder Scarring (1 point each) Macular, erytnematous, pigmented, or mildly atrophic (dish-like) scars	1 point	2 points	3 points
Moderate Scarring (2 points each) Moderately atrophic scars appearing dish-like: Punched-out scars with shallow bases, small scars (<5 mm). Shallow but broad atrophic areas	2 point	4 points	6 points
Severe Scarring (3 points each) - Papular scars with deep t but normal bases - Deep, broad atrophic areas	3 points (Area < 5mm)	6 points (Area 5-20) 6 mm^2	9 points (Area > 20) 6 mm^2
Hyperplastic Scarring - Papular scars	2 points **6** keloidal	12 points 6 points	18 points 18 points

Table 2: Criteria for objective assessment in the patients being treated with Dermaroller and Fractional CO2 laser resurfacing therapy

Grade	Remarks
Nil	No observable improvement in scar score.
Satisfactory	Improvement of up to **25%** in the total point score.
Good	Improvement between **26% and 50%** in the total point score.
Very Good	Improvement between **51% and 75%** in the total point score.
Excellent	Improvement of **more than 76%** in the total point score.

Subjective assessment of the response of the patient was evaluated on a 5-point visual analogue scale, done by the patient himself. The criteria used for assessment are given in Table 1.5

Table 3: Subjective Assessment of Improvement

Grade	Points	Remarks
Nil	0	No visible or measurable improvement.
Satisfactory	1	Improvement of up to 25% in overall scar appearance.
Good	2	Improvement between 26% and 50% in scar reduction.
Very Good	3	Improvement between 51% and 75% in scar appearance.
Excellent	4	Improvement of more than 76%, with marked visible changes.

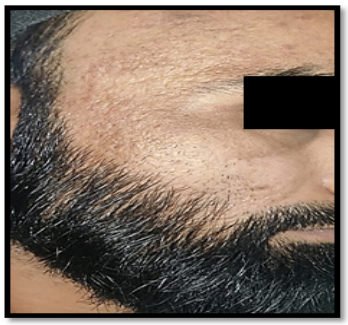
Results

Out of 100 patients, 92 completed the full treatment protocol. The majority of patients belonged to the 21–25-year age group, with a slight female predominance. Both treatment groups showed significant improvement in scar scores from baseline. Good improvement was the most commonly observed outcome in both groups. Dermaroller therapy showed a marginally higher proportion of very good responses, while excellent responses were infrequent in both groups.

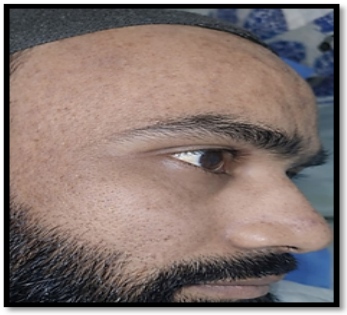
Figures 1A and 1B, and Figures 2A and 2B demonstrate the pre-treatment and post-treatment clinical improvement, respectively, in patients

treated with fractional CO_2 laser therapy. Figures 3A and 3B, and Figures 4A and 4B show the baseline and post-treatment improvement, respectively, in patients treated with dermaroller (microneedling) therapy. Erythema was observed in all patients; however, it was transient in nature (Figures 5 and 6), illustrating post-procedure erythema following fractional CO_2 laser therapy and dermaroller therapy, respectively. Pain was more frequently reported in the dermaroller group, whereas post-inflammatory hyperpigmentation was more commonly observed in the fractional CO_2 laser group (Figure 7).

GROUP A FRACTIONAL CO_2 LASER



Figures 1A

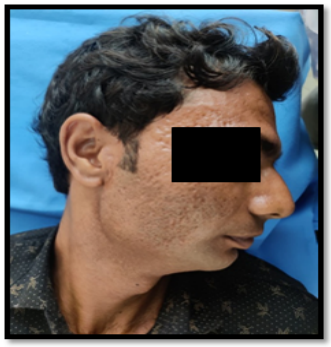


Figures 1B

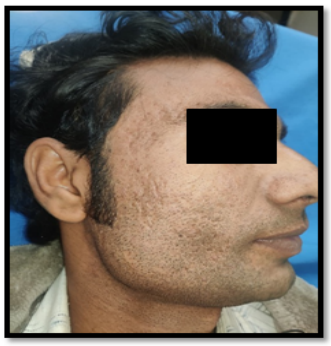
Figures 2A

Figures 2B

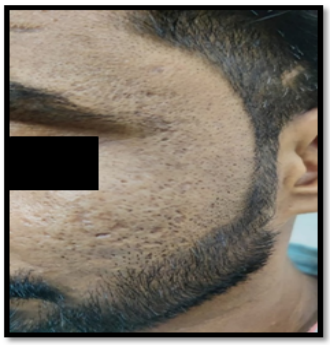
GROUP B: DERMAROLLER



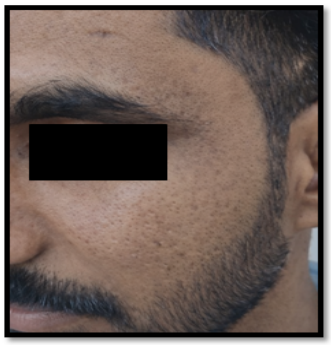
Figures 3A



Figures 3B



Figures 4A



Figures 4B

ERYTHEMA IN DIFFERENT GROUPS

CO2 LASER

Figure 5

DERMAROLLER

Figure 6

HYPERPIGMENTATION DUE TO CO2 LASER

Figure 7

Discussion

Fractional CO_2 laser resurfacing produces microthermal treatment zones by delivering focused thermal energy into the skin, leading to epidermal necrosis and dermal coagulation with a surrounding inflammatory response. This controlled injury stimulates collagen remodelling and dermal regeneration. [6-7] Re-epithelialization typically begins within a few days and is completed within 7–10 days. [8]

Microneedling using a dermaroller creates multiple controlled micro-injuries in the epidermis and dermis without significant epidermal ablation. These micro-injuries trigger the wound-healing cascade, resulting in the release of growth factors and subsequent neocollagenesis and neoangiogenesis. [10-12] In the present study, rolling and boxcar scars were the most common, while ice-pick scars were less frequent, which is consistent with previous reports. [3,13] Chapas et al. demonstrated significant improvement in acne scarring following fractional CO_2 laser treatment, particularly in rolling and boxcar scars. [14] Bhardwaj et al. reported microneedling to be an effective, safe, and economical modality for post-acne atrophic scars with minimal downtime. [15] Post-procedure erythema was transient in both treatment groups. Pain was more common in the dermaroller group, while post-inflammatory hyperpigmentation was observed more frequently following fractional CO_2 laser therapy, particularly in patients with higher Fitzpatrick skin types, as also reported in earlier studies. [8,16]

Limitations

The study was limited by a single-centre design and short follow-up duration. Long-term assessment of scar improvement was not performed.

Conclusion

Both fractional CO_2 laser resurfacing and dermaroller therapy are effective modalities for the treatment of post-acne atrophic scars. Dermaroller therapy offers comparable improvement with fewer pigmentary side effects and may be preferred in darker skin types.

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