

Original Article

Scar wars: Pinhole ablation with super-pulse carbon dioxide for papular scars

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ABSTRACT

Objectives: To assess the safety, efficacy, and therapeutic outcomes of the pinhole CO₂ laser technology for treating papular acne scars over face.

Material and Methods: A retrospective study was undertaken on 65 patients who presented with papular acne scars. To treat each papular lesion, superpulse CO₂ laser pulses were applied through pinholes. Sessions were scheduled at 4-6 weeks intervals. Clinical improvement was measured using the global scoring system (GSS), physician visual evaluation (PVE), and standardised photography during baseline and follow-up visits over a three-month period.

Results: A total of 65 individuals (mean age: 30) received treatment. Over 80% of patients showed significant clinical improvement, including a reduction in scar height and contour irregularity. Only minor side effects were seen, notably transitory erythema and oedema. No cases of post-inflammatory hyperpigmentation or scarring were documented.

Conclusion: The pinhole CO₂ laser technique is a safe, precise, and successful method for treating papular acne scars. Its targeted ablation technique allows controlled tissue remodelling with minimal downtime, making it an important addition to the treatment for acne scars.

Keywords: Ablative laser treatment, Papular acne scars, Pinhole technique

INTRODUCTION

Acne vulgaris is among the most common dermatological disorders in the world, and it frequently results in long-term scarring. While atrophic scars, such as the icepick, boxcar, and rolling scars, are well known and thoroughly researched, the papular acne scar is an underestimated but clinically significant variety.^{1,2} These lesions are distinguished by distinct, soft, skin-colored papules with a cobblestone-like appearance. They normally measure 1–4 mm in diameter and are mostly found on the nose, chin, jawline, and back.³ Histologically, these scars reveal superficial dermal fibrosis, chronic perivascular inflammation, and moderate vascular dilatation.^{1,3} Clinically, papular scars tend to be resistant to traditional systemic therapy, including oral antibiotics and isotretinoin, necessitating the development of specific interventional methods.³ Subcision, punch methods, and ablative laser resurfacing are all invasive procedures that have had varying degrees of effectiveness.⁴ While radiofrequency (RF) ablation, erbium YAG and CO₂ laser can result in post-inflammatory pigmentation and epidermal damage.⁵ Super-pulse (200 μs) pinhole CO₂ laser has evolved as a more selective method that allows for controlled dermal

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remodeling while preserving epidermal integrity.^{6,7} However, their broad use has been constrained by a lack of reliable clinical evidence and defined treatment methods.^{1,7} Given these gaps, the purpose of this study is to describe the clinical presentation of papular acne scars, determine the prevalence of these scars in a specific patient population, and assess the safety and effectiveness of super-pulse (200 μ s) pinhole ablative CO₂ laser therapy, as a new treatment approach. We hope to raise clinical awareness and provide the groundwork for more effective treatment approaches by studying this underappreciated category of acne scars.

MATERIAL AND METHODS

We performed a retrospective analysis of 65 patients with papular acne scars who attended the dermatology outpatient clinic to evaluate the effectiveness of pinhole CO₂ laser ablation. Patients with papular acne scars of Fitzpatrick skin types III–VI were treated using the pinhole method with super-pulse mode of the CO₂ laser, administered over 2–3 sessions at 4–6 weeks interval. Inclusion criteria were patients aged ≥ 18 years, who were able to understand and voluntarily signed the consent form. Exclusion criteria included prior laser treatments, pregnancy, history of keloids or hypertrophic scars, photosensitivity, pigmentary changes, infections, or other skin conditions, active vitiligo, psoriasis, and severe systemic diseases.

Treatment method

Preoperatively, EMLA cream (lignocaine 2.5% and prilocaine 2.5%) was evenly applied to the scarred area for 45 min. Pinhole ablation was done using the super-pulse mode of CO₂ laser device (Numitech Laser). Laser energy was delivered under the following settings: Pulse width: 0.7 ms, pulse interval: 0.5 ms, power: 1 Watt, and spot diameter: 0.05 mm. Punctures were made perpendicular to the surface of the papular scars. Contact time depended on the depth of the scar. Immediately after treatment, mupirocin cream was applied. Post-treatment care included sunscreen, topical, and systemic antibiotics for 1 week. Clinical improvement was evaluated on the basis of the Global scoring system (GSS) physician visual evaluation score, and standardized photography during baseline and follow-up visits were recorded over a period of 3 months. The quantitative GSS score was as follows: 2 points for 1–10 lesions, 4 points for 11–20 lesions, and 6 points for more than 20 lesions. The physician's visual evaluation used the following scoring system: 1 for improvement <25%, 2 for improvement between 25% and 50%, 3 for improvement between 51% and 75%, and 4 for improvement >75%. Adverse reactions were recorded during follow-up visits. The data were processed and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0.

Analysis of variance (ANOVA) test was used, with $P < 0.05$ indicating statistical significance.

RESULTS

Prevalence of papular acne scarring

Among the 65 patients with papular acne scarring, there were 31 (47.69%) males and 34 (52.3%) females. The mean age found was 31 years. The scarring involved the cheeks in 41 (63.07%) patients, the nose in 37 (56.92%) patients, and the forehead and chin in 9 (13.84%) and 7 (10.76%) patients, respectively. Most patients had skin-colored papular acne scars, which were observed in 63 (96.92%) patients. The average size of the lesion was 2.5 mm, suggesting moderate-sized papular acne scars.

Treatment evaluation of papular acne scarring

Out of 65 patients who underwent treatment, only one patient was lost to follow-up. Out of 65 participants, 56 (86.15%) patients had Type IV Fitzpatrick skin type and 9 (13.85%) patients had Type V skin. A robust follow-up rate was observed, with 98.5% of participants returning for post-treatment evaluation which reflects excellent participant compliance and procedural acceptability [Figures 1 and 2].

Quantitative global scoring system (GSS) scores

The initial GSS score before the first treatment was 4.36 ± 1.36 and after 1-month follow-up, it was 2.12 ± 1.45 , showing a significant difference from the score before the first treatment ($P < 0.001$). The GSS score after the 3rd-month follow-up was 1.38 ± 1.41 , which showed significant improvement in the number of lesions ($P = 1.076 \times 10^{-34}$) [Tables 1 and 2].

Physician visual evaluation results (PVE)

The physician's visual four-point assessment score after the first follow-up was <25% in 18 (94.7%) patients and 25–50% in 25 (58.1%) patients, which significantly improved after the 3rd-month follow-up. After 3 months, the physician's visual evaluation results showed that 19 (44.2%) patients had 51–75% improvement while 22 (51.2%) patients had >75% improvement. Over 50% of patients moved into the 51–75% or >75% improvement bracket, suggesting continued improvement over time [Figures 3 and 4; Tables 3 and 4].

Statistical analysis

Data was entered in Microsoft Excel and analyzed using SPSS. Categorical variables were represented in percentages, and continuous variables were represented in means and standard deviations. Repeated-measure ANOVA was used to find the statistical significance of GSS over different time points. *Post*



Figure 1: Clinical photos of a male patient with papular acne scars before and after pinhole carbon dioxide (CO₂) ablation. (a) Pre-treatment picture shows several distinct papular scars primarily over the nose and malar areas. (b) Immediate post-procedure image after pinhole CO₂ ablation of papular scars. (c) One month post-procedure image, (d) 2 months after the treatment, the scar has begun to flatten, and (e) 3rd-month follow-up image shows considerable improvement in scar texture and general skin appearance.

Table 1: GSS over time.

	Mean	SD
GSS before treatment	4.36	1.364
GSS after 1-month follow-up	2.123	1.452
GSS after 3-month follow-up	1.385	1.411

SD: Standard deviation, GSS: Global severity score

hoc Bonferroni was used to find the statistical significance of GSS between two points. $P < 0.05$ is considered statistically significant.

DISCUSSION

Acne vulgaris is an inflammatory skin disorder that affects hair follicles and sebaceous glands. It is ranked as the eighth most common disease, affecting 9.4% of the global

Table 2: Comparison of GSSs between time points.

Comparison	<i>P</i>
GSS 1	
GSS 2	8.182×10^{-24}
GSS 3	1.041×10^{-33}
GSS 2	
GSS 3	1.750×10^{-4}

GSS: Global severity score

population.¹ Acne scars are a common result of acne and can negatively impact both the patient's look and mental health.^{1,8} Papular acne scars are soft, elevated, skin-colored, or hypopigmented lesions usually found on the nose, chin, and trunk. The scars often measure 1–3 mm and have a cobblestone-like appearance.³ Acne inflammation destroys



Figure 2: Clinical images with papular acne scars over nose and cheeks. (a) Pre-treatment image shows multiple, skin colored papular acne scars predominantly over nose and cheeks. (b) Post-treatment image shows significant reduction of papular scars and improvement in skin texture.

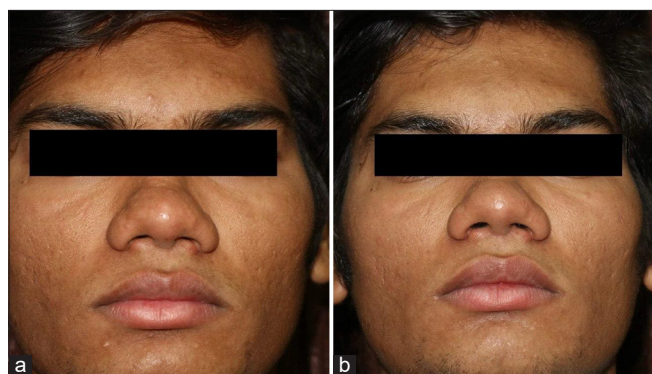


Figure 3: Clinical image shows papular scars over nose. (a) Before treatment, the image shows multiple papular scars with uneven texture over nose. (b) A 3-month follow-up image shows visible reduction of papular scars and smooth texture over the nose.

collagen and elastin fibers in the dermal tissues surrounding hair follicles, leading to the formation of papules.⁴

Using an ablative CO₂ laser, the pinhole technique generates multiple small holes that penetrate the epidermis and deeper dermis layers.^{4,9} This method can regenerate and realign collagen bundles, resulting in improved texture.⁷ The 10,600 nm CO₂ laser is highly suited for skin resurfacing due to its strong affinity to water, which gives accurate tissue destruction while conserving surrounding structures.⁴

Huang *et al.* assessed 35 patients with acne scars using CO₂ laser grid therapy, of which 91.4% of patients reported satisfactory results.¹



Figure 4: Clinical image shows post acne papular scars over nose. (a) Pre-treatment image shows multiple, discrete, and papular acne scars over the nose. (b) Post-treatment image showing improved skin texture with reduction of papular scar.

Table 3: PVE comparison before and after 1 month of treatment.

PVE before treatment	PVE after 1 month			
	No (%)	25–50(%)	51–75(%)	>75(%)
No	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
<25%	0 (0.0)	18 (94.7)	1 (5.3)	0 (0.0)
25–50%	0 (0.0)	25 (58.1)	18 (41.9)	0 (0.0)
51–75%	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)

PVE: Physician visual evaluation

Table 4: PVE comparison before and after 3 months of treatment.

PVE before treatment	PVE after 3 months			
	No (%)	25–50(%)	51–75(%)	>75(%)
No	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
<25%	0 (0.0)	0 (0.0)	11 (57.9)	8 (42.1)
25–50%	0 (0.0)	2 (4.7)	19 (44.2)	22 (51.2)
51–75%	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)

PVE: Physician visual evaluation

Fonseka *et al.* evaluated five patients with papular scars using ablative CO₂ laser therapy, where 100% patients reported good cosmetic results.¹⁰

Of 65 patients in this study, 31 (47.69%) were male patients and 34 (52.3%) were female patients, and 1 (1.5%) patient was lost to follow-up. Within a month, most patients with <25% physician visual evaluation (PVE) shifted to the 25–50% or 51–75% category, showing early treatment efficacy. After 3 months, a large majority of patients shifted to higher PVE brackets (>51%), with many achieving 51–75% improvement, indicating enhanced clinical improvements.

The therapy involved directing an ablative CO₂ laser beam using a pinhole technique perpendicular to the surface

of papular acne scars, resulting in laser perforations with spacings of 1–3 mm that penetrated deeper layers of the scars. Reducing treatment density maximizes treatment depth, promoting the healing and remodeling of papular scars. During treatment, some patients with prominent papular acne scars on the nose experienced immediate collapse and subsidence, while immediate effects on papular acne scars in the chin area were less noticeable. The difference may be due to local skin tension and disintegration of proliferative collagen fiber tissue.¹

Previously documented therapeutic procedures include radio frequency electrocoagulation, chemical peeling, and dermabrasion. However, these techniques have disadvantages, including low efficacy and the risk of post-inflammatory hyperpigmentation.¹ Acne scars can have a significant psychological impact, making appropriate treatment crucial.

CONCLUSION

The pinhole CO₂ laser approach has shown good results for treating papular acne scars, particularly on the nose. It allows focused collagen remodeling while causing minimal harm to the surrounding tissue. Patients in the study showed significant cosmetic improvement, especially with deeper laser penetration. It is more effective than traditional treatments and reduces the risk of pigmentation. This procedure may be a dependable and successful way to manage papular acne scars.

Authors' contributions: All authors contributed to the research study. Yogesh M. Bhingradia: data acquisition, experimented study, manuscript review. Kabilan Nagarajan: data analysis, manuscript preparation. Devna Pillai: Data analysis, manuscript review. Radhika Bansal: photograph editing, result writing. Eshritha Chigurupati: Manuscript review. Jatin K Reddy: Proof read and manuscript review final. Shaista Huma: Final conclusion and overview.

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