
Treatment of Inflammatory Facial Acne Vulgaris with the 1450-nm Diode Laser: A Pilot Study

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BACKGROUND. The 1450-nm diode laser has been found to damage sebaceous glands selectively and to be effective for the treatment of inflammatory acne on the back.

OBJECTIVE. To evaluate the efficacy and safety of the 1450-nm diode laser in the treatment of inflammatory facial acne vulgaris.

METHODS. Nineteen patients with inflammatory facial acne were treated with the 1450-nm diode laser at 4- to 6-week intervals. There was no control group. Clinical photographs and lesion counts were obtained at baseline and after each treatment. Subjective evaluation of response to treatment and pain was assessed using a questionnaire.

P. M. FRIEDMAN, MD, M. H. JIH, MD, PHD, A. KIMYAI-ASADI, MD, AND L. H. GOLDBERG, MD HAVE INDICATED NO SIGNIFICANT INTEREST WITH COMMERCIAL SUPPORTERS.

ACNE VULGARIS is estimated to afflict between 40- and 50-million people in the United States, with up to 34% of men and 27% of women between the ages of 15 and 44 having active acne lesions at any given time.¹ Although acne is often thought of as a minor dermatologic condition, there is often significant psychological and physical morbidity associated with the disease.²

The pathogenesis of acne is multifactorial. The initiating factor is thought to be the formation of a keratinous plug in the infundibulum of hair follicles as a result of abnormal differentiation and desquamation of follicular keratinocytes. The transformation of comedones into inflammatory lesions is due to proliferation of *Propionibacterium acnes* bacteria within the keratin plug, which are capable of metabolizing trapped sebum into proinflammatory free fatty acids. Mild acne often improves with various combinations of topical antimicrobials, retinoids, or keratolytics, which require frequent application and often result in irritation. Inflammatory disease often requires the long-term use of systemic antibiotics, and

RESULTS. All patients had a reduction in acne lesions. Lesion counts decreased 37% after one treatment ($p < 0.01$), 58% after two treatments ($p < 0.01$), and 83% after three treatments ($p < 0.01$). Treatment-related pain was well tolerated, and adverse effects were limited to transient erythema and edema at treatment sites.

CONCLUSION. This is the first published report documenting the safety and efficacy of laser treatment for inflammatory facial acne. In our study, clinical improvement was seen in all patients and was generally dramatic, even in those refractory to previous treatment with oral isotretinoin. Topical anesthetics should be used to minimize pain associated with treatment.

more severe disease may require systemic isotretinoin, which is associated with numerous untoward and potentially serious side effects. Many patients require continuous treatment with topical and oral medications for months or years. Moreover, despite the use of individual and combination therapies, patients often continue to develop new lesions for years.

The use of photothermal therapy is driven by the need for a safer, more effective, and more convenient treatment for acne. These therapies may help avoid side effects associated with both topical and systemic therapies while reducing the need for compliance with complicated regimens. These treatments are administered by physicians at relatively infrequent intervals or even on an as-needed basis. Initial light-based therapies for acne relied on the absorption of specific wavelengths of visible light by endogenous porphyrins produced by *P. acnes*.³ Photoactivation of porphyrins results in lethal oxidative damage to the bacteria, resulting in reduction of *P. acnes* colonization and a reduction in inflammatory acne lesions. Photodynamic therapy with 5-aminolevulinic acid has been introduced for the treatment of acne in order to augment this phenomenon.⁴

More recently, the 1450-nm diode laser has been used for the treatment of acne on the back.^{5,6}

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Paithankar et al.⁵ showed through heat transfer calculations and histologic verification on rabbit ear skin that the 1450-nm diode laser, with its wavelength in the infrared range, specifically targets thermal damage to the middermal layer of the skin, where the sebaceous glands are primarily located. The concurrent use of a cryogen spray device protected the epidermis from thermal damage. The use of this laser in patients was associated with a clinically and statistically significant reduction in acne lesions on the back. The only associated side effects were transient erythema and edema. As inflammatory facial acne is the most common reason for patients seeking treatment for acne, we performed a study to evaluate the safety and efficacy of the 1450-nm diode laser with a cryogen spray device for the treatment of inflammatory facial acne vulgaris. To our knowledge, this is the first published report of the use of lasers to treat inflammatory facial acne vulgaris.

Methods

Nineteen patients (12 women and 7 men) with active inflammatory facial acne with Fitzpatrick skin phototypes II–IV were enrolled in the study. The presence of at least five active inflammatory lesions was required. The age range was 15 to 44 years (mean 26 ± 7). Exclusion criteria included pregnancy, treatment with oral isotretinoin within the past 6 months, or the use of dermal fillers within the past 3 months. Patients were allowed to continue previous medications during the study. These medications included topical agents (antibiotics and retinoids) as well as oral antibiotics such as doxycycline. Seven patients had previously completed courses of oral isotretinoin.

Topical lidocaine 5% (Ela-Max; Ferndale Laboratories, Ferndale, MI) was applied under occlusion 1 hour before laser treatment to patients requesting provision of topical anesthesia. The entire face was treated with nonoverlapping single pulses of a 1450-nm diode laser (Smoothbeam; Candela Corporation, Wayland, MA) with an integrated dynamic cooling device. Treatment fluences ranged from 11 to 14 J/cm², delivered using a 6-mm spot size. The dynamic cooling device setting was set at 40 ms to cool the epidermis. Immediately after the treatment, a moisturizing cream and sunscreen were applied to the treated skin. Based on previous studies, treatments were separated by a 4- to 6-week period.

Inflammatory acne lesions were counted, and digital photographs using identical camera settings and lighting were obtained before each treatment. Complications were assessed at each visit. Evaluation of patients' subjective response to treatment was per-

formed by a questionnaire ranking the degree of satisfaction as "highly satisfied," "satisfied," "neutral," or "dissatisfied." Lesion counts and the standard deviation at baseline and at each subsequent treatment session were compared using the paired Student's *t*-test. For the purpose of statistical analysis, patients were also divided into mild (less than 15 lesions), moderate (15 to 50 lesions), and severe (more than 50 lesions). There was no control group in this study.

Results

All 19 patients demonstrated reductions in their acne lesion counts. Overall, the mean acne lesion count decreased from a baseline of 36.1 ± 29.5 to 22.6 ± 22.9 after the first treatment ($p < 0.01$). After the second and third treatments, the mean acne lesion count decreased to 15.2 ± 15.3 ($p < 0.01$) and 6.1 ± 6.8 ($p < 0.01$), respectively. This corresponded to a 37% reduction in mean acne lesion count after one treatment, a 58% decrease after two treatments, and an 83% decrease after three treatments (Figure 1). There was no difference in improvement between male and female patients ($p = 0.44$), as both showed statistically significant improvements ($p < 0.01$). Figures 2–5 demonstrate representative pretreatment and post-treatment clinical photographs of patients.

In the group with mild inflammatory acne ($n = 6$), the mean acne lesion count decreased from a baseline of 10.0 ± 4.19 to 5.0 ± 7.1 after the first treatment ($p = 0.12$). After the second and third treatments, the mean acne lesion count decreased to 9.2 ± 12.4 ($p = 0.84$) and 3.3 ± 5.8 ($p = 0.20$), respectively. In the group with moderate inflammatory acne ($n = 7$), the mean acne lesion count decreased from a baseline of 28.0 ± 15.1 to 19.2 ± 12.0 after the first treatment ($p < 0.01$). After the second and third treatments, the mean acne lesion count decreased to 11.8 ± 8.8 ($p < 0.05$) and 6.0 ± 4.7 ($p = 0.06$), respectively. In

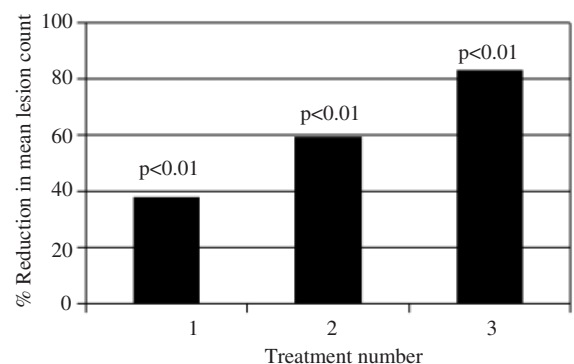


Figure 1. Percentage reduction in mean inflammatory acne lesion count after one, two, and three treatments with the 1450-nm diode laser.

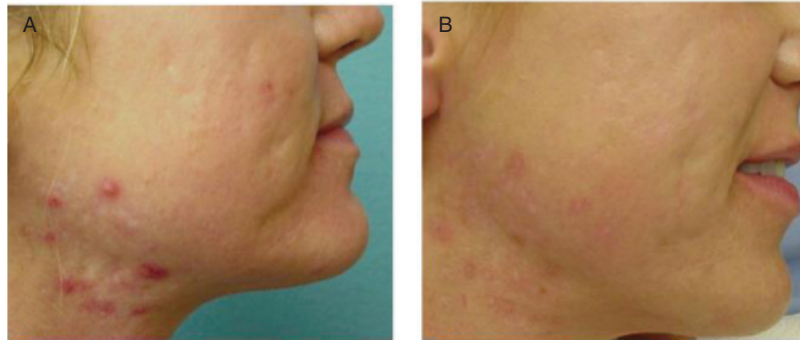


Figure 2. (A) Right cheek pretreatment with inflammatory papules and pustules. (B) A 100% clearance of lesions after three treatments with the 1450-nm diode laser.

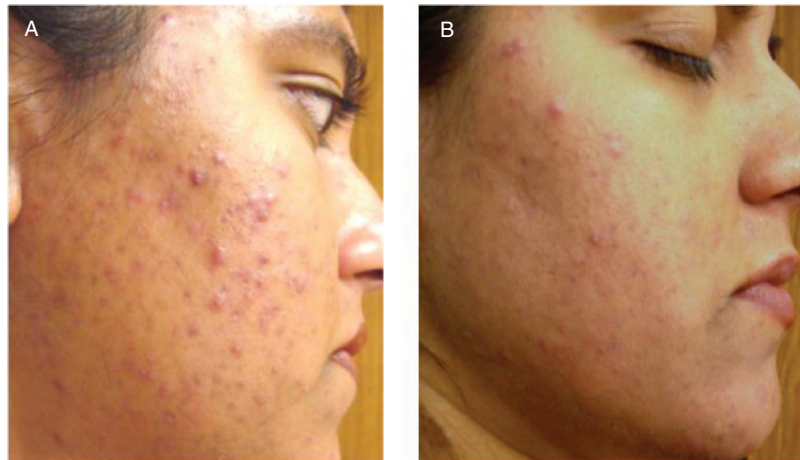


Figure 3. (A) Multiple inflammatory papules and few scattered pustules on the right cheek pretreatment. (B) After two treatments with the 1450-nm diode laser, a 39% decrease in active acne lesions was observed compared with baseline.

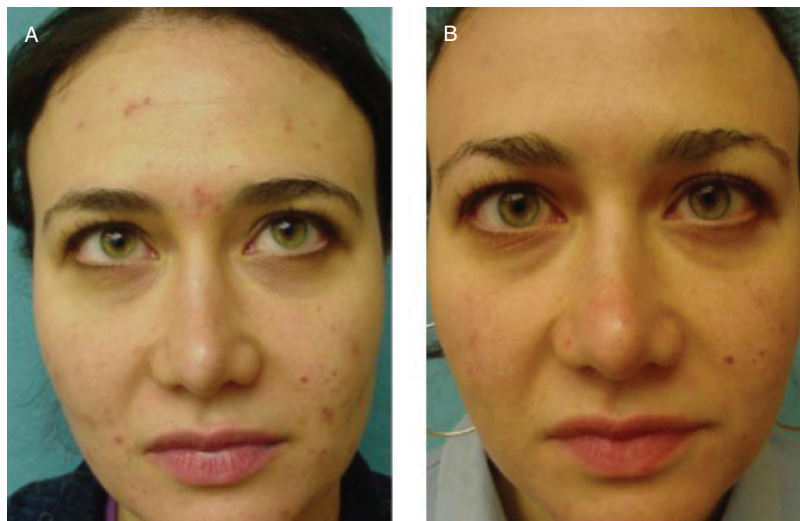


Figure 4. (A) Forehead and cheeks pretreatment with multiple inflammatory papules. (B) After three treatments, an 89% decrease in active acne lesions compared with baseline was observed.

the group with severe inflammatory acne, the mean acne lesion count decreased from a baseline of 70.2 ± 20.6 to 37.7 ± 29.5 after the first treatment

($p < 0.05$). After the second and third treatments, the mean acne lesion count decreased to 25.8 ± 20.2 ($p < 0.05$) and 10.5 ± 13.4 ($p < 0.05$), respectively.

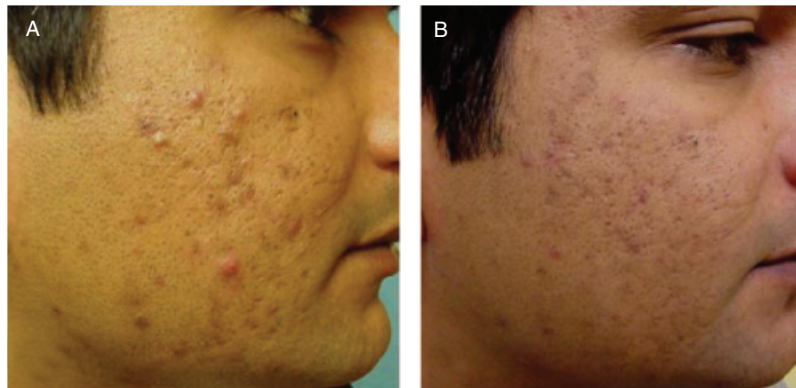


Figure 5. (A) Right-cheek pretreatment with inflammatory papules and pustules. (B) After four treatments with the 1450-nm diode laser, an 84% decrease in lesion counts from baseline was observed.

Patients were allowed to continue previous treatments. Topical agents used concurrently included clindamycin phosphate (seven patients), benzoyl peroxide (six patients), retinoids (seven patients), glycolic acid preparations (one patient), and sodium sulfacetamide (one patient). There were eight patients on concurrent oral antibiotics, including doxycycline (six patients), minocycline (one patient), and ampicillin (one patient). Improvement was seen in both patients on topical therapy ($p < 0.05$) and those on a combination of oral and topical therapies ($p < 0.05$). There was a single patient on no concomitant treatment whose acne lesion count decreased from a baseline of 7 to 0 after treatment. There was no difference in treatment response based on whether concurrent topical, oral, or combination treatments were used ($p = 0.67$).

When questioned regarding treatment, 50% of patients reported being “highly satisfied,” and 50% reported being “satisfied” with their outcome. Importantly, there were no patients who reported dissatisfaction with their treatment. In addition, 90% of patients stated that they would recommend the treatment to others. Pain related to laser treatment was well tolerated by all patients with the application of topical anesthetic (Ela-Max) 1 hour before treatment. A higher level of pain was associated with treatment in the perioral area and in areas with higher density of inflammatory lesions.

The most common side effect was transient erythema and edema at the treatment sites, which in most patients lasted up to 24 hours. No other adverse effects such as pigmentary alteration, scarring, or infection were observed.

Discussion

Our study demonstrates that treatment with the infrared 1450-nm diode laser can safely and effectively

reduce inflammatory acne lesions of the face. This laser has been shown to cause thermal coagulation of the sebaceous lobule and associated hair follicle,^{5,6} presumably resulting in reduced sebaceous gland secretions and thereby a reduction in inflammatory acne lesions. In addition, photothermal energy may have bacteriostatic effects, reducing the conversion of sebum into proinflammatory free fatty acids by *P. acnes*.³ Clinical improvement was seen in all patients and was generally dramatic, even in those refractory to previous treatment with oral isotretinoin.

In our study, there was a statistically significant improvement in inflammatory facial acne lesion counts overall as well as in subgroup analysis of the moderate (15 to 50 lesions) and severe (more than 50 lesions) groups. The dramatic improvement seen with this laser is reflected in the statistical significance achieved despite the small number of patients in each group. Indeed, in the mild (less than 15 lesion) group, there was a decrease in mean acne lesion count from 10 to 3, but given the small sample size, this was not statistically significant. Our mean acne lesion counts were associated with a high standard deviation because of the large variance in the number of acne lesions patients had at the onset (range of 5 to 104). As such, the paired *t*-test was appropriately picked for analysis to account for initial variation in lesion counts.

The duration of sustained improvement after each treatment was not addressed in our study. Paithankar et al.⁵ showed remissions of up to 6 months in patients treated for acne lesions on the back with the 1450-nm diode laser. Previous histologic studies did not demonstrate any long-term alteration in adnexal structure architecture, but it remains possible that photocoagulation of sebaceous lobules results in long-term alteration in sebaceous gland activity, with associated reduction in inflammatory acne lesions.⁵ Further functional sebaceous gland studies and clinical trials are being conducted at our center to confirm the

duration of sebaceous gland effects resulting from treatment with the 1450-nm diode laser. It is noteworthy that Paithankar et al. used the laser's cryogen spray as a control treatment, ruling out any role the cryogen spray may play in improving inflammatory acne.⁵

In our study, after premedication with Ela-Max 5% cream under occlusion 1 hour before each treatment, patients were able to tolerate the pain, which was uniformly rated as mild to moderate. Treatment in the perioral area was associated with the most significant pain. The transient erythema and edema seen after treatment generally resolved within 1 day, minimizing any treatment-associated down time. There were no sustained or long-term sequelae associated with this laser in our patients.

Patients were uniformly satisfied with their treatment. This may, in part, be due to the fact that our patients included previously refractory cases who responded dramatically to laser treatment. We believe that the effectiveness, convenience, and versatility of this treatment contribute to its high patient satisfaction rate. In our experience, this laser has been equally safe and effective when used to treat inflammatory acne on the trunk, and our data show that this treatment is effective regardless of which concomitant therapies are used. Although this study is not conducive to a cost-effectiveness analysis and was not carried out over a long period of time, this treatment should be considered as an alternative for the treatment of acne in patients who are noncompliant with or resistant to standard acne treatments.

The 1450-nm diode laser has been shown to cause an area of histologically visible thermal damage in the upper dermis that spares the epidermis.⁵ This dermal damage results in remodeling of dermal collagen, which can reduce the appearance of superficial acne scars. Although we did not specifically measure acne scarring in this study, many patients reported clinically notable improvement in their underlying acne scarring. This is consistent with results of studies demonstrating that nonablative resurfacing using infrared lasers can improve the appearance of scarring due to acne.⁷⁻⁹ Moreover, although comedonal lesions were not counted, some patients reported "smoothing" of the

affected skin with an accompanied decrease in comedonal lesions. This may be due to photocoagulation of hair follicles, reducing the potential for comedone formation.

The combination of clinically and statistically evident efficacy, tolerable pain profile, transient and mild side effects, and convenience of use of the 1450-nm diode laser for the treatment of facial acne contributed to the high patient satisfaction seen in our study. We believe that this treatment should be considered for acne patients who are unable to tolerate, are refractory to, or are noncompliant with traditional acne treatments. Further research into the mechanisms of action of this laser as well as determination of optimum treatment parameters and longevity of improvements is warranted at this time.

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