Light/laser therapy in the treatment of acne vulgaris

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Summary

Acne vulgaris is one of the most prevalent skin diseases known. As common as this condition is, the social and psychological consequences are limitless. Although current treatments are available and include topical or oral antibiotics, it is crucial to develop a less risky and more effective therapy such as light/laser therapy. This article focuses specifically on the benefits of the light/laser treatment on acne vulgaris.

Porphyrins accumulated in the bacteria, *Propionibacterium acnes*, one of the etiologic factors involved in the pathogenesis, allows phototherapy to be a successful modality. They have specific absorption peaks at which lasers have optimal effects. The longer the wavelength of the light is, the deeper its penetration and thus the greater its damage to the sebaceous glands. Although blue light is best for the activation of porphyrins, red light is best for deeper penetration and an anti-inflammatory effect. Ultraviolet (UV) light, although it may have initial an anti-inflammatory effects, has been proven to be potentially carcinogenic and have adverse effects such as aging (by UV-A) and burning (by UV-B).

Previous studies indicate successful long-term intervention and selective damage of the sebaceous glands by using a diode laser with indocyanine green (ICG) dye. Mid-infrared lasers have been found to decrease lesion counts while also reducing the oiliness of skin and the scarring process. Nonablative laser treatment of acne scars using the Er:YAG laser with a short-pulsed mode has been successful in reducing the appearance of scars by stimulating neocollagenesis.

The light/laser therapy has started to be explored with promising results in highly selected patients that require further investigation in greater populations and well-designed protocols.

Keywords: acne vulgaris, lasers, light therapy

Acne vulgaris is the most common skin disease that poses significant medical, social, and psychologic problems to the patient. Acne scarring ensues if not treated properly and at early stages of presentation.[1] The therapeutic approach of this multifactorial disorder affecting the pilosebaceous follicles is based on its pathogenesis. The factors involved are hyperkeratosis of the pilosebaceous duct, increased androgen-mediated sebum production, colonization by *Propionibacterium acnes*, and development of inflammation.[1,2] Established treatments for acne target one or more of these factors in an effort to eradicate the problem. The mainstay of acne treatment involves topical or oral antibiotics and, if severe, retinoids. Although conventional forms of treatment provide adequate control of the disorder for many patients, most medications to treat acne have various drawbacks of potential adverse effects or inconvenience for the patient.[3] In response to a need for the development of alternative modalities of

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treatment, numerous authors have reported a positive response among acne patients treated with various forms of phototherapy. Exposure to red, blue, violet, and ultraviolet (UV) light therapies has resulted in lesion-count reductions.[1,2,4]

The rationale behind treating acne with lasers rests on two mechanisms. Lasers that emit wavelengths in the visible light spectrum (400–700 nm) take therapeutic advantage of the Q-band absorption peaks (500–700 nm) of porphyrins stored within *P. acnes* and the subsequent self-destruction of the bacteria.[4] In addition, long-wavelength, near- and mid-infrared lasers cause photothermal damage to the sebaceous glands as a result of a deeper penetration.[5]

Ultraviolet (UVA and UVB) light treatments have shown little real antiacne activity, at least not better than expected from topical remedies. However, UV lights may have some anti-inflammatory effect in acne; this marginal benefit is limited and also comes with potentially carcinogenic effects.[1,2,5] Also, long-term exposure to UVA enlarges the sebaceous glands, and UVB light has a high risk of burning.

One of the main limitations of visible light therapy for acne is that the photons have to penetrate through the epidermis before they can reach the depth necessary for activation of the porphyrins. Theoretically, blue light has the most effective visible wavelength for photo-activation of *P. acnes*, endogenous porphyrin components because the 407–420-nm band has the strongest porphyrin photo-excitation coefficient. Red light (660 nm) is less effective at activating porphyrins, but it penetrates deeper into the tissue. In addition, red light may also have anti-inflammatory properties by influencing cytokine release from macrophages that stimulate fibroblast proliferation and the production of growth factors, and by influencing the process of inflammation, healing, and wound repair.[1,2] Phototherapy with mixed blue-red light may act synergistically, improving both comedonal and inflammatory acne by combining antibacterial and anti-inflammatory actions; however, statistically significant differences have not been reached.[1,2]

The rationale for the use of photodynamic therapy (PDT) in acne is based on the knowledge that aminolevulinic acid (ALA) is preferentially taken up by the pilosebaceous units and metabolized in the heme synthesis pathway to produce a buildup of protoporphyrin IX (PpIX), a potent photosensitizer. Once activated by light, PpIX produces singlet oxygen and free radicals that cause damage to the mitochondria, nuclei, and cell membranes. ALA-PDT [20% ALA cream plus a red light from a diode laser (635 nm, 25 mW/cm^2, 15 J/cm^2), pulse excimer dye laser (634 nm, 5 J/cm^2), or a broadband halogen source (600–700 nm, 13 J/cm^2)] offers a unique way of improving acne by selectively damaging the pilosebaceous units and killing *P. acnes*. There is little damage to the surrounding skin, and it produces prompt and sustained improvement even in nodular and cystic acne.[6] Despite the excellent outcomes, ALA-PDT has some significant adverse effects such as discomfort during treatment, transient hyperpigmentation, exfoliative erythema, crust formation, and photosensitivity.

A different approach is to treat with indocyanine green (ICG) dye applied topically and a diode laser in a low- or high-power mode to cause photothermal damage to the sebaceous glands. Lloyd and Mirkov applied ICG in conjunction with a diode laser (810 nm, 40 J/cm^2) and showed selective damage of the sebaceous glands with long-term improvement in back acne up to 10 months after the final treatment.[5]

Long-wave, mid-infrared lasers were developed for nonablative facial rejuvenation, but have become one of the most effective acne treatments available because of thermal injury of the sebaceous glands. In a pilot trial,[7] 14 of 15 patients who had four treatments every 3 weeks using the 1450-nm diode laser (18 J/cm^2) had a significant and sustained reduction of lesion counts up to 6 months following the final treatment. Mean lesion count reduction of truncal acne from 5.43 to 0.43 in a similar protocol has been reported.[2] However, no follow-up of the patients beyond 12 weeks was carried out, and transient postinflammatory hyperpigmentation was observed in two darker-skinned patients.

The 1450-nm diode laser has been directly compared to several other lasers and energy devices. It also (6 mm spot size, 12–14 J/cm^2, dynamic cryogen cooling of 40 μs) produced longer remissions (up to 12 weeks) but with comparable lesion reduction as the 595-nm pulse dye laser (7 mm spot size, 8–9 J/cm^2, 6 μs) in a split-face trial of 25 patients after four monthly treatments. Side effects were minimal except for mild discomfort.[2] Other mid-infrared lasers have been applied to active acne, decreasing lesion counts. The 1540-nm laser (four treatments at 4-week intervals) was used in 25 patients, observing 78% reduction in lesion counts. Patients also reported that their skin was less oily.[2]

Nonablative laser treatment of acne scars began after the discovery that laser irradiation promotes collagen remodeling with a profound impact on the appearance of acne scarring. Neocollagenesis has been demonstrated histologically following nonablative treatment with a 1320-nm wavelength neodinium:yttrium aluminum garnet (Nd:YAG)[8] laser, and a 1540-nm erbium glass (Er:YAG) laser. Rogachefsky *et al*. studied a 1320-nm Nd:YAG laser with cryogen cooling for the treatment of

Table 1

Important points to remember …

- Make sure that patients have realistic expectations.
- Acne can be a challenge to treat, with some patients not responding as well to treatments. Although some patients can see a significant improvement after a single session, most will require additional treatments.
- The costs and lack of insurance coverage may limit the use of these new modalities.
- Be certain to make the patient aware of the possible side effects, such as pain and photosensitivity in ALA-PDT, and postoperative skin pigmentation changes in IV to VI skin types, so that the potential effect can be anticipated.
- Incoherent light sources may be more advantageous than lasers, because they are less expensive and produce uniform skin surface illumination of larger areas.

atrophic and mixed pattern acne scars in 12 patients. Each patient received three monthly laser treatments, each consisting of three passes. They reported statistically significant acne scar improvement by physician ratings ($P = 0.002$) and by patient ratings ($P = 0.01$) after 6 months from the final treatment.[9] It has been found that five treatments with 1320-nm Nd:YAG with cryogen cooling produced superior improvement in acne scarring compared with only three treatments, as early as 2 months after commencement. Mean acne scar improvement was significant at both 5-month and 1-year objective assessments that correspond 20%–39% ($P = 0.002$) and 40%–59% ($P = 0.011$), respectively.[7] Woo *et al*. evaluated the clinical effects of resurfacing with short-pulsed, variable-pulsed, and dual-mode Er:YAG laser for acne scarring in 158 patients. Shallow boxcar boxes and ice-pick scars were treated successfully using any type of Er:YAG laser. In cases of rolling and deep boxcar boxes, the Er:YAG laser must be used with long-pulse duration for a significant thermal effect.[10]

Conclusions

Based on clinical experience gained in the last years, laser/light-based devices may offer alternatives to conventional acne modalities in selected patients, not only in nonresponder/noncompliant patients and in antibiotic-resistant patients, but also in patients whose doses are desirable to be reduced and to decrease the flair ups associated with retinoids. Make sure that patients have realistic expectations. The low morbidity of such treatments, the possible additional benefits of simultaneously treating acne scarring, and the rapid onset of results make light/laser therapy very attractive. Be certain to make the patient aware of the possible side effects, such as pain and photosensitivity in ALA-PDT, and post-operative skin pigmentation changes in IV to VI skin types, so potential effects can be anticipated. The costs and lack of insurance coverage may limit the use of these new modalities. More studies are necessary to establish efficacy in larger sets of patients and in longer follow-up periods. Also, well-designed studies are needed to elucidate the results of combining traditional regimens and light/laser treatments on our population.

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