

The role of pulsed light and heat energy (LHETM) in acne clearance

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BACKGROUND: *Propionibacterium acnes* synthesize and store a large amount of porphyrins. Once the porphyrin is exposed to visible light it becomes chemically active and transfers to an excited state, resulting in the formation of singlet oxygen, which combines with cell membranes to destroy the *P. acnes*. This process is dependent on the rate of production of excited porphyrin molecules, which is influenced by the concentration of porphyrins, the concentration of photons, the temperature, and the wavelength of the photons.

METHODS: Nineteen patients with mild to moderate acne underwent bi-weekly treatments for 4 weeks using the ClearTouchTM system. During each treatment, pulses of light and heat were applied. Each

pulse used an average energy density of 3.5 J/cm², a pulse width of 35 ms, and a wavelength between 430 and 1100 nm.

RESULTS: At the end of the eighth treatment, acne clearance for the non-inflammatory and inflammatory lesions was 63 ± 21% and 50 ± 32%, respectively. One month after the last treatment, the acne clearance for non-inflammatory and inflammatory lesions was 79 ± 22% and 74 ± 20%, respectively, with further improvement in acne clearance at 2 months after the last treatment (85 ± 17% and 87 ± 25%, respectively).

CONCLUSION: ClearTouch pulsed light and heat energy (LHETM) technology is effective and safe for the treatment of acne vulgaris. J Cosmet Laser Ther 2004; 6: 91–95

Introduction

Propionibacterium acnes (*P. acnes*) bacteria are a major factor in the genesis of acne. As part of its normal lifecycle, *P. acnes* also synthesize and store a large amount of porphyrins, which makes it a light-sensitive micro-organism.¹ Although there is a good correlation between acne severity and the level of circulating antibodies,² the porphyrin concentration rather than *P. acnes* concentration has been linked to acne severity.³ Once the porphyrin is exposed to the visible light it becomes chemically active and transfers to an excited state, resulting in the formation of singlet oxygen, which combines with cell membranes to destroy the *P. acnes* or cells of the sebaceous gland.⁴

Like any other photochemical reaction, the efficacy of

this process is determined by the rate of production of excited porphyrin molecules, which is influenced by the concentration of porphyrins, the concentration of photons, the temperature during the chemical reaction, and the wavelength of the photons.^{5,6} Therefore, in order to achieve maximal therapeutic efficiency, the controlled parameters such as photon concentration, temperature and wavelength can be optimized.

The purpose of this study was to investigate the effectiveness of an acne phototherapy system (Clear-TouchTM; Radiancy Inc., Orangeburg, NY, USA) that uses pulsed light and heat energy (LHETM) in the treatment of acne vulgaris.

Materials and methods

Nineteen patients with mild to moderate acne volunteered to participate in the study. Patients' demographic data are

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Original Research

No. of patients	19
Sex: f/m	12/7
Mean age: years	18
Age range: years	13–28
Non-inflammatory: mean \pm SD (range)	11.36 \pm 9.9 (5–43)
Inflammatory: mean (range)	7.4 \pm 5.9 (1–26)

Table 1

Patients' demographic data.

depicted in Table 1. Before entering the study, patients and/or guardians gave their informed consent. The study population was randomly selected from a private-based dermatology clinic. Patients had no past acne therapy (oral, topical, other) or any medical illnesses. Acne severity and grading were determined by the Burton scale.⁷ Acne assessments were performed before the initial treatment, after each weekly treatment, and 1 and 2 months after the last treatment. In addition, side effects were recorded and photographed (Nikon digital camera coolpix885) after each treatment/visit.

Treatments were applied twice a week for a period of 1 month using the ClearTouch system. Each treatment lasted approximately 10 minutes. During each treatment, pulses of light and heat were applied, covering the entire treatment area.

This process was repeated twice during each treatment session. Each pulse had an average energy density of 3.5 J/cm², a pulse width of 35 ms, a wavelength between 430 nm and 1100 nm, and a spot size of 22 \times 55 mm. Photographs of both the treated and the untreated areas were taken at baseline, and at the second, fourth, sixth and last treatment, as well as at each of the follow-up visits.

After each treatment and during follow-up visits, the patient and the practitioner assessed the treatment response as follows: 'no effect' (0), 'little' (1), 'moderate' (2), 'good' (3), 'very good' (4), and 'excellent' (5).

Results

All patients completed the study protocol with no adverse side effects. Furthermore, all patients responded to the treatment. As early as the second week (fourth treatment), 73% (14/19) of the patients demonstrated significant reduction in the severity and numbers of the acne lesions when compared with the baseline count. The mean baseline numbers of non-inflammatory and inflammatory lesions were 11.36 \pm 9.9 and 7.4 \pm 5.9, respectively. At the end of the treatment period (eighth treatment), acne clearance for the non-inflammatory and inflammatory lesions was 63 \pm 21% and 50 \pm 32%, respectively (Figures 1 and 2). One month after the last treatment, the acne clearance for non-inflammatory and inflammatory lesions was 79 \pm 22% and 74 \pm 20%, respectively, with further improvement in acne clearance at 2 months after the last treatment (85 \pm 17% and 87 \pm 25%, respectively) (Figures 1 and 2). In 63% (12/19) of the patients, improvement was consistent throughout the study period. Combined

non-inflammatory and inflammatory lesion counts at 2 months after the initial treatment decreased by close to 90% when compared with the baseline count. Improvement in skin status when compared with baseline, as ranked by the patients and the practitioner, were 3.7 \pm 1.2 ('good') and 4.1 \pm 1.3 ('very good'), respectively.

Discussion

The current study demonstrates that ClearTouch pulsed light and heat energy (LHE) is an effective and safe technology for the treatment of acne vulgaris. The intermittent and post-final visit demonstrated high clearance rates of both inflammatory and non-inflammatory acne.

Acne is a chronic inflammatory disease of the pilosebaceous units that has three distinct phases: first – the obstruction of the sebaceous follicles; second – colonization and proliferation of *P. acnes*; and third – an inflammatory response. In the current study, our patients demonstrated a marked acne clearance rate. In addition to effective treatment parameters, this clearance rate may represent individual different rates of sebaceous gland function and therefore resolution may also be associated with specific changes in these acne-prone hypersecreting glands.⁸

P. acnes are slow-growing microaerophiles and may be unable to colonize follicles in which the sebum excretion rate is high or because of photodamaging reactions involving excess oxygen and endogenous microbial porphyrins.⁹ Such factors could determine whether or not a follicle develops into a non-inflamed comedo and, subsequently, into an inflamed lesion.¹⁰ When a follicle becomes blocked, it behaves as a closed culture system from which the bacteria and their end products cannot escape. It is the build up of these end products to toxic levels that damages the follicle wall and/or initiates the inflammatory response.¹¹

Unlike current laser and non-laser light sources, which are based on a continuous wave mode, the ClearTouch system is a pulsed wave light source system. A 3.5 J/cm² pulsed light source with a 35 ms pulse width provides 10 000 times more photons compared with a 10 mW/cm² continuous wave. Consequently, the pulsed source is clearly more efficient.

According to the Arrhenius equation, a chemical reaction is directly dependant on temperature. Therefore, the higher the temperature, the faster a given chemical reaction will proceed. For most chemical reactions, elevating the temperature by 10°C doubles the speed of the reaction. Thus, using combined light and heat energy (LHE) results in better treatment of the acne lesions.

Although sun exposure has a beneficial effect on acne, it is not clear which wavelengths contribute to the favorable effect of sunlight. Blue/UV light is theoretically the most effective visible wavelength for photoactivation of the major endogenous porphyrin component of *P. acnes* because it matches the strongest porphyrin photoexcitation band.¹² However, blue/UV light has a poor skin penetration depth of less than 0.25 mm. On the other hand, red light penetrates more deeply into tissue, though it is less

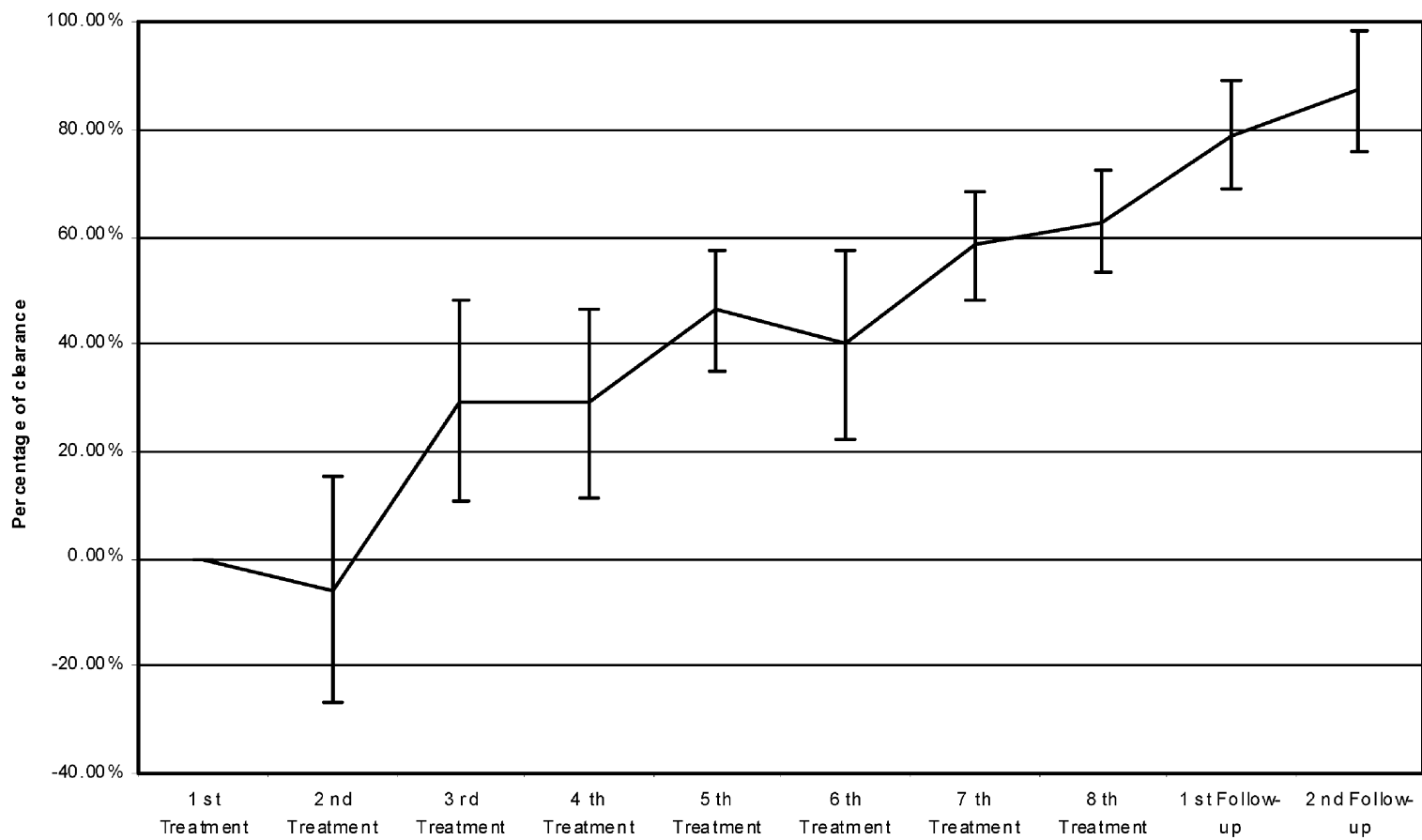


Figure 1
Group average clearance rate of non-inflammatory lesions (bars represent 95% confidence intervals).

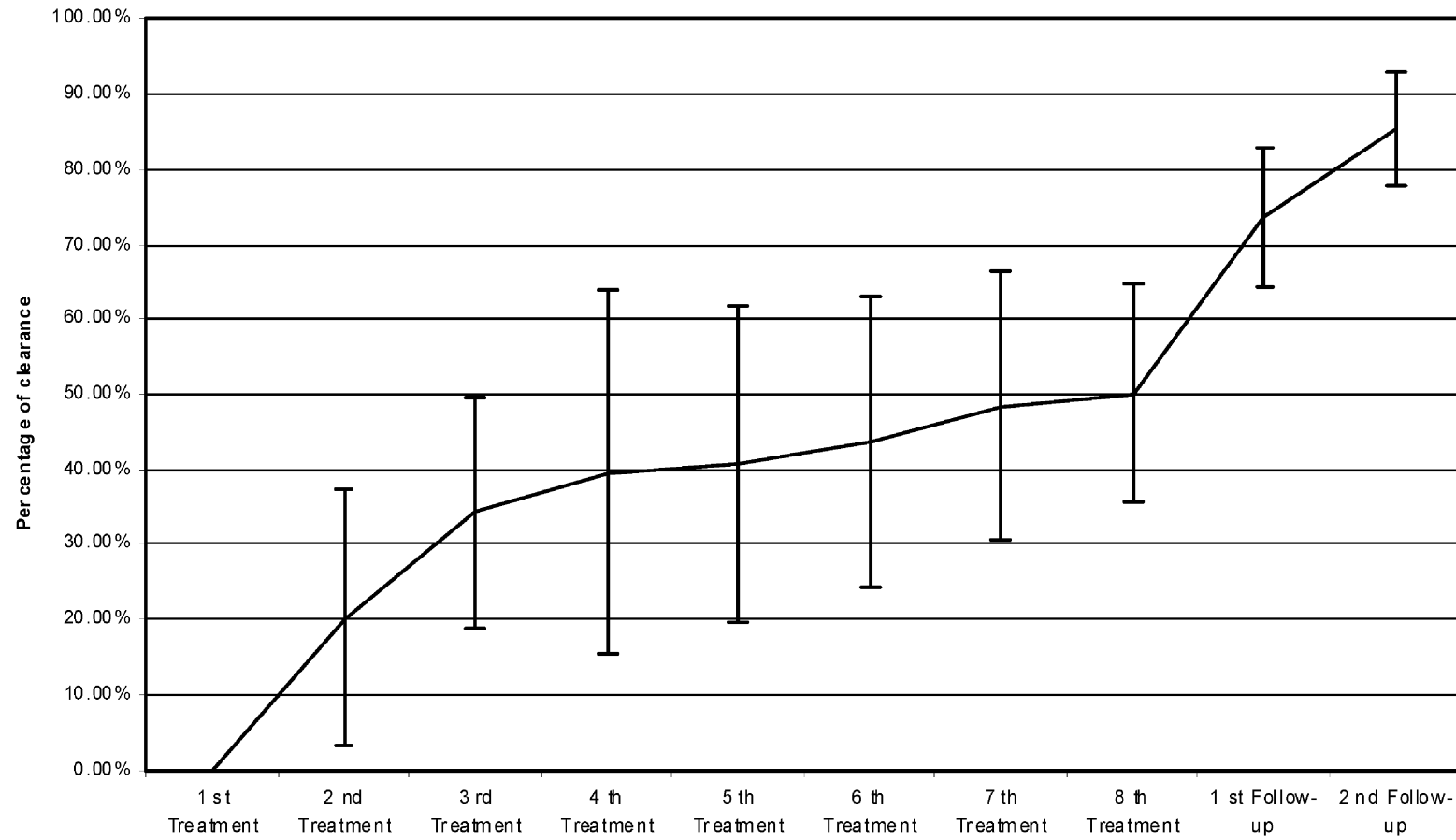


Figure 2
Group average clearance rate of inflammatory lesions (bars represent 95% confidence intervals).

effective, causing photoexcitation of porphyrins.¹³ In addition, red light when compared with blue light may have an anti-inflammatory reaction.¹⁴

One of the main limitations of acne light therapy is the fact that photons have to penetrate through the epidermis before they can reach the depth necessary for activation of the porphyrins. The depth of follicles on the face is up to 3 mm and even more on the back. ClearTouch utilizes the higher range of the light spectrum (green to yellow) as well as heat and red light energy. The higher range of the spectrum optimizes the tradeoff between the penetration depth and the porphyrin activation efficacy.

Thus, even though the excitation coefficient of porphyrins in the blue band is very high, since blue photons do not penetrate the skin sufficiently, they are unable to activate

the porphyrins in the acne lesions. Consequently, it is not the preferred wavelength for acne phototherapy. Other lower excitation coefficients of porphyrins are in the green and red bands, where penetration depths of photons are in the range of a few millimeters and this band is more suitable for acne phototherapy.

In summary, ClearTouch uses an optimal light spectrum without compromising the process of activating the porphyrin that initiates the anti-bacterial process resulting in *P. acne* destruction. In addition, by combining heat and red light energy, ClearTouch produces anti-inflammatory results while avoiding short-term adverse side effects. Therefore, the ClearTouch system and its LHE proprietary technology is an efficient and safe therapeutic modality for the treatment of acne.

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