Evaluating Pulsed Light and Heat Energy in Acne Clearance

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BACKGROUND: The ClearTouch™ Acne Clearance System powered by LHE™ Light Heat Energy is an alternative solution to currently available medications for the treatment of acne lesions.

OBJECTIVE: This study evaluates the effectiveness and safety of LHE™ Light Heat Energy for acne clearance using the ClearTouch™ Acne Clearance System.

METHODS: A group of 19 patients with acne lesions received a series of 8 treatments each over a 4-week period, with 2 follow-up evaluations 4 and 8 weeks after the last treatment.

CONCLUSIONS: All patients demonstrated a significant reduction (close to 90%) in the number of acne lesions following phototherapy using the ClearTouch LHE technology. No adverse side effects were reported.

Acne Phototherapy

Acne is a multifactorial disease of the upper body sebaceous glands, especially the face. The pathophysiology of acne results from the interplay of follicular hyperkeratinization, the presence of Propionibacterium acnes (P. acnes) bacteria in the follicular canal, and sebum production. In acne patients, it was observed that some follicles produce excessive sebum. These follicles represent acne-prone follicles.

The acne lesion process begins with follicles that become blocked by a plug, which is the result of hyper-proliferation of the keratinocytes lining the duct. At this stage, the lesion is called a comedone, referred to as a blackhead or a whitehead. These white and black heads can rapidly transform into inflamed lesions when the final step in the acne development process triggers a powerful immune response to the P. acnes and/or the Propionibacterium granulosum.2

Cutaneous P. acnes are slow-growing anaerobic bacteria and may be unable to multiply in follicles in which the sebum excretion rate is high as end products of bacterial metabolism escape with the out-flowing sebum. When a follicle becomes blocked, it behaves as a closed culture system from which bacteria and their end products cannot escape. It is the build up of these products to toxic levels that damages the follicle wall and/or initiates the inflammatory response. Bacteria will also die and release in situ, their intracellular contents and highly antigenic cell wall fragments into the duct.5

The P.acne produces porphyrin as part of its normal life cycle. Once the porphyrin is exposed to the visible light it becomes chemically active, inducing a photodynamic reaction, which results in the destruction of the P.acne bacteria and the sebaceous gland.4

Under light illumination the following chain of reactions schematically describes the process of P. acne destruction:

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\text{Photon} + \text{porphyrin} \rightarrow \text{excited porphyrin molecules} \rightarrow \text{cell attacking species} \rightarrow \text{P. acne and sebaceous gland destruction.}
\]

The porphyrin molecules absorb photons at the excitation bands and transfer 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.5,6

Like any other photochemical reaction, the efficacy of the process is determined by the rate of production of excited porphyrin molecules, which is influenced by:

- Concentration of porphyrins.
- Concentration of photons.
- Temperature during the chemical reaction.
- The wavelength of the photons.

The controlled parameters in this process can be optimized in order to achieve maximum process efficacy.
Clinical Study

ClearTouch (Radiancy Inc., Orangeburg, NY) is an acne phototherapy system that uses the company’s unique and proprietary LHE technology combining light and heat energy to trigger the destruction of P. acnes. To investigate the safety and effectiveness of LHE in the treatment of mild to moderate acne vulgaris, 19 patients (12 female and 7 males) between the ages of 13 to 28 volunteered to participate in the study. Clinical assessment and acne severity grading were performed before the initial treatment and one and two months after the last treatment. Patients have had no past acne therapy (oral, topical, other) or any medical illnesses. The mean baseline numbers of non-inflammatory and inflammatory lesions were 11.36 and 7.4, respectively.

Treatments were applied twice a week for a period of one month using the ClearTouch system. Patients returned for follow-up visits, one and two months after the last treatment. During each treatment, pulses of light and heat were applied, covering the entire treated area. This process was repeated twice during each treatment. Each pulse had an average energy density of 3.5J/cm², pulse width of 35msec, wavelength between 430-1100nm, and a spot size of 22x55mm. Photos of both the treated and the untreated areas were taken at the baseline, 2nd, 4th, 6th and last treatment, as well as at each of the follow-up visits.

As early as the second week, most patients demonstrated significant reduction in the severity and numbers of the acne lesions when compared to the baseline count. At the end of the treatment period, the acne clearance for the non-inflammatory and inflammatory lesions was 63% and 50% respectively. One month after the last treatment, the acne clearance for non-inflammatory and inflammatory lesions was 79% and 74% respectively, with further improvement in acne clearance at two months after the last treatment (85% and 87% respectively). Combined non-inflammatory and inflammatory lesion counts at 2-month after the initial treatment decreased by close to 90% when compared to the baseline count. In most cases, improvement was consistent throughout the study period. No adverse side effects were reported.

Summary and Conclusions

This study demonstrated that ClearTouch pulsed light and heat energy (LHE) technology is effective and safe for the treatment of acne vulgaris. The treatment response was time-dependent, and occurred as early as two weeks after the initial treatment.

As part of its reproduction and metabolism process, the P. acnes releases high amounts of endogenic porphyrin. Once Porphyria molecules absorb photons, they become chemically active and transform into a state of aggregation that results in the formation of free oxygen (i.e., type II photooxidation). This free oxygen attacks the cell membrane and leads to the destruction of the P. acnes bacterium.

The efficacy of this photochemical reaction process is determined by the rate of production of excited porphyrin molecules, which is influenced by several factors. Several of these factors can be controlled and optimized in order to achieve maximum process efficacy.

Concentration of Photons

A continuous wave (CW) light source, which is one of the methods used in acne phototherapy, emits a constant beam of light and delivers constant power. However, CW when compared to a pulsed light source has limited peak power. A 3.5 J/cm² pulsed light source with a 35msec pulse width provides 10,000 times more photons compared to a 10mw/cm² CW light source. Consequently, the pulsed source is clearly more efficient than the CW source.

Temperature

According to the Arrhenius equation, chemical reaction is directly dependant on temperature. Therefore, the higher the temperature, the faster a given chemical reaction will proceed. For most of the chemical reactions, elevating the temperature by 10°C doubles the speed of the reaction. Thus using combined Light and Heat Energy results in better treatment of the acne lesions.
THE ROLE OF PULSED LIGHT AND HEAT ENERGY IN ACNE CLEARANCE

Average Clearance of Inflammatory Lesions

Average Clearance of Non-Inflammatory Lesions

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The Wavelength of the Photons

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. However, blue/UV light has a poor skin penetration depth of less than 0.25mm. On the other hand, red light penetrates more deeply into tissue, though it is less effective causing photoexcitation of porphyrins. In addition, red light when compared to blue light may also have anti-inflammatory reaction.

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.

Calculation of light penetration depth reveals that blue light in the range 400-430 nm penetrates the skin to a depth of less than 0.25mm. Thus, even though the excitation coefficient of porphyrins in this band is very high, since blue photons do not penetrate the skin 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 mm and this band is more suitable for acne phototherapy.

Radiancy’s 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, ClearTouch uses the optimal light spectrum without compromising the process of activating the porphyrin that initiates the antibacterial process resulting in P. acnes destruction. In addition, by combining heat and red light energy, ClearTouch produces anti-inflammatory results while avoiding short-term adverse side effects.

References


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