Light and Heat Energy (LHE™) Technology – A Novel Approach to Nonablative Skin Rejuvenation

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ABSTRACT: Nonablative skin rejuvenation using laser, intense pulsed light (IPL) or RF techniques is becoming increasingly popular due to the aging population's desire for fresher, younger looking skin. Unlike ablative skin resurfacing, nonablative procedures entail minimal, if any, convalescence and pose essentially no risk of permanent complications. Depending on the modality used, nonablative skin rejuvenation can reverse signs of photo-damaged skin such as fine wrinkles, skin roughness, vascular lesions and pigmentary irregularities. To achieve these effects, current laser and IPL devices utilize high light energy fluences which necessitate large, expensive systems incorporating complex skin cooling techniques in order to avoid excessive thermal damage to the epidermis.

Conversely, Radiancy's patented pulsed light and heat energy (LHE™) technology enables the use of low light energy fluence to achieve the same skin rejuvenation effects without risk to the epidermis. Light emanating from the light unit assembly (LUA) targets melanin and hemoglobin in the skin while the heat generated in the LUA is conducted into the skin to cause controlled, mild thermal injury of dermal collagen, inducing new collagen formation. This more efficient selective photothermal process consumes less energy, facilitates a very compact, cost-effective unit and avoids the need for any skin cooling technique.

Radiancy's LHE™ technology thus affords effective nonablative treatment of all skin photoaging signs, in all skin types, while maintaining a large skin safety margin.

This article will describe Radiancy's LHE™ skin rejuvenation system and will review the results at our clinic which demonstrate clinical equivalency to existing laser and IPL photorejuvenation devices.

Introduction

Nonablative skin rejuvenation using laser, intense pulsed light or RF techniques is becoming increasingly popular due to the aging population's desire for fresher, younger looking skin (1-6). More and more patients are seeking non-invasive, no downtime techniques to obtain smoother skin, diminish age spots and discoloration and eliminate visible blood vessels. Recently developed photorejuvenation techniques address all these skin photoaging elements, which include rhytids, skin roughness, enlarged pores, telangectasia, redness, dyschromia and solar lentiges. Contrary to laser skin resurfacing or chemical peels, photorejuvenation enables the elimination or significant reduction of these signs of photoaging on the face, neck, chest or hands with little, if any, convalescence time and with minimal risk of adverse effects (7,8).

The theoretical basis for photorejuvenation lies in the theory of selective photothermolysis (9) combined with the phenomena of neo-collagenesis, which occurs in response to a mild thermal injury in the reticular and papillary dermis (10,11).

The most common pigmentary component of photoaging is solar lentigo. These are benign macular epidermal lesions caused by sun exposure that contain melanin within melanocytes and keratinocytes. Lasers or IPL pulses darken these lesions, which then peel off in 5-10 days (12,13). Solar lentigos frequently clear with a single treatment and recurrence is uncommon. Lentigo maligna or other premalignant or malignant pigmented lesions should not be treated with photorejuvenation.

Lasers and broadband intense pulsed light sources emitting visible wavelengths target hemoglobin in the microvasculature of the upper dermis, as well as in any present vascular irregularities such as telangectasia or rosacea (14-16). Light energy absorbed in these vessels is converted to heat, resulting both in the coagulation of these vessels as well as in mild heating of dermal collagen. Limiting the duration of the light pulse to about 10 msec. assures optimal effect on the smaller blood vessels, which are typical to photoaged skin. Light is absorbed in the red blood cells and diffuses throughout the circumference of the vessel to facilitate effective coagulation that results in vessel destruction.

The effect on skin texture in photorejuvenation is based on the stimulation of neo-collagenesis as a result of a mild thermal insult to dermal collagen. With existing laser and IPL devices this damage is achieved through two basic mechanisms. Visible wavelengths target discreet chromophores in the dermis or at the dermal-epidermal junction, while near and mid infrared wavelengths are directly absorbed by intra and extracellular water. The resulting mild thermal injury to the papillary and upper reticular dermis leads to fibroblast activation and synthesis of new collagen and extracellular matrix material, which occurs over a period of a few months. This wound healing response leads to improvement in skin texture, which has been shown to hold up over several years if patients practice stringent sun protection (17). While wrinkle improvement is subtle when compared to more aggressive ablative or surgical techniques, it is well appreciated by patients unwilling to undergo prolonged convalescence.

Though only recently introduced, photorejuvenation is already being applied with a plethora of different lasers and IPL devices. Lasers, which emit a single wavelength, are generally limited in their ability to address all aspects of photodamaged skin. Broadband IPL devices are therefore generally preferred however use of high energy fluence requires some means of skin cooling to avoid excessive damage to the epidermis (18). Cold gel, contact, cooled sapphire window, a burst of evaporative coolant or some other means of skin cooling are usually incorporated with current IPL devices. In addition to the added cost and complexity, these cooling techniques are also operator dependent and may compromise safety.

Radiancy's LHE system is a novel approach to pulsed light photorejuvenation, in that it simultaneously utilizes two different energy pathways - light and heat. Heat is responsible for collagen insult and the subsequent subsurface remodeling, so heat energy rather than excessive light energy is brought into play. By optimizing wavelengths, pulse duration and spot size, and by simultaneously applying its patented light and heat (LHE™) technology, Radiancy's photorejuvenation system achieves effective results on all skin photoaging elements more efficiently than existing laser and IPL devices, without the need for any skin cooling mechanism. Effective clinical results are obtained with a light energy fluence of up to 10 J/cm^2 as compared to the 15-35 J/cm^2 typically emitted from laser and IPL systems, thus enabling a significantly safer and more compact photorejuvenation system.

System Description and Operation:

Radiancy's LHE photorejuvenation system is a small, tabletop device. It utilizes a low fluence flashlamp, which emits light at wavelengths of 400-1200 nm. This broad spectral range accommodates well for hemoglobin, oxyhemoglobin, melanin and mild water absorption to address all aspects of photoaging. Pulse duration is set at 10 msec. to achieve optimal effect on the smaller blood vessels typical to photodamaged vascular irregularities and to better match the 3-7 msec. thermal relaxation time of the epidermis (19). The lamps are situated in a lightweight treatment head with a specially designed housing that directs both the light and heat generated in the head towards the aperture. This aperture defines a large effective spot size of 12x54 mm.

Using a single, simple, analog control knob, light energy fluence can be adjusted within the range of 5-10 J/cm^2 in one pulse sequence. Light energy fluence is displayed as percentage of maximum output and is typically set according to the client's skin type and primary indication.

Unlike most IPL photorejuvenation devices, Radiancy's LHE system does not require independent settings of wavelengths and pulse sequence parameters, thus simplifying the operation assuring a short learning curve and a high safety margin.

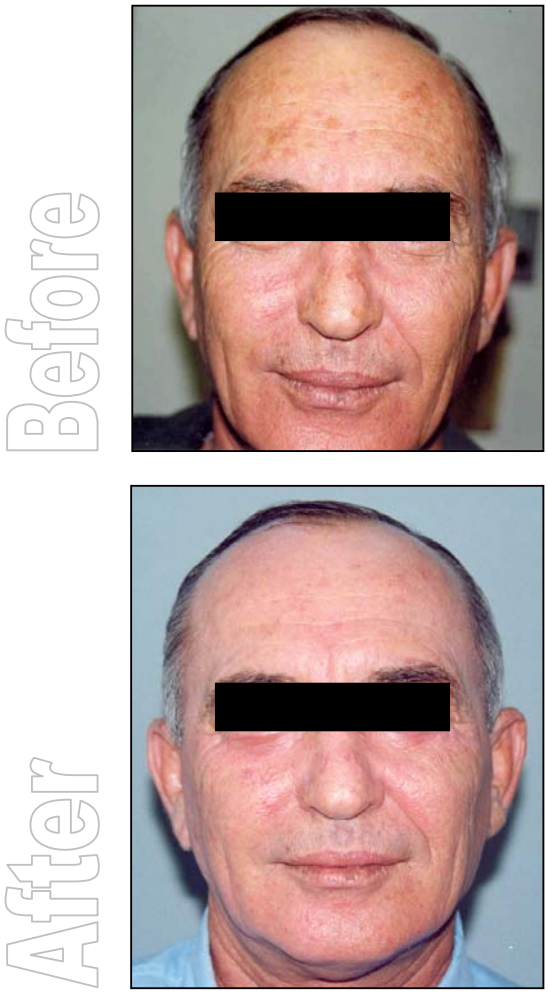

Figure 1: Male, skin type III (before & after 6 LHE treatments)

Treatment protocol:

Prior to treatment, conditions presented should be matched to the indications for LHE photorejuvenation. Particular care should be exercised to avoid treating any pigmented lesion suspicious of malignancy or pre-malignancy. Patients should be consulted for any contra-indications such as recent tanning, use of photosensitive medications or herbs, use of Accutane, any inflammatory skin conditions and any history of diseases stimulated by light.

Patient satisfaction with LHE photorejuvenation is directly linked to realistic expectations. These are best established through careful explanation of treatment capabilities and limitations with the aid of typical before/after exemplary photographs. Patients should be advised on sun avoidance prior, during and after treatments to be followed by a stringent practice of sun protection in order to maintain the results of photorejuvenation.

Male patients should be advised that treatment on the beard and moustache areas might affect hair growth.

LHE Photorejuvenation is a multi-session treatment so patients should be willing to complete the full treatment regimen. Discomfort associated with the treatment is usually minimal, however patients may be offered use of a topical anesthesia such as Ela-Max, EMLA or Topicaine. Ela-Max has the advantage that it is easier to apply and does not cause vasoconstriction that may effect treatment of vascular irregularities. Finally, patients should be carefully advised on the typical post treatment course, which may include erythema, edema and darkening of pigmented areas, as well as on the risk of adverse effects, though rare and usually transient.

LHE Photorejuvenation was administered at the energy settings recommended for a particular patient skin type. For each new patient, a test, at the lower of the specified settings, was first performed. Diffused mild erythema, slight edema and darkening of brown spots as well as darkening of visible blood vessels should appear within three minutes of the pulse. If not, energy is increased by 5-10% and the test is repeated on an adjacent spot. On the neck, chest and hands lower fluences are generally recommended. In dark skinned patients a delayed response of up to 24-48 hours is common so treatment should be delayed accordingly.

LHE photorejuvenation was focused on specific areas according to the primary indication. In the case of pigmentary sun damage treatment began with the energy setting recommended for the patient's skin type and was gradually increased, when necessary, until redness appeared on the pigmented spot but not on surrounding skin. The lesions were then treated with two passes in each session and treatments were repeated once a week. For vascular lesions energy was set so that diffused redness was visible on the area treated. Specific vessels often darkened indicating coagulation. For this condition two treatments per week were usually performed.

In the case of fine lines and wrinkles the entire aesthetic unit was treated using parameters, which assured only slight, diffused redness without any purpura. Two passes were administered in each session spaced by an interval of about three minutes, and sessions were repeated about once every ten days. In some cases LHE photorejuvenation was combined with Botox, which was administered to the larger, dynamic wrinkles.

Clinical results:

The Radiancy LHE SkinStation system has been used in our clinic for 8 months. In total 32 patients have been treated for photorejuvenation. In most of these patients sun damage pigmentation was the primary indication. Patients' mean age was 55 (range 32 to 70), skin types were I-V and location was mainly face and hands but also a few chests. Average number of treatment sessions was 4.75 (range 2 to 10) and follow-up is up to 6 months (mean 3.3). Treatment result was evaluated by both patient and physician on a scale of 0-4, from no result to excellent result. Average result was 2.7 (range 1 to 4). There were no significant adverse effects. All patients experienced temporary erythema, 28% had superficial crusting, two patients had blistering.

Patients with a primary indication of vascular irregularities underwent 4 treatment sessions and results were evaluated as good (2). No patient was treated for wrinkles as a sole indication. While objective evaluation of wrinkle improvement was not possible, patients did experience a subtle improvement in skin texture and skin tone.

It is interesting to note that in addition to the photorejuvenation treatments reported above, we have been using the Radiancy LHE system in our clinic to treat patients with erythematous keloids. In these patients the effect of collagen remodeling appears to be more dramatic, with most patients experiencing reduction in hypertrophy, softening of the scar and elimination of pain. This is in addition to a marked reduction in erythema.

Figure 2: Female, skin type III (before & after 2 LHE treatments)

Conclusions:

The new light and heat energy (LHE) technology implemented in the Radiancy SkinStation and SPR photorejuvenation systems affords safe and effective non-ablative skin rejuvenation at a fraction of the size and cost of clinically equivalent laser and IPL devices. The system is less operator dependent and requires no skin cooling technique. Clinical studies conducted with the Radiancy LHE system demonstrate clinical equivalence to existing laser and IPL photorejuvenation systems in eliminating pigmented sun damage and vascular irregularities. While subtle improvement in wrinkles, skin texture and skin tone has been experienced, it is at this stage doubtful whether these indications alone justify the use of any non-ablative photorejuvenation treatment. Since sun damaged, ageing skin generally exhibits pigmentary and vascular irregularities, this modality does present objective positive results for most patients seeking younger looking skin without the convalescence and complications associated with more aggressive, ablative techniques.

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