ORIGINAL ARTICLES

Clinical Improvement of Photodamaged Skin After a Single Intense Pulsed Light Treatment

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?1 ***Background and Objectives:*** *Photoaging is clinically characterized by irregular pigmentation (freckling, lentigines, persistent hyperpigmentation), dryness/roughness, telangiectasia, wrinkling, elastosis, and inelasticity. Currently available medical literature documents using intense pulsed light (IPL) 3 to 5 times to achieve satisfactory improvement.*

Study Design/Materials and Methods: *Twenty patients of Fitzpatrick skin types I–III, each with components of photodamaged skin including telangiectasias, dyschromia, skin roughness, enlarged pore size, and/or rhytides—participated in the study and were treated with a single Lumenis One IPL. Pretreatment and posttreatment photographs were graded by 2 independent physicians as to percent improvement.*

Results: *After 1 treatment with the Lumenis One IPL, results showed an average improvement of 40% in resolving telangiectasias, dyspigmentation, and fine wrinkling.*

Conclusions: *The present study demonstrates that as much as a 40% improvement in the overall appearance of photoaging can be obtained after a single treatment with the Lumenis One IPL. Previous studies with IPL using the Lumenis Photoderm, Vasculite, or Quantum systems found that 3 to 5 treatments were needed to obtain a similar improvement. These IPL systems have a smaller spot size, a different energy output profile, and cutaneous cooling mechanism that may explain their decreased efficacy compared with the Lumenis One.*

Unlike cutaneous intrinsic aging, which is a universal phenomenon attributable solely to the passage of time, cutaneous photoaging occurs secondary to chronic ultraviolet light exposure. Photoaging is clinically characterized by irregular pigmentation (freckling, lentigines, blotchy hyperpigmentation), dryness/roughness, telangiectasia, wrinkling, elastosis, and inelasticity.[1] Photoaging may also include premalignant lesions, such as actinic keratoses,[2] and malignant lesions, including basal cell carcinomas and squamous cell carcinomas. Premalignant and malignant lesions aside, the quest to reverse the effects of photoaging has included many diverse treatments. Such treatments have included glycolic acid peels and microdermabrasion;[3] tretinoin peeling;[4] salicylic acid peels;[5] deep chemical peels, such as phenol and 50% or greater trichloracetic acid;[6] radiofrequency resurfacing;[7,8] laser resurfacing;[9–11] and the use of a variety of nonablative lasers, such as the frequency doubled neodymium: yttrium-aluminum-garnet (Nd:YAG),[6,12] KTP (potassium titanyl phosphate; green 532-nm), the pulsed-dye laser (yellow 585-nm to 595-nm),[6,13,14] the 1064-nm Nd:YAG,[6,12,15] the 1320-nm Nd:YAG,[16] the 1450-nm diode laser,[17] and the 1540-nm erbium glass laser.[18] Visible nonlaser light sources, such as intense pulsed light (IPL), have also been used as a principle means of nonablative skin photorejuvenation.[19,20]

Unlike a laser, which consists of coherent, monochromatic light, IPL is noncoherent, polychromatic light covering a spectrum of wavelengths ranging from approximately 500 nm to approximately 1200 nm. IPL was first developed in San Diego in 1992 and was subsequently approved by the US Food and Drug Administration for use in late 1995 initially as the Photoderm (ESC/Sharplan, Norwood, MA; now Lumenis, Santa Clara, CA).[21] Since the birth of this initial IPL source, numerous manufacturers have produced various forms of IPL, each with an internal filter overlying the flashlamp, which prevents the emission of wavelengths less than 500 nm.[21] Cutoff filters—which, depending on the device, may include 515, 550, 560, 570, 590, 615, 645, 690, and 755 nm—are used to further block specific emission spectrums to meet the

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Physicians' Ratings of Improvement of Photodamaged Skin After 1 Intense Pulsed Light Treatment

Subject No.	Investigator 1				Investigator 2			
	Erythema	Solar Lentigos	Smoothness	Overall Appearance	Erythema	Solar Lengitos	Smoothness	Overall Appearance
1	50	50	50	50	40	30	20	35
2	75	50	30	60	50	40	40	40
3	30	75	50	60	40	60	40	50
4	30	30	30	30	20	30	20	20
5	0	50	50	50	40	50	20	40
6	75	30	50	50	50	30	30	40
7	50	50	50	50	40	40	30	40
8	50	30	50	50	0	10	10	10
9	30	30	30	30	30	10	10	20
10	50	75	50	60	20	30	20	20
11	50	75	50	60	20	4	20	30
12	50	50	50	50	40	50	40	45
13	50	50	50	50	40	50	30	40
14	50	75	50	60	10	35	10	20
15	75	75	50	60	4	60	40	50
16	75	50	50	60	40	30	30	30
17	30	50	50	40	50	50	40	50
18	75	75	50	60	60	60	50	60
19	25	25	25	25	20	10	20	15
20	75	30	50	50	30	40	50	35
Statistical analysis								
Mean score	49.75	51.25	45.75	50.25	32.2	35.95	28.5	34.5
Standard deviation	21.1184	18.2724267	8.77721332	11.05905	16.35012	17.4611599	12.6802789	13.56272
t Test*	0.005815	0.0018192	1.6874E-05	5.33E-05				
Combined data†								
Mean	40.975	43.6	37.125	42.375				
Standard deviation	20.65155	19.2670837	13.8623036	14.58782				

requirements for selective photothermolysis, thus targeting specific chromophores, such as hemoglobin and melanin.[21]

Using IPL for photorejuvenation has many benefits, including minimization of the possibility of purpura,[19,21] the ability to treat multiple aspects of photoaging (pigmentation, telangiectasia, and fine wrinkling) simultaneously,[19] minimal patient discomfort,[19,22] and no "down time" after treatments.[19,22] Previous studies have evaluated improvement in various aspects of photoaging after a series of 3 to 5 treatments with IPL.[19,20,23–26] Most studies have described improvements of at least 50% in photoaging after a series of multiple treatments. The purpose of this study is to evaluate the percentage improvement in various aspects of photodamaged skin after a single IPL treatment with a new IPL device.

Methods

Subjects

Twenty patients—each with components of photodamaged skin, including telangiectasias, dyschromia, skin roughness, enlarged pore size, and/or rhytides—participated in the study. All patients were of Fitzpatrick skin types I–III. The 20 patients were selected in a consecutive fashion from patients undergoing IPL treatments for evidence of photodamage. Pretreatment photographs were taken with the Canfield Visia Complexion Analysis device before any IPL ?2 treatment. Posttreatment photographs were taken 1 to 3 months after a single IPL treatment in all 20 patients. Patients were excluded if they had had any prior use of botulinum toxin within the past 3 months, fillers within the past 6 months, or laser resurfacing or use of other

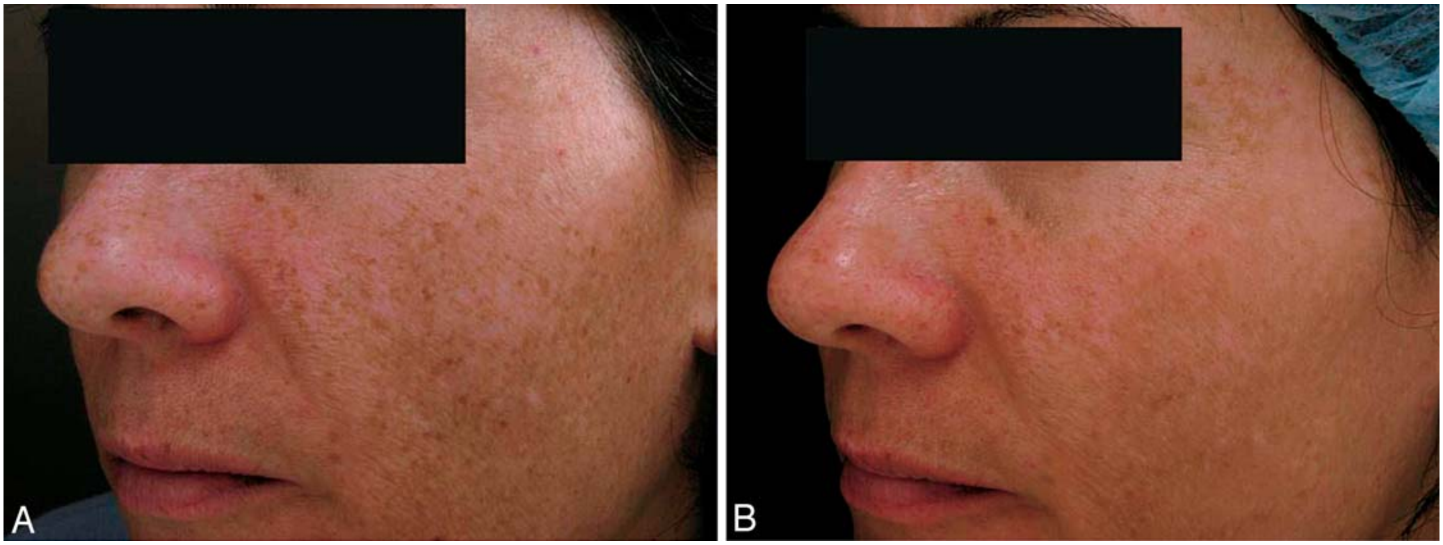

Figure 1. *Photo of a patient before (A) and 1 month after (B) treatment with intense pulsed light.*

lasers or IPL for nonablative photorejuvenation within the past 3 months. All patients gave informed consent before treatment.

Treatment Protocol

A noncoherent polychromatic filtered flashlamp IPL source (Lumenis One™, Lumenis, Santa Clara, CA) with an output range of 515 to 1200 nm and a spot size of 15 × 35 mm was used to treat each patient. The entire face (excluding the upper eyelids in all patients and the beard area in male patients) was treated at each session. Aluminum/stainless steel external eyeshields were used to protect the eyes and upper eyelids of each patient. Treatment fluences ranged from 16 to 20 J/cm^2 and

Figure 2. *Photo of a patient before (A) and 1 month after (B) treatment with intense pulsed light.*

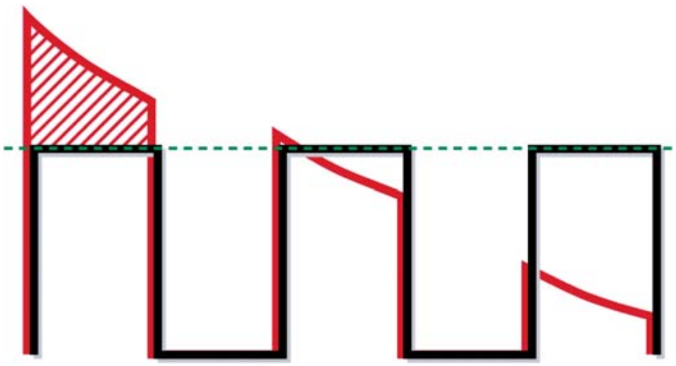

Figure 3. *Diagram showing older pulses in red and new optimal pulse technology in black.*

were based on patient tolerability and producing an immediate visual change of slight graying of lentigos and/or thrombosis or vasospasm of blood vessels. A 560-nm cutoff filter was used in the treatment of each patient. Treatment parameters were adjusted so that patients with dyspigmentation and vascular changes were treated with a double pulse setting of 3.5 msec and 3.5 msec with a delay time based on skin type (10 msec for light-skinned patients and 15 to 25 msec for those with slightly tan skin). A thin, 1-mm layer of colorless ultrasonic gel was applied to the patient's face immediately before the treatment to enhance conduction of light through the stratum corneum and to avoid small air pockets between the sapphire light guide (which was cooled to 4°C) and the epidermis. No general or topical anesthesia was used during the treatments. Postprocedure care included rinsing off the ultrasonic gel with a facial cleanser and applying a sunscreen of sun protection factor 30 or higher.

Photographs were taken before the initial treatment and after subsequent treatments, as previously described. Pretreatment and posttreatment photographs were randomized and graded independently by 2 physicians for change in each of the following types of lesions: erythema, solar lentigos, smoothness, and overall skin appearance. The physicians' assessment of change of the lesions was graded on a 0 to 100% change scale, with 0 being no improvement and 100% being greatest improvement.

Results

?5 As noted in the Table, there was a an overall average
improvement of 40.97% for erythema, an improvement
?3 of 43.6% in solar lentigos, an improvement of 37.12%
smoothness, and an overall cosmetic improvement of 42.37% with just 1 IPL treatment.

$$k = \frac{Q}{t} \times \frac{L}{A \times \Delta T}$$

Figure 4. *Thermal conductivity, k, is the property of a material that indicates its ability to conduct heat. It is defined as the quantity of heat, Q, transmitted in time t through a thickness L, in a direction normal to a surface of area A, because of a temperature difference ΔT, under steady-state conditions and when the heat transfer is dependent only on the temperature gradient. Thermal conductivity = heat flow rate × distance/(area × temperature difference).*

Figure 1 and Figure 2 demonstrate the clinical ?4
photographs of 2 patients before 1 treatment with IPL and 1 month after 1 treatment with IPL. There was a significant improvement in solar lentigos, erythema, and smoothness of the skin.

Discussion

The present study demonstrates that more than an improvement of more than 40% in the overall appearance of photoaging can be obtained after a single treatment with the Lumenis One IPL. As all previously published studies do not show an improvement with each procedure, it is difficult to be certain why 1 treatment with the Lumenis One IPL is so effective. Almost all previous published studies evaluating the effectiveness of the IPL in treating photoaging have been with the Lumenis Photoderm, Vasculite, or Quantum systems. These IPL systems each have a smaller spot size than the Lumenis One. The older IPLs also have a different energy output profile and cutaneous cooling mechanism that may explain their decreased efficacy.

The energy in all IPL systems other than the Lumenis One is higher at the beginning of the pulse and declines steadily towards the end of the pulse; often more than half of the pulse energy is emitted during the first third of the pulse (Figure 3).

The Lumenis One for the first time allows for the energy given in the pulse to be uniform throughout the
pulseduration. Lumenis terms this effect "optimal pulse ?6
technology."

In addition, the sapphire crystal cooling on the Lumenis One was not present on the Photoderm or Vasculite systems, which required 1 to 2 mm of cold gel to serve as a heat sink between the crystal and the skin. The Quantum requires contact with the skin using a quartz crystal light guide. The Lumenis One has a sapphire crystal light guide that is more efficient as a heat conductor than either water-based gel or a quartz crystal[27–29] (Figures 4 and 5).

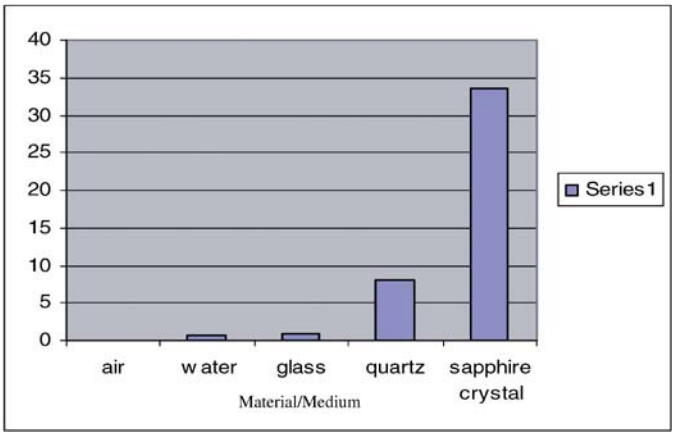

Figure 5. *Thermal conductivity of several materials X-axis: Medium/Material; Y-axis: Thermal conductivity.*

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