

Photorejuvenation for Asian Skin by Intense Pulsed Light

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BACKGROUND. Dermabrasion and deep chemical peeling are used in the treatment of photoaged skin. These ablative procedures are effective enough to produce a certain improvement but have often caused postinflammatory hyperpigmentation among Asian patients. To avoid such adverse effects, a new, nonablative procedure has been sought.

OBJECTIVE. To determine the effectiveness of photorejuvenation for Asian skin using intense pulsed light (IPL). The specific parameters used, improvement ratios, side-effects, and downtime required are also discussed.

METHODS. Ninety-seven patients were treated for photoaging using IPL. The cutoff filters of 550 nm and 570 nm were utilized for three to six treatments at intervals of 2 to 3 weeks.

RESULTS. Treatment results were evaluated and rated by both patients and physicians at the end of the third treatment based on improvement in pigmentation, telangiectasia, and skin texture. A combined rating of "good" or "excellent" was given to more than 90% of the patients for pigmentation, more than 83% for telangiectasia, and more than 65% for skin texture. There were some minor complications in four cases: one had erythema that continued to the next day and three had minor blisters leaving no marks.

CONCLUSION. Photorejuvenation using IPL is a completely safe and effective procedure even for Asian skin. It will be increasingly used for skin rejuvenation in the future.

IN JAPAN, the need for treatment of photoaged skin, such as pigmented lesions, telangiectasia, deteriorating smoothness of skin texture, and fine and coarse wrinkles, is increasing. To meet such needs, conventional modalities of collagen injections, rhytidectomies, and laser treatments have been performed according to the patient's symptoms. In Europe and the United States, however, the more ablative methods of dermabrasion, phenol peeling,¹ and laser resurfacing have been used. The new technologies of laser resurfacing using pulsed CO₂ laser and Er:YAG laser has gained popularity in recent years to improve various symptoms of photoaging.² These procedures are effective enough to improve photoaging for Asian skin, however, they have not been widely accepted in Asian countries because of posttreatment complications such as persistent hyperemia, hyperpigmentation, and even hypertrophic scar formation.^{3,4} The complications or downtime sometimes will last more than a year.

Photorejuvenation techniques are noninvasive procedures applying specific light over the skin to gain neocollagen formation in the papillary dermis. Conventional photorejuvenation techniques include various lasers and techniques mainly intended for the local

treatment of acne scar and wrinkles.⁵⁻⁸ We chose the intense pulsed light (IPL) technique, using controlled, noncoherent broad-spectrum light for a full-face treatment. A high success rate in the treatment of pigmentation and telangiectasia was obtained along with improved skin texture.

Patients

A total of 97 patients (4 men and 93 women) between the ages of 22 and 70 years were treated. Patients were limited to those who had not had laser treatment, chemical peeling, or any other skin rejuvenation procedure.

Methods

Equipment Used

A Vasculight HR (ESC Medical Systems Ltd., Yokneam, Israel), of the IPL family, was used. IPL is a noncoherent, broad-spectrum light emitted from a flashlamp. The light is conducted over the skin through specifically designed cutoff filters to eliminate shorter wavelengths. The light, having passed through the designated filter, has a wavelength up to 1200 nm. The filter completely cuts off a specific wavelength: 515, 550, 570, 590, 615, 645, 695, 715, or 755 nm. The characteristics of effects of these filters on the tissues are still under investigation. The cutoff filters used in this study were arbitrarily chosen by referring to published articles and the personal suggestions of Bitter.^{9,10} Pulse width can be controlled stepwise, from 0.5 to 25 msec, and fluence from 3.0 to 90.0 J/cm². Total fluence can be deliv-

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ered in one to three separate emissions with a delay time of 1–300 msec between pulses. Three spot sizes are available: 8 mm × 8 mm, 8 mm × 15 mm, and 8 mm × 35 mm.

Exposure Method

Through the cutoff filter of 550 nm or 570 nm, the parameters used for the treatments were a total fluence of 28–32 J/cm² with a double pulse mode of 2.5–4.0/4.0–5.0 msec and a delay time of 20.0/40.0 msec between pulses. The 550 nm filter was used to improve superficial lesions like pigmentations. The 570 nm filter was used to improve telangiectasias because of its deeper dermal penetration of energy. During the procedure, chilled, colorless gel was used to protect the epidermis and to aid in delivering the light uniformly onto the skin surface. Chilled gel was applied to the filter surface just before each shot, keeping about 2 mm of gel-filled space between the skin and filter surface to avoid the direct contact. Another important precaution was to keep the filter parallel to the skin to avoid uneven treatment (Figure 1).

The fluence was set so that there would be only a partial redness in the treated area immediately after exposure and a slight increase in the darkness of the pigmented lesion surface. Although we believe a higher efficacy can be obtained with a higher fluence, the energy strength was lowered if the patient complained of pain. Also, unbearable pain is a good telltale sign of a superficial burn of the skin.

Patients usually state at the impact that they feel heat and tolerable pain. No topical anesthesia or other pain treatment was necessary except for the sensitive patient who required an EMLA type of superficial anesthesia, which relieves much of the stimulating pain.

The procedure took an average of 20 minutes. The upper eyelids in all patients and the beard area in men were spared treatment. Treatment was repeated a minimum of three times and a maximum of six times at 2- to 3-week intervals.



Figure 1. The gel keeps the space between the skin and the filter constant and keeps the filter parallel to the skin.

No pretreatment was used. Melanin-suppressing treatment was started only in melasma patients after the end of the third treatment, using 5% hydroquinone, 0.1% retinoic acid, and steroid cream ointment. External applications of medication were suspended until the third treatment in order to observe the presence of any postinflammatory pigmentation. All patients gave informed consent for treatment and photographs.

Results

The results were evaluated and rated by both the patients and physicians on a four-point scale at the end of the third treatment:

- A: 76–100% improvement (excellent)
- B: 51–75% improvement (good)
- C: 26–50% improvement (fair)
- D: ≤25% improvement (poor)

Pigmentation

The results of the evaluations are presented in (Table 1). There were no cases that showed any increase in the dark color of the pigmented lesion. There were cases of repeated recurrence of melasma without any postinflammatory hyperpigmentation even though no external treatment was given. The dark color gradually faded through repeated treatment.

Clinical Applications

Patient 1. Patient 1 was a 47-year-old woman with pigmentation and telangiectasia over the cheek (Figure 2A). IPL treatment was repeated three times at 2-week intervals with 550 nm and 570 nm filters. There was an improvement in pigmentation and a remarkable improvement in telangiectasia (Figure 2B). The patient noted that improvement in both pigmentation and telangiectasia was excellent, while blinded physician assessment rated the improvement in pigmentation as good and in telangiectasia as excellent.

Patient 2. Patient 2 was a 36-year-old woman with fine, distinct pigmentation (Figure 3A). IPL treatment was repeated three times at intervals of 2–3 weeks with a 550 nm filter. There was remarkable improvement. The patient was satisfied, stating that her makeup held better (Figure 3B). The patient noted that improvement in pigmentation was excellent. Blinded physician assessment rated the improvement as good.

Patient 3. Patient 3 was a 66-year-old man. The patient had trouble with telangiectasia (Figure 4A). IPL treatment was repeated four times at intervals of 3 weeks with 550 nm and 570 nm filters. Telangiectasia was remarkably improved as well as improvement of skin

Table 1. The Results

Evaluation ^a	Pigmented Lesion			Telangiectasia			Skin Texture		
	Physician (%)	Patient (%)	Combined (%)	Physician (%)	Patient (%)	Combined (%)	Physician (%)	Patient (%)	Combined (%)
A	49.5	47.4	48.4	33.3	33.3	33.3	9.3	17.5	13.4
B	43.2	41.0	42.1	55.5	44.4	50.0	45.4	59.8	52.6
C	6.3	6.3	6.3	5.6	16.7	11.1	38.1	17.5	27.8
D	1.0	5.3	3.2	5.6	5.6	5.6	7.2	5.2	6.2

^a A: 76–100% improvement; B: 56–75% improvement; C: 26–55% improvement; D: 0–25% improvement.

texture (Figure 4B). The patient noted that improvement in telangiectasia was excellent and blinded physician assessment also rated the improvement as excellent.

Telangiectasia

In many cases, satisfactory results were identified even at an early stage of treatment (see Table 1).

Skin Texture

Almost all cases showed an improvement in skin texture (see Table 1). In some cases, wrinkles also became less noticeable. Most of the women were satisfied with the results, and felt that their makeup held better.

In this study the results were evaluated at the end of the third treatment. A limited number of patients received five treatments and were evaluated 3 weeks later. It was found that consistently better results were obtained in the group that received five treatments. No downtime was noted.

Complications were seen in four cases immediately after treatment as a fever sensation and redness in the treated area, which disappeared within 48 hours. Of

those, three cases developed into blister formation the following day but gradually healed within 5 days without leaving any scars, hypopigmentation, or hyperpigmentation.

Discussion

In this study, IPL technology and the parameters developed by Bitter^{9,10} were utilized to examine the possibility of applying the photorejuvenation procedure to type IV–V Asian skin. There were some reports on photorejuvenation, but their main objectives were limited to the treatment of wrinkles and acne scars. The reports by Bitter^{9,10} describe the general improvement of both pigmentation and deteriorating skin texture in aging skin by the photorejuvenation technique with IPL.

Conventional laser technologies including Q-switched, non-Q-switched, ruby, alexandrite, Nd:YAG, and pulsed dye lasers have proved effective in the treatment of pigmentation, but with some adverse sequelae of postinflammatory hyperemia and hyperpigmentation even among Caucasian patients. We observed in the trial cases of those ablative technologies that downtime would sometimes persist for more than 6 months in Asian skin.¹¹ This is the primary reason these ablative technologies have been abandoned by Asians. With IPL treatments, however, good results have been ob-

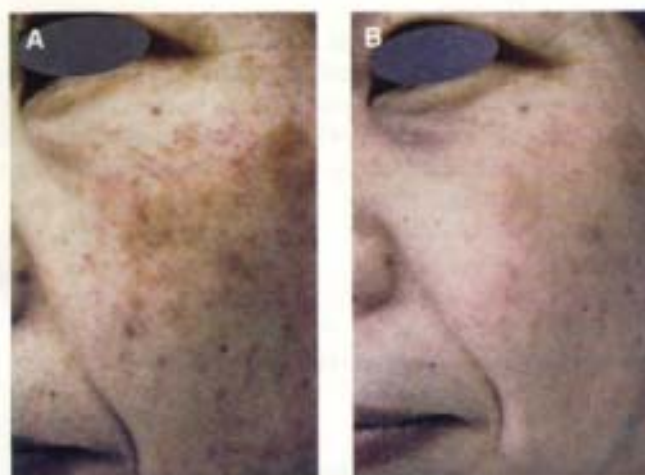


Figure 2. A 47-year-old woman A) before and B) 3 weeks after three IPL treatments. Note the improvement in pigmentation and telangiectasia.

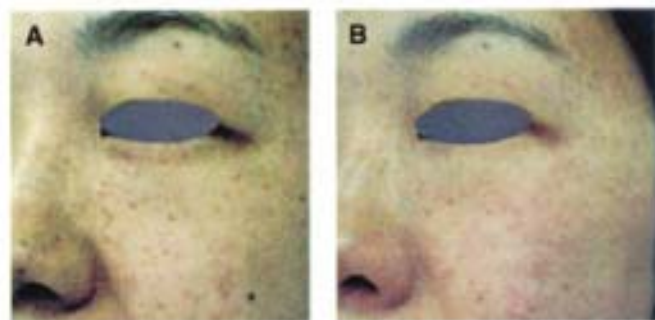


Figure 3. A 36-year-old woman A) before and B) 2 weeks after five IPL treatments. Note the overall improvement of the skin condition.



Figure 4. A 66-year-old man A) before and B) 3 weeks after four IPL treatments. Note the improvement in telangiectasia and skin texture.

tained, and we have not observed any postinflammatory hyperpigmentation in 95 cases, even in the pigmented lesions, including 4 cases with melasma. By the ablative technique, the superficial and medial layer of dermal collagen fibers go into coagulative degeneration together with desquamation of the epithelial layer. In the first stage of the healing process, after completion of epithelialization, phagocytization and regeneration of degenerated collagen fibers takes place. During the regeneration process, a relatively large amount of energy is needed, which causes the skin to be visibly hyperemic. During the time of hyperemia, not only the increased blood flow but also inflammation-related biochemical mediators such as arachidonic acid and prostaglandin induce melanin production, resulting in hyperpigmentation.¹² Hyperpigmentation will relapse in time or it can be prevented to some degree by suppressive drugs such as hydroquinones.

During IPL treatment in Asians, we did not observe any adverse side effects or downtime. This differs from the conventional technique of laser irradiation. We speculate that the main difference between lasers and IPL may be in the form of the light wave, single or broad spectrum. The broad-spectrum wave without any short component of visible light is not extensively

absorbed by target organs like blood vessels and melanin pigments, but will be absorbed in mild form including the collagen fiber. The mild degeneration of tissue without any downtime may gradually stimulate the regeneration process of skin. Furthermore, in this study the procedure was found to be relatively effective in treating melasma, even though melasma is considered as a contraindication to laser treatment due to the higher tendency to develop postinflammatory hyperpigmentation.

The procedure was found to be more effective and more advantageous in treating telangiectasia than conventional dye laser techniques. The significance of the longer pulse-width setting of IPL may well be adjusted to cope with the thermal relaxation time of thick or dilated blood vessels. The longer pulse width without any high peak spike does not generate any shock waves which will cause intradermal purpura formation.¹³⁻¹⁵

The reason the procedure is effective in improving skin texture is that microthermal damage caused in the dermis may increase collagen production during the wound healing process.¹⁶ According to other reports, however, the fibroblast itself is directly activated by the light stimulation.^{17,18} From our pathology specimen, the collagen and some elastic fiber proliferation were observed in the papillary and subpapillary layer of the dermis (Figure 5). The piled up collagen influences the smoothness of the epithelial layer and acceleration of epithelial turnover. The finding coincides with the pathology findings of CO₂ laser resurfacing, where the coagulation degenerated shrinking collagen is followed by an increase in collagen growth during the wound healing process like that of deep chemical peels.¹⁹ Er:YAG laser, in contrast, has less effect on collagen proliferation because it has a rather sharp cutting mechanism than coagulation because of the 10 times higher water absorption of light compared to CO₂ laser.^{2,3}

We believe the shrinkage of collagen and increase in superficial collagen proliferation following thermal degeneration will greatly accelerate the improvement ratio in wrinkle treatment. Currently nonablative rejuvenation procedures using various wavelengths or a

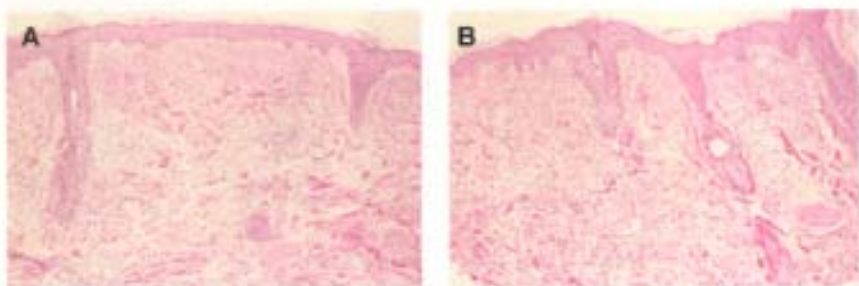


Figure 5. A 58-year-old woman A) before IPL treatment and B) 3 weeks after two IPL treatments. Neocollagen proliferation is seen. (Hematoxylin and eosin; magnification 100 \times .)

broader spectrum of pulse widths are being attempted. A report on the application of a nonablative procedure using an Nd:YAG laser with a wavelength of 1320 nm showed that the phenomena that occurred in the skin structure were the same as those in laser resurfacing, except that no destructive degeneration was found in the epidermis.⁵ While our procedure simultaneously satisfies various requirements for the treatment of various forms of photoaging, the procedure using a single laser with a wavelength of 1320 nm, which is not easily absorbed by melanin or oxyhemoglobin, is not suitable for treating superficial pigmentation and telangiectasia at the same time. Goldberg and Cutler²⁰ reported a procedure using IPL with a 645 nm filter for treating wrinkles. The 645 nm filter has the characteristics of pigment absorbance and deeper penetration of energy, but seems not be effective for the treatment of vascular target organs such as telangiectasia. Our use of 550 nm or 570 nm filters was targeted on melanin, hemoglobin, and collagen fibers at the same time. In the IPL technologies, there is a sharp increase in light energy starting from the wavelength of the cutoff filter up to 1200 nm, which provides a wide range of effective stimulation. The light spectrum needed to gain maximum treatment effect is not known and is under investigation. The large spot size allows more photons to be injected deeper into the skin so as to deliver sufficient energy for treatment. This will greatly improve the results of the treatment.

Based on a determination of clinical efficacy, further attempts using various wavelengths will probably help find more effective wavelengths. The investigation of optimization and individualization of parameters is presently under way.

Conclusion

Photorejuvenation using IPL was attempted on Fitzpatrick's skin type IV or V Asian skin and good results were obtained. The procedure is safe and effective on Asian skin, which has characteristics of a tendency to develop pigmentation and other complications by other skin rejuvenation procedures. It simultaneously improves both skin texture and superficial degeneration, including pigmentation and telangiectasia. Unlike conventional procedures, photorejuvenation is a nonablative procedure, requiring almost no downtime. Because of these advantages it will be easily accepted by socially active people. We believe the procedure will become widespread in the future and used on both genders.

Photorejuvenation is a very effective procedure that should be the first choice among skin rejuvenation procedures. Further research is still needed, however, including an investigation of optimum parameters, an evaluation of long-term results, and a histopathologic review of the procedures' mechanism. We shall continue our investigations and compile our findings in a follow-up report.

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Commentary

Since the introduction of the use of intense pulsed light (IPL) for skin rejuvenation, first reported in this journal,²¹ this new method of nonablative treatment for photoaging, erythema, and pigmentation problems has become increasingly popular throughout the United States as well as Europe and Asia. More than 500 physicians have been trained in this new technique and it is estimated that more than 1000 photorejuvenation procedures using IPL are performed each day in the United States alone. The use of IPL for skin rejuvenation represents a new concept in the approach to treatment of skin where light energy is used to treat not just individual "spots," but rather is used to accomplish a global visible improvement. The keys to the success of this new application of IPL are first, the entire skin area (eg, face, neck, chest, dorsal hand) is treated. Second, "gentler" parameters than are traditionally used for "spot" treatment are employed. Third, a series of treatments (generally five or more) are needed for optimal results.

The article by Negishi et al. makes three very important contributions to the area of noninvasive photorejuvenation. First, the present study is the first to corroborate the findings that IPL can be used safely and effectively as a modality to rejuvenate skin that were first published in *Dermatologic Surgery* in September 2000.²¹ Second, darker skin phenotypes, which traditionally have resulted in higher rates of complications such as hyperpigmentation, hypopigmentation, and scarring from laser or pulsed light treatments, can be safely and effectively treated with pulsed light. Third, the present study underscores the importance of proper training in IPL nonablative rejuvenation

techniques if results are to be successful and complications are to be minimized. As highlighted by Negishi et al., successful photorejuvenation with pulsed light is much more than choosing a set of parameters. Successful photorejuvenation with IPL requires proper patient selection and education, as well as finesse in treatment technique that must be learned. Knowledge of the proper distance of light guide from skin, quantity and temperature of cooling gel, number of passes across the skin, and observation of the optimal end point are necessary to achieve a successful outcome and to minimize potential complications. The technique reported by Negishi et al. follows very closely that previously presented.²¹

Intense interest in noninvasive methods for skin rejuvenation has been sparked. Additional studies are needed to report on long-term results for erythema, photoaging, and pigmentation problems and photorejuvenation in other darker skin phenotypes. Negishi et al. are to be commended for their important contribution to noninvasive photorejuvenation.

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