**Protection and Therapy of Photoaging**

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**Abstract**

Chronic and repeated sun exposure causes photoaging skin that includes solar lentigines, wrinkles, changes of texture, benign tumors, and cutaneous cancers. Various symptoms of photoaging have been a great concern in dermatology. Photoprotection using sunscreens is recommended to prevent these signs. Two measures, sun protection factor (SPF) for UVB and protection grade of UVA (PA) for UVA, are described on the label of sunscreens. Our recent investigation revealed defects in the correct knowledge of SPF and PA and a relationship between freckles and sun-exposure history. Education in the appropriate use of sunscreens and the significance of SPF and PA is needed.

Solar lentigines on the face decrease quality of life. Previous laser therapies cause erosion and crusts with downtime for the treatment of pigmentary lesions. Then, intense pulsed light (IPL) sources have been developed as noninvasive and nonablative modalities for facial solar lentigines. We demonstrated clinical effectiveness of an IPL source for solar lentigines and ephelides on the face with well tolerability. Then, we performed a histopathological study that indicated IPL produced highly selective photothermolysis of melanin pigment in the lesions of solar lentigines, leading to the clinical improvement. Moreover, we showed clinical effects of a novel IPL source on solar lentigines and ephelides. In the future, phototherapy including IPL sources will develop with more effectiveness and safety.

**KEY WORDS:** photoaging, photoprotection, sunscreen, therapy, intense pulsed light source

**Introduction**

Ultraviolet (UV) light from sun exposure induces various harmful effects, e.g. sunburn, suntan, photoaging, and cancers on the skin. Chronic exposure of UV to the skin causes photoaging. Photoaging skin is characterized with sallowness, mottled pigmentation, solar lentigines, dry and rough skin, loss of skin tone, leathery texture, laxity, coarse and fine wrinkles, and benign and malignant tumors. In order to prevent the various signs of photoaging, daily protection against UV is recommended. Therefore, it is important for children and adults to know the appropriate methods of photoprotection including sunscreens.

Topical agents such as glycolic acid, retinoids, ascorbic acid, a variety of chemical peeling agents, dermabrasion, epidermabrasion, and laser skin resurfacing have been reported for the treatment of the symptoms of photoaging. These effective therapies, mostly invasive, usually need patient downtime and sometimes cause adverse effects. Noninvasive and nonablative treatments without patient downtime are required. Then, intense pulsed light (IPL) therapy was developed.

In this review article, trends of sun protection and IPL therapy for solar lentigines from our investigation have been demonstrated.

**Protection**

Recently most sunscreens provide broad-spectrum UV-protection. Sun protection factor (SPF) implies the ability of UVB protection of sunscreens. For UVA, Japan Cosmetic Industrial Association proposed a labeling system of protection grade of UVA (PA) using immediate tanning as a measure. The European Commission has also recommended the in vivo persistent pigment darkening (PPD) method. In 2007, Food and Drug Administration has proposed a 4-star grading of UVA protection. For appropriate use of sunscreens, correct knowledge of SPF and PA is needed.

Kawada et al. studied the relationship between past history of sun exposure and photoaging signs. They investigated recent trends of sun exposure, freckles and wrinkles as photoaging symptoms, and skin phototype in a population of Japanese females. Then, they investigated the condition of sunscreen use and knowledge for SPF and PA in 2009. Five hundred and fourteen females, aged 20 to 69 years (mean 44 years), Japanese females, participated. They were given an online questionnaire consisting of multiple-choice and fill-in questions. By obtaining the history of each person’s cutaneous response to first sun exposure, about 1 hr at the beginning of the summer, skin phototype was determined by the following Japanese skin type (JST) classification: J-I burn easily and tan minimally; J-II...
Table 1. Presence of correct knowledge about the definition of sun protection factor (SPF) and protection grade of UVA (PA)

<table>
<thead>
<tr>
<th>Total (%)</th>
<th>J-I (%)</th>
<th>J-II (%)</th>
<th>J-III (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>knows SPF</td>
<td>449 (87)</td>
<td>135 (84)</td>
<td>248 (91)</td>
</tr>
<tr>
<td>(correctly knows)</td>
<td>(62 (12))</td>
<td>(23 (14))</td>
<td>(32 (12))</td>
</tr>
<tr>
<td>not know SPF</td>
<td>65 (13)</td>
<td>26 (16)</td>
<td>25 (9)</td>
</tr>
<tr>
<td>PA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>knows PA</td>
<td>378 (74)</td>
<td>123 (76)</td>
<td>199 (73)</td>
</tr>
<tr>
<td>(correctly knows)</td>
<td>(34 (7))</td>
<td>(13 (8))</td>
<td>(17 (6))</td>
</tr>
<tr>
<td>not know PA</td>
<td>136 (26)</td>
<td>38 (24)</td>
<td>74 (27)</td>
</tr>
</tbody>
</table>

Therapy of photoaging

IPL, a broadband visible light emitted from a noncoherent, nonlaser, filtered flashlamp, has been developed as a new noninvasive method. IPL is effective for superficial rhytides, wrinkling, skin coarseness, irregular pigmentation, pore size, and telangiectases.

1. IPL therapy for solar lentigines and ephelides

We performed an open study of IPL for the treatment of solar lentigines and ephelides. Sixty patients (56 women, 4 men), age 20–82 years (mean 50 years), with facial pigmented lesions participated in this study. Facial pigmented lesions were clinically diagnosed as solar lentigines, solar lentigines + ephelides, and ephelides. Solar lentigines were also classified into small (1 cm and less than 1 cm) and large plaques (more than 1 cm). A noncoherent, filtered, broadband, pulsed flashlamp (NatuLight, Lumenis CO., LTD. (Koto-ku, Tokyo, Japan)) emitting in the range of 500–1200 nm was used for all treatments. Each patient received three to five treatments (average number 4.0), given at 2- to 3-week intervals. Treatment fluences ranged from 20 to 24 J/cm². Energy was delivered in double- or triple-pulse trains of 2.6–5.0 msec with pulse delays of 20 msec. Cutoff filters of 560 nm were used. Overall, 48% of subjects showed more than 50% improvement and 20% had more than 75% improvement. Only one case had erosions, and no other cases showed hyperpigmentation, scarring, or downtime. In the solar lentigines group, 40% of subjects showed more than 50% improvement and 16% had more than 75% improvement. IPL was effective for small plaques of solar lentigines, with 48% having more than 50% improvement. On the contrary, 72% of the patients with small + large and large plaques had poor or slight improvement. The solar lentigines + ephelides and ephelides groups showed great improvement, with 75% and 71%, respectively, having more than 50% improvement. Representative cases with marked response are shown in Fig. 1 and Fig. 2. Therefore, IPL may be added to the panel of modalities used for the treatment of ephelides and small-type solar lentigines.

Asian skin easily associates with hyperpigmentation after various therapies for photoaging skin, such as laser surgery, chemical peeling, and CO₂ laser resurfacing. Q-switched ruby laser (QSRL) therapy, effective for solar lentigines in Japanese patients, causes postinflammatory hyperpigmentation, especially in patients with J-III. QSRL therapy should be performed carefully because of hyperpigmentation in J-III subjects with more melanogenicity. However, IPL therapy in our study showed no postinflammatory pigmentation in any subjects including J-III patients, indicating that IPL may have an advantage over QSRL for the treatment of pigmentary disorders. Only one patient in our study showed burn from IPL. This patient’s severe response may have been induced by ample amounts of melanin pigments in the lesion which is a target chromophore of IPL. Darker lesions and complexion should be treated cautiously because unexpected response may occur during IPL therapy. IPL therapy proved to be effective and tolerable for the patients, suggesting that IPL may be a possible good modality for solar lentigines and ephelides.

2. The mechanism of IPL therapy for solar lentigines

In order to reveal the mechanism of efficacy of intense pulsed light for solar lentigines, we performed histopathological examination. Twenty patients (18 females and 2 males), ages 30–78 years (mean 52 years), with solar lentigines participated in this study. Sequential histological pictures of small solar lentigines showed subepidermal cleft, vacuolization of pigmented basal keratinocytes and melanocytes, the disappearance of pigmentary incontinence in the papillary dermis at 30 m, lymphocytic infiltration in the upper dermis at 6 h, degenerated epidermis and enlargement of the cleft at 24 h, and crust at 7 days after irradiation. Results with Masson-Fontana staining also revealed vacuolated change of basal keratinocytes and melanocytes, degenerated epidermis with melanin pigments, and crust formation containing ample melans with decrease in melanin of basal cells. We demonstrated that clinical tiny-crust in the lesions of solar lentigines was the consequence of micro-crust formation histopathologically. Crust-formation was localized on the part of pigment spots, indicating the specificity of IPL for epidermal melanin under our condition. Formation and drop-off of the crusts lead to clinical improvement of pigmentary lesions of solar lentigines. Transient inflammation with redness was seen, while no adverse sequela such as hyperpigmentation and scarring appeared. Therefore, IPL may be a modality for solar lentigines as a highly selective therapy for pigment removal.
Protection and Therapy of Photoaging

**Fig. 1.** A 51-year-old female
A) before and B) 2 weeks after five IPL treatments.
Large and small pigmented lesions improved.

**Fig. 2.** A 45-year-old female
A) before and B) 2 weeks after five IPL treatments.
Small pigmented lesions improved.

**Fig. 3.** Sequential histopathological findings of pigment spots of solar lentigines.
Pigment spots at pre-irradiation (a), 30 min (b), 24 h (c), and 7 days (d) after irradiation of intense pulsed light were shown (a-d, hematoxylin-eosin staining; x 200).
3. Novel IPL modality for solar lentigines and ephelides

Recently a novel IPL source (Lumenis One™, Lumenis CO., LTD) with stronger irradiation and various filters has been developed as a second generation of IPL. Lumenis One is a phototherapy unit that composes of IPL, LightSheer diode laser for hair removal, and Multi-Spot Nd:YAG laser for leg veins and deeper vascular lesions. IPL of Lumenis One is characterized with stronger intensity, two spot sizes, replaceable seven filters, and an integrated dynamic cooling device, designating as a second platform of IPL. We investigated clinical effectiveness of Lumenis One on facial pigmentary lesions. Eighteen Japanese female patients aged 22–72 years (mean 50 years), with facial pigmentary lesions (solar lentigines, solar lentigines + ephelides, and ephelides), participated in this study. Each patient received three to five treatments. Each treatment, given at 2–3-week intervals, was administered on the face. Treatment fluences ranged from 12 to 14 J/cm². Energy was delivered in double pulse trains of 4.0 ms with pulsed delays of 20 ms. Cut-off filters of 560 nm were used. All the patients completed the study. No adverse effect were seen in any patients. Physicians’ overall assessments demonstrated clinical improvement in the total population, indicating that 28% of patients showed marked improvement, none did moderate improvement, and 39% did slight improvement. Thirty-three percent showed no change, while no patients did “worsened”. The melanin index decreased after the treatment comparing before the treatment. These results revealed the clinical effectiveness with well tolerability on facial pigmentary lesions, such as solar lentigines, ephelides, and solar lentigines + ephelides.

Conclusion

Photoaging skin is an important issue in the dermatological field. Various signs of photoaging include pigmentary lesions, wrinkles, changes of texture, benign tumors, and skin cancers. Daily sun protection is important to prevent these symptoms. Recent development of phototherapy helps improvement of pigmentary lesions.

References

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