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An Evaluation of Broad-spectrum Sunscreens against Topical PUVA-induced Erythema

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Protection against topical PUVA with broad-spectrum sunscreens was investigated. A protection factor against topical PUVA was established for broad-spectrum sunscreens against topical PUVA-induced erythema. ***Key words: Photoprotection.***

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For treatment of psoriasis, Kukita et al. (1) reported that oral 8-methoxypsoralen plus ultraviolet A (UVA) chemotherapy (PUVA) was less effective for Japanese than for Caucasians. Topical PUVA or bath PUVA is therefore more common than oral PUVA in Japan (2). It is necessary to protect the uninvolved skin from both acute harmful effects (erythema, blister) and chronic conditions (pigment freckles, premalignant or malignant skin tumors) resulting from topical or bath PUVA (3). However, the uninvolved skin of psoriatic patients is inappropriate for correctly assessing sunscreens.

In this study, we investigated protection by broad-spectrum sunscreens against topical PUVA-induced erythema in normal skin.

SUBJECTS AND METHODS

Subjects

Ten healthy Japanese males aged 23 to 26 yrs, who were receiving no medication, participated in this study, which was carried out between February and June 1988. All subjects

belonged to the Japanese skin type (4), J-II (burn moderately, tan moderately). The untanned back was used for the study. Informed consent was obtained.

Sunscreens

The following three broad-spectrum sunscreens were used:

1) écran total opaque teinte (15+ A+B) (5% octyl methoxycinnamate and 12% zinc oxide) (RoC S.A., France)
2) crème écran total antisolaire naturelle (10 A+B) (5% octyl methoxycinnamate and 12% zinc oxide) (RoC S.A., France)
3) crème antisolaire écran total moyen (5 A+B) (3.5% cinoxate, 7% zinc oxide, and 3% titanium dioxide) (RoC S.A., France).

Light source

The light source was a Dermaray Model M-DMR-1 (Eisai Co. Ltd., Tokyo). This reflector unit had a bank of five 'sunlamps' for UVB on one side and a bank of ten 'black lamps' for UVA on the other side. The 'sunlamps', described previously (5), were Toshiba FL 20S·E-30 lamps with a peak irradiance at 305 nm; and the 'black lamps' were Toshiba FL 20S·BLB lamps with a peak irradiance at 352 nm. Fig. 1 shows the relative irradiance spectrum of the lamp, as measured from 280 to 400 nm in steps of 5 nm using an optical radiation measurement system (Optronic Model 740A; Optronic Labs. Inc., Orlando, Flo). As measured with a Toshiba radiometer, Model UVR-305/365 (Eisai), the intensity at the skin surface was 1 mW/cm^2 at 305 nm for sunlamps and 7.5 mW/cm^2 at 365 nm for black lamps.

Minimal erythema dose (MED)

MED with UVB (UVB-MED) was defined as the smallest exposure dose needed to produce a minimally perceptible erythema in a strip measuring 10×5 cm on the left side of the back at 24 h after irradiation. 8-Methoxypsoralen (8-MOP) solution (0.3%; Taisho Pharm. Co., Tokyo), at a dose of 8 µl/cm^2, was applied to a strip measuring 10×5 cm on the right side of the back. Two hours later UVA was administered with a bank of ten black lamps. MED with topical PUVA (PUVA-MED) was defined as the smallest exposure dose needed to produce a minimally perceptible erythema at 72 h after irradiation.

Protection factors with UVB (UVB-PFs) and with PUVA (PUVA-PFs)

8-MOP solution (0.3%), at a dose of 8 µl/cm^2, was applied to three strips, each measuring 10×5 cm, on the right side of the back 1 h before the application of sunscreens. Each test agent, at a dose of 2 mg/cm^2, was spread uniformly over a strip measuring 10×5 cm on the back. Irradiation was carried out 1 h after the application of sunscreens. UVB-MED in the protected skin was determined 24 h later and the UVB-PF was calculated as the ratio of UVB-MED in protected skin to UVB-MED in unprotected skin. PUVA-MED in the protected skin was determined 72 h later and PUVA-PF was calculated as the ratio of PUVA-MED in protected skin to PUVA-MED in unprotected skin.

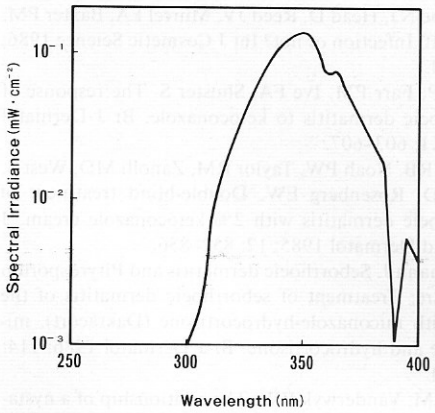

Fig. 1. Spectral irradiance of the FL20S·BLB black lamp (lamp to detector distance 23 cm).

Data analysis

The results were analysed by Student's *t*-test for independent samples.

RESULTS

MED

The mean UVB-MED was 50±10 mJ/cm^2, and the mean PUVA-MED was 533±90 mJ/cm^2.

UVB-PF

UVB-PFs showed log-normal distribution. The geometric mean UVB-PFs were 17.4±1.2 for 15+ A+B, 11.5±1.3 for 10 A+B, and 6.9±1.4 for 5 A+B. Significant differences were observed between 15+ A+B and 10 A+B ($p<0.01$), and between 10 A+B and 5 A+B ($p<0.01$).

PUVA-PF

PUVA-PFs showed log-normal distribution. The geometric mean PUVA-PFs were 8.7±1.3 for 15+ A+B, 6.8±1.3 for 10 A+B, and 4.4±1.3 for 5 A+B. Significant differences were observed between 15+ A+B and 10 A+B ($p<0.1$), and between 10 A+B and 5 A+B ($p<0.01$). The ratios of PUVA-PF to quoted PF were 58% (15+ A+B), 68% (10 A+B), and 88% (5 A+B).

DISCUSSION

The three broad-spectrum sunscreens contained both a chemical absorbant (methoxycinnamate) and a reflectant (zinc oxide). An in vitro study by Kawada et

al. (6) showed that one sunscreen, crème écran total antisolaire naturelle (10 A+B), had low transmission ratios in both the UVB and UVA ranges (0% in 280–320 nm, 1% at 350 nm, and 9% at 400 nm).

The UVB-PFs of the three broad-spectrum sunscreens studied were slightly higher than the PFs quoted by the manufacturer. Presumably, this difference was attributable to the light source used, since more UVA, which augments UVB-induced erythema, is contained in sunlight than in the light of the sunlamps used in this study. These sunscreens proved efficient in protecting against UVB-induced erythema. Their PUVA-PFs were lower than the PFs quoted by the manufacturer. The ratios of PUVA-PF to the quoted PF of 15+ A+B (58%) and 10 A+B (68%) were smaller than that of 5 A+B (88%). With a knowledge of the PUVA-PFs of these sunscreens, it is possible to protect uninvolved skin in psoriatic patients against PUVA-induced erythema. Diffey & Farr (7) reported that the PFs for UVA of broad-spectrum sunscreens were much lower than the quoted PFs. The PF of a sunscreen indicates protection against UVB only and is higher than the PF with UVA (UVA-PF) or PUVA-PF. If a sunscreen is used to protect patients with UVA-induced photo-sensitive disorders or in PUVA therapy, its UVA-PF or PUVA-PF should be examined.

Topical PUVA has been used in evaluating broad-spectrum sunscreens in previous studies (6, 8). This method does not require a high-intensity UVA source, a long exposure time, or consideration of the thermal effect on UVA-induced erythema. However, it is noteworthy that topical PUVA is not appropriate for normal individuals or patients with UVA-induced photosensitive disorders.

This study confirms the PUVA-PFs of three broad-spectrum sunscreens. These broad-spectrum sunscreens can therefore be effectively used for protection against topical PUVA-induced erythema.

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