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CLINICAL REPORT

Optimized UVB Treatment of Atopic Dermatitis Using Skin Reflectance Measurements. A Controlled, Left–Right Comparison Trial

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In a randomized, open, left-right comparison study, 20 patients with atopic dermatitis were treated with UVB. One side of the body received UVB in a conventional regimen with fixed dosage increments, the other side was given UVB dosages according to skin reflectance measurements of skin pigmentation and erythema. Clinical outcome was assessed by SCORAD. The initial, final and cumulative UVB dosages, time to 50% reduction in SCORAD, and side effects were compared. The initial UVB dosage was somewhat higher in the skin reflectance-guided treatment than in the conventional UVB regimen, although not significantly. There was no difference in the reduction of SCORAD comparing the two treatment options; however, the final UVB dosage and the cumulative UVB dosages were significantly lower in the optimized regimen. This new technique offers the same therapeutic advantage and security as a dose regimen guided by minimal erythema dose testing. However, measurement of skin pigmentation by skin reflectance is a rapid method, which can easily be operated by nurses. ***Key words: atopic dermatitis; UVB; dosimetry; skin reflectance measurement.***

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Ultraviolet B (UVB) is commonly used in the treatment of atopic dermatitis (1, 2). However, conventional UVB therapy with gradually increasing exposure is connected with adverse effects, such as xerosis, inflammation and pruritus, which can prolong the treatment (3, 4).

Skin reflectance is a rapid non-invasive technique to quantify both skin pigmentation and erythema. On the basis of the highly positive correlation between skin pigmentation and the erythema response to UVB, an instrument has been devised which calculates the optimal UVB dose for the patient (5–8). For patients with atopic dermatitis the instrument is adjusted to show the UVB dose just below what is needed to elicit an erythema reaction in the skin of the trunk. Skin pigmentation varies both between patients and in the same patient at different times during UV therapy. Therefore the instrument calculates different UVB dosages at different times and for different patients, and thereby the UV therapy is individualized.

The aim of this work was to compare the effect of the new individualized dosage regimen with the conventional standardized regimen in a randomized, left-right comparison study.

MATERIALS AND METHODS

Patients and protocol

Twenty patients (9 men and 11 women), median age 24 years (range 16–38), with mild to moderate atopic dermatitis were included in the study after giving informed consent. The study was approved by the Medical Ethics Committee of Copenhagen, Denmark.

The study was performed according to a randomized, open, bilateral left-right comparison design. Three to five times a week, one half of the body received a traditional UVB treatment with fixed dose increments according to a schedule; start dose 1.6 standard erythema doses (SED; mJ/cm^2) (9), increasing by 25% in each of the following treatment sessions. This UV dose is relatively small, an increase of 25% would normally not induce erythema in a general Danish population. If it still induced an erythema, the UV dose of the next treatment was reduced accordingly; i.e. the previous UV dose was applied. The other body half was treated according to a skin reflectance-guided UVB regimen, where measurements of the skin pigmentation determined the UVB exposure dose (8). To prevent any difference in facial tanning the whole face was always given the standard UVB treatment dosage. Patients were allowed to use topical steroids and emollients provided that they were used symmetrically. However, the use of topical steroids was ceased during UV treatment if possible. Prior to UV treatment and on a weekly basis the clinical severity of the dermatitis was assessed according to the severity score of atopic dermatitis (SCORAD) (10), and data were collected separately for each half of the body throughout the treatment course. Criteria for leaving the study were SCORAD <10 on either body half and/or 6 weeks of treatment. In addition to the clinical parameters, the initial, final and cumulative UVB dosages were recorded, and adverse effects like painful erythema and increased pruritus were registered.

Radiation source and UV exposure

All patients were exposed to a bank of Philips TL 01 UVB tubes. Irradiance was measured with a UV meter (International Light 1700 research radiometer with an IL SED 400 detector with a W quartz diffuser and a WBS 320

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filter). All UV dosages are given in SED; one SED is the dosage needed to elicit a just perceptible 24-h erythema on the buttock skin in the most sensitive people in a group of very sun-sensitive but otherwise healthy individuals (9). One SED is 10 mJ/cm^2 at 298 nm using the CIE erythema action spectrum and is equivalent to 1.6 kJ/m^2 of the UVB lamp.

Skin reflectance measurement

Skin reflectance measurement was performed with an instrument (UV-Optimize 555, Matic®, Copenhagen, Denmark) which measures the reflection of red (660 nm) and green (555 nm) light by the skin. Equations for calculating the percentages of skin redness and skin pigmentation independently and UVB dosages are built into the instrument (6, 11). The skin reflectance measurements were performed on non-lesional skin between the shoulder blades and on the chest of the patient before every UVB treatment. These two areas were chosen because they are representative for the more UV-sensitive parts of the body. The UV-Optimize was adjusted to calculate the highest dosage not eliciting erythema on the chest or on the back. The lower of the two readings was always used as the exposure dosage. One measurement with the UV-Optimize takes about 10 s to perform. The reproducibility of the skin reflectance measurements is high, it varies within 1% of the pigment measurement (12). As there are built-in corrections for the erythema in the UV-Optimize 555, measurement of redness will not influence the outcome of the pigment measurement and hence not influence the UV dose to be given.

Statistics

For each patient the parameters of left and right body half were compared and statistically processed using the Wilcoxon matched pairs test.

RESULTS

SCORAD at the beginning of the therapy ranged from 15 to 53, mean 32. There was no significant difference in the time to reduce SCORAD to <10 between the two treatment options (Table I).

The initial UVB dosage of the skin reflectance-guided regimen was not statistically different from the start dosage, but in the conventional therapy the final dosage was significantly higher in the standardized regimen ($p<0.01$) compared with the skin reflectance-guided treatment.

Also, the cumulative UVB dosage showed a highly significant difference between the two treatment modalities; in the traditional regimen the UVB dosages ranged from 29 to 186 SED, mean 124, and in the skin reflectance-guided treatment they ranged from 16 to 88 SED, mean 39 (Table I).

DISCUSSION

The main result from this study is that it is possible to reduce the cumulative UVB dosage in the treatment of atopic dermatitis with maintenance of the same clinical result and outcome as when using a traditional therapy scheme.

Our results are in accordance with a previous study with a similar design, in which a medium-dosage UVB regimen (40% of minimal erythema dose, MED) achieved the same healing score as a high-dose UVB regimen (80% of MED) (1). In a previous retrospective study, in which the two methods of UVB therapy were compared, it was observed that the cumulative UVB dosage was reduced in the skin reflectance group and that the healing score was higher (8). However, it was a retrospective study comparing one group of patients with another. In contrast, we used a left-right comparison in each patient, and hence could more easily monitor the endpoint of therapy.

Narrow-band UVB, effectively treating psoriasis (13) was notably more effective than UVA in the treatment of atopic dermatitis also (14).

The effect of UV dosage on the clinical outcome has been addressed in several studies. There was little effect of a low-dose UVB regimen (20% of MED) and only 5 of 18 patients achieved healing or considerable improvement (15). In contrast both medium- and high-dosage UVB regimens yielded a good clinical response in 16 of 25 patients. In our study we observed a good response on both sides within 3–4 weeks. UVA1 therapy studies also seem to indicate that there is a lower exposure dose limit, below which the clinical outcome is less favourable (16).

The effectiveness of UVB, and of low-dose UVB, is probably based on the combined effects on antigen-presenting cells, T lymphocytes (17, 18), bacteria (19), and increasing the amount of stratum corneum lipids (20). During UVB therapy the epidermal thickness

Table I. *Comparison of conventional UVB therapy with fixed dose increments with that of an optimized dose of the UVB guided by skin reflectance measurements (n=20; right–left comparison)*

	Conventional therapy	Skin reflectance-guided therapy	Result of the Wilcoxon test
Weeks to SCORAD <10	3.5 (1.5–6.0)	3.0 (2.0–5.5)	NS
UVB dose, SED ($\times 10$ mJ/cm^2)			
Initial	2.6 (1.9–2.8)	3.4 (2.6–5.8)	NS
Final	9.1 (4.7–14.7)	4.9 (3.1–9.2)	$p<0.01$
Cumulative	124 (29–186)	39 (16–88)	$p<0.01$

Data are shown as median values (5–95 percentiles). NS, not significant; SED, standard erythema dose (10 mJ/cm^2 at 298 nm); SCORAD, score of atopic dermatitis.

increases; on the one hand this defence response of the human skin towards UV irradiation leads to a smoother epidermis, but on the other hand the UV tolerance increases up to 50%, thus necessitating higher therapeutic UV dosages (21).

In a conventional setting, where UVB is given in a standardized regimen, increased exposure doses in the first 2 weeks have been shown to induce xerosis and inflammation, necessitating further UVB therapy (3).

However, we did not detect differences in the SCORAD index between the two treatment modalities, nor in the extent of subjective signs (of which pruritus is one). But, our clinical impression is that less itching is noted in an individualized setting.

A possible disadvantage of the skin reflectance-guided therapy is based on the previously mentioned epidermal hyperplasia during treatment with UV light. The apparatus calculates the UVB dose to be applied on the basis of erythema and pigmentation. It does not, however, automatically take into account the increased epidermal thickness. Therefore the effectiveness of the calculated UVB dosage may gradually decline. This phenomenon can possibly be overcome by adjusting the setting of the UV-Optimize so that the calculated UVB exposure dosage will be higher. Alternatively, the two regimens tested in this study could be combined by using the UV-Optimize calculated UVB exposure dosage as an indicator of the starting point in the subsequent increment schedule. An individually determined start dose may bypass the therapeutically low and insufficient UVB dosages that are sometimes administered initially in standard regimens, and may also avoid an overexposure of some patients resulting in erythema and pruritus.

In a standardized treatment regimen, the initial UVB dosage is chosen according to skin type. The classification is often done in a rudimentary fashion, and therefore nearly all patients are started at the same exposure level. This results in a standardized regimen, which is easy to perform, but not optimal for every patient. Optimization of therapy is a more efficient therapy than the conventional standardized treatment regimen. Last but not least, individualization may spare the patients from unnecessary therapy, reduce the cost of treatment by reducing therapy duration, and hence also reduce the risk of long-term side effects.

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