Climate therapy of psoriasis patients at Gran Canaria

High UV doses

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Abstract. Psoriasis is a chronic inflammatory disease involving about 2-3% of the European population. Sun exposure has a positive effect on most psoriasis lesions, but ultraviolet (UV) radiation also causes a direct DNA damage in the skin cells and comprises a carcinogenic potential. UV exposure on the skin causes a local as well as a systemic immune suppressive effect, but the relation between sun exposure and these biological effects is not well known. In March 2006 a study was carried out to investigate possible therapeutic outcome mechanisms in 20 psoriasis patients receiving climate therapy at Gran Canaria. This paper presents estimates of their individual skin UV doses based on UV measurements and patients’ diaries with information on time spent in the sun. On the first day of exposure the patients received on average 5.1 Standard Erythema Doses (SED) estimated to the skin. During the 15 days study they received 166 SED. There was no significant correlation between the therapeutic improvement and the UV dose. The UV doses were higher than if they had followed the prescribed exposure schedule and also higher than doses found from climate therapy studies at other locations. It seems beneficial to focus on the prescribed exposure schedules.

KEYWORDS: Psoriasis; climate therapy; ultraviolet radiation; measurements; UV-doses

1. Introduction

Psoriasis is a chronic inflammatory disease involving about 2-3% of the European population. Plaque psoriasis, the most common form of psoriasis, typically appears as raised areas of inflamed skin covered with silvery white scaly skin. The severity is usually graded as mild, moderate or severe. The Psoriasis Area Severity Index (PASI) is the most widely used tool to evaluate the psoriasis lesions. The PASI score varies from 0 (no symptoms) to a maximum of 72, reflecting the surface area affected and the severity of the lesions, i.e. the redness, thickness and scaling [1]. Ultraviolet (UV) radiation from the sun is an effective and natural treatment method for psoriasis [2]. Effects of UVB have been described to have beneficial effects [3, 4]. Climate therapy has been offered to psoriasis patients since many years at low latitude locations such as in the Dead Sea resort and the Canary Islands [5], and at high altitude locations, e.g. in Davos, Switzerland.

The original schedule for climate therapy of psoriasis lasted for 4 weeks with 6 hours daily sun exposure, after acclimatization during the first one to two weeks [6-8]. Recent studies from the Dead Sea area have reported good response in patients receiving only 3 hours daily sun exposure (excluding the noon hours) for 4 weeks [9-11]. Two of these studies and others have measured or estimated either the skin or the ambient doses in relation to climate therapy [7, 10-13]. Studies from the Dead Sea have also explored shorter therapy periods and showed better treatment response for patients treated for 4 weeks compared to only 2 weeks treatment [6]. A recent study reported lower percentage PASI reduction for patients receiving 2 weeks climate therapy compared to earlier studies [14], but with better results for those exceeding the prescribed 3 hours daily sun exposure.

This paper focuses on the UV dose estimates and is discussed with respect to length of daily sun exposure and length of treatment period.

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2. Material and Methods

The study was carried out at Gran Canaria (27°N, 15°W). Climate therapy for psoriasis patients at this treatment centre lasts for 21 days. The study period lasted for 15 of these 21 days, starting at 15 March 2006. The Regional Ethics Committee has approved the study.

2.1 Patient Material

The study included 20 Caucasian patients (mean age 47.2 years, range 24-65, 6 females and 14 males) with moderate to severe psoriasis. PASI before climate therapy was 9.8 (mean, range 3.8-18.8). PASI scores were assessed by dermatologists before and after the sun exposure. The patients had stopped using any psoriasis medication 4 weeks before the study started. Two of the patients had skin type II and 18 had skin type III according to the Fitzpatrick classification [15].

The patients followed a strict exposure schedule the first day of the study, exposing first the front side of the body for 30 minutes, the back side for 30 minutes, followed by 15 minutes exposure on each side in the period from about 11:00 and 13:00 local time (Fig. 1). They were allowed to stay outside after lunch, but only if a proper amount (2 mg/cm²) of sunscreen with sun protection factor (SPF) of 25 (Pediatrics Fotoprotector ISDN, 25B-10A-IR) was used for the whole body [16]. Then the patients were asked to gradually increase the hours of exposure per day, according to a schedule shown in Fig. 2 for skin type III and divided be half the exposure time before and after lunch. After day 10 there were no restrictions except if they experienced erythema. They were asked to use sunscreen mostly on locations easily burned. The patients registered time spent in the sun every day and for every 20 minute interval from 9:00 to 17:00 local time, as well as use of sunscreen and type of SPF factor.

Figure 1: Sun exposure for climate therapy patients at Gran Canaria.

2.2 UV Measurements

Spectral UVB (280-315 nm), UVA (315-400 nm) and CIE-weighted [17] UV irradiances were measured every hour from 9:00 to 17:00 local time using two broadband instruments (Solar Light Co PMA 2100 with UVB sensor PMA 2101 and UVA sensor PMA 2110, Gigahertz-Optik GmbH X1 1 Optometer with UVB and UVA sensors XD-9501). The instruments were positioned to monitor the UV radiation intensity on a horizontal surface. The sensors were calibrated and intercompared against a spectroradiometer (Brewer#185, measurement range 286.5-365nm, extended for UVA 365-400nm) at Izaña, Tenerife, prior to the study (by Mr. Alberto Redondas, Instituto Nacional de Meteorologia (INM), Spain), according to internationally accepted procedures [18, 19]. The overall measurement uncertainty can be estimated to ± 25%, and are due to uncertainty in the different instruments, temperature variations, azimuth variations and non ideal cosine response in broadband sensors.
2.3 UV Dose Estimates

Spectral UVB and UVA irradiances, in addition to CIE-weighted UVB and UVA irradiances, were calculated for the whole period using a radiation transfer model, libRadtran for irradiance calculations [20]. The model was run for the following conditions: cloudless sky, albedo of 0.05, sea level and ozone values from the TOMS satellite [21].

The UV irradiances were adjusted according to the measurements taken at the treatment centre to account for the real weather situation and possible discrepancies from the model parameters, such as different albedo and aerosol amount. Combining the calculated UV irradiances with the sun exposure time from the patients’ diaries, UV doses were estimated for each patient after 1 day and after the 15 days of sun exposure.

3. Results

The results are presented as CIE-weighted UV doses in J/cm² and in Standard Erythema Dose (1 SED = 100 J/m² = 0.01 J/cm²). Results are presented as mean doses ± Standard Deviation (SD). UV doses to each patient are set equal to the ambient UV doses divided by two, since only half the body can be exposed at any time. Doses the first day excludes exposure time when sunscreen is used, since the patients reported using approximately the proper amount of sunscreen after lunch (30 ml, SFP 25). The remaining days, all exposure time is included, since the patients reported using small amounts of sunscreen and only on easily burned locations. Pearson correlation coefficient was calculated between the CIE-weighted doses for the whole treatment period and the percentage reduction in PASI score. All statistical analyses were performed using SPSS 15.0 for Windows. P values ≤ 0.05 were considered statistically significant.

3.1 UV Doses

The daily maximum UV index (UVI) varied between 4 and 9 for the 15 days. The mean exposure time for the patients showed a gradual increase throughout the study period and was much higher than the prescribed exposure schedule (Fig. 2). The exposure time varied much among the patients.

**Figure 2:** Mean exposure hours at day 1, excluding time when using sunscreen, and for the remaining days, including all exposure time. The minimum and maximum exposure hours for the patient group are shown as the vertical lines. The stippled line shows the prescribed exposure schedule up to day 10.
3.1.1 Doses after 1 Day of Sun Exposure

The estimated UV doses after 1 day of sun exposure varied between 2.6 and 10.3 SED (Fig. 3) and with a mean dose of 5.1 ± 2.3 SED (Table 1). Seven patients exposed themselves to the sun without the prescribed sunscreen after lunch the first day and thereby received higher UV doses (Fig. 3). Fourteen out of the 20 patients reported erythema after the first day of sun exposure.

**Figure 3:** UV doses estimated for each patient after 1 day of sun exposure. The doses are equal to the ambient doses divided by 2. The black stippled line shows the dose if the patients had followed the prescribed exposure schedule. The light red rectangle indicates doses that can induce erythema in most white skin [22]. Blue triangles show doses including also the exposure time when the patients used sunscreen the first day.

**Table 1:** Estimated CIE-weighted UV doses for the patients after 1 and 15 days of sun exposure. Note: the values are equal to the respective ambient doses divided by 2.

<table>
<thead>
<tr>
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<th>UV doses after 1 day of sun exposure</th>
<th>UV doses after 15 days of sun exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE-weighted UV, [J/cm²]</td>
<td>Mean ± SD 0.051 ± 0.023</td>
<td>1.66 ± 0.25</td>
</tr>
<tr>
<td>Dose, SED</td>
<td>Mean ± SD 5.1 ± 2.3</td>
<td>166 ± 25</td>
</tr>
</tbody>
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3.1.1 Doses after 15 Days of Sun Exposure

The mean UV dose for each day (Fig. 4) showed roughly a gradual increase throughout the treatment period. An exception is at day 2 when all patients went by bus to and from the hospital in Las Palmas for taking blood samples and biopsies in connection with another study. The mean dose after 15 days sun exposure was 166 ± 25 SED (Table 1). The variation between minimum and maximum patient doses each day was large.
All patients experienced an overall reduction in PASI score of 72.8% ± 18.0. Pearson correlation coefficient between the percentage improvement in PASI score and the CIE-weighted doses for the whole treatment period was 0.21 and not significant.

**Figure 4:** Mean daily UV dose for each day. The doses are equal to the ambient doses divided by 2. The doses corresponding to the prescribed exposure schedule are shown for the actual weather situation and in case of clear sky.

4. Discussion

UV doses have been estimated for psoriasis patients receiving climate therapy at Gran Canaria. The doses were estimated combining a radiative transfer model, local UV measurements and sun exposure times registered by the patients.

Our method to measure and estimate UV doses is easier compared with using personal UV dosimeters, but is affected with more uncertainties. These are discussed in another paper [23], but the predominant uncertainty is assuming that the skin dose equals half the ambient dose. This is appropriate as a first approximation, in particular for the abdomen and back during sun bathing if the patients turned to expose these sites at equal amounts. Measurements using personal dosimeters in other studies support this assumption [7, 24-26]. For extremities doses are reported to be higher and lower for various activities and all vary more than during sun bathing [7, 26, 27]. The upper extremities probably often receive more than 50% of the ambient UV [7, 24, 26, 27] and are therefore more susceptible to be sunburned. These are where the patients reported to have used sunscreen through the treatment period.

As shown in Fig. 3 the calculated doses are mostly lower than needed to induce erythema, i.e. Harrison and Young [22] indicated moderate sunburn to occur for doses of 5-8 SED and painful, blistering sunburn at 10 SED, for most white skin. Still, 14 patients reported erythema. The explanation can be variation in doses over the body, that they exposed different body parts unequally, or that some patients have used less than the prescribed sunscreen this first day.
Our patients clearly exceeded the prescribed exposure schedule for the following days (Fig. 2). If they had followed this schedule, the skin dose would have been 105 SED (ambient dose 210 SED, i.e. 2 x skin dose) for the whole 15 days treatment period. Also a study of 2 weeks climate therapy at the Dead Sea [14] has reported similar findings. The Dead Sea exposure schedule involved maximum 3 hours daily sun bathing, but 83.5% of the patients exceeded this. These patients actually achieved better therapeutic results. Some of our patients have expressed their belief that more sun exposure cause better therapeutic results. Also presence of clouds may incorrectly give the impression of much lower UV intensities and thereby prolong the exposure times to receive what the patients believe is the necessary UV exposure.

The reduction in PASI score for our patients, as well as for the 2 weeks Dead Sea regime [14], is lower than for patients receiving 4 weeks therapy at the Dead Sea with only 3 hours daily exposure, i.e. > 80% reduction in PASI score [9-11]. One of the studies achieved such results for treatment in the months March to August, whereas around 70% reduction in September to November [10, 11]. The Dead Sea treatment site is at similar latitude as the Canary Islands, however, around 400 meters below sea level. Therefore, the UV radiation and particularly the UVB radiation (280-315 nm) is attenuated compared with that at sea level [28]. It is therefore interesting to see that the accumulated UV doses for our patients after 15 days (skin dose 166 SED, ambient dose 333 SED) were higher than for Dead Sea patients treated for 4 weeks and receiving an ambient dose of 170-390 SED (indicated in Fig. 5).

The full treatment period for our patients was 21 days, that would give a skin and ambient dose of around 250 and 500 SED, respectively, estimated by adding 6 days with doses equal to the average of the last 5 days of sun exposure (Day 11-15). If followed the exposure schedule, however, the skin and ambient doses would have been 170 and 340 SED for the actual weather situation and 210 and 420 SED in case of clear sky conditions. These doses are closer to the Dead Sea treatment doses.

**Figure 5:** Estimated ambient UV doses (2 x skin doses) for a full treatment period of 21 days as a function of time of the year. The doses are estimated using the sun exposure schedule, weather conditions and ozone values as for the study in March 2006 (red ring). The dose if followed the exposure schedule is indicated for the actual weather situation (light blue) and in case of clear sky (upward line). Ambient doses from other studies are indicated in the figure [7, 10, 11].

Psoriasis patients admitted to climate therapy seem to achieve good improvement also for other months and with approximately the same sun exposure hours. Fig. 5 shows estimated ambient doses for other months when patients are sent to Gran Canaria, assuming they follow the same exposure pattern as in March. It shows a factor 3 difference in UV dose between January and June. In particular,
patients treated in the summer months seem to receive too high doses. Even our patients treated in March may all have received high enough UV doses with respect to healing. This corresponds well with the fact that our results showed no correlation between reduction in PASI score and the UV dose.

Based on our study and the Dead Sea studies the accumulated UV dose does not need to be as high as for our patients. Other factors may be of importance for the therapeutic outcome and that have to be explored in future studies. All together, climate therapy patients should be restricted with respect to their sun exposure to avoid erythema and large accumulated doses.

5. Conclusion

In conclusion, estimated mean UV dose to the skin for 15 days climate therapy at Gran Canaria was 166 SED and resulted in 72.8% reduction in PASI score. The individual percentage reduction in PASI score did not seem to depend on the UV dose. The patients exceeded the prescribed exposure schedule and they received higher UV doses compared to climate therapy patients treated at other locations. It seems beneficial and necessary to further explore how to interpret the prescribed exposure schedules.

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REFERENCES