Transepidermal Water Loss in Dry and Clinically Normal Skin in Patients with Atopic Dermatitis

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To obtain data on the function of the epidermal barrier in patients with atopic dermatitis (AD) the transepidermal water loss (TEWL) was studied. Measurements were made on three body locations in two clinically well defined groups of patients with AD and in a control group. The TEWL was found to be increased both in dry non-eczematous skin and in clinically normal skin in patients with AD. The TEWL was highest in patients with dry skin. The result of the study may indicate a primary defect in the epidermal barrier: the stratum corneum.

Key words: Barrier function; Evaporimeter.

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One of the main functions of the skin is to produce and maintain the diffusion barrier between the internal and external milieu of the organism. This barrier function is located to the stratum corneum (1). Among other properties an adequate function of stratum corneum necessitates an optimal hydration state (2).

In patients with atopic dermatitis (AD) a common finding is the occurrence of dry skin on non-eczematous locations. Patients with AD are also predisposed to develop dermatitis secondary to physical and chemical irritation (3). These clinical findings suggest an altered barrier function.

The determination of the water content and barrier properties of stratum corneum in vivo is difficult to assess. The loss of water through the skin, the so-called transepidermal water loss (TEWL) is often used as a parameter considered to reflect the functional state of the epidermal diffusion barrier.

The present investigation was performed to define differences in the barrier function of dry and clinically normal skin in patients with AD. The TEWL was determined on three body locations in two clinically well defined groups of AD-patients and in a control group using a differential moisture recording instrument: The Evaporimeter (4).

MATERIAL AND METHODS

Material. Forty-eight persons, age 18-30 years, of both sexes, were studied. The patients included all fulfilled the criteria of atopic dermatitis according to Hanifin & Rajka (5). They were carefully chosen to fit in one of the two following groups, each consisting of 16 patients.

Group I: Patients with mild dermatitis in the flexures and with clinically normal skin on the rest of the body (11 women, 5 men).

Group II: Patients with dermatitis located to the flexures and with dry skin but no dermatitis on hands, arms and back. Dry skin (xerosis) was defined as a rough feeling on touching with very fine scaling but without any sign of erythema (13 women, 3 men).

Sixteen persons with no anamnestic or clinical signs of atopy, other dermatological disease or dry skin served as controls (14 women, 2 men).

Experimental conditions. The investigation was performed during the winter season. The patients were resting calmly in a chair. The environment temperature was kept constant at 24°C, the relative
humidity varied between 13% and 24%. In the AD-patients (group II) and in the control group the skin temperature was recorded with a Kane-May digitherm (Christian Bemer AB, Göteborg).

**Measurement of TEWL.** Using an Evaporimeter (4) (Evaporimeter Epl, ServoMed AB, Valllingby, Sweden) the TEWL was recorded on three different parts of the body: the back of the hand, the flexor side of the forearm and the lower back. The probe consists of two moisture sensors and two temperature sensors mounted on a teflon pipe. TEWL was given from a determination of the vapor-pressure gradient in the air close to the skin surface.

**Statistical analysis.** The logarithm of the measured values were used for the statistical analysis. A computer based variance analysis (ANOVA, Statpac, Karolinska Institutet) was applied for the analysis of the variance between the three groups. This analysis showed a significant difference between the groups ($p=0.05$). However, there was also a significant interaction term ($p=0.05$). In consequence, the analysis was expanded to comprise an analysis of the variances between the body locations in each separate group and a Studentized Range test of the means for the comparison between all three groups at each body location.

## RESULTS

The results of the measurements are given in Table I. The TEWL was lowest in the control group and highest in the AD patients with dry skin (group II). A significant increase ($p=0.05$) in the TEWL was found on all three body locations in this group. The results of the comparison between the groups on the different body locations are given in Table II. A significant increase in the TEWL ($p=0.05$) was also found in the AD patients with normal skin (group I) on the hand and forearm but not on the back. Within the two groups of AD patients there was a significant difference in TEWL on the arm and the back but not on the hand. The result of the analysis on the variance between the three body locations within each group showed a significant variance ($p=0.05$) in the control group and in group I but not in group II. The skin temperatures recorded were in the AD patients (group II) $30.5 \pm 1.7 ^\circ C$ (hand) $31.8 \pm 1.1 ^\circ C$ (arm) and $31.7 \pm 1.0 ^\circ C$ (back) and in the controls $30.3 \pm 1.6 ^\circ C$, $31.3 \pm 1.3 ^\circ C$ and $32.0 \pm 1.2 ^\circ C$.

## DISCUSSION

During the past decades much interest has been focused on the barrier function of the skin. One problem has been to find a method which allows a determination of the barrier properties in vivo. For this purpose determination of the TEWL has often been used to describe the functional state of the diffusion barrier. Different techniques have been described in the literature for measurement of TEWL (6, 7). However, the results obtained vary with the registration modalities and hence a direct comparison of data from different investigations is difficult to perform (8). The present investigation was performed during the winter season, when the relative humidity (RH) is low. A low RH might influence the measured values and increase the TEWL. Another factor that affects the TEWL is sweating. However, the skin temperatures recorded in this study were below the sweating point (34°C) and therefore it was not necessary to inhibit sweating before the measure-

<table>
<thead>
<tr>
<th></th>
<th>Controls (n=16)</th>
<th>Group I (n=16)</th>
<th>Group II (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back of hand</td>
<td>9.76±2.16</td>
<td>14.64±3.86</td>
<td>17.49±7.18</td>
</tr>
<tr>
<td>Forearm</td>
<td>4.69±1.91</td>
<td>7.55±2.76</td>
<td>13.30±5.76</td>
</tr>
<tr>
<td>Back</td>
<td>6.57±2.99</td>
<td>7.35±2.21</td>
<td>14.42±6.64</td>
</tr>
</tbody>
</table>

Table I. **TEWL (g/m$^2$/h) in AD patients and controls** (mean ± SD)
TABLE II. The result of the Studentized Range Test of the means for the TEWL between the groups on three body locations

<table>
<thead>
<tr>
<th></th>
<th>Gr I vs. Contr.</th>
<th>Gr II vs. Contr.</th>
<th>Gr I vs. Gr II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand</td>
<td>*</td>
<td>*</td>
<td>NS</td>
</tr>
<tr>
<td>Forearm</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Back</td>
<td>NS</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Table III. Previous studies on the TEWL in patients with atopic dermatitis

<table>
<thead>
<tr>
<th>Reference</th>
<th>Patients No.</th>
<th>Controls No.</th>
<th>Clinical appearance</th>
<th>Body location</th>
<th>RH %</th>
<th>Skin temp. (°C)</th>
<th>Method</th>
<th>TEWL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajka (6)</td>
<td>14</td>
<td>14</td>
<td>Involved mildly involved</td>
<td>Back of hand</td>
<td>35-37</td>
<td>24-34</td>
<td>Mecco</td>
<td>↑</td>
</tr>
<tr>
<td>Abe et al. (7)</td>
<td>22</td>
<td>40</td>
<td>Eczema dry skin</td>
<td>Antecubital fossa</td>
<td>50-72</td>
<td>31.6</td>
<td>Electrohygrom.</td>
<td>↑</td>
</tr>
<tr>
<td>Finley et al. (9)</td>
<td>3</td>
<td>11</td>
<td>Dry skin</td>
<td>Upper arm</td>
<td>N1</td>
<td>N1</td>
<td>Evaporimeter</td>
<td>↑</td>
</tr>
</tbody>
</table>

N1 = not indicated
of stratum corneum than normal (11). In a recent in vitro study it was shown that stratum corneum from dry non-eczematous skin from the back of AD patients had a decreased ability to bind water (12).

Alterations in the skin surface lipids in AD have been described (7, 13). The lipids within stratum corneum are shown to be of paramount importance for the barrier function (14). In this context it is interesting to note that the TEWL is increased in different forms of ichthyosis where it is also possible to detect alterations in the biochemical composition of stratum corneum (15).

The research on the barrier function of the skin in patients with AD suggests that there may be an alteration in the composition and/or architecture of the stratum corneum leading to an increased flux of water through stratum corneum and to an altered barrier function.

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REFERENCES