

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.* (Received February 29, 1984.)

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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 Berner AB, Göteborg).

Measurement of TEWL. Using an Evaporimeter (4) (Evaporimeter Ep1, ServoMed AB, Vällingby, 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) $30.5\pm 1.7^\circ\text{C}$ (hand) $31.8\pm 1.1^\circ\text{C}$ (arm) and $31.7\pm 1.0^\circ\text{C}$ (back) and in the controls $30.3\pm 1.6^\circ\text{C}$, $31.3\pm 1.3^\circ\text{C}$ and $32.0\pm 1.2^\circ\text{C}$.

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 I. TEWL ($\text{g}/\text{m}^2/\text{h}$) in AD patients and controls (mean \pm SD)

	Controls (n=16)	Group I (n=16)	Group II (n=16)
Back of hand	9.76 ± 2.16	14.64 ± 3.86	17.49 ± 7.18
Forearm	4.69 ± 1.91	7.55 ± 2.76	13.30 ± 5.76
Back	6.57 ± 2.99	7.35 ± 2.21	14.42 ± 6.64

Table II. The result of the Studentized Range Test of the means for the TEWL between the groups on three body locations

* = significant, NS = not significant ($p=0.05$), vs. = versus

	Gr I vs. Contr.	Gr II vs. Contr.	Gr I vs. Gr II
Hand	*	*	NS
Forearm	*	*	*
Back	NS	*	*

ments (6). The Evaporimeter used in the present study is simple to handle and it has been shown to give a good reproducibility under standardized conditions (4).

An increase in the TEWL has previously been described in patients with AD (Table III). To make it possible to compare functional data, e.g. TEWL, with structural information it is important to clearly define the body location and the degree of skin involvement in the patients studied. In the study by Rajka (6) the TEWL was measured on "involved or mildly involved" skin on one location: the back of the hand, a part often exposed to physical and chemical trauma. Abe et al. (7) compared the TEWL in "involved skin (eczema) and uninvolved skin (dry)" in the same patients using electrohygrometric methods. Finley et al. (9) measured the TEWL in only three patients using the Evaporimeter. In the present study the TEWL was determined on three body locations, among them the back, seldom the site for dermatitis and not exposed to physical or chemical trauma. The measurements were performed on two clinically well defined groups of patients with AD including normal appearing skin. A significant increase in TEWL was recorded on all three body locations in AD patients with dry skin (group II). This is in accordance with earlier results (6, 7, 9). The TEWL was also significantly elevated in AD patients with normal skin (group I) with the exception of the back. Within the two groups of AD patients no difference was found in the TEWL on the hand. These findings are interesting as they may suggest an early defect in the barrier function on predilection areas in AD. In all three groups the highest TEWL was found on the back of the hand.

The barrier function is, among other properties depending on the degree of hydration within stratum corneum. However, the absolute amount of water in the stratum corneum is not correlated to the TEWL (10). Thus, electrical measurements and infrared spectroscopy on clinically normal skin in patients with AD have indicated a higher water content

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

NI = not indicated

Reference	Patients No.	Controls No.	Clinical appearance	Body location	RH %	Skin temp. (°C)	Method	TEWL
Rajka (6)	14	14	Involved mildly involved	1. Back of hand	35-37	24-34	Mecco	↑
Abe et al. (7)	22	40	Eczema dry skin	1. Antecubital fossa 2. Forearm	50-72	31.6	Electrohygrom.	↑
Finley et al. (9)	3	11	Dry skin	1. Upper arm	NI	NI	Evaporimeter	↑

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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