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The Water Content of the Stratum corneum in Patients with Atopic Dermatitis

Measurement with the Corneometer CM 420

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The dry looking skin seen in many patients with atopic dermatitis reflects a defect in the epidermal barrier, the stratum corneum, as demonstrated by an increased transepidermal water loss (TEWL) and a decreased ability of the stratum corneum to bind water. The absolute amount of water within the stratum corneum is of importance both for barrier properties and for the clinical appearance of the skin. This water content was measured with a new instrument, the Corneometer CM 420, which takes advantage of the high dielectric constant of water. Forty patients with atopic dermatitis were studied—20 with dry skin and 20 with clinically normal skin on non-eczematous areas. The stratum corneum in dry skin was found to have a lower content of water than that in the clinically normal skin ($p<0.01$). Clinically normal skin in patients with atopic dermatitis did not differ significantly from normal control skin. An experiment was performed in vitro in an attempt to correlate the values obtained with the Corneometer to the absolute amount of water within the corneum. *Key words: Dry skin; Dielectric constant.* (Received December 16, 1985.)

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There is much evidence to indicate that in patients with atopic dermatitis there is an early defect in the skin barrier function even in non-eczematous skin of normal appearance. As many as 70 per cent of these patients have generalized or focal areas of dry skin (1), often on non-predilection sites. Both in dry and in normal-looking skin an increased transepidermal water loss (TEWL) has been found (2), reflecting a defect barrier function located exclusively within the stratum corneum. Dry skin has been shown in vitro to have a reduced ability to bind water (3). The absolute amount of water within the stratum corneum is one factor which influences the barrier properties. However, there are many difficulties associated with the determination of this water content in vivo. It is not documented that dry skin has a low water content and in fact some observations have suggested that the water content of dry skin in patients with atopic dermatitis is increased (4, 5).

The present investigation was performed with the Corneometer CM 420, a newly developed commercial instrument. The aim was to assess the water content of the stratum corneum in two clinically well defined groups of patients with atopic dermatitis.

MATERIAL AND METHODS

Material

Forty patients aged 18–40 years with atopic dermatitis according to the criteria of Hanifin & Rajka (6) were carefully selected to fit into one of the two following groups. Group I: 20 patients (8 men, 12 women) with dermatitis on the flexures and in addition clinically dry skin on the back. Dry skin was defined as roughened, finely scaling, non-inflammed, non-erythematous skin (1). Group II: 20 patients

(4 men, 16 women) with dermatitis on the flexures and/or the hands but with clinically normal skin on the back. The area of measurement in all patients was the lower part of the back. No ointment was applied to the back during the last three days prior to the study, and no shower or bath was allowed during the 24 hours preceding the measurements. No hot beverage was allowed one hour prior to the measurement. 20 persons (7 men, 13 women) with no anamnestic or clinical signs of atopy or dry skin served as controls. Patients with concomitant icthyosis vulgaris were excluded.

Experimental conditions

The investigation was performed during the summer and early autumn when the relative humidity (8) was fairly high, varying between 50 and 70%. The room temperature was kept constant at 21°C. The subject rested in a chair for at least 10 minutes prior to the measurements. The skin temperature on the back was recorded with a thermistor (Ellab Copenhagen).

Measurement of the water content of the stratum corneum

The Corneometer CM 420 (Schwarzhaupt Medizintechnik GMBH 5000, Köln 30) is constructed according to the following principle: The probe, which is 12 mm in diameter, works as a condensor, the capacitance of which is influenced by a change in the dielectrical constant of a material in contact with the probe. Organic materials such as the proteins of the stratum corneum are electrical isolators. The electric conductance of such materials is greatly influenced, however, by the water content. Furthermore, water has a proportionately high dielectrical constant, a physical characteristic which influences the capacitance, which will increase with an increase in the amount of water in the stratum corneum. The probe construction utilizes metals with low dielectrical constants to minimize effects of the probe itself on the measurement (7). The recording zone is considered to be the deeper part of the stratum corneum (8). When performing a measurement the probe is placed on the skin surface with a standard pressure of 3.5 N. After 3 seconds a value is shown on the digital display and after another 3 seconds a different value is given-the value already being influenced by an occlusion effect. The values are given without denomination as AE (German "Anzeige-einheiten"). The mean value of three recordings obtained at intervals of 5 seconds was used in assessing skin hydration. The accuracy of the instrument was found to be ±2.6 AE.

In vitro experiments

Human skin from the back, altogether nine pieces, obtained from autopsies, was used to prepare pieces of stratum corneum according to Kligman (9). After dehydration at 60°C for three days, the pieces of stratum corneum were gradually rehydrated in open air and the measurement with CM 420 were made on each piece of the stratum corneum with increasing hydration rate. Immediately thereafter their weight was recorded on an electrobalance (Cahn 25 Ventron Corporation). With a known dry weight the absolute amount of water expressed in mg H_2O/mg dry tissue could be calculated and correlated to the water content expressed as AE. At the end of the experiments all pieces of stratum corneum were examined after cryosection to confirm that only the corneum was left.

Statistical analysis

A computer-based analysis of variance (One-ANOVA Statpac, Karolinska Institute) was applied for analysis of the variance between the three groups and a Studentized Range test of the means was used for comparisons betweeen the gorups. ($p \leq 0.01$). Linear regression was used for the experiments in vitro.

RESULTS

There was significant variance between the three groups ($p<0.01$). The mean water content of the stratum corneum in patients with atopic dermatitis and dry skin (Group I) was significantly lower ($p<0.01$) than that both in the normal controls (77.5±14.1 and 103.4±10.7 AE respectively) and in the patients with atopic dermatitis and otherwise normal skin (Group II) (96.4±11.1 AE). There was no significant difference between group II and controls. The mean skin temperatures in groups I and II and the controls were 30.1±0.9, 30.2±0.9 and 30.9±0.7°C respectively. The results of the in vitro experiments are shown i Fig. 1; the calculated water content of the stratum corneum was 0.32 mg of water per mg dry tissue in group I, 0.59 mg/mg in group II and 0.69 mg/mg in the controls.

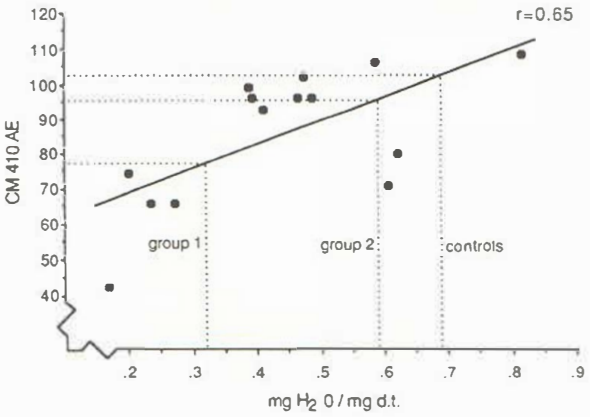

Fig. 1. Measurement with the CM 420 (AE) correlated to the absolute amount of water within the stratum corneum in vitro (mg H_2O/mg dry tissue). Group I: Atopic derm.-dry skin. Group II: Atopic derm. normal skin.

DISCUSSION

Various methods have been developed to measure the water content of the stratum corneum in vivo, most of them relying on electrical properties of the skin, for example capacitance or impedance (10). Different methods will record values at different depths within the stratum corneum. This is an important fact, since there is a gradient of water through the corneum resulting in a high water content in the deep strata and a low content in the outer strata (11).

It is also crucial to define the appearance of the skin, and to choose carefully the area to be tested. The best area should be a non-predeliction site, for example the back, if the purpose is to trace an early defect in the skin. Finley et al. (4) studied 11 patients with atopic dermatitis and clinical signs of dry skin on the outer aspect of the upper arm. They found that the impedance was lower than normal, indicating a high water content. The principal zone of recording with this method is supposed to be the outermost portion of the stratum corneum maybe including some surface hydration, which will lead to falsely low values of impedance. Gloor et al. (5) studied 20 patients with atopic dermatitis, grouping together those with dry and normal skin. The area of measurement was the flexor side of the arm, a predilection site for dermatitis. Using the method of Infrared Spectroscopy, whereby the recordings are again made on the outer part of the stratum corneum, he found an increased water content in all patients with atopic dermatitis. However, no increase in the water content was observed after stripping of the skin, which is surprising in view of the gradient that is known to exist within the stratum corneum. Al-Jaberi & Marks (12) did not find any differences between normal skin of patients with atopic dermatitis and the skin of healthy persons. In clinically damaged skin such as eczema or psoriasis, the water content of the stratum corneum is low (10), and the same has been found in aged skin (13). The results from use of the Corneometer CM 420 indicate a subnormal water content in clinically dry skin in patients with atopic dermatitis. This finding supports a previous observation that in vitro the stratum corneum of dry skin has a decreased ability to bind water (3). The discrepancy between the present results and those of other authors may be due to different methods of measurement and also to recordings in different depth of the stratum corneum. Differences in the clinical appearance of the skin and the area tested may also influence the results. Normal skin in patients with atopic dermatitis seemed to have a normal water content, which is in accordance with the findings of Al-Jaberi & Marks (12). Data for the absolute amount of water within the stratum corneum are in conformity with values reported by Blank (11), taking into account the fact that the recordings are made in deeper strata with the Corneometer CM 420.

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