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The Presence of Body Hair Influences the Measurement of Skin Hydration with the Corneometer

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Techniques for the assessment of skin hydration are often based on the electrical properties of the stratum corneum. A commonly used instrument for measurements of skin moisture is the corneometer, which detects changes in the dielectric constant of the material in contact with the probe. It has been suggested that different materials, for example cream residues and desquamating scales, may interfere with the Corneometer readings, but this question has not been settled conclusively in previous studies. In the present study the influence of body hair was examined.

Significantly lower Corneometer values were obtained on the dorsal aspect of the forearm than on the volar aspect ($p<0.05$), indicating that the former region was less hydrated than the latter. After shaving of the skin, however, there was no difference in the Corneometer readings between the two regions. Thus, the presence of hair needs to be considered when the hydration status of the skin is examined with the use of a Corneometer. ***Key words: skin capacitance; biophysical measurements; humans; hair growth.***

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A functioning stratum corneum is essential for water homeostasis in mammals. Besides protecting the human organism from water loss, the stratum corneum also contains water for plasticity and to provide a barrier function (1). A decrease in the moisture content below 10% makes the stratum corneum brittle (1). Hence, it is not surprising that a wide variety of techniques are being developed for measuring the water content of the stratum corneum and that, recently, a book focusing on bioengineering studies on water and the skin has been published (2).

Techniques for measurement of skin hydration are often based on the electrical properties of the stratum corneum, such as resistance, conductance, capacitance and impedance (3–9). A commonly used instrument is the Corneometer (model CM 420 or 820, Courage + Khazaka, Köln, Germany) (3, 10–16), which measures skin capacitance (10). The surface of the Corneometer probe works as a condenser and is influenced by changes in the dielectric constant of the material in contact with the probe (10). As water has by far the highest dielectric constant in the skin, an increase in the water content will increase the capacitance (arbitrary units), as measured by the Corneometer. A limitation of electrical measurements is that they only give qualitative information on changes in the water content, at poorly defined locations within the skin.

Despite the potential difficulties in determining skin hydration, measurement of skin capacitance is claimed to be useful in discriminating between different degrees of clinical dryness (17). Likewise, the Corneometer indicates that clinically dry skin in patients with atopic eczema (12–14, 18) and psoriatic lesions (19) contains less water than normal skin. Furthermore, the decreased ability of dry atopic and psoriatic skin to bind water has been demonstrated with the Corneometer (12, 13). The instrument has also been used to study the hydrating effect of single applications of moisturizers to normal skin (15, 16, 20–23). In previous studies, measurements of skin conductance and capacitance indicated a regional variation in skin hydration, which was suggested to be due to differences in the sweat gland densities between different body areas (3, 24). Since the variation might also be due to differences regarding the presence of body hair, we have examined the influence of body hair Corneometer readings of skin capacitance, by measuring the skin capacitance and then removing the body hair mechanically and remeasuring the shaved areas.

MATERIALS AND METHODS

Instruments

The electrical capacitance of the skin was determined using a Corneometer CM 820 (Courage + Khazaka GmbH, Köln, Germany). A Gilette sensor for mechanical dry shaving was used to remove hair from the skin surface.

Volunteers

The study comprised 11 healthy Caucasians without skin diseases, 9 women and 2 men, with a mean age of 37 ± 11 years.

Design

The capacitance of the skin surface on the volar and dorsal aspects of the forearm was measured with the Corneometer. Immediately after the measurement the skin on both body areas was gently shaved with the mechanical razor and the Corneometer measurements were repeated. The skin was shaved irrespective of the presence or absence of visible hair.

Statistics

Mean values and standard deviations were calculated. Statistical analysis of variance of paired values was performed, followed by the Tukey-Kramer multiple comparison test to compare the mean values. $p < 0.05$ was considered as significant.

RESULTS

The Corneometer value on the untreated dorsal aspect of the forearm was significantly lower than that on the untreated volar aspect (Fig. 1). After shaving of the skin, the values on the dorsal aspect increased significantly, and the difference between the volar and dorsal aspects was eliminated (Fig 1.)

DISCUSSION

The Corneometer is considered a valid instrument for measuring skin moisture (10). In a recent study, however, the instrument

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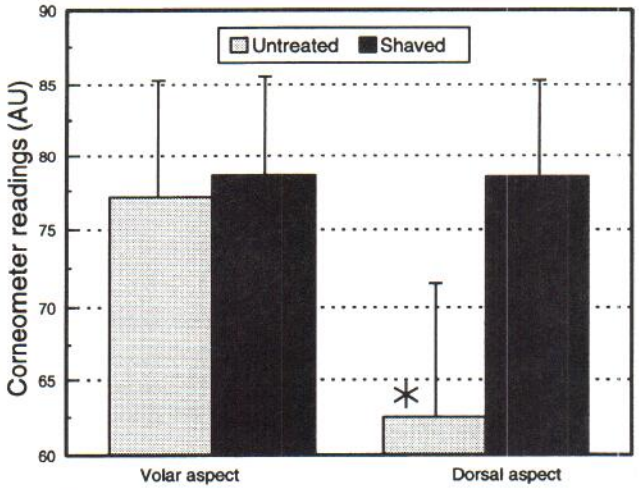

Fig. 1. Corneometer measurement of the skin capacitance on the forearm before and after shaving. n = 11; the *bars* denote S.D. and the *asterisk* denotes a significantly lower value compared with the dorsal aspect after shaving and with the volar aspect before and after shaving.

readings were found to correlate poorly with the hydration dynamics in normal stratum corneum (6). In the present study we found that the presence of hair influenced the Corneometer readings significantly. Prior to shaving, the readings indicated that the dorsal aspect of the forearm was less hydrated than the volar aspect, but after shaving, no difference between these regions was observed. Shaving did not significantly influence the Corneometer values obtained on the volar aspect of the forearm. This indicates that the less pronounced hair growth in that area did not affect the measurements significantly.

Previous studies have indicated that the Corneometer may reveal changes in hydration down to a depth of about 0.1 mm (3). This conclusion was based upon the finding that application of several layers of tape onto the skin surface did not quench the values entirely (3). Another obvious conclusion from these experiments is that the presence of materials on the skin will influence the readings, possibly leading to an underestimation of the skin capacitance. It has also been suggested that non-absorbed cream residues may influence the readings during evaluation of moisturizers (20).

It is concluded that the presence of hair on the skin surface affects Corneometer readings of skin capacitance. This has to be taken into account when comparisons are made, regarding the state of hydration, between different individuals and different body regions. Likewise, it is possible that the presence of scales might influence the readings of the hydration status in hyperproliferative skin diseases (18).

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