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Effect of Long-term Use of Moisturizer on Skin Hydration, Barrier Function and Susceptibility to Irritants

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Moisturizers are often used in the prevention and treatment of irritant contact dermatitis. The present study was to determine whether long-term daily use of a moisturizer on normal skin would affect skin barrier function, hydration state, or susceptibility to sodium lauryl sulphate. Healthy volunteers used a moisturizer on one forearm 3 times daily for 4 weeks. The other forearm served as a control. Afterwards both forearms were challenged with a patch-test of sodium lauryl sulphate. Skin barrier function was evaluated by measuring trans-epidermal water loss and skin hydration by measuring electrical capacitance. Electrical capacitance was significantly increased on the treated arm during the treatment period. After challenge with sodium lauryl sulphate, trans-epidermal water loss was significantly higher on the arm treated with moisturizer than on the control arm. The results suggest that long-term treatment with moisturizers on normal skin may increase skin susceptibility to irritants. ***Key words: TEWL; electrical capacitance; sodium lauryl sulphate.***

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Moisturizers are often recommended by dermatologists for prevention and treatment of irritant contact dermatitis (ICD). Barrier, or protective, creams are used in some hazardous occupations to prevent the penetration of irritants into the skin. However, there is no clear distinction between a barrier cream and other kinds of moisturizer. One field study showed that people working in wet conditions benefited subjectively from daily use of moisturizers for a period of 2 weeks (1). Experimental studies have shown that moisturizers are effective in preventing ICD when applied immediately before the irritant trauma, and in treating ICD when applied following the irritant trauma (2–6). These studies have focused either on the moisturizer used as a barrier cream or on the reparative effect of the moisturizer. There are only a few published studies on moisturizers used on normal skin (7–9). It is generally assumed that moisturizers increase the hydration level of the skin. Daily use of moisturizers on normal skin could theoretically interfere with the functional organization of the stratum corneum or with the synthesis of endogenous lipids, resulting in a change in the barrier function of the skin.

The present study examined the long-term effects of daily use of a moisturizer on normal skin with regard to skin barrier function, hydration level and susceptibility to irritants. Measurements of trans-epidermal water loss (TEWL) and electrical capacitance were used to evaluate skin reactions.

MATERIALS AND METHODS

Subjects

Twenty healthy volunteers (17 females, 3 males) with no history or clinical signs of dermatological disease or dry and scaly skin were included in the study. Their mean age was 38 years (range 21–57). They were instructed not to use moisturizers for at least 7 days prior to entering the study. They could bath and wash as usual. Informed consent was obtained from all participants, and the study was approved by the local ethics committee.

Moisturizer

The moisturizer used (Locobase®, Yamanouchi Pharma) contains paraffinum molle album, aqua, paraffinum liquidum, cetearyl alcohol, cetomacrogol 1000, methylparaben, citric acid and sodium citrate. It has a lipid content of 70% and is fragrance-free. The same moisturizer has proven effective in the prevention and treatment of ICD in a previous experimental study on moisturizers (2).

Sodium lauryl sulphate (SLS)

The detergent SLS (Sigma, >99% purity) was used to elicit an irritant reaction of the skin. A closed patch-test with 210 µl of 0.3% SLS aqueous solution on filter discs was applied on each of the flexor aspects of both forearms using an extra-large 18 mm Finn Chamber on Scanpore tape. The patches were placed symmetrically in the same anatomical position on each forearm, and a ruler was used to ensure the same distance from the fossa cubiti.

SLS is a surfactant commonly found in soaps, shampoos and cleansing products used both in wet working situations and domestically. It is widely used as a model irritant in experimental studies on ICD.

Evaluation methods

Evaluation was carried out using the non-invasive bioengineering techniques of measurement of electrical capacitance of the skin and of trans-epidermal water loss (TEWL).

The electrical capacitance of the skin is an indicator of the hydration level of the stratum corneum (10) and was measured using a Corneometer® CM 820 (GMBH. Köln, Germany). The average result of six recordings was taken.

TEWL is the passive diffusion of water through the stratum corneum and is an indicator of the integrity of the stratum corneum (11). This was measured using an Evaporimeter (Servo Med, Stockholm, Sweden) following the guidelines from the European Society of Contact Dermatitis (11). Details of the operating principle of the Evaporimeter are given elsewhere (12). Measurements were made in an incubator and the average value of three recordings was taken.

Participants rested for 30 min with their forearms exposed before measurements were taken. The relative humidity in the room where the measurements took place varied between 26 and 40%. The ambient room temperature was 19–22°C. Air convection was kept to a minimum. The study was carried out in April and May 1997.

Study procedure

The study period was 5 weeks. On day 1 the flexor aspect of each forearm was evaluated by measuring skin capacitance and TEWL (baseline). Each participant was given a supply of the moisturizer to be applied on one of the forearms 3 times daily for the following 27 days and a checklist for daily recording of the treatment. The other forearm served as control and was left untreated. All participants were instructed how to apply the moisturizer. Volunteers were randomized to apply the moisturizer on either the left or right arm. The randomization code was blinded to the investigators. Moisturizer treatment was stopped at the end of day 27. The participants were not allowed to use any other moisturizer during the study period.

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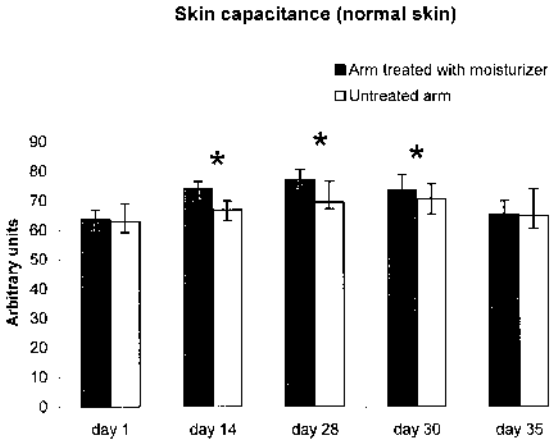

Fig. 1. Skin capacitance on normal skin. Values are given in medians and 25/75 percentiles, $*p < 0.05$.

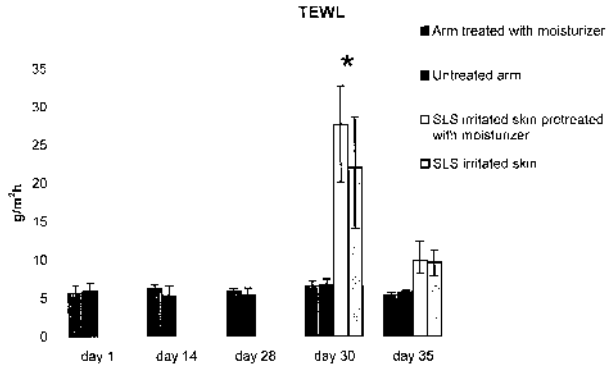

Fig. 2. TEWL values for normal skin and SLS irritated skin. Values are given in median values and 25/75 percentiles, $*p < 0.05$.

Follow-up measurements were made on days 14, 28, 30 and 35. On day 28 a patch-test of SLS was applied to each forearm for 24 h. The patches were applied more than 12 h after the last application of the moisturizer. The participants removed the patches themselves 24 h later and were instructed to clean the test area with lukewarm tap water. On days 30 and 35, measurements were made on both normal and SLS-irritated skin. On days 14 and 28, measurements were made more than 12 h after the last application of moisturizer. One participant was excluded from the study on day 35 because of non-compliance.

Statistics

The Wilcoxon test for paired observations was used for comparative studies. The moisturizer-treated arm was compared with the untreated arm of the same subject at the same time. A significance level of $p < 0.05$ was chosen. Results are given in medians and 25/75 percentiles.

RESULTS

Clinical observation

All participants reacted to the patch-test of SLS with an irritant skin reaction varying from slight to moderate redness and infiltration (day 30) followed by scaling (day 35).

Skin capacitance

The results are shown in Fig. 1. The electrical capacitance was increased significantly on the moisturizer-treated arm on days 14, 28 and 30 compared with the untreated arm. On day 35 (7 days after the use of the moisturizer ended) the skin capacitance had returned to baseline values. Since measurement of electrical capacitance in irritant patch test reactions has been reported not to correlate with the degree of irritation (13), values for SLS-irritated skin are not shown.

TEWL

The results are shown in Fig. 2. No statistically significant difference in TEWL was found between the moisturizer-treated and the untreated arm throughout the study period. On the SLS-exposed area, the moisturizer-treated arm showed a significantly higher increase in TEWL than the untreated arm on day 30. No significant difference between the two arms was observed on day 35.

The mean amount of moisturizer used in the study period was 27.4 g, (range 14–46 g). Within this range, the amount of moisturizer used did not affect the results.

DISCUSSION

Studies on the penetration of petrolatum after acetone-induced barrier disruption in human skin have shown that petrolatum can enter and even be incorporated within the intercellular lamellar bilayers of the stratum corneum, thus assisting in maintaining an adequate hydration level and skin integrity (14). Another study described topically applied lipids (cholesterol, ceramide and fatty acids) that could cross the stratum corneum of acetone-disrupted murine skin and become incorporated into the nucleated layers of the epidermis, possibly interfering with the endogenous lipid synthesis (15). These studies, however, were performed on barrier-damaged skin. Long-term studies on the effect of emulsion lipids on intact human skin are not available at present. Our study used a long treatment period in order to observe any interaction with endogenous lipogenesis, keeping in mind that the entire epidermis is replaced over 4 weeks and the stratum corneum turn-over time is about 2 weeks (16).

Studies on the effects of single applications of moisturizer on normal skin (7, 8) describe an evaporation phase (less than 15 min), in which the water in the moisturizer acts as a vehicle and evaporates immediately after application, followed by a lipidization phase, in which emulsion lipids may penetrate into the epidermis and cause an increase in electrical capacitance reflecting a higher hydration level of the skin. Repeated application of moisturizers on normal skin has been shown to increase the electrical capacitance after only 2 days' application (9), an effect which levels off gradually over 7 days following cessation of treatment. The increased hydration level of the moisturizer-treated skin in our study, as measured by electrical capacitance, is in accordance with this previous study.

Data on the TEWL values of moisturizer-treated skin are contradictory. Studies on a moisturizer that contained urea used on both dry and normal skin (17, 18) have shown a decrease in TEWL after 3 weeks' application. One study found that TEWL remains constant after 7 days of treatment (9). In the present study we found that TEWL values were not significantly changed throughout the treatment period on normal non-irritated skin. Provided there was no irritant effect of the

moisturizer used, this was to be expected, since normal skin by definition already has a normal barrier function. Long-term use of a moisturizer could theoretically lead to a down-regulation of the endogenous lipid production leading to a compromised barrier function when the treatment was discontinued. However, since TEWL values on normal skin remained constant on both arms on days 30 and 35 (2 and 7 days after stopping the treatment, respectively) our results did not confirm this hypothesis.

The greater increase in TEWL values on the moisturizer-treated arm following SLS-irritation on day 30 shows that moisturizer-treated skin was more susceptible to irritant challenge than untreated skin. This suggests that daily use of a moisturizer on normal skin may not necessarily offer any protection against irritant trauma caused by a detergent. When the stratum corneum is fully hydrated it may become more permeable to hydrophilic substances such as SLS. It has been reported that patients with X-linked ichthyosis have skin with low electrical capacitance as well as a decreased response to SLS compared with volunteers with normal skin (19). A high level of hydration of the skin may facilitate susceptibility to irritants rather than protect against it. The possible greater penetration of SLS could also be due to an alteration of either the structure of the lipid bilayer or to the lipid composition of the stratum corneum. Another mode of action could be that the moisturizer could penetrate into the nucleated cell layers of the epidermis and modify intrinsic lipogenesis, resulting in a deranged lipid composition of the stratum corneum followed by a greater penetration of SLS. However, TEWL values for SLS-irritated skin were not significantly different for moisturizer treated and untreated skin on day 35. This indicates that only the permeability of SLS was changed and not the recovering capacity of the epidermis.

The benefit of using barrier or protective creams in the prevention of ICD in industry or in wet working occupations is controversial. Barrier creams form an occlusive layer on the skin surface to prevent penetration of skin irritants such as cutting fluid and soap. One field study concluded there was a general benefit from the use of moisturizers for cleaners and kitchen workers during everyday exposure to water and detergents as evaluated by electrical capacitance and clinical examination, but no changes were observed in TEWL (1). This beneficial effect of moisturizers or barrier creams was not confirmed in a prospective field study on metal workers (20). Experimental studies on moisturizers used as barrier creams have shown that irritation caused by SLS was suppressed when the moisturizer was applied shortly before the SLS provocation (2 – 5). In one of these studies the moisturizer (the same moisturizer as used in the present study) was applied just 15 min prior to the SLS challenge (2), which resulted in a significantly reduced irritant reaction as recorded by TEWL measurement. Treatment of SLS-damaged skin with the moisturizer was also found to reduce the barrier damage (2).

While previous studies have shown that use of a moisturizer for the prevention and treatment of barrier damaged skin has a beneficial effect, our data indicate that long-term daily use of a moisturizer on normal skin may increase skin susceptibility to irritants such as SLS. Advising employees working in wet conditions on the use of moisturizing products may be much more complicated than generally assumed. The effect of daily use of moisturizers under real workplace conditions still needs to be investigated in long-term studies.

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