

Transepidermal Water Loss and Water Content in the Stratum Corneum in Infantile Seborrhoeic Dermatitis

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Thirty-seven patients with clinically diagnosed infantile seborrhoeic dermatitis (ISD) were studied in an attempt to establish the significance of transepidermal water loss (TEWL) and water content in the stratum corneum, in active disease and after recovery. All the patients were treated daily with topically applied borage oil (containing 24% gamma-linolenic acid). With this regimen they were completely free from all skin symptoms within 3–4 weeks. Analyses of essential fatty acids in serum showed aberrations as previously described, with elevated levels of 18:1w9 and 20:2w6. TEWL and water content were recorded at the time of diagnosis and after treatment from the right forearm in skin that was free from symptoms and not treated with borage oil. Twenty-five healthy children in an age-matched group without skin disorders were used as controls. Significant differences in TEWL between patients and controls were found before treatment. After treatment no significant differences were found. There were no significant differences between controls and patients regarding water content in the stratum corneum. Gamma-linolenic acid is suggested to be of importance in maintaining normal TEWL and also in promoting recovery in patients suffering from ISD. *Key word: Gamma-linolenic acid.*

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The epidermis acts as barrier between the external and internal environments. It protects the body from mechanical trauma, harmful matter, bacteria and radiation. A diffusion barrier is located mainly in the stratum corneum. Transepidermal water loss (TEWL) is a measure of the functional state of this barrier, increased loss levels being seen in various dermatological conditions.

Abnormalities in keratinocyte differentiation are thus reflected in TEWL and can be seen in plaques of eczema, psoriasis and other types of dermatitis. TEWL is also greater in dry but otherwise normal non-eczematous skin in humans with atopic dermatitis (1).

Increased TEWL has been described in experimental essential fatty acid deficiency (EFAD) in mice (2). A rapid normalization of TEWL in this state, and normalization of skin scaliness, were achieved when pure fatty acid triglycerides were applied topically to the skin in order to restore EFA levels to normal (3, 4).

In previous studies (5, 6) of essential fatty acids in infantile seborrhoeic dermatitis (ISD) and its treatment, we have found that patients suffering from ISD have significantly different EFA patterns in serum. The differences are not consistent with EFAD but rather with an impaired function of the enzyme delta-6-desaturase (D-6-D). When treated with preparations rich in gamma-linolenic acid (GLA), which is the first metabolic product of linoleic acid (LA) through desaturation by D-6-D (Fig. 1), all the children recovered within 10–20 days. Since LA and GLA are important for the function of the skin barrier (3), the TEWL was studied at the time of diagnosis and after treatment to complete recovery.

A reduced water content of the stratum corneum is a feature of psoriasis, eczema and of dry but normal skin in atopic states and also of other scaly dermatoses. Although water content is not directly related to TEWL, we also measured this in the epidermis in the infantile seborrhoeic dermatitis patients.

MATERIAL AND METHODS

Patients

Thirty-seven children suffering from ISD (19 girls and 18 boys aged between 1 and 7 months) participated in the study. All the children

Fig. 1. Metabolic pathway of two fatty acids.

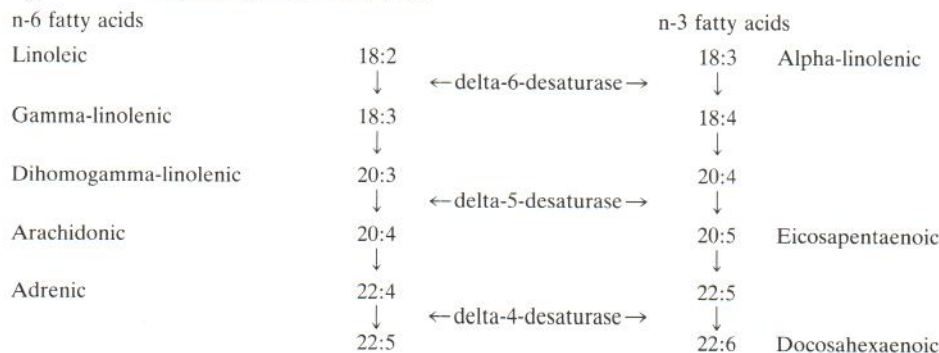


Table I. TEWL (g/m²/h) in controls and patients before and after treatment

Controls	Patients	
	Before treatment	After treatment
(n = 25) 3.9 SD 3.4	(n = 37) 9.5 SD 5.8	(n = 22) 4.7 SD 1.8

had typical skin symptoms of ISD according to Atherton (7), characterized by demarcated lesions of erythema and scaling in the scalp, face and the proximal flexures, most frequently combined with napkin dermatitis. At the time of diagnosis, when EFA in serum were analyzed and TEWL and water content were determined, the dermatitis had persisted for 4–28 weeks with a mean of 12 weeks.

Twenty-five healthy children (14 boys and 11 girls, 0.5–7 months) without skin disorders and attending child's health care units for regular check-ups, were used as controls. The controls were age-matched as a group, not as individuals, with approximately the same number of children in each age group.

The informed consent of all parents was obtained.

Methods

TEWL was measured with an evaporimeter Ep1 (ServoMed AB, Vällingby, Sweden). The vapour pressure gradient close to the skin surface was determined with a probe consisting of two moisture sensors and two temperature sensors mounted on a teflon pipe. TEWL was recorded on the right forearm in clinically normal skin. The children were otherwise healthy and none showed any signs of increased body temperature. The skin temperature was not measured. The probe was applied for 45 s using filter 10 s. The recordings stabilized within 30 s. Room temperature was kept at 21°C, and relative humidity ranged between 20% and 45%. For practical reasons we were unable to adhere to a strictly standardized method as described by Pinnagoda et al. (8).

The water content of the stratum corneum was measured with a corneometer CM 420 (Schwartzhaupt Medizintechnik GmbH 5000, Köln 30). The probe is placed on the skin surface and is considered to record the deeper part of the stratum corneum (9). After 3 s the digital display gives the value recorded.

Statistical analyses were performed using Student's *t*-test. Standard deviations were calculated and are presented in the tables.

EFA in serum were analyzed with gas liquid chromatography mass spectrometry (GLC-MS Finnigan Instruments) (10).

After determination of TEWL, the patients were treated with topically applied borage oil corresponding to 0.05 mg GLA/kg body weight daily. 0.5 ml of oil was applied b.d. in the napkin area. No other part of the body was treated. Repeated determinations of TEWL after treatment were possible in 22 cases.

RESULTS

The results are given in Table I. There were significant differences ($p < 0.001$) in TEWL between controls and children with ISD. After treatment, when the patients were free from skin symptoms, there was no significant difference between patients and controls.

The EFAs in serum were characterized by elevated levels of 18:1w9 and 20:2w6, and a slightly lowered level of 18:2w6, as previously described (5) (Table II).

In less than 3–4 weeks of treatment all the patients were completely free of ill skin symptoms. The only change in EFA pattern in serum after treatment was a minimal increase of LA.

There were no significant differences between controls and patients regarding water content in the stratum corneum either before or after treatment.

DISCUSSION

An increased TEWL has been demonstrated in animal models in states of EFAD. It is uncertain whether it is the lack of LA or any of its metabolites that causes the defect, though arachidonic acid (AA) is an important constituent of the cell membrane. Studies by Hartop & Prottey (11) indicate that LA and GLA are important in maintaining the barrier function of the epidermis. In studies of EFA-deficient mice, LA and, especially, GLA reduced TEWL to normal when each substance was applied topically to the skin. No effect on TEWL was seen after application of AA.

Houtsmuller & van der Beek (12), on the other hand, showed that both LA and AA exert rather similar effects in restoring the TEWL. This is not attributable to a retroconversion of AA to LA. These authors' work showed that labelled LA is readily taken up by the skin and transported into the body, since only 10–20% of the applied radioactivity was recovered from the whole skin.

Hansen & Jensen (13) suggest specific essential functions of LA in maintaining the integrity of the epidermal water permeability barrier. In analyses of skin specimens of EFAD rats, they found increased levels of LA even though the applied fatty acid was AA or columbinic acid. These authors suggested that the application of these fatty acids would stimulate the mobilization of LA from other tissues for incorporation into the epidermal sphingolipids. In neither of the two latter studies was GLA investigated.

In the present study, increased values of TEWL were demonstrated concomitantly with abnormalities in the patterns of serum fatty acids described earlier (5). These abnormalities are not attributable to an EFAD since the intake of LA and the amounts of LA in serum were both normal, nor was there a deficiency of AA in serum.

For ethical reasons, we were unable to perform biopsy analyses. The children were treated with topically applied borage oil and all skin symptoms disappeared within 3–4 weeks. At the same time TEWL was restored to normal when measured in locations not affected by skin lesions and to which borage oil

Table II. Analysis of essential fatty acid patterns in sera of patients at diagnosis and in controls

w 6	Patients n = 30 %	Control group n = 34 %	
16:0	22.80 SD 3.45	20.58 SD 2.76	$p < 0.01$
18:0	9.46 SD 2.31	9.30 SD 1.62	$p < 0.01$
18:1 Oleic acid	28.60 SD 3.82	25.84 SD 2.78	$p < 0.01$
18:2 Linoleic acid	25.86 SD 5.09	32.84 SD 4.58	$p < 0.001$
20:2 Docosadienic acid	0.49 SD 0.47	0.19 SD 0.05	$p < 0.01$
20:4 Arachidonic acid	4.87 SD 2.29	4.92 SD 1.59	n.s.
18:1/18:2	1.17 SD 0.38	0.81 SD 0.18	$p < 0.001$

had not been applied. No effect on EFA levels in serum, except a slight increase in LA, was seen. It appears that there must be an absorption of fatty acids which normalizes the TEWL but cannot be revealed by serum analyses. GLA is the only fatty acid in the w-6 series that is too transient to be analysed both in patients and in controls.

ISD is combined with significant abnormalities in the EFA patterns in serum and can be successfully treated with topically applied preparations rich in GLA (5, 6). There seem to be general effects of the alterations in the EFA patterns, since skin not affected by dermatitis showed increased TEWL values. The effect of the application of oil rich in GLA did not depend on a local influence of the barrier functions, since the oil was applied only in the napkin area and the dermatitis in other locations of the body cleared without any other local treatment and the TEWL were restored to normal in skin not treated with the oil.

Topical application of LA in states of EFAD has earlier (14, 15) been shown to restore levels of EFA in serum to normal. The absorption of LA through the skin exceeds oral and intravenous absorption.

GLA seems to be just as readily absorbed through the skin as LA and exerts effects in other locations than those to which it is applied. We consider GLA to play an important role in the regulation of the barrier functions of the epidermis.

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