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Skin Barrier Parameters in Acne Vulgaris versus Normal Controls: A Cross-Sectional Analytic Study

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Aim: Data of objective skin barrier parameters in acne patients with and without therapy compared with normal controls are limited. This information could provide more insight into the pathogenesis of acne vulgaris and optimal acne treatment.

Purpose: To measure and compare skin barrier parameters in a large cohort of acne patients with and without therapy compared with normal controls.

Methods: This cross-sectional analytic study was conducted on healthy Thai volunteers. After completing a questionnaire on their general information and skincare routine, volunteers received a full skin examination and were divided into subjects with and without acne. Skin barrier parameters, including the transepidermal water loss (TEWL), skin hydration and sebum production were measured and compared between the two groups. Factors that may affect each parameter were analysed and adjusted for in a multivariate regression analysis. In addition, data from acne patients with and without treatment were evaluated.

Results: The study included 316 volunteers (164 acne patients, 152 controls), mostly female (79% acne, 78% controls). The mean age of the acne group was considerably lower than that of the control group (34 vs 48.6 years ($p < 0.001$)). Acne patients showed significantly higher TEWL (13.16 vs 10.63 g/m²/day, $p < 0.001$), sebum production (median 3 vs 0 A.U, $p = 0.002$), and skin hydration (244.60 vs 222.60 uS, $p = 0.001$). These differences remained significant after adjusting for confounding factors. Additionally, significant differences were observed between controls, acne. Patients receiving and not receiving acne medications. The highest TEWL was observed in acne patients receiving treatment, followed by untreated acne patients and normal controls ($p = 0.0003$). Skin hydration exhibited a comparable pattern ($p = 0.03$).

Conclusion: There were significantly higher TEWL, sebum production and hydration in acne patients. Acne treatment further impaired the skin barrier. These findings support the possible benefits of moisturisers with barrier-enhancing properties in patients receiving acne medications.

Keywords: skin barrier function, acne vulgaris, transpidermal water loss, skin hydration

Introduction

Acne vulgaris is one of the most common skin disorders, primarily affecting adolescents and up to 64% and 43% of patients in their 20s and 30s respectively.[1] The pathogenesis centres around the increased sebum secretion, follicular hyperkeratosis, Cutibacterium acnes colonization and consequent inflammatory process.[2] Previous studies and reviews have suggested that a compromise in epidermal barrier functions were present in acne patients and may additionally contribute to the formation of acne[3–5] while methods for improvements of skin barrier have been incorporated into the management of acne vulgaris.[6,7] Additionally, both topical and systemic acne treatments inevitably cause further disruption of the epidermal barrier and subsequent symptomatic irritation.[4]

The stratum corneum is mainly responsible for the functions of the epidermal barrier. It is not only a physical barrier, but also a layer that helps regulate microorganisms, provides an antioxidant function, protects against ultraviolet radiation and responds to external allergens.[8] Present technologies have provided non-invasive methods to objectively assess the

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epidermal barrier function, such as measurements of the transepidermal water loss (TEWL), stratum corneum hydration and surface sebum.[9] Due to the complexity of the epidermal barrier, a combination of various parameters should be obtained to fully interpret the barrier function as well as explore the relationships between each parameter. Information on skin barrier parameters in acne patients could provide more insight into the pathogenesis of acne vulgaris and optimal skin care in acne patients. However, studies comparing objective skin parameters in acne patients with those of normal healthy controls are limited.[5,10] Our study aims to evaluate the skin barrier parameters, including TEWL, hydration and sebum in a large cohort of acne patients in comparison to normal controls and to evaluate the effects of acne treatment on these parameters.

Materials and Methods

This cross-sectional analytic study complies with the Declaration of Helsinki and was approved by Mahidol University Institutional Review Board (ID 10–61-54). The study was conducted at the Division of Dermatology, Ramathibodi hospital, Bangkok, Thailand during the relatively cool dry season (October to February). The study outline was announced through hospital e-posters and intranet, which allowed recruitment of volunteers from patients, visitors, and healthcare workers in the hospital. Details of each parameter measurement as well as the length of time required (less than one hour) were described and informed consent was obtained from all participants. Participants were assured that their participation is voluntary, and that any information provided would be treated as confidential. Healthy volunteers aged 18 years or older, without serious illnesses were eligible to participate in the study. Patients with any skin diseases other than acne vulgaris (eg seborrheic dermatitis, atopic dermatitis, psoriasis, xerosis etc) were excluded due to the potential disruption of their skin barrier from those conditions. Pregnant or lactating subjects were also excluded.

Before the skin parameter assessments, participants were asked to complete a questionnaire on their general information, skincare routine and facial medications/treatments. The questionnaire included details of all topical and oral treatment for acne vulgaris, including names of medication, frequency and duration of use. Full facial skin examination was performed by one dermatologist (S.S) to ensure no other skin conditions other than acne were present. Subjects were then divided into two groups; with and without facial acne. Skin barrier parameters were measured on the face, thus subjects without facial acne but with acne lesions on the chest, back or elsewhere on the body were considered as controls. Volunteers in the facial acne group were further assessed for their acne severity using the Thai Global Acne Grading System (TGAGS) which provides a numerical score (0–44): mild (score 1–18), moderate (score 19–30), severe (score 31–38) and very severe (score>39).[11,12] Following the physical examination, skin parameter assessments were performed using tools from DermaLab System (cyberDERM, Inc. Cortex Technology, Penn) as described below. Results were then compared between patients with and without acne. In further subgroup analysis, acne patients were divided into those with and without acne medication based on the information gathered from the questionnaire. A comparison between acne patients with treatment, without treatment and healthy controls were performed.

Statistical analysis was completed on Stata 14.0 (StataCorp LLC, College Station, TX, USA). Continuous data is presented as mean with standard deviations (SD) and median with range, while categorical data is displayed as percentages. Differences in baseline characteristics between participants with acne and controls were assessed using chi-square and *t*-test. The association between different factors, including acne vulgaris (using both GAGS grading and score), and the skin barrier parameters were evaluated using linear regression analysis and presented as correlation coefficients with corresponding 95% intervals (95% CI). Factors that showed significant association with each skin barrier parameter were then adjusted for in multivariate regression analysis. In addition, skin barrier parameters from acne patients with and without treatment were compared and differences calculated using *t*-test and Mann–Whitney test. P value less than 0.05 was considered significant.

Sebum Assessment

Sebum assessment was performed before face washing. A thin microporous lipid-absorbent tape (Sebutape®; CuDerm Corp., Dallas, TX, USA) was applied on each participant's forehead for 10 minutes before insertion into the sebum assessment port. Measurements of sebum, ranged 0–99 arbitrary unit (A.U), were recorded.

Transepidermal Water Loss Assessment (TEWL)

The open chamber technique was performed in this study. The environment of the skin parameter assessment unit was regulated for optimal TEWL measurement (room temperature between 20 and 22 degree Celsius, relative humidity lower than 60%), as recommended by the European Group for Efficacy Measurements on Cosmetics and Other Topical Products (EEMCO).[13,14] Patients were advised to avoid caffeine-containing drinks and smoking at least 4 hours before and during the measurement. After washing their face, the participant was asked to stay and acclimatise to the assessment room for 30 minutes. The TEWL port was placed on normal looking skin on participant's right cheek. Three readings were performed, and the mean number was calculated (g/m2/h).

Skin Hydration

Skin hydration was assessed using the conductance method after face washing. Eight measurements were obtained from both cheeks, and the mean number was recorded (uSiemens).

Results

A total number of 316 volunteers; 164 acne patients and 152 normal controls, participated in the study. Baseline characteristics and skin barrier parameters of the acne group and normal controls are displayed in Table 1. In both groups, the majority were females (79% and 78% in the acne and the control group, respectively). Mean age of the acne group was significantly lower than the control group; 34 years and 48.6 years, respectively ($p < 0.001$). Common underlying diseases such as diabetes, hypertension and dyslipidaemia were significantly more prevalent in the control group, possibly due to the older age. Most participants were non-smoker and non-drinkers.

Among the 164 participants with acne, up to 90% had mild acne severity and only 41% were using acne medications at the time of assessment. The most reported medications were topical benzoyl peroxide (12.8%), topical antibiotics (10.4%), topical vitamin A (9.2%) and AHA/BHA (7.3%). Around 1–2% of acne patients were on oral antibiotics and/or

Table 1 Baseline Characteristics and Skin Barrier Parameters in Acne Patients (n = 164) Vs Normal Controls (n = 152)

	Acne Patients	Normal Controls	P value
Sex Male (%) Female (%)	 34 (20.73) 130 (79.26)	 33 (21.71) 119 (78.29)	 0.83
Age (years) Mean (sd)	 34 (13.17)	 48.56 (16.33)	 **<0.001**
BMI (kg/m^2) Mean (sd)	 22.12 (3.53)	 23.35 (3.67)	 **0.003**
Underlying diseases Diabetes mellitus n(%) Hypertension n(%) Dyslipidemia n(%) Heart disease n(%) Others n(%)	 2 (1.22) 7 (4.27) 8 (4.88) 0 (0) 35 (21.34)	 14 (9.21) 25 (16.45) 27 (17.76) 5 (3.29) 31 (20.39)	 **0.001** **<0.001** **<0.001** **0.025** 0.84
Smoking Non-smoker n(%) Smoker n(%)	 157 (95.73) 7 (6.70)	 146 (96.05) 6 (6.30)	 0.89
Alcohol No n(%) Yes n(%)	 121 (73.78) 43 (26.22)	 125 (82.24) 27 (17.76)	 0.27

(*Continued*)

Table 1 (Continued).

	Acne Patients	Normal Controls	P value
Acne severity Mild n(%) Moderate n(%) Severe n(%)	 146 (89.02) 17 (10.98) 1 (0.61)	-	-
Acne treatment None n(%) Topical BP n(%) Topical AHA, BHA n(%) Topical ATB n(%) Topical vitamin A n(%) Oral ATB n(%) Oral isotretinoin n(%)	 96 (58.54) 21 (12.80) 12 (7.32) 17 (10.37) 15 (9.15) 2 (1.22) 3 (1.83)	-	-
TEWL (g/m2 /h) Mean (sd)	 13.16 (5.29)	 10.63 (4.83)	 **<0.001**
Sebum (A.U.) Median (range)	 3(0–65)	 0(0–37)	 **0.0002**
Hydration (uS) Mean (sd)	 244.60 (52.95)	 222.60 (48.39)	 **0.0001**

Notes: Bold values represent statistically significant findings (P value less than 0.05).
Abbreviations: BMI, body mass index; BP, benzyl peroxide; AHA, alpha hydroxy acid; BHA, beta hydroxy acid; ATB, antibiotics; TEWL, transepidermal water loss.

oral isotretinoin (Table 1). None of the subjects had recent treatment with other modalities, such as lasers, energy-based devices, chemical peels or intralesional corticosteroids.

Direct comparison between acne group and normal control group reveals significant differences across all measured skin barrier parameters. The mean TEWL was significantly elevated in acne group (13.16 vs 10.63 g/m2 /h, $p < 0.001$), as well as the median sebum (3 vs 0 A.U, $p = 0.002$) and mean skin hydration (244.60 vs 222.60 uS, $p = 0.001$).

Table 2 demonstrates all the factors that may affect TEWL. Significantly higher TEWL was found in males ($p < 0.001$), younger participants ($p < 0.001$) and in participants not using regular facial moisturizer ($p = 0.015$). Since both hydration and sebum level can interfere with TEWL, we included both in the univariate analysis[5,13] and found a weakly positive correlation between sebum level and TEWL (coefficient = 0.11, CI 0.06–0.17). As for the effect of acne vulgaris on TEWL, positive correlations indicating higher TEWL in acne participants were found, both when acne gradings and

Table 2 Factors Affecting Transepidermal Water Loss (TEWL)

		Univariate Regression Analysis		Multivariate Regression Analysis with Acne Gradings		Multivariate Regression Analysis with TGAGS Score	
	Mean TEWL (sd)	Co-efficient (95% CI)	P value	Co-efficient (95% CI)	P value	Co-efficient (95% CI)	P value
Sex Female Male	 11.08 (5.12) 15.14 (4.33)	 1 4.06 (2.72, 5.41)	 **<0.001**	 1 3.59 (2.21, 4.97)	 **<0.001**	 1 3.53 (2.14, 4.93)	 **<0.001**
Age (years)	-	−0.06 (−0.10, −0.03)	**<0.001**	−0.02 (−0.06, 0.01)	0.24	−0.023 (−0.06, 0.01)	0.23

(*Continued*)

Table 2 (Continued).

		Univariate Regression Analysis		Multivariate Regression Analysis with Acne Gradings		Multivariate Regression Analysis with TGAGS Score	
	Mean TEWL (sd)	**Co-efficient (95% CI)**	**P value**	**Co-efficient (95% CI)**	**P value**	**Co-efficient (95% CI)**	**P value**
Regular application of facial moisturizer							
No	12.87 (5.75)	1		1		1	
Yes	11.40 (4.82)	−1.47(−2.66, - 0.28)	**0.015**	−0.73 (−1.91, 0.45)	0.18	−0.54 (−1.72, 0.63)	0.37
Smoking							
Non-smoker	11.91 (5.27)	1					
smoker	12.65 (4.22)	0.73 (−2.18, 3.65)	0.62	-	-	-	-
Hydration	-	0.001 (−0.01, 0.01)	0.85	-	-		-
Sebum	-	0.11 (0.06, 0.17)	**<0.001**	0.04 (−0.01, 0.10)	0.13	0.04 (−0.01, 0.10)	0.14
Acne							
None	10.63 (4.83)	1		1			
Mild	12.96 (5.31)	2.32 (1.17, 3.48)	**<0.001**	2.18 (0.95, 3.40)	**0.001**	-	-
Moderate-severe	14.82 (5.01)	4.19 (1.71, 6.68)	**0.001**	3.73 (1.18, 6.23)	**0.004**		
TGAGS score	-	0.20 (0.12, 0.29)	**<0.001**	-		0.16 (0.06, 0.26)	**0.002**

Notes: Multivariate analysis performed for variables with p value<0.2. Bold values represent statistically significant findings (P value less than 0.05). The blue fill indicates the effect of acne vulgaris.
Abbreviation: TGAGS, Thai global acne grading system.

severity scores were used. The correlation was stronger in moderate-severe acne (coefficient = 4.19, CI 1.71–6.68) than in mild acne (coefficient = 2.32, CI 1.17–3.48). After all the significant variables were adjusted for in multivariate model, using either the grading system or the continuous acne score, the positive correlation between acne and TEWL still remained significant.

Skin hydration significantly correlated with younger age ($p < 0.001$), regular use of moisturizer ($p = 0.032$) and unexpectedly, acne vulgaris ($p < 0.001$ for mild acne) (Table 3). Sebum level was assumed to affect hydration in the past,[15] but in this study we found no correlation. After all the significant variables were adjusted for in multivariate model, acne still correlated with higher hydration when compared to normal controls. However, after applying the

Table 3 factors Affecting Skin Hydration

		Univariate Regression Analysis		Multivariate Regression Analysis with Acne Gradings		Multivariate Regression Analysis with TGAGS Score	
	Mean hydration (sd)	**Co-efficient (95% CI)**	**P value**	**Co-efficient (95% CI)**	**P value**	**Co-efficient (95% CI)**	**P value**
Sex							
Female	234.31 (49.72)	1		-	-	-	-
Male	232.91 (59.77)	−1.40 (−15.48, 12.68)	0.85				
Age (years)	-	−0.71 (−1.06, −0.37)	**<0.001**	−0.58 (−0.97, −0.20)	**0.003**	−0.65 (−1.05, −0.25)	**0.001**

(*Continued*)

Table 3 (Continued).

		Univariate Regression Analysis		Multivariate Regression Analysis with Acne Gradings		Multivariate Regression Analysis with TGAGS Score	
	Mean hydration (sd)	Co-efficient (95% CI)	P value	Co-efficient (95% CI)	P value	Co-efficient (95% CI)	P value
Regular application of facial moisturizer							
No	225.86 (50.52)	1		1		1	
Yes	238.81 (52.24)	12.95 (1.11, 24.78)	**0.032**	12.72 (0.95, 24.49)	**0.034**	13.35 (1.64, 25.07)	**0.026**
Smoking							
Non-smoker	233.60 (52.70)	1					
Smoker	243.77 (27.03)	10.17 (−18.78, 39.12)	0.49	-	-	-	-
Sebum	-	0.29 (−0.26, 0.85)	0.30				
Acne							
None	222.60 (48.39)	1		1			
Mild	245.59 (53.78)	22.99 (11.40, 34.58)	**<0.001**	13.06 (0.27, 25.87)	**0.045**	-	-
Moderate-severe	236.56 (46.22)	13.96 (−10.98, 38.90)	0.27	−3.11 (−29.19, 22.98)	0.82		
TGAGS score	-	1.25 (0.38, 2.12)	**0.005**	-	-	0.29 (−0.72, 1.29)	0.57

Notes: Multivariate analysis performed for variables with p value<0.2. Bold values represent statistically significant findings (P value less than 0.05). The blue fill indicates the effect of acne vulgaris.
Abbreviation: TGAGS, Thai global acne grading system.

multivariate analysis, the correlation existed only with mild acne (coefficient = 13.06, CI 0.27–25.87) and only when severity grading, not the continuous score, was included in the analysis.

Table 4 explores the factors affecting skin surface sebum. Higher sebum level significantly correlated with male gender ($p < 0.001$), regular use of moisturizer ($p = 0.04$) and acne vulgaris, with a significantly stronger correlation in

Table 4 Factors Affecting Sebum Production

		Univariate Quantile Regression Analysis		Multivariate Quantile Regression Analysis with Acne Gradings		Multivariate Quantile Regression Analysis with TGAGS Score	
	Median sebum production (range)	Co-efficient (95% CI)	P value	Co-efficient (95% CI)	P value	Co-efficient (95% CI)	P value
Sex							
Female	0 (0–70)	1		1		1	
Male	6 (0–46)	6 (3.97, 8.03)	**<0.001**	6 (3.45, 8.55)	**<0.001**	5.67 (3.16, 8.17)	**<0.001**
Age (years)	-	−0.04 (−0.10, 0.02)	0.16	0 (−0.07, 0.07)	1	0 (−0.07, 0.07)	1
Regular application of facial moisturizer							
No	2 (0–65)	1		1		1	
Yes	0 (0–70)	−2 (−3.90, - 0.10)	**0.04**	0 (−0.07, 0.07)	1	0 (−2.15, 2.15)	1

(*Continued*)

Table 4 (Continued).

		Univariate Quantile Regression Analysis		Multivariate Quantile Regression Analysis with Acne Gradings		Multivariate Quantile Regression Analysis with TGAGS Score	
	Median sebum production (range)	**Co-efficient (95% CI)**	**P value**	**Co-efficient (95% CI)**	**P value**	**Co-efficient (95% CI)**	**P value**
Smoking Non-smoker Smoker	 1 (0–70) 1 (0–37)	 1 0 (−4.84, 4.84)	 1.00	 -	 -	 -	 -
Acne None Mild Moderate-severe	 0 (0–37) 2 (0–65) 8.5 (0–70)	 1 2 (0.21, 3.79) 10 (6.15, 13.85)	 **0.028** **<0.001**	 1 2 (−0.27, 4.27) 10 (5.38, 14.62)	 0.084 **<0.001**	 -	 -
TGAGS score	-	0.37 (0.22, 0.51)	**<0.001**	-	-	0.33 (0.16, 0.51)	**<0.001**

Notes: Multivariate analysis performed for variables with p value<0.2. Bold values represent statistically significant findings (P value less than 0.05). The blue fill indicates the effect of acne vulgaris.
Abbreviation: TGAGS, Thai global acne grading system.

Table 5 Comparison of Skin Barrier Parameters Between Normal Controls (n = 152), Acne Patients Without Treatment (n = 96) and Acne Patients with Treatment (n = 68)

	Normal Controls	**Acne Patients Without Any Current Treatment**	**Acne Patients with Ongoing Treatment**	**P value**
TEWL (g/m2 /h) Mean (sd)	10.63 (4.83)	12.86 (5.35)	13.59 (5.22)	**0.0003***
Skin hydration (uS) Mean (sd)	222.60 (48.39)	237.42 (47.47)	254.74 (58.72)	**0.03****
Sebum (A.U.) Median (range)	0 (0–37)	2 (0–44)	4 (0–70)	0.13*

Notes: *Adjusted for sex, age, regular use of moisturizer. **Adjusted for age and regular use of moisturizer. Bold values represent statistically significant findings (P value less than 0.05).
Abbreviation: TEWL, transpidermal water loss.

moderate-severe acne ($p < 0.001$) than mild acne ($p = 0.028$). Again, the correlation between sebum and acne was apparent even after other variables were adjusted for.

To evaluate the effects of acne medications on skin barrier parameters, from the data received in the questionnaire, acne patients were further divided into those receiving at least one acne medication and those without any medication. The skin barrier functions of these 2 acne subgroups; with or without treatment, were again compared to normal controls (Table 5). There was a statistically significant difference between TEWL among the groups, with highest TEWL observed in acne patients receiving treatment, followed by acne patients without treatment and normal controls ($p = 0.0003$). The same was observed with skin hydration measurements, with higher hydration in both acne groups in comparison to controls ($p = 0.03$).

Discussion

Objective assessments of the skin barrier require measurements of different parameters, mainly the TEWL, hydration and skin surface lipids. TEWL, the most widely used method, measures the rate of water diffusion across the stratum

corneum to the ambient environment.[13] Elevated values are observed in diseases with skin barrier abnormalities, such as atopic dermatitis, psoriasis and ichthyosis.[16] Stratum corneum hydration is obtained through electrical conductance, capacitance, or impedance. In general, a lower value reflects the failure to retain water which can induce dryness and impair epidermal barrier function.[9] Lastly, the skin surface lipids provide a non-specific protective mechanism of the skin barrier.[9] These parameters vary tremendously with both individual factors, eg age, gender, race, smoking; and environmental factors, eg temperature, humidity, season etc.[9,17–20] Application of facial moisturisers can improve these parameters,[6] as supported by our data showing lower TEWL and higher skin hydration in participants with regular use of facial moisturisers. This could be due to the occlusive effect preventing TEWL or absorption of water from the atmosphere by humectants. Moreover, there is often a complex interplay of parameters, making the results difficult to interpret. The correlation between hydration and TEWL can be positive or negative, depending on the skin status. In chronic diseases, high TEWL is associated with low hydration, while in acute dermatitis, TEWL and hydration are both elevated.[13] Skin hydration can also be influenced by the surface lipids,[15] possibly from an occlusion effect. In this study, we attempt to control the study environment and adjust for all the factors that may influence each parameter, as well as consider their interactions, to compare the skin barrier status between subjects with and without acne vulgaris.

In the past, Yamamoto et al compared 36 males with acne vulgaris with 29 age-matched male controls and found a higher TEWL accompanied by lower hydration in acne patients when compared to controls. These changes were more pronounced in cases with moderate acne in comparison to those with mild acne, suggesting that the degree of barrier impairment correlates with the severity of acne.[5] Another study demonstrated seasonal variations of TEWL and that TEWL was higher in subjects with acne (n = 7) than without acne (n = 10) across all seasons.[20] In contrast, another study found the TEWL to be lower in 412 acne patients compared to 400 normal controls and concluded that the skin barrier was not impaired in acne vulgaris.[10] Studies on sebum secretion rate confirmed higher production in acne patients. Acne severity has also been shown to correlate with sebum excretion rate.[21] Reported changes in sebum composition include reduced levels of linoleic acid, increased levels of squalene and lipid peroxides, and an increased ratio of saturated/mono-unsaturated fatty acid.[21] Another study of stratum corneum lipids revealed lower amount of ceramide in acne patients when compared to controls.[5]

Results from this study show that patients with acne vulgaris have significantly higher TEWL, sebum and hydration. The elevations of TEWL and sebum production are in accordance with previous studies and the values were higher in moderate to severe acne when compared to mild acne, agreeing with the speculation that the impairment correlates with acne severity.[5,20,21] However, in this study the increase in hydration among acne patients were unanticipated and there is no clear explanation to these findings, especially when the hydration value was even higher in those on acne treatment. Importantly, we have demonstrated that there was no correlation between skin hydration and TEWL, indicating that the higher TEWL was not the result of the high moisture content and therefore reflected a true barrier disruption in patients with acne. These data suggest that adjunctive moisturizers for acne patients should not focus on increasing moisture or hydration, as water content appears to be sufficient, but should be formulated to optimize the epidermal barrier.

There are a few possible mechanisms of epidermal barrier disruption in acne vulgaris. Filaggrin plays a key role in epidermal differentiation, giving rise to the formation of natural moisturizing factors and contribute to skin physical strength.[3,22] Previous studies had shown an increased expression of filaggrin in follicular keratinocytes within acne lesions[23] and that C. acnes can increase filaggrin expression.[24] These contradictory findings raise the question of whether there is a functional impairment in the increased amount of filaggrin and that we should assess not only quantity but also the quality of this protein.[22] Another mechanism is linked to the increase in sebum production. Although an increase in sebum production is widely recognised in acne,[25] whether the sebum exerts its effect on development of acne via skin barrier disruption is unclear. Previous studies have proposed that sebum can have a dilutional effect on epidermal lipids in acne.[5,26] These epidermal lipids, especially ceramides, may be essential to skin barrier integrity. Studies have demonstrated that low level of ceramide was detected and correlated with high TEWL in acne patients.[5,27]

Impairment of the skin barrier can also be induced by commonly prescribed acne medications. Benzoyl peroxide (BP) is well known for its irritant potential, being more likely to induce irritant contact dermatitis more than an allergic reaction.[28] A study has shown an increase in TEWL by 1.9-fold when 10% BP was applied on the back.[29] Changes in the SC permeability barrier associated with both topical and oral retinoid therapy do not appear to be related to any reduction

in SC lipids comprising the intercellular lipid membrane of the SC.[4] Topical retinoids can induce retinoid dermatitis in the first few weeks of application, which interestingly coincides with the induction of acanthosis, hypergranulosis and relative decrease in stratum corneum in that time period.[4,30] The increase in cell turnover and decrease in number of corneocyte cell layers seem to correlate with high TEWL.[15] Another study demonstrated that applying a moisturizer that enhances stratum corneum barrier function before and after application of 0.025% tretinoin cream in photodamaged females can prevent an increase in TEWL,[31] further emphasizing the importance of adjunctive moisturizer use in patients receiving acne treatment.

Systemic retinoids almost invariably cause skin and mucosal dryness, erythema and photosensitivity, in a dose-dependent manner. These agents have been associated with epidermal dyscohesion, sebum suppression along with an increase in susceptibility to staphylococcal colonization.[32]

Our results demonstrate a significantly higher TEWL in acne patients with current acne treatment when compared to those without, confirming that although the pathology of acne vulgaris can innately impair the epidermal barrier function, acne medications may worsen the situation. However, due to the small number of patients and concurrent usage of multiple acne medications further analysis to assess the association between different medications and skin barrier parameters could not be performed. This study design was cross-sectional, therefore, it was impossible to know for certain if the changes precede or follow acne vulgaris. The detectable skin barrier impairment may increase the susceptibility for acne or may be the result of acne and/or acne treatment. Another limitation of the study results is that the measurement of sebum was crude without analysis of lipid classes, which may help clarify the influence of sebum on skin barrier. In the future, prospective studies with longitudinal follow ups in a larger number of subjects may help elaborate the relationship between acne and epidermal skin barrier. Other aspects of the skin barrier that are potentially affected by acne, such as the microbiome,[3] could also be studied.

Conclusion

The objective measurements of skin barrier function in this study demonstrated a significantly higher TEWL, hydration and sebum production in patients with acne vulgaris. These apparent impairments may have preceded or occurred as a result of acne formation. Treatment with acne medications may also further impair the skin barrier. From the study results we propose the use of moisturizers with overall barrier-enhancing properties (eg those containing ceramides) rather than just skin hydrating properties (eg occlusive moisturizers or humectants). Longitudinal studies are required to assess the relationship between acne and epidermal skin barrier function in order to help develop suitable adjunctive skincare that enhances the skin barrier, reduces treatment side effects and improves treatment outcome.

Disclosure

The authors report no conflicts of interest in this work.

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