Transepidermal Water Loss in Psoriasis: A Case-control Study

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Abstract

Context: Psoriasis is a common papulosquamous disorder characterized by increased epidermal turnover resulting in excessive skin shedding and a compromised barrier function of the skin. Transepidermal water loss (TEWL) is an effective and non-invasive way to measure the barrier function in this condition. **Aims:** To measure the physiological changes in the skin barrier function in psoriasis by measuring the extent of TEWL. To study the differences in TEWL in pathologically involved and uninvolved skin in psoriasis. To compare the TEWL in skin lesions in psoriatic patients and site matched controls. **Subjects and Methods:** To determine the barrier quality of the stratum corneum, we performed TEWL measurements using the closed chamber evaporation method (VapoMeter Delfin Technologies, Kuopio, Finland). The ambient temperature ranged between 21°C and 24°C, with a mean relative humidity range of 39%–50%. In total, four sites were measured for all the 50 cases, two involved plaques on the body were selected for the study of lesional psoriatic skin, and the standard sites of ankle and elbow were measured irrespective of being involved or uninvolved with psoriatic skin. TEWL measurements in controls were site matched. Statistical testing was done using SPSS ver. 17. The interval scale data were tested for normality using Shapiro-Wilk test, and between groups testing was done using Mann-Whitney test. **Results:** The TEWL was higher among the cases in all the four measured areas compared to the controls, thus showing overall impaired skin barrier function in psoriatic skin. In addition, among the cases, the involved sites show higher TEWL in comparison to the uninvolved skin. This is highly suggestive that plaques of psoriasis have reduced water holding capacity. **Conclusions:** Psoriasis is a dermatosis with overall compromise of the skin barrier function exhibiting exponential TEWL in lesional skin, with increased TEWL over non-lesional skin as well. Thus, it may be concluded that TEWL is an effective, non-invasive and objective method in assessment of skin barrier function.

Keywords: *Barrier function, psoriasis, transepidermal water loss*

Introduction

Psoriasis vulgaris is a genetic, systemic, inflammatory, chronic disorder, which can be altered by environmental factors. It may be associated with other inflammatory disorders such as psoriatic arthritis, inflammatory bowel disease, and coronary artery disease.[1] The inflammation of skin is probably because of abnormal epidermal differentiation and lymphocytic infiltration for which various hypotheses have been proposed, but the etiopathogenesis is not completely understood. It has been hypothesized that the disease starts with the activation of T cell by an unknown antigen, which leads to secretion of an array of cytokines by activated T cells, inflammatory cells, and keratinocytes. The characteristic lesion of psoriasis is because of the hyper-proliferation of the keratinocyte. Activated Langerhans cells migrate from the skin to the lymph nodes, presenting the antigen to nodal naive T cells (cells that have not been activated by antigen previously).[2]

One of the main functions of skin is barrier function, which prevents invasion of pathogens, loss of water, electrolytes, and proteins. It is also a major organ for innate and adaptive immunity. The permeability barrier of the skin resides largely in the stratum corneum (SC), and it depends upon a two compartment system, i.e., corneocytes (cellular) and lipid-rich matrix (intercellular). SC lipids are derived from the content of lamellar bodies in the granular cells, and comprise of a mixture of sphingo lipids, cholesterol, and fatty acids arranged as intercellular membrane bilayers that are required for the epidermal permeability barrier.[3-6] Transepidermal water loss (TEWL) is a measure of the steady-state water vapor

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flux crossing the skin to the external environment, and it has been used extensively to characterize skin barrier function. TEWL is directly related to the reciprocal of the diffusional permeation path length through the SC.[7] Both TEWL and percutaneous absorption rates increase when the integrity of the SC barrier is compromised.[8]

Subjects and Methods

In this prospective case control study, subjects were recruited from December 2016 to May 2017. A total of 100 subjects were included in the study of which 50 were cases and 50 were age and sex matched controls. Fifty cases diagnosed with psoriasis involving body surface area (BSA) >10% - ≤70% and age >18 years, attending the Dermatology out-patient department were selected and compared with controls. Controls were recruited from the patients visiting the same outpatient department, without any skin conditions affecting the barrier function i.e., contact dermatitis, eczemas, atopic individuals, etc., were excluded. Patients with psoriasis and B.S.A. >70%, hemodynamic instability, critically ill patients, advanced renal and liver disease, erythroderma, and other cases with compromised skin barrier function were excluded from the study. Written informed consent and photographs / digital image release consent was obtained before enrollment in the study. All the patients underwent a thorough clinical examination. To determine the barrier quality of the SC, we performed TEWL measurements using the closed chamber evaporation method (VapoMeter Delfin Technologies, Kuopio, Finland). The results were used to provide information regarding the status of the permeability barrier under normal and diseased conditions. Published guidelines for the measurement of TEWL and skin hydration were followed. The condition of all subjects was first stabilized for 15 to 20 min, in a climate- and humidity-controlled room. The ambient temperature ranged between 21°C and 24°C, with a mean relative humidity range of 39%–50%.[9] In total, four sites were measured for all 50 cases, two psoriatic plaques on the body, which were clinically diagnosed as psoriasis, with a positive Auspitz sign, and were from different anatomic locations (contiguous lesions were avoided) were selected for study of lesional psoriatic skin [Figure 1]. The standard

sites of ankle and elbow were measured irrespective of being involved or uninvolved with psoriatic skin. TEWL measurements in controls were site matched.

Results

Of the recruited subjects, in both case and control groups, 21 were females and 29 were males. The mean ages of case and control populations were 46.32 ± 15.56 and 42.86 ± 16.05 years, respectively. Tables 1 and 2 shows the mean and median of the cumulative water loss in all the four sites. The mean of the TEWL is higher in the group 1 compared to group 2, in all 4 areas, showing higher TEWL in cases. Among the cases, it is noteworthy that the involved sites show higher TEWL compared to standard sites [Table 1]. Conversely, in the control group, the mean and median of the TEWL are lower compared to the cases, and in addition, the TEWL at all four sites are almost equal in value, showing no significant water loss difference among the four sites [Tables 1 and 2].

Characteristic of case population

Among 50 subjects of case group, 21 persons had elbow involvement with psoriatic plaques, whereas 29 did not.
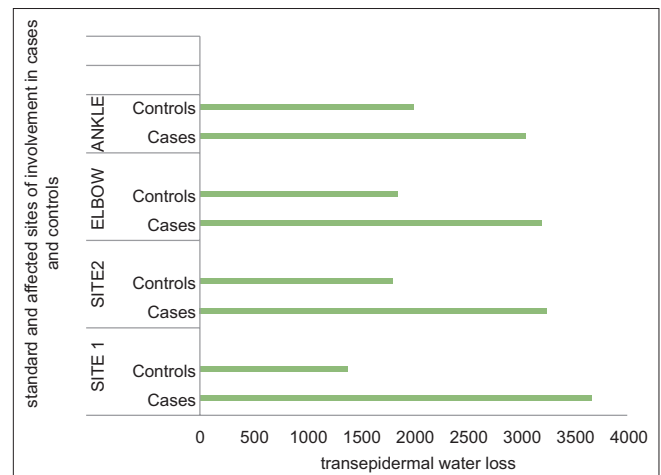

Figure 1: Graph showing the total TEWL among cases vs. controls at all four measured sites. The x-axis shows the total TEWL; TEWL in cases is higher in comparison to controls. The y-axis shows the distribution of cases and controls among standard and affected sites

Table 1: TEWL in the case group from both lesional and standard sites					
	Age	**Site 1**	**Site 2**	**Elbow**	**Ankle**
n	50.00	50.00	50.00	50.00	50.00
Mean of TEWL	46.32	73.28	64.40	54.25	54.20
Median of TEWL	45.50	70.40	64.95	52.45	47.60
Standard deviation	15.56	27.23	17.22	21.84	22.80
Percentiles					
25.00	34.00	48.68	49.35	37.00	32.08
50.00	45.50	70.40	64.95	52.45	47.60
75.00	58.75	92.88	80.05	67.60	72.25
Mean±Standard deviation	46.32±15.56	73.28±27.23	64.4±17.22	54.25±21.84	54.2±22.8
Median (Inter-Quartile range)	45.5 (34-58.75)	70.4 (48.68-92.88)	64.95 (49.35-80.05)	52.45 (37-67.6)	47.6 (32.08-72.25)

Twenty-two patients had psoriatic lesions involving ankle, and 28 patients did not have lesions over the ankle. The mean water loss is higher in the standard sites with psoriatic involvement [Table 3].

To compare TEWL between case and control population at different sites, we applied Mann-Whitney U test. The difference in water loss is statistically significant between the case and control group ($P < 0.001$) [Table 4].

The comparison of TEWL between affected and non-affected subjects in case population at elbow and ankle region (Mann-Whitney U test) showed increased water loss at the affected sites [Table 5]. Overall, the TEWL among cases was significantly high compared to controls [Figure 2].

Discussion

Skin hydration and TEWL measurements showed decreased skin hydration and increased TEWL in the affected and unaffected skin of patients of psoriasis, compared to that of a healthy control. The results of our study are found to be consistent with study done by Young Lee *et al*. who used the same parameters in a smaller sample of 19 patients of psoriasis and 10 controls. Skin lesions selected were divided into the 3 groups of psoriatic lesional, psoriatic peri-lesional, and normal non-psoriatic skin. The study

concluded that skin hydration and TEWL measurements showed decreased skin hydration and increased TEWL in the lesional and peri-lesional skin of psoriasis, compared to healthy controls.[9]

In our study, skin affected by psoriasis has shown TEWL to be enormously increased compared to the controls. A 20-fold increase in the skin water loss was reported in psoriasis and exfoliative dermatitis by study done by Grice KA *et al*.[10]

According to reports of Tagami and Yoshikuni, psoriatic plaques have reduced conductance and increased TEWL. They suggested that psoriatic skin is known to have reduced water holding capacity. In addition, they found that TEWL correlated with clinical severity of disease and thick scaly skin has more TEWL than thin scaly skin.[11]

Limitations of the study

We did not do a longitudinal follow-up of patients; hence, we could not study the role of emollients in improving skin hydration, which could have added more value to our results. In our study, we could not include paediatric psoriasis cases because of relative sparsity of those cases visiting our outpatient department, this limits extrapolation of our results to patients of all age groups. In addition, it was a single point study spanning a duration of 6 months

Table 2: TEWL in the control population from lesional and standard sites					
	Age	**Site 1**	**Site 2**	**Elbow**	**Ankle**
n	50.00	50.00	50.00	50.00	50.00
Mean of TEWL	42.86	31.47	45.11	34.49	37.59
Median of TEWL	43.00	29.05	43.45	36.55	38.35
Standard deviation	16.05	11.77	14.59	13.86	12.83
Percentiles					
25.00	32.00	21.68	34.73	20.25	27.15
50.00	43.00	29.05	43.45	36.55	38.35
75.00	53.25	38.93	54.08	44.33	43.33
Mean±Standard deviation	42.86±16.05	31.47±11.77	45.11±14.59	34.49±13.86	37.59±12.83
Median (Inter-Quartile range)	43 (32-53.25)	29.05 (21.68-38.93)	43.45 (34.73-54.08)	36.55 (20.25-44.33)	38.35 (27.15-43.33)

Table 3: TEWL in case group of the standard sites with psoriatic involvement vs. TEWL of the standard sites without psoriatic involvement				
	TEWL of case subjects without elbow involvement	**TEWL of case subjects with elbow involvement**	**TEWL of case subjects with ankle involvement**	**TEWL of case subjects without ankle involvement**
n	29.00	21.00	22.00	28.00
Mean of TEWL	45.47	66.39	63.36	47.00
Median of TEWL	45.20	65.30	58.25	40.35
Standard deviation	17.98	21.21	24.96	18.34
Percentiles				
25.00	30.45	47.35	43.68	30.78
50.00	45.20	65.30	58.25	40.35
75.00	61.00	80.15	83.08	64.00
Mean±Standard deviation	45.47±17.98	66.39±21.21	63.36±24.96	47±18.34
Median (Inter-Quartile range)	45.2 (30.45-61)	65.3 (47.35-80.15)	58.25 (43.68-83.08)	40.35 (30.78-64)

Table 4: Comparison of TEWL between case and control population at different sites (Mann-Whitney U test)

Group	*n*	Mean rank	Sum of ranks	*P*
Site 1				
Cases	50	73.30	3665.00	<0.001
Controls	50	27.70	1385.00	
Total	100			
Site 2				
Cases	50	64.97	3248.50	<0.001
Controls	50	36.03	1801.50	
Total	100			
Elbow				
Cases	50	63.99	3199.50	<0.001
Controls	50	37.01	1850.50	
Total	100			
Ankle				
Cases	50	60.97	3048.50	<0.001
Controls	50	40.03	2001.50	
Total	100			

Table 5: Comparison of TEWL between affected and non-affected subjects in case population at elbow and ankle region (Mann-Whitney U test)

Group	*n*	Mean rank	Sum of ranks	*P*
Elbow				
1	21	33.26	698.50	<0.001
2	29	19.88	576.50	
Total	50			
Ankle				
1	22	31.25	687.50	0.013
2	28	20.98	587.50	
Total	50			

Figure 2: A case with psoriatic lesions over the extensor arm

because of time constraints; hence, multiple follow-ups were not performed, which would have been ideal in this situation to assess the improvement or degradation of barrier function.

Strengths of study

As per our knowledge and literature search, this is one of the few studies done in the Indian population. In comparison to other studies, the sample size in our study is more which gives an added credibility to our study.

Conclusion

In our study, it was found that TEWL is significantly higher in psoriatic patients compared with other skin disorders. Among psoriatic patients, TEWL is found to be higher in sites affected by psoriatic lesions than the unaffected sites. As TEWL is considered as marker of skin hydration and barrier function of the skin, it may demonstrate the extent of impaired skin barrier function and reduced skin hydration. Thus, the damage in psoriasis is not just limited to lesional skin but extends beyond. Hence, we can postulate that

psoriasis is also a condition with defective skin barrier and requires comprehensive skin cover with emollients akin to atopic skin.[12] The TEWL values can be useful to decide the amount of hydration and supplementation of topical emollients that have to be administered to affected patients, thus helps to improve the quality of life in psoriatic patients. Thus, as TEWL is a non-invasive and an objective method for assessing skin barrier function, it is a highly efficacious assessment modality in disrupted skin barrier function conditions.

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Conflicts of interest

There are no conflicts of interest.

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