Changes of Transepidermal Water Loss (TEWL) in Psoriatic Plaques during D-PUVA Therapy

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Background: **Psoriatic lesions have reduced water-holding capacity and show increased transepidermal water loss (TEWL). The effect of D-PUVA therapy, which combines topical calcipotriol and PUVA therapy, on epidermal barrier function has not yet been evaluated.**

Objective: **The purpose of this study was to verify the change of TEWL in lesional and normal skin according to D-PUVA therapy in psoriasis patients.**

Methods: **TEWL was measured consecutively by TEWAMETER TM210® in 13 psoriasis patients who received D-PUVA therapy. Clinical grading was done according to psoriasis severity index (PSI).**

Results: **TEWL of psoriatic lesion decreased as D-PUVA continued. TEWL of normal-looking skin gradually increased, although the increase was trivial. Clinical grading of scale and infiltration followed the pattern of PSI in the decrease of TEWL, while that of erythema did not.**

Conclusion: **In psoriatic plaques, TEWL was decreased according to the improvement. In normal-looking skin, D-PUVA therapy caused only a little effect on TEWL.**

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Key Words: TEWL, PUVA

Psoriatic lesions have reduced water-holding capacity and show increased transepidermal water loss (TEWL)[1-4]. D-PUVA therapy, which combines calcipotriol and PUVA, is an excellent treatment method of psoriasis. There have been some reports about the effect of each of ultraviolet irradiation and calcipotriol on epidermal barrier function[5-10]. However, the effect of D-PUVA therapy on epidermal barrier function in vivo has not been elucidated in psoriasis patients. Ultraviolet irradiation of mammalian skin induces a variety of well-documented acute responses, including erythema, hyperproliferation, desquamation, and permeability barrier alterations[5]. Diminished barrier function has also been reported in response to ultraviolet B (UVB)[6], combined ultraviolet A (UVA) and UVB[7], or ultraviolet C (UVC)[8]. Treatment with calcipotriol in psoriasis may cause lesional, perilesional and ectopic facial irritation in 5~25% of patients treated[11-13]. However, the effect of calcipotriol on epidermal barrier function of normal skin does not look so great[9,10]. The purpose of this study was to observe the change of TEWL during D-PUVA therapy and to verify the effect of D-PUVA therapy on epidermal barrier function in psoriatic lesions and normal skin.

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PATIENTS AND METHODS

This study was made on 13 Korean patients with psoriasis (male 5, female 8) aged 31-51 years (mean 41.2). They applied calcipotriol 0.005% ointment on psoriatic lesions twice a day and received PUVA therapy twice a week. We initiated PUVA at 2.0J/cm^2 and increased the energy by 0.5J/cm^2 each treatment session. None of them received phototherapies at least for the past year. Two plaques on the arm and back per patient were selected for the study. Previous to the measurement of TEWL, we scored these plaques by the extent of scale, erythema, and infiltration as follows: score 0 = none; score 1 = slight; score 2 = moderate; score 3 = striking; score 4 = exceptionally striking. The sum of the scores of three clinical parameters is referred to as psoriasis severity index (PSI)[14].

The measurement of TEWL was made with TEWAMETER TM210® (COURAGE+KHAZAKA Electronic GmbH, Cologne, Germany) just before photochemotherapy. Patients took a rest at least 30 minutes before measurements. Temperature and humidity were maintained at 20± 2℃ and 40± 3%, respectively. We also measured TEWL in normal-looking skin near the lesion as regional controls in each patient.

Statistical significance was determined using Student's t test and Spearman's rank order correlation test. $p<0.05$ was considered to be significant.

RESULTS

Thirteen patients all showed clinical improvement at the end of the study. The mean PSI of the lesions before starting D-PUVA therapy was 8.6± 1.7, and that at the end of the study was 3.2±1.8.

Table 1 summarizes the TEWL measurements according to the number of treatment sessions during D-PUVA therapy. There was no definite difference of TEWL between arm and back. On the average, TEWL of psoriatic lesions was 3 times as high as that of normal-looking skin before treatment on both arm and back ($p<0.001$). TEWL of psoriatic lesion decreased as the PUVA sessions progressed. On the other hand, TEWL of normal-looking skin hardly changed during D-PUVA therapy. The gap of TEWL between psoriatic lesions and normal-looking skin gradually decreased, and at the time of 6th PUVA session the difference was not significant any more ($p=0.14$ in arm, $p=0.16$ in back).

When we plotted TEWL against PSI (Fig. 1), TEWL of psoriatic lesion decreased according to the clinical improvement, whereas that of normal-looking skin remained unchanged. This tendency was more distinct on back than on arm. In back, TEWL of psoriatic lesion was about 5 times higher than that of normal-looking skin before treatment. The difference of TEWL between psoriatic lesion and normal-looking skin gradually decreased, but TEWL of psoriatic lesion was still 1.5 times higher than that of normal-looking skin when the psoriatic lesion was almost normalized clinically ($p<0.05$). When we plotted TEWL against the grade of scale (Fig. 2) and infiltration (Fig. 3), TEWL changed in the same manner as that against PSI. In the case of erythema, TEWL of psoriatic lesion changed somewhat differently (Fig. 4). TEWL of psoriatic lesion did not decrease definitely in spite of the decrease of clinical erythema in arm.

DISCUSSION

There are some studies on epidermal hydration and water-barrier function of psoriatic lesions[1-4,15,16,17]. According to the report of Tagami and Yoshikuni[2], psoriatic plaques have decreased conductance and increased TEWL. They suggested

Table 1. The changes of TEWL(g/m^2/h) during D-PUVA therapy

No. of session	0	2	4	6	10
Arm(lesion)	20.1 ± 12.1	18.4 ± 10.6	16.1 ± 10.6	10.9 ± 5.8	15.7 ± 6.1
Arm(control)	6.4 ± 2.6	8.7 ± 6.3	7.3 ± 4.5	7.8 ± 2	9.3 ± 3.2
Back(lesion)	23.5 ± 13.4	16.8 ± 7.7	15.6 ± 10.5	11.8 ± 5.9	16.2 ± 8.9
Back(control)	7.4 ± 4.7	8.2 ± 6.3	6.9 ± 3.4	8.7 ± 3.4	8.9 ± 2.1

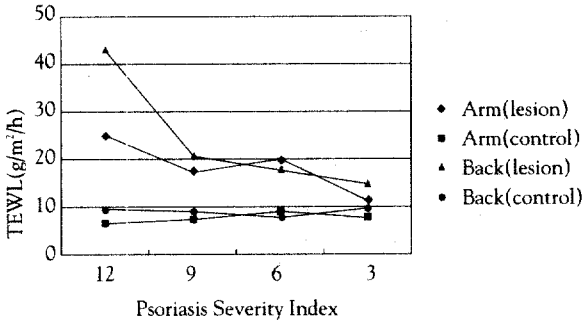

Fig. 1. The change of TEWL in relation to psoriasis severity index (PSI).

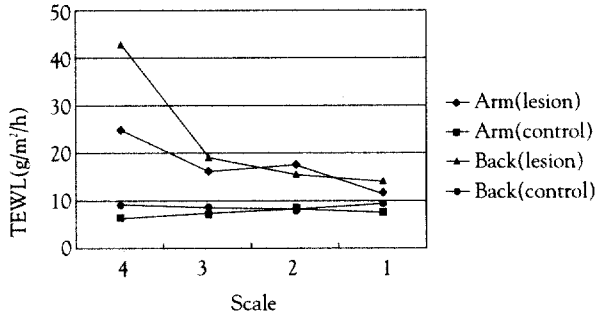

Fig. 2. The change of TEWL in relation to the grade of scale.

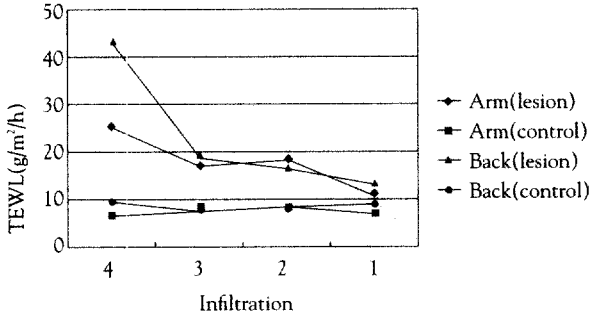

Fig. 3. The change of TEWL in relation to the grade of infiltration.

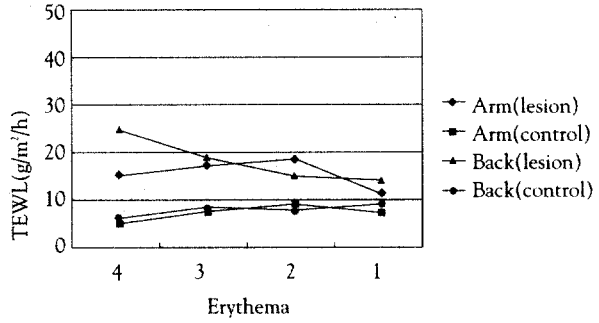

Fig. 4. The change of TEWL in relation to the grade of erythema.

that psoriatic epidermis had reduced water-holding capacity. Increase of TEWL appeared to be proportional to clinical severity, i.e., thick scaly lesions were accompanied by higher TEWL levels than thin scaly lesions. Rajka and Thune[17] also claimed that the clinical course showed a fairly good correlation with TEWL values. However, Serup and Blichmann[4] contended that plaques with no or mild scaling did not differ from that of grossly scaly plaques in the measurement of TEWL. Our study favors the result of Tagami and Yoshikuni[2] in that TEWL of lesions diminished with decrease of the grade of scale. However, correlation between TEWL and the extent of scale was weak on both arm and back ($r \cong 0.3$). Biphasic decreasing pattern of TEWL might cause this weak correlation. TEWL of psoriatic lesion was greatly reduced when the grade of scaling had fallen from 4 to 3. Thereafter, the decrease of TEWL was rather slow.

TEWL of psoriatic lesions also decreased in accordance with the decrease of PSI. TEWL has been thought to reflect the clinical course of psoriasis, especially during photochemotherapy[1,18]. According to Marks et al.[1] and Rogers[18], at the time of clinical clearing, TEWL returned to that of adjacent, uninvolved skin in PUVA-treated group, while TEWL of psoriatic lesions remained considerably elevated in dithranol-treated group. With PUVA treatment, psoriatic plaques with a greater pretreatment TEWL took longer to be cleared than those with a smaller TEWL. On the contrary, in the measurement of TEWL according to the grade of erythema, TEWL of psoriatic lesion did not diminish in spite of the decrease of clinical erythema in arm. From this finding, we could know that erythema or cutaneous blood flow does not have significant correlation with TEWL as suggested by the report of Effendy et al.[12].

TEWL of normal-looking skin did not show definite change during D-PUVA therapy. Diminished permeability barrier function has been reported in response to UV irradiation, but the majority of the reports were about UVB[6,7,19]. According to Haratake et al.[5], UVB produces delayed alteration in barrier function, and both an epidermal proliferative re-

sponse and thymocyte-mediated events appear to contribute to UVB-induced abrogation of the permeability barrier. UVB also induces cutaneous inflammation, but indomethacin blockade of the UVB-induced increase in cutaneous PGE_2 levels did not interfere with development of the permeability barrier abnormality[5]. Moreover, co-application of topical corticosteroids, pharmacologic agents with broad anti-inflammatory effects, also did not diminish the UVB-induced barrier alterations[5]. It is possible that UVA also increases epidermal thickness although it is not so remarkable as UVB exposure[20]. However, in our study, TEWL levels of normal-looking skin did not change greatly by PUVA. This may be due to relatively low energy of UVA. We initiated PUVA at 2.0J/cm^2 and increased the energy by 0.5J/cm2 each treatment session.

Although the main concern of this study was on UVA, calcipotriol is an important component of D-PUVA therapy. Calcipotriol may cause redness and it may be expressed as irritation reaction by patients[9-11,13]. However, calcipotriol induces no increase of TEWL[12,13]. Based on the results of the bioengineering methods, it is found that calcipotriol primarily affects the vasculature and results in vasodilatation, since increase of blood flow and increase of erythema are the main parameters affected[13]. Thus the skin reactions caused by calcipotriol are non-disruptive, in contrast to the sodium lauryl sulfate (SLS) which causes the disruption of epidermal barrier and the increase in TEWL[13]. In psoriatic lesions, calcipotriol restores the barrier function because of its therapeutic effect. According to Berardesca et al.[21], restoration of TEWL correlated well with the PASI score in calcipotriol-treated group. Calcipotriol slowly decreased PASI score as its therapeutic effect exerts on psoriatic lesions. Therefore, calcipotriol plus PUVA therapy (D-PUVA) might synergize with each other and accelerate the decrease of TEWL in psoriatic lesions. We need to perform further investigative studies about this point.

REFERENCES

1. Marks J, Rogers S, Chadkirk B, Shuster S. Clearance of chronic plaque psoriasis by anthralin subjective and objective assessment and comparison with photochemotherapy. Br J Dermatol 105:96-99, 1981.
2. Tagami H, Yoshikuni K. Interrelationship between water-barrier and reservoir functions of pathologic stratum corneum. Arch Dermatol 121:642-645, 1985.
3. Tagami H, Kanamaru Y, Inoue K, et al. Water sorption-desorption test of the skin in vivo by electrical measurement. J Invest Dermatol 78:425-428, 1982.
4. Serup J, Blichmann C. Epidermal hydration of psoriasis plaques and the relation to scaling: Measurement of electrical conductance and transepidermal water loss. Acta Derm Venereol (Stockh) 67:357-366, 1987.
5. Haratake A, Uchida Y, Schmuth M, et al. UVB-induced alterations in permeability barrier function: Roles for epidermal hyperproliferation and thymocyte-mediated response. J Invest Dermatol 108:769-775, 1997.
6. Haratake A, Uchida Y, Mimura K, Elias PM, Holleran WM. Intrinsically aged epidermis displays diminished UVB-induced alterations in barrier function associated with decreased proliferation. J Invest Dermatol 108:319-323, 1997.
7. Bissett DL, Hannon DP, Orr TV. An animal model of solar-aged skin: histological, physical, and visible changes in UV-irradiated hairless mouse skin. Photochem Photobiol 46:367-378, 1987.
8. Solomon AE, Lowe NJ. Percutaneous absorption in experimental epidermal disease. Br J Dermatol 100:717-722, 1979.
9. Effendy I, Kwangsukstith C, Chiappe M, Maibach HI. Effects of calcipotriol on stratum corneum barrier function, hydration and cell renewal in humans. Br J Dermatol 135:545-549, 1996.
10. Fullerton A, Avnstorp C, Agner T, Dahl JC, Olsen LO, Serup J. Patch test study with calcipotriol ointment in different patient groups, including psoriatic patients with and without adverse dermatitis. Acta Derm Venereol (Stockh) 76:194-202, 1996.
11. Kragballe K, Gjertsen BT, de Hoop D, et al. Double-blind, right/left comparison of calcipotriol and betamethasone valerate in treatment of psoriasis vulgaris. Lancet 337:193-196, 1991.
12. Cunliffe WJ, Berth-Jones J, Claudy A, et al. Comparative study of calcipotriol (MC903) ointment and betamethasone 17-valerate ointment in patients with psoriasis vulgaris. J Am Acad Dermatol 26:736-743, 1992.
13. Berth-Jones J, Chu AC, Dodd WAH, et al. A multicentre, parallel-group comparison of calcipotriol

ointment and short-contact dithranol therapy in chronic plaque psoriasis. Br J Dermatol 127:266-271, 1992.
14. Gollnick H, Bauer R, Brindley C, et al. Acitretin versus etretinate in psoriasis. Clinical and pharmacokinetic results of a German multicenter study. J Am Acad Dermatol, 1988;19:458-68.
15. Hagemann I, Proksch E. Topical treatment by urea reduces epidermal hyperproliferation and induces differentiation in psoriasis. Acta Dermal Venereol (Stockh) 76:353-356, 1996.
16. Grice K, Sattar H, Baker H, Sharratt M. The relationship of transepidermal water loss to skin temperature in psoriasis and eczema. J Invest Dermatol 64:313-315, 1975.
17. Rajka G, Thune P. The relationship between the course of psoriasis and transepidermal water loss, photoelectric plethysmography and reflex photometry. Br J Dermatol 94:253-261, 1976
18. Rogers S. Measurement of plaque thickness and evaporative water loss in psoriasis with PUVA and dithranol treatment. Clin Exp Dermatol 18:21-24, 1993.
19. Lamauad E, Schalla W. Influence of UV irradiation on penetration of hydrocortisone. In vivo study in hairless rat skin. Br J Dermatol 111(suppl 27):152-157, 1984.
20. Youn JI. Photomedicine. Ryomoongak, Seoul, 1994, pp89-109.
21. Berardesca E, Vignoli GP, Farinelli N, Vignini M, Distante F, Rabbiosi G. Non-invasive evaluation of topical calcipotriol versus clobetasol in the treatment of psoriasis. Acta Derm Venereol (Stockh) 74:302-304, 1994.Legends