

Biophysical properties in different body areas of adult-onset atopic dermatitis patients.

Supenya Varothai MD,

Suthasinee Pattaravadee BSc,

Sakunee Khankham MD,

Leena Chularojanamontri MD,

Kanokvalai Kulthanan MD.

ABSTRACT :

VAROTHAI S, PATTARAVADEE S, KHANKHAM S, CHULAROJANAMONTRI L, KULTHANAN K. BIOPHYSICAL PROPERTIES IN DIFFERENT BODY AREAS OF ADULT-ONSET ATOPIC DERMATITIS PATIENTS. THAI J DERMATOL 2012; 28: 219-232.

DEPARTMENT OF DERMATOLOGY, FACULTY OF MEDICINE SIRIRAJ HOSPITAL, MAHIDOL UNIVERSITY, BANGKOK, THAILAND.

Background: Skin bioengineering studies in atopic dermatitis (AD) patients indicated skin barrier dysfunction. Most studies were performed in children and adult AD related to the early-onset AD extending to adult life. There still lack of information in adult-onset atopic dermatitis (AAD).

Objectives: To investigate the biophysical properties and skin barrier defects of clinically normal skin in AAD patients and compare with healthy subjects.

Methods: Twenty-six participants including 13 AAD patients in remission and 13 controls were enrolled. The measured parameters were collected from 27 skin regions including transepidermal water loss, stratum corneum hydration, skin pH, skin surface lipids and skin roughness.

Results: No significant difference between cases and controls was found in all parameters.

Conclusion: It is possible that biophysical properties of skin of AAD patients during remission period are similar to healthy subjects. Further study in a large sample size is suggested.

Key word: adult-onset atopic dermatitis, transepidermal water loss, stratum corneum hydration, skin pH, skin surface lipids

บทคัดย่อ :

สุเพ็ญญา วโรทัย, สุธาสินี ภัทรวดี, ศกุนี ชันคำ, ลีนา จุฬาโรจน์มนตรี, กนกวลัย กุลทันทน์ คุณสมบัติทางชีวฟิสิกส์ของผิวหนังในผู้ป่วยโรคผื่นภูมิแพ้ผิวหนังที่เริ่มเกิดในวัยผู้ใหญ่ วารสารโรคผิวหนัง 2555; 28: 219-232.

ภาควิชาจักษุวิทยา คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล

การศึกษาสภาพผิวหนังในผู้ป่วยโรคภูมิแพ้ผิวหนังพบว่าสภาพผิวหนังของผู้ป่วยกลุ่มนี้มีความผิดปกติ ซึ่งการศึกษาส่วนใหญ่ทำในผู้ป่วยเด็ก หรือผู้ป่วยผู้ใหญ่ที่ได้รับการวินิจฉัยว่าเป็นโรคภูมิแพ้ผิวหนังตั้งแต่ยังเด็ก พบว่ายังขาดข้อมูลเกี่ยวกับสภาพผิวหนังในผู้ป่วยโรคภูมิแพ้ผิวหนังที่เริ่มมีอาการภายหลังอายุ 18 ปี

วัตถุประสงค์: เพื่อศึกษาสภาพผิวหนังในผู้ป่วยโรคภูมิแพ้ผิวหนังที่เริ่มมีอาการภายหลังอายุ 18 ปี และ เปรียบเทียบกับประชากรปกติ

วิธีการศึกษา: ผู้ป่วย 13 รายและกลุ่มควบคุม 13 ราย ที่เข้าร่วมการวิจัย จะได้รับการวัดสภาพผิวหนังจาก ตำแหน่งต่างๆ บนร่างกายรวม 27 ตำแหน่ง โดยวัดปริมาณน้ำที่สูญเสียไปทางผิวหนัง, ปริมาณน้ำในผิวหนัง, ค่าความเป็นกรด-ด่างของผิวหนัง, ปริมาณไขมันและความหนาของผิวหนัง

ผลการศึกษา: ไม่พบความแตกต่างอย่างมีนัยสำคัญของสภาพผิวหนังระหว่างผิวหนังของผู้ป่วย เปรียบเทียบกับกลุ่มควบคุม

สรุปผลการศึกษา: สภาพผิวหนังของผู้ป่วยภูมิแพ้ผิวหนังที่เริ่มมีอาการภายหลังอายุ 18 ปี ในขณะที่โรคสงบ ไม่มีความแตกต่างจากประชากรกลุ่มควบคุม

คำสำคัญ: โรคภูมิแพ้ผิวหนัง, ปริมาณน้ำที่สูญเสียไปทางผิวหนัง, ปริมาณน้ำในผิวหนัง, ค่าความเป็นกรด-ด่าง ของผิวหนัง, ปริมาณไขมันของผิวหนัง

Introduction

Atopic dermatitis (AD) is a chronic pruritic relapsing inflammatory skin disease and is clinically presented by dryness of the skin.^{1, 2} Onset of AD predominated in infancy or early childhood. Adult-onset atopic dermatitis (AAD) is an entity of AD which defined as AD with onset at the age of 18 or older.^{1, 3-5} Previous studies showed that AAD accounted for 13-47% of all subgroups of AD.^{1, 6} Besides typical eczematous flexural distribution, it also has non-typical morphology.^{1, 4, 5}

AD can be divided into two different subtypes, extrinsic AD (eAD) which correlated with classic IgE-mediated and intrinsic AD (iAD) or non-allergic AD which has normal serum IgE levels. In comparison to extrinsic type, intrinsic type has later onset and no correlation with filaggrin gene mutation; therefore it may imply that iAD might not be correlated with skin barrier dysfunction.^{7, 8} The physical characteristics of AD skin reported by previous studies are increased transepidermal water loss (TEWL), decrease ceramides 1,3 in the stratum corneum, alteration of the intercellular lipid organization and lamellar bodies extrusion which can be measured by non-invasive bioengineering methods.^{7, 9}

However, most studies concerning the biophysical properties of AD were performed in children & adult AD related to the early-onset AD extending to adult life.¹⁰⁻¹⁵ This study focused on the biophysical

properties of normal-appearing skin of AAD patients and compared those parameters with healthy subjects.

Materials and Methods

Study population

A total number of 26 participants were enrolled including 13 AAD patients and 13 healthy subjects. We recruited patients diagnosed as AAD according to the criteria of Hanaffin and Rajka¹⁶ from out-patient clinic, Department of Dermatology, Siriraj Hospital, Mahidol University, Bangkok, Thailand from September 2010 to December 2010. All cases developed skin lesions after the age of 18 and were in remission during the study period. All control subjects had no signs or symptoms of AD or other skin diseases influencing skin barrier function and were age and gender compatible with cases.

For further classification of AAD, demographic data, a complete history including personal and family history of atopy (allergic rhinitis, asthma, and allergic conjunctivitis), onset and activity of personal atopy, and previous treatment were reviewed. Investigation included skin prick testing (SPT) using 28 allergens and serum total IgE levels determined by Nephelometry method (Dade Behring, Germany). Normal levels were less than 100 kU/L.

The intrinsic form of AD was defined by low total serum IgE level (<200 kU/L), no specific serum IgE antibodies and/or negative SPT for common aeroallergens and/or food allergens, and the absence of associated respiratory atopic diseases.¹⁷

Inform consent was obtained from all participants, and this study was approved by Siriraj Institutional Review Board, Siriraj Hospital, Mahidol University, Bangkok, Thailand.

Methods

All participants had at least 2 weeks wash-out period of systemic steroids, topical steroids and topical calcinurin inhibitors. On the study day, participants were informed to avoid all type of cleansers and emollients 12 hours prior to the examination. A whole body skin examination was carefully done by the investigators and only clinically normal skin was examined.

In our study, all measurements were performed by the same well-trained and experienced technician under standardize condition with air temperature range from 19-24 °C and 50-58% relative humidity. All participants were kept there for at least 15 minutes before the measurements to acclimatize to this condition.

The studied parameters, including TEWL, stratum corneum hydration(SCH), skin surface pH, skin surface lipids and skin roughness, were measured non-invasively by the Tewameter[®] TM 300, Corneometer[®] CM 825, Skin pH meter[®] PH 905, Sebumeter[®] SM 815 and Visioscan[®] VC 98 (Courage + Khazaka electronic GmbH ,Köln Germany) respectively at 27 different body areas and were randomized left sided or right sided, including flexural area (neck, antecubital fossa,

wrist, popliteal fossa, ankle, and inguinal region), extensor area (elbow, mid-dorsum forearm, dorsum hand, knee, shin, and dorsum foot), seborrheic area (scalp, forehead, cheek, retro-auricular area, and interscapular area) and non-flexural area (eyelid, infraorbital area, lower lip, mid-volar forearm, palm, abdomen, nipple, lower back, calf, and sole). At each site, an average value of two measurements of each parameter was obtained.

Statistic analysis

SPSS for windows version 17(SPSS,Chicago,IL,USA) performed the tests to analyze all statistical data. Descriptive statistics e.g. median, minimum, maximum, percentages and standard deviation were applied to describe demographic data and laboratory findings. Comparison of measured values of biophysical properties in different body areas between AAD and healthy groups was performed using unpaired t-test or Mann-Whitney U test for quantitative data with and without normal distribution, respectively. Only the *p* value less than 0.05 is statistically significant.

Results

Among 13 AAD cases, 9 cases were female. The mean age (SD) was 39 (9.5) years old and the mean age of onset of AD lesions(SD) was 32 (10.8) years old. Two cases were diagnosed as iAD. (table 1)

Table 1 Characteristics of adult onset atopic dermatitis (AAD) patients

Data	Positive, n(%)	Negative, n(%)
Positive history of personal atopy		
Allergic rhinitis	7(53.8)	6(46.2)
Asthma	0(0)	13(100)
Allergic conjunctivitis	2(7.7)	11(42.3)
Serum total IgE*	5(38.46) [high]	8(61.54) [normal]
Skin prick testing results	8(61.5)	5(38.5)

*normal levels were less than 100 kU/L

The results of TEWL, SCH, skin surface pH, skin surface lipid and skin roughness in this study which were collected from 27 skin regions showed no significant difference between cases and controls. Even the most common involved areas such as antecubital

fossa and popliteal fossa still have no significant difference. However, SCH of cases tend to be lower than controls in many areas such as neck, knee, forehead, infra-orbital area and lower back as shown in table 2-6.

Table 2 Comparison of measured values of transepidermal water loss (TEWL) in different body areas between AAD and healthy groups

Measurement	TEWL (g/h/m ²): Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
Flexural			
- Neck	8.30(4.52)	6.87(2.37)	0.89
- Antecubital	11.57(4.79)	12.54(8.16)	0.96
- Wrist	14.20(5.42)	15.15(3.81)	0.40
- Popliteal	9.07(3.10)	9.54(3.80)	0.89
- Ankle	9.87(3.68)	8.57(1.99)	0.36
- Inguinal region	10.92(4.00)	9.27(2.42)	0.22
Extensor			
- Elbow	14.09(3.70)	15.03(4.55)	0.65
- Mid-dorsum forearm	10.04(3.69)	7.58(2.35)	0.09

Measurement	TEWL (g/h/m ²): Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
- Dorsum hand	11.84(5.83)	9.60(2.85)	0.55
- Knee	11.43(4.79)	9.75(2.25)	0.36
- Shin	7.57(2.91)	6.77(1.88)	0.52
- Dorsum foot	10.09(3.55)	8.44(2.04)	0.24
Seborrheic area			
- Scalp	12.18(4.70)	11.61(3.81)	0.70
- Forehead	13.40(5.04)	11.14(4.07)	0.26
- Cheek	14.79(6.00)	12.58(4.14)	0.46
- Retroauricular area	11.49(6.19)	9.14(3.10)	0.59
- Inter-scapular area	9.55(3.68)	9.60(3.77)	0.97
Nonflexural			
- Eyelid	17.88(7.10)	18.59(7.57)	0.76
- Infraorbital area	18.62(7.33)	19.40(7.02)	0.83
- Lower lip	49.64(11.50)	40.77(13.08)	0.08
- Mid-volar forearm	10.99(4.42)	9.24(2.22)	0.46
- Palm	31.04(6.15)	37.81(10.64)	0.03
- Abdomen	11.76(3.96)	10.24(2.44)	0.27
- Nipple	12.13(4.44)	11.29(3.14)	0.71
- Lower back	10.48(5.04)	8.19(4.73)	0.17
- Calf	11.27(3.07)	9.22(2.35)	0.07
- Sole	21.65(6.09)	23.44(10.08)	0.96

Table 3 Comparison of measured values of stratum corneum hydration(SCH) in different body areas between AAD and healthy groups

Measurement	SCH (CM units): Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
Flexural			
- Neck	63.82(11.23)	68.34(8.58)	0.31
- Anticubital	49.97(11.66)	44.25(13.57)	0.15
- Wrist	39.30(12.54)	51.55(53.69)	0.97
- Popliteal	39.57(12.02)	41.64(6.98)	0.59
- Ankle	28.34(8.59)	31.82(9.12)	0.32
- Inguinal region	47.12(9.90)	44.85(7.25)	0.51
Extensor			
- Elbow	37.02(7.99)	38.20(9.46)	0.83
- Mid-dorsum forearm	43.35(8.93)	45.95(7.56)	0.31
- Dorsum hand	39.06(10.12)	41.69(9.87)	0.57
- Knee	42.12(10.16)	51.34(7.22)	0.02
- Shin	38.29(9.34)	43.14(9.96)	0.20
- Dorsum foot	30.95(10.92)	37.37(13.40)	0.19
Seborrheic area			
- Scalp	6.64(3.89)	5.46(2.39)	0.27
- Forehead	55.34(14.60)	61.23(9.56)	0.31
- Cheek	43.73(10.87)	45.55(15.46)	0.49
- Retroauricular area	54.32(10.24)	53.70(16.61)	0.84
- Inter-scapular area	61.84(11.34)	61.99(12.36)	0.97
Nonflexural			
- Eyelid	73.85(16.22)	78.33(7.39)	0.62
- Infraorbital area	73.97(11.48)	72.72(10.58)	0.69
- Lower lip	46.15(5.25)	49.20(16.38)	0.40
- Mid-volar forearm	45.13(10.12)	45.93(5.92)	0.75
- Palm	35.89(15.30)	33.06(9.60)	0.80

- Abdomen	41.25(12.61)	42.30(6.18)	0.96
- Nipple	42.61(7.03)	43.81(12.66)	0.81
- Lower back	46.95(10.51)	53.71(10.27)	0.22
- Calf	40.45(9.47)	43.22(5.28)	0.24
- Sole	15.14(6.98)	15.44(4.64)	0.72

Table 4 Comparison of measured values of skin pH in different body areas between AAD and healthy groups

Measurement	pH: Mean (SD)		p-value
Body areas	AD (n=13)	NC (n=13)	
Flexural			
- Neck	5.02(0.36)	4.98(0.35)	0.38
- Anticubital	5.08(0.37)	5.03(0.42)	0.62
- Wrist	5.13(0.37)	5.04(0.40)	0.61
- Popliteal	5.13(0.37)	5.15(0.34)	0.79
- Ankle	5.12(0.37)	5.09(0.29)	1.00
- Inguinal region	5.21(0.52)	5.11(0.42)	0.46
Extensor			
- Elbow	5.12(0.33)	5.04(0.43)	0.72
- Mid-dorsum forearm	4.96(0.36)	4.97(0.44)	0.87
- Dorsum hand	5.13(0.36)	4.94(0.26)	0.11
- Knee	5.22(0.48)	5.09(0.36)	0.41
- Shin	4.88(0.44)	5.14(0.35)	0.81
- Dorsum foot	5.08(0.46)	5.12(0.34)	0.89
Seborrheic area			
- Scalp	4.95(0.44)	5.18(0.51)	0.32
- Forehead	4.78(0.46)	5.02(0.44)	0.31
- Cheek	4.96(0.43)	4.92(0.43)	0.76
- Retroauricular area	4.94(0.32)	4.91(0.32)	0.91
- Inter-scapular area	5.14(0.26)	4.98(0.37)	0.15

Measurement	pH: Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
Nonflexural			
- Eyelid	4.99(0.51)	5.01(0.37)	1.00
- Infraorbital area	4.95(0.43)	4.93(0.42)	0.70
- Lower lip	5.10(0.35)	5.07(0.34)	0.70
- Mid-volar forearm	5.00(0.36)	4.93(0.35)	0.48
- Palm	5.35(0.32)	5.27(0.29)	0.37
- Abdomen	5.06(0.46)	5.05(0.43)	0.95
- Nipple	5.14(0.40)	4.99(0.34)	0.21
- Lower back	5.12(0.33)	5.10(0.39)	0.81
- Calf	5.26(0.37)	5.05(0.42)	0.40
- Sole	5.26(0.37)	5.05(0.42)	0.97

Table 5 Comparison of measured values of skin surface lipids in different body areas between AAD and healthy groups

Measurement	Skin surface lipids ($\mu\text{g}/\text{cm}^2$): Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
Flexural			
- Neck	18.38(16.32)	17.50(18.83)	0.85
- Anticubital	1.50(1.63)	2.54(4.23)	0.70
- Wrist	0.46(1.20)	0.38(0.87)	0.93
- Popliteal	0.46(0.52)	0.31(0.63)	0.41
- Ankle	0.38(0.65)	0.00(0.00)	0.10
- Inguinal region	1.08(2.75)	0.69(1.38)	0.90
Extensor			
- Elbow	0.85(0.69)	0.46(0.52)	0.21
- Mid-dorsum forearm	0.50(0.65)	0.38(0.51)	0.84
- Dorsum hand	2.58(4.86)	1.04(1.27)	0.94
- Knee	0.54(0.66)	0.62(0.77)	0.98
- Shin	0.62(1.12)	0.31(0.48)	0.81

Measurement	Skin surface lipids ($\mu\text{g}/\text{cm}^2$): Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
- Dorsum foot	0.62(0.65)	0.23(0.44)	0.17
Seborrheic area			
- Scalp	39.84(49.14)	27.96(27.72)	0.89
- Forehead	134.46(90.63)	112.15(53.60)	0.55
- Cheek	87.38(77.44)	74.58(50.98)	0.89
- Retroauricular area	59.58(66.03)	46.54(37.64)	0.70
- Inter-scapular area	22.19(17.98)	10.62(9.33)	0.09
Nonflexural			
- Eyelid	35.69(26.65)	38.42(35.05)	0.91
- Infraorbital area	52.73(40.98)	59.50(46.27)	0.88
- Lower lip	28.65(27.95)	43.19(50.95)	0.40
- Mid-volar forearm	1.12(3.15)	0.08(0.28)	0.27
- Palm	1.04(1.56)	2.19(3.91)	0.58
- Abdomen	1.96(2.57)	0.38(0.65)	0.03
- Nipple	4.81(5.54)	5.50(7.43)	0.72
- Lower back	1.69(1.89)	1.08(1.26)	0.39
- Calf	0.31(0.63)	0.54(1.13)	0.73
- Sole	1.31(1.80)	0.38(0.51)	0.20

Table 6 Comparison of measured values of skin roughness in different body areas between AAD and healthy groups

Measurement	Skin roughness: Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
Flexural			
- Neck	3.00(1.02)	2.59(0.60)	0.37
- Anticubital	2.66(0.59)	2.66(0.63)	0.99
- Wrist	2.45(0.57)	2.65(0.74)	0.48
- Popliteal	3.13(1.02)	2.52(0.61)	0.15
- Ankle	4.13(0.88)	4.19(1.77)	0.51

Measurement	Skin roughness: Mean (SD)		
Body areas	AD (n=13)	NC (n=13)	p-value
- Inguinal region	2.64(1.20)	2.59(0.78)	0.52
Extensor			
- Elbow	3.41(1.08)	3.19(0.47)	0.62
- Mid-dorsum forearm	3.76(1.73)	3.99(1.76)	0.76
- Dorsum hand	3.47(1.55)	3.50(1.69)	0.79
- Knee	4.26(0.91)	6.58(5.10)	0.24
- Shin	8.01(4.97)	8.21(5.26)	0.84
- Dorsum foot	3.68(1.04)	4.09(1.16)	0.39
Seborrheic area			
- Scalp	11.41(5.01)	10.78(7.88)	0.24
- Forehead	3.60(1.02)	4.14(1.04)	0.24
- Cheek	3.45(1.05)	3.82(1.01)	0.36
- Retroauricular area	2.57(0.80)	2.51(0.97)	0.61
- Inter-scapular area	3.23(0.97)	3.01(1.52)	0.36
Nonflexural			
- Eyelid	3.33(1.06)	4.16(2.49)	0.92
- Infraorbital area	3.00(0.59)	2.88(0.81)	0.61
- Lower lip	4.86(1.48)	4.52(1.86)	0.42
- Mid-volar forearm	2.67(0.91)	2.59(0.90)	0.66
- Palm	3.21(0.79)	3.54(1.28)	0.65
- Abdomen	3.63(3.51)	3.79(5.86)	0.85
- Nipple	2.98(0.95)	3.26(1.96)	0.93
- Lower back	2.71(1.01)	2.74(1.62)	0.69
- Calf	3.64(0.94)	4.28(3.17)	0.60
- Sole	4.84(2.51)	5.71(2.02)	0.15

However even the clinically normal skin of AD patients also showed tiny scales under the visioscan, suggesting of the skin roughness. Our study also showed that primary and secondary glyphic lines of skin were more prominent in cases than controls. (figure 1)

Parameters acquired from 2 patients with intrinsic type AAD also indicated no significant differences in all aspects. (data not shown)

Discussion

In AD patients, skin functions undergo variation to the degree of severity of the diseases. The biophysical properties of AD patients showed an increase of TEWL and a decrease of SCH, suggesting impaired skin barrier function in AD patients.^{9-15, 18-21} The studies also showed that skin pH shifted valued toward alkalinity, indicating a defect in the maintenance of the skin barrier homeostasis. In addition, the biophysical properties of AD patients showed a reduction of total skin lipids especially ceramides in stratum corneum, which plays a major role in maintaining the efficient barrier function of stratum corneum and increasing skin roughness, defined as dry skin, which means decreasing water content of the stratum corneum.^{2, 9, 13, 14} Previous studies have been performed to determine the accurate evaluation of skin barrier function and to find a correlation between skin barrier function and clinical features or severity in AD.^{11, 12, 15} Some data showed no strong correlation among biophysical properties, weak correlation between the level of TEWL and that of SCH, and no correlation between level of pH, TEWL,

and capacitance between healthy and atopic children's skins. In contrast, a correlation between impaired skin barrier function and clinical severity and the restoration of skin barrier function after the treatment of AD were observed.^{10, 11, 14, 19, 22} Alteration of TEWL and pH at uninvolved skin, indicating that the function of the skin is abnormal even before or after the active phase of the diseases.¹⁰ In clinically normal skin, the impaired skin barrier function is still controversial. Many studies have found impaired skin barrier function^{23, 24}, while other could not demonstrate impaired skin barrier function in AD patients.^{25, 26} To our knowledge, no study has ever been done about skin barrier function in AAD patients.

Some studies have found an increase TEWL in normal-appearing skin of AD children and adults^{10, 12, 13, 27}, whereas others have demonstrated no difference in TEWL which was similar to our results.^{11, 28} Sakurai et al, reported that TEWL in clinically normal skin of active severe and moderate AD patients were significantly increased compared with the normal control.²⁹ However, remission AD patients for more than 5 years showed normal TEWL.²⁹ In addition, patients in remission for over 2 years show non-significant difference of TEWL value compared with non-atopic individual.³⁰

Water content of stratum corneum significantly diminished in adult AD patients^{9, 13, 15, 27} and children affected AD¹⁰, but unchanged values¹² have been reported on normal-looking skin of adult AD compared

with control group. Our results found no significant difference between cases and controls.

In addition, pH values were significantly higher in lesional and non-lesional skin of children affected AD than in healthy skin of control subjects, and pH values of uninvolved skin showed a shift towards alkalinity^{12, 15}. In our study, values obtained from normal-looking skin of AAD patients did not differ significantly from those of controls.

Sator et al. showed a significant decrease of non-lesional skin lipids in adult onset AD patients.¹⁵ However, from our study, this measured parameter was similar. For skin roughness, clinically normal skin in adult patients and in children with atopic eczema did not differ from skin of the controls¹²⁻¹⁴; this observation was also present in our study.

In summary, we were unable to detect skin barrier defects in AAD by biophysical properties. It is possible that the skins of AAD patients during remission period may be similar to healthy subjects due to less severity than that of other subgroups of AD and may be partly due to high humidity climate in Thailand. Perhaps, these reasons lead to adult onset of the disease. However, the research with larger scale is needed to conclude these findings. Also there might be some difference among iAD and eAD of AAD patients.

Acknowledgement

We would like to thank Dr.Chulaluk Komoltri and Associated Prof. Papapit Tuchinda, MD. for all kind support.

References

1. Kulthanan K, Samutrapong P, Jiamton S, Tuchinda P. Adult-onset atopic dermatitis: a cross-sectional study of natural history and clinical manifestation. *Asian Pac J Allergy Immunol* 2007;25:207-14.
2. Linde YW. Dry skin in atopic dermatitis. *Acta Derm Venereol Suppl (Stockh)* 1992;177:9-13.
3. Ingordo V, D'Andria G, D'Andria C. Adult-onset atopic dermatitis in a patch test population. *Dermatology* 2003;206:197-203.
4. Ozkaya E. Adult-onset atopic dermatitis. *J Am Acad Dermatol* 2005;52:579-82.
5. Bannister MJ, Freeman S. Adult-onset atopic dermatitis. *Australas J Dermatol* 2000;41:225-8.
6. Wolkewitz M, Rothenbacher D, Low M, Stegmaier C, Ziegler H, Radulescu M, et al. Lifetime prevalence of self-reported atopic diseases in a population-based sample of elderly subjects: results of the ESTHER study. *The British journal of dermatology* 2007;156:693-7.
7. Tokura Y. Extrinsic and intrinsic types of atopic dermatitis. *Journal of dermatological science* 2010;58:1-7..
8. Choi SJ, Song MG, Sung WT, Lee DY, Lee JH, Lee ES, et al. Comparison of transepidermal water loss, capacitance and pH values in the skin between intrinsic and extrinsic atopic dermatitis patients. *Journal of Korean medical science* 2003;18:93-6.
9. Addor FA, Aoki V. Skin barrier in atopic dermatitis. *An Bras Dermatol* 2010;85:184-94.
10. Seidenari S, Giusti G. Objective assessment of the skin of children affected by atopic dermatitis: a study of pH, capacitance and TEWL in eczematous and clinically uninvolved skin. *Acta dermato-venereologica* 1995;75:429-33.
11. Holm EA, Wulf HC, Thomassen L, Jemec GB. Instrumental assessment of atopic eczema: validation of transepidermal water loss, stratum corneum hydration, erythema, scaling, and edema. *J Am Acad Dermatol* 2006;55:772-80.
12. Eberlein-König B, Schafer T, Huss-Marp J, Darsow U, Mohrenschlager M, Herbert O, et al. Skin surface pH, stratum corneum hydration, trans-epidermal water loss and skin roughness related to atopic eczema and skin dryness in a population of primary school children. *Acta dermato-venereologica* 2000;80:188-91.
13. Loden M, Olsson H, Axell T, Linde YW. Friction, capacitance and transepidermal water loss (TEWL) in dry atopic and normal skin. *The British journal of dermatology* 1992;126:137-41.
14. Kim DW, Park JY, Na GY, Lee SJ, Lee WJ. Correlation of clinical features and skin barrier function in adolescent and adult patients with atopic dermatitis. *Int J Dermatol* 2006;45:698-701.
15. Sator PG, Schmidt JB, Honigsmann H. Comparison of epidermal hydration and skin surface lipids in healthy individuals and in patients with atopic dermatitis. *J Am Acad Dermatol* 2003;48:352-8.
16. Hanifin J, Rajka G. Diagnostic features of atopic dermatitis. *Acta dermato-venereologica (Stockholm) Suppl* 1980;92:44-7.
17. Folster-Holst R, Pape M, Buss YL, Christophers E, Weichenthal M. Low prevalence of the intrinsic form of

- atopic dermatitis among adult patients. *Allergy* 2006;61:629-32.
18. Hon KL, Wong KY, Leung TF, Chow CM, Ng PC. Comparison of skin hydration evaluation sites and correlations among skin hydration, transepidermal water loss, SCORAD index, Nottingham Eczema Severity Score, and quality of life in patients with atopic dermatitis. *Am J Clin Dermatol* 2008;9:45-50.
 19. Gupta J, Grube E, Ericksen MB, Stevenson MD, Lucky AW, Sheth AP, et al. Intrinsically defective skin barrier function in children with atopic dermatitis correlates with disease severity. *J Allergy Clin Immunol* 2008;121:725-30 e2.
 20. Rippke F, Schreiner V, Doering T, Maibach HI. Stratum corneum pH in atopic dermatitis: impact on skin barrier function and colonization with *Staphylococcus Aureus*. *Am J Clin Dermatol* 2004;5:217-23.
 21. Schmid-Wendtner MH, Korting HC. The pH of the skin surface and its impact on the barrier function. *Skin Pharmacol Physiol* 2006;19:296-302.
 22. Shahidullah M, Raffle EJ, Rimmer AR, Frain-Bell W. Transepidermal water loss in patients with dermatitis. *The British journal of dermatology* 1969;81:722-30.
 23. Berardesca E, Fideli D, Borroni G, Rabbiosi G, Maibach H. In vivo hydration and water-retention capacity of stratum corneum in clinically uninvolved skin in atopic and psoriatic patients. *Acta dermato-venereologica* 1990;70:400-4.
 24. Werner Y, Lindberg M. Transepidermal water loss in dry and clinically normal skin in patients with atopic dermatitis. *Acta dermato-venereologica*. 1985;65:102-5.
 25. Tanaka M, Zhen YX, Tagami H. Normal recovery of the stratum corneum barrier function following damage induced by tape stripping in patients with atopic dermatitis. *The British journal of dermatology* 1997;136:966-7.
 26. Werner Y. The water content of the stratum corneum in patients with atopic dermatitis. Measurement with the Corneometer CM 420. *Acta dermato-venereologica* 1986;66:281-4.
 27. Hagstromer L, Kuzmina N, Lapins J, Talme T, Emtestam L. Biophysical assessment of atopic dermatitis skin and effects of a moisturizer. *Clinical and experimental dermatology* 2006;31:272-7.
 28. Nicander I, Ollmar S. Clinically normal atopic skin vs. non-atopic skin as seen through electrical impedance. *Skin research and technology : official journal of International Society for Bioengineering and the Skin* 2004;10:178-83.
 29. Sakurai K, Sugiura H, Matsumoto M, Uehara M. Occurrence of patchy parakeratosis in normal-appearing skin in patients with active atopic dermatitis and in patients with healed atopic dermatitis: a cause of impaired barrier function of the atopic skin. *Journal of dermatological science* 2002;30:37-42.
 30. Agner T. Skin susceptibility in uninvolved skin of hand eczema patients and healthy controls. *The British journal of dermatology* 1991;125:140-6.