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ORIGINAL ARTICLE

The Clinical Efficacy, Safety and Functionality of Anion Textile in the Treatment of Atopic Dermatitis

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Background: Several previous studies have suggested the improvement of atopic dermatitis (AD) in response to special fabrics. In particular, beneficial effects have been reported, following the use of anion textiles. **Objective:** The purpose of this study is to evaluate the effectiveness and safety of an anion textile in patients suffering from AD. **Methods:** We compared an anion textile with a pure cotton textile. Fifty-two atopic patients (n = 52) were enrolled and divided into two groups. The patients in the test (n = 25) and control (n = 19) groups wore undergarments made of an anion textile or pure cotton over a period of 4 weeks. The overall severity of disease was evaluated using the SCORing atopic dermatitis (SCORAD) index, whereas, the treatment efficacy was measured using a Tewameter® (Courage & Khazaka, Cologne, Germany), Mexameter® (Courage & Khazaka) and Corneo meter® (Courage & Khazaka). **Results:** At the end of the study, a significant decrease in the SCORAD index was observed among the patients with AD in the test group (mean SCORAD decreased from 47.2 to 36.1). Similarly, improvements in the mean transepidermal water loss, skin erythema and stratum corneum hydration were significantly greater among the patients with AD in the test group than in the control group. **Conclusion:** Anion textiles may be used to significantly improve the objective and subjective symptoms of AD, and are similar in terms of comfort to cotton textiles. The use of anion textiles may be beneficial in the management of patients with AD. **(Ann Dermatol 24(4) 438～443, 2012)**

-Keywords-
Anion textile, Atopic dermatitis

INTRODUCTION

Atopic dermatitis (AD) is a chronic relapsing inflammatory skin disease, which easily exacerbated by many irritants, including fabrics[1] and bacterial colonization[2,3]. Hermanns et al.[4] suggested that softened fabrics are less destructive and promote accelerated healing of the skin in patients with AD.

Several previous studies have suggested the clinical improvement of patients with AD in response to special fabrics in the area covered by the textile[5-12]. Anion textiles are composed of polyester fibers containing fine-crusted tourmaline that emits electromagnetic radiation in the far-infrared region and negative ions[13-15]. Far-infrared rays have been shown to positively affect several dermatologic diseases, including psoriasis[16] and AD[17-23]. The objective of this study is to evaluate the clinical efficacy, safety, and functionality of anion textiles in patients with AD.

MATERIALS AND METHODS

Patients and the study plan

This study was performed as a prospective, randomized, and placebo-controlled. Fifty-two patients, between 2 and 30 years of age with mild to severe AD who visited our dermatologic clinic between February and March 2007, were included in the study. Almost all of the included

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patients showed mild to moderate severity, a few severe patients who refused systemic steroid and other immunomodulatory agents were also included. Inclusion was based on the diagnostic criteria of Hanifin and Rajka[13]. The exclusion criteria included severe generalized disease; the use of antimicrobial agents, and immunomodulative therapy within 2 weeks of the study. A detailed patient history was obtained and disease severity was assessed using the SCORing atopic dermatitis (SCORAD) index[14] by a dermatologist. All of the subjects were volunteers and informed consent was obtained. All protocols and study plan was approved by our Institutional Review Board.

The patients were divided into two study groups, randomly: 30 patients received two pairs of undergarments made of anion textile (group A), while the other 22 patients received two pairs of undergarments made of pure cotton (group B). The subjects in the two groups were similar in age and clinical picture. The patients were asked to wear the undergarments at all times during the study period. Systemic and topical agent, including glucocorticoids, immunosuppressive and immunomodulatory, were not permitted in either group. Only low-sedating antihistamine and topical emollients were permitted to treat pruritus in some patients with severe itching sense.

Textiles

The undergarments used in this study were designed and produced by SEDA Co-operation Ltd. (Busan, Korea). The undergarments were made from an anion textile constructed from pure polyester filaments containing nano-sized fine-crusted tourmaline powder (Fig. 1). Tourmaline is a crystal boron silicate mineral compounded with elements, such as aluminium, iron, magnesium, sodium, or potassium. Tourmaline has pyroelectric and piezoelectric properties and radiated far-infrared rays and exhibit improved far infrared emission properties as the particle size decreases[24].

Evaluation of efficacy

Clinical efficacy was evaluated using the SCORAD index at the baseline (day 0) and after 1, 2, 3, and 4 weeks. All estimates were performed by the same dermatologist. To evaluate the skin barrier function in each patient, we measured transepidermal water loss (TEWL), stratum corneum hydration (SCH), and skin erythema, using the Multiprobe Adaptor System (MPA®; Courage & Khazaka Electronic, Cologne, Germany). This system included a TM 300 Tewameter® (Courage & Khazaka), a CM 825 Corneometer® (Courage & Khazaka), and an MX 18 Mexameter® (Courage & Khazaka). The Tewameter® was used to quantify the barrier status of the skin in terms of g/h/m^2. Corneometers® were used to quantify the relative hydration of the stratum corneum in terms of arbitrary units (AUs)[16], and Mexameters® were used to provide an index of erythema by estimating the hemoglobin content at 568 and 660 nm in terms of AUs[17,18].

Wearing comfort

To assess the wearing comfort of the textiles, the questionnaire used by Gauger et al.[9] in a previous report was administered at the end of the study. The patients or their parents, if the patients were too young to respond, answered the questions and the data were analyzed by the investigator.

Statistical analysis

Statistical analysis was performed using SAS version 9.1.3 (SAS Institute Inc., Cary, NC, USA). For comparison in the different phases of treatment, the repeated measures ANOVA and paired t-test were used in cases of unpaired and paired observation, respectively. *p*-values lower than 0.05 was considered as statistically significant.

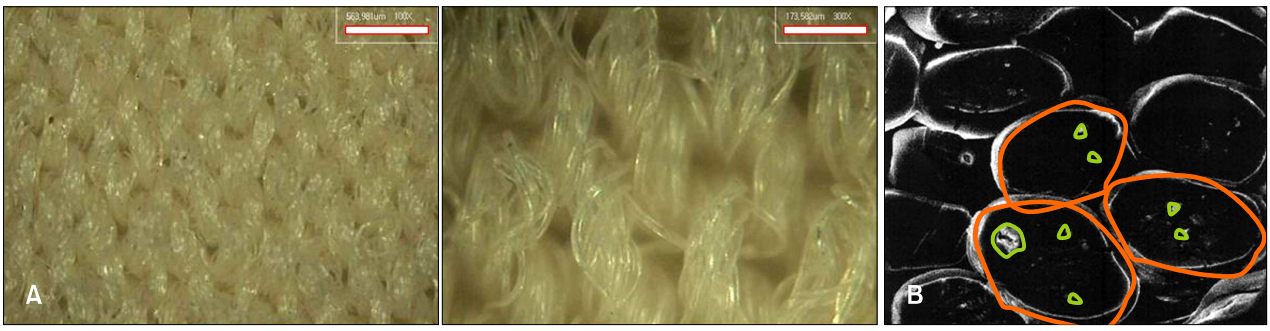

Fig. 1. Optical and electron microscopic structures of the anion textile. (A) ×100, ×300, (B) ×2,000. The anion textile fibers are regular and rounded without stubby ends, resulting in a smooth feeling overall. The polyester filaments (orange circle) contain nano-sized fine-crusted tourmaline powder (green circle).

RESULTS

A total of eight patients (five patients from the anion group and three patients from the cotton group) were dropped from the study due to noncompliance. Five patients (three patients from the anion group and two patients from the cotton group) were dropped because they complained about the wearing the undergarments at all times (from one week to three weeks). In these patients group, the mean SCORAD index changes were similar with the score of patients who completed the study protocol. Three patients (two patients from the anion group and one patient from the cotton group) dropped out because of severe, refractory pruritus (from one week to four weeks). All of these patients were initially included with high SCORAD index (the SCORAD index of these dropped patients were higher than 60). The remaining 44 patients (23 males and 21 females) completed the entire study protocol. The mean age of all the patients was 10.1 years (2 to 22 years). The mean initial SCORAD scores in groups A and B were 47.2 (range 25.7～81.7) and 41.8 (range 26.8～81.7), respectively. The means SCORAD score in group A at the baseline was slightly higher than that in group B, but the distribution between the two groups was similar.

Clinical efficacy using SCORAD index

In patients from group A who wore the anion textile garment, the mean SCORAD index decreased significantly from 47.2±14.0 to 36.1±16.5 ($p<0.0001$), compared to the baseline. In contrast, the mean SCORAD index of the subjects in group B, who wore the pure cotton textile garment, decreased only slightly from 41.8±16.3 to 37.7±17.2 ($p=0.0839$). Overall, the SCORAD index values between groups A and B were significantly different ($p=0.0308$) (Fig. 2). The mean objective SCORAD index, which accounts for the extent and intensity of disease, for group A decreased significantly from 36.0±12.2 to 28.6±14.1 ($p=0.0005$), compared to the baseline. In contrast, the mean index values for group B decreased only slightly from 31.9±14.1 to 29.0±14.2 ($p=0.0769$). Overall, no significant difference was observed between groups A and B ($p=0.0993$). The mean subjective index values (e.g., sleep loss and daytime pruritus) for group A decreased significantly from 11.6±3.7 to 7.4±4.4 ($p<0.0001$) compared to the baseline, whereas the value for group B decreased only slightly from 9.8±3.6 to 8.5±4.5 ($p=0.1067$). Overall, the difference between the values for groups A and B was statistically significant ($p=0.0064$).

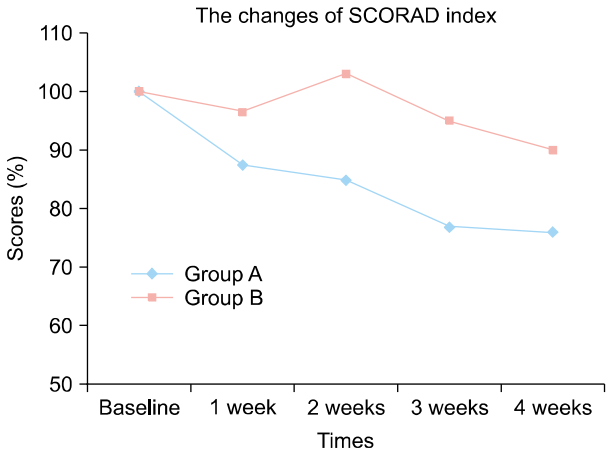

Fig. 2. The mean SCORAD index values for groups A and B during the study period. The values for group A decreased significantly at 4 week ($p<0.0001$); in addition, a significant difference was detected between the groups ($p=0.0308$). SCORAD: SCORing atopic dermatitis.

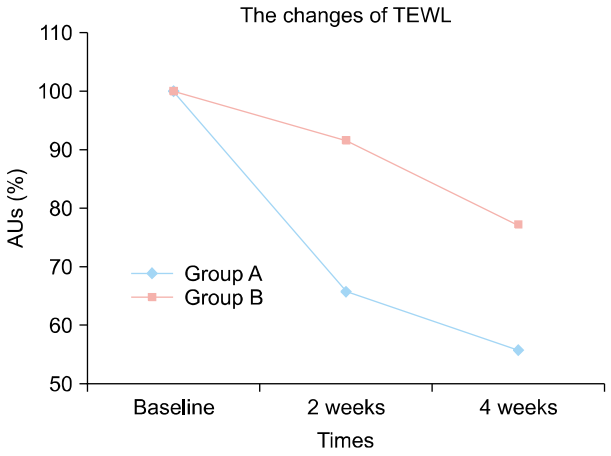

Fig. 3. TEWL from eczematous lesions on the flexor surface of the forearm. At 4 week, group A showed a significant decrease in mean TEWL compared to the baseline ($p<0.0001$) by using the repeated measures ANOVA. TEWL: transepidermal water loss, AUs: arbitrary units.

Barrier functions of the skin

The mean TEWL from eczematous lesions on the flexor surface of the forearm for group A decreased significantly, compared to the baseline from 37.1±17.1 to 20.7±15.5 g/h/m^2 ($p<0.0001$). Although the value for group B also decreased from 30.4±19.8 to 23.5±15.2 g/h/m^2, the reduction was not significant ($p=0.0607$). A significant difference was detected in the mean TEWL from eczematous lesions between groups A and B ($p=0.0359$) (Fig. 3). And no significant difference was observed in the mean TEWL from perilesional normal skin between groups A and B ($p=0.0822$). In all patients from both

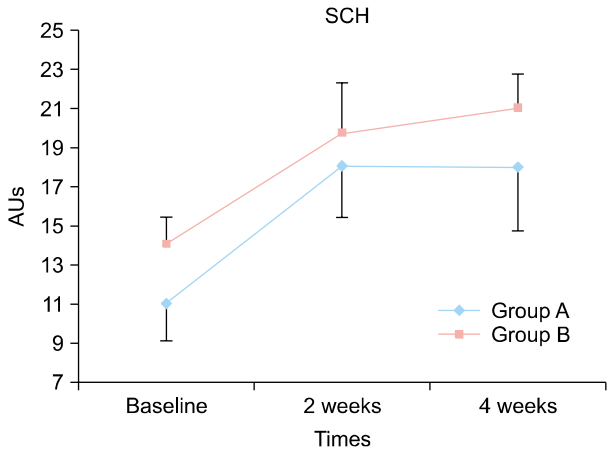

Fig. 4. Stratum corneum hydration (SCH) in eczematous lesions on the flexor surface of the forearm. At 4 week, group A showed a significant improvement in the mean SCH compared to the baseline ($p=0.0004$). Although group B also showed an improvement in the mean SCH compared with the baseline, it was not statistically significant. Values are expressed as mean±standard error of the mean. AUs: arbitrary units.

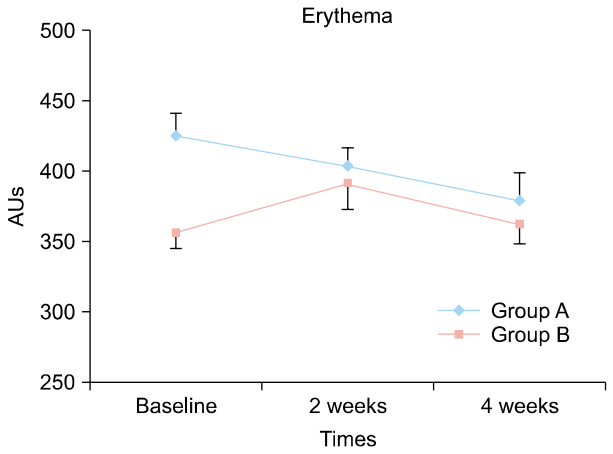

Fig. 5. Skin erythema in eczematous lesions on the flexor surface of the forearm. At 4 week, group A showed decreased mean skin erythema significantly compared to the baseline ($p=0.0025$) during the study period by using the repeated measures ANOVA. Values are expressed as mean±standard error of the mean. AUs: arbitrary units.

groups, the TEWL from eczematous lesions was consistently higher than that from the perilesional normal skin. The mean values for SCH in the eczematous lesions were 16.2±10.1 and 13.9±9.3 AUs, respectively, for groups A and B at the beginning of the study, and 26.1±13.0 and 24.3±11.2 AUs at the end of the study. The mean SCH value increased steadily in both groups; however, the improvement seen in group A was significant ($p=0.0004$), whereas that in group B was not ($p=0.0510$). In addition, no significant difference was seen in the mean SCH for eczematous lesions between groups A and B ($p=0.6788$) (Fig. 4). In all patients from both groups, SCH in the eczematous lesions was consistently lower than that in the perilesional normal skin, and the improvement detected were paralleled by an increase in the mean SCH values for both groups.

The mean skin erythema in eczematous lesions on the flexor surface of the forearm in group A decreased significantly from 425.6±75.8 to 379.6±91.4 AUs, compared to the baseline ($p=0.0025$). In contrast, the mean values for group B increased only slightly from 356.8±51.3 to 362.7±62.3 AUs ($p=0.0692$); a statistically significant difference, however, was detected in the mean values between groups A and B ($p=0.0106$) (Fig. 5). In all patients from both groups, the skin erythema values measured for the eczematous lesions were consistently higher than those measured for perilesional normal skin.

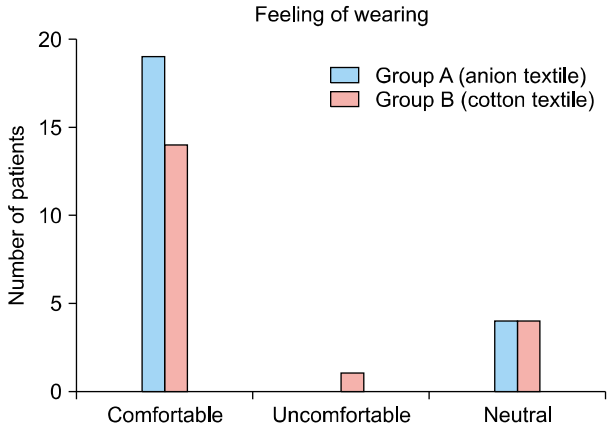

Fig. 6. The reported wearing comfort of the anion and cotton textiles.

Wearing comfort of the textiles

No feelings of discomfort in the skin, such as tingling, a pricking sensation, or pain due to the wearing of the textiles used, were reported. Nineteen of the patients (76%) in group A and 14 of the patients (74%) in group B reported that they felt comfortable wearing the textiles (Fig. 6).

Adverse events

Side effects due to the wearing of the anion and cotton undergarments, such as contact dermatitis, contact urticaria, and irritability, were not observed during the study period.

DISCUSSION

The skin of patients with AD is quite sensitive and easily aggravated by factors, such as detergents, variations in temperature from cold to hot and vice versa, and fabrics[1-4]. Textiles are used in the management of AD to provide a barrier against trauma and exogenous provocative factors[24-30]. Generally, clothes made from cotton fibers are recommended for patients with AD[21] because of their inherent properties, which include good folding endurance, heat conduction, and moisture absorption[7].

Anion textiles, which consist of polyester fibers containing tourmaline powder, radiate far-infrared rays[22] and have been found to emit negative ions using a Com-3010pro ion tester (Com System, Inc., Tokyo, Japan). Beneficial psychological and physiological effects from exposure to far-infrared rays and negative ions have been reported in humans[23-29], including sleep enhancement, increased growth, the potentiation of peripheral blood flow and body temperature, autonomic nervous system control, the inhibition of obesity, and bacteriolysis[22-26]. Although the mechanisms underlying these effects are not fully understood, Yoo et al.[26] demonstrated that tourmaline powders radiated far-infrared rays and that the radiation energy from the tourmaline powders elevated the human skin temperature. They thought that the measured skin temperature elevation might be the result of the acceleration of percutaneous blood circulation. Niwa et al.[22] moreover, suggested that far-infrared radiation could induce cellular activation in a variety of tissues by increasing [Ca^{2+}] uptake by the cell membrane, while Suzuki et al.[27] suggested that negative ions contribute to the inhibition of stress responses via a neural mechanism, involving the modulation of autonomic regulation. Also there are reports that daily treatment with an infrared lamp raised skin temperature, induced improvement in all patients within 3 weeks[23].

Although long term safety of tourmaline powders is not investigated, in mural model, the tourmaline ionizer system decreased the elevated blood pressure, and controlled the sympathetic nervous activity and the parasympathetic nervous activity[25]. In a human study using an infrared thermal analyzer, far-infrared rays of tourmaline powders showed therapeutic effects by changes of the skin temperature and no observable significant adverse effects[26].

In the present study, those patients that wore the anion textile (group A) showed an improvement in the SCORAD index, which considers both objective and subjective symptoms ($p<0.0001$), while those dressed in pure cotton (group B) showed mild improvements that were not statistically relevant. In addition, patients and parents of the patients in group A reported an improvement in their cutaneous lesions and subjective symptoms (e.g., interruption of the 'itch-and-scratch cycle'). Furthermore, we saw an improvement in the skin barrier function in patients who wore the anion textile as indicated by TEWL, SCH, and skin erythema in eczematous lesions on the flexor surface of the forearm ($p<0.0001$, $p=0.0004$, and $p=0.0025$, respectively). Those patients who wore cotton also showed improvement, but none of the values were statistically significant ($p=0.0607$, $p=0.0510$, and $p=0.0692$, respectively).

The reported concentration of negative ions in various environments was 40～50 ions/ml in an urban area, 400～600 ions/ml in a park, 700～1000 ions/ml in a rural area, and >20,000 ions/ml at a waterfall or beach. The concentration of negative ions was found to be positively correlated with feelings of comfort, refreshment, or pleasure. Therefore, anion textiles may have beneficial effects on both the skin and emotions of patients with AD.

In summary, the results of this study demonstrate the clinical efficacy and safety of anion textiles in the treatment of AD without adverse and/or allergic reactions. The anion textile, used in this study, reduced the clinical severity of AD and improved skin barrier function (e.g., TEWL, SCH, and skin erythema) within 4 weeks without adverse events. No feelings of skin discomfort due to the anion textile were reported; moreover, the wearing comfort and functionality of the anion and cotton textiles were found to be similar. Therefore, anion textiles may be helpful for the management of AD. To the best of our knowledge, this study is the first to consider the beneficial properties of this textile for the treatment of AD. In the future, the results of this study should be verified and additional research concerning the functions and effects of anion textiles should be conducted.

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