Release of Cervical Muscle Tension Improves Psychological Stress and Symptoms of Moderate-to-Severe Atopic Dermatitis: a Case Series with 20 Patients

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ABSTRACT

Introduction: Atopic dermatitis (AD) is a chronic relapsing inflammatory skin disease that is triggered by intense pruritus, impaired skin barrier function, and immune responses to allergenic substances. Break-through therapies for AD include molecular-targeted drugs and the effective management of severe symptoms of AD. However, patients with clinical improvements may continue scratching owing to the influence of psychological stress, which might lead to quick relapses of stressors and subsequent intensive scratching. New drugs may be ineffective because of such scratching behavior caused by stressors. Therefore, it may be useful to consider adjunctive treatment options that focus on external stressors as triggers of deterioration of AD. We hypothesized that improvement of psychological stress by relieving cervical muscle tension would reduce pruritus and atopic symptoms.

Methods: Overall, 21 patients with moderate-to-severe AD were treated to relieve cervical muscular tension using Spineliner SA201, which assists in osteopathic manipulative treatment. We assessed the subjective and objective symptoms of AD, cervical muscle tension, which was evaluated using cervical range of motion (ROM), and psychological burden. Only moisturizers were applied topically during the study period, and no topical corticosteroid therapy was used.

Results: Twenty patients who completed the treatment demonstrated improvement in the symptoms of AD: changes on the visual analog scale (VAS) for pruritus were $-44.2\%$, Eczema Area and Severity Index (EASI) was $-67.9\%$, thymus and activation-regulated chemokine (TARC) was $-56.2\%$, Hospital Anxiety and Depression Scale (HADS) was $-27.2\%$, sleep disturbance was $-49.7\%$, and Dermatology Life Quality Index (DLQI) was $-46.7\%$. Additionally, the cervical muscle tension improved significantly: changes in cervical ROM were $14.7\%$.

Conclusions: Release of cervical muscle tension may improve psychological stress and have an effect on moderate-to-severe AD.
PLAIN LANGUAGE SUMMARY

Atopic dermatitis is a chronic relapsing inflammatory skin disease triggered by intense pruritus, impaired skin barrier function, and immune responses. Standard dermatological therapies for patients with atopic dermatitis include topical glucocorticoid treatments. In some cases, scratching and inflammation could not be adequately controlled, a relapse could not be prevented after remission, and their efficacy is limited. Break-through therapies for atopic dermatitis include new molecular biological drugs, which have demonstrated significantly improved and effective management of severe atopic symptoms. However, patients with clinical improvements may continue scratching owing to psychological stress, which might lead to quick relapses of stressors and subsequent intensive scratching. New drugs may be ineffective owing to such scratching behavior caused by stressors. Therefore, it may be useful to consider adjunctive treatment options focusing on external stressors as triggers for worsening atopic dermatitis. We hypothesized that improvement of psychological stress by relieving cervical muscle tension would reduce pruritus and atopic symptoms. Overall, 21 patients with moderate-to-severe atopic dermatitis were treated to relieve cervical muscular tension using Spineliner SA201, which assists in osteopathic manipulative treatment. We assessed the subjective and objective atopic symptoms, cervical muscle tension, and psychological burden. Only moisturizers were applied topically during the study period, and no topical corticosteroid therapy was used. Twenty patients completed the treatment, atopic symptoms improved significantly, cervical muscular tension improved, and the psychological burden decreased with the treatment. Release of cervical muscle tension may improve psychological stress and affect moderate-to-severe atopic dermatitis.

Keywords: Atopic dermatitis; Cervical muscular tension; Itch–scratch cycle; Psychological stress

Key Summary Points

Why carry out this study?
Psychological stress may cause repeated scratching, which may lead to pruritus, and may perpetuate the itch–scratch cycle and aggravate atopic dermatitis (AD)
We suggest a new approach for treating psychological stress that causes acute exacerbation of AD and scratching habits

What was learned from the study?
The release of cervical muscle tension may improve psychological stress and affect moderate-to-severe AD
The release of muscle tension as a specific countermeasure to psychological stress can enhance the effectiveness of dermatological treatment for AD

INTRODUCTION

Atopic dermatitis (AD) is a chronic relapsing inflammatory skin disease triggered by intense pruritus, impaired skin barrier function, and type 2 helper T-cell immune responses to allergenic substances [1]. Standard dermatological therapies for patients with moderate-to-severe AD include topical treatments, such as topical glucocorticoids and calcineurin inhibitors to reduce cutaneous inflammation; however, scratching and inflammation could not be adequately controlled and relapse could not be prevented after remission in some cases, and their efficacy is limited [2]. Break-through therapies for AD include new drugs, such as dupilumab and upadacitinib, that have demonstrated significantly improved and effective management of severe symptoms of AD in the short term [3].

Despite good short-term outcomes, there is a lack of clinical research on the long-term effects of new AD drugs [4]. Furthermore, the same
mechanism might occur in patients with clinical improvements with molecular targeted drugs, thus resulting in a rapid relapse of stressors and subsequent intensive scratching [5]. A risk exists that drugs may no longer be effective because of the scratching behavior caused by stressors [5]. Therefore, it may be useful to consider adjunctive treatment options focusing on external stressors as triggers that worsen AD.

The management of AD with a focus on psychological stress includes autogenic training (AT) and progressive muscle relaxation (PMR) as relaxation methods; additionally, acupuncture has been reported to be effective as well [6][7]. Studies of the musculoskeletal system have also demonstrated that high levels of psychological stress can modulate the autonomic nervous system and induce increased muscle tension, especially neck stiffness [8]. Recently, Hosono et al. reported that the release of cervical muscular tension in three cases of moderate-to-severe AD improved neck stiffness, severe pruritus, sleep disturbances, and atopic symptoms [9]. However, they evaluated only three cases, and psychological factors were not fully considered in the evaluations. The study of psychological factors may provide additional clues to solve the potential future problems that may occur with molecular-targeted drugs.

We hypothesized that the improvement of psychological stress by relieving cervical muscle tension would reduce pruritus and atopic symptoms. This study analyzed the relationship between reduction in atopic subjective and objective symptoms, improvements in the cervical range of motion (ROM), and a decrease in the psychological burden in 20 patients with moderate-to-severe AD.

**METHODS**

**Patients and Treatment**

This study included 21 consecutive patients with moderate-to-severe AD examined at the Hosono Clinic, Tokyo, Japan, from July 2019 to December 2020. Patients were eligible to enroll in this study according to the following inclusion criteria: age ≥ 18 years; visual analog scale (VAS) score for pruritis of 50 mm, which has a range of 0–100 mm, with higher scores indicating worse itching [10]; a score of 3 (moderate) or 4 (severe) on the Investigator’s Global Assessment (IGA), which ranges from 0 to 4, with higher scores indicating worse disease severity [11]; and a score of more than 10 on the Eczema Area and Severity Index (EASI; scores range from 0 to 72, with higher scores indicating more severe disease) [12]. Patients were excluded if they had received any of the following: systemic treatment for AD within 4 weeks before participating in this study; topical calcineurin inhibitors or very potent or potent topical glucocorticoids within 2 weeks prior to the study; or moderately potent or mild topical glucocorticoids or antihistamines (systemic or topical) within 1 week before the study. None of the patients received ultraviolet radiation therapy during this period.

The patients were treated to release cervical muscular tension using Spineliner SA201 (Sigma Inc., Cranberry Township, PA, USA) [13], which can be used as an adjunct to osteopathic manipulative treatment [14]. The treatment was executed by the stimulation of resonance oscillation of the muscles at all contact points, which could be practiced in a single visit to the clinic. Each treatment session took approximately 10–15 min and was practiced once to twice a week for 3 months. Each patient received a total of 15 treatments. All patients discontinued topical corticosteroid treatments before this study. When rescue therapy was needed, we were prepared to use topical corticosteroids, but it was not required.

**Assessment of Clinical Efficacy**

The outcome measures and time schedules of this study are presented in Table 1. All the outcome measurements were evaluated before initiating the treatment. Patient-reported outcomes in this study included the VAS for pruritis, and the Patient-Oriented Eczema Measure (POEM), ranging from 0 to 28, with higher scores indicating worse severity [15]. Additionally, the minimal clinically important difference (MCID) in the POEM score has been
Table 1 Timetable of outcome measurements

|                      | Pre | Tx1 | Tx2 | Tx3 | Tx4 | Tx5 | Tx6 | Tx7 | Tx8 | Tx9 | Tx10 | Tx11 | Tx12 | Tx13 | Tx14 | Tx15 | Post |
|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|-----|------|
| **Patient-reported outcome** |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| VAS for pruritis     | O   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| POEM score           |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| VAS for sleep disturbance | O   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| 5-D pruritis scale   |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| HADS score           |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| PSQI score           |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| DLQI score           |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| SF36                 |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| **Dermatological findings** | O   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| EASI score           |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| IGA score            |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| BSA score            |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| **Laboratory testing** | O   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| TARC, LDH,           |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| eosinophil counts, IgE |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |
| **Cervical ROM**     | O   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |     |      |

BSA body surface area, EASI Dermatology Life Quality Index, EASI Eczema Area Severity Index, HADS Hospital Anxiety and Depression Scale, IGA Investigator's Global Assessment, IgE immunoglobulin E, LDH lactate dehydrogenase, POEM Patient-Oriented Eczema Measure, PSQI Pittsburgh Sleep Quality Index, ROM range of motion, SF36 Short Form-36 Health Survey, TARC thymus and activation-regulated chemokine, Tx treatment, VAS visual analog scale.
estimated as a change of 3.4 points [15]. The 5-D itch scale ranges from 5 to 25, with higher scores indicating a greater itching effect [16]. AD severity was assessed using EASI; a change of 6.6 points in the EASI score is the estimated MCID [15]. Additionally, IGA, which is scored from 0 (clear) to 4 (severe), and body surface area (BSA) affected by AD were also used. Hematological parameters were assessed, which included serum levels of thymus and activation-regulated chemokine (TARC), peripheral eosinophil counts, lactate dehydrogenase serum levels (LDH), and total immunoglobulin E serum levels (IgE). TARC serum levels (normal, < 450 pg/mL for adults) are related to AD severity [17]. The eosinophils in the peripheral blood (normal, 70–450/µL) are useful in estimating AD severity [18]. LDH serum levels (normal, 105–245 IU/L) are a useful parameter of AD severity in the short term [18]. Total IgE levels in serum (normal, < 170 IU/mL) are an indicator of the long-term response to the AD treatment [19–21]. Tension in the cervical muscle was assessed by measuring the cervical ROM using radiography, with higher scores indicating more flexibility and mobility and less stiffness [22].

Patient-reported outcomes regarding the psychological burden included the Hospital Anxiety and Depression Scale (HADS), VAS for sleep disturbance, Pittsburgh Sleep Quality Index (PSQI), Dermatology Life Quality Index (DLQI), and Short Form-36 Health Survey (SF-36v2). HADS screens for symptoms of anxiety and depression. It is scored on a scale of 0–21 for each subscale; a score ≤ 7 is normal, a score of 8–10 is considered borderline, and a score ≥ 11 indicates clinically significant anxiety or depression [23]. The VAS score for sleep disturbance ranges from 0 to 100, with higher scores indicating no sleep at all [24]. PSQI sets a range from 0 to 21, with higher scores indicating more sleep disturbance [25]. The DLQI has a range of 0–30, and higher scores are associated with a lower quality of life (QoL) [26, 27] and an MCID change of 4 points [27]. The SF-36v2 score ranges from 0 to 100, with higher scores indicating a greater health-related QoL (HRQoL) [28].

Only nonmedicated emollients were applied topically during the study period, and emollients with antioxidant or anti-inflammatory substances were not used. Topical medicated treatments [topical corticosteroids, calcineurin inhibitors, Janus kinase (JAK) inhibitors, antihistamines, antibiotic ointments, tars] and systemic treatments (oral corticosteroids, molecular-targeted drugs, or antiallergic medications) were not used.

This study was performed in accordance with the Helsinki Declaration of 1964 and its later amendments, and reviewed and approved by the local ethics review board in Tokyo (no. 635023-20181214). Documented informed consent was obtained from all patients.

Statistical Analysis

The Wilcoxon signed-rank test was conducted to examine the statistical significance of the differences pre- and post-treatment. Statistical analyses were processed with Excel 2019 (Microsoft, USA). The differences were considered to be statistically significant at \( p < 0.05 \).

RESULTS

Patient Characteristics

Overall, 21 patients participated in this study, and 20 completed the treatment (Table 2). One patient experienced an exacerbation, was
hospitalized, and withdrew from the study owing to psychological stress caused by a natural disaster. The mean overall duration of treatment was 76 (42–133) days.

### Clinical Efficacy of Itch and Other Cutaneous Symptoms

The VAS score for pruritus decreased significantly after the treatment (Table 3 and Fig. 1a). The total POEM and 5-D itch scores improved significantly compared with the respective pre-treatment scores (Table 3). Regarding itch frequency on POEM, all patients experienced pruritus daily during the week before the treatment, and 80% (16/20) of them described experiencing pruritus every day of the week after the treatment (Table 4). Regarding the duration of itch on the 5-D pruritus scale, 70% (14/20) of the patients experienced pruritus for at least 12 h per day before the treatment, and 15% (3/20) of patients reported pruritus for at least 12 h per day after the treatment. The degree of itch was graded as unbearable and severe on the 5-D pruritus scale by 30% (6/20) and 60% (12/20) of patients before the treatment, respectively; after the treatment, 0% and 30% (6/20) of patients reported their itch as unbearable and severe, respectively. Concerning improvement or worsening, 35% (7/20) and

| Table 3 Outcome comparison between pre- and post-treatment |
|-----------------|-----------------|-----------------|
| **Itch and other cutaneous symptoms** | **Pre** | **Post** | **p** |
| VAS for pruritis (SD) | 87.2 (9.0) | 48.6 (24.7) | < 0.01* |
| POEM score (SD) | 24.1 (4.1) | 20.6 (7.3) | < 0.01* |
| 5-D pruritus scale (SD) | 19.9 (2.1) | 14.0 (2.7) | < 0.01* |
| EASI score (SD) | 36.3 (10.2) | 11.6 (6.0) | < 0.01* |
| BSA score (SD) | 74.7 (10.2) | 37.5 (15.2) | < 0.01* |
| IGA score of 4, N (%) | 17 (85) | 0 (0) |

### Laboratory testing

| **Laboratory testing** | **Pre** | **Post** | **p** |
|------------------------|---------|---------|-------|
| TARC (SD) | 6988.4 (5480.7) | 3057.5 (3886.8) | 0.010* |
| LDH (SD) | 340.1 (91.1) | 287.0 (78.8) | < 0.01* |
| Eosinophil counts (SD) | 1505.2 (777.3) | 1056.9 (634.3) | 0.011* |
| IgE (SD) | 6256.1 (5480.7) | 6589.4 (5741.6) | 0.596 |
| Cervical ROM (SD) | 95.9 (15.4) | 110.2 (10.1) | < 0.01* |

### Psychological burden

| **Psychological burden** | **Pre** | **Post** | **p** |
|--------------------------|---------|---------|-------|
| HADS score (SD) | 18.1 (6.0) | 13.1 (7.5) | 0.024* |
| VAS for sleep disturbance (SD) | 82.8 (13.7) | 41.6 (23.7) | < 0.01* |
| PSQI score (SD) | 13.9 (2.1) | 9.2 (3.7) | < 0.01* |

| Table 3 continued |
|-------------------|---------|---------|-------|
| **Pre** | **Post** | **p** |
| DLQI score (SD) | 21.6 (3.7) | 11.5 (6.6) | < 0.01* |

BSA body surface area, DLQI Dermatology Life Quality Index, EASI Eczema Area Severity Index, HADS Hospital Anxiety and Depression Scale, IGA Investigator's Global Assessment, IgE immunoglobulin E, LDH lactate dehydrogenase, N number, POEM Patient-Oriented Eczema Measure, PSQI Pittsburgh Sleep Quality Index, ROM range of motion, SD standard deviation, TARC thymus and activation-regulated chemokine, Tx treatment, VAS visual analog scale

*p < 0.05 by Wilcoxon signed-rank test

*p < 0.05 by Wilcoxon signed-rank test
50% (10/20) of patients reported that their symptoms worsened and remained unchanged before the treatment, respectively; after the treatment, 5% (1/20) each reported their symptoms were worsened and unchanged, respectively. Before the treatment, 15% (3/20) and 0% of patients reported that itching was slightly better but still present and much better but still present, respectively; after the treatment, 45% (9/20) of patients reported that itching was slightly better or much better but still present.

EASI, IGA, and BSA scores were significantly improved after the treatment (Table 3). In the EASI score, 95% (19/20) of patients reached EASI-50, 45% (9/20) reached EASI-75, and none reached EASI-90 (Table 5). A two-grade reduction of IGA score from the baseline was achieved by 40% (8/20) of the patients, and 5% (1/20) of patients had IGA scores of 0 (clear) or 1 (almost clear) after the treatment (data not shown).

Clinical Efficacy Based on Laboratory Results

The serum TARC and LDH levels, as well as the eosinophil count in the peripheral blood, were significantly improved after the treatment. However, the change in the serum total IgE levels did not achieve statistical significance (Table 3 and Fig. 2).
Clinical Efficacy of Release of Cervical Stiffness

Cervical ROM, which is related to neck stiffness, was significantly improved. The average cervical ROM was 95.9° before the treatment and improved to 110.2° after the treatment (Table 3 and Fig. 1b).

Clinical Efficacy of Psychological Burden

The total HADS score decreased significantly after the treatment (Table 3). Before the treatment, 45% (9/20) of the patients had subscale scores of at least 11 for anxiety or depression, which is regarded as the threshold value in anxiety or depression clinical cases. The percentage of patients with anxiety or depression subscale scores of 11 or higher decreased to 30% (6/20) after the treatment (Table 6). The VAS score for sleep disturbance and the PSQI score, which strongly suggests sleep disturbance, significantly decreased after the treatment (Table 3 and Fig. 1c). The total DLQI score, which coincides with a significant impact on the patients’ daily lives, decreased significantly after the treatment (Table 3 and Fig. 1d).

Additionally, SF36v2 is a self-administered generic HRQoL questionnaire composed of 36 items related to eight domains and three summaries. It demonstrated significant improvements in the domains of role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH), and a mild change in physical functioning (PF) after the treatment (Table 7). The physical component summary (PCS) did not change, while the mental component summary (MCS) and role-social component summary (RCS) significantly improved (data not shown).
DISCUSSION

In this study, our treatment in 20 patients demonstrated improvement in the symptoms of AD: changes on the VAS for pruritus were $-44.2\%$, EASI was $-67.9\%$, TARC was $-56.2\%$, HADS was $-27.2\%$, sleep disturbance was $-49.7\%$, and DLQI was $-46.7\%$. The improved POEM, EASI, and DLQI scores exceeded the respective MCID values. Additionally, cervical muscle tension improved significantly: changes in the cervical ROM were $14.7\%$.

Forty patients with AD were treated with dupilumab in a single-center study on molecular-targeted drugs in Japan [29]. The study reported that EASI and IGA scores were significantly improved, and serum levels of TARC and LDH were markedly reduced by the treatment. Approximately $90\%$ of participants reached EASI-50, $72.5\%$ reached EASI-75, and $22.5\%$ reached EASI-90. Although the effectiveness of the present treatment is considered inferior in terms of EASI achievement rate, it is considered similar to that of molecular-targeted drugs. Additionally, we evaluated psychological stress, which was not examined in that study.

Pruritus triggered by psychological stress causes scratching and forms a vicious cycle that worsens AD [30]. Therefore, countermeasures against stress are considered important [31]. It has been highlighted that stress-induced scratching may worsen atopic symptoms even after treatment with molecular-targeted drugs [5]. Scratching worsens pruritus, causes sleep disturbance, and lowers HRQoL, which in turn worsens AD [30]. Stress has been evaluated in the past [32] and is believed to be correlated with depression and anxiety symptoms [33]. It
worsens the symptoms of depression and anxiety, causes sleep disturbances, and lowers HRQoL [34]. Anxiety stimulates a type 2 helper T-cell immune response that promotes IgE synthesis [35]. It is also known that stress increases muscle tension in the neck [8].

Reduction of stress improves the atopic symptoms, and mind–body therapies, such as PMR and acupuncture, have been highlighted as adjunctive therapies [36]. In a study of PMR in AD, EASI scores and stress markers were reported to improve [37]. In another study on acupuncture, improvements in EASI scores were reported [38], and psychological interventions were also effective in treating atopic pruritus [7].

Exercise is also important in regulating skin metabolism [39]. In the relationship between exercise and AD, sweating is believed to be a worsening factor in AD; however, exercise may positively affect AD [40]. Exercise improves blood circulation and relieves muscle tension; however, no study has directly targeted cervical muscle tension in AD.

In this study, the release of cervical muscle tension using Spineliner SA201 for moderate-to-severe AD showed improvement in itching and other atopic symptoms and allergy-related markers without standard dermatological treatments, such as topical corticosteroids and molecular-targeted drugs. This treatment also reduced HADS, which correlates with psychological stress, and significantly improved VAS scores for sleep disturbances. DLQI and SF36v2 scores, which are associated with HRQoL, also improved. These results reflect a reduction in psychological stress, which improved pruritus, atopic symptoms, and immune response by releasing cervical stiffness (Fig. 3).

Table 6 Comparison of HADS score between pre- and post-treatment

|                  | Pre  | Post | p     |
|------------------|------|------|-------|
| HADS total score | 18.1 | 13.1 | 0.024*|
| HADS-A score     | 10.0 | 7.7  | 0.061 |
| HADS-A ≥ 11, N (%)| 8 (40)| 6 (30)|       |
| HADS-A ≥ 8, N (%) | 12 (60)| 10 (50)|      |
| HADS-D score     | 8.2  | 5.4  | 0.021*|
| HADS-D ≥ 11, N (%)| 4 (20)| 1 (5) |       |
| HADS-D ≥ 8, N (%) | 11 (55)| 3 (15)|       |

HADS Hospital Anxiety and Depression Scale, HADS-A Hospital Anxiety and Depression Scale anxiety, HADS-D Hospital Anxiety and Depression Scale depression, N number

*p < 0.05 by Wilcoxon signed-rank test

Table 7 Comparison of SF36 between pre- and post-treatment

|                  | Pre       | Post       | p     |
|------------------|-----------|------------|-------|
| Physical functioning | 71.3 (22.4)| 80.8 (20.8)| 0.172 |
| Role physical     | 31.9 (27.9)| 59.1 (31.0)| < 0.01*|
| Bodily pain       | 38.1 (29.2)| 59.4 (28.2)| 0.024*|
| General health    | 38.5 (19.2)| 51.8 (19.8)| 0.037*|
| Vitality          | 31.9 (18.2)| 52.8 (18.7)| < 0.01*|
| Social functioning| 31.9 (24.5)| 66.3 (22.3)| < 0.01*|
| Role emotional    | 32.9 (35.8)| 68.3 (29.7)| < 0.01*|
| Mental health     | 36.0 (19.6)| 64.3 (19.9)| < 0.01*|

SF36 Short Form-36 Health Survey

*p < 0.05 by Wilcoxon signed-rank test
A mismatch is observed between the improvement of pruritus and skin lesion reductions. The Spineliner SA201 treatment in this study reduces atopic pruritus and psychological stress but may not be potent enough to suppress skin inflammation directly. In addition, the lack of topical corticosteroids to reduce skin inflammation might be the reason for the mismatch between improvement of pruritus and skin lesion reduction.

This treatment has no side effects, unlike drugs such as corticosteroids and molecular-targeted drugs, although the appropriate treatment duration and termination still needs to be studied. In addition to the effects of this treatment on AD, it is expected to enhance the therapeutic effects of corticosteroids and molecular-targeted drugs, which may contribute to increasing the treatment options for AD. Psychological conditions, and atopic symptoms, need to be the targeted focus of treatment, even with molecular-targeted drugs.

This study has several limitations. This study included a small group of patients, which may have resulted in sample bias, a short duration of Spineliner SA201 treatment, and a short follow-up period. Additionally, our results may not be applicable to any other population groups, such as older patients and children. Finally, establishing a causal relationship between improvements in psychological stress and atopic symptoms was not possible in this study. Further clinical trials with larger study populations are required, and case-control studies are planned.

CONCLUSION

The release of cervical muscle tension may improve psychological stress and affect the symptoms of moderate-to-severe AD.

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Compliance with Ethics Guidelines. This study was reviewed and approved by the local Ethics Review Board in Tokyo (no.635023–20181,214) and performed in accordance with the Helsinki convention on human rights. The documented informed consent was obtained from all patients.

Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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