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Improvement of Post-inflammatory Hyperpigmentation, Subsequent to Cold Atmospheric Plasma Treatment, in a Patient with Atopic Dermatitis

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Cold atmospheric plasma (CAP) is a material that generates free radicals through the ionization of air. Despite the application in various medical fields, the efficacy and safety of CAP on post-inflammatory hyperpigmentation due to atopic dermatitis have not been reported. Herein, we report the improvement in post-inflammatory hyperpigmentation of atopic dermatitis, after CAP treatment of three sessions weekly, 10 minutes per session. We examined the clinical severity indexes before and after treatment, including the Investigator's Global Assessment, modified Atopic Dermatitis Antecubital Severity, Eczema Area and Severity Index, and pruritus visual analogue scores. Our results indicate that CAP alleviates the post-inflammatory hyperpigmentation and clinical severity of atopic dermatitis, and effectively improves the atopic skin lesion without severe safety issues. We believe that the previously reported anti-bacterial effects and production of interleukin-6 after CAP treatment are probably responsible for the underlying mechanisms leading to clinical improvement.

Key words

Cold atmospheric plasma; Post-inflammatory hyperpigmentation; Atopic dermatitis

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INTRODUCTION

Atopic dermatitis is a chronic, recurrent inflammatory skin disease, for which pruritus is a main symptom. Persistent pruritus leads to physical damage due to repeated scratching, resulting in accelerated skin inflammation. The inflammation ultimately causes post-inflammatory hyperpigmentation (PIH), which is not only a cosmetic problem but also reduces patient's quality of life. Therefore, there is a need for a new treatment that blocks the inflammatory processes of the damaged skin barrier, persistent pruritus, and the physical damage of scratching. Herein, we report the improvement of PIH of atopic dermatitis after cold atmospheric plasma (CAP) treatment.

CASE REPORT

A 32-year-old man presented with erythematous patches with scales on his trunk and upper extremities due to prolonged itchy atopic dermatitis. He had experienced atopic dermatitis since childhood and used emollients and topical corticosteroids. PIH was prominent, especially on the flexor and extensor surfaces of both arms. He was treated with a CAP device (Medipl Derm; MediPL, Gyeonggi, Korea) on his left arm for 10 minutes once weekly for 3 weeks and received treatment with a sham device for the same duration and frequency on his right arm as a control. The Investigator's Global Assessment (IGA) scale, Eczema Area and Severity Index (EASI), pruritus visual analogue scale (VAS), and modified Atopic

Dermatitis Antecubital Severity (ADAS) scores were also assessed on the first and final visits. After three treatments with the CAP device, the hyperpigmentation on his arms dramatically improved (Fig. 1, 2). Additionally, the IGA (3 to 0), EASI (10 to 6.5), pruritus VAS (7 to 2), and modified ADAS (85 to 0) scores all decreased. There were no safety issues due to CAP treatment during the visits. The patient was also satisfied with the alleviation of the hyperpigmentation. The improvement has been maintained for 4 months until the last follow up.

DISCUSSION

The application of plasma devices has been a recent focus in the field of dermatology. Specifically, Ar microwave plasma, a recently-developed medical plasma device, boosts skin regeneration and wound healing by increasing interleukin (IL)-6 and transforming growth factor (TGF)- β in the skin.¹ An anti-bacterial effect has also been reported, with a 7.86-fold decrease in the number of bacteria on a chronic, refractory wound.²

Patients with atopic dermatitis are susceptible to secondary infections due to the damaged skin barrier. *Staphylococcus aureus* is identified in 90% of the skin lesions of adult patients with atopic dermatitis. Particularly in the aggravation phase of atopic dermatitis, the diversity of microbiota decreases sharply, making *S. aureus* dominant in the skin lesions. Recent studies suggest that medications for atopic dermatitis, including topical corticosteroids and topical calcineurin inhibitors, play a role in restoring the diversity of the skin microbiome and suggest

Fig. 1. (A) Flexor surfaces of both arms before treatment (visit 2). (B) Flexor surfaces of both arms after three weekly treatment sessions (visit 5).

Fig. 2. (A) Extensor surfaces of both arms before treatment (visit 2). (B) Extensor surfaces of both arms after three weekly treatment sessions (visit 5).

that the reestablishment of the diversity of skin microbiome contributes to the improvement of atopic dermatitis. Therefore, argon microwave plasma with antibacterial effects may improve atopic dermatitis lesions not only by preventing secondary infections but also by creating a heterogeneous skin microbiome.

Recent studies reported that IL-1, IL-4, IL-6, and other inflammatory mediators regulate human epidermal melanocyte proliferation and differentiation.⁴ Among these, IL-6, the levels of which increase after CAP treatment, decreases tyrosinase activity and melanogenesis.⁵ This may be a key regulator to prevent post-inflammatory hyperpigmentation caused by atopic dermatitis.

This is the first report in human skin to evaluate the efficacy of CAP on postinflammatory hyperpigmentation of atopic dermatitis. We believe this novel device to be a promising therapeutic option for chronic dermatosis, particularly atopic dermatitis.

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CONFLICT OF INTEREST

None declared.

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