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CASE REPORT

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Deposition and Retention of Hair Care Product Residue Over Time on Specific Skin Areas

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BACKGROUND

Hair care products can cause acne. Pomade acne was originally described in African American men and characterized primarily by closed comedones on the forehead and temples from frequent use of oils and thick emollients for the hair and scalp. More recently pomade acne has been described in all skin types, and in both men and women. The American Academy of Dermatology also discusses acne cosmetica on the hairline, forehead, and back of the neck from hair care products. There are also numerous reports from dermatologists' clinical experience and in the popular press about hair care products causing acne in other areas, including the scalp, face (not just forehead), chest and back. These reports include rinse off products like shampoo causing acne. The mechanism for hair care products causing acne, for both rinse-off and leave-in formulations, has not yet been fully described.

METHODS

The objective of this study was to evaluate and visualize the deposition of both rinse-off and leave-in hair care products residue on the scalp, forehead, cheek, and top of the back utilizing ATR-FTIR imaging spectroscopy.

D-Squame tapes were applied to the skin areas of interest in a single female subject with long hair before hair treatment, and at different time points after application of shampoo and conditioner. The shampoo and conditioner were rinsed off normally during a regular shower and the head was allowed to dry for 20 mintues. D-squame tapes were applied and collected on the skin areas of interest after 30 minutes, 1 hour, 2 hours for the shampoo and conditioner.

D-squame tapes were applied to the skin areas of interest in the same female subject 3 days later before hair treatment, and after using a leave-in styling product. D-squame tapes were applied and collected on the skin areas of interest after 30 minutes, 1 hour, 2 hours, and 4 hours for the leave-in styling product. D-squame tapes were then scanned by ATR-FTIR imaging spectroscopy to assess hair product deposition on the specific skin areas at various time points (Figure 1).

The top selling shampoo, conditioner, and styling cream in U.S. salons (based on Kline PRO database Q1-Q3 2018) was used for the study. FTIR spectra were recorded on the shampoo, conditioner, and styling product to identify infrared (IR) markers that could be used to follow specifically hair product deposition on the skin. The IR markers were in a spectral area with almost no skin contribution in this spectral area (Figure 2, Figure 3).

To visualize the presence of hair products on specific skin areas before and after treatment, we generated specific ATR-FTIR images from skin cells extracted by the D-squame tapes. There is absence (dark blue) of hair product residue before applying shampoo/conditioner or the leave-in styling product. Up to 2 hours after using shampoo and conditioner, there is significant (red, yellow, green) hair product deposition remaining on the scalp (Figure 4), forehead, cheek, and upper back (Figure 5). Up to 4 hours after using the leave-in styling product, there is significant (red, yellow, green) hair product deposition remaining on the scalp (Figure 6), forehead, cheek, and upper back (Figure 7).

All the FTIR images were acquired with a Spotlight 400 imaging system (Perkin Elmer Instruments, USA) using a MCT (mercury-cadmium-telluride) focal plane array detector. FTIR Images were collected in reflective mode with an ATR imaging accessory at a spectral resolution of 4 cm^{-1} in the mid-infrared (MIR) region between 4000 and 750 cm^{-1} with a spatial resolution of 6.25 x 6.25 µm and sample size of 300 x 300 µm. These conditions allowed us to obtain good quality spectra with acceptable recording time (7 minutes per hyperspectral image).

This FTIR Imaging System produces hyperspectral images that can provide maps showing the co-localization of specific molecular components or spectroscopic parameters. These images are generated with false colors where the red represent highest values and blue lowest values for each parameter investigated. These images were used to visualize the deposition and the retention of rinse-off and leave-in hair products on the skin surfaces at specific locations.

All the FTIR spectra and FTIR images presented in this study were processed using GRAMS/AI (Thermo Fisher Scientific) or ISys software from Spectral Dimensions (Olney, MD). Us-

FIGURE 1. D-squame tapes were applied on the scalp, forehead, cheek, and top of the back before treatment with hair care products (control), and at various time points after using shampoo and conditioner, and a leave-in styling product.

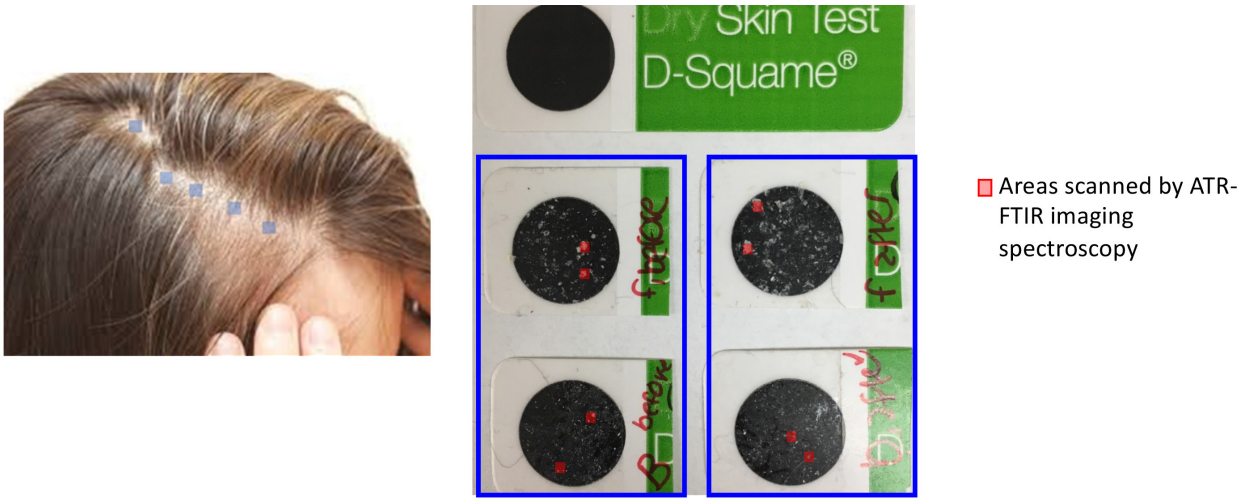


FIGURE 2. FTIR spectra recorded on the shampoo (blue) and the conditioner (red) used for this study as well as the spectrum recorded on untreated human skin (black). The red ellipses show the IR bands which can be used to follow specifically the hair products used to treat the hairs. Indeed there is almost no skin contribution in this spectral area. The band around 800cm^{-1} was used in this study to investigate if after the washing step some hair product residues were still present at the surface of different skin locations.

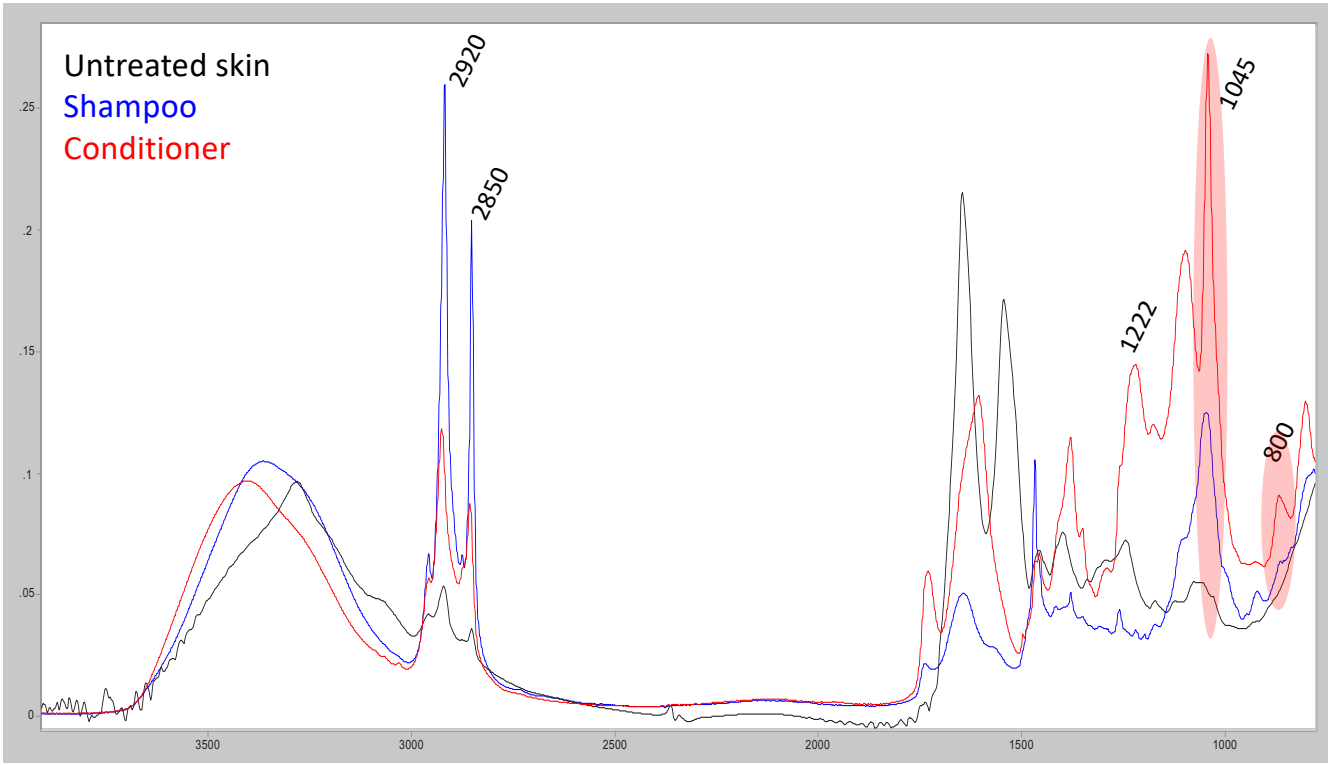


FIGURE 3. FTIR spectrum recorded on leave-in hair styling product used for this study. The red ellipse shows the IR marker that was used to follow specifically the leave-in styling product used to treat the hairs. Indeed, there is almost no skin contribution in this spectral area. The band around 800cm^{-1} was used in this study to investigate over time the deposition of leave-in product at the surface of different skin locations.

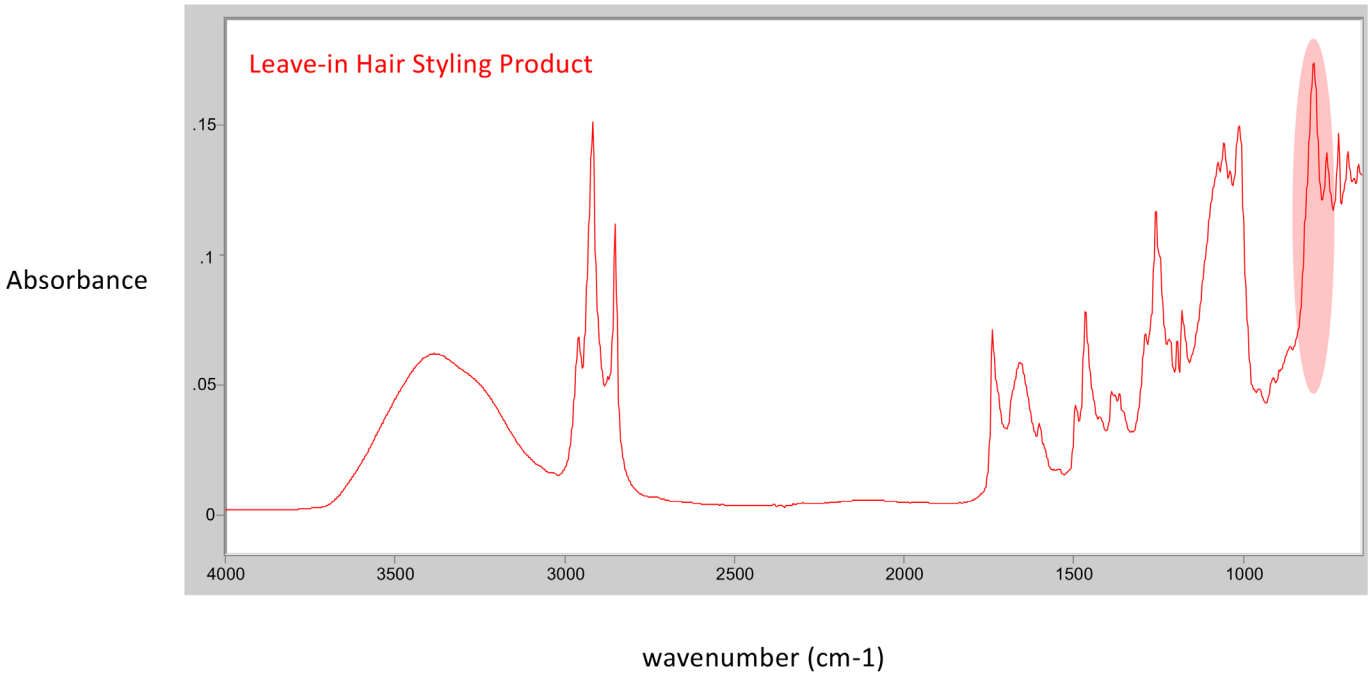


FIGURE 4. To visualize the presence of rinse off hair products (shampoo and conditioner) on the scalp before and after treatment, we generated specific ATR-FTIR images from skin cells extracted by the D-squame tapes. The ATR-FTIR image shows the 830-770 cm^{-1} band area. This band is specific of the hair products used. The higher the value the redder the image is, and the higher the deposition of hair product is on the scalp.

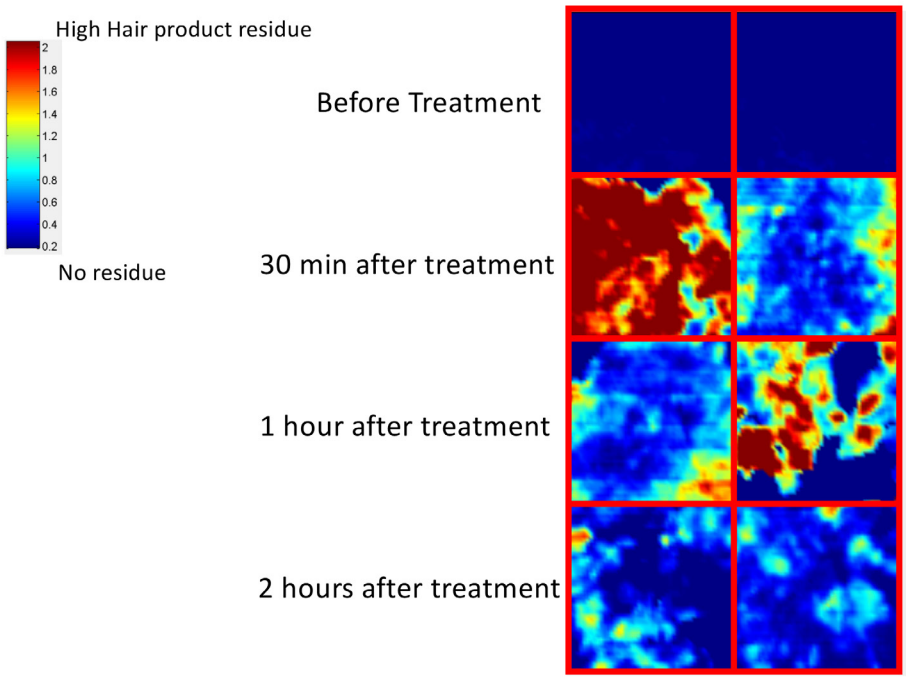


FIGURE 5. To visualize the presence of rinse off hair products (shampoo and conditioner) on the back, forehead, and cheek before and after treatment, we generated specific ATR-FTIR images from skin cells extracted by the D-squame tapes. The ATR-FTIR image shows the 830-770 cm^{-1} band area. This band is specific of the hair products used. The higher the value the redder the image is, and the higher the deposition of hair product is on the skin.

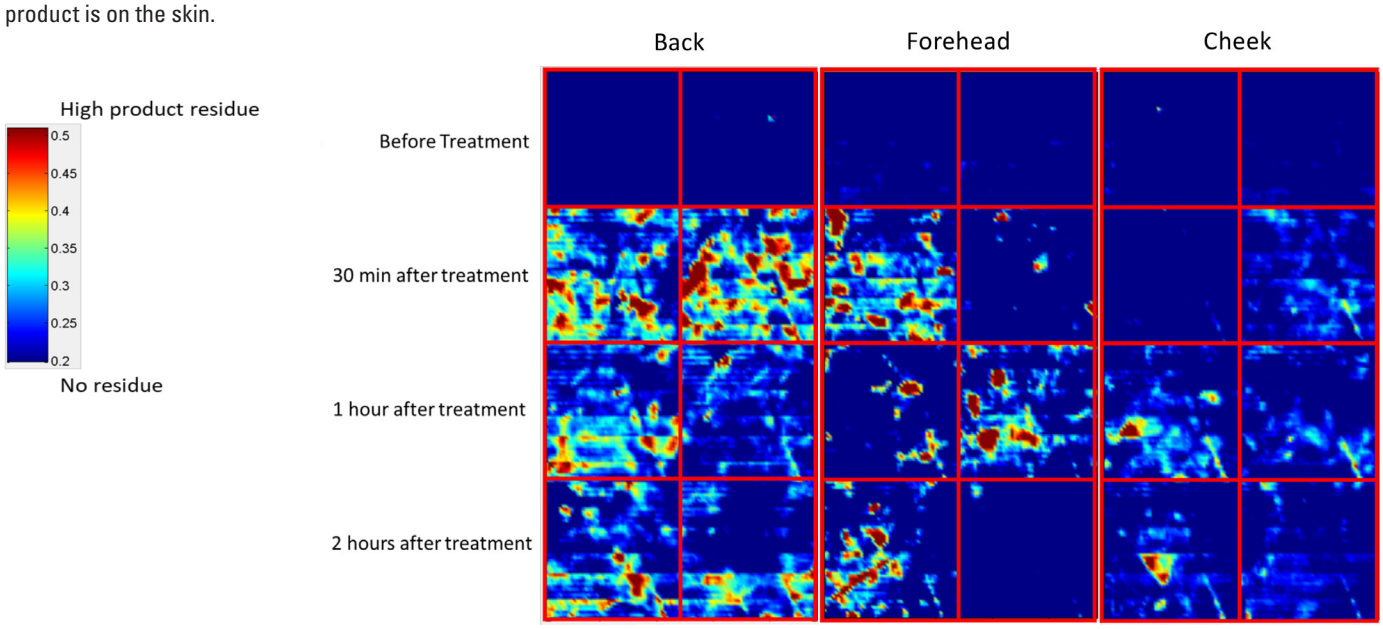


FIGURE 6. To visualize the presence of leave-in styling hair product on the scalp before and after treatment, we generated specific ATR-FTIR images from the skin cells extracted by D-squame tapes. The ATR-FTIR image shows the 830-770 cm^{-1} band area. This band is specific of the hair product used. The higher the value the redder the image is, and the higher the deposition of hair product is on the surface of the scalp.

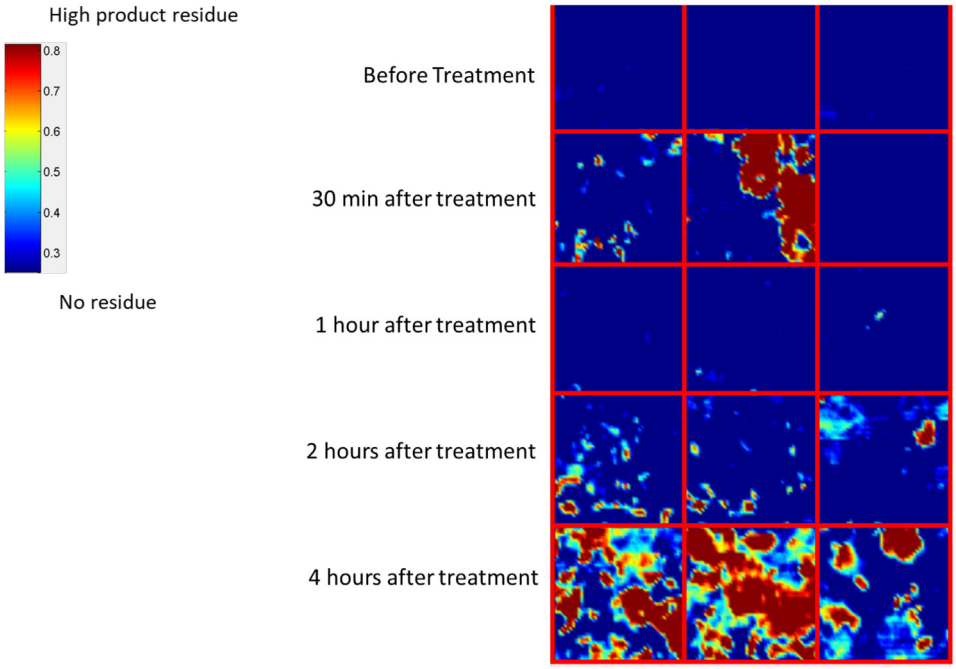
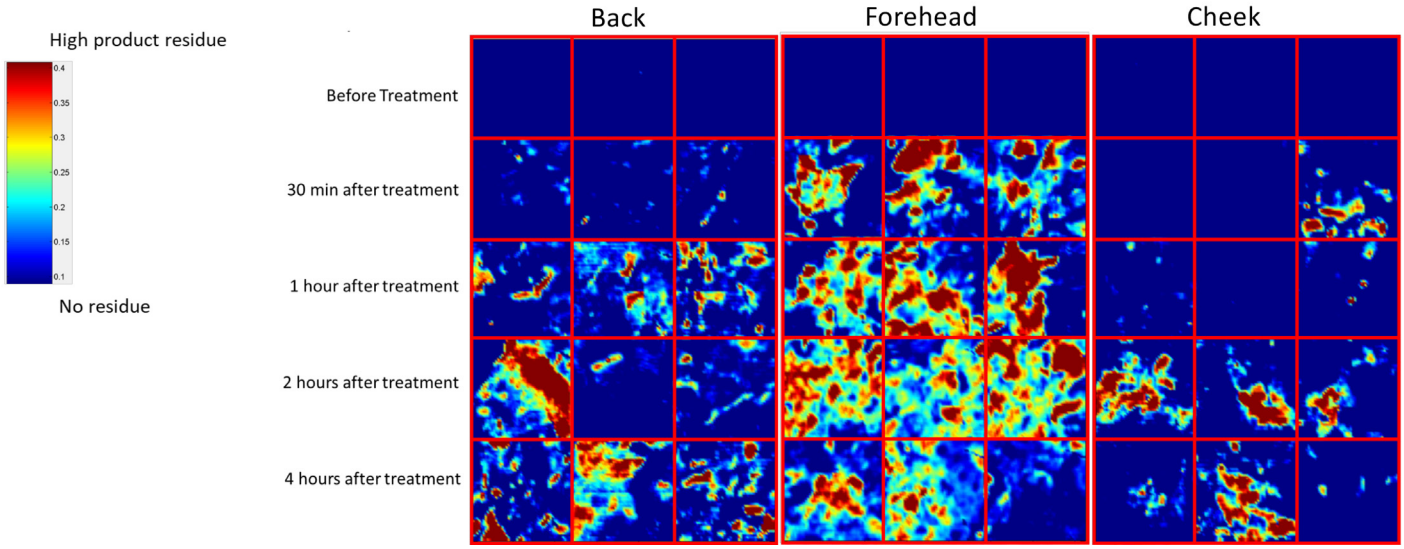


FIGURE 7. To visualize the presence of leave-in styling hair product on the back, forehead, and cheek before and after treatment, we generated specific ATR-FTIR images from the skin cells extracted by D-squame tapes. The ATR-FTIR image shows the 830-770 cm^{-1} band area. This band is specific of the hair product used. The higher the value the redder is the image is, and the higher the deposition of hair product is on the skin.



ing this software, spectroscopic parameters were defined to investigate specifically the hair products used in this study on the skin surface.

DISCUSSION

These findings indicate that shampoo and conditioner are not totally removed after rinsing, and a significant amount of rinse off hair care products end up on our scalp, forehead, cheek, and upper back. And the residue on the skin from the leave-in styling product actually increased over time, with the greatest amount of residue occurring 2-4 hours after application. We did not measure beyond 2 hours for the rinse-off products and 4 hours for the leave-in products. We did not assess skin areas beyond those referenced.

To our knowledge this is the first report demonstrating that hair care products deposit on specific skin areas (scalp, face, back), and stay on the skin for hours after using them. These findings may explain reports of acne from hair care products which are not commonly tested for comedogenicity and often have ingredients with a high propensity for comedogenicity. People may be bathing in comedogenic ingredients daily via their hair care products without realizing it.

Further research would be useful to demonstrate the other skin areas on which hair care products may deposit, and the full duration that the products stay on the skin.

CONCLUSION

Given these findings, hair care products should be considered as a potential contributing factor for acne. In addition, hair care products should be tested in a similar manner as skin care products, including with comedogenicity testing and repeat insult patch testing (RIPT) testing for allergy and irritation.

DISCLOSURES

Iris K Rubin, MD is Founder and Chief Medical Officer of SEEN Hair Care, Bethesda, MD. Study performed by Samuel Gourion-Arsiquaud (Ph.D) Director at TRI Princeton.

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CASE REPORT

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Treating Field Cancerization by Ablative Fractional Laser and Indoor Daylight: Assessment of Efficacy and Tolerability

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ABSTRACT

Objective: To assess if ablative fractional laser combined with indoor daylight photodynamic therapy are effective and safe for the treatment of skin field cancerization associated with actinic keratosis (AK).

Methods: A total of 46 patients with field cancerized skin and AK were treated by a single session of laser assisted drug delivery (LAAD) and indoor daylight photodynamic therapy (IDL-PDT). LAAD was applied using a CO_2 ablative fractional laser (AFXL) and aminolevulonic acid. Thereafter, IDL-PDT was administered using a novel device that mimics the sun radiation with a total dose of 48 J/cm². **Results:** All patients showed remission following subsequent to the study protocol (complete: 71.7%, partial: 28.3%). Pain scores using a visual analog scare immediately following treatments were 9.0 ± 2.0.

Conclusions: AFXL-LAAD combined with IDL-PDT is extremely effective for the treatment of skin field cancerization associated with AK. Nevertheless, the high pain scores associated with this combined approach may prove to be a limiting factor. Thus, further protocol modifications in larger scale studies are still warranted.

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INTRODUCTION

Field cancerization, which is commonly associated with actinic keratosis (AK), depicts the accumulation of genetic alterations in cells adjacent to a primary tumor leading to premalignant transformation and potentially new primary tumors.[1] Photodynamic therapy (PDT) has been established as one of the most widely used and effective treatment options for AK. Most importantly, its ability to treat large and multiple lesions makes it ideal for managing field cancerization.[2] Despite being generally well tolerated, PDT-induced pain remains a significantly limiting factor.[3] Replacing the artificial light emitting devices with daylight PDT (DL-PDT) appears to be somewhat effective in reducing PDT-induced pain.[4] However since DL-PDT is dependent on the naturally occurring sun light, its outcomes are readily influenced by several factors such as seasonal variations, ambient temperature fluctuations, and the emission of UVB.[5] These limitations could be hypothetically avoided by developing a standardized indoor light (IDL) source that mimics the effective sun radiation spectrum. In support, several currently available IDL devices have been used in the context of PDT.[6] Another modification to the classical PDT protocol entails the integration of laser assisted drug delivery (LAAD). The combination of LAAD with PDT has been reported to result in increased efficiency and decreased photosensitizer incubation time.[7,8] The objective of this pilot study was to evaluate the clinical efficacy and tolerability of a novel IDL device for PDT in combination with LAAD in patients with AK field cancerized skin.

METHODS

Forty-six patients diagnosed with field cancerized skin in association with AK were included in this retrospective study. Field cancerization was defined by the presence of more than 5 AK lesions. All clinical evaluations were performed by a single board-certified dermatologist. All patients provided informed written consent prior to participating in the study. Initially, AK lesions were prepared by removing any existing crusts using 25% trichloroacetic acid chemical peels over the course of 1 – 3 sessions. All patients received a single treatment cycle that consisted of LAAD and IDL-PDT. On the day of the treatment, LAAD was performed by targeting the treatment areas with an ablative fractional laser (AFXL, Pixel CO_2, 10,600 nm, Alma Lasers Ltd, Caesarea, Israel) adjusted to the following settings in paintbrush mode: coverage 6%, spot size 120 µm, pulse duration 0.5