AN IMAGING-BASED METHOD TO EVALUATE ANTI-ACNE EFFICACY AT EARLY STAGE

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LI Shuting[1], ZHOU Zhijun (Amanda) [1], LIU Xin (Sean) [1], WANG Hequn (Tracy) [1], FLAMENT Frédéric[2], STEEL Andrew[1]

1 Research and Innovation Department, L'Oréal China, 550 Jinyu Road, Pudong, Shanghai, China;

2 Research and Innovation Department, L'Oréal,188-200 Rue Paul Hochart, 94550 Chevilly-Larue, France

1 INTRODUCTION

Acne Vulgaris is a common skin condition of pilosebaceous unit [1], which affects most adolescents and adults with a high prevalence in worldwide [2-4] and has negative impact on the quality of life of acne patients. Current method to clinically evaluate treatment efficacy for individuals with acne prone skin relies on the observation of the evolution of the clinical inflammatory and non-inflammatory lesions. However, before the acne lesions emerge, to our knowledge, there is no way to define and characterize acne proneness through visualization. Hyper-keratinization of follicle is one of the main pathogenic factors of acne development, which happens underneath skin surface and even at the early stage before clinical lesions form, however the hyper-keratinized hair follicles are usually unrecognized and could not be observed by naked eyes [5]. Reflectance confocal microscopy (RCM) with its nature of having high image contrast from keratin structure[6], opens a new window onto the in-vivo characterization of follicle and pore health at microstructure level and enables the possibilities to provide management plans and interventions for acne prone skin at early stage.

In present work, we aim to explore the morphological differences of hair follicles on a normal/healthy looking skin area between less acne prone (LAP) volunteers and acne prone (AP) volunteers, to characterize the features related to skin acne proneness and to build new method to evaluate anti-acne efficacy at the early stage. Furthermore, we aim to investigate the correlation of the characteristics of hyper-keratinization of hair follicle with the frequency of acne and build the prediction model of acne occurrence.

2 MATERIALS AND METHODS

CLINICAL ENROLLMENT

5 LAP skin volunteers (Cell 1) 10 AP skin volunteers (Cell 2) and are enrolled in this study. AP and LAP skin type are classified by dermatologist based on the result of self-claimed acne history check and on-site clinical evaluation.

Group	Sample size	Age	Acne frequency*				Acne severity*			
			0	*1*	*2*	*3*	*0*	*1*	*2*	*3*
LAP	5	27-40	5	0	0	0	1	4	0	0
AP	10	21-37	0	2	7	1	0	0	3	7

Table 1: Demographic information of all 15 volunteers enrolled.

**:Acne frequency level 0: over 3 months, 1: monthly, 2: biweekly, and 3: weekly; Acne severity degree 0: no acne lesions, 1: rare non-inflammatory acnes, 2: mild acnes with non-inflammatory lesions, 3: moderate acnes with many non-inflammatory lesions and some inflammatory lesions.*

INSTRUMENTAL EVALUATION BY RCM IMAGING

RCM is introduced to characterize the feature of morphology of hair follicle of normal-looking skin area (lower cheek area) of both AP and LAP skin volunteers. Below features are researched (Fig 1).

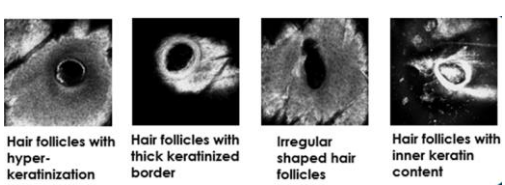

Fig 1. Illustration of different features of hair follicles in RCM imaging, from left to right shows hyper-keratinized follicle, follicles with thick keratinized border, ratio of irregular shaped follicle, follicle with inner keratin content

Ratio of follicles present with specific features = (Number of follicles with specific features/total number of follicles) *100%.

ACNE TREATMENT PRODUCT AND PRODUCT EFFICAY EVALUATION

In this study, a 4-week treatment was only performed on the AP skin subjects. Their product efficacy on the improvement of hyper-keratinization are analyze after 4-week application of an anti-acne product with peeling ingredients (glycolic acid, salicylic acid, capryloyl salicylic acid).

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3 RESULT AND DISCUSSION

We identified the key difference of AP skin and LAP skin from RCM imaging, while also by computing the correlation matrix we identified the key RCM parameters which has highest correlation with acne frequency. So that we further build classification model by machine learning to classify "acne proneness" and "acne frequency".

COMPARISON BETWEEN AP AND LAP SKIN GROUPS & CORRELATION MATRIX

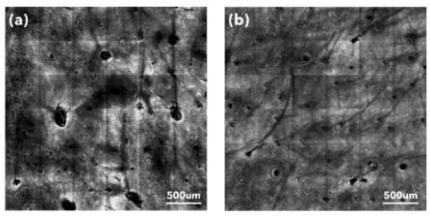

Fig. 2 Comparison of RCM images of hair follicles on scanned facial areas between 2 groups (l) volunteer from AP skin group (Cell 2) (r)volunteer from LAP skin group (Cell 1)

AP skin range (80 to 230 um) is larger than LAP (50um to 120 um) skin follicle's size at epidermis level. AP skin also found a higher ratio of hyper-keratinization features than LAP skin (Fig.3 l). RCM measurement results also showed a high correlation with self-claimed historical acne frequency. (Fig.3 r)

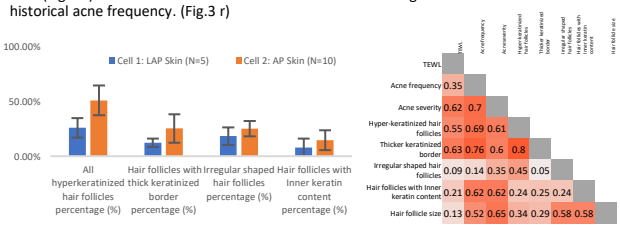

Fig. 3 (l) Comparison of hair follicle characteristics measured by RCM between LAP skin group (Cell 1) and AP skin group (Cell 2); (r)Correlation matrix

EVALUATION OF PRODUCT EFFICACY TO HYPER-KERATINIZATION

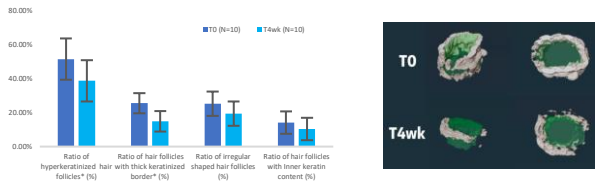

Fig.4 (l)RCM measurement result comparison between initial data (T0) and after 4-week treatment (T4wk) of AP skin. Note: * P<0.05. (r)3D illustration on a single follicle observed

After 4-week treatment, the ratio of hyper-keratinized hair follicles reduced 12.25% (p<0.05) and the ratio of thick keratin border decreases 10.51% (p<0.05) for AP skin group.

CLASSIFICATION MODEL FOR ACNE PRONENESS

Decision tree machine learning models were built to predict classification of "AP skin" vs "LAP skin" (Fig.5-l) as well as the "acne frequency" (Fig.5-r). The accuracy for "acne proneness" classification model is 100% by a 70%-30% training-test sampling at current sample size (N=15).

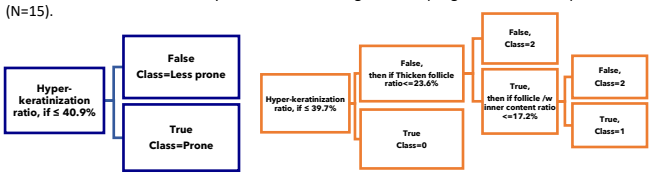

Fig 5. (l)Decision tree for acne proneness classification (r)Decision tree for acne frequency classification, Class 0 ="less than once every 3 month", Class 1 = "once every month"; Class2="every 2 weeks".

4 CONCLUSION

Analyzing the hyper-keratinization related parameters of the follicles through RCM imaging is an effective new method to characterize acne proneness. The proposed machine learning based method can help diagnose and classify the acne proneness and provide alternative options and complementary information to traditional dermatologist-based diagnosis. Peeling ingredient association is proven to improve the follicle hyper-keratinization status and to ultimately reduce the acne proneness and acne frequency. We envision the proposed method also provides new directions for anti-acne clinical assessment and for acne-prevention through evaluating the hyperactivation of key biological processes of follicles at early stage.

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