A Study on the Development and Application of Image-based Facial Skin Aging Diagnosis Technology Using A.I. Model

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Abstract (Maximum of 250 words)

Background: Image analysis using artificial intelligence (A.I.) technology is being used in various fields. In this study, we developed an image-based facial aging diagnosis system to evaluate the overall facial skin aging and investigated the applicability of this system in skin aging change studies and efficacy evaluation of anti-aging cosmetics.

Methods: The facial skin aging diagnostic system was developed using 11,000 facial images. Five clinical experts to determine the correlation between human aging awareness and the results of this system. To confirm the applicability of this system to skin aging study and cosmetic efficacy evaluation, the facial images obtained from the long-term skin aging study and the efficacy evaluation study of anti-aging cosmetics were analyzed and compared with the results of the existing method.

Results: The A.I. facial skin aging diagnostic system's predicted age showed a difference of biological age and ±3 years old in facial images of various ages, and it showed a significant correlation with the actual facial age determined by clinical experts. This system also could analyze the aging of participants who used anti-aging product.

Conclusion: Our facial skin aging diagnosis system was verified by comparison with expert evaluation and it showed high accuracy. We expect that the image-based facial aging diagnosis system using A.I. can be used not only for skin change study or cosmetic evaluation research, but also for personalization services such as customized cosmetics.

Keywords: Artificial intelligence(A.I.); facial aging; skin; deep learning; diagnosis

Introduction.

Image analysis using artificial intelligence (A.I.) technology is being used in various fields [1], and the demand is increasing with the development of skin research, cosmetics industry, and personalization services [2][3]. In particular, methods of using A.I. model that learned facial image for quantitative evaluation of facial skin aging have been attempted [4][5], but the correlation with human skin aging recognition and the suitability for skin aging research have not been confirmed. In this study, we developed an image-based facial aging diagnosis system to evaluate the overall facial skin aging with intuitive and quantified age levels using deep learning technology, and confirmed the correlation with the expert's judgment. In addition, we investigated the applicability of this system in skin aging change studies and efficacy evaluation of anti-aging cosmetics.

Materials and Methods.

To develop a system for facial skin aging diagnosis, 11,000 facial images were collected from Korean volunteers aged 19 to 79 years. The A.I. facial skin aging diagnostic system (Dr.AMORE) was developed based on the SSR-Net (Soft Stagewise Regression Network) model which was initialized with ImageNet Pretrained Weight and was developed to predict perceive age according to facial aging. 2,000 facial images were used for development tests to verify the diagnostic accuracy and performance of this system. In addition, 160 facial images were used by five clinical experts to determine the correlation between human aging awareness and the results of this system. In addition, to confirm the applicability of this system to skin aging study and cosmetic efficacy evaluation, the facial images obtained from the long-term skin aging study and the efficacy evaluation study of anti-aging cosmetics were analyzed and compared with the results of the existing method. Statistical analysis, Intraclass Correlation Coefficient and Paired T-test, were performed using SPSS Statistics 24 (IBM Corp., USA).

Results.

As a result of confirming the skin aging diagnosis performance of the system in facial images of various ages, the AI system’s predicted age showed a difference of biological age and ±3 years old, and it showed a significant correlation with the perceive facial age determined by five clinical experts (Table 1).

		ICC (95% confidence interval)	*p*-Value
AI predicted age - Clinical Experts	AMI	0.928 (0.728, 0.969)	<0.001

*Average measures Intraclass

Table 1. ICC value for AI predicted facial age compared to clinical experts.

In addition, it was possible to quantify the aging degree of the participants by analyzing the aging of the entire face in the 4-year long skin aging study. The group using retinol-containing products, which are anti-aging components, showed lower predicted facial age than the control group without use after 4 years. And the changes in the predicted age of the face within the group was also lower (Figure 1).

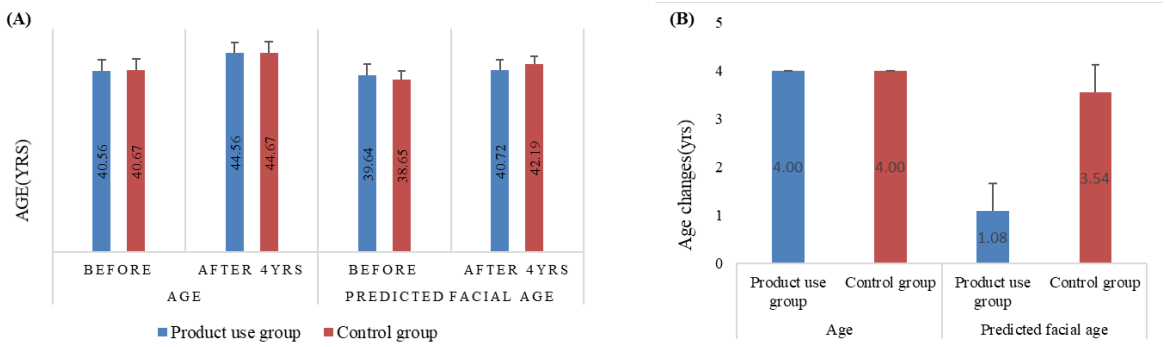

Figure 1. Results of 4-year long skin aging study. (A) Comparison result of product use group and control group for the age and predicted facial age in 2012 and 2016. (B) Comparison result of increased ages for the age and predicted facial age between product use group and control group.

The result of evaluating images of participants who used anti-aging products with syringaresinol, hydrolyzed ginseng saponins, and bioflavonoids as the main active ingredients, it was showed that the predicted facial age after 8weeks of use was significantly lowered compared to before use (Figure 2).

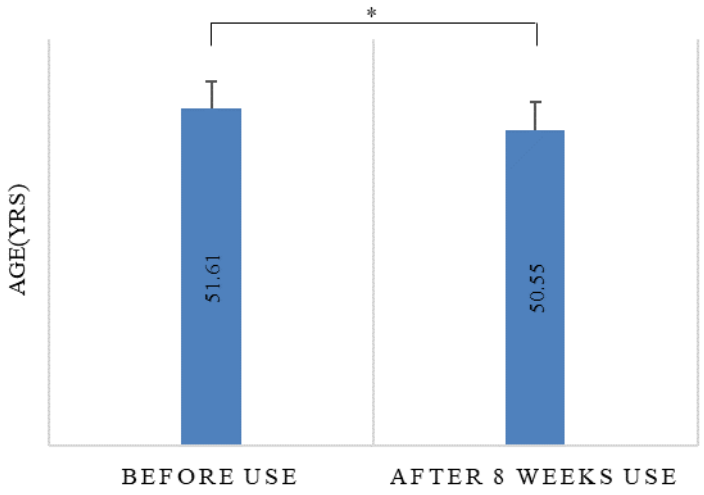

Figure 2. Predicted facial age results of participants who used anti-aging cosmetic products.

*p<0.05 before use vs after use.

Discussion.

The facial skin aging diagnosis system developed by deep learning can evaluate overall facial skin aging changes using only an optical facial image like as clinical experts and predict facial skin age based on this result. In addition, although there was no significant difference in the results of this study, the prediction facial age of AI system is expected to be useful in long-term facial skin aging studies because it showed a tendency of change in predictive facial age unlike actual age in four-year long-term studies of anti-aging products. We also evaluated the efficacy of anti-aging cosmetics, and participants using anti-aging products were able to identify significantly lower facial skin ages compared to before use. This shows that our A.I. facial skin aging diagnostic systems can be used in cosmetic efficacy studies.

Conclusion. Our facial skin aging diagnosis system was verified by comparison with expert evaluation and it showed high accuracy. In addition, the system has the advantage of being able to evaluate the entire face more objectively, consistently, and at a faster and lower cost than conventional skin evaluation equipment of visual assessments of experts. It is thought that it can be useful for skin aging research of cosmetic efficacy evaluation for anti-aging.

Acknowledgments. The authors sincerely thank all members of the Clinical Research Lab for their invaluable assistance.

Conflict of Interest Statement. NONE.

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