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Loss of skin elasticity precedes to rapid increase of wrinkle levels

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Summary

Background: Decreased skin elasticity is considered as a factor that promotes wrinkle formation. However, the relationship between decreased skin elasticity and the formation of wrinkles is not fully understood.
Objective: The purpose of this study is to characterize the relationship between skin elasticity and wrinkle formation using quantitative methods.
Methods: Skin elasticity at the corner of the eye was measured using a Cutometer SEM575^{TM}. Wrinkle levels at the corner of the eye were determined from three-dimensional analysis of surface replicas. Ninety healthy female volunteers living in Tokyo, Japan (aged 18—76 years) were examined in this study.
Results: In each scatter plot examined, women with lower U_r/U_f values or with higher U_v/U_e values showed a tendency for increased R_a and R_{max} values. However, this study determined widely scattered values for both types of parameters. These relationships were then reanalyzed in relation to age. Results were compared within a young (YNG) group of 27 women (aged 18—29), a middle-aged (MED) group of 26 women (aged 30—48) and an elderly (OLD) group of 37 women (aged 50—76). For elasticity parameters, U_r/U_f and U_v/U_e values, significant differences were found between the YNG and MED groups and also between the MED and OLD groups. For roughness parameters, a significant difference was found only between the MED and OLD groups. These results suggest that changes in R_a or R_{max} values lag about 20 years behind changes in skin elasticity values.
Conclusions: Despite a strong relationship, elasticity parameters are unlikely to be an independent predictor of wrinkle levels. The amount of UV exposure to skin with decreased elasticity seems to be the variable that determines wrinkle levels. This finding represents another complexity in the mechanism of wrinkle formation.

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1. Introduction

Many studies have investigated the relationships among elastic properties of the skin, age and wrinkles [1—5], and decreased skin elasticity is considered a factor that promotes wrinkle formation [1,2,6—8]. However, the relationship between decreased skin elasticity and wrinkle formation is not fully understood.

In general, elasticity is a term with many possible meanings and thus one cannot know whether an elastic substance means that it stretches a lot, stretches rapidly, easily returns to its original shape, or has all of those abilities. Multiple parameters: i.e., immediate distention (U_e), final distention (U_f), immediate retraction (U_r), delayed distention (U_v), the ability to return to the original position after deformation (U_r/U_f) and ratio between viscosity and elasticity (U_v/U_e) are frequently used in studies of skin elasticity.

Previously, Takema et al. compared the age-dependent changes of elasticity parameters in sun-exposed and in non-exposed sites (facial and forearm skins) and found that the raw parameters (U_e, U_f, U_r, U_v) reflect actinic aging while the relative parameters (U_r/U_f, U_v/U_e) reflect intrinsic aging [1]. In a later study, they also evaluated U_e and U_r/U_f values and wrinkle levels. Interestingly, there was no correlation between wrinkle levels and U_e values, which had been reported in their earlier study as a parameter that reflects actinic aging, but a correlation was determined in U_r/U_f values, which were reported as parameters that reflect intrinsic aging [2]. That result contradicts a large body of evidence which supports a close relationship between actinic aging and wrinkle formation [6—8].

To evaluate wrinkle levels, Takema et al. employed a five-point visual scoring method, although that approach may have limitations in detecting small differences between two points [2]. Using a 3D image analyzer, Akazaki et al. measured wrinkle depth at the corner of the eye and compared that with U_r/U_f values, and reported a weak negative correlation [5]. Although their finding supports a close relationship between skin elasticity and wrinkle levels, Akazaki et al. evaluated only U_r/U_f values as elasticity parameters and their subjects were limited to women aged 60 years or older.

In this study, we analyzed the elasticity of skin at the corners of the eye in relation to wrinkle levels in a wider range of subjects (aged 18—76 years) and examined two elasticity parameters, U_r/U_f and U_v/U_e. Among multiple quantitative parameters that represent the level of wrinkles, we examined both the mean value (R_a) and the maximum value (R_{max}) of skin roughness.

2. Materials and methods

2.1. Subjects and protocol

This study received ethical approval from an authorized Ethical Committee. The subjects consisted of 90 healthy Japanese women aged from 18 to 76 years and living in Tokyo. After explaining the tests to all subjects, their informed consent was obtained, and adequate consideration was given to their human rights and safety throughout the study. All data were obtained on the same day from each individual. Each subject washed her face with a liquid face wash (Kao Corporation, Japan) and then acclimated for at least 20 min (approx. 23 °C/60% RH) prior to measurement. The subject populations by age group are 18—19 years; $n = 15$, 20—29 years; $n = 12$, 30—39 years; $n = 11$, 40—49 years; $n = 15$, 50—59 years; $n = 10$, 60—69 years; $n = 15$, 70—76 years; $n = 12$, average = 44.1 years.

2.2. Measurement of elastic properties of the skin

A Cutometer SEM575™ (Courage and Khazaka, Cologne, Germany) was used to measure the elastic properties of the skin. A 200-mbar suction was transmitted to the skin for 5 s through a 2-mm opening in the Cutometer probe, and was then followed by a 2-s relaxation. The immediate distention (U_e), the final distention (U_f), and the immediate retraction (U_r) were measured at 0.1-, 4.85- and 5.15-s, respectively. Measurements were performed five times at the corner of the eye for each subject. The delayed distention (U_v) was obtained from the difference between U_f and U_e. These parameters are functions of skin thickness, and thus cannot be simply compared. The viscosity to elasticity ratio (U_v/U_e), as well as the ability of skin to return to its initial position after deformation (U_r/U_f), that are calculated from the above parameters, have been reported to be independent of skin thickness. Therefore we used U_r/U_f and U_v/U_e values as parameters of skin elasticity. Previous reports [1,9] provide more details about this methodology.

2.3. Measurement of skin roughness

Skin roughness was quantitatively evaluated using skin replicas. Using a hydrophilic vinyl silicone impression material (GC Exafine, GC Co. Ltd., Tokyo, Japan), replicas were obtained from each