# EFFECT OF AGE AND GENDER ON THE VISCOELASTIC PROPERTIES OF SKIN

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**Summary:** The physical properties of skin are frequently measured using a variety of mechanical devices. In this study, we have developed a new data analysis technique with the Cutometer 575 to characterize "overall skin elasticity." We also propose two additional new physical parameters which correlate to chronological and photo-ageing – "viscous and elastic recovery." This study was conducted on 430 subjects of different age, gender and ethnicity. Using a novel type of area analysis of the Cutometer displacement-time curve, the results suggest a significant decreasing trend in "elastic recovery" with age, while the "viscous recovery" showed no significant change over the same age span. These unique parameters offer more accuracy than existing outputs from the Cutometer, and may provide increased sensitivity in skin-care efficacy testing than existing methods.

**Introduction:** The Cutometer measures skin elasticity in vivo and has been frequently used in skin research [1,2]. Many parameters, *Uf, Ue, Uv, Ur, Ua, Ue/Uf, Ur/Uf, and Ur/Ue*, are measured in an attempt to describe skin's mechanical response. The elasticity of skin has been reported to decrease with age using Cutometer and Twistometer, but changes in the viscous component has not been consistent [3,4]. This may be related to differences in the determination of the inflection point on the curve. The Cutometer software traditionally approximates the point as 0.1 second after vacuum is off. In this study, we show that our calculated time is lower than the 0.1 sec estimate. Accurate determination of the inflection point results in a more accurate analysis of the viscoelastic property of the skin. Using the point together with area analysis, we have attempted to obtain a more precise description of skin elasticity by separating the elastic and viscous components of the viscoelastic behavior. This presentation shows the application of the new analysis method in human skin elasticity studies.

**Material and Methods:** Cutometer SEM575 (CK Electronic GmbH) with a 2-mm aperture probe was used in this study. All measurements were taken in the lab under controlled temperature and humidity (20-22°C, 45-50%RH). Measurement Mode 1 was employed with a negative pressure at 500 mbar. The suction time and vacuum release times were each set at 1 second. Measurements were taken on the cheeks of 430 male and female subjects aged from 20 – 69 years old. Major ethnic groups included Asian, Caucasian, and Hispanic. The subject demography is shown in Figure 1. Linear parameters of Cutometer results were compared with the area parameters and three new linear parameters were established to define three viscoelastic properties of skin. A silicone rubber block of known hardness was used as an elastic standard.

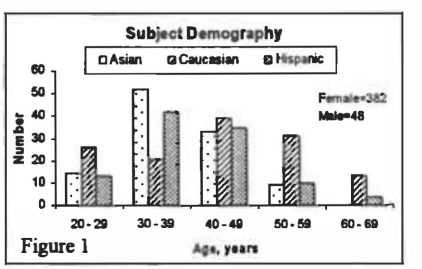

Figure 1

**Results and discussions:**

I. Definition of skin elasticity using area parameters. Our analysis of the Cutometer displacement-time curve lead us believe that an area ratio of relaxation and extension is the most appropriate method to analyze Cutometer data. An ideal elastic material such as a silicone rubber standard recovers a displacement completely after release of tension, and therefore the area ratio of recovery ($B$) and extension ($A$) is 1. Human skin, being viscoelastic in nature, exhibits two components in the recovery area, an elastic recovery area $B_E$, and a viscous recovery area $B_V$. Using these areas, the overall elasticity, elastic component, and viscous component can be determined.

II. Determination of the inflection point on the relaxation curve. This point represents the elastic recovery time, $t_{ER}$, at which the relaxation curve deviates from its initial linearity and indicates the separation of elastic and viscous recovery components. We developed a computational algorithm to calculate $t_{ER}$ from each Cutometer curve. The results from the 430 subjects showed an average of 0.068 second with a standard deviation of 0.012.

III. Distribution of skin elasticity, elastic recovery fraction, and viscous recovery fraction. Using the definition and method described above we analyzed the Cutometer curves of 430 subjects. The overall

elasticity, elastic recovery fraction, and viscous recovery fraction are calculated to be at averages of 0.562, 0.398, and 0.148, respectively. Figure 2 shows the distributions.

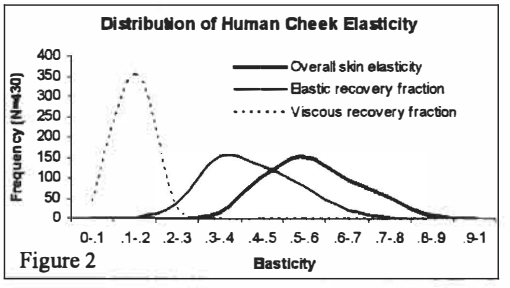

Figure 2

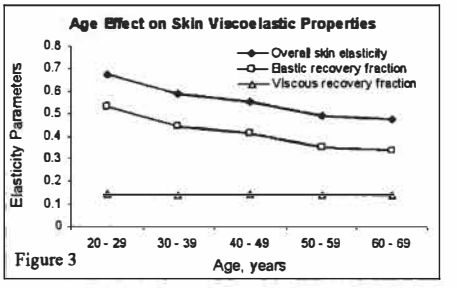

Figure 3

IV. Effect of age and gender on the viscoelastic behavior of skin. We found that overall skin elasticity decreased significantly with age as shown in Figure 3. Not surprisingly, the decrease was directly attributed to the elastic component which decreased in the same fashion. The viscous component, however, did not show significant change with age. Figure 4 shows the gender difference in skin viscoelastic properties. It was significant in all three parameters. Female subjects exhibited greater elastic recovery and lower viscous recovery than male subjects.

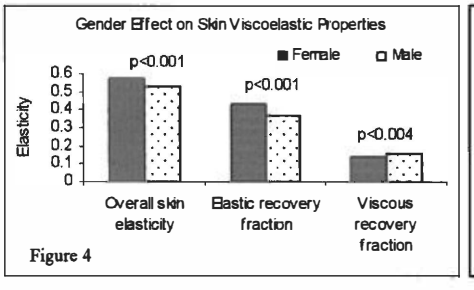

Figure 4

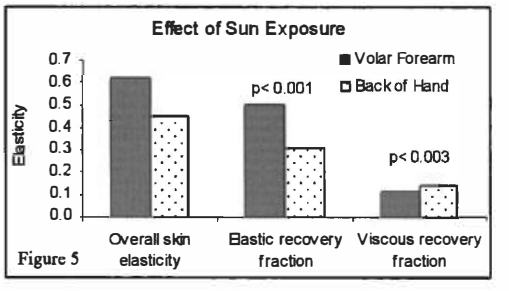

Figure 5

V. Effect of sun exposure on the viscoelastic behavior of skin. Figure 5 shows the results of a study comparing sun-exposed skin on the back of the hand (between thumb and forefinger) to skin from the volar forearm. A marked decrease in overall elasticity and in the elastic recovey component was observed with sun-exposed skin. The viscous component was significantly higher in the sun exposed skin.

VI. Use of a linear quantity to calculate overall elasticity. Since the Cutometer does not easily calculate area ratios we have defined a new parameter, R10, to estimate overall skin elasticity in the Cutometer outputs. This new parameter is a composite result for the extent, *Ua/Uf*, and the speed, *Ur/Uf*, of skin viscoelastic recovery. Figure 6 shows a satisfactory correlation between the more involved area calculation and this new R10 parameter.

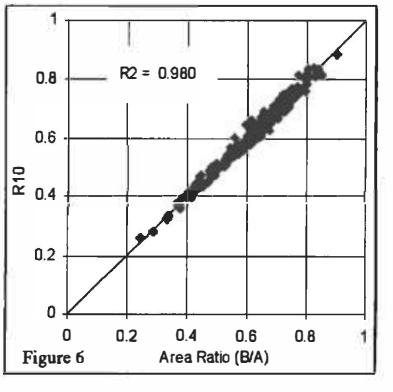

Figure 6

**Conclusion:** We believe that the area ratios defined in this study more accurately reflect skin viscoelastic properties. Separation of elastic and viscous recovery components improves upon the current understanding of in vivo elasticity measurement of skin.

**Reference**

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