

# Measurement of skin mechanics

## A study of inter- and intra-individual variation using the Dermaflex A

Gregor B. E. Jemec<sup>1</sup>, Monika Gniadecka<sup>1</sup> and Barbara Jemec<sup>2</sup>

<sup>1</sup>Bioengineering Laboratory, Department of Dermatology, Bispebjerg Hospital, University of Copenhagen, Denmark, and

<sup>2</sup>Department of Plastic Surgery, Wexham Park Hospital, Slough, UK

**Background/aims:** Skin mechanics may be affected by a number of dermatological and systemic conditions, and reliable quantification of skin distension may therefore be of considerable interest. This study was undertaken in order to assess the intra- and inter-individual variation of measurements of skin distensibility when using Dermaflex A.

**Methods:** Dermaflex is a suction device that measures the deformation of the skin surface within a 10-mm cup following application of given suction. Three levels of suction were studied on the flexural side of the forearm in 19 healthy volunteers.

**Results:** Increasing levels of suction produced significantly increasing skin distension ( $P < 0.0001$ ) with a significant non-linear trend ( $P = 0.0310$ ). Inter-individual variation (coefficient of variation range 15.43–27.88%) was significantly larger than intra-individual

variation (coefficient of variation range 9.16–11.45%,  $P = 0.0031$ ) throughout the range of suction tested. There was no significant difference between the intra- and inter-individual coefficients of variation with different levels of suction.

**Conclusion:** The results suggest that measurements of skin distensibility can be a useful method for objective determination of skin mechanics.

**Key words:** accuracy – Dermaflex – distensibility – coefficient of variation – methodology – intra-individual variation – inter-individual variation.

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FEW STUDIES of methodological accuracy have been published about skin mechanics measurement (1–3). Standardized assessment of intra- and inter-individual variation is needed in order to evaluate the usefulness of a given method, and serve as a background for general guidelines for use of equipment and interpretation of results. A number of techniques are available for the study of skin mechanics, and this study was undertaken in order to make an assessment of the inter- and intra-individual variation in measurement of skin mechanics using the Dermaflex A (Cortex Technology, Hadsund, Denmark) (1, 4).

### Materials and Methods

A total of 19 (16 women, 3 men) healthy volunteers without active or generalized skin disease was included after informed consent. Their mean age was 37.3 years (95% confidence interval: 30.7–43.8 years).

Skin mechanics were measured using the Dermaflex A on the volar aspect of the arms of the

volunteers (Fig. 1). Each arm was measured in 3 symmetrical areas using different settings of vacuum (150 mbar, 300 mbar and 600 mbar) but with a constant setting of 6 cycles of 4 seconds each. The areas were randomized and each measured 3 times. The mean value was used in the further analysis. The probe was attached to the skin by a double adhesive ring, and only supported lightly during measurements to allow the probe weight to be the only pressure applied to the study area. It was moved between each measurement, so that no piece of skin was measured more than once. Each series of measurements included a radial, a central and an ulnar site. The analysis was carried out following acclimatisation, and with the volunteer sitting upright resting the forearms on a table.

Distensibility was studied. Distensibility is numerically the largest parameter measured by the Dermaflex, and is defined as the elevation in millimetres of the skin surface within the suction chamber the first time suction is applied.

The following methods were used to describe the intra- and inter-individual variation: left to right



Fig. 1. Dermaflex machine and probe.

comparison using the paired Student's *t*-test and coefficients of variation, multiple comparisons using ANOVA; coefficient of variation for measurements with one setting for one person (intra-individual variation); and coefficient of variation for matched measurements in different people (inter-individual variation).

Based on the observed standard deviations, sample size was calculated for studies comparing different groups of patients and for different settings of suction.

TABLE 2. Coefficients of variation

Applied suction and site	Intra-individual coefficient of variation	Inter-individual coefficient of variation
150 mbar R	9.58	23.12
150 mbar L	11.45	27.78
300 mbar R	9.88	22.22
300 mbar L	7.48	18.58
600 mbar R	11.19	16.14
600 mbar L	9.16	15.43

Coefficients of variation (SD/mean  $\times$  100) calculated both for intra- and inter-individual comparisons. Intra-individual coefficients of variation are significantly smaller than inter-individual coefficients ( $P=0.003$ ).

## Results

There were no significant differences between measurements of symmetrical areas on the left and right arms. The pairing of measurements was effective as indicated by a positively significant correlation with  $r^2$  in the range of 0.45–0.67 (Table 1). Increased suction caused increased distension of the skin surface ( $P<0.001$ ). Additional analysis showed that significant ( $P=0.031$ ) trend even after accounting for the linear trend. Inter-individual variation was significantly larger than intra-individual variation ( $P=0.003$ ). Data of variation are given in Table 2. None of the subjects experienced any discomfort or pain at even the highest level of suction.

## Discussion

Quantitative non-invasive measures of biological qualities offer important insight into the underlying mechanisms without the need for a full description of cellular or subcellular mechanisms. Such measurements may help not only our understanding of physiological phenomena, but can be used to verify changes induced by pharmacological or physical agents (5). Comparison of different groups is subject to variation due to differences between individuals (inter-individual) as well as within each individual (intra-individual). An enumeration of this variation is necessary when planning such studies in order to

TABLE 1. Means distensibilities at different levels of suction

Suction	Right arm mean, mm	Right arm standard deviation	Right arm 95% confidence interval, mm	Left arm mean, mm	Left arm standard deviation	Left arm 95% confidence interval, mm
150 mbar	1.702	0.394	1.512–1.892	1.769	0.492	1.533–2.006
300 mbar	2.117	0.470	1.891–2.344	2.075	0.386	1.889–2.261
600 mbar	2.402	0.388	2.215–2.588	2.395	0.370	2.217–2.573

achieve a sufficient statistical power of the results to allow firm conclusions.

'Left to right' or 'pre and post' comparisons of changes induced by, e.g., topical treatment is a common technique used in many dermatological studies (5–8). The present study shows that the method allows direct comparison of symmetrical regions on the arms, as no significant differences were found between the two sides. A significant positive correlation was found at all three settings of the machine, although the correlation coefficients found ( $r^2$ : 0.45–0.67) stressed the existence of some intra-individual variation. For investigations of short-term changes in the mechanical properties of the skin, pre- versus post-intervention studies are therefore still recommended (6–8).

Changes in the setting of the machine produced significant differences in the measured extensibility. Very predictably, a higher degree of suction produced a larger deformation of the skin surface. The overall trend also reflected a significant non-linear trend, as would be expected from the stress-strain curves of skin.

In this study we have shown that the intra-individual coefficient of variation of measurement of skin mechanics (simple distension) with the use of the Dermaflex A is significantly smaller than that of the inter-individual variation.

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Address:  
 Gregor Jemec  
 Strandvejen 97, 3tv  
 DK-2900 Hellerup  
 Denmark  
 Fax +45 3118 0916