# **BIOPHYSICAL SKIN MEASURES: SITE DEPENDENCE AND CORRELATIONS**

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## **OJECTIVES**

Biophysical measurements for the assessment of stratum corneum (SC) hydration, skin-to-fat water content and transepidermal water loss (TEWL) are useful for many purposes including the characterization of skin properties and their change with a variety of conditions. Such measures also have potential utility for developing skin-related parameters to serve as covariates in investigations dealing with transdermal drug transport. Although each of these measures has been studied either individually or in pairs, there has been no systematic investigation of the triplicate measures within the same subjects at multiple sites. Because skin structure and function differ among anatomical sites, it is essential to know the extent to which these parameters vary among sites. In addition, it is useful to know the degree of correlation for a given parameter among the different sites and the correlation between the different parameters. Our goal was to address these issues by measuring and comparing SC capacitance, TEWL and the tissue dielectric constant (TDC) as an index of tissue water to depths below the epidermis of 0.5, 1.5 and 2.5 mm. Measurements were done at 17 sites in 32 healthy female subjects who were evaluated in a supine position.

### **METHODS and MEASUREMENTS**

Subjects with an age (mean ± SD) of 33.7 ± 14.0 vrs and a BMI of 25.1 ± 5.4 were evaluated after signing an institutionally approved consent. All measurements were done at the 17 specific skin sites listed in table 1. Sites were marked and measurements done in the following order: TDC at 2.5 1.5 and 0.5 mm effective depths, SC, TEWL and then skin temperature. Measurements started at the forehead and ended at the foot.



Medial Malleolus - below

# Marking measuring sites with surgical pe



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### **METHODS and MEASUREMENTS (Cont.)**

SC hydration (B) was based on SC capacitance at 1.25 MHz, TDC (A) was measured at 300 MHz and used to estimate the relative water content of skin to depths of 0.5, 1.5 and 2.5 mm. TEWL (C) was measured using a closed chamber unventilated system. Skin temperature was measured using an infrared thermometer. Room temperature and relative humidity were 25.0 ± 1.0°C and 44.5 ± 2.2%.



and probes for TDC measurements B. MoistureMeter-SC for SC hydration measurements

A. MoistureMeter-D

C. Vapometer for TEWL measurements

by Delfin Technologies Ltd., Kuopio, Finland

### RESULTS

Parameter values varied widely among sites as shown in Table 2 where sites with largest and smallest values (mean ± SD) are indicated.

Table 2				
Parameter	Largest Value Site	Value	Least Value Site	Value
SC	Forehead	71.6 ± 29.4	M. Malleolus	9.6 ± 8.4
TDC @ 0.5 mm	Forehead	39.6 ± 7.3	M. Malleolus	27.0 ± 4.4
TDC @ 1.5 mm	Forehead	36.9 ± 2.7	M. Malleolus	26.7 ± 3.6
TDC @ 2.5 mm	Palm-Thenar	39.1 ± 4.6	A. Forearm	24.7 ± 3.2
TEWL (g/m²/hr)	Thumb-Pulp	47.5 ± 26.8	A. Forearm	8.26 ± 4.9
Skin Temp (°C)	Forehead	34.1 ± 0.7	Great Toe	27.0 ± 3.6
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Parameter values for each site are shown in the separate bar graphs as means and sem for the 32 subjects evaluated. Within each chart, sites are arranged in descending order from greatest to least value. Skin tissue water, judged by TDC values, decreased significantly (p<0.01) with increasing measurement depth except at sites with substantial sweat glands (palm of the hand and great toe plantar surfaces) where TDC values actually increased with measurement depth. TDC values were significantly positively correlated with SC values at 15 of the 17 sites with the strongest correlation between TDC values at 0.5 mm depth and SC values (p<0.01). Contrastingly, TDC values positively correlated with TEWL values at 5 of the 17 sites that included the palm of the hand, hand dorsum, thumb, great toe plantar surface and medial gaiter areas (p0.01). A significant correlation between SC and TEWL (p<0.01) could only be demonstrated on the hand palm (center and thenar eminence) and on the great toe plantar surface.

Dr. Mayrovitz invites you to e-mail him at mayovit@nova.edu with any questions or comments or to request an electronic copy of this poster.



#### CONCLUSION

These findings help establish parameter value ranges for each measured biophysical quantity and show that for most sites there is a significant correlation between skin tissue dielectric constant values and stratum corneum values. These correlations suggest that SC hydration is directly linked to dermal tissue water levels. Although such a relationship is consistent with skin structure-function considerations, it is thought that the present work is the first to provide direct evidence of such a possible relationship. In contrast to the TDC-SC linkage, the present results could find little evidence linking TEWL to either SC or TDC values. This may indicate that in normal skin, TEWL in most sites is not much dependent on dermal and sub-dermal hydration, at least to a depth of about 2.5 mm below the epidermal surface. Exceptions were found in palmar surfaces of the hands, the plantar surface of the great toe and in the medial gaiter area. Finally, these findings suggest that the substantial variation in the biophysical parameter values among sites needs to be prudently considered in the design and interpretation of any comparative study involving different skin sites.