

# Sequential Variability in Localized Thigh Skin Dermal Tissue Water

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## Background

Skin tissue dielectric constant (TDC) measurements have been used as indices of local skin tissue water and its change in a variety of clinically-related applications. Biophysical values have been reported at various anatomical sites, but the temporal variability in lower extremity TDC values in young adults has not been previously reported. Since TDC values vary by anatomical site, such information is valuable directly as a reference and also to help set criteria for sequential studies in which measurements are made in patients over days or weeks. Thus the goal of this research was to use TDC measurements as part of research training program to study variability of these values over time in lower extremities.

## TDC Measurement Methods

The device we used to measure TDC was the MoistureMeter-D. It consists of a cylindrical probe connected to a control unit that displays the TDC value when the probe is placed in contact with the skin. A very low intensity 300MHz signal is generated within the control unit and is transmitted to the tissue via the probe that is in contact with the skin. The probe acts as an open-ended coaxial

transmission line. The portion of the incident electromagnetic wave that is reflected depends on the tissue dielectric constant, which itself depends on the amount of free and bound water in the tissue volume through which the wave passes. Reflected wave

information is processed and the dielectric constant is displayed. For reference, pure water has a value of about 78. The effective measurement depth depends on probe dimensions, with larger spacing between inner and outer conductors corresponding to greater penetration depths. In the present study a probe with effective measurement depth of 1.5mm was used.



Figure 1. TDC Measurement device and 1.5 mm depth probe.

## Measurement Methods

Self-TDC measurements were performed by six male student research trainees on the proximal one-third of the right anterior thigh while in a seated position at five separate sessions: day 0, day 1, day 7, day 21 and day 28 (Fig. 2). Twenty-four hours prior to each session (except day 1), the students shaved the region of their anterior thigh to be measured. Self-measurements were taken with the students at rest in a seated position with the legs touching the floor for at least 5 minutes prior to taking any measurements. At each session TDC was measured in triplicate to a skin depth of about 1.5 mm, which is a depth that includes the epidermis and dermis but not the underlying hypodermis or subcutaneous fat. A person not involved with the measurements analyzed the data.



Figure 2. Self-TDC measurement with a 1.5 mm depth probe.

## Results

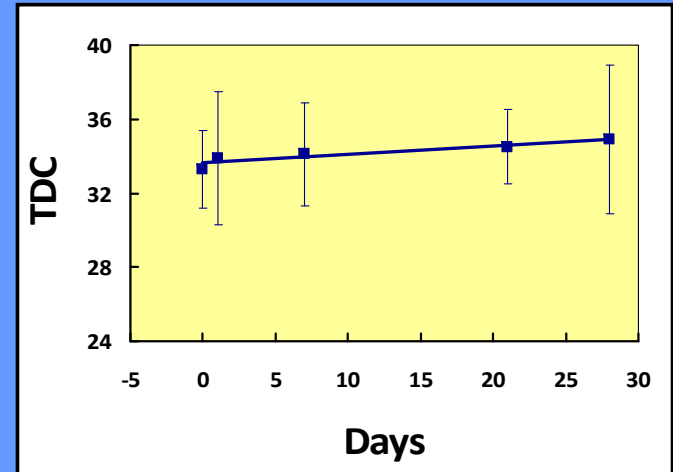


Figure 3. Average TDC values vs. Time (Error bars =  $\pm 1$  SD)

TDC values for five sequential measurement sessions (mean  $\pm$  SD) were respectively  $33.3 \pm 2.1$ ,  $33.9 \pm 3.6$ ,  $34.1 \pm 2.8$ ,  $34.5 \pm 2.0$ , and  $34.9 \pm 4.0$ . ANOVA analysis for repeated measures showed no overall time effect ( $p=0.629$ ) but an increasing trend appears present for the mean values shown in figure 3. As compared to day 0, subsequent TDC mean values increased sequentially by 1.7%, 2.6%, 3.6% and 4.5%. It is unclear as to the cause of this apparent (but not significant) increasing trend.

## Conclusions

The present findings are the first documentation of the magnitude and sequential changes of thigh dermal tissue water determined by local TDC measurements. Since it is known<sup>[1-2]</sup> that TDC values vary among anatomical sites these results add to the growing reference database of TDC values. Such reference values are needed as first steps in characterizing normal values to pave the way for clinical assessments. Interestingly, the overall average TDC value herein determined, taking into account all measurements ( $n=30$ ), was  $34.2 \pm 2.8$ , which was similar to values previously determined in forearm dermis of 30 male subjects ( $33.2 \pm 4.0$ <sup>[3]</sup>) and in cheek dermis ( $35.9 \pm 4.9$ <sup>[4]</sup>). The maximum difference in TDC values was less than 5% and occurred between day 0 and day 28 thus indicating good measurement repeatability associated with the TDC measurement method.

## References

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