Background and Purpose

There is an important need to conveniently obtain non-invasive quantitative estimates of skin tissue water content in many conditions especially those related to evaluating local edema and lymphedema. One method that is capable of measuring at any anatomical site relies on the measurement of the skin tissue dielectric constant (TDC) at a frequency of 300 MHz. Since the TDC value is largely dependent on the tissue water content, the TDC value itself can be used as an index of local tissue water content and its subsequent change that might accompany therapy.

More recently, a fully portable compact device has been developed that integrates the probe and control box features into a single handheld apparatus, which might be more readily usable in clinical settings. However, the relationship between TDC values measured with this compact system to those measured with a multiprobe system is currently unclear. Clarity of these relationships would facilitate comparisons of TDC data already in the literature and allow for future data comparisons.

Consequently, there is a necessary need to provide a consensus on the method of TDC value measurement for comparison of results obtained in different studies. Moreover, in order for TDC values to be truly useful in clinical settings, they need to be validated and standardized with respect to probe, site and gender.

The present study was aimed to determine differences in TDC values between male and female (1) and differences between anatomical site at any depth nor was there any significant difference in TDC values in females with and without breast cancer.

Method

Sixty four mostly young and self-reported healthy adults participated in this study (32 male and 32 female) along with 12 female patients who were awaiting surgery (within 2 week) for breast cancer.

Method – TDC Measurement Devices

The multiprobe device used to measure TDC was the MoistureMeterD (MMD) and the compact device used was the MMD Compact (MMDC; Defin Technologies). The MMD consists of a cylindrical probe connected to a control unit that displays the TDC values when the probe is placed in contact with the skin (Figure 1A), transmitting a 300 MHz signal and acting as an open-ended coaxial transmission line (4,5). The portion of the incident electromagnetic wave that is reflected depends on the dielectric constant of the tissue, which itself depends on the amount of free and bound water in the tissue volume through which the wave passes. For references, pure water has a value of about 78.5 and the display scale range is 1 to 80. In the present study, probes with effective measurement depths of 1.5 mm and 2.5 mm for probe A and 2.5 mm for probe B. Probe C is the self contained MMDC unit.

Figure 1: Measurement devices and probes. 1A) MMD unit with probe in contact with forearm skin; 1B) Compact MMDC unit; 1C) Probes shown from measuring surface end. Probes A and B are used with the MMD unit and have effective measurement depths of 1.5 mm for A and 2.5 mm for probe B. Probe C is the self contained MMDC unit.

Analysis

All measurements were done after a 10 minute acclimation rest interval with the subjects seated. TDC measurements were made on standardized sites on the anterior part of both forearms and both biceps.

The MMD contacts the skin and is held in position for about 10 seconds and an audible signal is given off, indicating completion of the measurement.

In the healthy subject group, TDC measurements at each site were made first with the 2.5 mm depth probe (Figure 1B), followed by the measurements of the 1.5 mm depth probe (Figure 1A), and lastly by the compact probe (MMDC) (1C).

In the patient group, TDC measurements were made only using the compact probe, but at the corresponding sites used in the healthy group.

TDC measurements, arm, gluth (circumference) at the measurement sites were determined using a Gulick-type tape measure.

The MMD contacts the skin and is held in position for about 10 seconds and an audible signal is given off, indicating completion of the measurement.


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Results

Dominant and non-dominant arm TDC measurements were averaged to obtain a single averaged TDC value (forearm and biceps separately).

Possible differences among TDC measurements obtained with 1.5, 2.5 and compact probes on healthy group were tested using a general linear model (GLM) with repeated measures for each measure.

Possible differences between male and female TDC values were tested using independent t tests with a pvalue <0.01 taken as a significant difference.

Possible differences in TDC values between arms were tested directly by comparing dominant vs. non-dominant absolute TDC values (paired t-test).

The ratio of TDC values (dominant/non-dominant) was calculated for each subject and compared by probe, site and gender.

TDC measurements made only on female arms with the corresponding anatomic sites were tested for differences using independent t-tests.

There was no significant difference in muscle thickness gain or loss in the breast cancer group.

Possible differences among TDC values measured with each probe were significantly different (p<0.001) from each other (graph 1).

The results suggest that at least at this early stage the presence of the breast cancer did not alter the ratio.

Conclusions

TDC values in healthy male arms are significantly greater than in healthy female arms.

TDC values measured with the compact probe are between those measured to 1.5 and 2.5 mm depths and exceeds the 2.5 mm probe value by about 5.6%.

Inters-arm TDC values and ratios (dominant/non-dominant) did not significantly differ with respect to probe, site or gender.

Absolute TDC values and inter-arm ratios measured with the compact probe in breast cancer patients did not significantly differ form those measured in younger healthy female.

References