

Young Adult Gender Differences in Forearm Skin-to-Fat Tissue Dielectric Constant (TDC) Values Measured at 300 MHz

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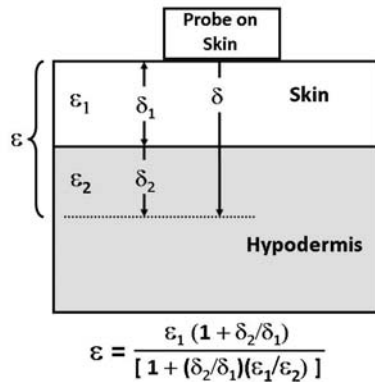
Background and Objective

Previous methods have shown no significant differences of skin-water content between genders in comparison of young adult forearms. Skin-to-fat tissue dielectric constant (TDC) values depend on depth and gender but the role of gender is not clear. Skin thickness data suggest that prior TDC measurements to an apparent 1.5 mm depth would have included contributions from stratum corneum, epidermis, dermis, and also some amount of hypodermis. However, it is not known if shallower or deeper measurement depths would parallel the prior findings that showed greater TDC values among young adult males compared with age-matched females.

Our purpose was to determine the potential male-female difference in TDC values when different components of skin were included in the measurement and to provide TDC references ranges applicable to young adults for these differing forearm tissue depths. This can provide a unique reference range applicable to young adults for differing forearm tissue depths in respect to edematous conditions.

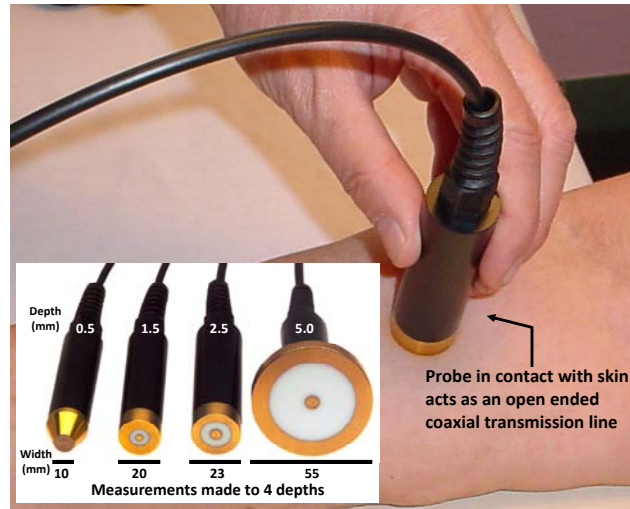
Methods

Bilateral forearm TDC measurements were assessed on young males and females with ages ranging 24.7 to 27.3 years. Subjects were divided into four groups with 30, 150, 60, and 50 males and females in each. TDC values were measured to depths of 0.5, 1.5, 2.5, and 5.0 mm, respectively, with each subject supine on a padded and insulated examination table with their arms resting and palms up. Measurements were started after subjects have been supine for a minimum of 5 minutes and were done in triplicate on both volar forearms 6 cm distal to the antecubital fossa. The average of the three measurements was used to characterize the TDC value of each arm and reported as the average of the two arms. This procedure was done for each of the four effective measurement depths.



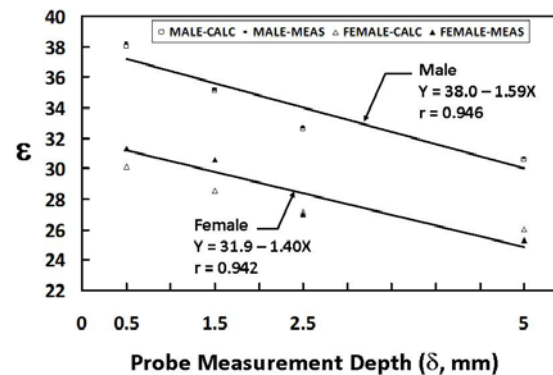
Conceptual model to assess skin and hypodermis effects on measured TDC. The parameter ϵ represents the tissue dielectric constant measured by the probes of various effective measurement depths (δ) in terms of the dielectric constants ϵ_1 and ϵ_2 for skin and hypodermis, respectively. The parameter δ_1 is the skin (epidermis + dermis) thickness (different for males and females) and δ_2 is the effective penetration depth into the hypodermis measured from the skin-hypodermis margin.

Measurements Illustrated



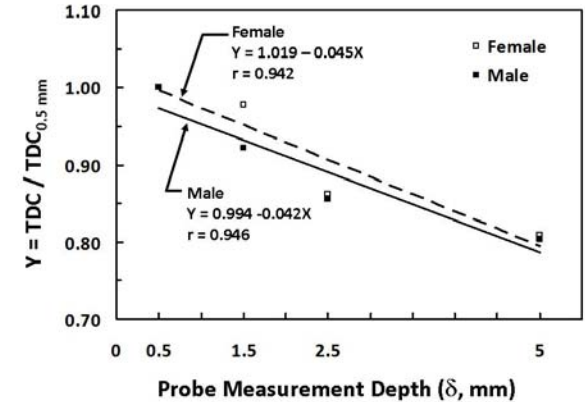
Measuring tissue dielectric constant (TDC). TDC measured in triplicate bilaterally at each of four effective measurement depths. Touching the skin activates an automatic process and yields a TDC value in less than 10 s. Larger width probes have greater effective measurement depths as shown.

Results



Measured vs. calculated TDC values for young males and females. The calculated TDC values (ϵ) for the composite model of this figure (open symbols) are shown vs. the measured values (closed symbols). The regression lines and equations correspond to the measured data for males and females.

Results (Continued)



Probe Measurement Depth (δ , mm)
TDC variation with measurement depth: Data points are mean TDC values for females and males normalized to their values at a measurement depth of 0.5 mm ($TDC/TDC_{0.5 \text{ mm}}$). Lines are computed linear regression lines for this ratio vs. effective measurement depth. Regressions are similar for females and males.

For females and males there was a significant difference in TDC values among depths ($p < 0.001$) with TDC values decreasing with increasing skin depth. Gender comparisons showed that TDC values of males were significantly ($p < 0.001$) greater than values for females at each depth. Male-female percentage differences ranged from 14.8% to 22.0%. Model calculations suggest that gender-differences might be explained by skin thickness differences.

Conclusions

Findings indicate that decisions with regard to skin water content among or between groups based on TDC measurements need to account for gender and are best made when corresponding skin thickness measurements are available. However, changes in TDC values assessed in individual patients and comparisons between corresponding skin areas in affected and non-affected sites are not limited. Thus, assessments of acute treatment effects and assessments of inter-arm or inter-leg TDC differences or ratios within genders are a useful and suitable method to characterize edema and lymphedema features.

Selected References

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