

Depth Distribution of Thigh Skin-to-Fat Tissue Water

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Background: Based on prior tissue dielectric constant (TDC) measurements it was shown that local skin tissue water (LTW) depends on the anatomical site and at the forearm TDC values vary with the depth of the measurement, being less the greater the depth included in the measurement. However, few such data are available for the lower extremities and none are available for the soft tissue of the thigh. The need for such basic data relates to the need to establish an adequate reference database of normal values, at different depths, from which edematous changes in a variety of conditions and treatment modalities may be judged.

Objectives: To learn to use the noninvasive TDC measurement device and apply it as part of a research training program to study the concept of biological variability and use the TDC method to characterize the depth dependence of TDC values.

Methods: Six male student research-trainees performed self-TDC measurements on one of their anterior thighs while in a seated position to depths of 0.5mm, 1.5mm, 2.5mm, and 5.0mm at two sessions 28 days apart. They were seated in a chair that was sized appropriately to ensure that both legs were resting on the floor for 5 minutes prior to any measurements being taken. The leg measurement site was shaved 24 hours earlier to avoid variability with probe contact and possible hair effects. All depths include epidermal and dermal layers, while varying in the amount of subcutaneous fat measured, with greater subcutaneous fat content increasing at deeper depths. For reference, the TDC value of 100% pure water measured at 300 MHz is about 78. The actual measurement was done by touching the skin with cylindrical open-ended coaxial probe for about 10 seconds per measurement. The obtained data was analyzed by a person not involved with the measurements.

Results: At baseline (day 0), TDC values linearly decreased ($TDC = -2.1DEPTH + 37.3$, $r=0.992$, $P<0.001$) with increasing depths. Absolute TDC values (mean \pm SD) were 36.4 ± 3.5 , 34.6 ± 2.6 , 31.2 ± 2.2 , and 27.1 ± 2.3 corresponding to effective measurement depths of 0.5, 1.5, 2.5 and 5.0 mm respectively. These values were insignificantly different from values obtained at corresponding depths 28 days later.

Conclusion: The anticipated reduction in tissue water with measured depth is consistent with the inclusion of increasing amounts of low-water content fat tissue as observed in forearm. The similarity of the distribution over 28 days suggests that the depth-distribution of water within the skin-fat tissue measured in the thigh is reasonably constant over the one month time interval. These findings further indicate that the anterior thigh represents a stable area for studies related to tissue water measurements over time.