

Skin Water by Tissue Dielectric Constant in Healthy Arms as a Reference for Use in Detecting Lymphedema in Male Breast Cancer

Background/Goals: Breast cancer (BC) treatment-related lymphedema is a recognized complication in women and methods to help detect its insidious development include measurements of local changes in arm skin water based on non-invasive measurements of the tissue dielectric constant (TDC)¹⁻². Although BC is rare in males (1/100,000 men) it does occur and there is no male reference TDC normative data from which lymphedema changes may be judged. Thus, our goal was provide such reference data for males and to investigate the role of body composition as a determinant of locally measured TDC values.

Methods: To date, TDC was measured bilaterally on anterior forearms and biceps of 31 adult males. This procedure requires touching the skin with sensors of different size for about 10 seconds. The different sizes allow measurements of TDC (and hence relative water content) to effective depths of 0.5, 1.5, 2.5 and 5.0 mm below the epidermis. Each measurement was done in triplicate and averaged. Whole body and segmental composition of each subject was assessed by bioimpedance at 50 KHz with a scale upon which subjects stood. TDC data were analyzed to determine TDC absolute values, dominant/non-dominant arm differences and ratios and to determine if TDC values correlated with body composition parameters. Arm girths were measured at all sites at which TDC was measured with a tape measure.

Results: TDC values monotonically decreased with increasing depth (0.5 to 5.0 mm) yielding forearm averaged values (mean \pm SD) of 38.2 \pm 5.1, 36.0 \pm 3.8, 33.6 \pm 4.5 and 32.3 \pm 5.6. For reference 100% water at 32°C has a TDC value of 76. For depths of 5.0 and 2.5 mm the non-dominant arm TDC value was significantly greater ($p < 0.01$) than the dominant arm (33.3 \pm 5.3 vs. 31.3 \pm 6.3 at 5.0 mm and 34.6 \pm 4.4 vs. 32.4 \pm 4.2 at 2.5 mm) but no TDC differences between arms was found for depths of 1.5 and 0.5 mm. Dominant/Non-Dominant TDC ratios at forearm were 0.983 \pm 0.075, 0.984 \pm 0.062, 0.946 \pm 0.066 and 0.955 \pm 0.084 for 0.5 to 5.0 mm depths respectively. Ratios for biceps at 0.5, 1.5 and 2.5 mm were respectively 0.991 \pm 0.064, 0.993 \pm 0.038 and 0.972 \pm 0.059. TDC values measured at ALL DEPTHS were directly correlated with total body water and inversely to total body fat with forearm 5.0 mm depth best correlating with total body water ($r = 0.768$, $p < 0.001$) and the 0.5 mm depth the least correlation ($r = 0.511$, $p < 0.001$).

Discussion/Conclusions: The reduced TDC value with depth is likely due to inclusion of greater amounts of low water containing fat at greater depths; this trend is similar to that in females¹ but absolute TDC values are here greater for males. Prior female TDC data showed no inter-arm difference but here for males the TDC of the non-dominant arm is greater at 2.5 and 5.0 mm depths. This finding is not consistent with what one would predict based on greater fat content of non-dominant arms (17.7 \pm 5.4% vs. 16.6 \pm 4.7%, $p < 0.001$) and is unexplained. Finally, the inverse correlation of TDC values with total body fat suggests that clinical assessments seeking to detect insipient lymphedema in males must consider possible confounding effects of body composition when trying to establish TDC detection thresholds. This work is ongoing to reach a total of 60 males.

References: ¹Mayrovitz HN, Davey S, Shapiro E. "Local tissue water assessed by tissue dielectric constant: anatomical site and depth dependence in women prior to breast cancer treatment-related surgery". Clin Physiol Funct Imaging 2008;28:337-342. ²Mayrovitz HN, Weingrad DN, Davey S. "Local tissue water in at-risk and contralateral forearms of women with and without breast cancer treatment-related lymphedema". Lymphat Res Biol 2009;7:153-158