Tissue Dielectric Constant (TDC) Values for use to Detect Water Content in Male Arms as a Baseline for Potential use in Early Detection of Lymphedema in Male Breast Cancer Assessed in Two Age Groups

Kelly Corbitt OMS II, Alexandra Grammenos OMS II, Simona Bartos OMS III, HN Mayrovitz PhD
Nova Southeastern University, Ft. Lauderdale FL 33328

Background and Objective

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 constants (TDC) 1-3. Although BC is rare in males it does occur (1/100,000 men) and there is no male reference TDC normative data from which lymphedema changes may be judged. Our goal was to provide TDC reference data for males and to investigate the role of body composition as a determinant of locally measured TDC values. We also utilized two distinct age groups (under 30 and over 50) to detect possible age-related differences in TDC values and to generate an age appropriate reference range for males.

Methods

To date, TDC was measured bilaterally on anterior forearms and biceps of 47 adult males, 30 under 30 years of age and 17 over 50 years. This procedure requires touching the skin with sensors of different sizes for about 10 seconds. Each measurement was done on the forearm 6 cm distal to the antecubital fossa (Fig 1) and on the biceps 8 cm proximal to the antecubital fossa (Fig 2). Each site was measured bilaterally in triplicate and averaged. Different probe sizes (Fig 3) allow measurements of TDC (and hence relative water content) to depths of 0.5, 1.5, 2.5 and 5.0 mm below the epidermis.

Body composition parameters of each subject was assessed by bioimpedance at 50 KHz with a scale (Fig 4). Arm girths were measured at all sites at which TDC was measured with a tape measure (Figs 5-6).

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.

Results

Young vs. old groups (mean ± SD) differed significantly (p<0.001) by age (25.2 ±2.3 vs. 70.0 ±10.3 years), total body fat % (16.7 ±5.7 vs. 25.6 ±6.7) and total body water % (59.0 ±4.7 vs. 53.1 ±2.4). TDC values measured at forearm and biceps monotonically decreased (p=0.001) in both young and older groups with increasing measurement depth. At the shallowest depth (0.5 mm) young TDC values at forearm and biceps (38.2 ±5.1 and 38.7 ±4.2) were significantly less (p<0.001) than for the older group with values of 44.7 ±5.8 and 43.5 ±5.3 respectively (Fig 7).

However, TDC values were not significantly different between groups at any other depth. TDC ratios (dominant arm/non-dominant) were not different between young and old at any depth. TDC values measured at all depths at each site for each group were directly correlated with total body water percentage and inversely correlated with total body fat percentage. The strongest correlations were between TDC values measured to a depth of 5 mm with correlation coefficients ranging from -0.771 to -0.759 for fat percentage and 0.768 to 0.719 for water (Fig 8).

Discussion and Conclusions

Despite large differences in age, skin tissue water assessed by TDC measurements values showed age-related differences only at the shallowest epidermal-to-target depth of 0.5 mm. TDC values indicate greater %water within this depth for the older group. This unexpected result may be due to more bound water in this region that is uniquely measurable at the employed 300 MHz frequency. Whatever the reason, the age dependent difference should be considered when comparing TDC values among patients of widely varying age.

Main outcomes

Figure 1. Forearm TDC measurement
Figure 2. Biceps TDC measurement
Figure 3. TDC Device
Figure 4. Bioimpedance Scale
Figure 5. Biceps Girth Measurement
Figure 6. Forearm girth measurement
Figure 7. Forearm TDC values: Young vs. Old * Significantly different than young, p< 0.001
Figure 8. Forearm TDC-TBW Relationship

References


Dr. Mayrovitz would be pleased to hear your questions or comments: mayrovitz@nova.edu