Temporal Patterns of Tissue Dielectric Constant (TDC) Values to Assess Local Skin-to-Fat Water Changes in Women Treated for Breast Cancer

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Objective. To assess the utility of sequential TDC measurements to characterize temporal changes in skin-to-fat tissue water as a potential way to detect lymphedema in its earliest stages.

Background. Non-invasive quantitative measurements for early detection of breast cancer (BC) treatment-related lymphedema (BCRL) are needed. Earliest BCRL changes may occur in skin and subcutis and might be detectible via local skin-tissue water changes assessed by TDC measurements at 300 MHz.

Methods. Bilateral TDC measurements were made in triplicate on volar forearms to effective depths of 0.5, 1.5, 2.5 and 5.0 mm below the epidermis in 80 women treated for unilateral BC. Also, whole arm water was assessed via bioimpedance. In addition, TDC measurements to a depth of 2.5 mm were made in forearms, biceps, axilla and lateral thorax. All 80 women were evaluated prior to their surgery (month 0) and followed for up to 24 months post-surgery with 35 evaluated at 3, 6, 12, 18 and 24 months post-surgery.

Results. Forearm TDC values monotonically decreased with increasing depth at all months. Presurgery at-risk (A) to control side (C) ratios (A/C) were (mean ± sd) 0.995±0.051 for arm volumes and 0.998±0.052 for bioimpedance. TDC ratios for forearm, biceps, axilla and lateral thorax were respectively 0.997±0.086, 0.991±0.118, 1.002±0.134 and 0.992±0.103. Forearm and thorax TDC ratios peaked at 6-months but only sustained through 24-months for thorax. Axilla TDC values had a minimum at 6-months that was sustained through 24-months. There was no significant change in whole arm A/C bioimpedance ratio at any month. At 24 months post-surgery, 23% of patients exceeded an A/C threshold ratio of 1.20 at thorax compared to 8.2% at forearm and 8.8% for the bioimpedance.

Conclusions. For TDC measurements, TDC side-to-side ratios at the lateral thorax emerge as the most likely and sensitive parameter for potentially detecting early BCRL.