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LETTER TO THE EDITOR

BIOELECTRICAL IMPEDANCE ANALYSIS REVISITED

We read with interest the article by Mikes et al published in Lymphology (1) titled "Bioelectrical impedance analysis revisited". The authors presented a valuable appraisal of bioelectrical impedance analysis (BIA) for the evaluation of lymphedema. They highlight the important and essential feature of the need for a reference value or range to enable valid comparisons (a feature of virtually all lymphedema measurement methodologies). The authors while acknowledging, correctly, that BIA is the only practical method (given cost and portability constraints) available to measure the amount of excess peripheral lymph they also note, again correctly, that the technique has been 'limited' to the assessment of unilateral lymphedema or the serial assessment of lymphedema in a given individual where the basis for comparison is the ratio of impedances between the unaffected and affected limbs. Certainly, in our studies to date, upon which Mikes et al. draw heavily, this has been the approach taken. However, the possibility exists for absolute quantification of extracellular fluid volume or edema from segmental BIA measurement. This approach has been used for estimating segmental fluid volumes in control subjects (2) and is deserving of attention by the lymphedema research community.

The authors also correctly state that changes due to lymphedema are not restricted to volume changes, but are also associated with changes in tissue type and structure. This aspect has been previously emphasized (3,4). Lymphedema is not simply an increase in extracellular fluid volume but also, as emphasized by Casley-Smith (4), *it is an increase in protein concentration accompanied by an alteration in tissues including the dermis and subcutaneous tissue layers.*

Bioelectrical impedance analysis has been predominantly used to monitor fluid volumes; and in this mode of operation it is unable to detect fibrous tissue deposition, as correctly cited by the authors. However the tissue and fibrotic changes associated with advanced lymphedema can be detected and indeed quantified using bioelectrical impedance measurements. An 'index' of changes to the dermal and subdermal tissues can be obtained from localized impedance measurements made using a combination of both the standard tetra-polar electrode arrangement as well as a bi-polar electrode arrangement. Using the basic electrical principles of each circuit the transverse electrical impedance of the dermal and subdermal tissues can be determined. We have previously shown that these transverse impedance measures are highly correlated with ultrasound measures of tissue changes associated with advanced lymphedema (5). It should be noted that this modified BIA measurement technique is only appropriate in cases of advanced lymphedema where tissue changes occur in conjunction with increased protein concentration and lymphocyte content in the "stagnant" extracellular fluids.

We thank Mikes et al for their timely critique of the impedance method and its application to the diagnosis and monitoring of lymphedema. It is our hope that this will stimulate yet further research in the area.

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