A New Technique for the Quantification of Peripheral Edema with Application in both Unilateral and Bilateral Cases.

Abstract:
Current non-invasive techniques for the routine and frequent quantification of peripheral lymphedema in patients are total limb volume measurement (by water immersion or by circumferential measurements) and bioelectrical impedance analysis (BIA). However both of these techniques require standardizing the measurement using a contra-lateral measurement from the unaffected limb. Hence these techniques are essentially restricted to unilateral lymphedema. This paper describes the results from a preliminary study to investigate an alternative approach to the analysis of the data from multiple frequency BIA to produce an index of lymphedema without the need for normalization to another body segment. Twenty patients receiving surgical treatment for breast cancer were monitored prior to surgery and again after diagnosis with unilateral lymphedema. The data recorded were total limb volume, by circumferential measurements; and BIA measurements of both limbs. From these measurements total limb volumes and extra-cellular fluid volumes were calculated and expressed as ratios of the affected limb to that of the unaffected limb. An index of the ratio of the extra-cellular fluid volume to the intracellular fluid volume was determined. This ECW/ICW index was calculated for both the affected and unaffected limbs at both measurement times. Results confirmed that the established techniques of total limb volume and extra-cellular fluid volume normalized to the unaffected contra-lateral limb were accurate in the detection of the lymphedema (p<10^{-6}). Comparison of the ECW/ICW index from the affected limb after diagnosis with that from the pre-surgery measurement revealed a significant (p< 10^{-6}) and considerable (75%) increase. The results of the pilot study suggest that by using multiple frequency bioelectrical impedance analysis, an index of the ECW/ICW ratio can be obtained and this index appears to have an equal or better sensitivity than the other techniques in detecting lymphedema. More importantly, this index does not require normalization to another body segment and can be used to detect all types of peripheral edema including both unilateral and bilateral lymphedema.