Ex-Vivo Dielectric Characterization of Normal, Benign, and Malignant Breast Tissue at Microwave Frequencies: Preliminary Results from a Multi-Institutional Study

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Several dielectric spectroscopy studies of breast tissue reported in the literature over the past 50 years suggest that the dielectric-properties contrast between malignant and normal breast tissue is greater than 2:1 in the microwave frequency range. Recognition of the potential diagnostic value of such a contrast has fueled a number of recent investigations of novel microwave breast cancer detection and treatment technologies. However, there is little or no dielectric-properties data above 3 GHz – a region of practical importance since shorter wavelengths offer higher spatial resolution. More importantly, the existing data does not cover all of the possible tissue types present in the heterogeneous normal, pre-cancerous, or cancerous breast. Furthermore, the different dielectric-properties data sets are not all in agreement. In fact, Hurt et al (*IEEE Trans. Biomed. Eng.*, 1:396-401, March 2000) recently pointed out that out of 18 human tissue types, the greatest uncertainty in dielectric properties at microwave frequencies currently exists for normal breast tissue. Consequently, a number of important questions remain.

To fill in the gaps in our understanding, the University of Wisconsin (UW) and the University of Calgary (UC) are conducting a comprehensive NIH-funded prospective study of the dielectric properties of malignant, benign, and normal breast tissue at microwave frequencies (up to 20 GHz). We are characterizing freshly excised tissue specimens from excisional biopsy, mastectomy, lumpectomy, and reduction mammoplasty surgeries at the UW Hospital and Clinics and the UC Tom Baker Cancer Centre. The dielectric properties of selected regions of each tissue specimen are measured using an open-ended coaxial probe technique with a special-purpose probe and Agilent vector network analyzer. Each measurement is carefully correlated with the histopathology of the region of the specimen "sensed" by the probe.

In this talk, we will present preliminary results from our multi-year study. These results begin to provide answers to questions of engineering importance for future microwave technology developments related to the detection, diagnosis, monitoring, and treatment of breast cancer.