JURA
Journal of Undergraduate Research in Alberta

UNIVERSITY OF CALGARY

DIFFERENTIATING BETWEEN HEALTHY AND MALIGNANT LYMPH NODES AT MICROWAVE FREQUENCIES

Alison Deighton[1], Elise Fear[1], Brie Banks[2], Tak Fung[3], Trevor Cameron[1], Audrey Kertesz[1], Travis Ogilvie[4], Daphne Mew[2]

[1]Schulich School of Engineering, University of Calgary, [2]Department of Surgery, University of Calgary, [3]Department of Mathematics and Statistics, University of Calgary, [4] Department of Pathology and Laboratory Medicine, University of Calgary

amdeighton93@gmail.com

INTRODUCTION

Patients diagnosed with early stage breast cancer must have their primary tumour removed and under go a Sentinel Lymph Node Biopsy (SLNB). The sentinel lymph node is removed and sent to a pathologist. This procedure determines further therapy and staging for the breast cancer. If the SLNB is positive then the breast cancer has developed the ability to metastasize. Uncertainty associated with the SLNB occurs because the incorrect lymph node was identified then removed, or the metastases might not be identified during the initial pathologic examination. This uncertainty motivates the development of a sensing or imaging method of lymph node analysis. Dielectric spectroscopy is a less invasive approach to initial assessment of a lymph node during a SLNB. Dielectric spectroscopy is a technique that measures the permittivity and conductivity of materials as a function of frequency. Research on the dielectric properties of healthy and malignant tissues has been reported [1]. This study will expand on the small amount of reported research on the properties of lymph nodes at microwave frequencies. The dielectric properties of malignant and healthy lymph node samples will be measured at microwave frequencies and analyzed.

METHODS

Surface and cross-sectional measurements were performed on freshly removed lymph nodes from patients at the Foothills Medical Centre in Calgary, Alberta, Canada. A precision open-ended coaxial probe, designed for the dielectric characterization of biological tissues [2], was used to collect measurements. There were different amounts of observations per patient. Surface measurements were collected for all samples, and cross sectional measurements were introduced after the tenth patient. The measurement site on the lymph node was marked with an ink dot. Pathology data regarding the tissue make up at the measurement location was collected. 59 measurements were collected from 27 patients. Six measurements were excluded from the final analysis. Once the raw complex coefficient data was processed into permittivity and conductivity, pathology data was used to color code and plot the measurements based on percent fat, and lymphoid content. Figure 1 shows permittivity versus frequency for three percent fat groups. Statistical analysis was completed using SPSS (v20, IBM, United States).

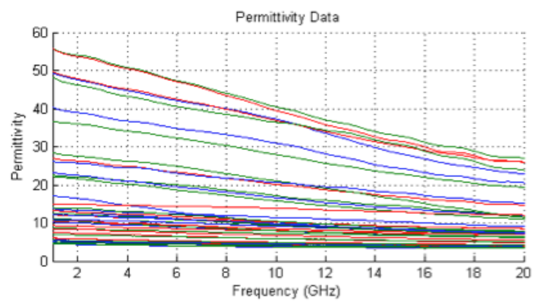

Figure 1. Permittivity versus frequency (GHz) for 45 healthy samples. Low fat samples (red = 0-15% fat), medium fat samples (green = 16-46% fat), and high fat samples (blue = 47-100% fat)

RESULTS

No evident trends were seen in the percent tissue plots, so statistical analysis using the generalized estimating equations (GEE) method was carried out to further analyze the data. Statistical analysis indicated that there was a difference between malignant and healthy nodes for the low fat and corresponding high lymphoid percent tissue groups. There was a significant difference in surface and cross-sectional measurements when measuring malignant nodes.

DISCUSSION AND CONCLUSIONS

The statistically significant difference between normal and malignant lymph nodes in low fat and high lymphoid tissue groups displays the potential for the proposed method of dielectric spectroscopy in lymph node analysis.

REFERENCES

1. C. Gabriel, et al. *Phys Med Biol.* **41** (11): 2231-2249.
2. D. Popovic, et al. *IEEE Trans Microw Theory Tech.* **53**: 1713-1721, 2005.