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Identification of Malignant Alterations in Human Breast Tissue Through Raman Spectroscopy – A Pilot Study

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Background, Motivation and Objective. This work aims the application of near-infrared Raman spectroscopy (dispersive, 830 nm) in the identification of biochemical changes related to pathological changes in human breast tissues obtained by core biopsy *in vitro*. The work includes the study of spectral differences in samples of benign and malignant breast lesions compared to normal breast tissues, identified by the imaging methods of mammography and ultrasound, in order to correlate the histological and immunohistochemical diagnosis with the spectroscopic findings and to validate the optical technique as a tool for detecting changes in these breast lesions, thus enabling the Raman technique for its use in the diagnosis of breast diseases in real time.

Methods. A fragment of a lesion identified by ultrasonically guided thick core needle biopsy was obtained and the fragment was subjected to freezing by exposure to dry ice, being transported to the Raman spectroscopy laboratory. At the time for spectroscopic evaluation, the tissue fragments were passively warmed up and submitted to Raman spectroscopy. The spectral analysis was based on the comparison of the spectral features of cancer and normal tissues, trying to find which peaks, related to proteins, lipids and nucleic acids, can be correlated to each tissue type. Also, a spectral model based on principal components analysis (PCA) was employed in order to discriminate cancer from normal breast tissue fragments.

Results and Discussion. The Raman features found in the mean spectrum of normal breast tissue (Figure 1) indicates that it is primarily composed of fat (spectral features of triolein) as normal breast tissue contains both glandular and adipose tissues. The Raman features found in the mean spectrum of infiltrating carcinoma tissue (Figure 1) show contribution from proteins (mainly collagen) due to fibroblast proliferation in response to stromal invasion by the malignant epithelial cells. Also, peaks referred to nucleic acids (from cell nucleus) are observed. An interesting spectral feature of carotenoids are also seen in this spectrum, which can be due to accumulation of carotenoids in abnormal tissues. Figure 2 (left) shows the discrimination of the cancer from normal tissue using the principal components scores PC1 and PC2. The PCA showed that the principal components loading vectors (Figure 2 right) are well differentiated in both tissues, corroborating the findings in the literature that altered and normal breast tissues have spectral signatures of the biochemicals of lipids, proteins, nucleic acids, among others.

Conclusions. Results demonstrated that Raman spectroscopy has the potential to be applied to accurately classify breast lesions compared to normal tissue, thereby contributing to the reduction in the number of excisional breast biopsies that are performed, and possibly to be applied as a different diagnostic tool in incisional biopsies and surgical procedures *in vivo*, in real time diagnosis.

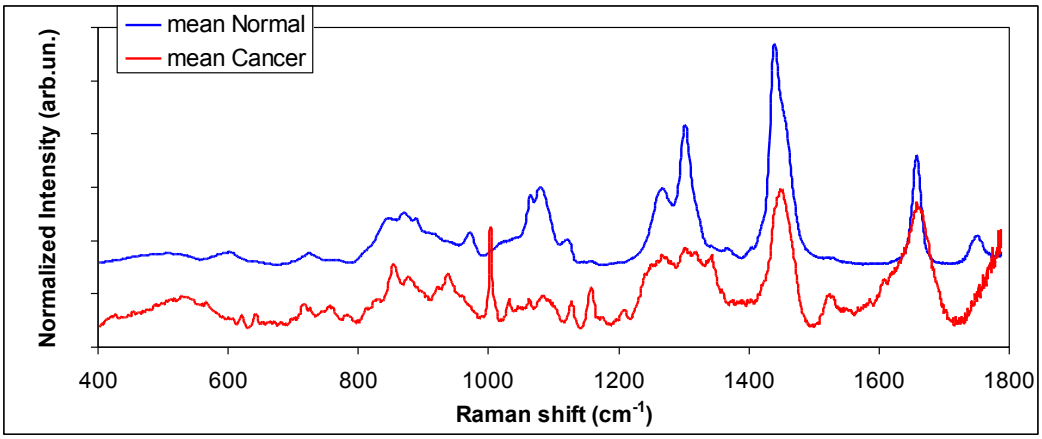

Figure 1 – Raman spectra of normal tissue and breast cancer, with the mains spectral features referred to proteins (cancer) and lipids (normal).

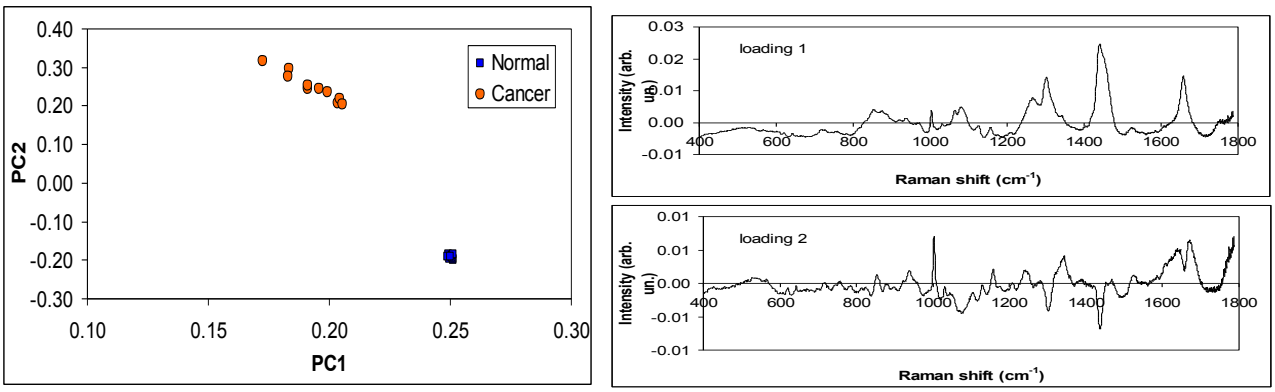

Figure 2 – Principal components scores (PC1 x PC2) and loading vectors (loading 1 and loading 2) extracted from the spectra of breast tissues.

Keywords: breast cancer; Raman spectroscopy; laser diagnosis.