Applications of LIBS and LIF Techniques in the Diagnosis of Breast and Colorectal Human Cancer (In Vitro Study)

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Abstract

Cancer diagnosis and classification is extremely complicated and, for the most part, relies on subjective interpretation of biopsy material. Conventional methods are laborious and in some cases may result in different contradicting results depending on the histopathologist performing the examination. In the present work we are presenting a detailed in vitro study for cancer diagnosis using two spectrochemical analytical techniques namely, laser induced breakdown spectroscopy (LIBS) and laser induced fluorescence (LIF). LIBS as a quick and simple method for spectrochemical analysis to identify and characterize some types of human malignancies via detection of the abundance of certain elements namely calcium and magnesium in such tissues with respect to the non - neoplastic ones. Because of the bad LIBS signal to noise ratio in case of fresh tissues, the measurements have been performed under vacuum (10-2 Torr) and the samples were frozen down to -196 oC in a specially designed vacuum chamber. Significant discriminating results have been obtained in case of breast and colorectal cancers indicating the possibility of adopting LIBS in the early detection of the malignancy as well as the identification of the severity and the grade of the disease. Among laser spectrochemical analytical techniques, fluorescence spectroscopy is an evolving technology that can rapidly differentiate between non - neoplastic and malignant tissues. These differences are thought to be due to endogenous fluorophores, including nicotinamide adenine dinucleotide, flavin adenine dinucleotide, tryptophan, and absorbers such as β- carotene and hemoglobin. This technique is a non-invasive diagnostic tool that can identify diseased tissue sites in vivo and in real time. In this way, it could have a major impact on the detection and treatment of cancer. The current study evaluates the utility of autofluorescence spectroscopy to distinguish tissue transformation associated with the malignant change in two types of human cancer, namely breast and colorectal cancer. Important information pertaining to fluorescent structure might be lost with the use of a single excitation wavelength, but might be obtained with other excitation wavelengths and thus enhancing the diagnostic capability of the obtained tissue spectra. For this reason, fluorescence spectra in the present work were obtained using a high-sensitivity fiber optic spectrometer and two types of excitation sources, an argon ion laser with an emission at wavelength 488 nm and a xenon lamp with nearly constant intensity in the range from 300-800 nm.The obtained results show a remarkable demarcation in case of breast and colorectal cancers indicating the feasibility of using LIF technique in the early detection of malignancy as well as the identification of the severity and the grade of the disease. This study presents reliable and highly sensitive spectroscopic techniques for in vitro measurements and demonstrated that future in vivo measurements are also feasible and reliable using especial endoscopic systems for delivery of laser beam and collection of the emitted plasma and fluorescent light. Another advantage of these techniques is providing new tools for better understanding the cancer biology.