Quantitative Optical Spectroscopy for Earlier Cancer Diagnosis.

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We are developing novel screening and detection modalities for *in situ* detection of pre-cancer. These devices are based on quantitative optical imaging and spectroscopy and use of low power light sources, fiber optics and semiconductor detectors to provide painless, non-invasive, instantaneous diagnosis. We seek to optimize these systems by understanding the interaction between light and tissue at the microscopic and biomolecular levels. Our efforts are focused on detection of curable precursors to epithelial cancer in cervix, ovary, and oral cavity. Earlier detection of an epithelial neoplasia followed by a simple surgical procedure can avoid development of invasive cancers.

We are exploring the potential of fluorescence spectroscopy, reflectance spectroscopy using polarized and unpolarized light, 3D real time fiber optic confocal imaging, and optical coherence tomography (OCT) for cancer detection. A method based on fluorescence emission spectra from cervical tissue *in vivo* has shown considerable promise for detection of cervical precancers. In clinical trials of over 200 women, spectroscopic diagnosis had equivalent sensitivity and superior specificity compared to highly trained gynecologists. Different combinations of these optical spectroscopic techniques should provide even better results and more information about morphology, architecture and biochemistry of tissues. We have built fiber optic systems to measure simultaneously tissue reflectance and fluorescence spectra over the UV-Vis-NIR spectral regions in near real time. Tissue reflectance spectra provide information about the wavelength dependent scattering of tissue (related to changes in chromatin texture) as well as electronic absorption bands, primarily those of oxy- and deoxy hemoglobin. Fluorescence spectra provide additional information about electronic transitions of the most common naturally occurring biological fluorophores: the aromatic amino acids, the co-factors NAD(P)H and FAD, which describe the tissue metabolic rate, crosslinks associated with collagen and elastin, and porphyrins. Use of polarized light can significantly reduce diffuse scattering from tissues thus allowing analysis of fine structure in reflectance spectra of epithelial cells. Information similar to a histological analysis can potentially be obtained in real time avoiding painless and costly biopsies.

In summary, fiber based optical imaging and spectroscopic techniques have great potential for non-invasive specific and selective diagnosis of epithelial precancers. Optical methods can give clinicians instantaneous access to the structural and functional changes and specific molecular alterations in a diseased tissue.