Purpose: to demonstrate the effectiveness of a non-invasive multimodal sono-contrast spectroscopy system in breast cancer diagnosis.

Methods: This multimodal spectroscopy system combines three modules: diffuse reflectance spectroscopy (DRS), ultrasonography and low intensity focused ultrasound (LIFU). This multimodal system reports the optical functional difference in breast cancer and in normal tissue/benign lesion after transient LIFU stimulation of the vascular network. An IRB-approved clinical study has been carried out to evaluate its diagnostic power. Currently 33 patients were enrolled with informed consent, grouped into histologically-proven cancer, benign mass, and breast tissue, respectively. The ratio of intensities at wavelengths 685nm and 830nm was decomposed into low frequency and high frequency components using wavelet technique.

Results: Comparison of the high-frequency component showed that LIFU stimulated transitory fluctuation in non-cancer tissue, but not in malignant tissue, as quantified in terms of the variance. The ratios of the variance during LIFU vs. baseline in cancer, benign and breast tissue are [mean (max/min/std)] 1.18 (2.04/0.60/0.45), 2.22 (2.74/1.51/0.54) and 3.21 (6.64/1.20/1.27), respectively. This suggests that the high-frequency fluctuation was amplified in non-cancer tissue during LIFU stimulation. Statistical analysis also reveals that these ratios of variance induced by LIFU are significantly different in cancer vs. non-cancer ($p=0.0007$), and cancer vs. benign tissue ($p=0.006$). So far it has not suggested significant difference in benign vs. breast tissue ($p=0.06$).

Conclusions: Current clinical results demonstrate the potential of the multimodal system in characterizing cancer vs. non-cancer tissues. LIFU appears to exert more pronounced influence on blood flow in non-cancer tissue than in breast cancer. This lack of response to LIFU in breast cancer is possibly due to its abnormal blood vasculature. The clinical study is ongoing to further assessing correlating factors, such as histological tissue types, hormone status (age), breast density, and to define the sensitivity and specificity of this promising technique.

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