In Vivo Quantitative Ultrasound Imaging and Scatter Assessments

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Instrument independent measurements of ultrasound scattering and attenuation provide useful diagnostic information not available with conventional ultrasound imaging. This dissertation is a continuing effort to test the above hypothesis and to incorporate quantitative ultrasound methods into clinical examinations for early detection of diffuse liver disease. A method for producing quantitative backscatter images was developed and verified in phantoms. The method involves digitized rf echo signals from a clinical scanner and depth-dependent ratios of echo data from tissue to echo data from a reference phantom to eliminate instrumentation dependencies and compute attenuation coefficients in the tissue. Quantitative backscatter images are constructed by compensating echo data for the computed tissue attenuation. A new technique was developed to compensate for additional attenuation losses through the overlying layers. The method was applied to thirty five healthy subjects and 16 patients with diffuse liver disease. Both the attenuation coefficient and the backscatter coefficient exhibited strong discriminating power ($p<0.001$) for differentiating healthy from fatty livers. Statistically significant differences in the backscatter coefficient ($p<0.01$) were observed between normal and cirrhotic livers but not in the attenuation coefficient. An in vivo animal model of steroid hepatopathy was used to investigate the system sensitivity in detecting early changes in canine liver resulting from corticosteroid administration. The average attenuation coefficient slope increased from 0.7 dB/cm/MHz in controls to 0.82 dB/cm/MHz (at 6 MHz) in treated animals on day 14 into the treatment, and the backscatter coefficient was 2.6E-3/cm-Sr in controls compared with 7.4E-3/cm-Sr (at 6 MHz) in treated animals. A simplified quantitative approach using video image signals was developed and provided equally sensitive results to the changes in the liver in this animal model.