In Vivo Frequency Dependent Backscatter Estimations In Liver

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The work presented in this thesis is a continuation of our research to develop and evaluate quantitative backscatter parameters for diagnosing diffuse and focal liver disease. Emphasis was placed on developing echo data acquisition hardware and software to digitize signals from clinical ultrasound scanners. A reference phantom method was employed to measure backscatter and attenuation coefficients of test samples. The method compares echo signals from a well calibrated tissue-mimicking phantom to those acquired from a test sample.

Bulk acoustic properties were studied in four animal models of diffuse liver disease to determine the usefulness of ultrasound in the early detection of these abnormal states. The changes observed in the backscatter and attenuation coefficients for these animal models were in good agreement with trends observed in human conditions of these diseases. Initial investigations into an animal model of focal disease in liver was also investigated, and variation in the dependence of scattering from the tumor from that of normal liver was observed.

A reference phantom method for the determination of the effective number of scatterers versus frequency was also developed in this work. Phantoms with sparse scatterer concentrations were used to verify the validity of this method. In addition to backscatter and attenuation results, effective scatterer number density estimates, Neff, in the models of diffuse liver disease in animals were obtained. The results showed Neff can be used as a parameter to quantify a difference between diffusely diseased liver from that of normal liver in these models.

Finally, initial research into the attenuation properties of ultrasound contrast agents is presented. A significant dependence on pressure amplitude in these agents was noted in the laboratory measurements, and initial clinical trials were based upon these results. A measurable change over time in the attenuation coefficient of three dogs livers was measured post administration of ultrasound contrast agent. The clinical results along with the significant pressure dependence of the agent on incident pressure amplitude of the ultrasound waves suggests the future possibility of measuring perfusion using ultrasound.