

QUANTITATIVE CHARACTERIZATION OF THE ULTRASONIC SCATTERING NATURE OF TISSUE AND TISSUE-MIMICKING MATERIALS

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In the medical community there exists a need for fast, non invasive quantitative diagnostic procedures to evaluate in vivo the state of soft tissues. Ultrasound, with its ability to probe the internal structure of soft tissue, promises to be such a modality. However, a great deal of research is needed in the area of characterizing the acoustic properties of soft tissues before diagnostic ultrasound techniques can reach their full potential.

This thesis addresses the topic of characterizing the ultrasonic scattering properties of soft tissues. An experimental apparatus has been assembled and data-reduction techniques developed that provide capabilities for achieving the following four goals: (1) To characterize the intrinsic scattering nature of small volumes of tissue and tissue-mimicking (TM) materials by measuring the Differential Scattering Cross Sections per unit Volume (DSCV) as a function of ultrasonic frequency and scattering angle. (2) To describe theoretically the observed scattering characteristics from these target materials in terms of "small" and "intermediate" sized particle scatter theory. (Small and intermediate sized refers to the relative dimensions of the scatterers compared to the wavelength of the interrogating beam.) (3) To utilize the results from studying TM materials to gain insight into the scattering characteristics of soft tissues. (4) To improve current TM materials to more fully mimic tissue in terms of all relevant acoustic parameters.

The apparatus employed long source-to-target and target-to-receiver distances to produce a geometry that helped minimize the influence of the measurement procedure on the experimental results while producing a situation favorable to computer modelling. The apparatus and data reduction technique were tested (experimentally and theoretically) under a variety of controlled conditions to insure correct operation.

Preliminary studies were performed on excised samples of bovine liver tissue, bovine heart tissue and human breast tissues in order to characterize their scattering nature and develop tissue handling techniques to minimize the effect of in vitro measurements.